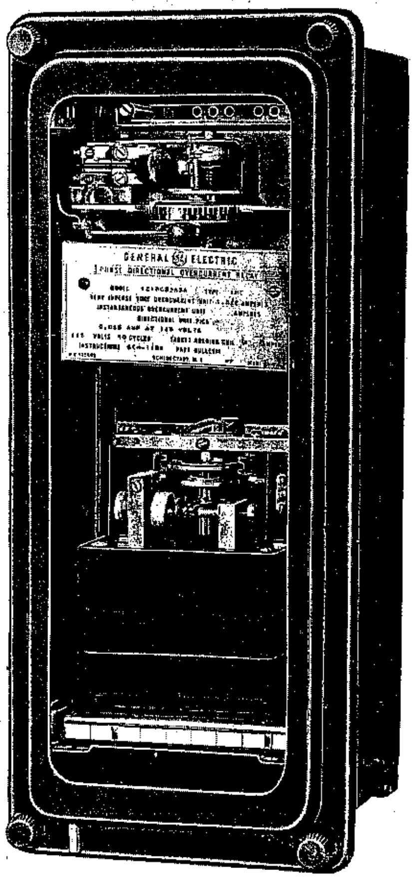
INSTRUCTIONS Switchgear

DIRECTIONAL OVERCURRENT RELAYS



Types

IBC33A IBCC33A IBCP33A
IBC34A IBCC34A IBCP34A

GENERAL ELECTRIC

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CONTENTS

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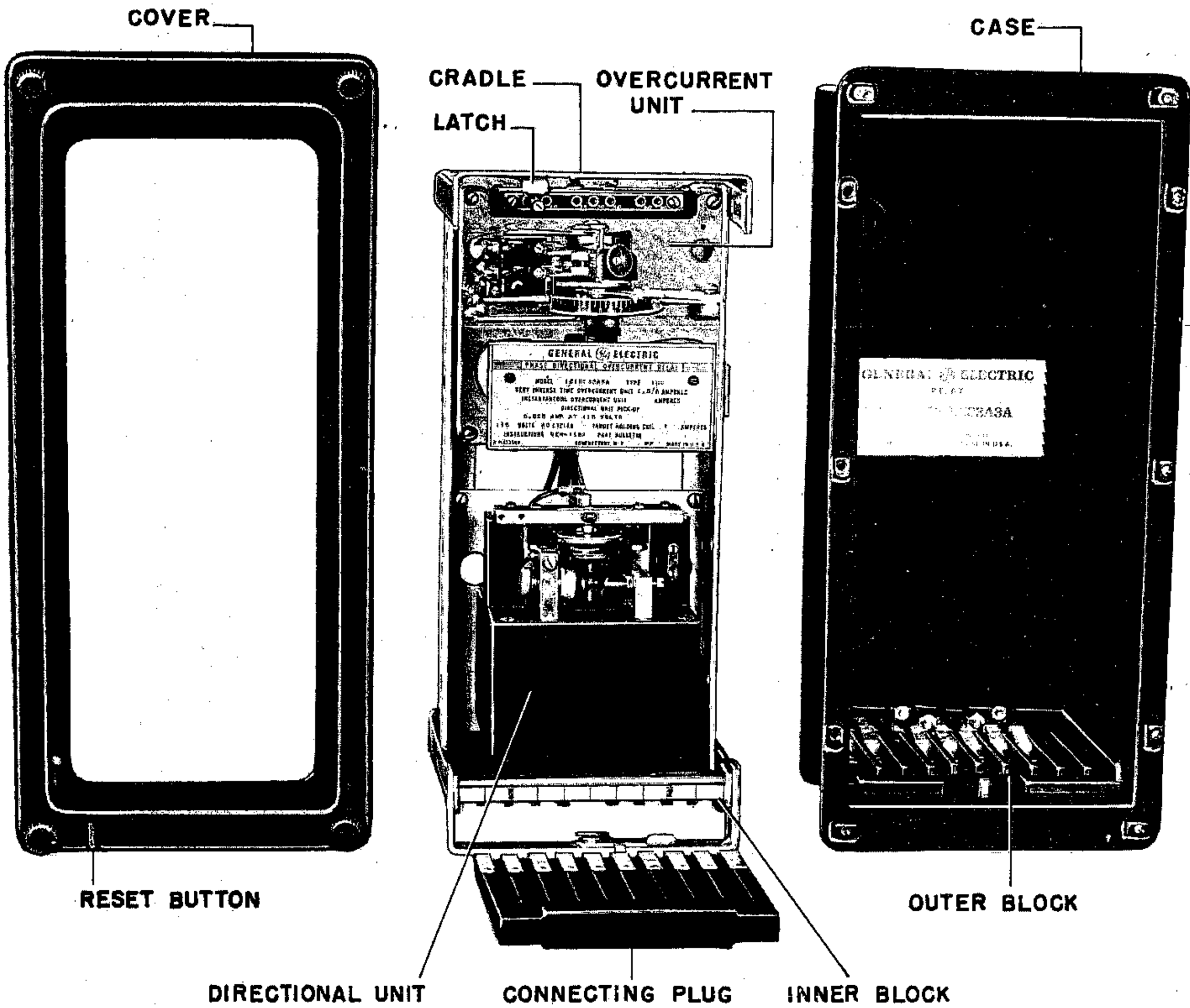

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Fig. 1 The Type IBC33A Relay Disassembled

DIRECTIONAL OVERCURRENT RELAYS
TYPE IBC

INTRODUCTION

The type IBC relays comprise a group of relays that are employed primarily for protection of feeders and transmission lines in applications where single-phase relays, instead of polyphase power-directional relays, are desired or required.

The type IBC directional overcurrent relays of the very inverse time characteristic consists of two units, an instantaneous power directional unit (bottom) of the induction-cup type and a very inverse time overcurrent unit (top) of the induction disk type. The directional unit contacts control the operation of the overcurrent unit (directional control).

The various relays in this group are identified by model numbers. The relays differ in the number of contacts, angle of maximum torque, and the type of polarization (potential polarized or current polarized).

OVERCURRENT UNIT

The overcurrent unit of the type IBC relay with very inverse time characteristic has a watthour meter type of driving element with spring return. The upper half of the driving element has two windings. One of these is a tapped current winding and the other is a coil with several hundred turns which energized two coils on the lower half of the driving magnet when the directional unit contacts are closed. The overcurrent unit is, therefore, inoperative except when power flows in the proper direction for tripping.

Since the retarding force of the spring varies according to the position of the disk, and since the driving force is not compensated for this change, the disk will begin to operate at the No. 10 time lever setting at a lower current than that required to close the contacts. This change is rather small and should be considered only when the load current is high, relative to the desired minimum operating current.

A curve showing the current necessary to move the disk at any time lever setting is given in Fig. 2.

DIRECTIONAL UNIT

This unit is an induction cylinder device for alternating-current circuits. The principle by which torque is developed in these induction cylinder relays is the same as that employed in an induction disk relay with a watthour meter element, though in arrangement of parts they are more like split-phase induction motors.

The stator has eight laminated magnetic poles projecting inward and arranged symmetrically around a central magnetic core. The poles are fitted with current and potential coils (on the potential polarized relay); four potential coils which are internally connected forming a single circuit as well as four current coils similarly connected. In the annular air gap between the poles and central core is the cylindrical part of the cup-like aluminum rotor which turns freely in the air gap. The central core is fixed to the stator frame, the rotor alone turns.

The current polarized unit differs from the above unit by using current coils instead of the potential coils.

This construction provides higher torque and lower rotor inertia than the induction disk construction, making these relays faster and more sensitive.

CASE

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

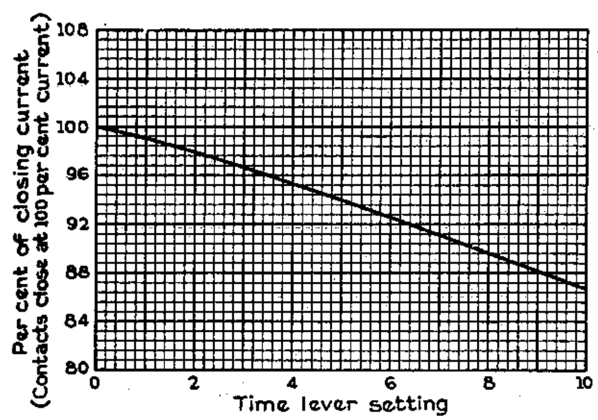


Fig. 2 Minimum Current Required to Start Rotation of Disk of Very Inverse-Time Overcurrent Units of the Type IBC Relay

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.

APPLICATION

For the protection of a single line, Figs. 3 and 4 illustrate the application of these relays to phase-fault protection.

The quadrature or 90-degree connection of current and potential transformers as shown in Fig. 3 is recommended as providing the most reliable potential for the directional units during usual fault conditions. With this connection, the current (at unit-power-factor load) leads the potential 90 deg. at the relay terminals. The internal resistor shorting link should be opened by disconnecting it from the top screw to give the 45-degree characteristic. (The link is located on the right-hand post at the top of the cup-type unit). The directional unit will then have maximum torque when the fault current lags its unity-power-factor position by about 45 degrees.

When used in conjunction with a ground relay which requires that the potential-transformer primaries be connected in wye, with secondaries in delta, the quadrature connection cannot be employed. For this application the 60-degree connection as shown in Fig. 4 is recommended. The current at unity-power-factor load then leads the potential 60 degrees at the relay terminals, and the internal resistor in the potential circuit should be shorted with the link. This gives the directional unit a maximum torque when the fault current lags its unity-power-factor position by approximately 70 degrees at 50/60 cycles (60 degrees at 25 cycles).

The quadrature and 60-degree connections are used with these relays because fault currents are usually highly lagging. With these connections the directional unit will have substantially maximum torque under usual fault conditions. Vector relationships for these two connections are shown in the table on page 9.

The schemes previously described protect against phase-to-phase and polyphase short circuits. They also protect against ground faults if the ground current is not limited to a value too small to operate the relay. For cases where this ground current is limited (either by resistance in the system ground or by the system characteristics) to values that will not operate the phase relays, a ground relay should be provided as shown in Fig. 5 to 7. The relays used for ground-fault protection usually have a low current coil with taps which may be rated 0.5-2.0, or 1.5-6 amperes, although the 4 - 15 amp rating is also available. Normally no current flows through the ground relay.

Fig. 5 shows the external connections of the type IBC relay for directional overcurrent protection on ground faults with wye-broken-delta (broken delta signifies a complete delta with one corner open), potential transformers. If the potential transformers are connected wye-wye instead of wye-broken-delta, auxiliary wye-broken-delta potential transformers (type YT-1557) should be provided. The auxiliary potential transformer should be connected as the potential transformers shown connected in Fig. 6.

OPERATING CHARACTERISTICS

The type IBC33A is a phase relay, potential polarized, with single circuit closing contacts, and having an internal resistor in the directional unit to provide maximum torque angles of 20 and 45 degrees lead for 50 and 60 cycle relays, and 30 and 45 deg. lead for 25 cycle relays.

The type IBC34A relay differs from the IBC33A only in that the contacts are two circuit closing.

The type IBCP33A is a ground relay, similar to the IBC33A, potential polarized with single circuit closing contacts but having an internal capacitor in the directional unit to providecmaximum torque in the directional unit at lagging fault currents (45 deg.)

The type IBCP34A relay differs from the IBCP33A relay only in that the contacts are two circuit closing.

The type IBCC33A is a ground relay, current polarized, with single circuit closing contacts.

The type IBCC34A relay differs from the IBCC33A in that the contacts are two circuit closing.

The preceding distinguishing features are summarized in the following table:

DEVICE FUNCTION NUMBERS FOR USE WITH EXTERNAL DIAGRAMS

52 - Power Circuit Breaker.

67 - Directional Overcurrent Relay, Type IBC

67N - Directional Ground Relay, Type IBC

a - Auxiliary Contact, Open when Breaker opens

DIR - Directional Unit

HC - Holding Coil

OC - Overcurrent Unit

TC - Trip Coil

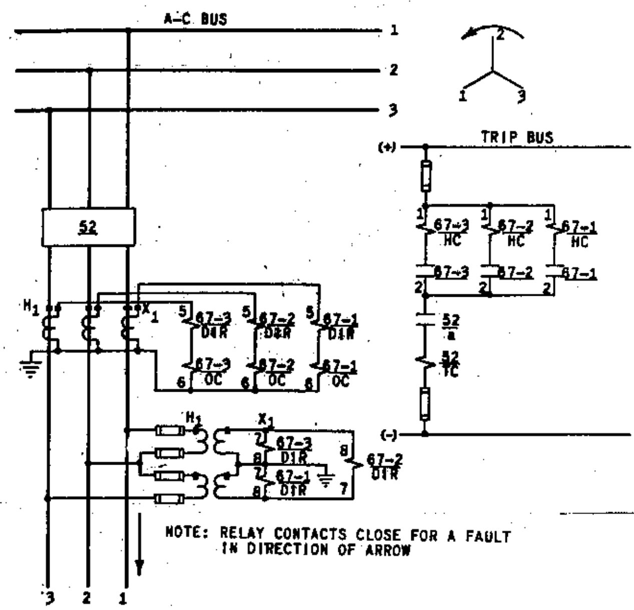


Fig. 3 90-degree Connection of Three Type IBC33A Relays Used for Directional Overcurrent Protection of a Single Line

(Fig. 3)(K-6375695)

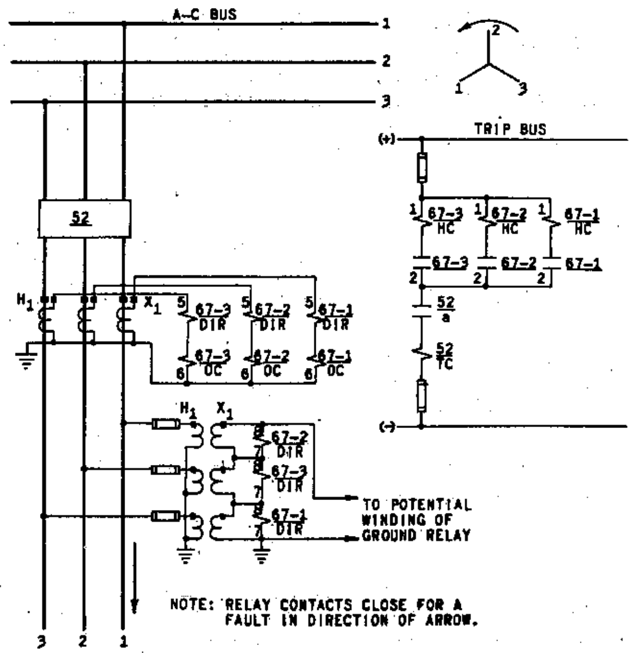


Fig. 4 60-degree Connection of Three Type IBC33A Relays Used for Directional Overcurrent Protection of a Single Line

(Fig. 4)(K-6375696)

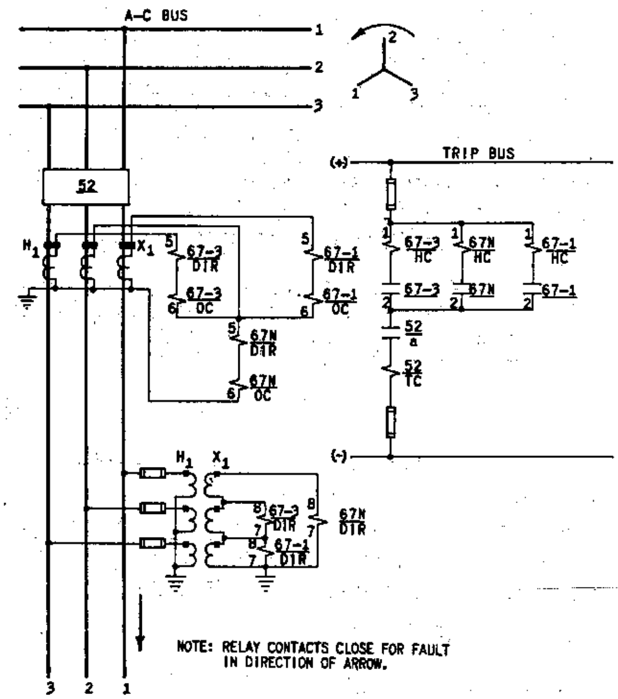


Fig. 5 Connections of Two Type IBC33A Relays and One Type IBCP33A Relay Used for Directional Phase and Ground Overcurrent Protection of a Single Line.

(Fig. 5)(K-6375697)

Type IBC Relays -- Very Inverse Time Characteristics

Relay	Function on	Overcurrent Unit Contacts	Directional Unit Polarized	Phase Angle Obtained By	Approx. Angle of Max. Torque (Current with Respect to Potential
IBC33A	Phase-to-phase and Ground Faults	Single Circuit Closing	Potential	Internal resis. in series with the pot. coils (Dir. unit)	Internal res. cut out 50/60 cycles-20 deg. lead 25 cycles-30 deg. lead internal resistor in. 25/50/60 cycles-45 deg. lead
IBC34A	Phase-to phase and Ground Faults	Two Circuit Closing	Potential	Same as IBC33A	Same as IBC33A
IBCP33A	Ground Faults	Single Circuit Closing	Potential	Internal cap. in series with pot. coils (Dir. unit)	45 deg. lag
IBCP34A	Ground Faults	Two Circuit Closing	Potential	Same as IBCP33A	45 deg. lag
IBCC33A	Ground Faults	Single Circuit Closing	Current		Max. torque when currents are approximately in phase.
IBCC34A	Ground Faults	Two Circuit Closing	Current		

DIRECTIONAL UNIT (115-Volt Rating)

The directional unit, potential polarized, will operate properly on 1 volt and 4 amperes in relays with a 4-15 amp coil in the overcurrent unit. The directional unit of the relays with current coils rated 0.5-2.0 amps or 1.5-6.0 amps will operate properly at approximately 0.5 amp with the two coils in series, on 1 volt and 2 amps. Current polarized directional units should operate properly at approximately 0.5 amp with the two coils in series. Figs. 10 and 11 show time curves of these units.

OVERCURRENT UNIT

The least current required to rotate the disk very slowly and close the contacts should be within 5 per cent of the values marked on the tap plate. If this adjustment has been disturbed, it may be restored by changing the return spring tension. The outer supporting post of the spring being mounted on an adjustable arm.

The above adjustment for minimum closing current is probably best made on the third tap (6 amp tap of the 4-15 ampere relay, for example) or, if this is known, on the particular tap to be used in service. When made on the third tap, the other taps should check within 5 per cent of their marked values.

Note that on some relays, in particular those of 25 cycles, there is a resistor in series with the lower operating unit and the directional unit contacts to give the proper pick-up values for that particular frequency

RATINGS

Rating of Operating Coils - IBC Overcurrent Unit

Tap Range in Amp	Tap Rating in amp.	2-sec. Rating in Amps	Continuous Rating in Amps.
4-15	4,5,6,8,10,12, and 15	200	10
1.5-6	1.5,2,2.5,3,4,5, and 6	75	$4\frac{1}{2}$
0.5-2	0.5, 0.6,0.8,1.0,1.5 and 2	25	$1\frac{1}{2}$*

* Continuous rating is same as tap rating, where this exceeds the value listed.

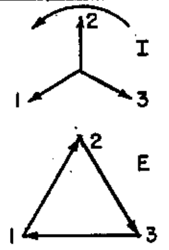
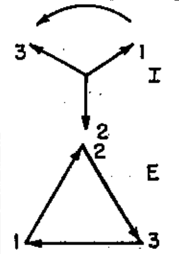
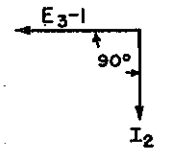
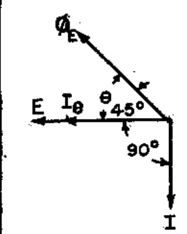
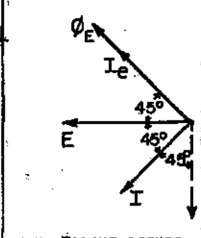
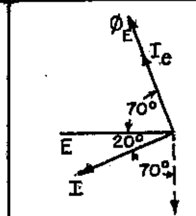
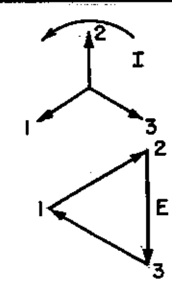
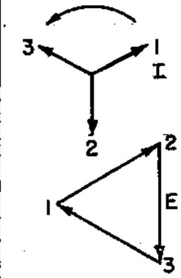
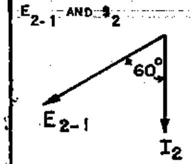
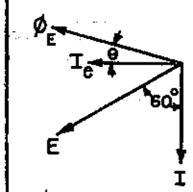
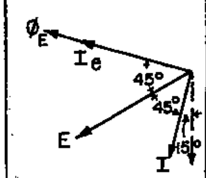
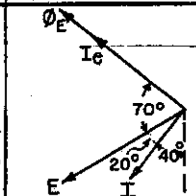
CURRENT COILS

The short-time and continuous rating of the operating coils are in the preceding table:

CONTACTS

The current-closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying rating is limited by the two forms of target and holding coils. Relays with 1.0 ampere target and holding coils have a rating of 30 amperes for tripping duty and hence will trip any circuit breaker with trip-coil current within this rating. Relays with two-circuit contacts may be used to trip two breakers provided the sum of the tripping cur-

CONDITIONS FOR MAXIMUM TORQUE IN IBC RELAYS USING 90° AND 60° CONNECTIONS

CONNECTION (1-2-3 PHASE SEQUENCE)	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 OF UNITY P.F. LOAD WHEN CURRENT FLOWS IN TRIP DIRECTION	VECTOR RELATIONSHIP OF EDDY-CURRENTS IN INDUCTION CYLINDER TO FLUX SET UP BY POTENTIAL WINDING AT UNITY P.F. LOAD SHORTING LINK OFF (FREQ. - 60 CYCLES)	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK OFF (FREQ. - 60 CYCLES)	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK ON (FREQ. - 60 CYCLES)
QUADRATURE (CURRENT LEADS POTENTIAL 90 DEGREES WHEN FLOWING IN TRIPPING DIRECTION AT UNITY P.F. LOAD)			E_{3-1} AND I_2  I LEADS E BY 90 DEGREES		 MAX. TORQUE OCCURS WHEN I LAGS UNITY P.F. POSITION BY 45 DEGREES.	 MAX. TORQUE OCCURS WHEN I LAGS UNITY P.F. POSITION BY 70 DEGREES
60 DEGREE (CURRENT LEADS POTENTIAL 60 DEGREES WHEN FLOWING IN TRIPPING DIRECTION AT UNITY P.F. LOAD)			E_{2-1} AND I_2  I LEADS E BY 60 DEGREES		 MAX. TORQUE OCCURS WHEN I LAGS UNITY P.F. POSITION BY 15 DEGREES	 MAX. TORQUE OCCURS WHEN I LAGS UNITY P.F. POSITION BY 40 DEGREES

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

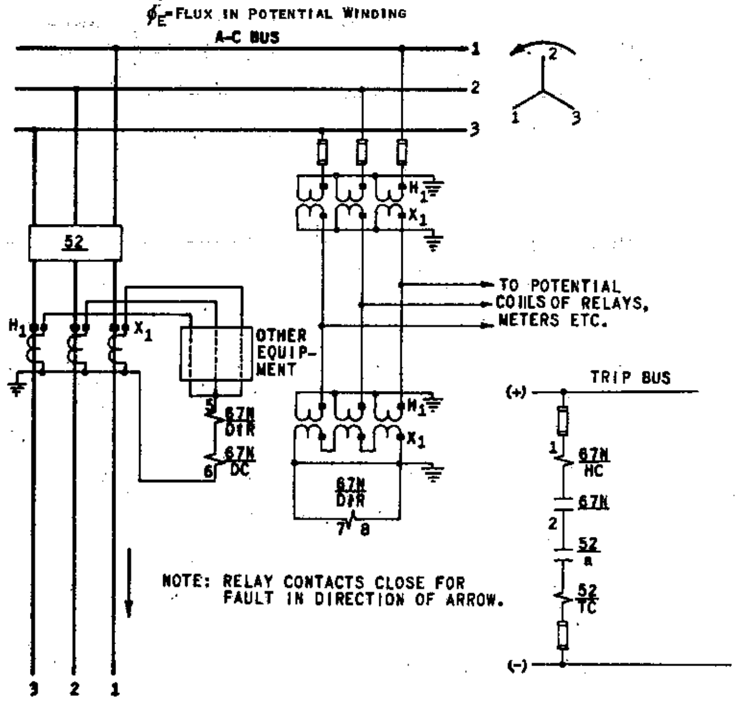


Fig. 6 Connections for Directional Ground Protection of a Single Line Using one IBCP33A Relay With Auxiliary Wye-broken-delta Transformer.

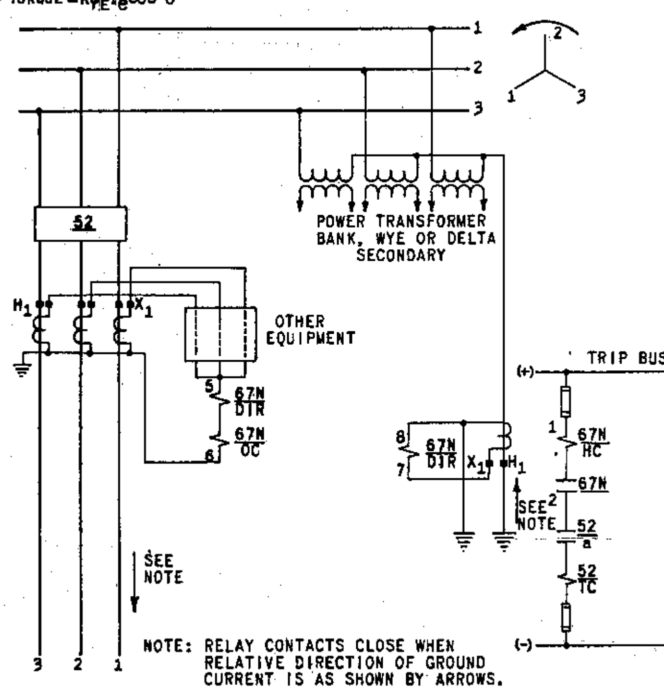


Fig. 7 Connections for Directional Ground-fault Protection of a Single Line With Current Polarized Relay Type IBCC33A.

(Fig. 6)(K-6375698) (Fig. 7)(K-6375699)

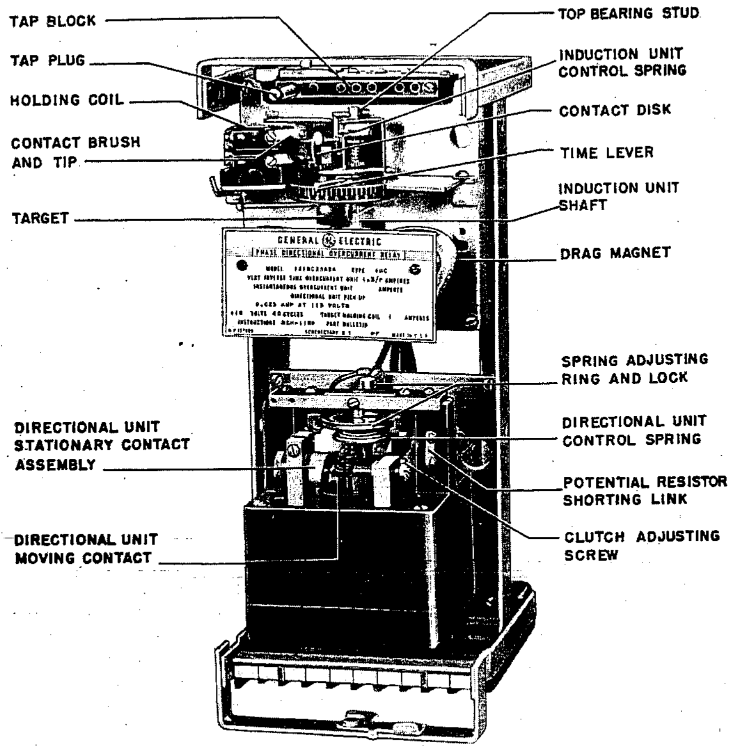


Fig. 8 The Type IBC33A Relay Removed From the Case (Front View)

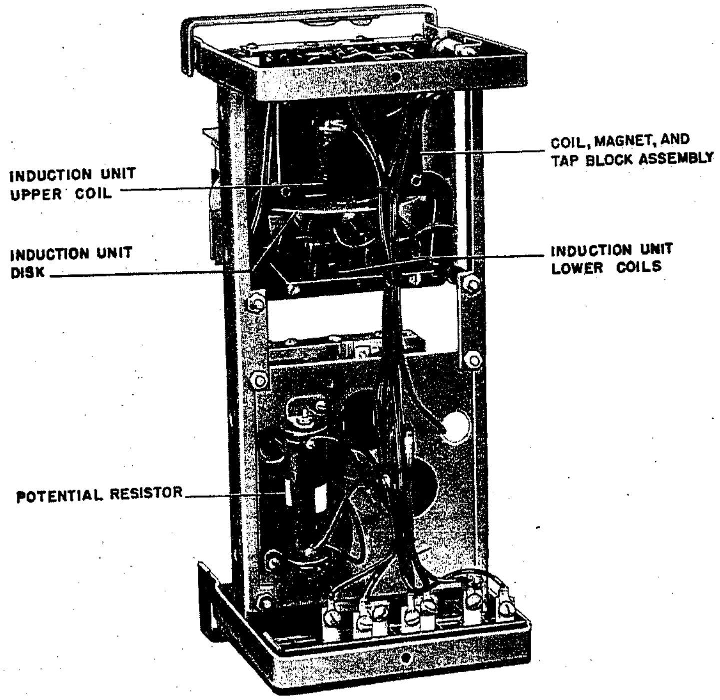


Fig. 9 The Type IBC33A Relay Removed From the Case (Back View)

rents for both breakers does not exceed 30 amperes. If more than two circuit breakers are to be tripped, or if the total tripping current exceeds 30 amperes, an auxiliary relay must be used with the type IBC relays. After tripping occurs, the tripping circuit must be opened by an auxiliary switch on the circuit breaker or by other automatic means as the relay contacts are sealed closed when tripping current is flowing.

TARGET AND HOLDING COILS

There are two ratings of these coils available. The choice between them depends on the current taken by the tripping circuit.

The 0.2-ampere coil is for use with trip coils that operate on currents ranging from 0.2 to 1.0 ampere at the minimum control voltage. If this coil is used with trip coils that take 1.0 ampere, or more, there is a possibility that the 7-ohm resistance will reduce the tripping current to so low a value that the breakers will not be tripped.

The 1.0-ampere coil should be used with trip coils that take 1.0 ampere or more at the minimum control voltage provided the tripping current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes an auxiliary relay must be used to control the trip-coil circuit, the connections being such that the tripping current does not pass through the contacts or the target and holding coil of the type IBC relays.

When it is desirable to adopt one type of relay as standard to be used anywhere on a system, relays with the 1-ampere target and holding coil should be chosen. These relays should also be used where it is impossible to obtain trip-coil data, but attention is called to the fact that the target may not operate if used in connection with trip coils taking less than 1.0 ampere.

The ratings of the two forms of target and holding coils are as follows:

Function	Amperes, AC or DC	
	1 amp (0.25 ohm) Coil	0.2 amp (7 ohm) Coil
Carry for Tripping Duty	30	5
Carry Continuously	4	0.8

OPERATION OF TARGET

The construction of the target-release mechanism assures positive operation of the target when a current of 2 to 3 times rating flows through the target and holding coil for one cycle or longer. The target will also operate when rated current flows through the coil for a few tenths of a second.

BURDENS

In the following tabulation the burdens are given

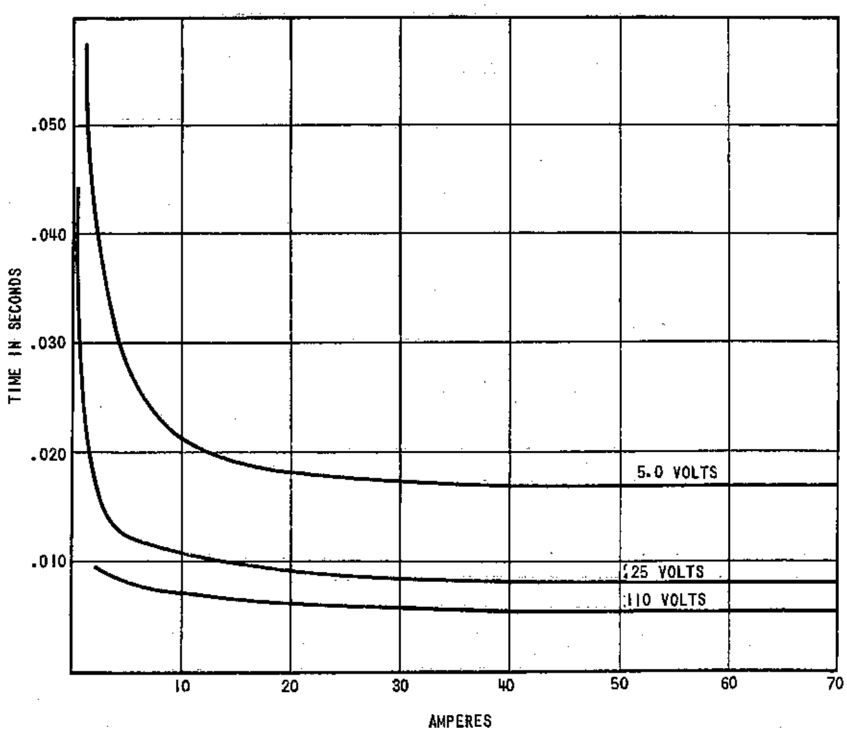


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Fig. 10 Time Curves for Directional Unit of Type IBC Relay for Voltage Applied in Phase With the Current.

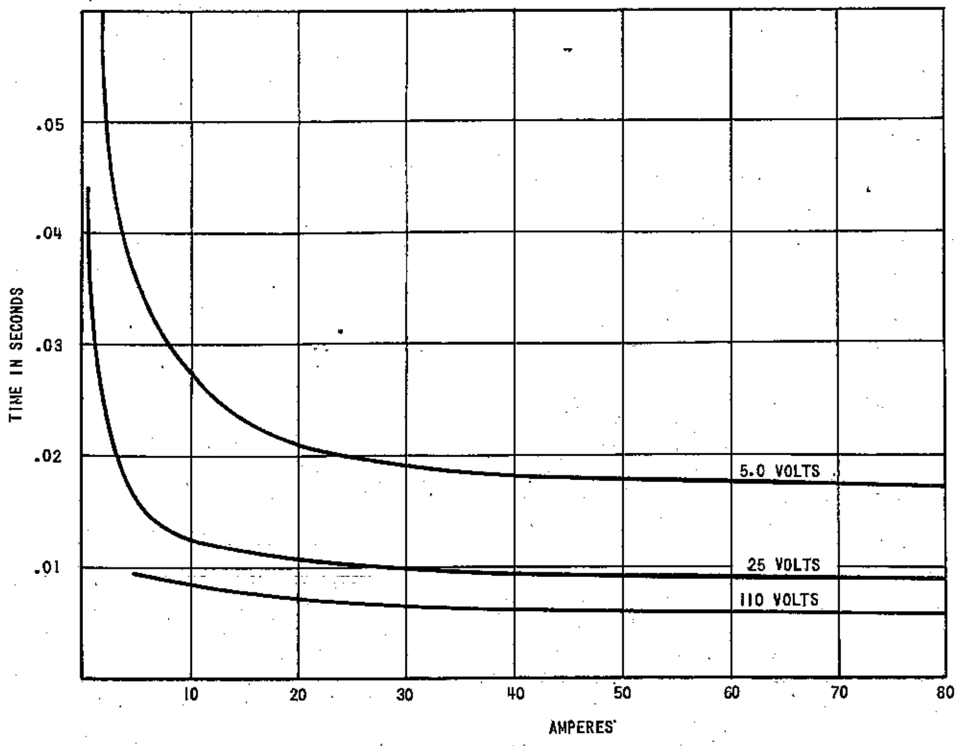


Fig. 11 Time Curves for Directional Unit of Type IBC Relay for Voltages Applied in Phase With the current.

for both ground and phase relays of groups with very inverse-time characteristics.

Current Coil Burdens at 5 Amperes and Rated Frequency				
Relay	Current Range In Amps	Freq	Watts	Volt-Amperes
IBC33A	4-15	60	2.95	4.5
IBC34A	1.5-6	60	15.3	29.7
IBCP33A	0.5-2.0	60	83*	164
IBCP34A	1.5-6.0	60	15.3*	29.7
IBCC33A	0.5-2.0	60	83*	164 (A)
IBCC34A		60	4.75*	5 (B)
	1.5-6.0	60	15.3 *	29.7 (A)
		60	4.75*	5 (B)

*These relays are ordinarily used in the residual circuit of current transformers for ground fault protection. The burden is, therefore, not imposed except for the duration of the ground fault and need not be considered except for this momentary period

(A) Burden of operating current coil.
(B) Burden of polarizing current coil.

Potential Coil Burdens at 115 Volts and Rated Frequency				
Relay	Current Range in Amp	Freq	Watts	Volt-Amperes
IBC33A	4-15	60	8.3	21.9 (C)
IBC34A	1.5-6	60	11.8	16.7 (D)
IBCP33A	0.5-2.5	60	7.0	9.9 (E)
IBCP34A	1.5-6.0	60		

(C) Burden with internal resistor shorted.
(D) Burden with series internal resistor.
(E) Capacitive.

RECEIVING, HANDLING AND STORAGE

RECEIVING

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 the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident,

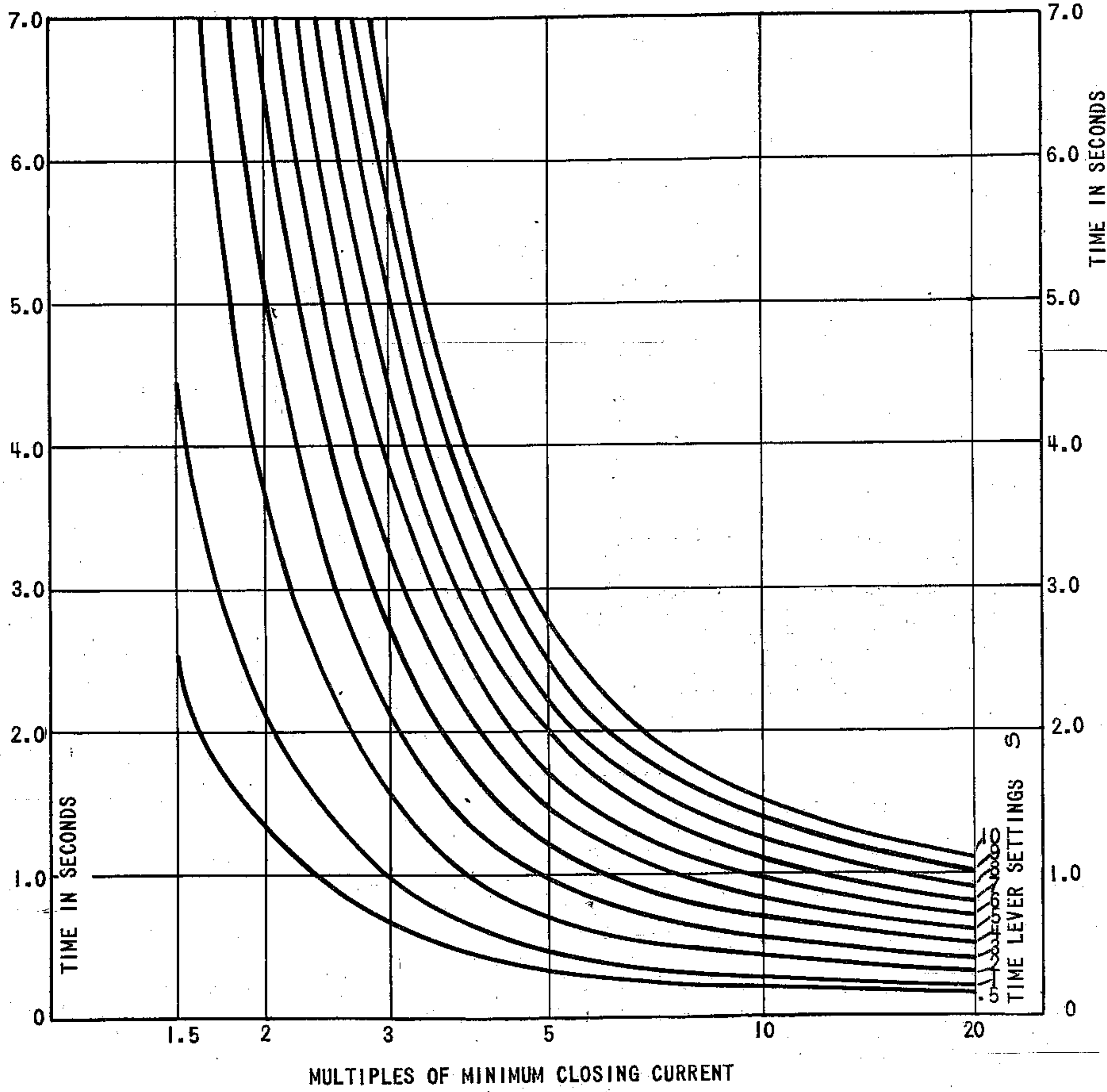


Fig. 12 Time-current Curves for Very Inverse Time-Overcurrent Unit of Type IBC Relays.

IBC 33 CURVES DIFFER ~~FROM THE IBC 53 CURVES~~

(K-6209200-B)

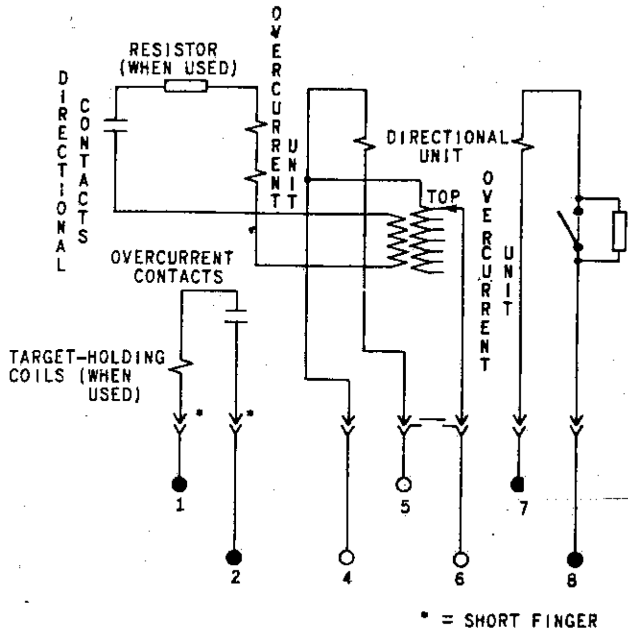


Fig. 13 Internal Connections for the Type IBC33A Relay (Front View)

(Fig. 13)(K-6174687)

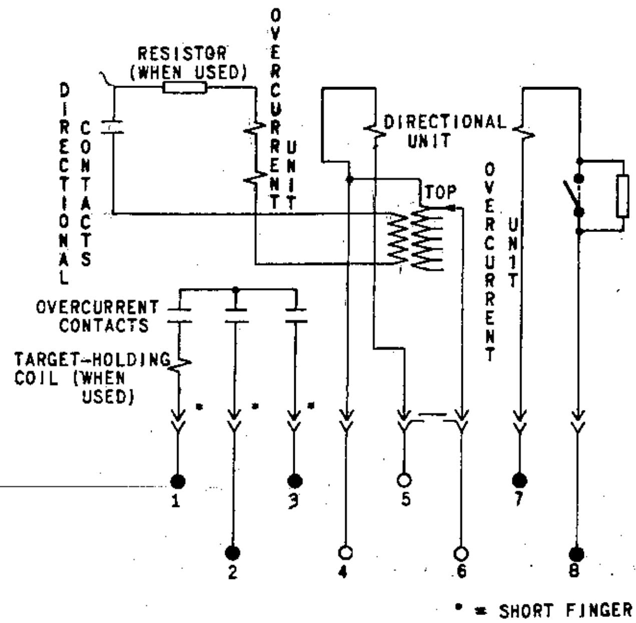


Fig. 14 Internal Connections for the Type IBC34A Relay (Front View)

(Fig. 14)(K-6174780)

a claim should be filed at once with the transportation company, and the nearest Sales Office of the General Electric Company notified promptly.

HANDLING

Reasonable care should be exercised in unpacking the relay, in order that none of the parts are injured or the adjustments disturbed.

STORAGE

If the relays are not to be installed immediately, they should be stored in their original carton in a place that is free from moisture, dust, and metallic chips.

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. 23.

CONNECTIONS

Internal connection diagrams for the various relay types are shown in Figs. 13 to 18 inclusive.

Typical wiring diagrams are given in Figs. 3 to 7 inclusive.

GROUND CONNECTIONS

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.

ADJUSTMENTS

OVERCURRENT UNIT

1. CURRENT TAP

The minimum current at which the overcurrent unit will close its contacts is determined by the position of the plug in the tap block on the overcurrent unit. The tap block is marked in amperes

When changing the current setting of the relay while in the case, remove the connecting plug to short the current transformer secondary circuit.

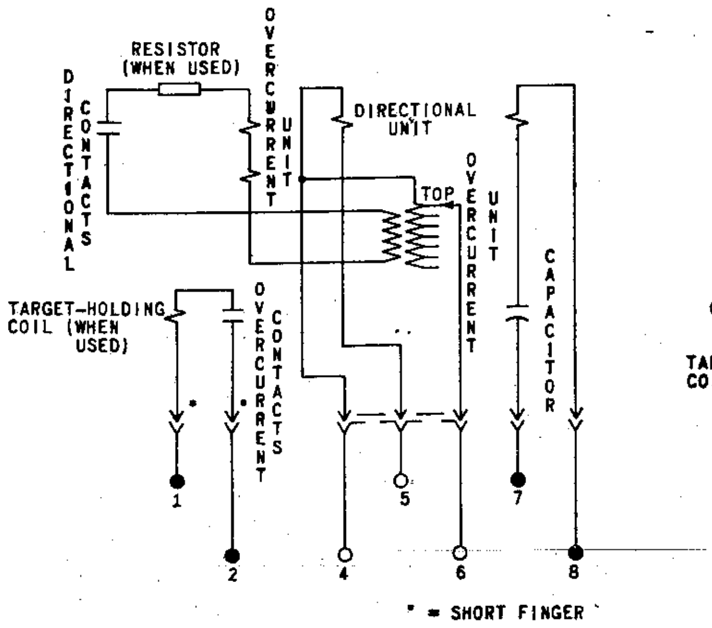


Fig. 15 Internal Connections for the Type IBCP33A Relay (Front View)

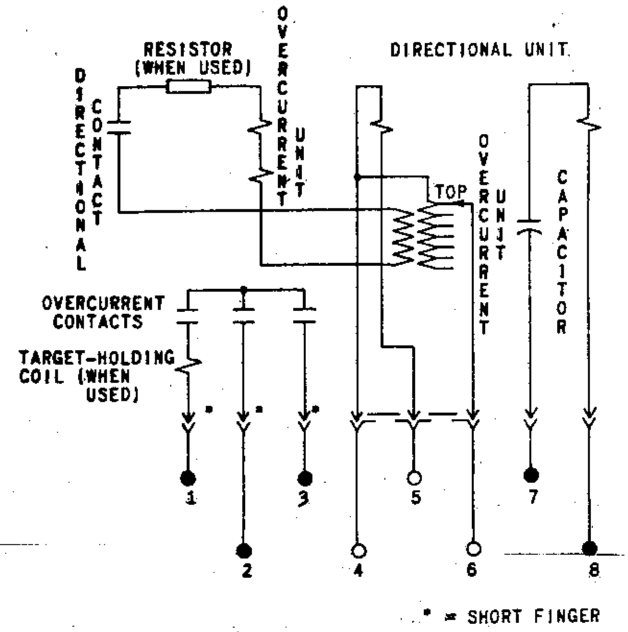


Fig. 16 Internal Connections for the Type IBCP34A Relay (Front View)

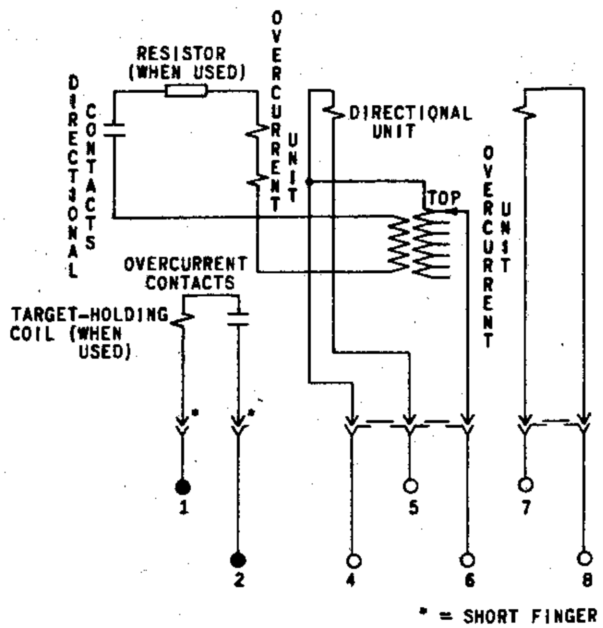


Fig. 17 Internal Connections for the Type IBCC33A Relay (Front View)

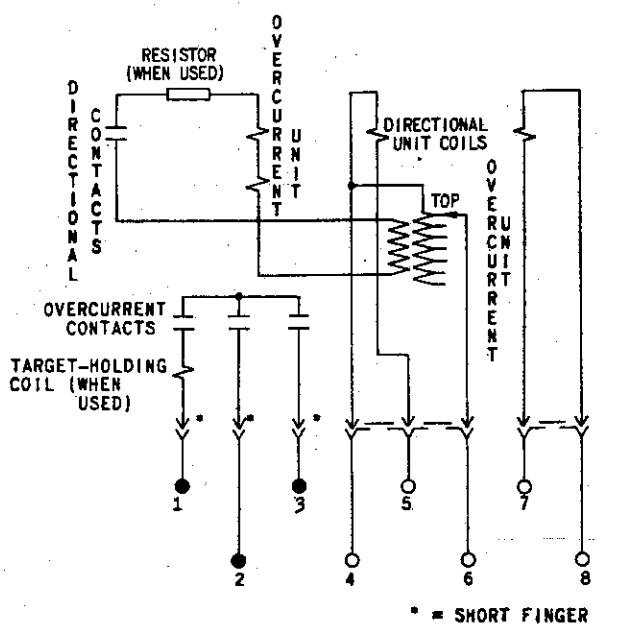


Fig. 18 Internal Connections for the Type IBCC34A Relay (Front View)

(Fig. 14)(K-6174780) (Fig. 15)(K-6375650) (Fig. 16)(K-6375651) (Fig. 17)(K-6375657) (Fig. 18)(K-6375659)

Next, screw the tap plug into tap marked for the desired current and then replace the connecting plug.

The least current required to rotate the disk very slowly and close the contacts should be within 5 per cent of the values marked on the tap plate. If this adjustment has been disturbed, it may be restored by changing the return spring tension. The outer supporting post of the spring being mounted on an adjustable arm.

The above adjustment for minimum closing current is probably best made on the third tap (6 ampere tap of the 4-15 ampere relay, for example) or, if this is known, on the particular tap to be used in service. When made on the third tap, the other taps should check within 5 per cent of their marked values.

Note that on some relays, in particular those of 25 cycles, there is a resistor in series with the lower operating unit and the directional unit contacts to give the proper pick-up values for that particular frequency.

2. TIME SETTING

The time delay at any given overcurrent is determined by the position of the time lever over the graduated scale on the contact mechanism plate. The time delay is also inversely proportional to the amount of the overcurrent. These relations are shown by the data on the time data plate on the front of the overcurrent unit and on curves in Fig. 12.

Note that the current values are given as multiples of the current-tap setting. That is, the time delay is the same for 80 amperes (secondary) on the 8-ampere tap as for 50 amperes on the 5-ampere tap (in both cases, the current is 10 times tap value).

A numerical example will illustrate these points. Let it be assumed that consideration of the shape of the time-current curve indicates that the greatest selectivity between the relay in question and other relays will be obtained if the tap setting corresponds to 450 amperes line current and the time lever is set to provide 1 second delay for a fault giving 3750 amperes line current. Also let it be assumed that the current transformer ratio is 60 to 1.

Then $\frac{450}{60} = 7.5$ amperes secondary (use 8-ampere tap).

$\frac{3750}{60} = 62.5$ amperes secondary, and

$\frac{62.5}{8} = 7.8$ times current tap setting

Referring to the time-current curves in Fig. 12, it will be seen that 7.8 times the minimum operating current gives 1 second delay when the time lever is set at the 5.25 position.

It is advisable to check the time setting with an accurate timing device. Slight readjustments of the time lever position may then be made until the desired time is obtained.

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

DIRECTIONAL UNIT

1. POTENTIAL RESISTOR LINK

On directional units provided with an internal resistor for torque-angle adjustment, a link is located on the right-hand molded post which supports the bearing plate.

The link is used to short out the resistor; and when so connected, the angle of maximum torque occurs with the current leading 20 degrees (approx) on 50/60 cycles and 30-degree leading on 25 cycles. For 45-degree lead, the link is disconnected and turned in a counterclockwise direction from its top fastening screw. It is left attached by the lower screw so as not to be lost from the relay.

2. POLARITY CHECK

The polarity of the directional unit connections in phase-to-phase fault applications 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.

The ground relay connections are shown in Figs. 5 to 7. The following tests should be made on the ground element to insure that the currents, or current and voltage, go to the proper relay terminals.

The polarity of the potential polarized, ground directional unit may be checked by using load currents. The idea is to obtain current from one transformer and voltage from the same phase. The voltage is obtained by removing phase one from the primary of the broken-delta transformer and shorting the phase one primary winding to ground. 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 current.

Connect a phase-angle meter to read the angle between the current and voltage supplied to the relay. The relay has maximum torque at 45 degree 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 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.

The polarity of the type IBC phase relay directional units can be checked with the circuits given in Fig. 21. When connected as shown for the particular relay the contacts will close with rated voltage and frequency.

3. 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 partial 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 contacts.

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:

DISK AND BEARINGS - OVERCURRENT UNIT

The lower jewel bearing may be tested for cracks by exploring its surfaces with the point of a fine needle. If it is necessary to replace the jewel bearing, a very small drop of G-E Meter Jewel Oil, Cat. No. 66X728, should be placed on the new jewel before it is inserted. A new pivot should be screwed into the end of the disk shaft at the same time. The overcurrent unit jewel bearing should be turned up until the disk is centered in the air gaps, after which it should be locked in position by the set screw provided for the purpose.

The upper bearing pin should be adjusted so that the disk shaft has about 1/64-in. end play.

CLUTCH ADJUSTMENT - OVERCURRENT UNIT

The current at which the clutch slips may be adjusted by screwing the nut on the top of the main shaft up or down, thereby decreasing or increasing the spring tension. The clutch should slip with a current equal to ten times the tap setting, ~~but should~~ not slip at five times the tap setting.

TIME CURRENT CURVE - OVERCURRENT UNIT

To readjust the relay to agree with the time plate values, proceed as follows:

Connect the relay in a test circuit as shown in Fig. 19 or Fig. 20. Make sure that the timing device will begin to record at exactly the moment the

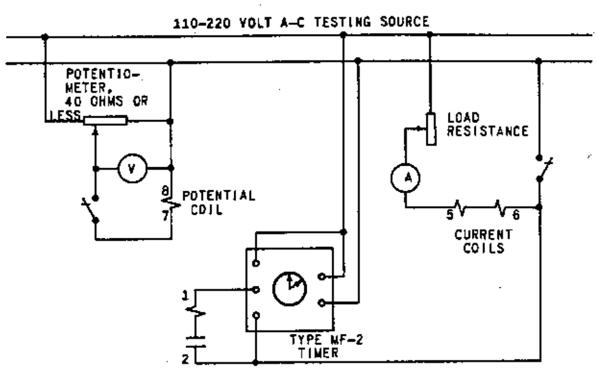


Fig. 19 Testing Connections for Potential-polarized Type IBC Relays

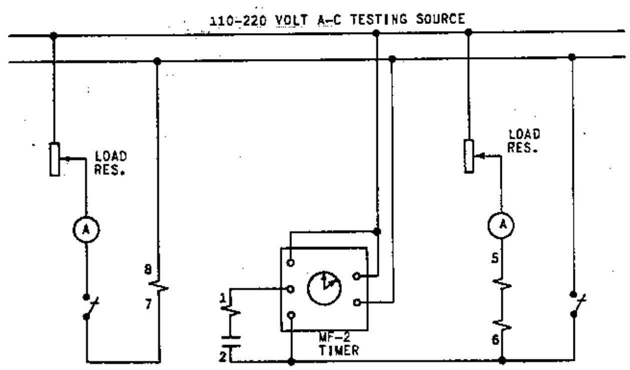


Fig. 20 Testing Connections for Current-polarized Type IBC Relays

(Fig. 19)(K-6375717) (Fig. 20)(K-6375718) relay current circuit is closed, and will stop as soon as the relay contacts close. Use source of 115 volts or greater, and of good wave form and constant frequency. Step-down transformers, or phantom loads, should not be employed in testing induction relays as their use results in a distorted wave form. In relays arranged for directional control, close the contacts of the directional unit and block the moving armature.

Adjust the position of the damping magnet on its shelf until the time delay obtained at No. 12 time-lever setting with ten times tap current is the value shown on the data plate or the curves in Fig. 12. For example, on relay Model No. 12IBC33A1 the time delay with 60 amperes on the 6-ampere tap should be 1.5 seconds.

Next, check the time delay at two times tap current. It should be within 7 per cent of the data plate value. A slight readjustment at 10 times tap current may be necessary to bring the "2 times" value within limits.

Other points on the time-current curves may then be checked as desired. It is always best to take time readings at the critical values of short-circuit current expected in service and with the actual tap and time-lever settings to be used.

In adjusting the damping magnet, note that moving it toward the disk-shaft decreases the time; moving it out toward the disk edge increases the time. The magnet should not be moved farther out than the point at which the magnet shoe comes in line with the end of the shelf.

GEAR MESH - OVERCURRENT UNIT

The gear and pinion should be meshed as deeply as possible without binding in any position when the disk is rotated. This adjustment is correct when a slight backlash can be felt in all disk positions. The two screws holding the contact mechanism assembly to the relay frame should be tightened securely after this adjustment is made.

CONTACTS - OVERCURRENT UNIT

With the contacts just closed, there should be enough space between the contact holding armature and the poles of the target magnet to permit the fixed contact tips to be deflected about 1/32 inch when the armature is finally pushed against its poles. The tips should lie in the same vertical plane. These adjustments are readily secured by moving each contact brush by means of the screws in the front of the brush block which pushes against it near its center.

When the time lever is moved to the position where it holds the contacts just closed, it should indicate zero on the time-lever scale. If it does not, and the brushes are correctly adjusted, shift the scale slightly after loosening the two small screws holding it to the under side of the contact plate.

CONTACT CLEANING - BOTH UNITS

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 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. Sometimes an ordinary file cannot reach the actual points of contact because of some obstruction from some other part of the relay.

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 closing.

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

CONTACTS - DIRECTIONAL UNIT

The contacts should be cleaned in the manner outlined above.

The contacts of the directional unit, Fig. 22 are specially constructed to suppress bouncing. The stationary contact (G) is mounted on a flat spiral spring (F) backed up by a thin diaphragm (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 brush, 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.

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

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

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

CUP AND STATOR - DIRECTIONAL UNIT

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

(a) Disconnect the two leads from the resistor and two leads from the secondary of the transformer at the contact block structure.

(Fig. 22)(K-6077069)

(Fig. 21)(K-6154293)

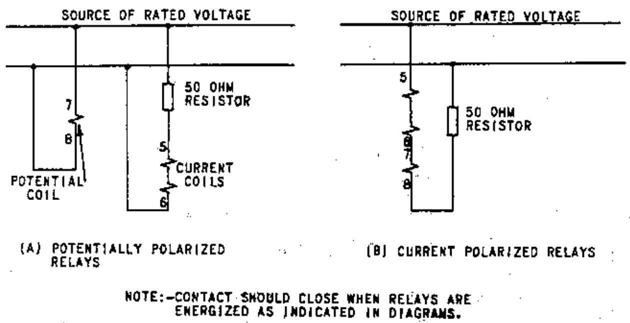


Fig. 21 Polarity Test Connections for Type IBC Relay

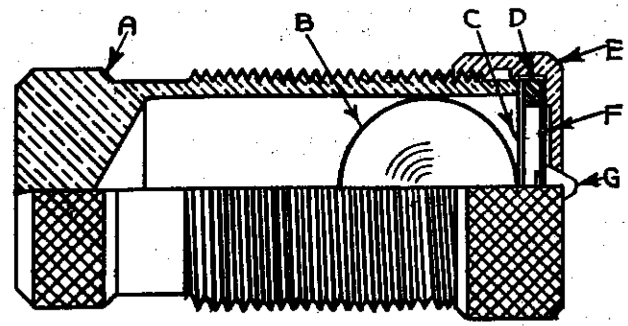


Fig. 22 Contact Assembly for Directional Unit of IBC Relays

(b) Remove unit intact with its mounting plate.

(c) Avoiding any disturbance to the top bearing plate, remove the entire top structure from the stator assembly by removal of the four corner screws. This will give access to the cup and stator assembly.

(d) In this way all parts will again be aligned by the pins when replaced.

BEARINGS - DIRECTIONAL UNIT

The lower jewel bearing should be screwed all the way in until its head engages the end of the threaded core. 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 and thus depress 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. If a jewel is replaced by a new one, a new pivot should be screwed into the end of the shaft at the same time and a drop of General Electric Meter Jewel Oil, Cat. No. 66X728, should be placed in the new jewel before it is inserted.

TORQUE ADJUSTMENT - DIRECTIONAL UNIT

The spiral spring on the contact shaft should have barely enough tension to return the moving contact arm to the neutral position where it rests against the stop screw when de-energized. Its tension may be varied by slipping the adjusting ring by first loosening the hexagonal head locking screw which connects the lead to this lead-in spiral spring. Sufficient tension will be had when this ring is rotated in the counterclockwise direction about 1/2 inch from the neutral position as measured on the periphery of the ring.

The polarity of the Type IBC relay directional units can be checked with the circuits given in Fig. 21. When connected as shown for the particular relay the contacts will close with rated voltage and frequency.

The torque adjustment is only necessary on the phase fault relays. For in these relays the directional unit is provided with a notch core, while the ground relays have unnotched cores.

The current coil of the phase-to-phase fault relays should be energized, with the potential coil shorted, by the following values of current corresponding to its rating.

Current Rating	Test Amp.
0.5-2) 1.5-6.0)	30
4-15	60

With the spring tension such as to balance the moving contact structure between the stationary contact and the stop, the core should be turned to keep it in this same position when the above test amps are applied with shorted potential coil. The core is turned with a screw driver in the bearing slot after first loosening the locknut holding it in place.

The above test should be made with the internal resistor shorted with the link; also, it should be kept in mind that the coils will overheat with too frequent applications of large currents so that sufficient time should be allowed for them to cool between tests.

CLUTCH ADJUSTMENT - DIRECTIONAL UNIT

Clutch adjustment is made with connections similar to those for the polarity check, Fig. 21, except that the 50-ohm fixed resistor should be replaced by an adjustable resistor capable of controlling the current in the current coil(s) between 5 and 15 amperes. A screw on the side of the moving arm controls the clutch pressure. Using rated frequency (and voltage for potential polarized relays) the clutch should be set to slip at the proper current from the following table:

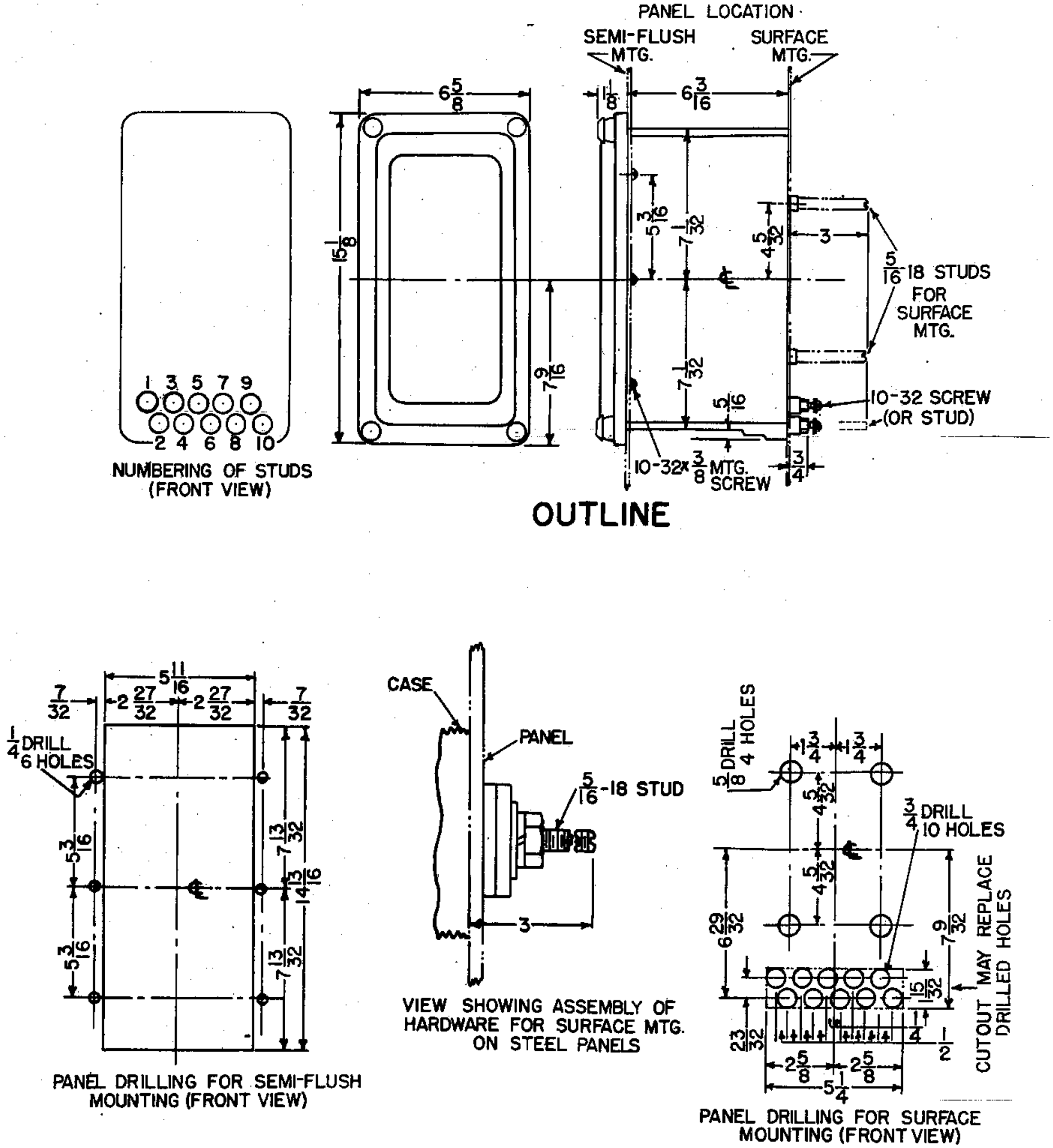
Polarization	Pick-up Amps Rating	Position of Shorting Link	Amps for Clutch to Slip
Potential	4-15	Closed	12.7
Potential	1.5-6.0 } 0.5-2.0 }	Closed	8.5
Current	4-15		12
Current	1.5-6.0 } 0.5-2.0 }		7

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.

ORDERING DIRECTIONS

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 including serial number. If possible, give the General Electric Company requisition number on which the relay was furnished.



(K-6209273)

Fig. 23 Outline and Panel Drilling for Relay Types IBC33A, IBC34A, IBCP33A, IBCP34A, IBCC33A and IBCC34A.

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IF AT ANY TIME you find it necessary to repair, recondition, or rebuild your G-E apparatus, there are 30 G-E service shops whose facilities are available day and night for work in the shops or on your premises. Factory methods and genuine G-E renewal parts are used to maintain the original performance of your G-E apparatus. If you need parts only, immediate shipment of many items can be made from warehouse stock.

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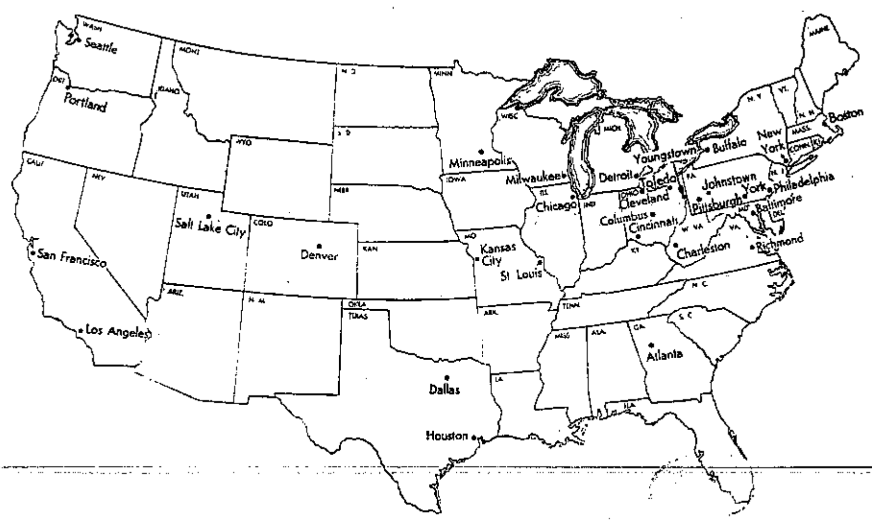

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Sioux City 13, Iowa. . . . . 507 Sixth St.
Sioux Falls, S. D. . . . . . . 321½ S. Phillips Ave.
South Bend 11, Ind. . . . 112 W. Jefferson Blvd.
Spokane 8, Wash. . . . . S. 162 Post St.
Springfield, Ill. . . . . 607 E. Adams St.
Springfield 3, Mass. . . . . 1387 Main St.
Stockton, Calif. . . . . . . 11 So. San Joaquin St.
Syracuse 2, N. Y. . . . . 113 S. Salina St.
Tacoma 1, Wash. . . . . 1019 Pacific Ave.
Tampa 6, Fla. . . . . 1206 North A St.
Toledo 4, Ohio. . . . . 420 Madison Ave.
Trenton 8, N. J. . . . . 214 E. Hanover St.
Tulsa 3, Okla. . . . . 320 S. Boston Ave.
Utica 2, N. Y. . . . . 258 Genesee St.
Washington 5, D.C. . . . 806 Fifteenth St., N.W.
Waterbury 89, Conn. . . . . . . 111 W. Main St.
Waterloo, Iowa. . . . . 206 W. 4th St.
Wheeling, W. Va. . . . . 40 Fourteenth St.
Wichita 2, Kan. . . . . 200 E. First St.
Williamston, N. C. . . . . City Hall
Wilmington, Del. . . . . 1326 N. Market St.
Worcester 8, Mass. . . . . 507 Main St.
York, Pa. . . . . 56 N. Harrison St.
Youngstown 5, Ohio. . . 272 E. Indianola Ave.

Hawaii: W. A. Ramsay, Ltd., Honolulu **Canada: Canadian General Electric Company, Ltd., Toronto**

APPARATUS DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

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