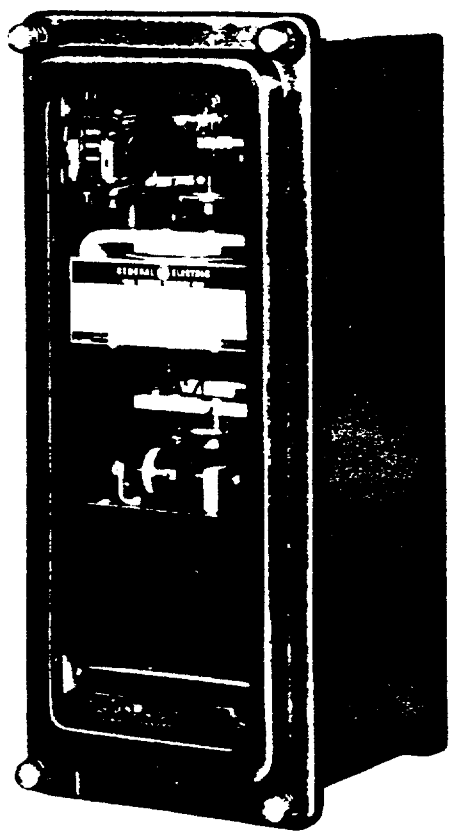
INSTRUCTIONS

GEH-1817C

SUPERSEDES GEH-1817B

PHASE DIRECTIONAL OVERCURRENT RELAYS

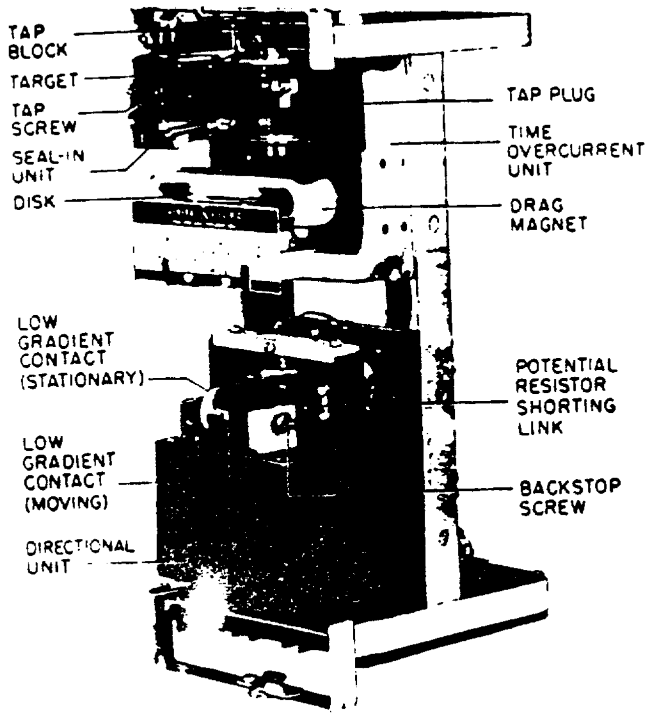


Types

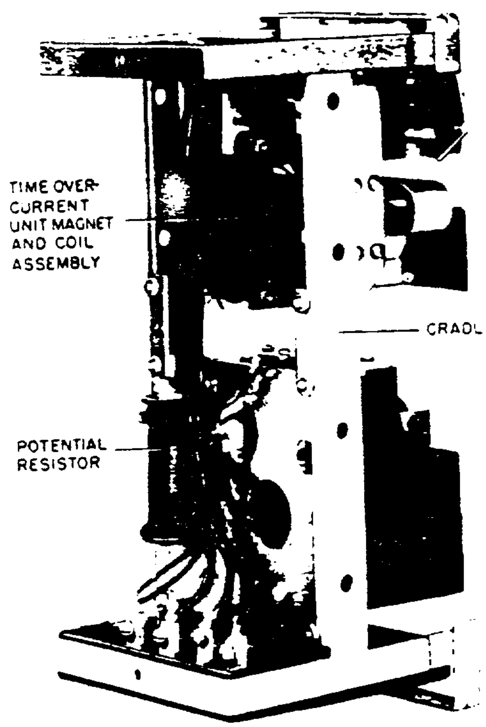
IBC51E IBC53H IBC77E

IBC52E IBC54H IBC78E

GENERAL ELECTRIC



Front View



Rear View

Fig. 1 Type IBC51E Relay Unit Removed From Case

Fig. 1 Front View (8023359)

Fig. 1 Rear View (802335

Cover (8023361)

PHASE DIRECTIONAL OVERCURRENT RELAYS
TYPE IBC

INTRODUCTION

Type IBC relays are single phase, directional overcurrent relays used primarily for the protection of feeders and transmission lines. They are available with either inverse, very inverse or extremely inverse time characteristics.

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

APPLICATION

Type IBC relays are generally applied for phase fault protection of a single line. Since fault currents are usually highly lagging, the quadrature (90 degree) connection of current and potential transformers should be used. With these connections, the directional unit will develop approximately maximum torque under usual fault conditions. The vector relationships associated with these connections are shown in Table II.

The quadrature connections, shown in Fig. 8, provides the most reliable potential for the directional unit during usual fault conditions. At the relay terminals, the current, at unity power-factor load, leads the potential by 90 degrees. With the connection, the potential resistor shorting-link should be opened by disconnecting it from the top screw. This link is located on the right hand post at the top of the cup unit. (See Fig. 1). This gives the relay an approximate maximum torque angle characteristic of 45 degrees lead (current leads voltage). Hence, the directional unit will develop maximum operating torque when the fault current lags its unity power-factor position by about 45 degrees.

When a directional-overcurrent ground relay is present and Type IBC relays are used in only two of the phases, then the phase from which the phase relay is omitted must be the same throughout the system.

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 and extremely 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 and even longer with extremely inverse time relays. For such cases, the inverse time relay is more applicable.

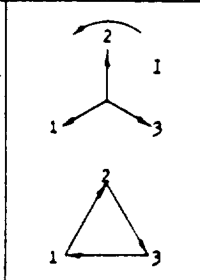
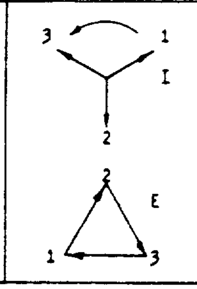
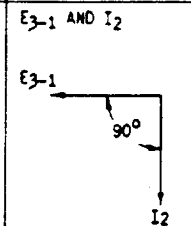
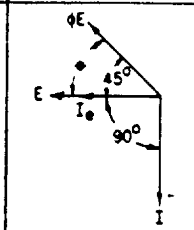
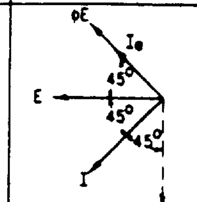
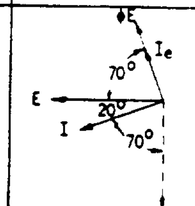
The choice between very inverse and extremely inverse time relays is more limited than between them and the inverse time relay as they are more nearly alike in their time-current characteristic curves. For grading with fuses the extremely inverse time relay should be chosen as the time-current curves more nearly match the fuse curve. Another advantage of the extremely inverse relay is that it is better suited than both the inverse and very inverse relays for picking up cold load. For any given cold load pick-up capability, the resulting settings will provide faster protection at high fault currents with the extremely inverse relay than with the less inverse relays.

TABLE I

Relay Model	Time Characteristic	Circuit Closing Contacts	Internal Connections
IBC51E	Inverse	One	Fig. 2
IBC52E	Inverse	Two	Fig. 3
IBC53H	Very Inverse	One	Fig. 4
IBC54H	Very Inverse	Two	Fig. 5
IBC77E	Extr. Inverse	One	Fig. 6
IBC78E	Extr. Inverse	Two	Fig. 7

TABLE II

CONDITIONS FOR MAXIMUM TORQUE USING 90° CONNECTION

CONNECTION (1-2-3 PHASE SEQUENCE - AT 60 CYCLES)	PHASE RELATIONSHIP AT RELAY TERMINALS FOR CURRENT FLOWING IN THE NON-TRIP DIRECTION AT UNITY POWER FACTOR LOAD.	PHASE RELATIONSHIP AT RELAY TERMINALS FOR CURRENT FLOWING IN THE TRIPPING DIRECTION AT UNITY POWER FACTOR LOAD.	VOLTAGE AND CURRENT USED IN PHASE 2 RELAY WITH PHASE RELATIONSHIP AT UNITY P.F. LOAD WHEN CURRENT FLOWS IN TRIPPING DIRECTION.	VECTOR RELATIONSHIP OF EDDY-CURRENTS IN INDUCTION CYLINDER TO FLUX SET UP BY POTENTIAL WINDING AT UNITY P.F. LOAD-SHORTING LINK OFF.	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK OFF.	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK ON.
QUADRATURE (CURRENT LEADS POTENTIAL 90 DEGREE WHEN FLOWING IN TRIPPING DIRECTION AT UNITY P.F. LOAD)			 I LEADS E BY 90 DEGREES		 MAX. TORQUE OCCURS WHEN I LAGS ITS UNITY P.F. POSITION BY 45 DEGREES.	 MAX. TORQUE OCCURS WHEN I LAGS ITS UNITY P.F. POSITION BY 70 DEGREES.

NOTES: I_e = EDDY-CURRENT IN INDUCTION CUP, SET UP BY I.
ϕ = FLUX IN POTENTIAL WINDING.
θ = ANGLE BETWEEN I_e AND ϕ_E.
TORQUE = $K\phi_E \cos\theta$

Table II (264B453-0)

OPERATING CHARACTERISTICS

PICKUP

At the maximum torque angle, the directional unit will pick up at one percent of rated voltage with 2 amperes for relays with 1.5/6 ampere time overcurrent units, and 4 amperes for relays with 4/16 ampere time overcurrent units.

The maximum operating current required to close the time overcurrent unit contacts, at any time-dial position, will be within five percent of the tap plug setting.

RESET

The minimum percentage of minimum closing current at which the time overcurrent unit will reset is 90% for inverse-time relays and 85% for very inverse and extremely 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 and extremely inverse time relays.

OPERATING TIME

The time curves of the time overcurrent unit are shown in Figs. 14, 15 and 16 respectively for inverse, very inverse and extremely inverse time relays. For the same operating conditions, the relay will operate repeatedly within one or two percent of the same time.

RATINGS

CURRENT COILS

The continuous and short time ratings of the operating coil circuits are shown in Table III.

TABLE III

RATINGS OF TIME OVERCURRENT UNIT OPERATING COILS

Tap Range (Amps)	Tap Ratings (Amps)	* Cont. Rating (Amps)	One Sec. Rating (Amps)
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

* The continuous rating of the operating circuit is limited by the directional unit operating coil.

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-ampre tap is for use with trip coils which operate on currents ranging from 0.2 up to 2.0 amperes, 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 2 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

0.2/2.0 Amp. Target Seal-in Unit			
Tap Used		0.2	2.0
Carry 30 Amps For	(Sec)	0.05	2.2
Carry 10 Amps For	(Sec)	0.45	20
Carry Continuously	(Amps)	0.37	2.3
Minimum Operating	(Amps)	0.2	2.0
Minimum Drop-out	(Amps)	0.05	0.5
D-C Resistance	(Ohms)	8.3	0.24
60 Hertz Impedance	(Ohms)	50	0.65
50 Hertz Impedance	(Ohms)	42	0.54

CONTACTS

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

BURDENS

Tables V and VI give the burdens of the potential and current circuits respectively.

TABLE V

POTENTIAL CIRCUIT BURDENS AT 60 CYCLES AND RATED VOLTS

Potential Resistor Shorting Link	Volt Amperes	Power Factor	Watts
Open	16.7	0.71	11.8
Closed	21.9	0.38	8.3

TABLE VI

CURRENT CIRCUIT BURDENS AT 60 CYCLES

Time Charac-teristic	Tap Range (Amps)	Burdens At Minimum Pickup				Power Factor	Ohms Impedance At		# VA At Five Amperes
		Eff. Res. (Ohms)	React. (Ohms)	* Imped. (Ohms)	+ Volt Amperes		3 Times Min. P.U.	10 Times Min. P.U.	
Inverse	1.5/6	1.12	3.00	3.20	7.20	0.35	1.90	1.10	80
Inverse	4/16	0.20	0.48	0.52	8.30	0.38	0.31	0.18	13
Very Inverse	1.5/6	0.40	0.83	0.92	2.10	0.43	0.87	0.73	23
Very Inverse	4/16	0.11	0.21	0.24	3.80	0.46	0.22	0.19	6
Extremely Inverse	1.5/6	0.13	0.16	0.21	0.47	0.62	0.21	0.20	5.2
Extremely Inverse	4/16	0.036	0.042	0.053	0.88	0.65	0.055	0.054	1.38

* The impedance values given are those for the minimum tap of each relay. The impedance for other taps, at pickup current (tap rating), varies inversely approximately as the square of the current rating. Example: for the Type IBC51E relay, 1.5/6 amperes the impedance of the 1.5 ampere tap is 3.20 ohms. The impedance of the 3 ampere tap, at 3 amperes, is approximately $(1.5/3)^2 \times 3.20 = 0.80$ 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.

**Indicates Revision

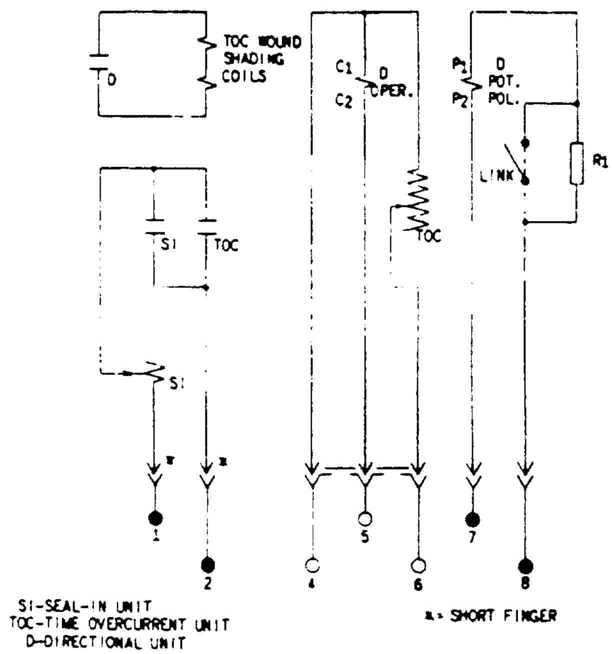


Fig. 2 Internal Connections For Type IBC51E Relay (Front View)

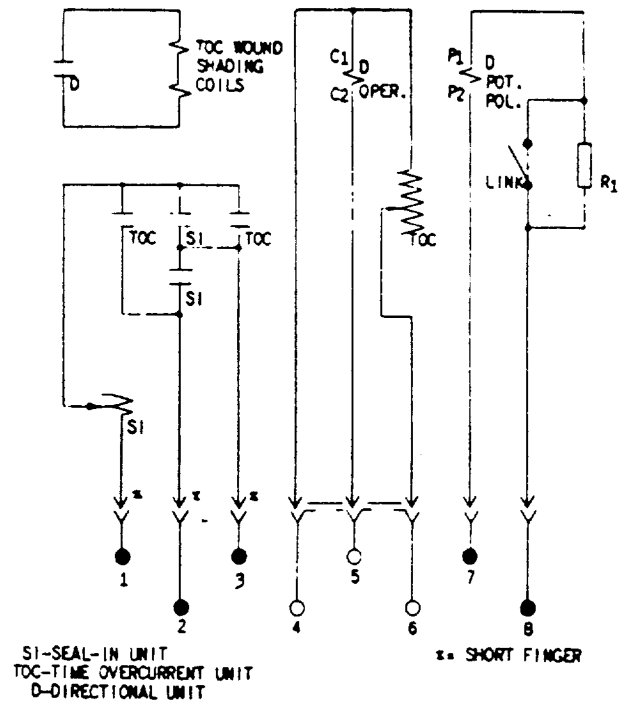


Fig. 3 Internal Connections For Type IBC52E Relay (Front View)

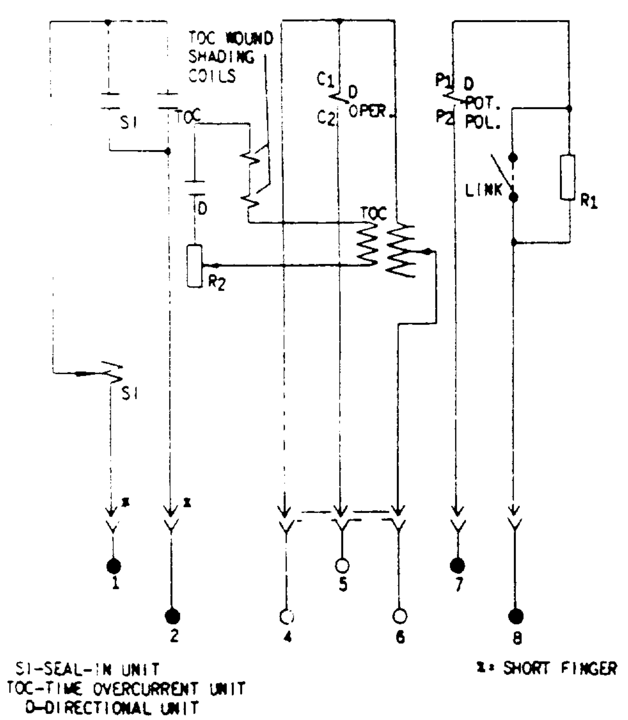


Fig. 4 Internal Connections For Type IBC53H Relay (Front View)

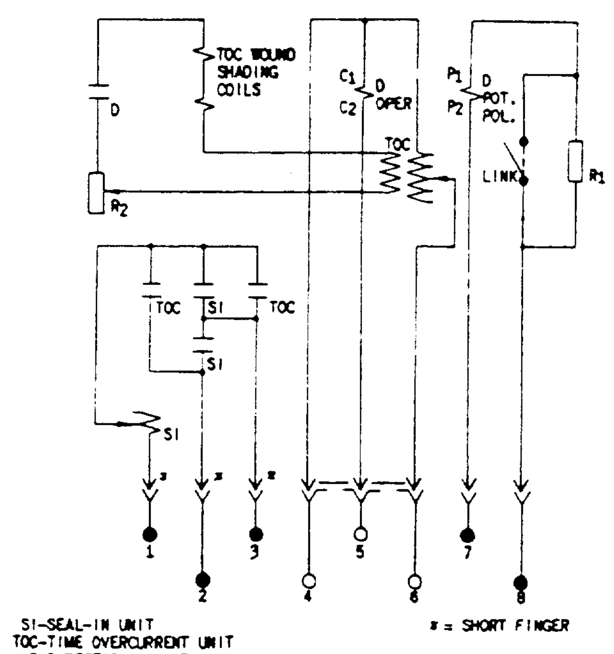


Fig. 5 Internal Connections For Type IBC54H Relay (Front View)

Fig. 2 (418A900-0)
Fig. 3 (418A902-0)
Fig. 4 (418A904-0)
Fig. 5 (418A906-0)

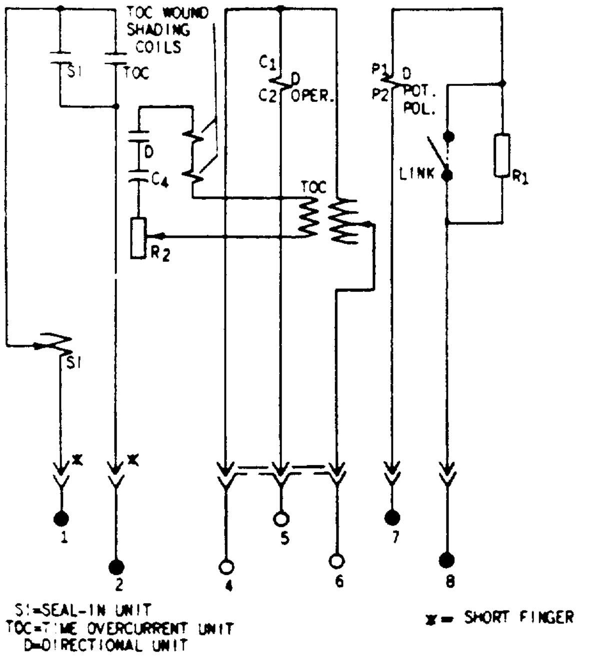


Fig. 6 Internal Connections for Type IBC77E Relay (Front View)

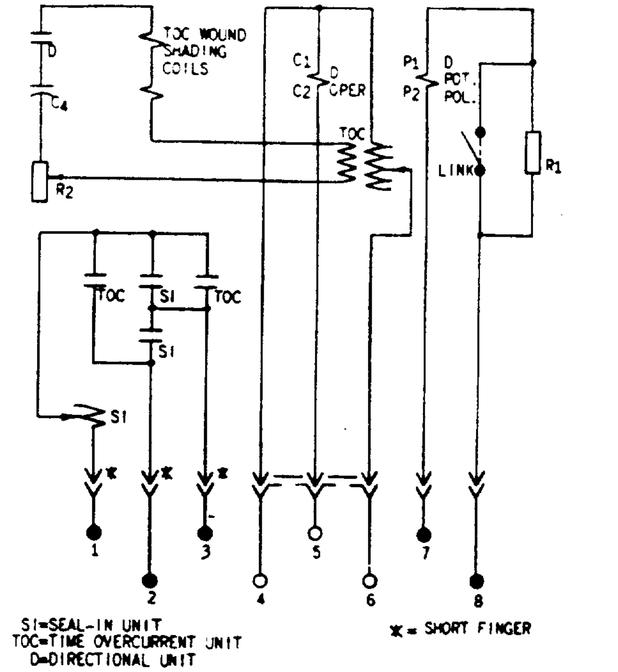


Fig. 7 Internal Connections for Type IBC78E Relay (Front View)

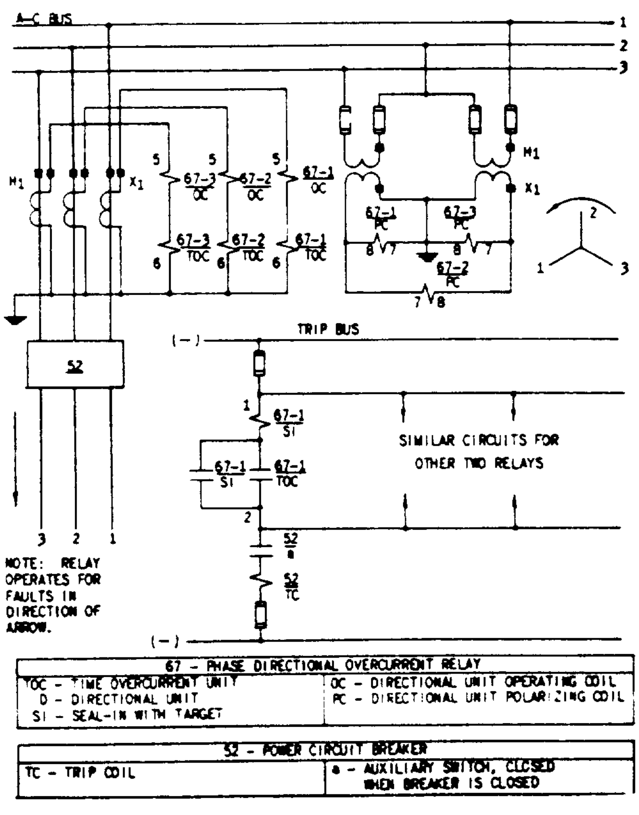
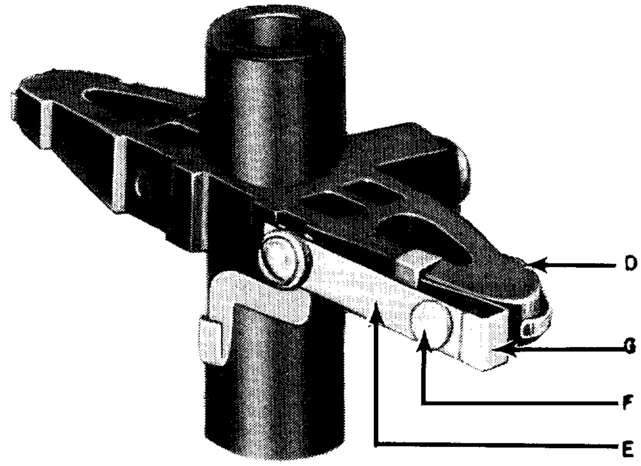


Fig. 8 Quadrature Connection of Three Single Phase Type IBC Relays for Directional Phase Fault Protection of A Single Line

Fig. 6 (0127A9421-0)
Fig. 7 (0127A9422-0)
Fig. 8 (418A931-0)

Stationary Contact Assembly



Moving Contact Assembly

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

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

Fig. 9 Low Gradient Contact Assembly for the Directional Unit

Fig. 9 (8027688) & (8023399)

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.

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 the directional unit contacts. 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 and the extremely inverse time overcurrent units are 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, a capacitor (extremely inverse only), and the two coils on the lower legs of the magnetic circuit. When power flow is in such a direction as to close the directional unit contacts, 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.

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 alternately with current operating coils 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.

SEAL-IN UNIT

A seal-in unit is mounted on the left side of the overcurrent unit as indicated in Fig. 1. This unit has its coil in series and its contacts in parallel with the main contacts of the over-current unit, arranged in such a manner that when the main contacts close, the seal-in unit picks up and seals-in around the main contacts. When the seal-in unit operates, it raises a target into view which latches up and remains exposed until manually released by pressing the button located at the lower-left corner of the cover.

CONTACTS

The directional unit contacts which control the time overcurrent unit, are shown in Fig. 9. 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 stop screw (J), mounted on the contact dial, functions to stop the motion of the contact arm by striking the moving contact brush retainer after the moving and stationary contact members have made contact. The stationary contact support (K) and the contact dial are assembled together by means of a mounting screw (L) and two locknuts (M).

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. 17.

CONNECTIONS

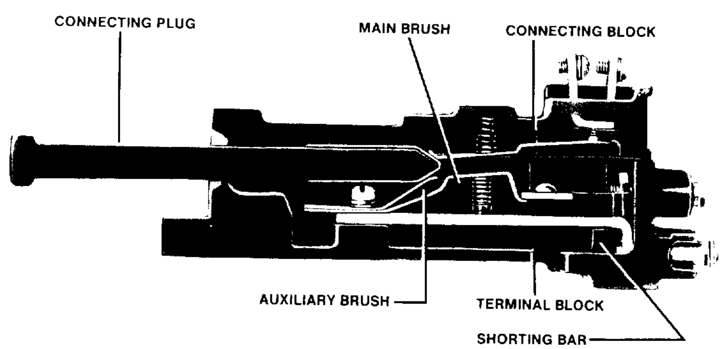
The internal connection diagrams for the various relays are shown in Figs. 2 through 7. A typical wiring diagram is shown in Fig. 8. Note the phase rotation specified in Fig. 8 must be adhered to, if correct directional action is to be obtained.

Unless mounted on a steel panel which adequately grounds the relay case, it is recommended that the case be grounded through a mounting stud or screw with a conductor not less than #12 B & S gauge 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.

CAUTION: Every circuit in the drawout case has an auxiliary brush. It is especially important on current circuits and other circuits with shorting bars that the auxiliary brush be bent high enough to engage the connecting plug or test plug before the main brushes do. This will prevent CT secondary circuits from being opened.



NOTE: AFTER ENGAGING AUXILIARY BRUSH CONNECTING PLUG TRAVELS ¼ INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK.

Fig. 10 Cross Section of Drawout Case Showing Position of Auxiliary Brush

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 overcurrent unit contacts.

ADJUSTMENTS

TIME-OVERCURRENT UNIT

TARGET AND SEAL-IN UNIT

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 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 he 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.

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 III.

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 percent 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. Use a source of 120 volts or greater with good wave form and constant frequency. Step-down 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 Figs. 14, 15 and 16. 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

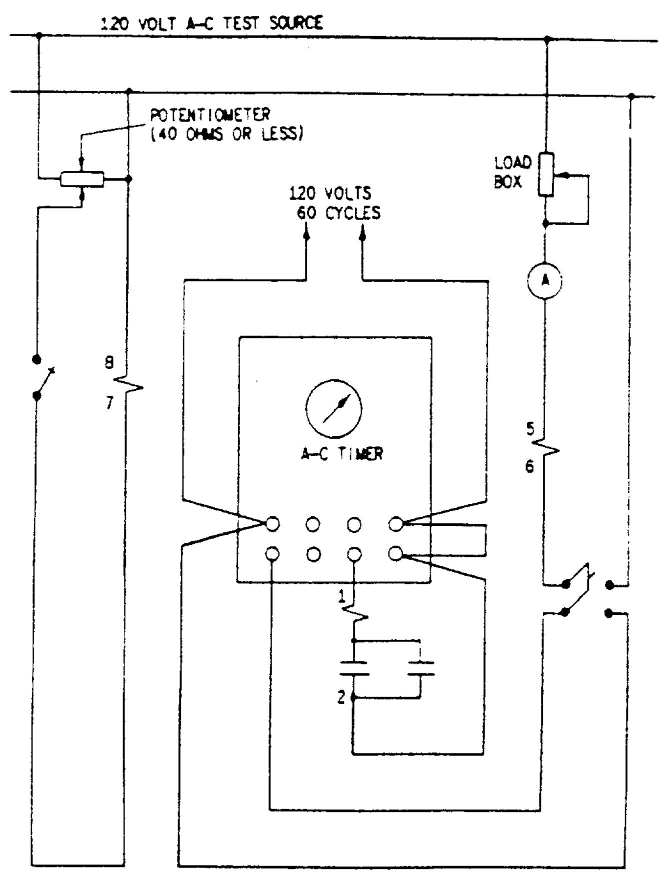


Fig. 11 Test Connections for Checking Pickup and Operating Time of the Time Overcurrent Unit

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 overcurrent unit can be made easily and quickly. Each time value shown in Figs. 14, 15 and 16 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.

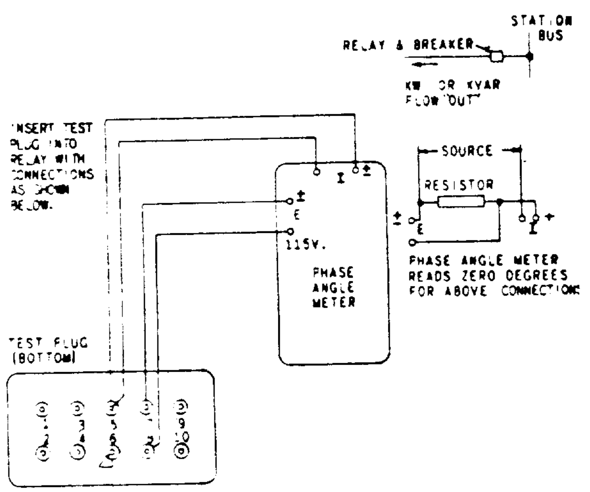
Assume that the relay is being used in a circuit where the circuit breaker should trip on a sustained current of approximately 450 amperes, and that the breaker should trip in one second on a short-circuit current of 3750 amperes. Assume further that current transformers of 60/1 ratio are used.

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 Figs. 14, 15 and 16, 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, a No. 6.0 time dial setting on a very inverse time relay and a No. 10 time dial setting on the extremely inverse time relay.

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

Resistor R2 shown in Figs. 4 to 7 inclusive has been adjusted at the factory and further adjustment is not necessary.

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

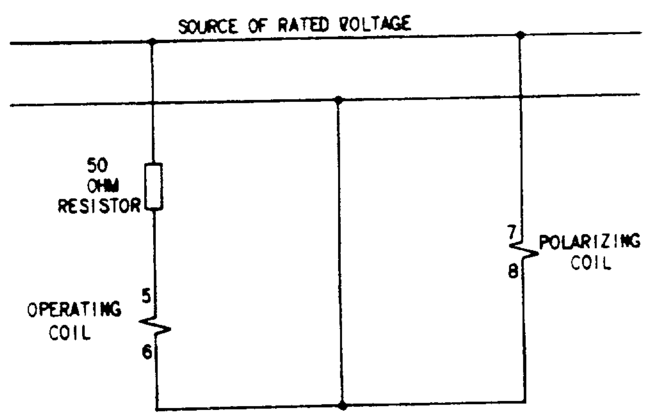


POWER FACTOR ANGLE DEG. LEAD	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-360
KW & KVAR DIRECTIONS WITH RESPECT TO THE BUS	KW OUT KVAR IN	KVAR IN > KW OUT	KVAR IN > KW IN	KW IN KVAR IN	KW IN > KVAR OUT	KVAR OUT > KW IN	KVAR OUT > KW OUT	KW OUT KVAR OUT
METER READING WITH PROPER EXT. CONNS.	30-135	135-180	180-225	225-270	270-315	315-360	0-45	45-90

THE ABOVE RANGES OF PHASE ANGLE METER READINGS ARE THE ANGLES BY WHICH THE CURRENT LEADS THE VOLTAGE WITH THE DESCRIBED CONDITIONS OF POWER (KW) AND REACTIVE POWER (KVAR) FLOW WITH THE STATION BUS CONSIDERED AS THE REFERENCE IN ALL CASES. > MEANS GREATER THAN.
CAUTION. MAKE CORRECTIONS FOR METER ERRORS ON LOW CURRENTS, INHERENT IN SOME PHASE-ANGLE METERS.

Fig. 12 Test Connections for External Wiring of Type IBC Relay using the 90 Degree Connection

Fig. 12 (377A195-3)



NOTE: THE DIRECTIONAL UNIT CONTACTS SHOULD CLOSE WHEN THE RELAY IS ENERGIZED WITH THE ABOVE CONNECTIONS.

Fig. 13 Test Connections for Checking Polarity of the Directional Unit Internal Wiring

Fig. 13 (418A970-0)

DIRECTIONAL UNIT

POTENTIAL RESISTOR SHORTING LINK

The potential resistor shorting link is located on the right hand molded post which supports the bearing plate and is in parallel with a series resistor located in the potential polarizing circuit. With the link open (potential resistor unshorted), the maximum torque angle is 45° lead (current leads voltage). With the link closed (potential resistor shorted), the maximum torque angle is 20° lead (current leads voltage). When the link is left open, it should be attached by the lower screw so that it will not be lost.

POLARITY CHECK

The polarity of the external connections to the directional-unit may be verified by observing the direction of contact armature torque when the line is carrying load at unity power factor, or slightly lagging power factor. Note that in most directional overcurrent relay applications, the desired directions are: contact-closing for power flow away from the bus, and contact opening for power flow toward the bus. In case of doubt refer to Fig. 12 for a more accurate method of checking the polarity of the connections.

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

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 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.

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 keept 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 make contact adjustments, refer to Fig. 9 for identification of low gradient contact parts and proceed as follows:

Loosen the locknut which secures the backstop screw (located at the right hand corner of the unit) to its support. Unwind the backstop screw 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 sprial 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 stationary contact mounting screw to the stationary contact support. Wind the mounting screw inward until the stationary and moving contact members just begin to touch. Unwind the mounting screw until the stationary contact stop lines up with the moving contact brush retainer. Wind the backstop screw inward until the moving and stationary contact members again just begin to touch. Loosen the locknut of the stationary contact stop screw, and advance this screw until it just touches the moving contact brush retainer. Unwind the screw 1-1/2 turns to provide contact wipe. Tighten the locknut. Unwind the backstop screw 2/3 turn and tighten the locknut which secures the backstop screw to its support. Finally, adjust the tension on the stationary contact brush such that, when the contacts are made and fully wiped in, there is approximately an equal deflection on each brush.

TORQUE ADJUSTMENT

The directional unit is provided with a notched core which is used to minimize the torque produced on the rotor by current alone in the operating coils with the polarizing circuits, de-energized. This adjustment is made at the factory and may be checked as follows:

First, short out the potential polarizing circuit. Adjust the control spring so that the moving contact structure is balanced between the stationary contact and the stop. This can be done by loosening the hexagonal-head locking screw, which clamps the spring adjusting ring in position and turning the ring to the left until the balance point is reached.

Energize the operating circuit with 30 amperes for relays with 1.5/6 ampere time overcurrent units or 60 amperes for relays with 4/16 ampere time overcurrent units, and check that the contact arm does not move. The core should be turned in small steps until a point is reached where there is no "bias" torque from current alone. The core can be turned by loosening the large hexagonal nut on 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 currents of these magnitudes will cause the coils 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 to cool.

After the torque adjustments has been made, the spiral spring should be set to have barely enough tension to swing the moving contact arm against the stop screw when the unit is de-energized. Sufficient tension will be obtained if the adjusting ring is rotated about 1/2 inch from the neutral position in the counterclockwise direction, as measured on the periphery of the ring.

CLUTCH ADJUSTMENT

The connections shown in Fig. 13 for the polarity check can also be used in making the clutch adjustment. The 50 ohm fixed resistor should be replaced with an adjustable resistor capable of providing the current range listed in Table VII for the relay type and rating in question. A screw, projecting from the side of the moving contact arm, controls the clutch pressure, and consequently, the current value which will cause the clutch to slip. With rated frequency and at rated volts, the clutch should be set to slip at the current values listed in Table VII. In all cases the current is in phase with the voltage.

TABLE VII

CLUTCH ADJUSTMENT

Potential Resistor Shorting Link	Tap Range (Amps)	Amperes For Clutch To Slip
Closed	1.5/6	11
Closed	4/16	22

CONTACT CLEANING

* For cleaning 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 file. 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.

* 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, thus preventing 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. If possible, give the General Electric Company requisition number on which the relay was furnished.

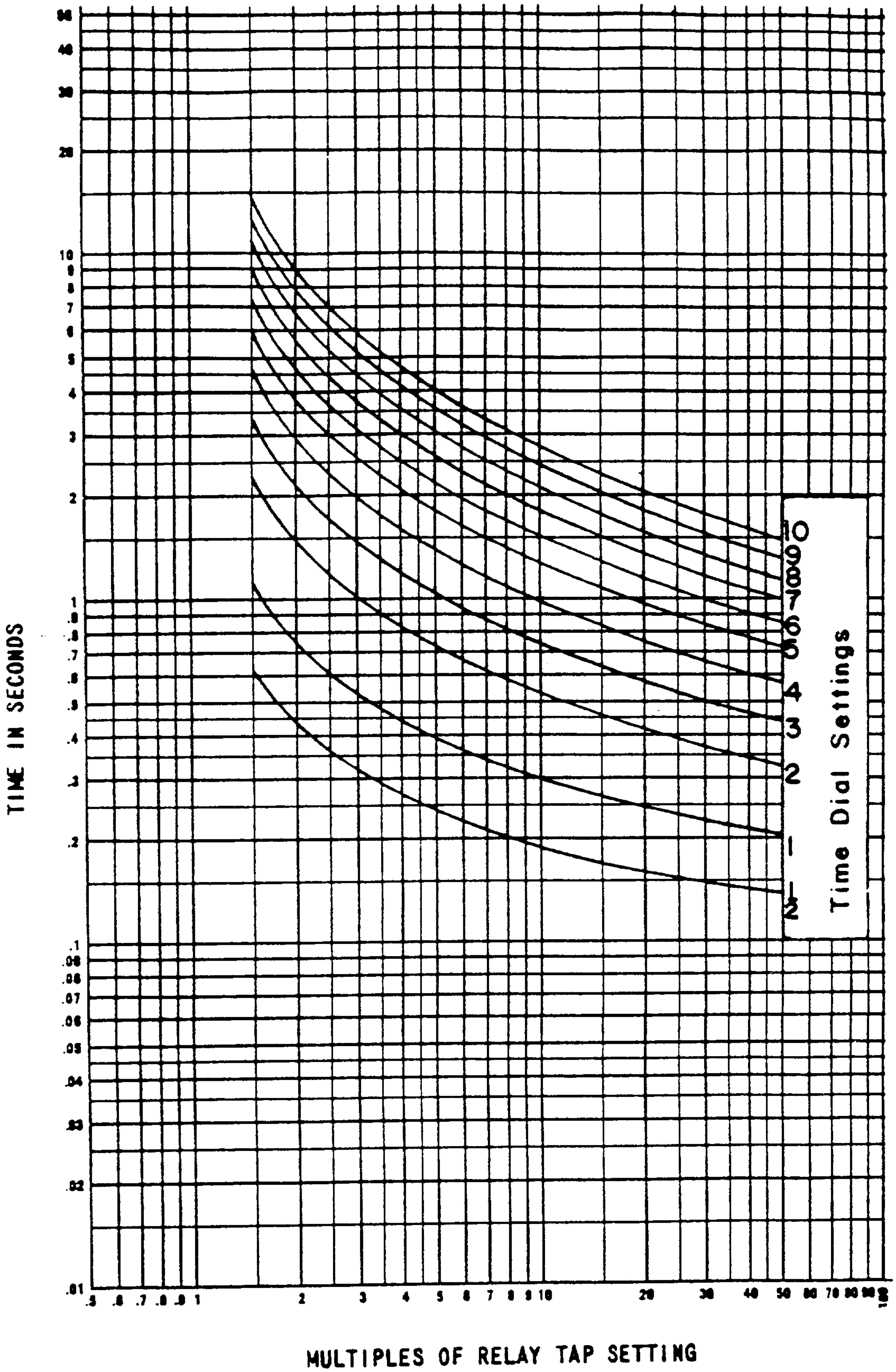


Fig. 14 Time-Current Curves for Inverse Time Overcurrent Unit (IBC51 and IBC52)

Fig. 14 (0888W0785-0)

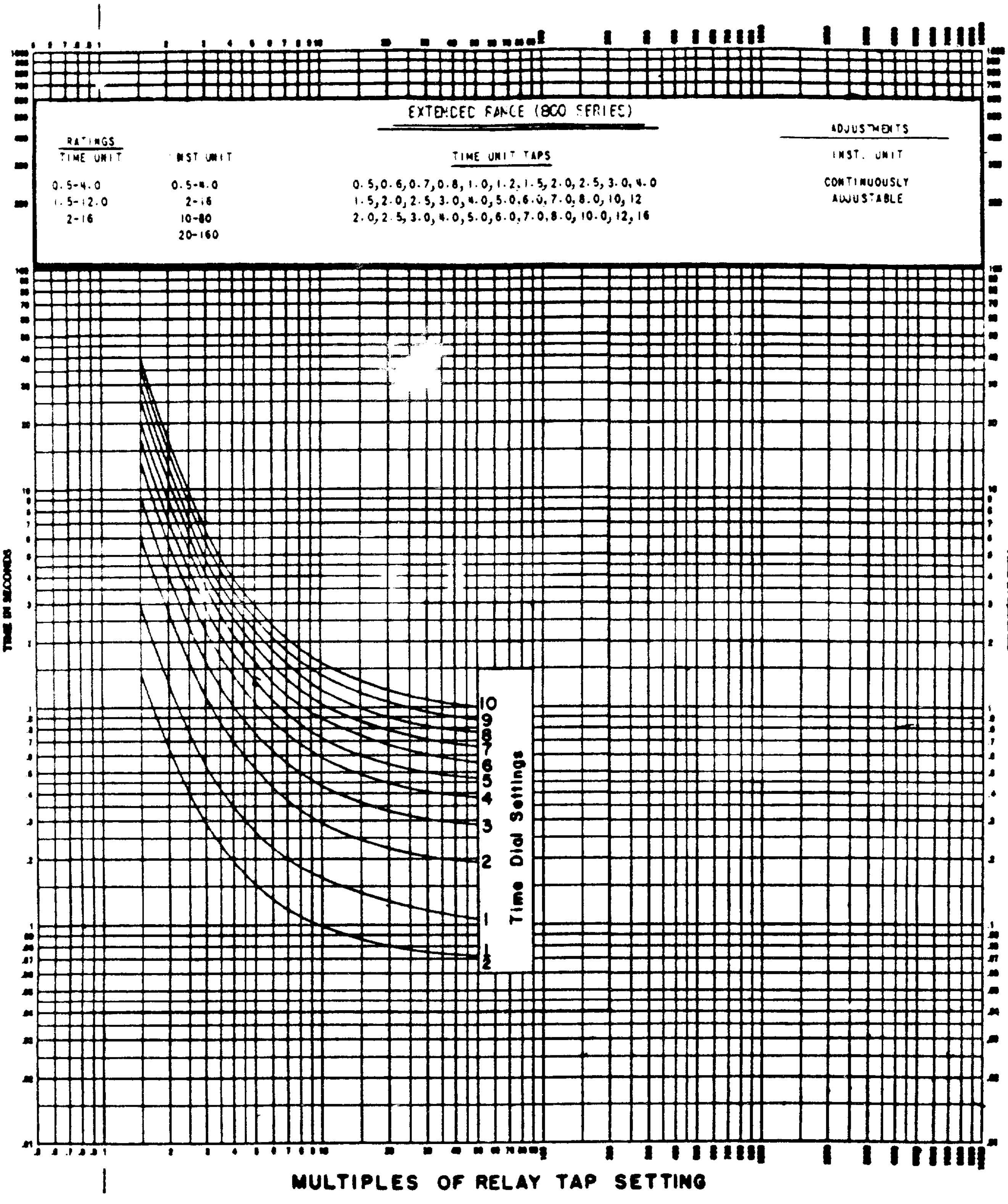


*Fig. 15 (0888B0270-3) Time-Current Curves for Very Inverse Time Overcurrent Unit (IBC53 and IBC54)

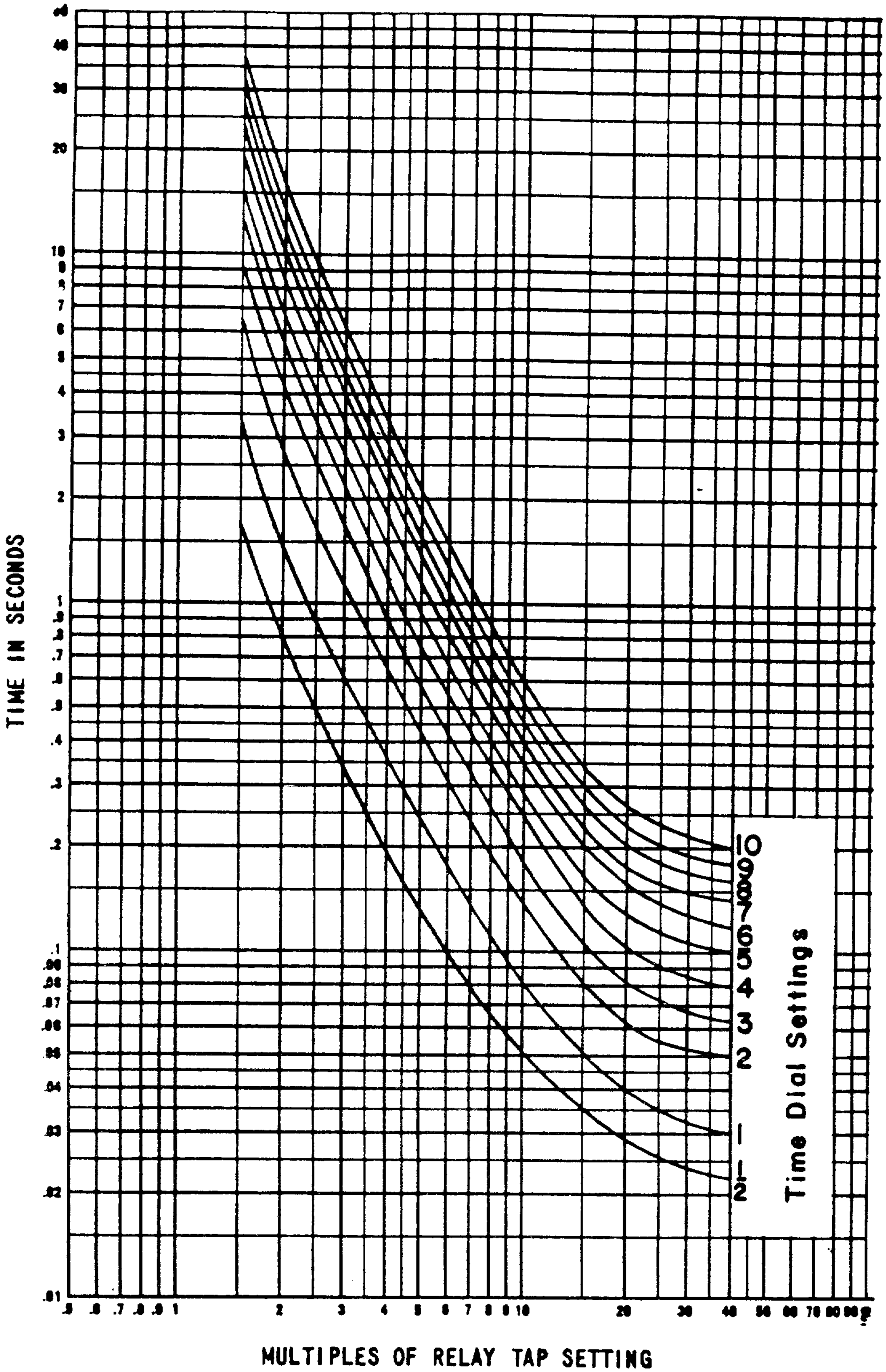


Fig. 16 (0888B0274-0)

Fig. 16 Time-Current Curves for Extremely Inverse Time Overcurrent Unit (IBC77 and IBC78)

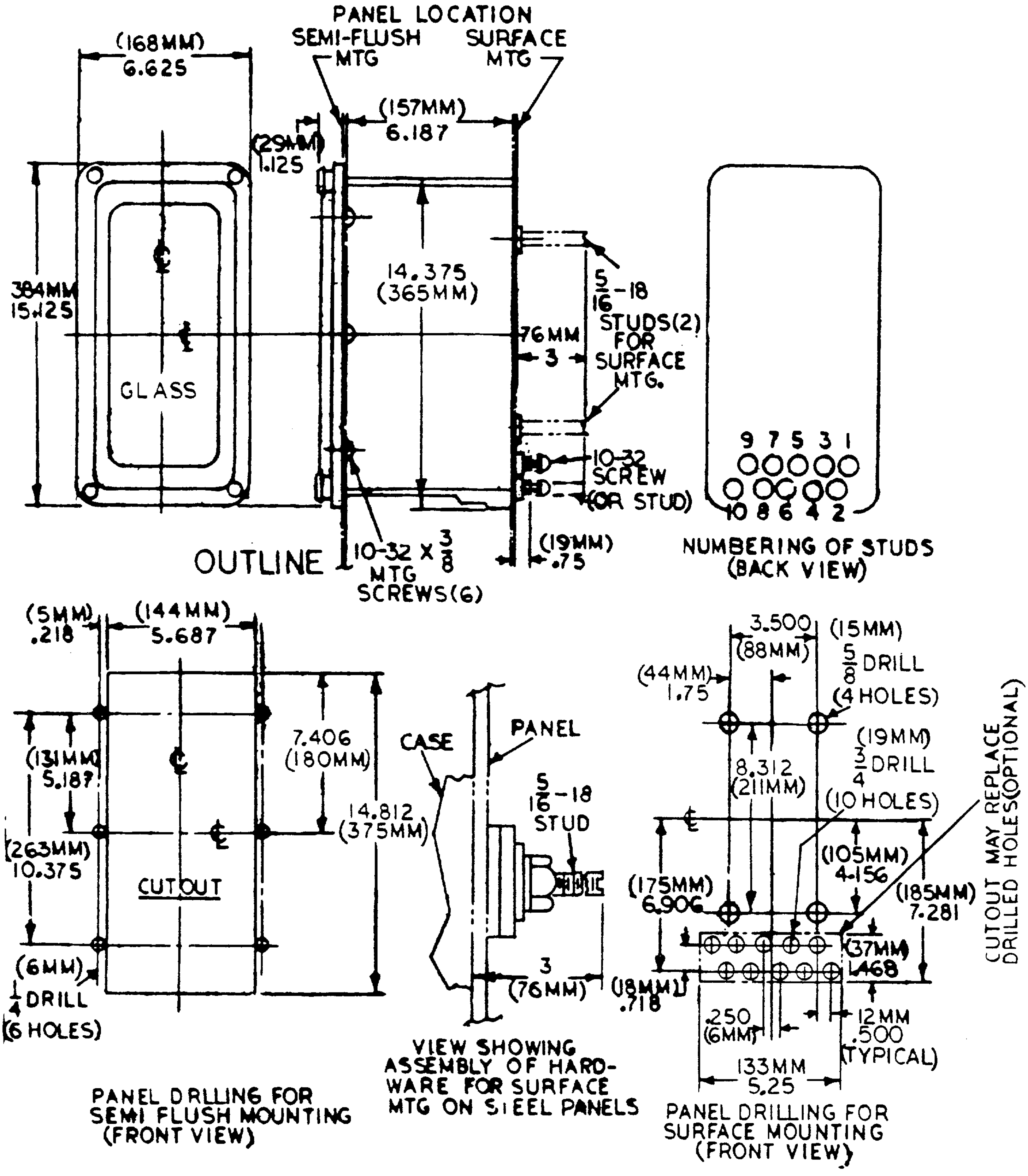


*Fig. 17 (K-6209273-3) Outline and Panel Drilling Dimensions for IBC Relays

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