INSTRUCTIONS

GEH-1818A
SUPERSEDES GEH-1818

GROUND DIRECTIONAL OVERCURRENT RELAYS

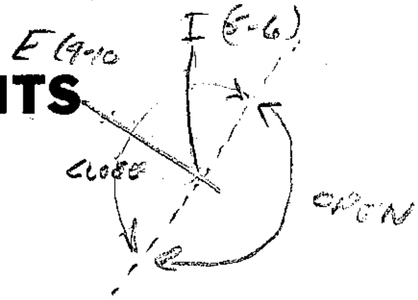
Types
JBCG51E JBCG52E
JBCG53E JBCG54E

LOW VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS



GROUND DIRECTIONAL OVERCURRENT RELAY
TYPE JBCG

INTRODUCTION

Type JBCG relays are ground directional overcurrent relays used primarily for the protection of feeders and transmission lines. They are available with either inverse time or very inverse time characteristics.

They consist of three units, an instantaneous overcurrent unit (top) of the induction-cup type, a time overcurrent unit (middle) of the induction-disk type, and an instantaneous power-directional unit (bottom) of the induction-cup type. The directional unit is either potential or current polarized and, by means of its closing contacts, directionally controls the operation of both the time overcurrent and instantaneous overcurrent units.

APPLICATION

Type JBCG relays are used for ground fault protection of a single line. They have a low-range operating coil which may be rated 0.5/2 or 1.5/6 amperes, although the 4/16 ampere rating is also available. Under normal conditions, no current flows in either the operating or current polarizing coils, nor is there any voltage across the potential polarizing coils.

Fig. 9 shows the external connections when the Type JBCG relay is used in conjunction with phase relays polarized from wye-wye potential transformers. The polarizing voltage for the ground relay is obtained by means of an auxiliary wye-broken-delta potential transformer.

Fig. 10 shows the external connections for the Type JBCG ground relay when current polarized from a local source of ground current.

On some applications, system conditions may at one time be such that potential polarization is desirable, and at other times be such that current polarization would be preferred. The Type JBCG relay, with its dual polarization feature, is well suited for such applications. The curves in Fig. 1 compare the performance of the relay when dual polarized with its performance when either potential or current polarized alone.

The differences between the various models covered by this instruction book are shown in Table I. Inverse time relays should be used on systems where the fault current flowing through a given relay is influenced largely by the system generating capacity at the time of the fault. Very inverse time relays should be used in cases where the fault current magnitude is dependent mainly upon the location of the fault in relation to the relay, and only slightly or not at all upon the system generating setup. The reason for this is that relays must be set to be selective with maximum fault current flowing. For fault currents below this value, the operating time becomes greater as the current is decreased. If there is a wide range in generating capacity together with variation in short-circuit current with fault position, the operating time with minimum fault current may be exceedingly long with very inverse time relays. For such cases, the inverse time relay is more applicable.

TABLE I

Relay Model	Time Charact-eristic	Circuit Closing Contacts	Internal Connections
JBCG51E	Inverse	One	Fig. 2
JBCG52E	Inverse	Two	Fig. 3
JBCG53E	Very Inverse	One	Fig. 4
JBCG54E	Very Inverse	Two	Fig. 5

OPERATING CHARACTERISTICS

PICKUP

When potential polarized, the directional unit will operate at 3.6 volt-amperes at the maximum torque angle of 60 degrees lag (current lags voltage). When current polarized, it will operate at approximately 0.5 ampere with the operating and polarizing coils connected in series. The performance of the unit with simultaneous current and potential polarization is typified in Fig. 1.

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.

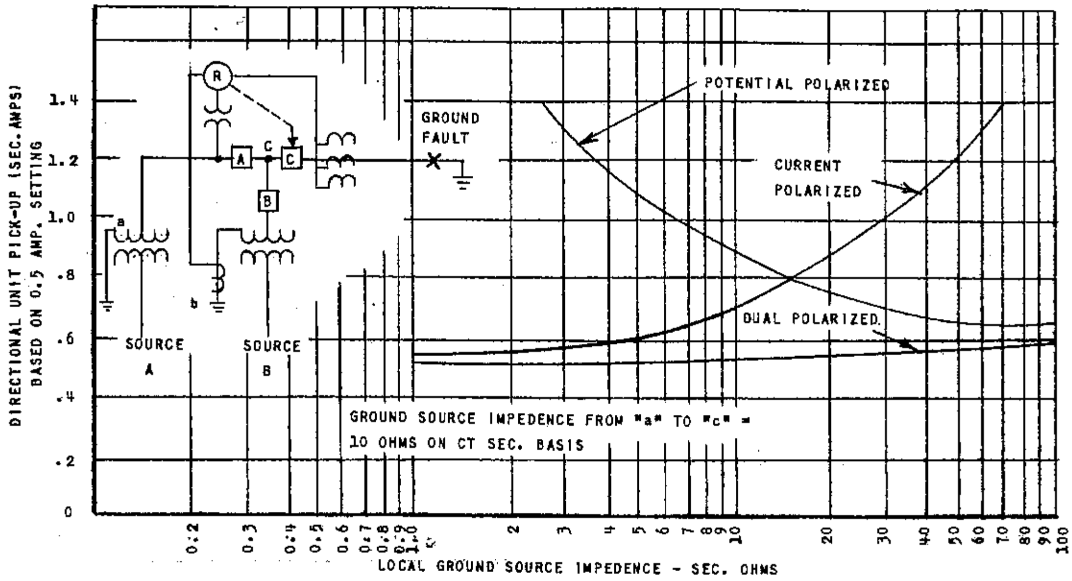


Fig. 1 Type JBCG Directional Unit Pickup For Various Values Of Ground Fault Impedance With Current, Potential, Or Dual Polarization

Fig. 1 (362A684)

The maximum operating current required to close the time overcurrent unit contacts, at any time-dial position, will be within five per cent of the tap plug setting. The pickup of the instantaneous overcurrent unit can be adjusted over a four-to-one range as indicated in Table III.

RESET

The minimum percentage of minimum closing current at which the time overcurrent until will reset is 90% for inverse-time relays and 85% for very inverse-time relays. When the relay is de-energized, the time required for the disk to completely reset to the number 10 time dial position is approximately 6 seconds for inverse time relays and 60 seconds for very inverse time relays.

OPERATING TIME

The time curve for the directional unit is shown in Fig. 15.

The time curves of the time overcurrent unit are shown in Fig. 17 and Fig. 18 respectively for inverse-time and very inverse-time relays. For the same operating conditions, the relay will operate repeatedly within one or two per cent of the same time.

The time curve for the instantaneous overcurrent unit is shown in Fig. 16.

RATINGS

CURRENT CIRCUITS

The continuous and short time ratings of the time overcurrent unit operating coil circuit are shown in Table II. These same ratings are applicable to the directional unit operating coil circuit except that its continuous rating is independent of changes in the time overcurrent unit tap setting. Hence, the information associated with the asterisk under Table II does not apply to the directional unit operating coil. The directional unit current polarizing coils have a continuous rating of 5 amperes and a one (1) second rating of 150 amperes. Table III shows the ratings of the available ranges of the instantaneous overcurrent unit. Since all operating current circuits are normally connected in series, the operating coil ratings of all three units should be considered in determining the rating of the entire operating circuit.

TABLE II

RATINGS OF TIME OVERCURRENT UNIT OPERATING COILS

Tap Range (Amps)	Tap Ratings (Amps)	*Cont. Rating (Amps)	One Sec. Rating (Amps)
0.5/2	0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0	1.5	100**
1.5/6	1.5, 2, 2.5, 3, 4, 5, 6	5	200
4/16	4, 5, 6, 8, 10, 12, 16	10	220

* Applies to all taps up to and including this value. The continuous rating of higher current taps is the same as the tap value.

** Applies to very inverse time relays only. The one second rating of inverse time relays is 65 amperes.

TABLE III

RATINGS OF INSTANTANEOUS OVERCURRENT UNIT OPERATING COILS

Pickup Range (Amps)	Continuous Rating (Amps)	One Second Rating (Amps)
2-8	5	150
4-16	5	150
10-40	5	220
20-80	5	220
40-160	5	220

POTENTIAL COILS

The potential polarizing coils will withstand 120 volts for 20 minutes and 360 volts for 10 seconds.

SEAL-IN UNIT

The rating and impedance of the seal-in unit for the 0.2 and 2 ampere taps are given in Table IV. The tap setting used will depend on the current drawn by the trip coil. The current ratings are either a-c or d-c.

The 0.2 ampere tap is for use with trip coils which operate on currents ranging from 0.2 up to 2.0 ampere at the minimum control voltage. If this tap is used with trip coils requiring more than 2 amperes, there is a possibility that the resistance of 7 ohms will reduce the current to so low a value that the breaker will not be tripped.

The 2 ampere tap should be used with trip coils that take two amperes or more at minimum control voltage, provided the current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes, the connections should be arranged so that the induction unit contacts will operate an auxiliary relay which in turn energizes the trip coil or coils. On such an application, it may be necessary to connect a loading resistor in parallel with the auxiliary relay coil to allow enough current to operate the target seal-in unit.

TABLE IV

SEAL-IN UNIT RATINGS

	2 AMP TAP	0.2 AMP TAP
Carry-Tripping Duty	30 Amps	5 Amps
Carry Continuously	3 Amps	0.3 Amps
D-C Resistance	0.13 Ohms	7 Ohms
Impedance (60 cycles)	0.53 Ohms	52 Ohms

CONTACTS

The current-closing rating of the induction unit contacts is 30 amperes for voltage not exceeding 250 volts. Their current-carrying rating is limited by the tap rating of the seal-in unit.

BURDENS

The capacitive burden of the potential polarizing circuit of the directional unit at 60 cycles and 120 volts is 19.6 volt-amperes at 0.78 power factor. Table V gives the current circuit burdens of the directional unit.

Table VI gives the total burden of the time overcurrent unit plus the instantaneous overcurrent unit.

Ordinarily, the potential circuit is in the open corner of broken delta potential transformers and the current circuits are in the residual circuits of current transformers. The burden is, therefore, only imposed for the duration of the ground fault and need be considered only for this brief period.

TABLE V

DIRECTIONAL UNIT CURRENT CIRCUIT BURDENS AT 60 CYCLES AND 5 AMPERES

CIRCUIT	Z(OHMS)	VA	P.F.	WATTS
Operating	0.46	12.0	0.52	6.24
Polarizing	0.35	8.6	0.95	8.17

RECEIVING, HANDLING AND STORAGE

These relays, when not included as a 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 in order that none of the parts are injured or the adjustments disturbed.

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.

TABLE VI

BURDENS OF OVERCURRENT UNITS (TIME AND INSTANTANEOUS) AT 60 CYCLES

Time Character-istic	RANGE		BURDENS AT MINIMUM PICKUP OF TIME UNIT					OHMS IMPEDANCE AT		‡ VA
	Time Unit	Inst. Unit	Eff. Res. (Ohms)	React. (Ohms)	*Imped. (Ohms)	+Volt-Amps	Power Factor	3 Times Min. P.U.	10 Times Min. P.U.	At 5 Amps
Inverse	0.5/2	All Ranges	7.90	19.7	21.1	5.3	0.37	12.6	7.30	530
Inverse	1.5/6	2-8	1.00	2.7	2.9	6.5	0.35	1.70	1.00	73
Inverse	1.5/6	4-16 10-40 20-80	0.96	2.6	2.8	6.3	0.34	1.70	0.97	70
Inverse	4/16	2-8	0.23	0.41	0.47	7.5	0.49	0.28	0.16	12
Inverse	4/16	4-16	0.18	0.38	0.42	6.7	0.42	0.25	0.15	10.5
Inverse	4/16	10-40 20-80	0.15	0.37	0.40	6.1	0.38	0.24	0.14	10.0
Very Inverse	0.5/2	All Ranges	2.10	4.80	5.20	1.3	0.40	4.90	4.20	130
Very Inverse	1.5/6	2-8	0.32	0.60	0.68	1.5	0.47	0.64	0.55	17
Very Inverse	1.5/6	4-16 10-40 20-80	0.25	0.51	0.57	1.3	0.44	0.53	0.46	14
Very Inverse	4/16	2-8	0.14	0.13	0.19	3.0	0.73	0.18	0.15	4.7
Very Inverse	4/16	4-16	0.09	0.11	0.14	2.2	0.64	0.13	0.11	3.5
Very Inverse	4/16	10-40 20-80	0.06	0.10	0.12	1.9	0.50	0.11	0.10	3.0

* The impedance values given are those for the minimum tap of each relay. The impedance for other taps, at pick-up current (tap rating), varies inversely approximately as the square of the current rating. Example: for the Type JBCG51E relay, 0.5/2 amperes the impedance of the 0.5 ampere tap is 21.1 ohms. The impedance of the 1 ampere tap, at 1 ampere, is approximately $(0.5/1)^2 \times 21.1 = 5.28$ ohms.

+ Some companies list relay burdens only as the volt-ampere input to operate at minimum pickup. This column is included so a direct comparison can be made. It should not be used in calculating volt-ampere burdens in a CT secondary circuit, since the burden at 5 amperes is used for this purpose.

‡ Calculated from burden at minimum pickup.

DESCRIPTION

TIME OVERCURRENT UNIT

The inverse time overcurrent unit consists of a tapped current operating coil wound on a U-magnet iron structure. The tapped operating coil is connected to taps on the tap block. The U-magnet contains wound shading coils which are connected in series with a directional unit contact. When power flow is in such a direction as to close the directional unit contacts, the shading coils act to produce a split-phase field which, in turn, develops torque on the operating disk.

The very inverse time overcurrent unit is of the wattmetric type similar to that used in watthour meters except as follows: the upper portion of the iron structure has two concentric windings on the middle leg of the magnetic circuit. One of these is a tapped current winding connected to taps on the tap block; the other is a floating winding which is connected in series with the directional unit contacts, a resistor, and the two coils on the lower legs of the magnetic circuit. When power flow is in such a direction as to close a directional unit contact, the unit develops torque on the operating disk.

The disk shaft carries the moving contact which completes the trip circuit when it touches the stationary contact or contacts. The shaft is restrained by a spiral spring to give the proper contact-closing current, and its motion is retarded by a permanent magnet acting on the disk to produce the desired time characteristic. The variable retarding force resulting from the gradient of the spiral spring is compensated by the spiral shape of the induction disk, which results in an increased driving force as the spring winds up.

Fig. 2 (418A865) Fig. 3 (418A866) Fig. 4 (418A867) Fig. 5 (418A869)

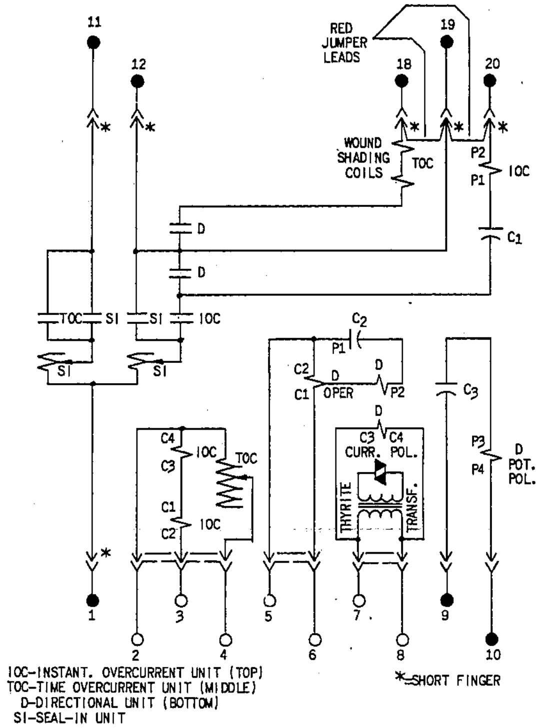


Fig. 2 Internal Connections For The Type JBCG51E Relay (Front View)

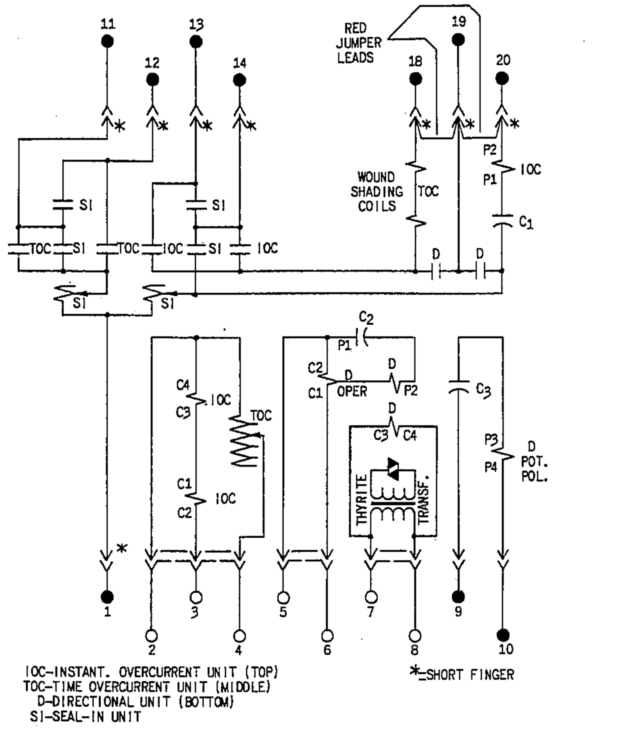


Fig. 3 Internal Connections For The Type JBCG52E Relay (Front View)

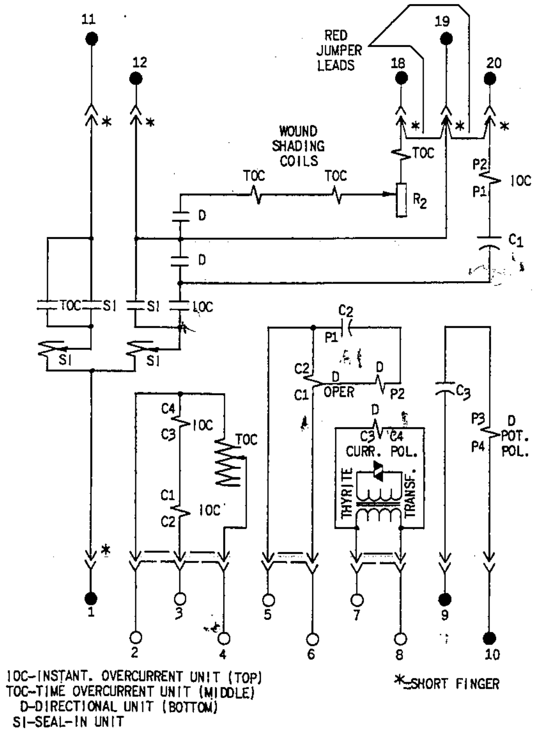


Fig. 4 Internal Connections For The Type JBCG53E Relay (Front View)

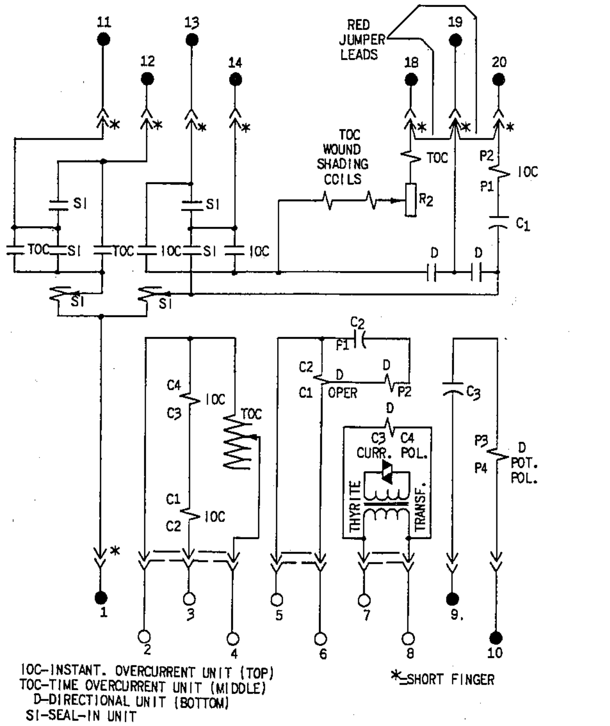
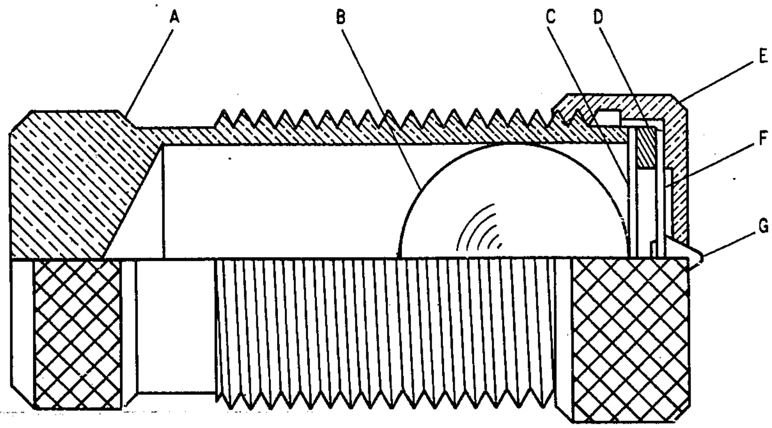


Fig. 5 Internal Connections For The Type JBCG54E Relay (Front View)



A – INCLINED TUBE
B – STAINLESS STEEL BALL
C – DIAPHRAM
D – SPACER
E – CAP
F – FLAT SPIRAL SPRING
G – CONTACT

Fig. 6 (K-6077069)

Fig. 6 Barrel Contact Assembly For The Directional And Instantaneous Overcurrent Units

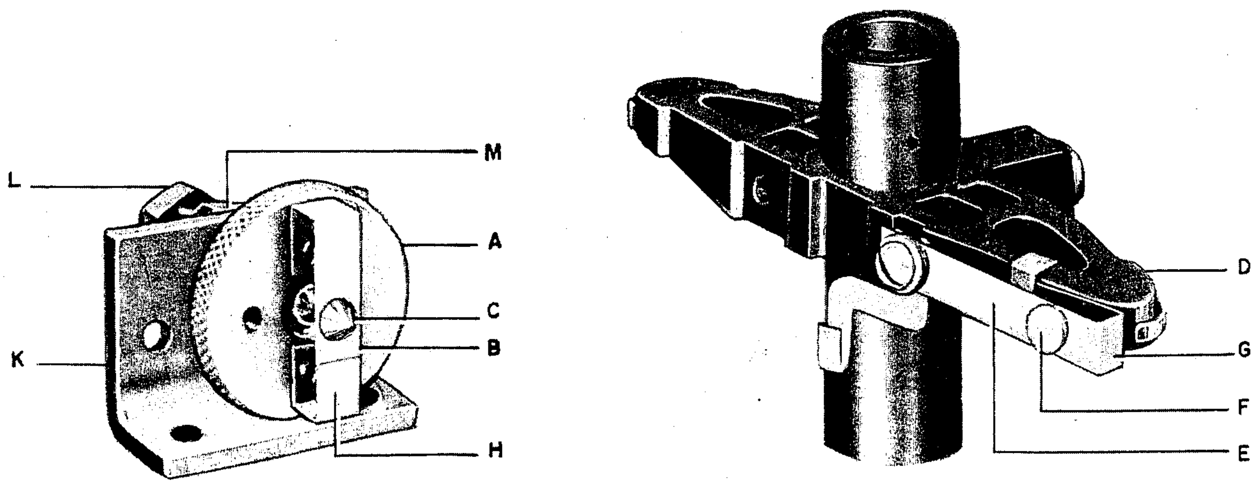


Fig.7(8023401)(8023399)

Stationary Contact Assembly

A - Contact Dial
B - Contact Brush
C - Contact Tip
H - Contact Brush Retainer
K - Contact Support
L - Mounting Screw
M - Locknut

Moving Contact Assembly

D - Contact Arm
E - Contact Brush
F - Contact Tip
G - Contact Brush Retainer

Fig. 7 Low Gradient Contact Assembly For The Directional Unit

The torque control circuits of both the time overcurrent and instantaneous overcurrent units are wired to terminals on the relay contact block. These terminals are shorted together by internally connected red jumper leads when the relays leave the factory (See Fig. 2 through Fig. 5). If external torque control is desired, these jumper leads should be removed.

DIRECTIONAL UNIT

The directional unit is of the induction-cylinder construction with a laminated stator having eight poles projecting inward and arranged symmetrically around a stationary central core. The cup-like aluminum induction rotor is free to operate in the annular air gap between the poles and the core. The poles are fitted with current operating, current polarizing, and potential polarizing coils.

The principle by which torque is developed is the same as that of an induction disk relay with a wattmetric element, although, in arrangement of parts, the unit is more like a split-phase induction motor. The induction-cylinder construction provides higher torque and lower rotor inertia than the induction-disk construction resulting in a faster and more sensitive relay.

INSTANTANEOUS OVERCURRENT UNIT

This unit is similar in construction to the directional unit described above, differing only in coil turns and connections. The four corner coils consist of two windings, an inner winding consisting of a large number of turns of fine wire, and an outer winding having a few turns of heavy wire. The outer windings of the corner coils, together with the four side coils, are all connected in series with the operating coil of the time overcurrent unit. The inner windings of the corner coils are all connected in series, and in turn are connected in series with a capacitor and a contact of the directional unit. This circuit controls the torque of the instantaneous overcurrent unit. When the directional unit contacts are open, the instantaneous unit will develop no torque. When the directional unit contacts are closed, the instantaneous unit will develop torque in proportion to the square of the current.

The instantaneous overcurrent unit develops operating torque in a direction opposite to that of the directional unit. This makes the relay less susceptible to the effects of shock.

SEAL-IN UNIT

The seal-in units for both the time-overcurrent and instantaneous-overcurrent contacts are mounted on the middle units, as indicated in Fig. 8.

The left seal-in unit operates in conjunction with the time-overcurrent unit contacts and is labeled "T". Its coil is in series and its contacts in parallel with the main contacts of the time-overcurrent unit so that when the main contacts close, the seal-in unit will pick up and seal-in around the main contact.

The right seal-in unit, labeled "I" operates in conjunction with the instantaneous overcurrent unit. Its coil is in series with the instantaneous-unit contact and a contact of the directional unit, and its contact is connected to seal-in around these two contacts when the unit operates.

Both seal-in units are equipped with targets which are raised into view when the unit operates. These targets latch and remain exposed until manually released by means of the button projecting below the lower-left corner of the cover.

CONTACTS

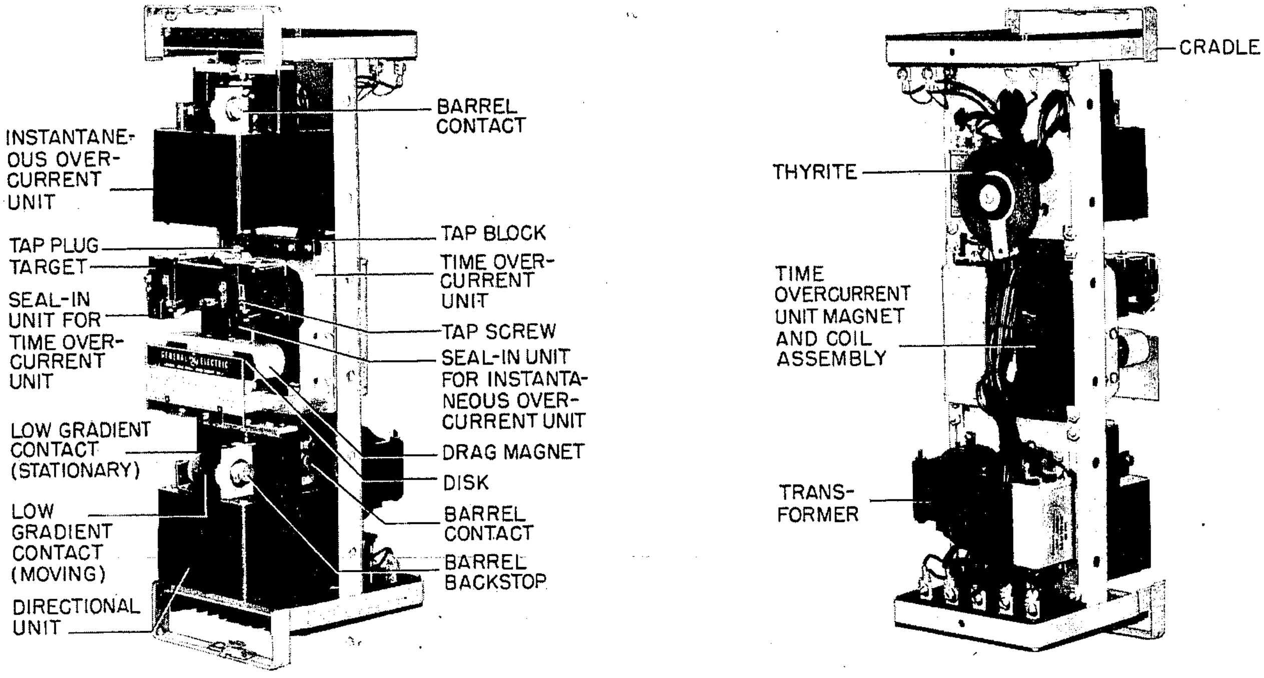
LOW GRADIENT CONTACT

The directional unit contacts (left front), which control the time overcurrent unit, are shown in Fig. 7. They are of the low gradient type specially constructed to minimize the effects of vibration. Both the stationary and moving contact brushes are made of low gradient material which, when subjected to vibration, tend to follow one another, hence, they resist contact separation.

The contact dial (A) supports the stationary contact brush (B) on which is mounted a conical contact tip (C). The moving contact arm (D) supports the moving contact brush (E) on which is mounted a button contact tip (F). The end of the moving contact brush bears against the inner face of the moving contact brush retainer (G). Similarly, the end of the stationary contact brush bears against the inner face of the stationary contact brush retainer (H). The stationary contact support (K) and the contact dial are assembled together by means of a mounting screw (L) and two locknuts (M).

BARREL CONTACT

The directional unit contacts (right rear), which control the instantaneous overcurrent unit, are shown in Fig. 6. They are specially constructed to suppress bouncing. The stationary contact (G) is mounted on a flat spiral spring (F) backed up by a thin diaphgram (C). These are both mounted in a slightly inclined tube (A). A stainless steel ball (B) is placed in the tube before the diaphragm is assembled. When the moving contact hits the stationary contact, the energy of the former is imparted to the latter and thence to the ball, which is free to roll up the inclined tube. Thus, the moving contact comes to rest with substantially no rebound or vibration. To change the stationary contact mounting spring, remove the contact barrel and sleeve as a complete unit after loosening the screw at the front of the contact block. Unscrew the cap (E). The contact and its flat spiral mounting spring may then be removed.



Front View   Rear View

Fig. 8 Type JBCG51E Relay Unit Removed from Case

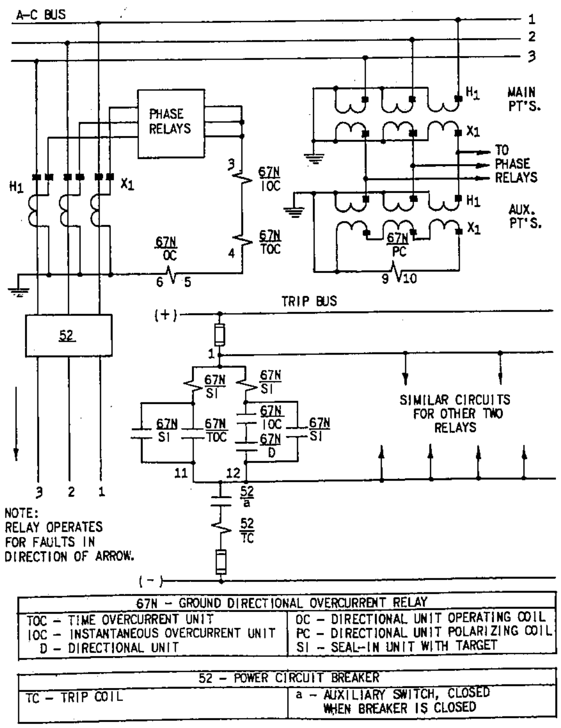


Fig. 9 External Connections For Type JBCG51E Relay For Directional Ground Fault Protection Of A Single Line Using Potential Polarization

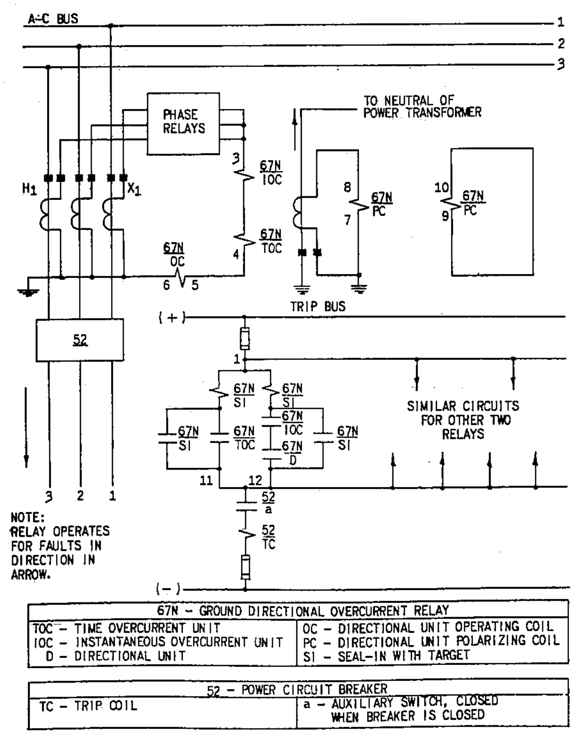


Fig. 10 External Connections For Type JBCG51E Relay For Directional Ground Fault Protection Of A Single Line Using Current Polarization

Fig.8 Front View(8023349) 8 Rear View(8023351)

Fig. 9 (418A939) Fig. 10 (418A940,

CASE

The case is suitable for either surface or semiflush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case ans also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at both ends or at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug which completes the circuits. The outer blocks, attached to the case, have the studs for the external connections, and the inner blocks have the terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit the cover is first removed and the plug drawn out. Shorting bars are provided in the case to short the current transformer circuits. The latches are then released, and the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel either from its own source of current and voltage, or from other sources. Or, the relay unit can be drawn out and replaced by another which has been tested in the laboratory.

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration and well lighted to facilitate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel drilling diagram is shown in Fig. 19.

CONNECTIONS

The internal connection diagrams for the various relays are shown in Figs. 2 through 5. Typical wiring diagrams are shown in Figs. 9 and 10.

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B & S gage copper wire or its equivalent.

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other imperfections. If any trouble is found, it should be corrected in the manner described under MAINTENANCE.

OPERATION

Before the relay is put into service, it should be given a check to determine that factory adjustments have not been disturbed. The time dial will be set at zero before the relay leaves the factory. It is necessary to change this setting in order to open the time overcurrent unit contacts.

ADJUSTMENTS

TIME OVERCURRENT UNIT

TARGET AND SEAL-IN UNIT (MARKED "T")

When used with trip coils operating on currents ranging from 0.2 to 2.0 amperes at the minimum control voltage, the target and seal-in tap screw should be set in the 0.2-ampere tap. When the trip coil current ranges from 2 to 30 amperes at the minimum control voltage, the tap screw should be placed in the 2.0 ampere tap.

The seal-in unit tap screw is the screw holding the right-hand stationary contact of the seal-in unit. To change the tap setting, first remove the connecting plug. Then take a screw from the left-hand stationary contact and place it in the desired tap. Next, remove the screw from the other tap and place it back in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. If tap screws are left in both taps, the pickup will be less than 2.0 amperes d-c, but the seal-in unit will take longer to close its contacts.

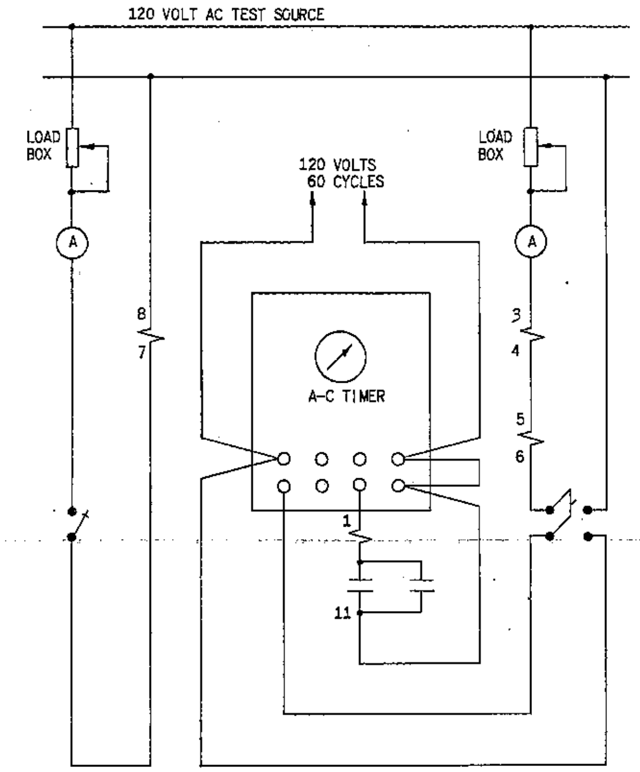


Fig. 11 Test Connections For Checking Pickup And Operating Time Of The Time Overcurrent Unit Using Current Polarization

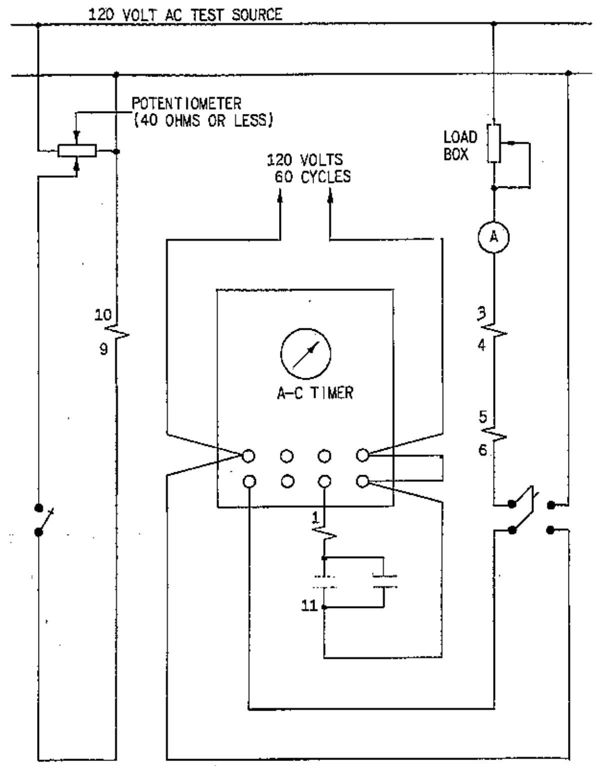


Fig. 12 Test Connections For Checking Pickup And Operating Time Of The Time Overcurrent Unit Using Current Polarization

Fig. 11 (418A976)

Fig. 12 (418A977)

CURRENT SETTING

The minimum current at which the time overcurrent unit will close its contacts is determined by the position of the plug in the tap block. The tap plate on this block is marked in amperes, as shown in Table II.

When the tap setting is changed with the relay in its case, the following procedure must be followed: (1) remove the connecting plug; this de-energizes the relay and shorts the current transformer secondary winding. (2) remove the tap plug and place it in the tap marked for the desired pick-up current. (3) replace the connecting plug.

The minimum current required to rotate the disk slowly and to close the contacts should be within five per cent of the value marked on the tap plate for any tap setting and time dial position. If this adjustment has been disturbed, it can be restored by means of the spring adjusting ring. The ring can be turned by inserting a screw driver blade in the notches around the edge. By turning the ring, the operating current of the unit can be brought into agreement with the tap setting employed. This adjustment also permits any desired setting to be obtained intermediate between the available tap settings.

Test connections for making pickup and time checks on the time overcurrent unit are shown in Fig. 11 and Fig. 12. Use a source of 120 volts or greater with good wave form and constant frequency. Stepdown transformers or phantom loads should not be employed in testing induction relays since their use may cause a distorted wave form.

TIME SETTING

The operating time of the time overcurrent unit for any given value of current and tap setting is determined by the time dial setting. This operating time is inversely proportional to the current magnitude as illustrated by the time curves in Fig. 17 and Fig. 18. Note that the current values on these curves are given as multiples of the tap setting. That is, for a given time dial setting, the time will be the same for 80 amperes on the 8 ampere tap as for 50 amperes on the 5 ampere tap, since in both cases, the current is 10 times tap setting.

If selective action of two or more relays is required, determine the maximum possible short-circuit current of the line and then choose a time value for each relay that differs sufficiently to insure the proper sequence in the operation of the several circuit breakers. Allowance must be made for the time involved in opening each breaker after the relay contacts close. For this reason, unless the circuit time of operation is known with accuracy, there should be a difference of about 0.5 second (at the maximum current) between relays whose operation is to be selective.

EXAMPLE OF SETTING

The time and current settings of the time overcurrent unit can be made easily and quickly. Each time value shown in Fig. 17 and Fig. 18 indicates the time required for the contacts to close with a particular time-dial setting when the current is a prescribed number of times the current-tap setting. In order to obtain any particular time-current setting, insert the removable plug in the proper tap receptacle and adjust the time dial to the proper position. The following example illustrates the procedure in making a relay setting.

Assume that the relay is being used in a circuit where the circuit breaker should trip on a sustained current of approximately 450 amperes, and that the breaker should trip in one second on a short-circuit current of 3750 amperes. Assume further that current transformers of 60/1 ratio are used.

The current-tap setting is found by dividing minimum primary tripping current by the current transformer ratio. In this case, 450 divided by 60 equals 7.5 amperes. Since there is no 7.5 ampere tap, the 8-ampere tap is used. To find the proper time-dial setting to give one second time delay at 3750 amperes, divide 3750 by the transformer ratio. This gives 62.5 amperes secondary current which is 7.8 times the 8-ampere setting. By referring to the time-current curves Fig. 17 and Fig. 18, it will be seen that 7.8 times the minimum operating current gives a one second time delay for a No. 3.4 time dial setting on an inverse time relay or a No. 6.0 time dial setting on a very inverse time relay.

The above results should be checked by means of an accurate timing device. Slight readjustment of the dial can be made until the desired time is obtained.

Aid in making the proper selection of relay settings may be obtained on application to the nearest Sales Office of the General Electric Company.

DIRECTIONAL UNIT

POLARITY CHECK

The polarity of the external connections to the directional unit, when it is potential polarized, may be checked using load currents. The idea is to obtain current from one current transformer and voltage from the same phase. The voltage is obtained by removing phase 1 from the primary of the wye-broken-delta transformer and shorting the phase-one primary winding. Current is obtained by shorting the current transformers in phases two and three and opening their circuits to the relay. This permits the current transformer in phase one to supply the operating current.

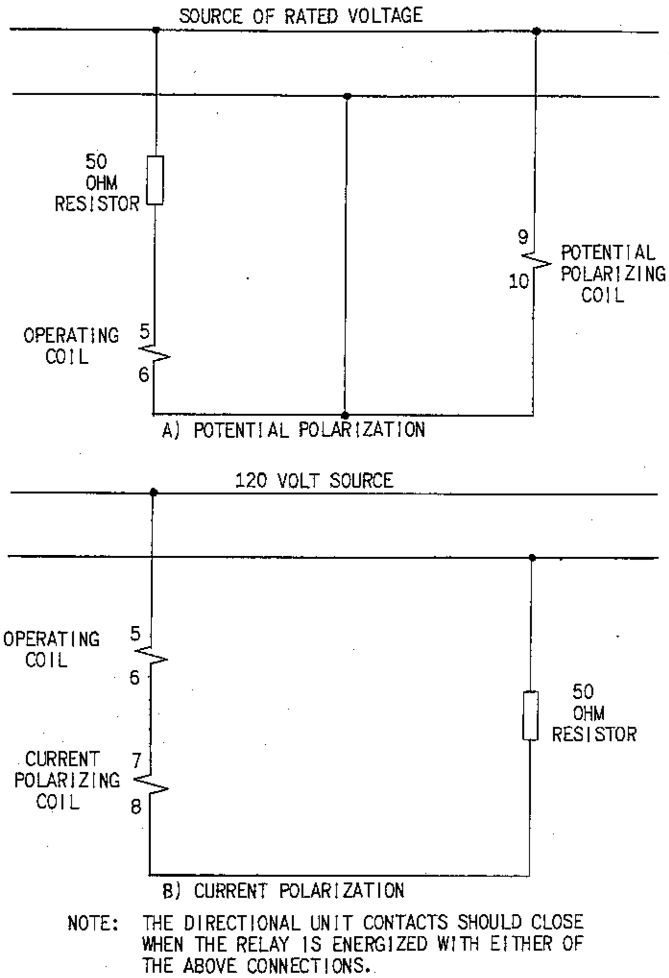


Fig. 13 Test Connections For Checking Polarity Of The Directional Unit Internal Wiring

Fig. 13 (418A969)

Connect a phase angle meter to read the angle between the current and voltage supplied to the relay. The relay has maximum torque at 60 degrees lag. With power flowing in the proper direction for operation, the relay should operate for phase angles within plus or minus 60 degrees of the maximum torque angle.

If the unit is current polarized from a current transformer in the power transformer neutral, such a check is not easily made. It is sometimes practical to introduce a single phase current in one phase of the primary circuits in such a way that current flows through both the transformer neutral current transformer and one of the line current transformers. If this cannot be done, a careful wiring check must suffice.

Fig. 13 shows the test connections for checking the polarity of the directional unit itself.

INSTANTANEOUS OVERCURRENT UNIT

TARGET AND SEAL-IN UNIT (MARKED "I")

The target and seal-in unit for the instantaneous overcurrent unit, is mounted on the right-hand side of the time overcurrent unit and is identified by a white "I" engraved on its front. The unit is identical with the target and seal-in unit of the time overcurrent unit, and the same instructions should be followed in adjusting the unit.

PICKUP SETTING

The pickup of the instantaneous overcurrent unit can be adjusted over a four-to-one range, as indicated in Table III, by varying the tension of the spiral control spring. The outside end of this spring is fastened to a post on the adjusting ring above the moving contact, and the ring is in turn clamped in position by a hexagonal-head locking screw. If this screw is loosened, the ring can be slipped to vary the spring tension.

In adjusting pickup, the desired pick-up current should be passed through the coils, and the control spring should be adjusted until the contact just closes. The adjusting ring should then be locked in position and the pick-up current rechecked. Note that the directional-unit contacts must be held closed during this adjustment.

MAINTENANCE

These relays are adjusted at the factory and it is advisable not to disturb the adjustments. If, for any reason, they have been disturbed, the following points should be observed in restoring them:

TIME OVERCURRENT UNIT

DISK AND BEARINGS

The lower jewel may be tested for cracks by exploring its surface with the point of a fine needle. The jewel should be turned up until the disk is centered in the air gaps, after which it should be locked in this position by the set screw provided for this purpose. The upper bearing pin should next be adjusted so that the disk shaft has about 1/64 inch end play.

CONTACT ADJUSTMENT

The contacts should have about 1/32 inch wipe. That is, the stationary contact tip should be deflected about 1/32 inch when the disk completes its travel. Wipe is adjusted by turning the wipe adjustment screw thereby adjusting the position of the brush relative to the brush stop. On two-circuit closing relays, the two stationary contact tips should be in the same vertical plane.

When the time dial is moved to the position where it holds the contacts just closed, it should indicate zero on the time-dial scale. If it does not and the brushes are correctly adjusted, shift the dial by changing the position of the arm attached to the shaft just below the time dial. Loosen the screw clamping the arm to the shaft and turn the arm relative to the shaft until the contacts just make for zero time-dial setting.

DIRECTIONAL UNIT

BEARINGS

The lower jewel bearing should be screwed all the way in until its head engages the end of the threaded core support. The upper bearing should be adjusted to allow about 1/64 inch end play to the shaft.

To check the clearance between the iron core and the inside of the rotor cup, press down on the contact arm near the shaft, thus depressing the spring-mounted jewel until the cup strikes the iron. The shaft should move about 1/16 inch.

The lower jewel can be tested for fractures by exploring its surface with a fine needle.

CUP AND STATOR

Should it be necessary to remove the cup-type rotor from the directional unit, the following procedure should be followed:

All leads to the unit should first be disconnected and tagged for identification in reconnecting. The unit can then be removed from the cradle with its mounting plate still attached.

The upper of the three flat-head screws holding the unit to the plate should now be removed. On some models, it may be necessary to remove a resistor or capacitor to expose this screw. The four corner screws clamping the unit together, should next be removed, and the entire top structure lifted off. This gives access to the cup assembly and exposes the stator assembly, which should be protected to keep it free from dust and metallic particles until the unit is reassembled.

To remove the shaft and rotor from the contact head assembly, the spring clip at the top of the shaft must be pulled out and the clutch adjusting screw taken out of the side of the molded contact arm. The shaft and cup can now be pulled out of the molding. The rotor must be handled very carefully while it is out of the unit.

CONTACT ADJUSTMENTS

To facilitate adjustment of contacts, remove the two red jumper leads from terminals 18, 19, and 20 and use a neon indicating lamp in series with an AC voltage supply across terminals 18 & 19 and 19 & 20 to signify all contact closures. Refer to Fig. 6 and Fig. 7 for identification of barrel and low gradient contact parts respectively and proceed as follows:

Loosen slightly the screw which secures the barrel backstop (located at the right front corner of the unit) to its support. This screw should be only loose enough to allow the barrel to rotate in its sleeve but not so loose as to allow the sleeve to move within the support. Unwind the barrel backstop so that the moving contact arm is permitted to swing freely. Adjust the tension of each low gradient contact brush so that 1-2 grams of pressure are required at the contact tip in order to cause the end of the brush to separate from the inner face of its respective brush retainer. Adjust the spiral spring until the moving contact arm is in a neutral position, i.e., with the arm pointing directly forward. Loosen the locknut which secures the low gradient stationary contact mounting screw to the stationary contact support. Wind the mounting screw inward until the low gradient stationary and moving contact members just begin to touch. Unwind the mounting screw until the stationary contact brush is vertical with the stationary contact brush retainer down. Then tighten the locknut which secures the mounting screw to the stationary contact support.

Loosen slightly the screw which secures the barrel contact to its support. This screw should be only loose enough to allow the barrel to rotate in its sleeve, but not so loose as to allow the sleeve to move within the support. Wind the barrel backstop in until the low gradient moving and stationary contact members just begin to touch. Wind the barrel contact in until the barrel contacts just begin to touch. Unwind the barrel contact 1/4 turn. Tighten the screw which secures the barrel contact to its support. Unwind the barrel backstop 2/3 turn. Tighten the screw which secures the barrel backstop to its support. Make sure that this screw is not so tight that it prevents the ball from rolling freely within the barrel. Finally, adjust the tension on the low gradient stationary contact brush such that, when the low gradient contacts are made and fully wiped in, there is approximately an equal deflection on each brush.

CAUTION: When the above adjustments are complete, be sure to replace the two red jumper leads.

TORQUE ADJUSTMENT

Connect the current operating and current polarizing coils in series by connecting a jumper across terminals 6 and 7. Apply current to terminals 5 and 8 and adjust the directional unit spiral spring so that the unit picks up at 0.5 ampere.

The core of the directional unit has a small flat portion, the purpose of which is to minimize the effect of bias torques produced on the rotor. Such torques can be produced by any one of the operating or polarizing quantities acting alone with the other two circuits de-energized. The adjustment of the core is made at the factory, but may be checked by observing that the unit responds as outlined below:

Short circuit terminals 9 and 10 and connect the circuit shown in Fig. 14A. Set I_o for 0.25 ampere and I_p for 30 amperes and check that the unit does not operate. Higher values of I_p may be

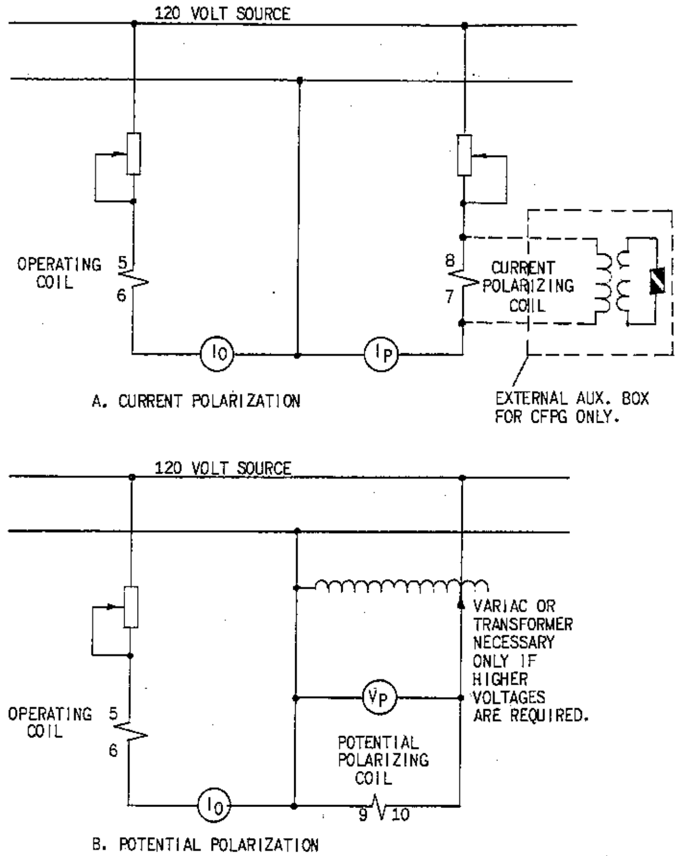


Fig. 14 Test Connections For Checking Proper Directional Unit Core Position

used if such values of polarizing can be expected from the system. Open the current polarizing circuit, adjust I_o for 7 amperes, and check that the unit does not operate.

Unshort terminals 9 and 10 and connect the circuit shown in Fig. 14B. Set I_o for 0.25 ampere and V_p for 120 volts and check that the unit does not operate. Higher values of V_p may be used if such values of polarizing voltage can be expected from the system.

If the unit does not satisfy the above conditions, rotate the core to a position which causes it to do so. The core can be turned by loosening the large hexagonal nut at the bottom of the unit and turning the core by means of the slotted bearing screw. This screw should be held securely in position when the nut is retightened.

Keep in mind that thirty amperes will cause the current polarizing coils and thyrite resistor to overheat if left on too long. Therefore, leave the test current on only for short intervals and allow sufficient time between tests for the coils and thyrite to cool.

Fig. 14 (418A986)

CLUTCH ADJUSTMENT

The connections shown in Fig. 13 for the polarity check can also be used in making the clutch adjustment. The clutch should be adjusted using either potential or current polarization, not both. The 50 ohm resistor should be replaced with an adjustable resistor capabable of providing the current range listed in Table VII for the relay rating in question. A screw, projecting from the side of the moving contact arm, controls the clutch pressure, and consequently the current value at which the clutch will slip. With rated frequency (and at rated volts for potential polarization), the clutch should be set to slip at the current values listed in Table VII.

TABLE VII

DIRECTIONAL UNIT CLUTCH ADJUSTMENT

Method of Polarization	Tap Range (Amps)	Amperes for Clutch to Slip
Current	0.5/2	10-15
Current	1.5/6	10-15
Current	4/16	20-25
Potential	0.5/2	7-10
Potential	1.5/6	7-10
Potential	4/16	12-15

INSTANTANEOUS OVERCURRENT UNIT

BEARINGS

The section BEARINGS, under DIRECTIONAL UNIT, also applies to the bearings of the instantaneous overcurrent unit.

CUP AND STATOR

The section CUP AND STATOR, under DIRECTIONAL UNIT, also applies to the cup and stator of the instantaneous overcurrent unit.

CONTACT ADJUSTMENTS

The contact gap may be adjusted by loosening slightly the screw at the front of the contact support. The screw should be only loose enough to allow the contact barrel to rotate in its sleeve.

The backstop screw fastened with a locknut should hold the moving contact arm in a neutral position, i.e., with the arm pointing directly forward. Then, by rotating the barrel, advance the stationary contact until it just touches the moving contact. Next, back it away 2/3 turn to obtain approximately 0.020 inch gap. Last, tighten the screw which secures the barrel.

The moving contact may be removed by loosening the screw which secures it to the contact arm and sliding it from under the screw head.

CLUTCH ADJUSTMENT

The clutch on the instantaneous overcurrent unit can be adjusted by means of the screw located on the right-hand side of the moving contact arm. If the locknut is loosened and the screw turned in, the current at which the clutch will slip will be increased. The clutch should be adjusted to slip at the current values shown in Table VIII with the directional unit contacts held closed.

TABLE VIII

INSTANTANEOUS OVERCURRENT UNIT CLUTCH ADJUSTMENT

PICKUP RANGE	CLUTCH MUST NOT SLIP AT	CLUTCH MUST SLIP AT
2 - 8	12	16
4 - 16	24	32
* 10 - 40	-	-
* 20 - 80	-	-
* 40 - 160	-	-

* Tighten clutch as much as possible.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine fine. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility of the tool insures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent contact closing.

The burnishing tool described above can be obtained from the factory.

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 part wanted, and give complete nameplate data, and the serial number which may be found stamped on the instantaneous unit in black ink. If possible, give the General Electric Company requisition number on which the relay was furnished.

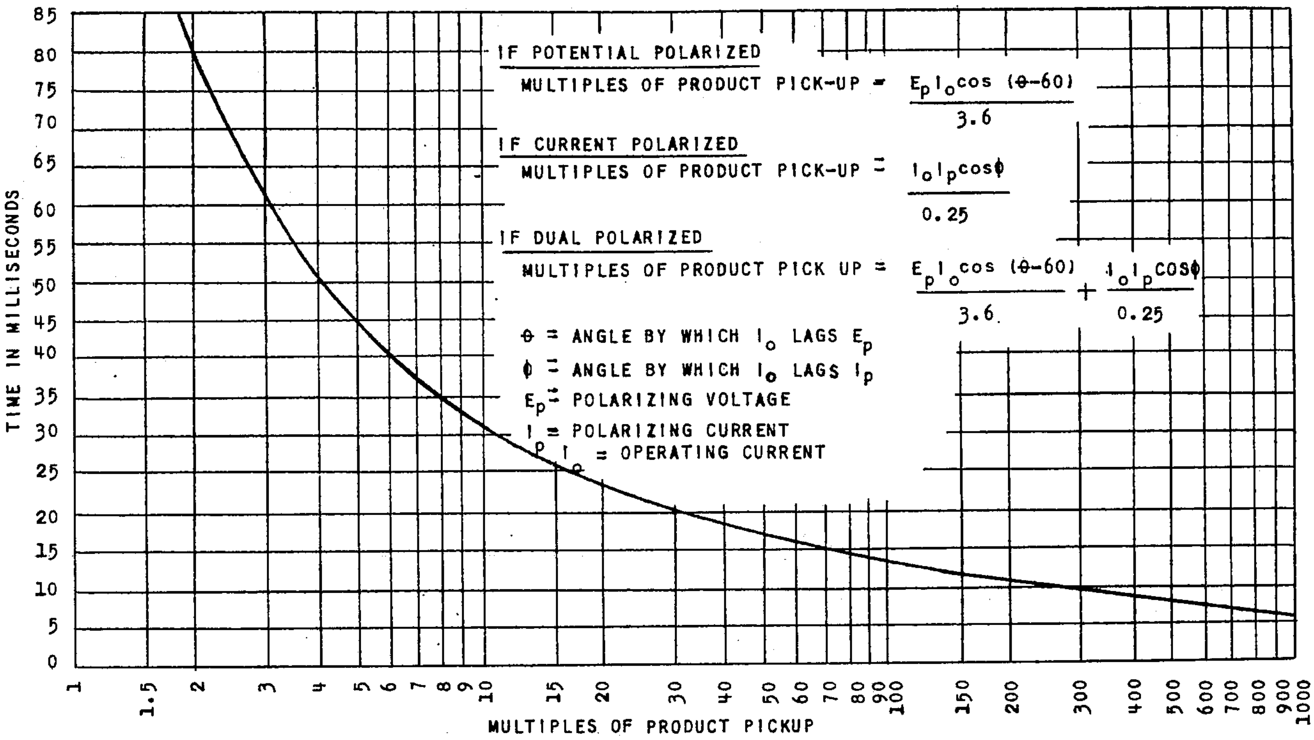


Fig. 15 Directional Unit Time Curve, Current or Potential Polarized

Fig. 15 (376A934)

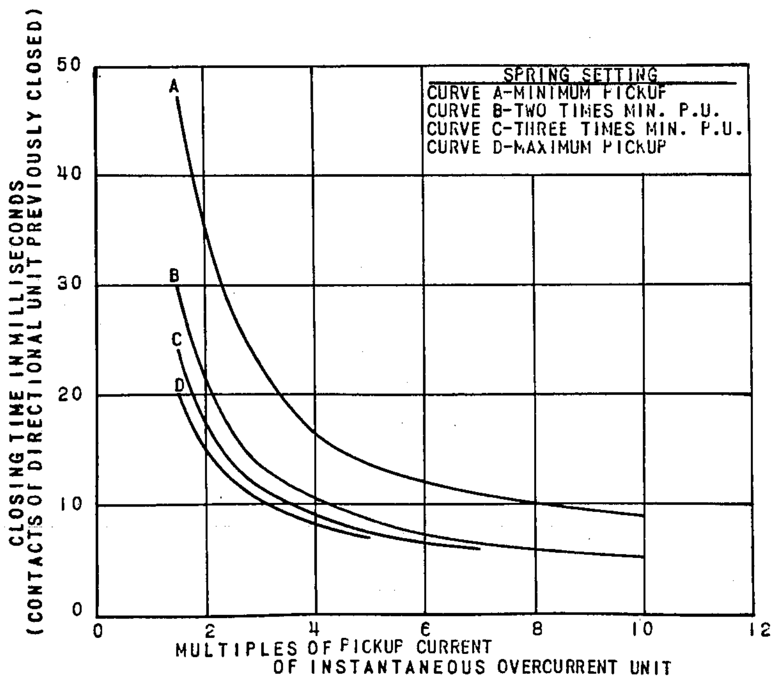


Fig. 16 Instantaneous Overcurrent Unit Time Curve

Fig. 16 (K-6556439)

Fig. 17 (K-6306879)

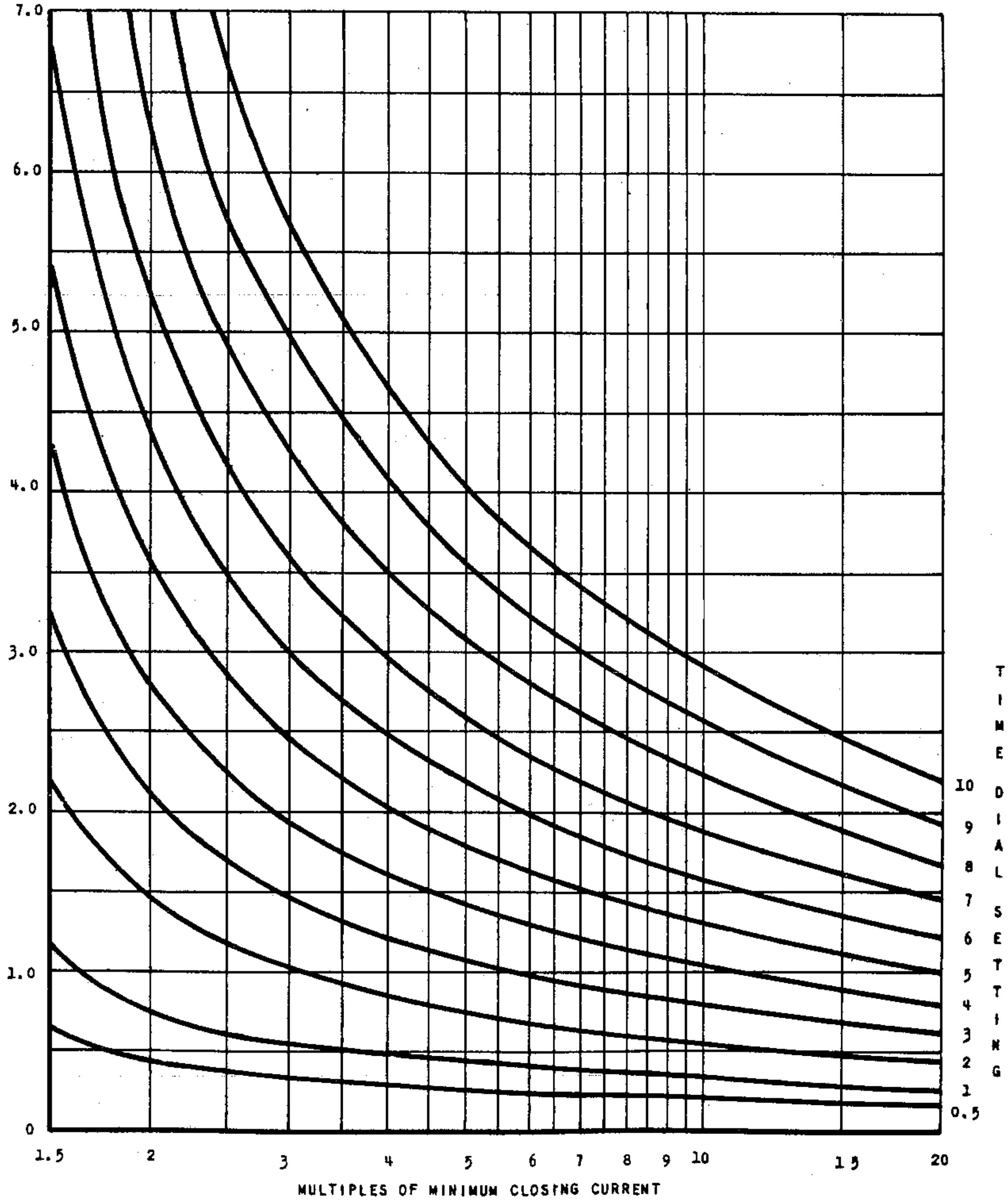


Fig. 17 Time-Current Curves For Inverse Time Overcurrent Unit

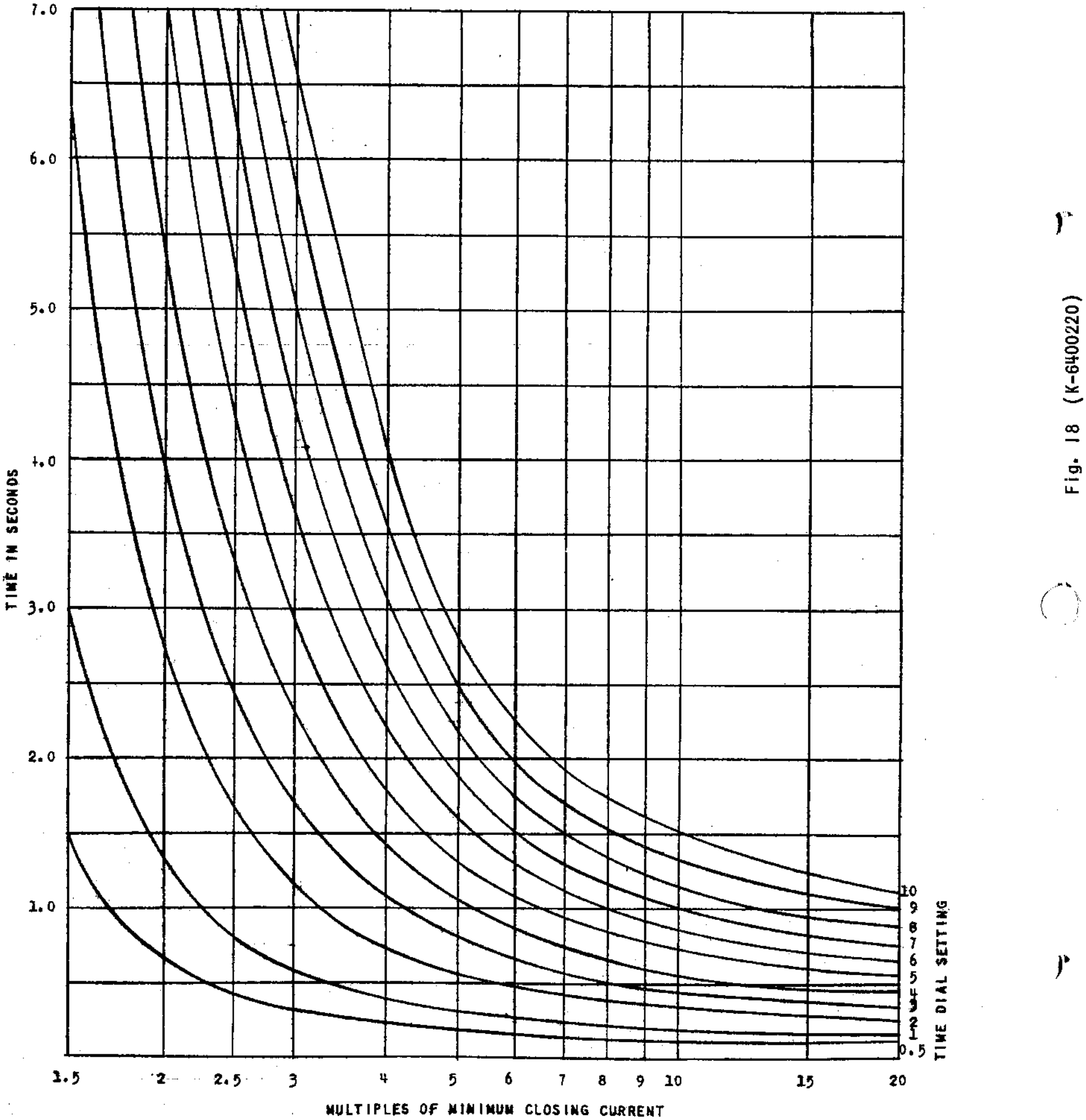


Fig. 18 Time-Current Curves For Very Inverse Time Overcurrent Unit

Fig. 19 (K-6209276)

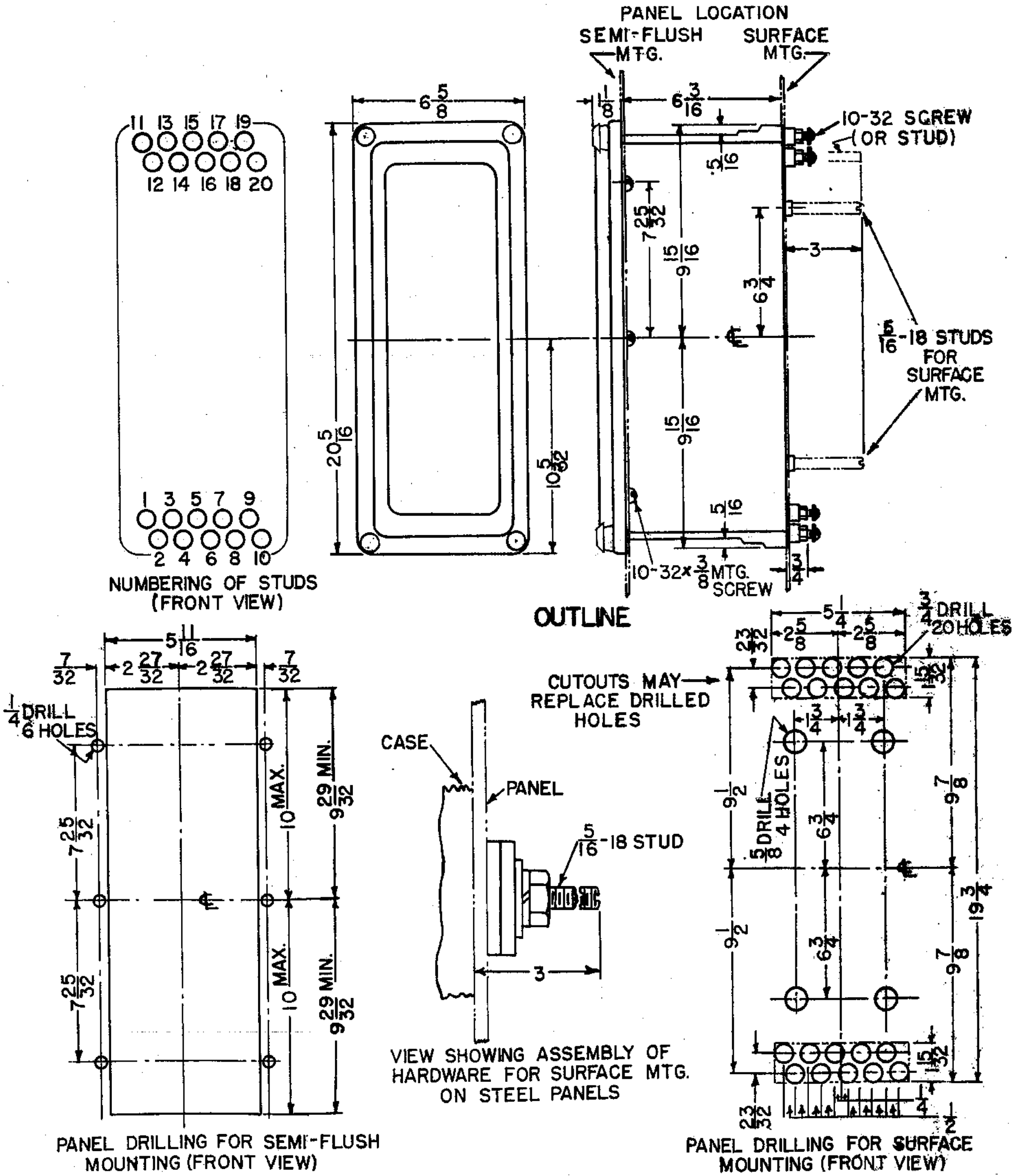


Fig. 19 Outline and Panel Drilling Dimensions

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Cleveland 4, Ohio . . . 4966 Woodland Ave.
Columbus 23, Ohio . . . 2128 Eakin Rd.
Corpus Christi, Texas . . . 115 Busse St.
Dallas, Texas . . . 3202 Manor Way
Denver, Colo. . . . 3353 Larimer St.
Detroit 2, Mich. . . . 5950 Third Ave.
Ft. Wayne, Ind. . . . 606 W. Superior St.
Hialeah, Fla. . . . 1062 E. 28th St.
Houston 20, Texas . . . 5534 Harvey Wilson Dr.
Indianapolis 22, Ind. . . . 1740 W. Vermont St.
Johnstown, Pa. . . . 841 Oak St.
Kansas City 20, Mo. . . . 3525 Gardner Ave.
Los Angeles 1, Calif. . . . 6900 Stanford Ave.
Louisville, Ky. . . . 3900 Critten Dr.
Midland, Tex. . . . 3404 Bankhead Hwy.
Milwaukee 3, Wisc. . . . 940 W. St. Paul Ave.
Minneapolis 12, Minn. . . . 2025 49th Ave., N.
New Orleans, La. . . . 2815 N. Robertson St.
New York—N. Bergen, N. J. . 6001 Tonnelle Ave.
Oakland, Calif. . . . 1525 Peralta St.
*Ontario, Calif. . . . Ont. Int'l Airport
Philadelphia 24, Pa. . . . 1040 E. Erie Ave.
Pittsburgh 6, Pa. . . . 6519 Penn Ave.
Portland 10, Oregon . . . 2727 N.W. 29th Ave.
Richmond 24, Va. . . . 1403 Ingram Ave.
Roanoke 7, Va. . . . 115 Albermarle Ave., S.E.
Sacramento, Calif. . . . 99 N. 17th St.
St. Louis 10, Mo. . . . 1115 East Rd.
Salt Lake City 4, Utah . . . 301 S. Seventh W. St.
San Francisco 3, Calif. . . . 1098 Harrison St.
Seattle 4, Wash. . . . 3422 First Ave., S.
*Seattle 4, Wash. . . . 3422 First Ave., S.
Southington, Conn. . . . 45 Railroad Ave.
Spokane 3, Wash. . . . S. 155 Sherman St.
Tampa 1, Fla. . . . P.O. Box 1245
Toledo 4, Ohio . . . 405 Dearborn St.
York, Pa. . . . 54 N. Harrison St.
Youngstown 7, Ohio . . . 272 E. Indianola Ave.

GENERAL ELECTRIC COMPANY, PHILADELPHIA, PA.

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