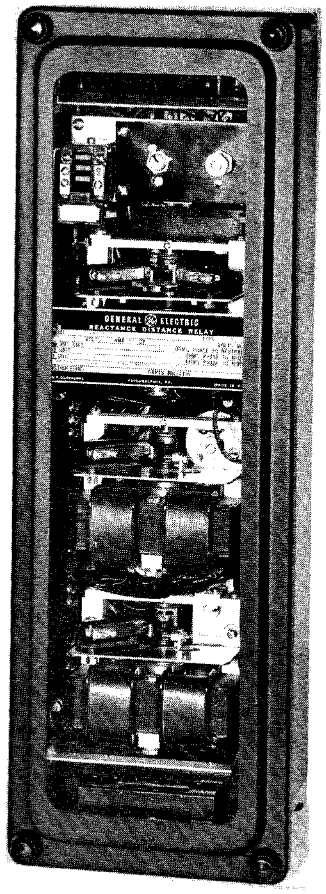
INSTRUCTIONS

GEI-90812A
SUPERSEDES GEI-90812

REACTANCE DISTANCE RELAY



Type GCXY11A

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

NOTES

REACTANCE DISTANCE RELAY
TYPE GCXY11A

INTRODUCTION

The GCXY11A relay is a single phase, three zone, step distance relay for phase fault protection on transmission and sub-transmission lines. It is comprised of a first zone reactance unit, a second zone directional mho unit, a third zone offset mho unit, an auxiliary unit(S) and a target seal-in unit all in one L2 case. Three GCXY11A relays plus one suitable RPM11D timing relay are required per terminal to provide three zone, step distance protection for all multi-phase faults.

APPLICATION

The GCXY11A relays may be applied as illustrated in the elementary diagram of Fig. 1 for three step distance protection of transmission and sub-transmission lines. In such applications the third zone OM3 unit may be connected to look in the same direction as zones 1 and 2 to obtain three forward looking zones or it may be connected to look in the reverse direction to provide a reversed third zone. In either case this unit may be set with either 1 ohm or zero offset. When the relays are connected for three forward looking zones, three GCXY11A plus one RPM11D make up a complete terminal for protection against all multi-phase faults. If the relays are connected for reversed third zone operation, one rectifier assembly is required in addition to the relays to complete the terminal. This is illustrated in the elementary diagram of Fig. 1.

The GCXY11A relays are also applicable for multi-phase fault protection in directional comparison and line transferred tripping schemes. Instruction Book GEI-83950 provides information on the application of the GCXY11A relay in directional comparison carrier schemes. Information on transferred tripping schemes may be obtained from the local district office.

Regardless of the protective scheme, the GCXY11A relay will perform best if the minimum three phase fault current on the remote bus produces at least 6 amperes in the relay with the 0.5-5.0 ohm reactance unit. For the relay with the 0.25-2.5 ohm reactance unit, this minimum current is 8 amperes.

When applying this relay for the protection of a given circuit, regardless of the scheme of protection, it is generally advantageous to select the relay having the highest first zone ohmic range that can accommodate the desired setting. This is to provide units which operate at a higher torque level than would units with the lower range. However, before selecting a range, all settings should be calculated.

The curves of Figs. 2 through 5 indicate the operating time of the relay for a first zone fault as a function of fault location and the fault current. The data in Table A gives the minimum fault current that is required to insure positive first zone tripping on zero voltage faults with normal voltage before the fault.

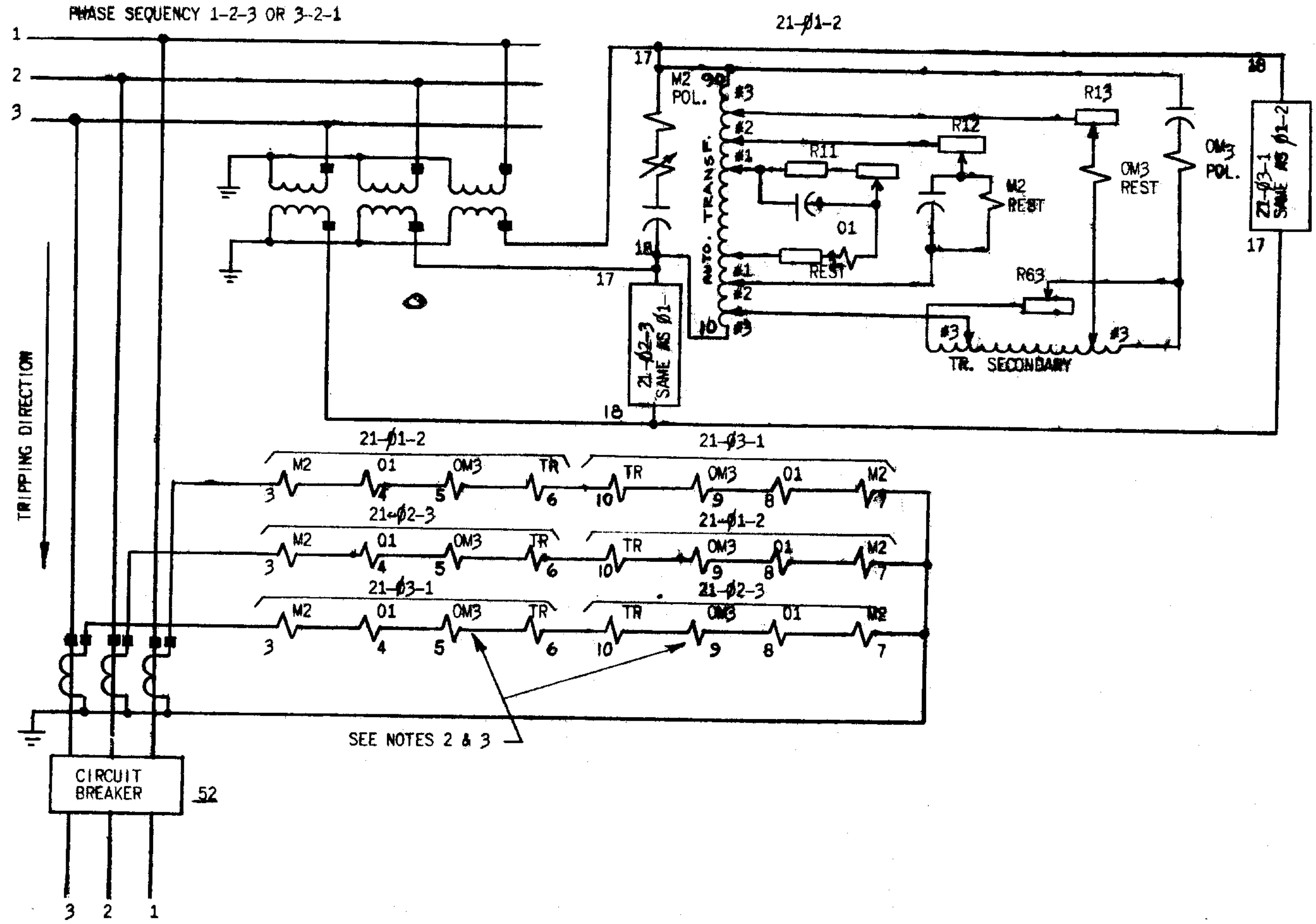
TABLE A

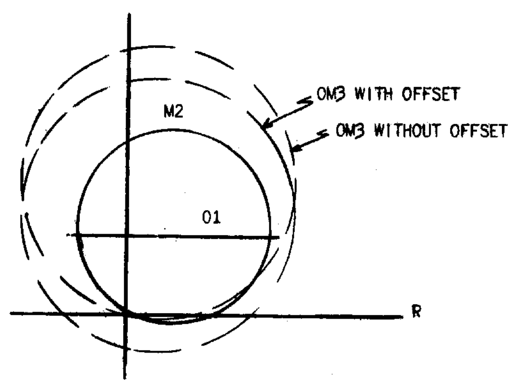
RELAY	MIN. RELAY REACH	MIN. FAULT CUR. TO TRIP
GCXY11A	0.25 OHMS	8 AMPS
GCXY11A	0.50 OHMS	6 AMPS

The solid curves of Figs. 6 and 7 illustrate the steady state current required to operate the M2 unit for second zone time delay tripping as a function of the impedance to the fault. It should be noted that the M2 unit can operate to close its contacts only momentarily on memory action for zero voltage faults. This will be adequate to provide first zone tripping in conjunction with the 01 unit for fault currents in excess of those values given in Table A. For second zone faults, the M2 unit is required to remain closed to provide time delay tripping for faults that are located on the line just inside the end of the first zone reach to some distance beyond the remotest line terminal. In this area, there can be no zero voltage faults from the relays point of view. The dash curves of this same Fig. 6 indicate the minimum current required to operate the M2 unit on a transient basis with memory action. This curve is used to determine the sensitivity of the M2 unit in directional comparison and transferred tripping schemes where this unit provides a high speed trip circuit in conjunction with the pilot channel. For these types of applications it is only necessary for the M2 unit to close momentarily on zero voltage faults to affect a trip.

The OM3 unit which has a 3-30 ohm range is capable of being set with either zero or 1.0 ohm offset. When this unit is used in a protective scheme, such as directional comparison, where it is essential that it pick up and stay picked up

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.



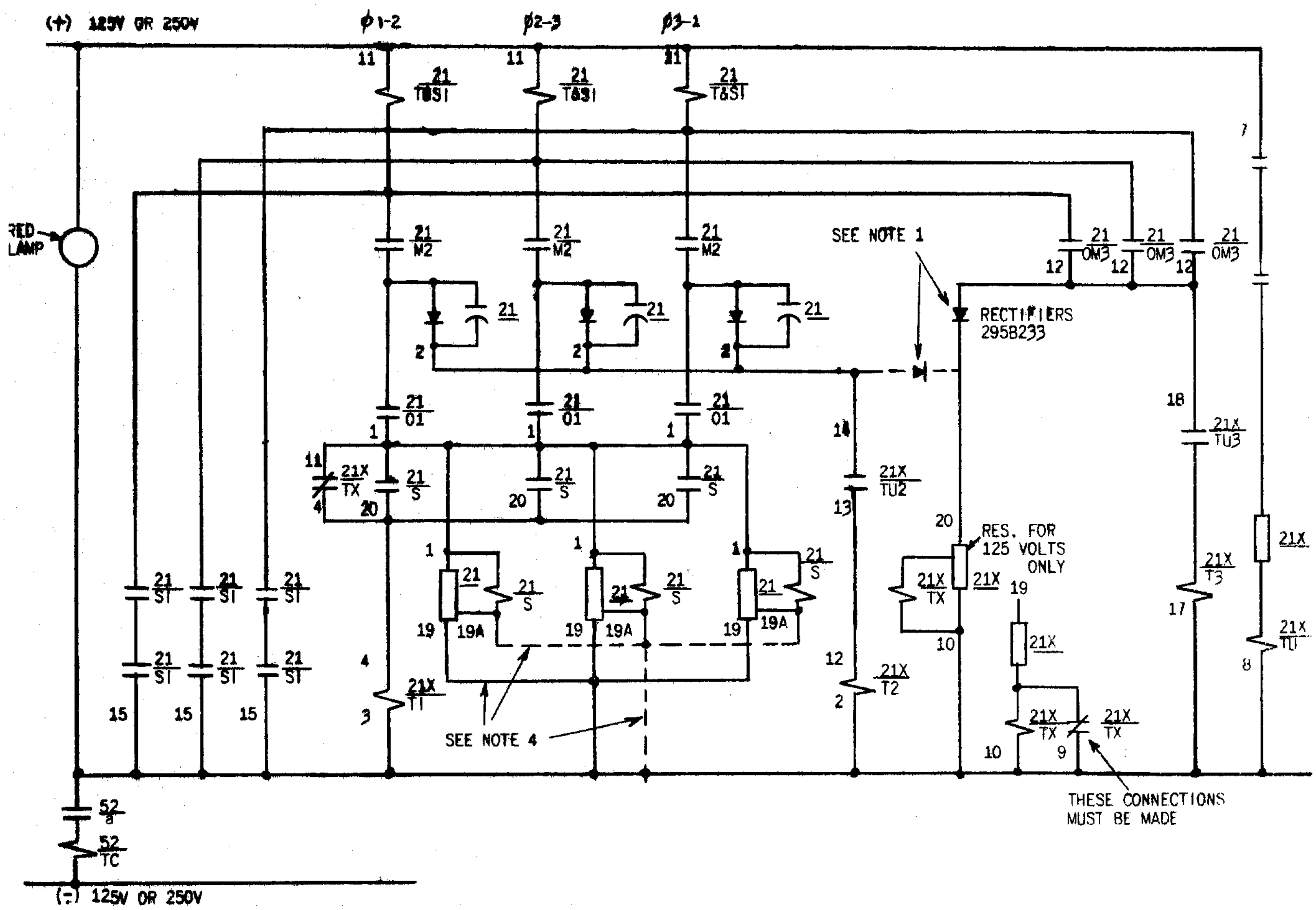


TABULATION OF DEVICES			
TYPE		INT. CONNS.	OUTLINE
GCXY11A		0165A6060	K-6209276
RPM11D	250V	K-6209282	K-6209272
RPM11D	125V	K-6209282	K-6209272
2958233 G15	250V		418A984
2958233 G14	125V		418A984

SEE NOTE 1

LEGEND			
DEVICE NO.	DEVICE TYPE	INCL. ELEM.	DESCRIPTION
21	GCXY11A		STEP DISTANCE RELAY
		01	FIRST ZONE REACTANCE UNIT
		M2	SECOND ZONE MHO UNIT
		OM3	THIRD ZONE OFFSET MHO UNIT
		S	COORDINATING AUXILIARY UNIT
		T&SI	TARGET & SEAL-IN
21X	RPM11D		TIMING RELAY
		T1,2&3	ZONE 1,2,&3 TARGETS
		TU	TIMING UNIT
		TX	AUXILIARY TO TIMING UNIT

Fig. 1 (7381B62-2) Elementary Diagram for 3 Step Distance Protection Using GCXY11A and RPM11D Relays



NOTES:

(1)-IF THE OM3 UNIT IS REVERSED THEN MAKE DASH CONNECTIONS & USE DOUBLE RECTIFIER ASSEMBLY. IF THE OM3 UNIT LOOKS FORWARD MAKE SOLID CONNECTIONS & DO NOT USE THE RECTIFIER ASSEMBLY

21X/TX (2)-IF THE OM3 UNIT IS REVERSED, INTERCHANGE CONNECTIONS BETWEEN STUDS 5 & 6 AND INTERCHANGE CONNECTIONS BETWEEN STUDS 9 & 10. IF THE OM3 UNIT LOOKS FORWARD USE CONNECTIONS AS SHOWN.

21X/TX (3)-IF OFFSET IS DESIRED ON OM3, USE TR AS SHOWN. IF OFFSET IS NOT DESIRED REMOVE TR FROM CIRCUIT ON STUDS 5 AND 9 IN THE RELAY AS INDICATED ON THE INTERNAL CONNECTION DIAGRAM.

(4)-USE STUD 19A FOR 125 VOLTS & USE STUD 19 FOR 250 VOLTS

Fig. 1 (Continued) Elementary Diagram for 3 Step Distance Protection Using GCXY11A and RPM11D Relays

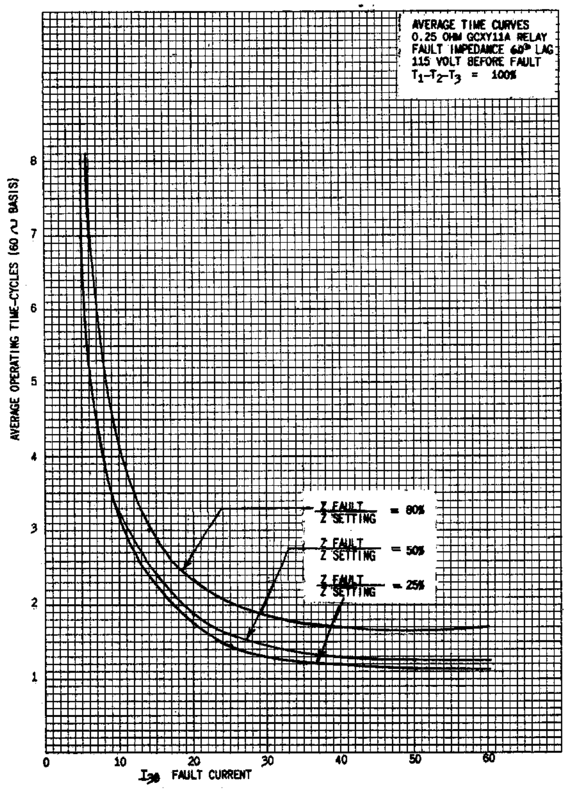


Fig. 2 (0165A9334-0) Average Time Curves of the 0.25 Ohm GCXY11A Relay When Voltage Before the Fault is 115 Volts

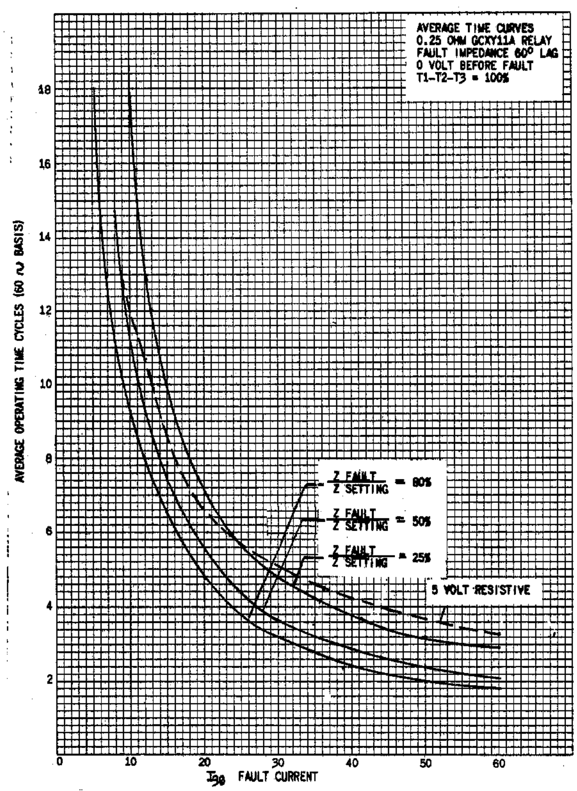


Fig. 3 (0165A9335-0) Average Time Curves of the 0.25 Ohm GCXY11A Relay When Voltage Before the Fault is Zero Volts

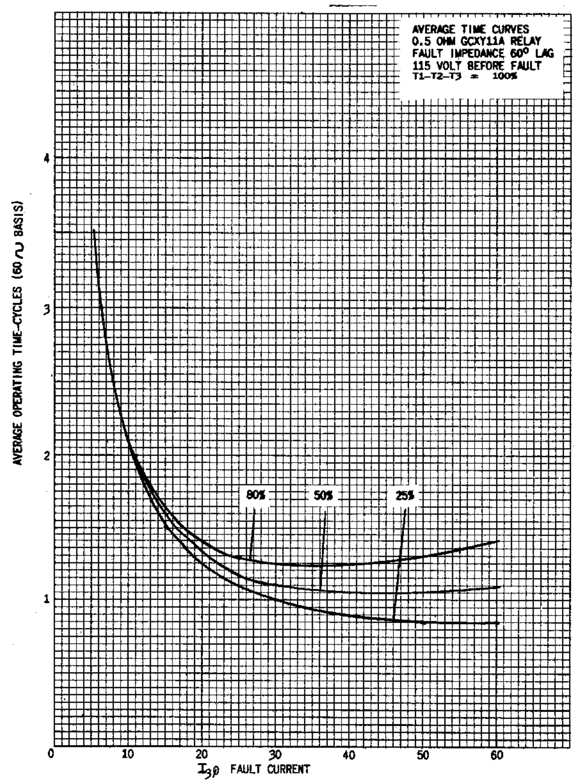


Fig. 4 (0165A9336-0) Average Time Curves of the 0.5 Ohm GCXY11A Relay When Voltage Before the Fault is 115 Volts

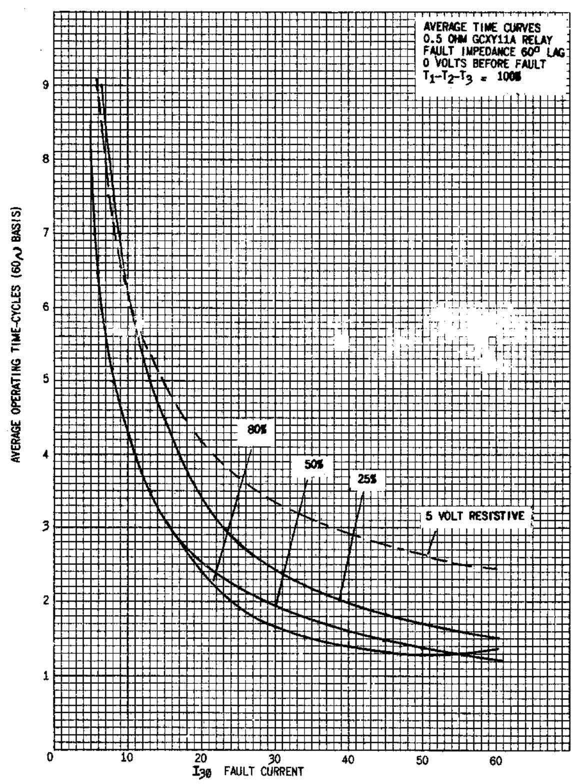


Fig. 5 (0165A9337-0) Average Time Curves of the 0.5 Ohm GCXY11A Relay When Voltage Before the Fault is Zero Volts

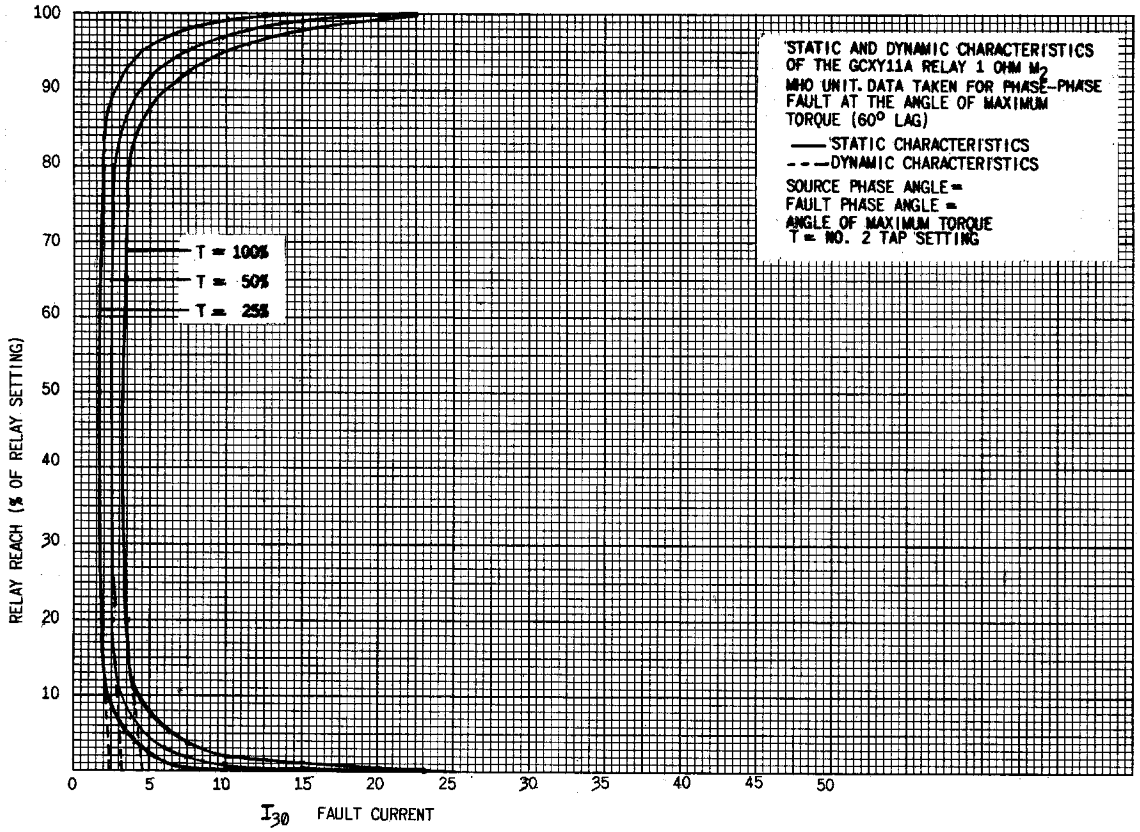


Fig. 6 (0165A9338-0) Static and Dynamic Reach Data for the 1-Ohm M2 Mho Unit of Relay Type GCXY11A

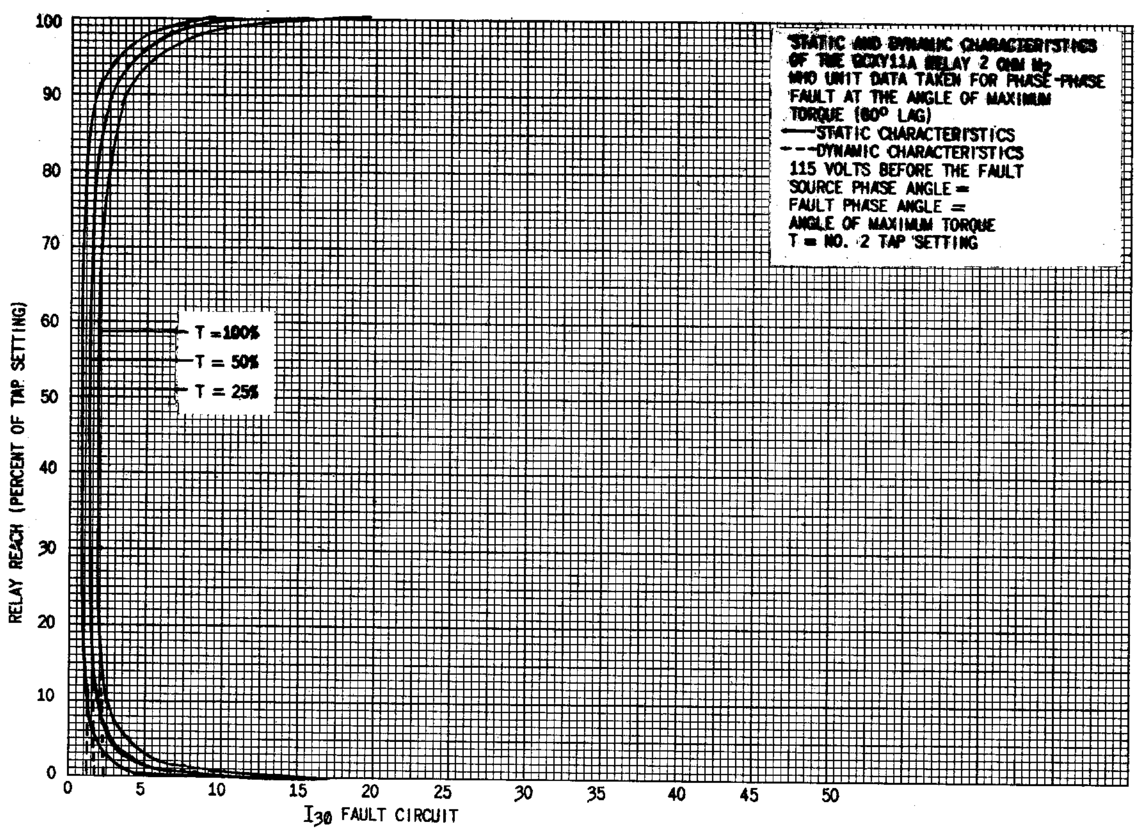


Fig. 7 (0165A9339-0) Static and Dynamic Reach Data for the 2-Ohm M2 Mho Unit of Relay Type GCXY11A for a prolonged period on zero voltage faults, it must be set with the 1.0 ohm offset. With such a setting this unit provides positive operation on zero voltage faults for currents in excess of 3 amperes.

The curves of Fig. 8 give the maximum transient overreach characteristics of the first zone reactance unit. This curve should be consulted to establish what percentage of the line it is safe to protect on first zone. For information on settings see the section on CALCULATION OF SETTINGS which includes a worked example.

RATING

The GCXY11A relay has a rating of 115 volts, 5 amperes, 60 cycles and either 125 or 250 volts DC. The reach of the units in phase to neutral ohms is given in Table B.

TABLE B

RELAY	01 OHM UNIT	M2-60°*	OM 3 75° *	OM 3 OFFSET
GCXY11A	0.25-2.5	1-10	3-30	0/1
GCXY11A	0.5 -5.0	2-20	3-30	0/1

* Angle of maximum torque of the unit

The contacts of the GCXY relay will close and carry momentarily 30 amperes at 250 volts DC for tripping duty. However, the breaker trip circuit must be opened by a breaker auxiliary switch or other suitable means.

The target seal-in unit has ratings as indicated in Table C.

TABLE C

TARGET SEAL-IN UNIT

	2 AMP TAP	0.6 AMP TAP
D. C. Resistance	0.13 Ohms	0.6 Ohms
Min. Operating	2.0 Amps	0.6 Ohms
Carry Continuously	3.0 Amps	0.9 Amps
Carry 30 Amps For	4.0 Sec.	0.5 Sec.

CHARACTERISTICS

OPERATING PRINCIPLES

OM3 Mho Unit

The OM3 unit when used without offset has a circular impedance characteristic which passes thru the origin as shown on Fig. 11. This unit is a four pole induction cup relay with schematic connections as shown in Fig. 10. The two side poles are energized with line to line voltage (E_{1-2} for phase 1-2) to produce the polarizing flux. The back pole is energized by a percentage of this same voltage and it produces a flux which reacts with the polarizing flux to provide restraining torque which holds the contact open. The front pole is energized with difference of the currents in the two lines involved (I_1-I_2 for phase 1-2) which is called the delta current. The flux from the front pole interacts with the polarizing flux to produce the operating torque. The basic equation for OM3 unit is:-

$$Z_R = Z_{min} \left(\frac{100}{T}\right) \cos(\theta - 75^\circ)$$

Where:

Z_R = relay reach in ohms

Z_{min} = minimum relay setting

T = No. 3 relay tap setting in percent

θ = angle of fault impedance

75° = unit angle of maximum torque

When the relay characteristic is offset, the center of the unit characteristic circle remains on the 75° line but moves one ohm nearer the origin as shown in Fig. 11. To offset the characteristic the transactor secondary voltage is added to the polarizing voltage and also part of it is added to the restraint voltage. The basic relay equation at the angle of the relay maximum torque then becomes:

$$Z_R = Z_{min} \left(\frac{100}{T}\right) - Z_{TR} \left(\frac{TR}{T}\right)$$

Where:

Z_R = relay reach in ohms

Z_{min} = minimum relay setting

Z_{TR} = transactor impedance (offset ohms)

TR = transactor tap setting in percent

The OM3 unit reach can be set as desired by changing the No. 3 relay taps (and if used the transactor taps) in accordance with above equations. Since Z_{TR} is set at one ohm, if the OM3 unit is set at its minimum reach (T equals 100) then

$$Z_R = 3 \left(\frac{100}{100}\right) - 1 = 2 \text{ ohms at } 75^\circ$$

M2 Mho Unit

The M2 unit is also a 4 pole induction cylinder unit similar in construction and operation to the OM3 unit except that it has no transactor to offset its characteristic and the angle of maximum torque is 60 degrees. The M2 minimum characteristic is shown in Fig. 1. This characteristic can be expanded by changing the autotransformer No. 2 taps to reduce the restraint voltage in accordance with the following formula.

$$\text{Ohmic Reach} = \frac{Z_{min} \cos(\theta - \phi)\ 100}{\text{No. 2 Tap Setting (\%)}}$$

Where:

θ = angle of maximum torque of the relay

ϕ = angle of the line impedance

Z_{min} = relay minimum impedance setting

Thus we can obtain a family of characteristics each of which passes thru the origin and has its center on the 60 degree line.

The M2 unit provides directional supervision for the first zone tripping, fault detection for second zone tripping and if the OM3 unit is reversed it also starts the RPM timer. The second zone tripping occurs after the RPM timer has measured an adjustable time delay and closed its T2 contact. See Fig. 1 for illustration of connections.

Ohm Unit

The ohm unit is also a four pole induction cylinder unit but it responds to line reactance rather than impedance. It is used to provide tripping for first zone faults. It is especially suitable for protection of short transmission lines since it is not affected by the arc resistance which may be an appreciable part of the fault impedance on a short line. Fig. 12 shows the schematic connections for the ohm unit.

In this unit both the operating coil and the polarizing coils are energized by the delta current and produce the operating torque. The restraining coil is energized by the phase to phase voltage and it reacts with the polarizing flux to provide the restraining torque.

The torque equation at pick up is:

$$KI^2 = \frac{I\ ET\ \cos(\theta - \phi)}{100}$$

Where:

- E = phase to phase voltage (E_{1-2})
- ϕ = impedance angle of the line
- I = the delta current ($I_1 - I_2$)
- $\theta = 90^\circ$ = angle of maximum torque of the unit
- K = design constant
- $Z = \frac{E}{I}$ (fault impedance)
- T = relay No. 1 tap setting in percent

Dividing thru by I^2 and transposing reduces the equation to

$$Z \cos(90 - \phi) = \frac{K100}{T} \quad \text{or}$$

$$Z \sin \phi = \frac{K100}{T}$$

and we see this unit will operate when the fault reactance is equal to or less than $\frac{100K}{T}$ where K will be minimum relay reactance setting.

$$X_R = \frac{X_{min}\ (100)}{T}$$

Where X_R is the relay reach in ohms

BURDENS

CURRENT CIRCUITS

The maximum current burden imposed on each CT by a practical setting on a three-phase terminal of three GCXY relays at 5 amps and rated frequency.

TABLE D-1

TOTAL CURRENT BURDEN PER PHASE

GCXY RELAY WITH: 0.25 OHM 01 UNIT-1 OHM M2 UNIT 3 OHMS OM3 UNIT				
	Freq.	Watts	Vars	Volt-Amperes
With Offset	60	11.9	13.85	18.25
Without Offset	60	5.25	7.5	9.3

GCXY RELAY WITH: 0.5 OHM 01 UNIT-1 OHM M2 UNIT 3 OHMS OM3 UNIT				
	Freq.	Watts	Vars	Volt-Amperes
With Offset	60	9.55	11.3	14.75
Without Offset	60	3.15	5.25	6.2

The above burden was measured under phase-to-phase fault conditions which yield higher burden readings than balanced three-phase conditions.

POTENTIAL CIRCUITS

The potential burdens will vary with the tap settings used for the ohm and mho unit potential coils, therefore, potential burdens should be calculated from the following formulae. All burdens are at 115 volts.

Ohm Unit:

$$VA = (a+jb)\ (\text{No. 1 Tap}/100)^2$$

where a+jb is given in Table D-2. No. 1 tap is the first zone setting in percent.

TABLE D-2

POTENTIAL BURDEN CONSTANTS	
01 Restraint a+jb	23+j0
M2 Restraint c+jd	5.12+j 2.24
M2 Polarizing e+jf	8.11+j 2.04
OM3 Restraint g+jh	5.23-j 9.88
OM2 Polarizing k+jl	8.42+j0

M2 Unit:

$$VA = (c+jd)\ (\text{No. 2 Tap}/100)^2 + (e+jf)$$

where (c+jd) and (e+jf) are given in Table D-2. No. 2 tap is the second zone setting in percent.

OM3 Unit - Without Offset

$$VA = (g+jh)\ (\text{No. 3 Tap}/100) + (k+j1)$$

where (g+jh) and (k+j1) are given in Table D-2. No. 3 tap is the third zone setting in percent. The terms (c+jd) and (g+jh) represents the burden of the mho unit restraint coil circuits while the terms (e+jf) and (h+j1) represent the burden of the mho unit polarizing coil circuits.

OM3 Unit with Offset

$$VA_{MAX} = (VA_{MAX} \text{ of OM3 Without Offset})(1.17)$$

The maximum potential burdens will exist when all taps are in 100 percent setting. At 115 volts the maximum potential burdens are given in Table D-3.

CALCULATION OF SETTINGS

The Table "E" illustrates qualitatively how to set the three zones when the relays are applied in straight distance schemes. For directional comparison carrier applications, see GEI-83950.

Assume that it is desired to use GCXY11A relays to protect the two terminal, 5 mile, 69 KV transmission circuit shown in Fig. 17.

CT Ratio - 600/5

PT Ratio - 69,000/115

$$Z_{sec} = Z_{prim} \frac{\text{CT Ratio}}{\text{PT Ratio}}$$

$$Z_{sec} = 5\ (0.14 + j\ 0.80)\ \frac{120}{600} = 0.14 + j\ 0.80 \text{ ohms}$$

$$Z_{sec} = 0.813 \ \angle 80^{\circ}$$

Select the relay having a first zone range of 0.5 - 5.0 reactive ohms.

From a system fault study, determine the minimum secondary fault current at breaker #1 for a three phase fault at bus B. Now determine the minimum secondary fault current at breaker #2 for a three phase fault at bus A. Both these values should exceed 6 amperes for the relay selected above.

The percent tap setting for the first zone reactance unit is obtained from the following equation:

$$T = \frac{(X_{min})}{X_L} \times 100$$

Where:

T = #1 tap setting in percent

X_{min} = Minimum ohms of reactance unit

X_L = Desired reactance reach in secondary phase to neutral ohms

If we assume that it is desired to set the first zone for 90 percent of the distance to the remote terminal, then:

$$X_L = 0.9\ (0.80) = 0.72$$

For this relay:

$$X_{min} = 0.50$$

Thus:

$$T = \frac{0.50}{0.72} \times 100 = 69.4 \text{ percent}$$

From the curves of Fig. 8, the transient overreach of the ohm unit on an 80 degree line and with a tap setting near 70 percent will be about 5 percent. If it is felt that the line reactance is known accurately to within 5 percent of the 0.80 ohms given

TABLE D-3

MAXIMUM POTENTIAL BURDENS						
	FREQ.	VOLTS	IMPEDANCE	P. F.	WATTS	VA
01 Restraint	60	115	575+j0	1.0	23	23
M2 Restraint	60	115	2180-j955	.92	5.1	5.6
M2 Polarizing	60	115	1530-j384	.97	8.1	8.4
OM3 Restraint	60	115	553+j1045	.45	5.2	11.2
OM3 Polarizing	60	115	1575+j0	1.0	8.4	8.42
Total Relay	60	115	260+j0	1.0	51	51

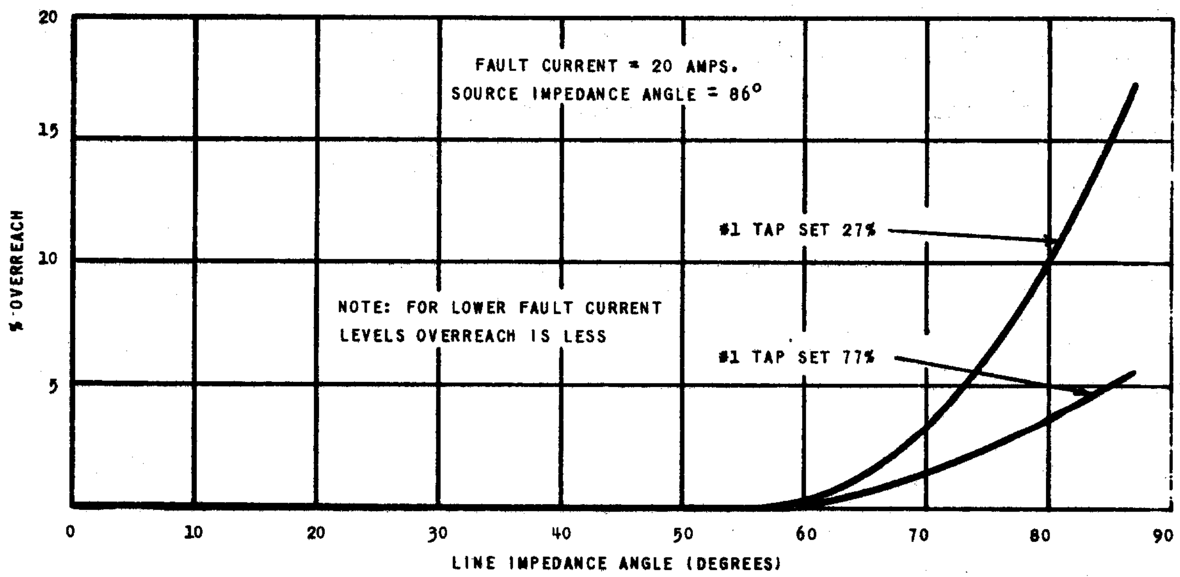


Fig. 8 (362A622-1) Transient Overreach Characteristic for Ohm Unit Alone

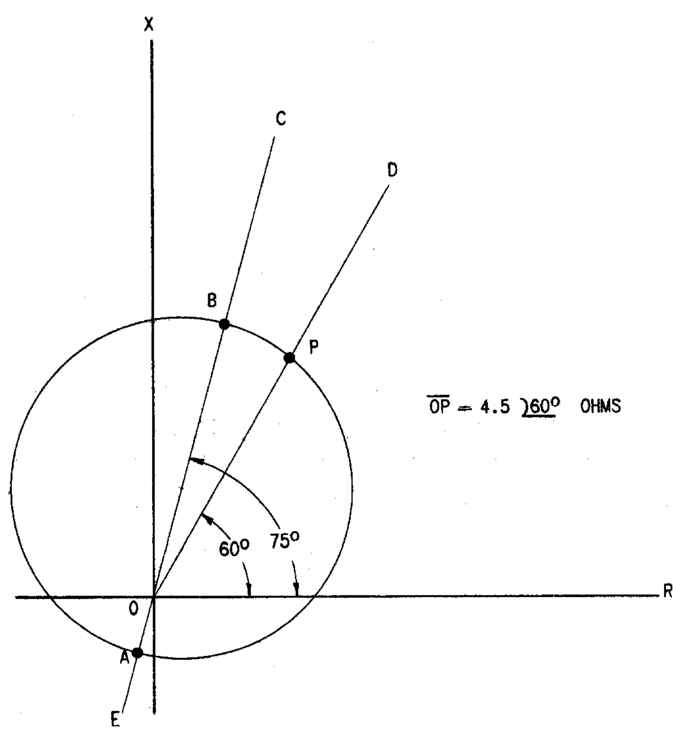


Fig. 9 (0165A7714-0) Graphical Solution of Tap Setting for OM-3 Unit

TABLE E

UNIT	Settings on two terminal lines	Settings on three terminal lines
01	Set for 80-90 percent of the total line reactance.	Set for 80-90 percent of the reactance to the nearest remote terminal. Do not include the effects of infeed.
M2	Set for at least 110 percent of the total line impedance taking the line impedance angle into consideration.	With all three terminal breakers closed, calculate the effective impedance seen by this unit for a three phase fault at one of the remote terminals. Repeat for a fault at the second remote terminal. Include the effects infeed in both cases. Select the larger of the two impedances and set this unit for at least 110 percent of this impedance taking the angle into consideration.
OM3	Since the first and second zone units will provide complete coverage for the protected line and possibly some back-up protection for adjacent lines and busses, the OM3 unit is entirely a back-up unit. If it is set to look in the same direction as M2, it will provide a measure of back-up protection for lines fed from the remote terminal(s) busses. If offset is used, it will also provide back-up protection for the local bus and some portion of the lines fed from this bus. If the OM3 unit is set to look in the reverse direction, it will provide back-up protection in that direction. The setting of this unit will depend entirely on the users philosophy regarding back-up protection. However, its reach should not be set so large that it is subject to operation on heavy loads or minor system swings.	

above, then setting the relay to reach 90 percent of the line is satisfactory. If the line reactance is only known to an accuracy of 10 percent, the first zone should be set for no more than 85 percent of the line length.

Since the 69.4 percent calculated from the equation above is not an integral number, use the next highest #1 tap which is 70 percent.

The second zone M2 unit must be set to reach beyond the far terminal. If the relays are being used in a directional comparison scheme for carrier tripping as well as second zone back up protection, both applications should be considered.

Assume that after due consideration it is desired to set the second zone mho unit (M2) for a reach of 0.42 + j 2.4 secondary ohms. This is:

$$Z_{sec} = 0.42 + j\ 2.4 = 2.44 \angle 80^{\circ}$$

The percent tap setting on the M2 unit for such a reach is:

$$T = \frac{Z_{min}}{Z_L} \times 100 \cos (60^{\circ} - \phi)$$

Where T = #2 Tap setting in percent:

Z_{min} = Minimum reach of M2 unit as marked on the nameplate

Z_L = Desired impedance reach in secondary phase to neutral ohms

ϕ = Impedance angle of Z

60° = Angle of maximum torque of M2 unit

For this case:

$$T = \frac{2.0}{2.44} \times 100 \cos (60^{\circ} - 80^{\circ})$$

$$T = 77 \text{ percent}$$

The third zone OM3 unit may be set to look either in the forward or the reverse direction and it may be set with zero or one ohm offset. If it is to be set with zero offset, regardless of the direction in which it looks, the required tap setting is given by the following equation:

$$T = \frac{300}{Z_L} \cos (75^{\circ} - \phi)$$

Where:

T = #3 tap setting in perecent. Note this same value must be set on both pairs of #3 taps

Z_L = Desired impedance reach in secondary phase to neutral ohms

ϕ = Impedance angle of Z_L

75° = Angle of maximum torque of the OM3 unit

If it is desired to set this unit for a reach of 4.5 secondary phase to neutral ohms at an angle of 60 degrees, the tap setting would be:

$$T = \frac{300}{4.5} \cos (75^{\circ} - 60^{\circ})$$

$$T = 64.4 \text{ percent}$$

Set both pairs of #3 tap for 65 percent.

Consider now the case where the 1 ohm offset is to be used and assume that the same 4.5 ohms reach at 60 degrees is required. Since the maximum torque and offset angle of this OM3 unit are different from the 60 degree reach requirement, the easiest method to determine the tap setting is graphical. Fig. 9 illustrates how this is done.

First draw the R-X diagram and a line EC at an angle of 75 degrees passing through the origin. This is the maximum torque line of the OM3 unit. Now draw the impedance angle line $\overline{OD}$ at 60 degrees. On line OD, scale off a distance $\overline{OP}$ equal to 4.5 ohms. On line $\overline{EC}$, scale off a distance $\overline{OA}$ equal to the 1 ohm offset of this unit. Now draw a circle with its center on line $\overline{OB}$ and passing through both points P and A. The desired tap setting for the OM3 unit may now be determined from the scaled off diameter $\overline{AB}$ of the circle.

$$T = \frac{300}{\overline{AB}}$$

Where:

T = tap setting in percent

$\overline{AB}$ = secondary phase to neutral ohms

In this instance, $\overline{AB}$ is scaled off to be 5.65 ohms. Thus,

$$T = \frac{300}{5.65} = 53 \text{ percent}$$

Set both pairs of #3 tap for 53 percent

CONSTRUCTION

The elements which comprise the GCXY11A relay are mounted in a standard L2 case and the outline and panel drilling is shown in Fig. 14.

The relay is mounted in a cradle assembly which is latched into a drawout case when the relay is in operation but it can be easily removed when desired. To do this, the relay is first disconnected by removing the connection plug which completes the electrical connections between the case block and the cradle block. To test the relay in its case this connection block can be replaced by a test plug. The cover, which is attached to the front of the relay case, contains the target reset mechanism and an interlock arm which prevents the cover from being replaced until the connection plugs have been inserted.

The relay case is suitable for either semi-flush or surface mounting on all panels up to 2 inches thick and appropriate hardware is available. However, panel thickness must be indicated on the relay order to insure that proper hardware will be included.

Every circuit in the drawout case has an auxiliary brush, as shown in Fig. 15, to provide adequate overlap when the connecting plug is withdrawn or inserted. By providing this overlap the auxiliary brushes relieve the main brushes from any arcing damage. Also on circuits which are equipped with shorting bars (see Fig. 13) it is especially important that the auxiliary brush makes positive contact as indicated in Fig. 15 to prevent the opening of C.T. secondary circuits or important interlock circuits.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay. If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust, and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

ACCEPTANCE TESTS

Immediately upon receipt of the relay an INSPECTION AND ACCEPTANCE TEST should be made to insure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If the examination or test indicates that readjustment is necessary, refer to the section on SERVICING.

VISUAL INSPECTION

Check the nameplate stamping to insure that the model number and rating of the relay agree with the requisitions.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage, and that all screws are tight.

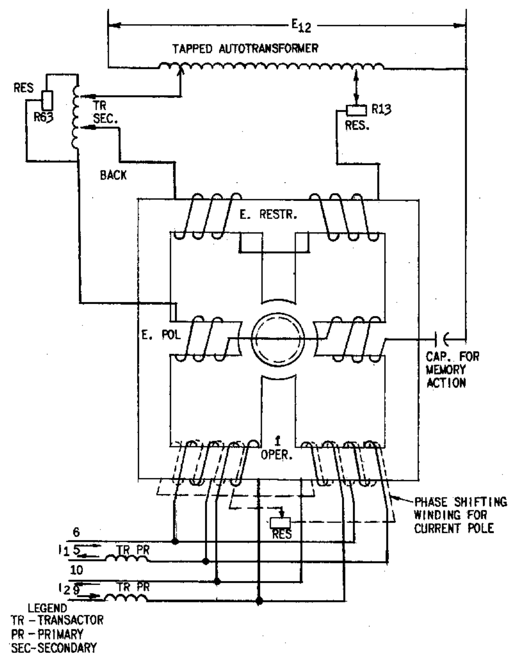


Fig. 10 (0165A7713-0) Schematic Connections Diagram for OM-3 Mho Unit

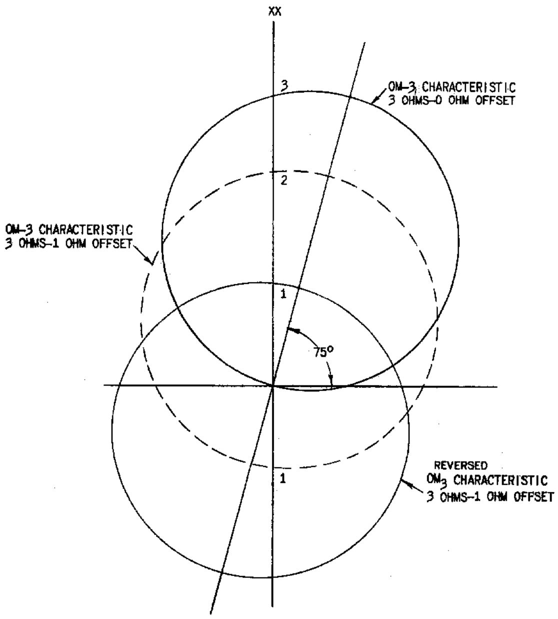


Fig. 11 (0165A7716-0) Characteristic of the OM-3 Unit for Relay Type GCXY11A

Check the location of the contact brushes on the cradle and case blocks.

MECHANICAL INSPECTION

It is recommended that the following mechanical adjustments be checked:

1.

Check Point	OM-3 Unit	M-2 Unit	01 Ohm Unit
Rotating Shaft End Play	.005 " to .008"	.005" to .008"	.005" to .008"
Contact Gap	.055" to .065	.005" to .065"	.055" to .065"
Contact Wipe	.004" to .006"	.004" to .006"	.004" to .006"

2. There should be no noticeable friction in the rotating structure of the ohm and mho units.

3. Make sure the control springs are not deformed and spring convolutions do not touch each other.

4. With the relay well leveled in its upright position the ohm and mho unit contacts must be open. The moving contacts of these units should rest against their backstops lightly.

5. The armature and contacts of the target-seal-in unit should move freely when operated by hand. There should be at least 1/32" wipe on the seal-in contacts.

6. The armature of the telephone type auxiliary relay should move freely.

7. With telephone type relay auxiliary relay "S" deenergized each normally open contact should have a gap of 0.10" - 0.15". Observe the wipe on each normally closed contact by deflecting the stationary contact member towards the frame. The wipe should be approximately .005".

The wipe on each normally open contact should be approximately .005". This can be checked by inserting a .005" shim between the residual screw and the pole piece and operating the armature by hand. The normally open contact should make before the residual screw strikes the shim.

ELECTRICAL TESTS

The electrical tests circuits described these instructions in order to eliminate errors due to meter calibration include the following portable test equipment.

Two test plugs XLA12A1
One test box - Cat. #102L201
One test reactor - Cat. #6054975G1
One non-inductive test resistor DL-6158546

The test reactor has some small amount of resistance and Table F gives the reactor angle to permit correction where necessary.

TABLE F

TAP	ANGLE	COS (Ø-60)
0.5	78.0	.951
1.0	80.7	.935
2.0	83.0	.921
3.0	84.3	.911
6.0	86.5	.895
12.0	87.0	.891
24	87.5	.887

Before making the electrical tests, connect rated voltage to the potential coils and let them warm up for about 15 minutes. This is to give more accurate results since the relay tends to underreach slightly when cold.

A. OM3 UNIT

1. Connect the OM3 unit to look forward without an offset and check its reach as follows. Make connections as shown in Fig. 16 and choose a test reactor tap which will given an impedance somewhat larger than twice the relay reach setting used and near the unit angle of maximum torque. With about 10 amperes of current flowing, find the test box autotransformer tap setting that will permit the OM3 unit to just close its contact. This value should be within two percent of the value given by the following equation:

$$T_B = \frac{2Z_{min}}{Z_T} \frac{(100)^2}{T_3} \cos(75^o - \emptyset)$$

Where:

T_B = test box tap setting in percent
Z_{min} = relay minimum reach setting

Z_T = test impedance in ohms

T_3 = #3 relay tap setting in percent

ϕ = angle of the test impedance

By adjusting the DC current to relay stud 11 the target will indicate when the OM3 unit has closed its contact.

2. By checking the OM3 unit with this one impedance value the unit reach can be checked. If desired, the unit's characteristic can be checked by using impedances with other angles. For example if the test reactor alone is used as the test impedance for one reach test and the test resistor alone for another these three points will be sufficient to establish the unit characteristic.

3. Connect the offset transactor in the circuit and check the unit reach with the #3 taps at 100 percent. Under these conditions the unit characteristic with the offset is a circle three ohms in diameter with its center on the 75° line one-half an ohm from the origin in the positive direction (see Fig. 11). By drawing this operating characteristic carefully on polar coordinate paper the impedance at which the relay should operate at any selected impedance angle can be determined graphically. To do so, draw the test impedance at its correct angle on the offset unit characteristic. The point at which this impedance line intersects the characteristic will establish the maximum impedance value (Z_R) which will permit the unit to operate with 100% unit tap setting.

Then the test box tap setting will be

$$T_B = \frac{2Z_R}{Z_T} (100)$$

Where:

T_B = test box tap setting in percent

Z_R = maximum unit operating impedance at test impedance angle

Z_T = test impedance

B. M2 Unit

1. The M2 unit characteristic is similar to the OM3 characteristic without offset except that the angle of maximum torque is 60 degrees. The test procedure should be the same as outlined under A-1 above and the test box tap setting is given by the following equation.

$$T_B = \frac{2Z_{min} (100)^2}{Z_T \quad T_2} \cos (60-\phi)$$

Where:

T_B = test box tap setting in percent

Z_T = test impedance in ohms

T_2 = #2 relay tap setting in percent

ϕ = angle of the test impedance

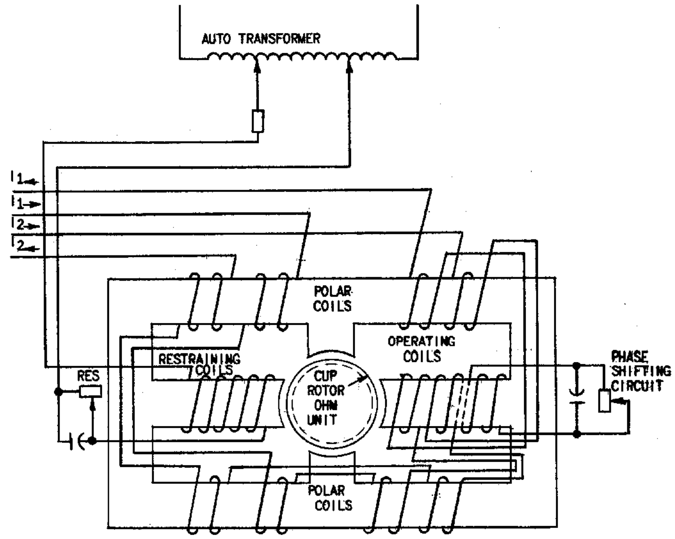


Fig. 12 (0165A7712-0) Schematic Connection Diagram for 01 Unit

C. 01 Unit

Make the test connections as shown in Fig. 16 except omit the test resistor R_T using the reactor alone as test impedance. Select a reactor tap to give a test impedance slightly above twice the 01 unit reach setting used. Adjust the tap setting of the test box so that the 01 unit will just close its contacts. This tap setting should be within one percent of the value given by the following equation.

$$T_B = \frac{2X_{min} (100)^2}{Z_T \quad T_1} \text{ sine } \phi$$

Where:

T_B = test box tap setting in percent

Z_T = test impedance

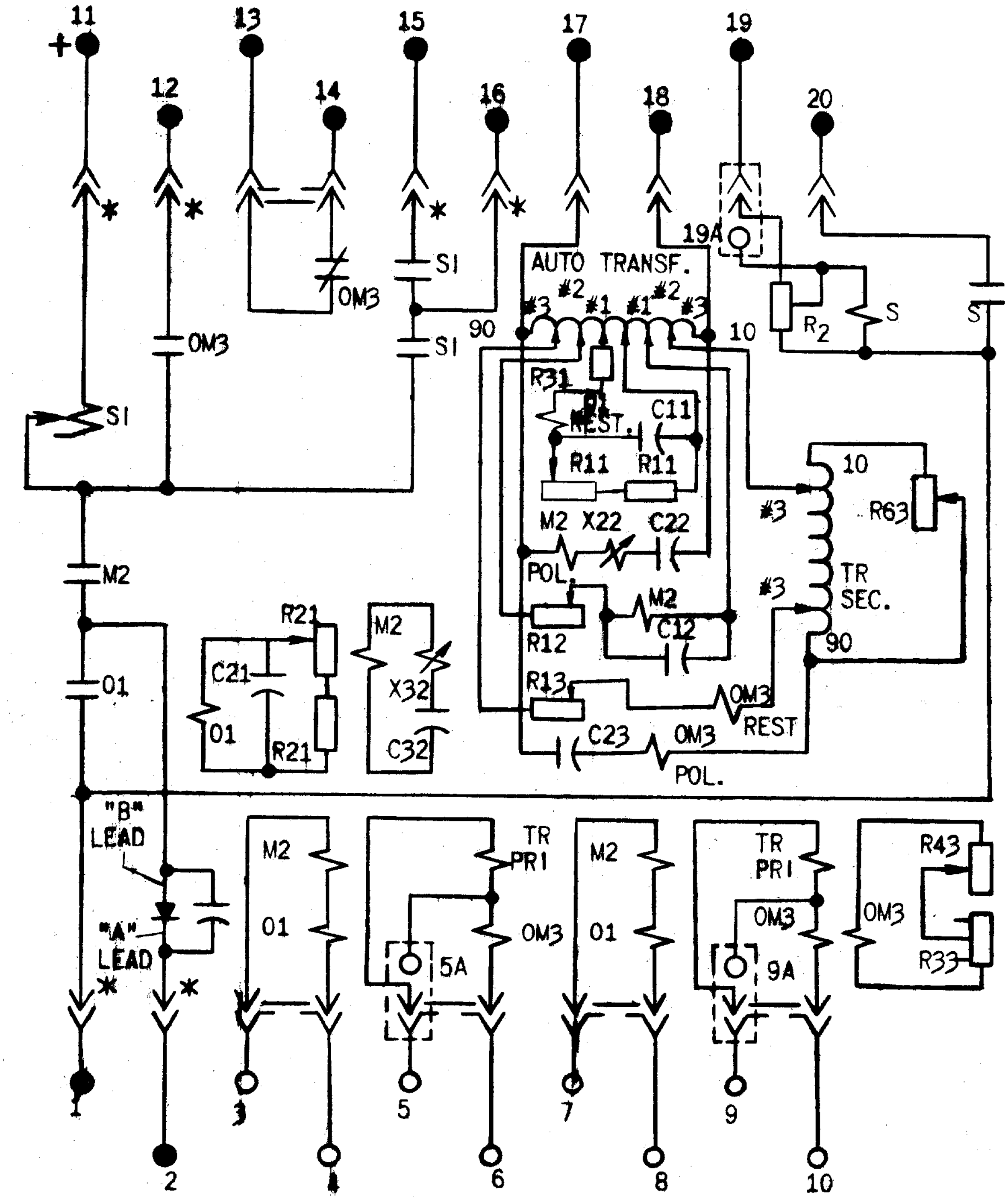
T_1 = relay #1 tap setting in percent

X = minimum relay reach

ϕ = angle of the test impedance

During this test the #2 relay taps should be set so that the M2 unit will also pickup. Then by making the DC connections to the relay studs 11 and 1 and by adjusting the current thru this circuit to a value above the target seal-in tap value used the target operation will show when the 01 unit has closed its contact.

D. Check that the "S" auxiliary unit picks up at 80% or less of rated voltage. An indicating light connected to relay stud 20 as indicated in Fig. 16



* = SHORT FINGER

NOTE A - IF STUD 11 POLARITY IS NEGATIVE, REVERSE POLARITY OF RECTIFIER BY INTERCHANGING "A" & "B" LEADS

Fig. 13 (0165A6060-0) Internal Connection Diagram (Front View) of the GCXY11A Relay (125/250 V DC)

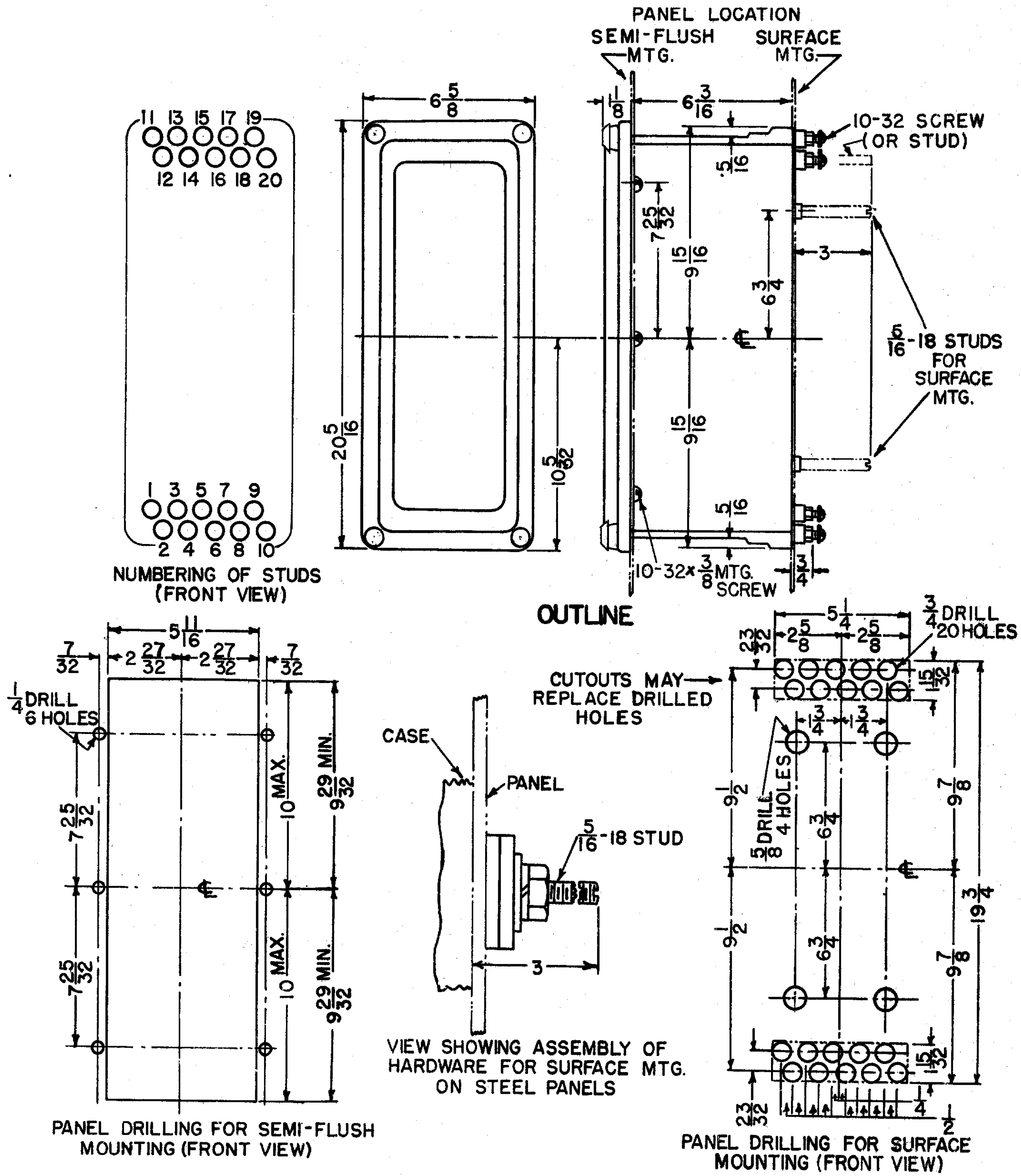


Fig. 14 (6209276-1) Outline and Panel Drilling Dimensions for Relay Type GCXY11A will give an indication when the "S" unit closes its contacts.

The seal in unit should pick up at a current equal to or less than the rating of the tap used. This should be checked during the OM3 unit tests described above.

INSTALLATION PROCEDURE

If after the acceptance tests the relay is held in storage before shipment to the job site, it is recommended that the visual and mechanical inspection described under the section on ACCEPTANCE TESTS be repeated before installation.

Before making the following electrical tests the relay should be in its case and well leveled in a vertical position (preferably the relay should be mounted in its permanent location). The relay should be preheated for 15 minutes by having its potential coil circuits energized at full rated voltage.

Check the reach of the OM3, the M2 and the 01 units at the setting to be used in its permanent location. Follow the procedure described under ACCEPTANCE TESTS except connect the OM3 unit for a reverse characteristic if it is to be used in this manner. It should not be necessary to check the unit characteristics at this time unless the unit reach is outside the acceptable limits.

Check the target seal-in unit and the "S" unit as described under ACCEPTANCE TESTS.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

In view of the vital role of protective relays in the operation of a power system it is important that a periodic test program be followed. It is recognized that the interval between periodic checks will vary depending upon environment, type of relay, and the user's experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to his individual requirements it is suggested that the points listed under INSTALLATION PROCEDURE be checked at an interval of from one to two years.

Check that the relay contacts are clean and untarnished.

If any tests indicate that adjustments are required, refer to the SERVICING section.

SERVICING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of an etched roughened strip of flexible metal, resembling a superfine file which removes corroded material quickly without scratching the surface. The flexibility of the tool insures the cleaning of the actual points of contact. Never use knives, files, abrasive paper or cloth to clean fine silver contacts. A burnishing tool as described above can be obtained from the factory.

If any of the mechanical or electrical check points described in the previous sections are found to be out of limits the following points should be observed in restoring them.

MECHANICAL

1. Friction - If a tendency to bind or excessive friction is evident, check for obstructions to the induction cylinder travel. Dirt or metallic particles in the stator gap are the most frequent cause of excessive friction.

2. End Play - End play in the shaft is adjusted by means of the upper guide bearing. Loosen the set screw and position the guide bearing so that end play falls within the .005 to .008 inch limit. Note that care must be taken not to disturb the spring windup while the end play is being adjusted.

3. Contact Gap - The contact gaps of the normally open and normally closed contacts are controlled by positioning the stationary contact support on the shelf. The recommended settings are illustrated in Figs. 18 and 19.

4. Clutch Slip - The clutch on both the mho-type and ohm units is adjusted by means of the steel collar at the upper end of the rotating shaft. To adjust the clutch loosen the set screw in the collar, and rotate the shaft through the number of half turns necessary to obtain the correct pressure. Turning the collar down increases the clutch pressure. The pressure required to slip the clutch should be 45 to 65 grams on the mho unit and as given in Table E for the ohm unit. The pressure required to slip the clutch should be measured by means of a gram gage applied at the moving contact.

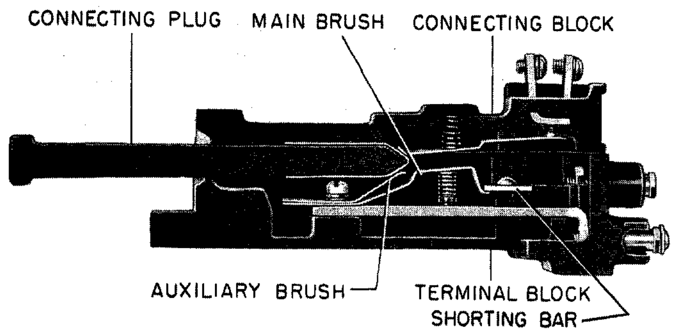


Fig. 15 (8025039) Cross Section of Drawout Case Showing Position of Auxiliary Brush and Shorting Bar

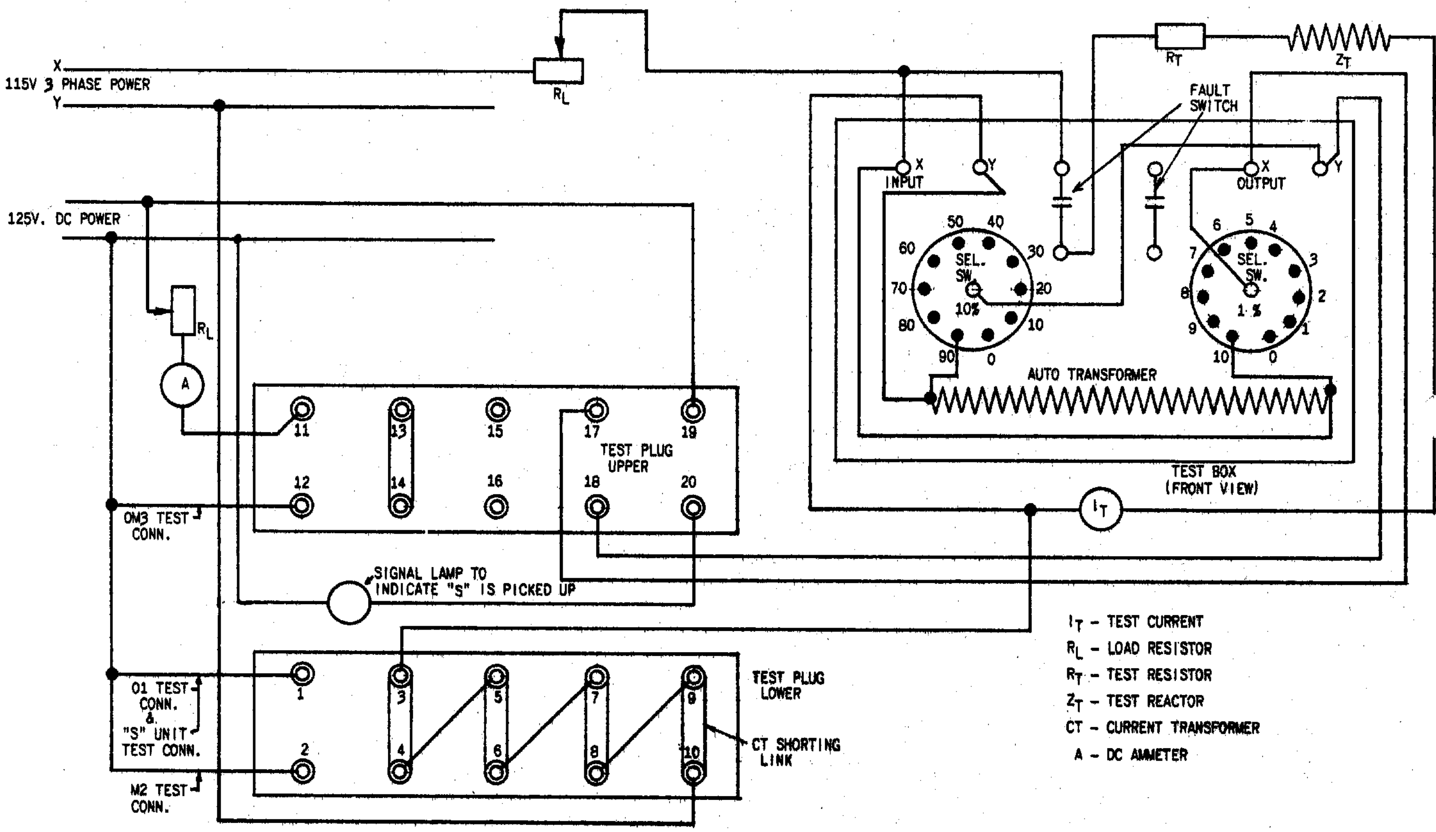


Fig. 16 (0116B6818-0) Test Connections for GCXY11A Relay

The collar should then be locked by means of the set screw which seats in a groove on the shaft. Care should be taken to set the screw in this groove rather than tightening it against the threaded shaft.

5. Control Spring Adjustment

Make sure the relay is well leveled in its upright position. Loosen the upper shaft bearing lock screw and rotate the control spring adjusting arm so that the moving contact just touches its backstop (when the backstop is removed the moving contact should not move). Now tighten the lock screw.

NOTE: - It is recommended that control spring adjustments for the ohm and mho units be checked with the relay set in its position on the panel.

ELECTRICAL

a. OM3 Unit

Directional Characteristic - If the OM3 unit fails to perform properly as outlined under ACCEPTANCE TESTS, the inner stator or core must be readjusted. Loosen the core lock on the bottom of the unit and turn the core a very slight amount, lock the nut and recheck the directional action. If it has not improved, repeat the core adjustment in the opposite direction. Very slight changes in core position are usually sufficient.

b. Ohm Unit

Reach and Angle of Maximum Torque Adjustment - The minimum reach of the ohm unit is controlled with R_{21}. The ohm unit is a reactance measuring device and its angle of maximum torque is 90^o, current lagging voltage. The angle of maximum torque is controlled with R_{11}.

R_{11}, however, effects the reach of the relay and R_{21} effects the angle of maximum torque.

With these factors in mind; should it become necessary to recalibrate the ohm unit, use the test circuit shown in Fig. 13 permitting the unit to heat up for 15 minutes before starting the tests. Assuming that the potential bias is correct the adjustment of R_{21} resistor will rectify an incorrect ohmic reach testing with reactance alone. R_{11} shifts the angle of maximum torque so that the unit will measure only the reactive component of an impedance. Since each of these adjustments affect one another, check the calibration with and without fault or arc resistance after both resistors are set. The setting of the R_{11} and R_{21} is made with currents about 10 amps. Further tests should be made using current ranges in Table E. Of course with the arc resistance in the circuit use the maximum current obtained from the 115 volt supply. During the test to determine the flatness of the curve over the wide range of currents it may become necessary to resort to a minor core adjustment to bring the unit within the tolerable range of measurement. The turning up of the curve at low currents means the control spring resetting torque is excessive.

TABLE G

MIN. OHMS	TEST CURRENT RANGE AMPS
0.25	5-60
0.5	3-50

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken, or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of the part wanted, and give complete nameplate data. If possible, give the General Electric requisition number on which the relay was furnished.

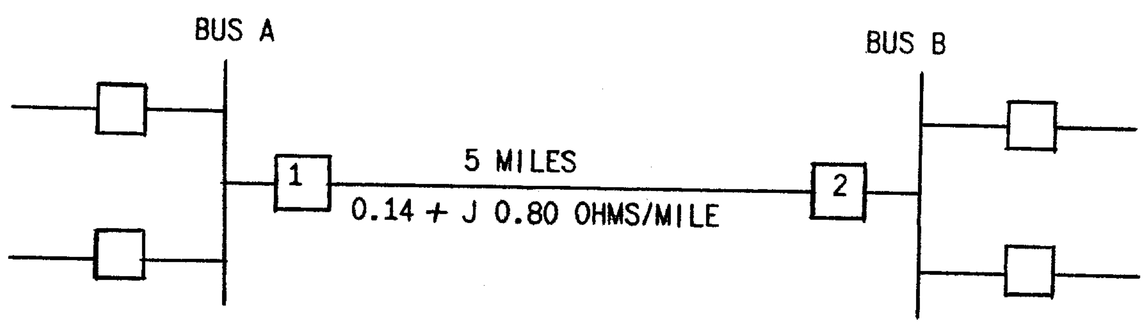


Fig. 17 (0165A7715-0) Typical Transmission Circuit

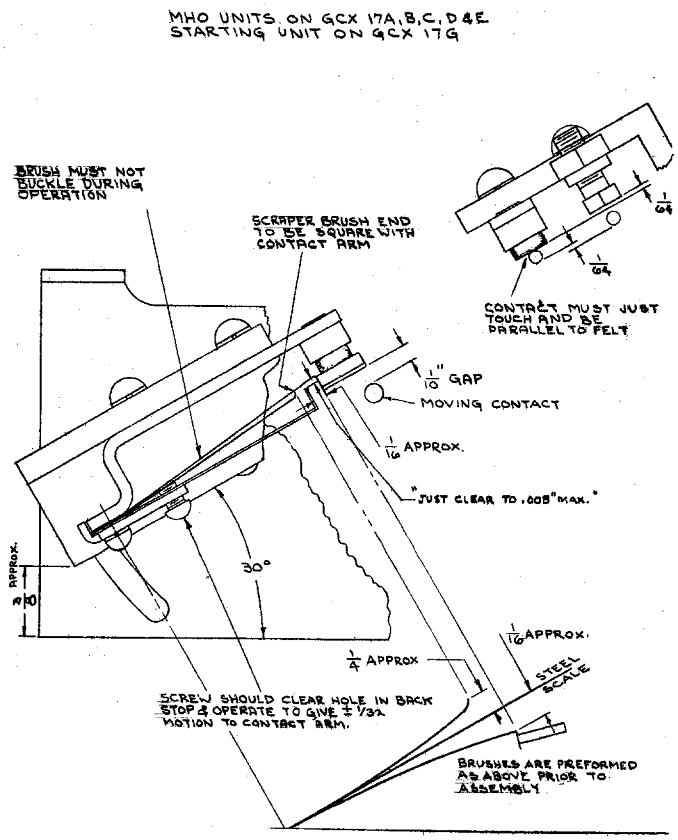


Fig. 18 (365A400-2 Sh. 1) Contact Adjustment of Mho Units on Type GCX11A Relays

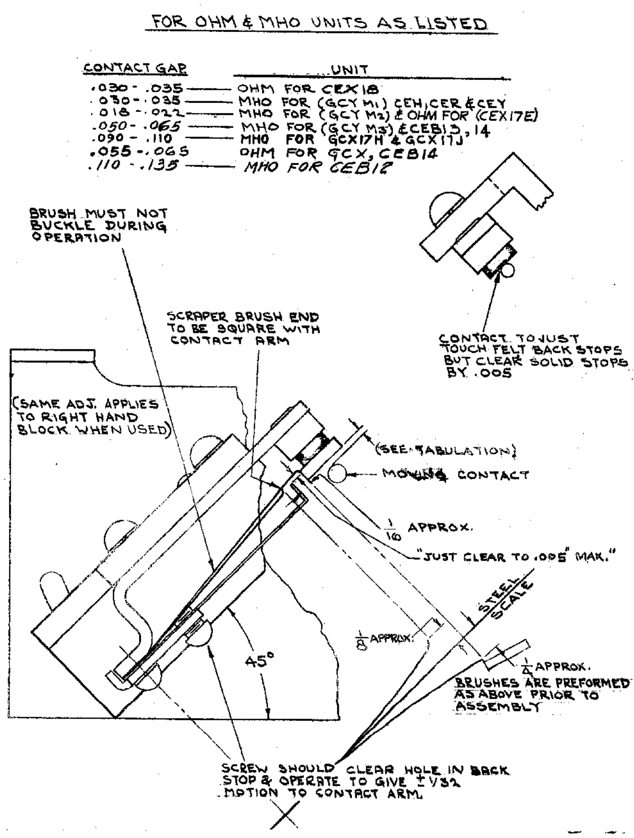


Fig. 19 (365A400-9 Sh. 2) Contact Adjustment of Ohm Units on Type GCXY11A Relays

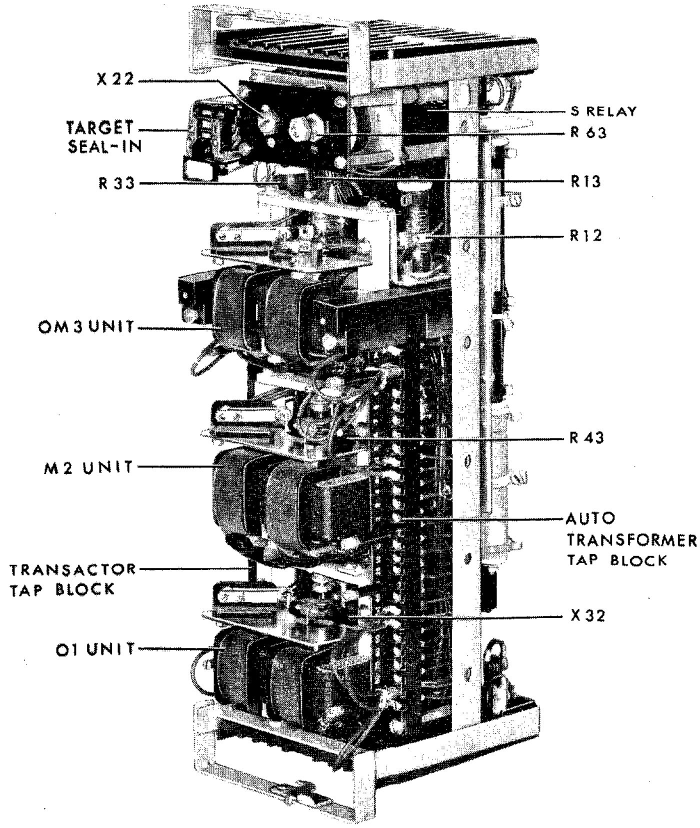


Fig. 20 (8034213) GCXY11A Relay Removed from Case (Front View)

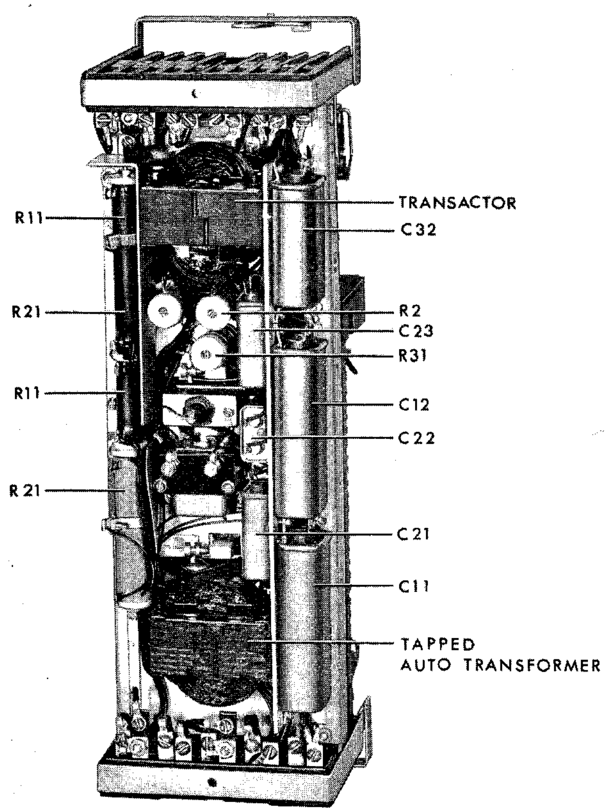


Fig. 20A (8034211) GCXY11A Relay Removed from Case (Rear View)

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