INSTRUCTIONS

GEI-93845C

Supersedes [illegible]

GROUND DIRECTIONAL OVERCURRENT RELAY

TYPES

JBCG51K

JBCG52K

JBCG53K

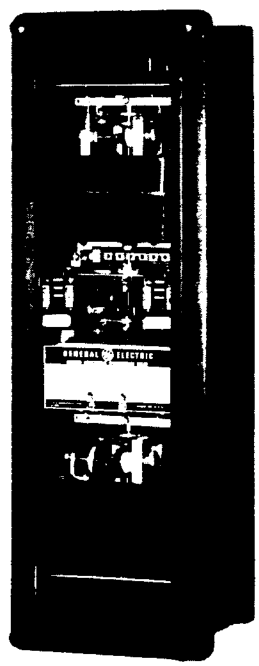
JBCG54K

JBCG61K

JBCG63K

JBCG77K

JBCG78K



GENERAL ELECTRIC

CONTENTS

NOTE: This instruction book has had a major revision. Please check your previous revision to compare material.

GROUND DIRECTIONAL OVERCURRENT RELAYS

TYPE JBCG

DESCRIPTION

Type JBCG relays are ground directional overcurrent relays used primarily for the protection of feeders and transmission lines. They are available with inverse, very inverse, extremely inverse or long 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 can be potential and/or current polarized and, by means of its closing contacts, directionally controls the operation of both the time overcurrent and instantaneous overcurrent units. All units are mounted in the L2, (large double-ended) drawout case.

APPLICATION

Type JBCG relays are used for ground fault protection of a single line. They have a four-to-one range time-overcurrent unit which may be rated 0.5/2, 1/4, 1.5/6, 2/8 or 4/16 except for JBCG to K which has an 0.5 to 1.5 ampere range. The instantaneous overcurrent unit may be rated according to the pickup ranges listed in Table III. Within a given range, the relay pickup is continuously adjustable. Because the transient overreach of this unit is low, the instantaneous unit may be set 10 percent above the maximum line fault current for a fault at the remote bus.

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. 2 shows the external connections for the single circuit type JBCG relays.

Fig. 3 shows the external connections for the double circuit type JBCG relays.

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. 4 compare the performance of the relay when dual polarized with its performance when either potential or current polarized alone. The simultaneous use of both sets of polarizing coils is advantageous on applications where current and potential polarizing sources are available and there is a possibility that one or the other source may be temporarily lost.

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 JBCG61K and JBCG63K relays have the same time and instantaneous current characteristics, but differ in the internal connections from the JBCG51K and JBCG53K relays, respectively. The JBCG61K and JBCG63K relays may be used anywhere the JBCG51K and JBCG53K relays can, but they were designed primarily for use in TRANSFERRED TRIP pilot relaying schemes. Please contact the nearest General Electric District Sales Office for further details on the application of these relays.

TABLE I

Relay Model	Time Characteristic	Circuit Closing Contacts	Internal Connections
JBCG51K	Inverse	One	Fig. 11
JBCG52K	Inverse	Two	Fig. 12
JBCG53K	Very Inverse	One	Fig. 11
JBCG54K	Very Inverse	Two	Fig. 12
JBCG61K	Inverse	One	Fig. 13
JBCG63K	Very Inverse	One	Fig. 13
JBCG70K	Long	Two	Fig. 12
JBCG77K	Extr. Inverse	One	Fig. 14
JBCG78K	Extr. Inverse	Two	Fig. 15

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 five amperes and a one 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)	*Continuous Rating (Amps)	One Second Rating (Amps)
0.5/2	0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0	1.5	**130
1/4	1, 1.2, 1.6, 2, 2.4, 3, 4	3	200
1.5/6	1.5, 2, 2.5, 3, 4, 5, 6	5	200
2/8	2, 2.5, 3, 4, 5, 6, 8	5	220
4/16	4, 5, 6, 7, 8, 10, 12, 16	10	220
0.5-1.5	0.5, 0.6, 0.7, 0.8, 1.0, 1.2, 1.5	1.5	130

*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 the very inverse time relays only. The one second rating of inverse and extremely 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)
0.5-2	2	90
1-4	4	160
2-8	5	160
4-16	5	160
10-40	5	220
20-80	5	220
40-160	5	220

POTENTIAL COILS

The potential polarizing coils will withstand 120 volts continuously and 360 volts for 60 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 0.2 ampere 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 two amperes, there is a possibility that the resistance of seven ohms will reduce the current to so low a value that the breaker will not be tripped.

The two 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	3 Amps
Carry Continuously	3 Amps	0.3 Amps
D-C Resistance	0.13 Ohms	7 Ohms
Impedance (60 Cycles)	0.53 Ohms	52 Ohms

CHARACTERISTICS

PICKUP

When potential polarized, the directional unit will pick up at 4.5 volt amperes plus or minus ten percent at the maximum torque angle of 60 degrees lag plus or minus ten degrees (current lags voltage). When current polarized, it will pick up at approximately 0.5 ampere with the operating and polarizing coils connected in series. The performance of the unit with simultaneous current potential polarization is typified in Fig. 4.

The current required to close the time overcurrent unit contacts will be within five percent of the tap screw setting. The pickup of the instantaneous overcurrent unit can be adjusted over a four-to-one range as indicated in Table III.

RESET (TIME OVERCURRENT UNIT)

The minimum percentage of minimum closing current at which the time overcurrent unit will reset is 90 percent for inverse-time relays and 85 percent for very inverse, extremely inverse and long 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 six seconds for inverse time relays and 60 seconds for very inverse, extremely inverse and long time relays.

OPERATING TIME

The time curve for the directional unit is shown in Fig. 5.

The time curves of the time overcurrent unit are shown in Figs. 6, 7, 8, and 9 respectively for inverse, very inverse, extremely inverse and long time relays. For the same operating conditions, the relay will operate repeatedly within one or two percent of the same time.

The time curve for the instantaneous overcurrent unit is shown in Fig. 10.

BURDENS

The capacitive burden of the potential polarizing circuit of the directional unit at 60 cycles and 120 volts is 10 volt-amperes at 0.86 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	0.24	6.0	0.95	5.7

TABLE VI

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

Time Characteristic	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	0.5-2	1.33	3.1	3.3	7.4	0.40	1.97	1.14	83
Inverse	1.5/6	1-4 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 40-160	0.96	2.6	2.8	6.3	0.34	1.70	0.97	70
Inverse	4/16	0.5-2	0.82	1.1	1.9	31.1	0.42	1.13	0.65	49
Inverse	4/16	1-4	0.28	0.53	0.61	9.7	0.46	0.36	0.21	15
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 40-160	0.15	0.37	0.40	6.1	0.38	0.24	0.14	10.0
Very Inverse	0.5/2	0.5-2	2.80	5.58	6.24	1.56	0.45	5.88	5.06	156
Very Inverse	0.5/2	1-4	2.26	4.99	5.48	1.37	0.41	5.16	4.45	137
Very Inverse	0.5/2	2-8	2.13	4.84	5.29	1.32	0.40	4.98	4.29	132
Very Inverse	0.5/2	4-16 10-40 20-80 40-160	2.10	4.80	5.20	1.3	0.40	4.90	4.20	130
Very Inverse	1/4	0.5-2	1.24	1.98	2.34	2.34	0.53	2.19	1.89	58
Very Inverse	1/4	1-4	0.70	1.39	1.56	1.56	0.45	1.46	1.26	39

TABLE VI (Continued)

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

Time Characteristic	Range		Burdens at Minimum Pickup of Time Unit					Ohms Impedance at		±VA At 5 Amps
	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.	
Very Inverse	1/4	2-8	0.57	1.25	1.37	1.37	0.41	1.28	1.11	34
Very Inverse	1/4	4-16	0.53	1.21	1.32	1.32	0.40	1.23	1.07	33
Very Inverse	1/4	10-40 20-80 40-160	0.52	1.20	1.31	1.31	0.40	1.22	1.06	33
Very Inverse	1.5/6	0.5-2	0.95	1.29	1.60	3.50	0.59	1.51	1.29	40
Very Inverse	1.5/6	1-4	0.41	0.70	0.81	1.82	0.51	0.76	0.65	20
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 40-160	0.25	0.51	0.57	1.3	0.44	0.53	0.46	14
Very Inverse	2/8	0.5-2	0.88	1.11	1.41	5.64	0.62	1.32	1.15	35
Very Inverse	2/8	1-4	0.34	0.52	0.62	2.47	0.55	0.58	0.51	15
Very Inverse	2/8	2-8	0.21	0.37	0.42	1.69	0.50	0.39	0.34	11
Very Inverse	2/8	4-16	0.17	0.33	0.37	1.49	0.45	0.35	0.30	9
Very Inverse	2/8	10-40 20-80 40-160	0.16	0.32	0.35	1.43	0.45	0.33	0.29	8.9
Very Inverse	4/16	0.5-2	0.78	0.89	1.18	19.0	0.72	1.10	0.96	29
Very Inverse	4/16	1-4	0.24	0.30	0.39	6.2	0.62	0.36	0.32	[illegible]
Very Inverse	4/16	2-8	0.11	0.15	0.18	2.9	0.61	0.17	0.15	4.5
Very Inverse	4/16	4-16	0.07	0.11	0.13	2.1	0.54	0.12	0.11	[illegible]
Very Inverse	4/16	10-40 20-80 40-160	0.06	0.10	0.12	1.9	0.50	0.11	0.10	[illegible]
Extremely Inverse	0.5/2	0.5-2	1.79	2.14	2.79	0.70	0.64	2.79	2.74	
Extremely Inverse	0.5/2	1-4	1.25	1.55	1.99	0.50	0.63	1.99	1.95	
Extremely Inverse	0.5/2	2-8 4-16 10-40 20-80 40-160	1.12	1.40	1.80	0.46	0.62	1.80	1.79	[illegible]

TABLE VI (Continued)

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

Time Character-istic	Range		Burdens at Minimum Pickup of Time Unit					Ohms Impedance at		±VA At 5 Amps
	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.	
Extremely Inverse	1.5/6	0.5-2	0.84	1.00	1.31	2.94	0.65	1.31	1.29	33
Extremely Inverse	1.5/6	1-4	0.30	0.41	0.51	1.15	0.59	0.51	0.50	12.7
Extremely Inverse	1.5/6	2-8	0.17	0.26	0.31	0.70	0.55	0.31	0.30	7.8
Extremely Inverse	1.5/6	4-16	0.14	0.18	0.24	0.54	0.58	0.24	0.23	6.0
Extremely Inverse	1.5/6	10-40 20-80 40-160	0.13	0.16	0.21	0.47	0.62	0.21	0.20	5.2
Extremely Inverse	4/16	0.5-2	0.75	0.84	1.13	18.0	0.67	1.13	1.11	28
Extremely Inverse		1-4	0.21	0.26	0.34	5.4	0.63	0.34	0.33	8.4
Extremely Inverse		2-8	0.08	0.10	0.13	2.07	0.62	0.13	0.13	3.23
Extremely Inverse	4/16	4-16	0.045	0.065	0.079	1.26	0.57	0.079	0.078	1.98
Extremely Inverse	4/16	10-40	0.038	0.048	0.061	0.98	0.62	0.061	0.060	1.53
Extremely Inverse	4/16	20-80 40-160	0.036	0.042	0.055	0.88	0.65	0.055	0.054	1.38
Long	0.5/1.5	0.5-2	3.25	19.5	19.8	4.94	0.16	9.3	4.4	494
Long	0.5/1.5	1-4	2.71	18.9	19.1	4.78	0.14	9.0	4.2	477
Long	0.5/1.5	2-8	2.58	18.8	18.9	4.74	0.14	8.9	4.2	474
Long	0.5/1.5	4-16 10-40 20-80 40-160	2.54	18.7	18.9	4.73	0.13	8.9	4.2	473

* The impedance values given are those for the minimum tap of each relay. The impedance for other taps, pickup 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 one ampere tap, at one 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 co... is included so a direct comparison can be made. It should not be used in calculating volt-ampere bur... in a CT secondary circuit, since the burden at five amperes is used for this purpose.

± Calculated from burden at minimum pickup.

CALCULATION OF SETTING

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 magnitu... illustrated by the time curves in Figs. 6, 7, 8, and 9. 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 80 amperes on the eight ampere tap as for 50 amperes on the five ampere tap, since in both cases, the curr... is ten 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 ensure 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

Assume that the relay is being used in a circuit where the circuit breaker should trip on a minimum fault of 450 amperes, and that the breaker should trip in one second on a short circuit of 2,250 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, and then allowing a 50 percent margin of safety. In this case, 450 amperes divided by 60 equals 7.5 amperes, and 7.5 divided by 1.50 equals 5 amperes. Thus, the 5 ampere tap is used. To find the proper time-dial setting to give one second time delay at 2,250 amperes, divide 2,250 by the transformer ratio. This gives 37.5 amperes secondary current which is 7.5 times the 5 ampere tap setting. By referring to the time-current curves Figs. 6, 7, 8, and 9, it will be seen that 7.5 times the minimum operating current gives a one second delay for a Number 3.6 time-dial setting on an inverse time relay, a Number 5.5 time-dial setting on a very inverse time relay, and a Number 10 time-dial setting on an extremely 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.

Because of its low transient overreach the instantaneous overcurrent unit may be set 10 percent above the maximum line fault current for a fault at the remote bus is 2,250 amperes. The instantaneous current setting is found by dividing 2,250 amperes by the current transformer ratio which is 60/1 and then allowing a 10 percent margin. In this case, 2,250 amperes divided by 60/1 equals 37.5 amperes multiplied by 1.10 equals 41.25 amperes. Thus, rounding off to a half ampere, a 41.5 setting should be used.

The time and instantaneous overcurrent units are controlled by the directional unit. In general, the current setting of the time unit is always below the instantaneous current setting. It is desirable to determine that, at the pickup of the time overcurrent unit, the directional unit will operate. This can be readily done by calculating from system fault data, the zero sequence currents at the relay for a fault restricted to the pickup value of the time overcurrent unit. With potential polarization only, 3.6 volt-amperes at the maximum torque angle of 60 degrees lag (current times voltage) is required. With current polarization only, 0.25 ($I_0 x I_{polar}$. in phase) is required.

CONSTRUCTION

TIME OVERCURRENT UNIT

The inverse, very inverse and long time overcurrent units consist 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 extremely 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, a capacitor 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.

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. 11 through Fig. 15). 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 watt-metric 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 unit.

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. 1.

The left seal-in unit operates in conjunction with the time overcurrent unit contacts and is labeled "TIME". 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 "INST." 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.16 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. 17. They are specially constructed to suppress bouncing. The stationary contact (G) is mounted on a flat spiral spring (F) backed up by a slightly inclined tube (A). A stainless steel ball (B) is placed in the tube before the diaphragm is assmebled. 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.

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.

ACCEPTANCE TESTS

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

VISUAL INSPECTION

Check the nameplate stamping to ensure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage and that all screws are tight. Check that the shorting bars are in the proper location(s) and that they are properly formed (See Fig. 18).

MECHANICAL INSPECTION

A. TOP UNIT (IOC)

1. The rotating shaft end play should be 0.015 - 0.020 inch.
2. The contact gap should be 0.028 - 0.036 inch.
3. There should be no noticeable friction in the rotating structure.
4. With the relay well leveled and in its upright position, the contact should be open and resting against the backstop.

B. MIDDLE UNIT (TOC)

1. The disk shaft end play should be 0.005 - 0.015 inch.
2. The disk should be centered in the air gaps of both the electro magnet and drag magnet.
3. Both gaps should be free of foreign matter.
4. The disk should rotate freely.
5. The moving contact should just touch the stationary contact when the time dial is at the zero time-dial position.

C. BOTTOM UNIT (DIR)

1. The rotating shaft end play should be 0.015 - 0.020 inch.
2. The contact gap should be 0.015 - 0.025 inch on the low gradient front contact.
3. The front contact should close approximately 0.005 to 0.010 inch before the rear contact.

D. TARGET SEAL-IN UNIT

1. Both contacts should make at approximately the same time.
2. The target should latch into view just as the contacts make.
3. The contacts should have approximately 0.030 inch wipe.

E. ELECTRICAL TESTS

(To properly duplicate operating conditions all electrical tests should be conducted with the relay reasonably level and in its case.)

1. TOP UNIT (IOC)

   a. Connect relay per Figure A of Test Connections (Fig. 19).

   b. Block directional unit contacts closed.

   c. Unit should close its contacts within plus or minus five percent of the minimum pickup current range.

   d. Apply the maximum current pickup of the unit; it should not be necessary to wind the control spring more than one turn (360 degrees) to just balance the restraining and operating torques.

   e. Reset the control spring for minimum pickup.

   f. The clutch should not slip at six times pickup current. It may, however, slip at eight times pickup current.

   g. Open the directional unit contacts. At 20 times pickup current the instantaneous unit should not operate.

2. MIDDLE UNIT (TOC)

   a. Connect relay per Figure B of Test Connections (Fig. 19).

   b. Block directional unit contacts closed.

   c. Set tap screw in lowest tap and the time dial at the 0.5 time-dial position. The unit should close its contact within plus or minus 5 percent of the tap value.

   d. In a like manner, each of the other taps may be checked.

   e. To check the time curve, set the tap screw in the minimum tap and the time dial at the Number 5 time-dial position. Apply five times pickup current; the operating time should be:

Relay Time	Oper. Time (seconds ±5%)
Long	18.6
Inverse	1.78
Very Inverse	1.31
Extremely Inverse	0.93

   f. Open the directional unit contacts. At 20 times pickup current the time-overcurrent unit (TOC) should not operate.

3A. BOTTOM UNIT (Current Polarization)

   a. Connect per Figure C of Test Connections (Fig. 19).

   b. The unit should close its contacts within five percent of 0.5 ampere. The clutch should slip between 8-18 amperes.

3B. BOTTOM UNIT (Potential Polarization)

   a. Connect per Figure D of Test Connections. (Fig. 19).

   b. With V set for five volts the unit should close its contacts between 0.75-1.65 amperes.

4. TARGET SEAL-IN UNIT

   a. The unit should pickup between 85 and 100 percent of the tap value and drop out at 25 percent or more of tape value.

INSTALLATION PROCEDURE

LOCATION

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

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel drilling dimensions are shown in Fig. 20.

CONNECTIONS

The internal connections are shown in Figs. 11, 12, 14, and 15.

VISUAL INSPECTION

Remove the relay from its case and check that there are no broken or cracked component parts and that all screws are tight.

MECHANICAL INSPECTION

Recheck the adjustments mentioned under MECHANICAL INSPECTION in the section on ACCEPTANCE TESTS.

ELECTRICAL TESTS

1. TOP UNIT (IOC)
   a. Connect per Figure A of Test Connection (Fig. 19).
   b. Block the directional unit contacts closed.
   c. Loosen the hexagonal clamping screw which holds the control spring adjusting ring.
   d. Adjust the control spring for the desired pickup.
   e. Retighten the hexagonal clamping screw and recheck pickup.

2. MIDDLE UNIT (TOC)
   a. Connect per Figure B of Test Connections (Fig. 19).
   b. Block the directional unit contacts closed.
   c. Set the tap screw in the desired tap and the time dial at the 0.5 time-dial position. Check that pickup is within five percent of the selected tap. If it is desired to set pickup for some value other than tap value, the control spring may be adjusted for any value between taps.
   d. Apply the calculated multiples of pickup and set the time dial for the desired operating time. Fine adjustment of time may be obtained by moving the permanent magnet (drag magnet) in or out along the supporting shelf.

3. BOTTOM UNIT (Directional Unit)
   a. Connect per Figure C of Test Connections (Fig. 19).
   b. Adjust the control spring for 0.5 ampere pickup if current polarized or dual polarized.
   c. If potential polarized connect per Figure D of Test Connections (Fig. 19).
   d. Adjust the control spring for 7.2 volt-amperes (±10 percent). Twenty volts and 0.36 amperes are recommended values for this test.

4. TARGET SEAL-IN UNITS
   a. The unit should pickup between 85 and 100 percent of the tap value and drop out at 25 percent or more of tap value.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

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

CONTACT CLEANING

Check that the contacts are clean and burnish where necessary.

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 it will clean off any corrosion thoroughly and rapidly. Its flexibility insures the cleaning of the actual points of contact. Do not use knives, files, abrasive paper or cloth of any kind to clean relay contacts.

SERVICING

If it is found during the installation or periodic tests that the unit calibrations are out of limits, they should be recalibrated as outlined in the following paragraphs. It is suggested that these calibrations be made in the laboratory. The circuit components listed below, which are normally considered as factory adjustments, are used in recalibrating the units. These parts may be located from Figs. 1 and 2.

Top Unit (IOC)

The clutch adjustment is made by means of a screw located on the right hand side (front view) of the moving contact assembly. Turning the screw in increases the value of current at which the clutch will slip.

The control spring adjustment for setting pickup has been previously described in the INSTALLATION section.

Middle Unit (TOC)

Extremely inverse relays only.

In addition to the control spring setting for setting pickup, there is a resistor (R2) for adjusting the torque level.

If the control spring has been replaced, the resistor must be readjusted as follows:

1. Unwind the control spring until the moving contact just "floats" at the Number 1 time-dial position.
2. Wind the control spring two full turns (720 degrees).
3. Set the resistor in its mid range.
4. Connect per Figure A of Test Connections (Fig. 19).
5. Check pickup per ACCEPTANCE TESTS.
6. Make adjustments in resistor setting to obtain proper pickup.

Bottom Unit (Directional)

The contact construction has been previously described in the CONSTRUCTION section.

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 and 19 and 19 and 20 to signify all contact closures. Refer to Fig. 17 and Fig. 16 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. 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.

BIAS 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 cirectional 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 out the potential polarizing coil (terminals 9 and 10), leaving the current polarizing coil (terminals 7 and 8) unshorted. Supply 30 amperes through the operating coil (terminals 5 and 6) and check that the unit does not operate.

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 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.

RENEWAL PARTS

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

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

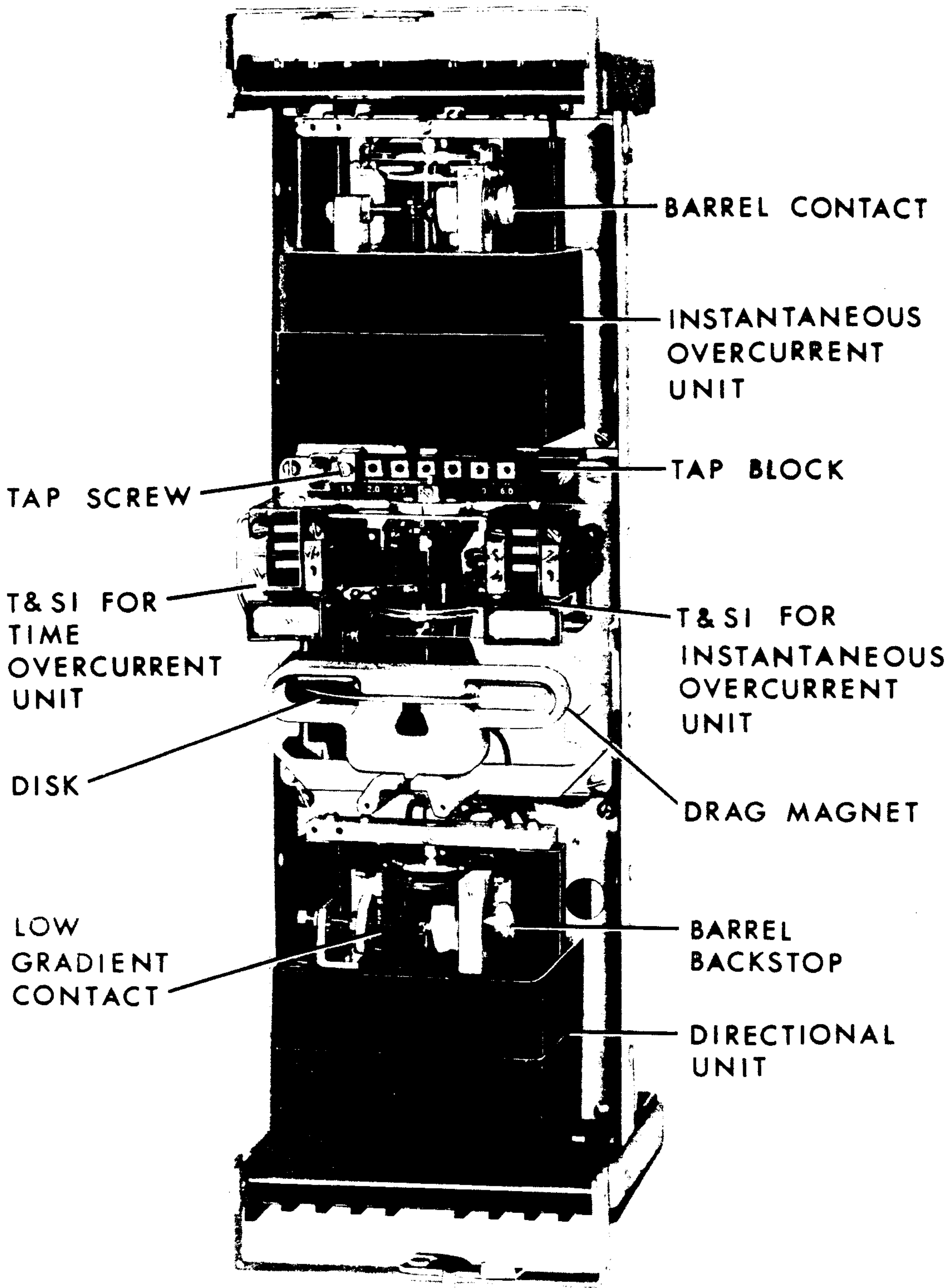


FIG. 1A (8035174) Type JBCG53K Relay. Front View, in Cradle.

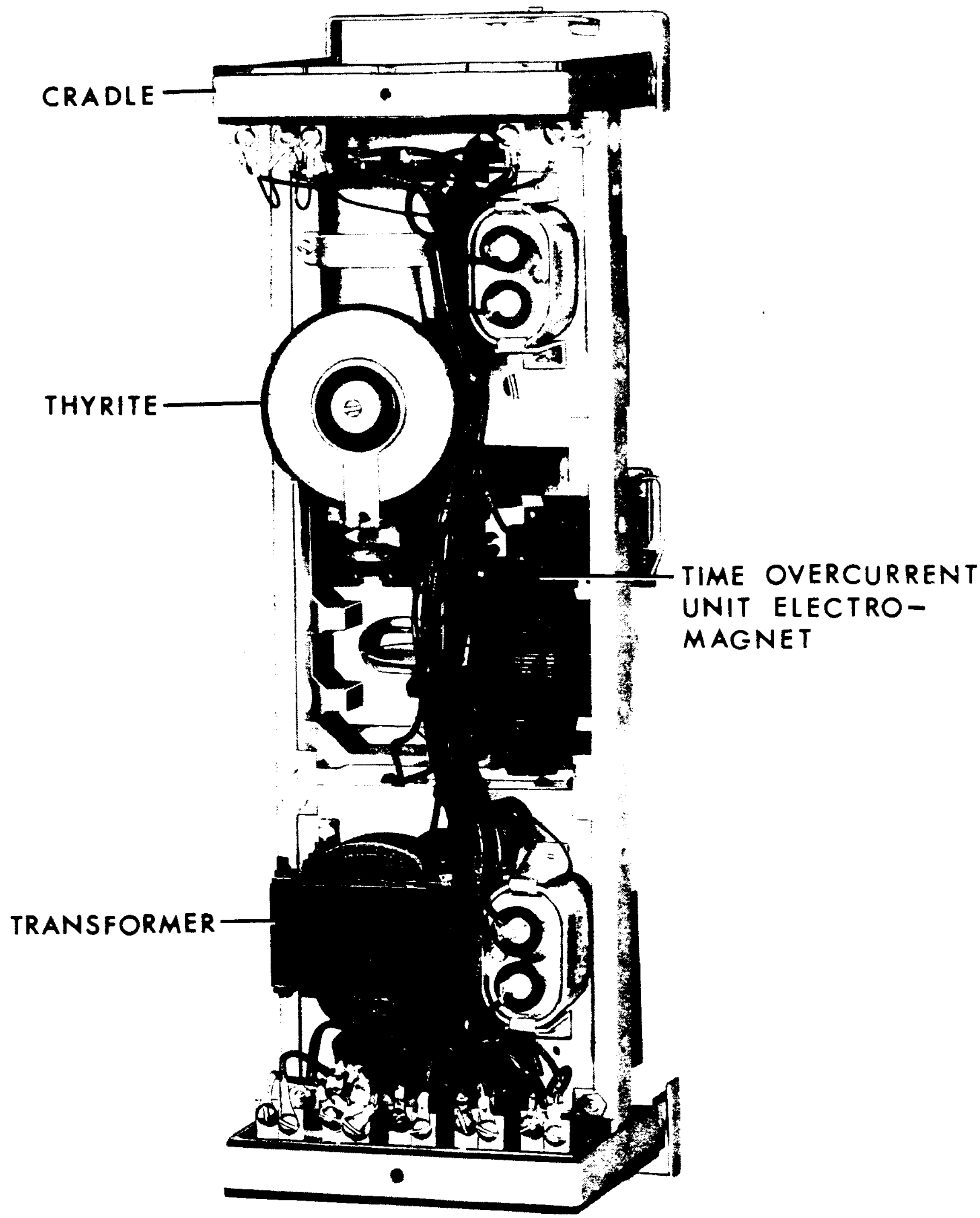


FIG. 1B (8035175) Type JBCG53K Relay. Rear View, in Cradle.

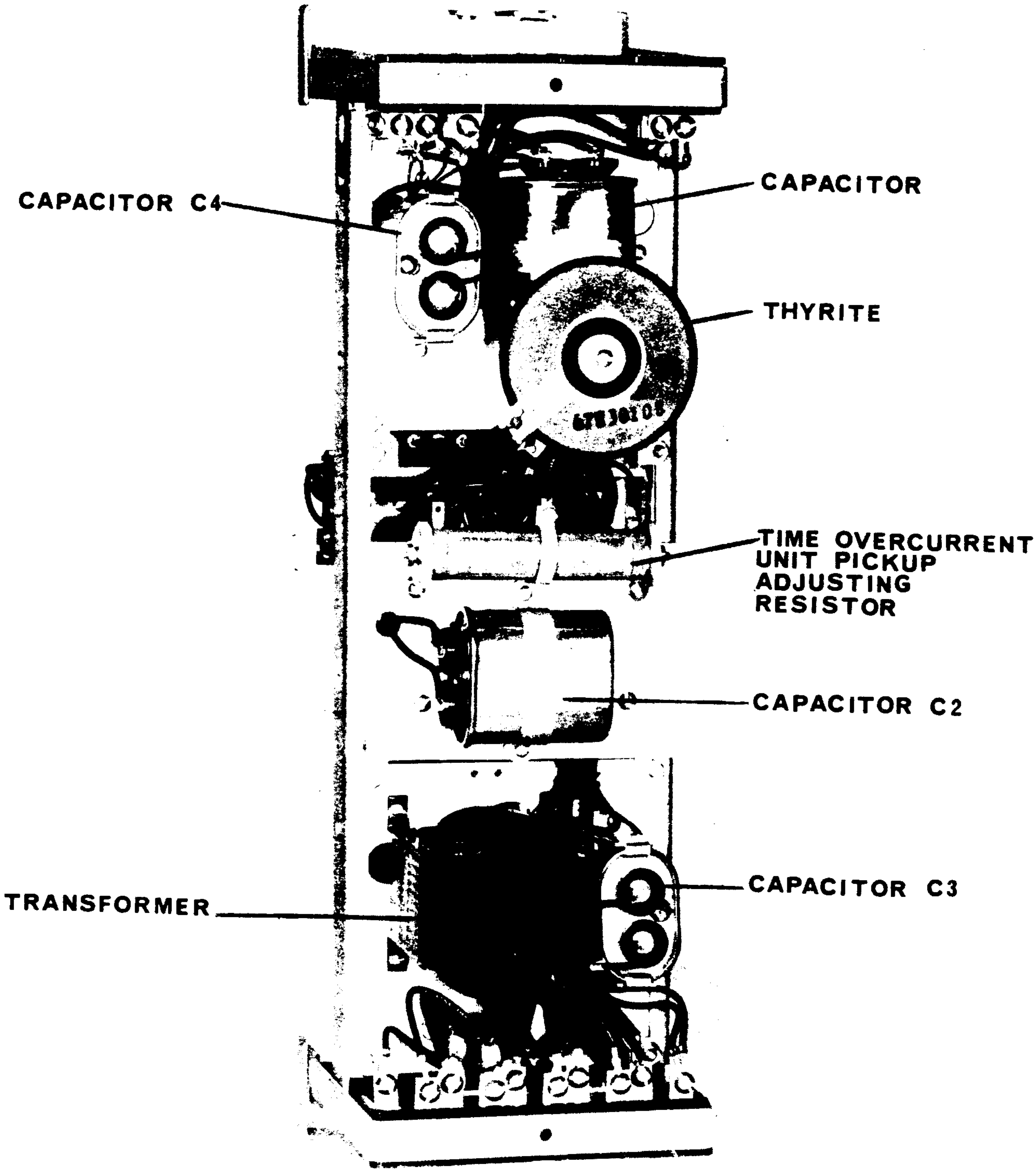


FIG. 1C (8035399) Type JBCG77K Relay. Rear View, in Cradle.

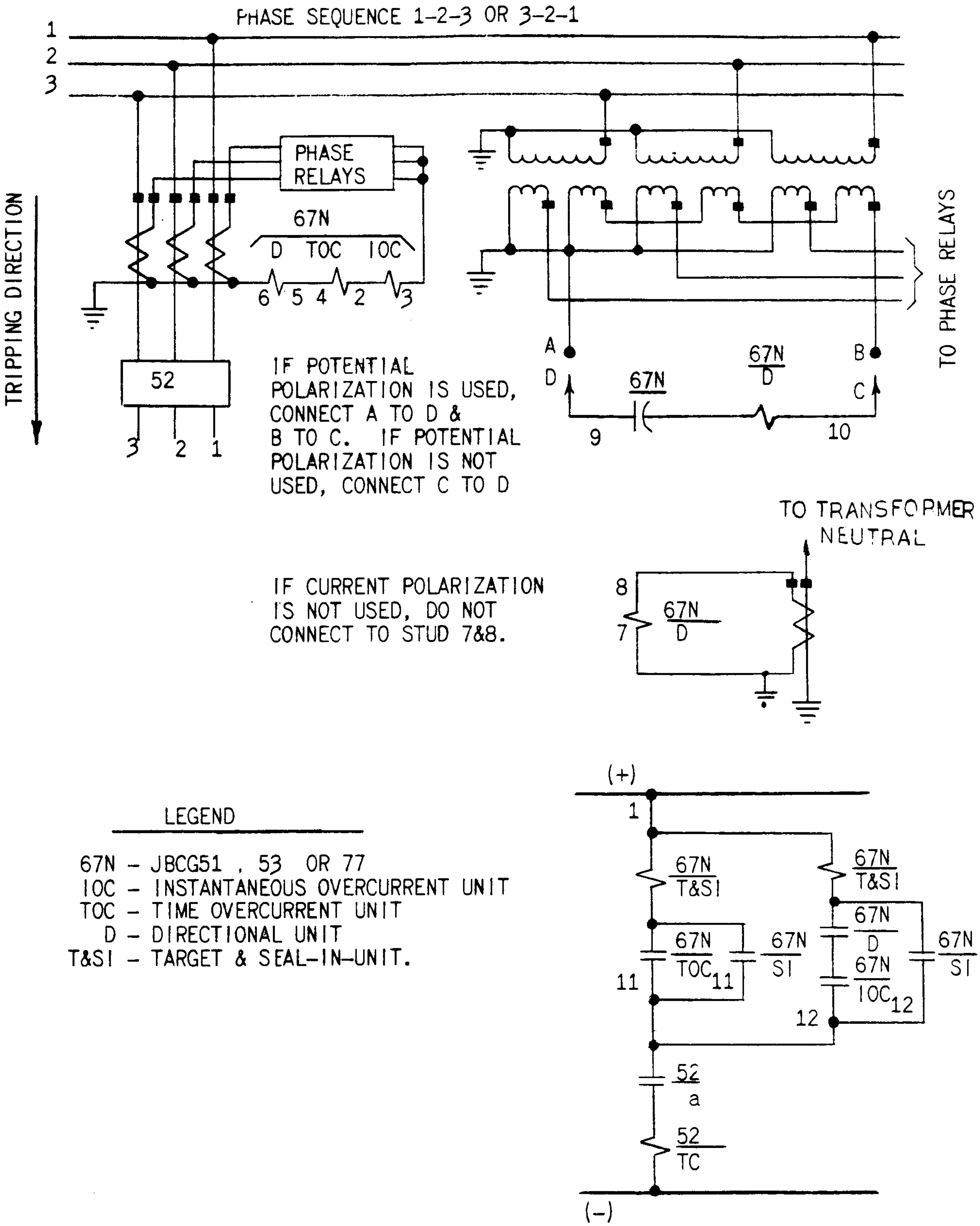


FIG. 2 (0148A4012-3) External Connections Diagram for Relay Types JBCG51K, 53K, or 77K

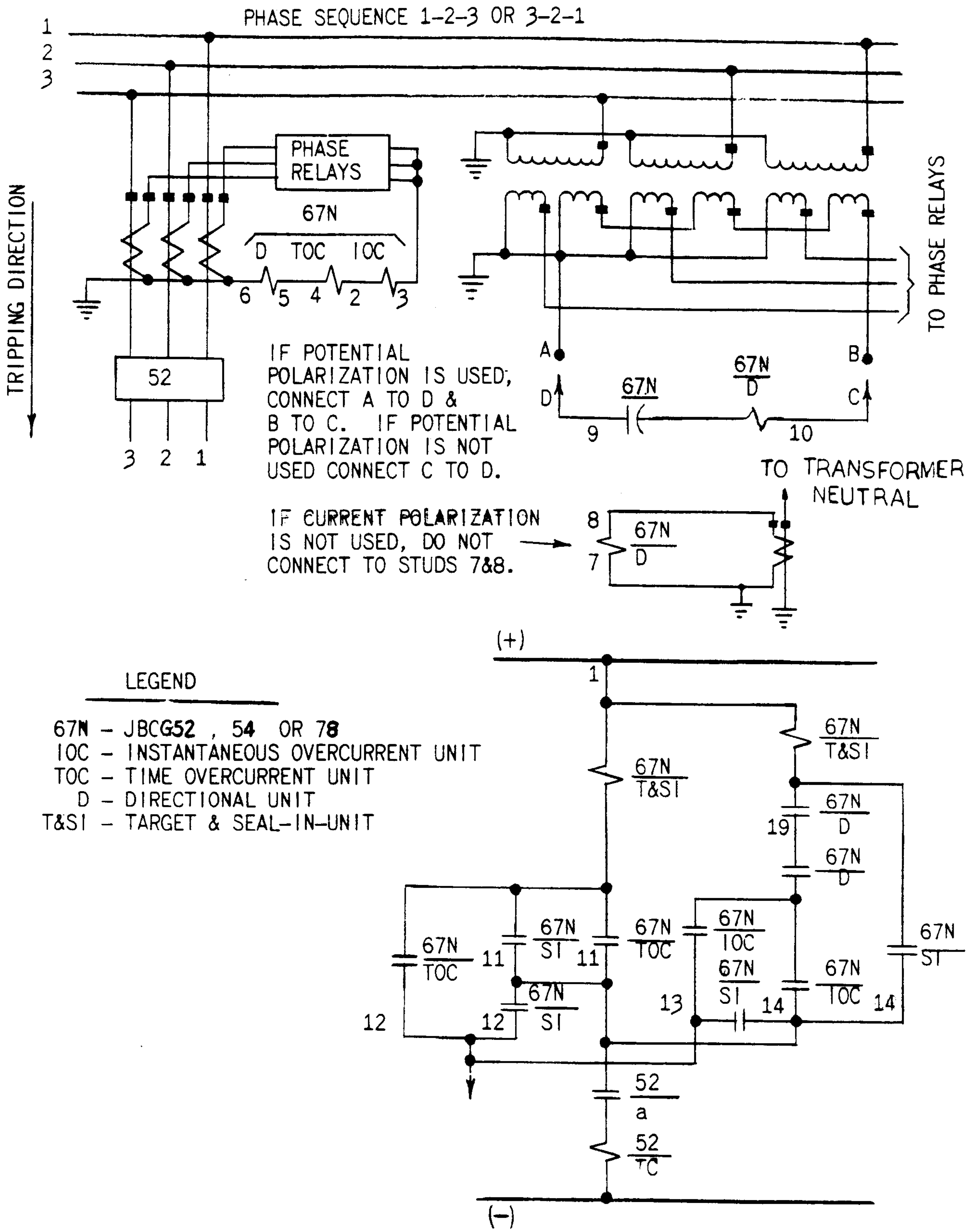


FIG. 3 (0148A4013-3) External Connection Diagram for Relay Types JBCG52K, 54K, 70K, or 78K

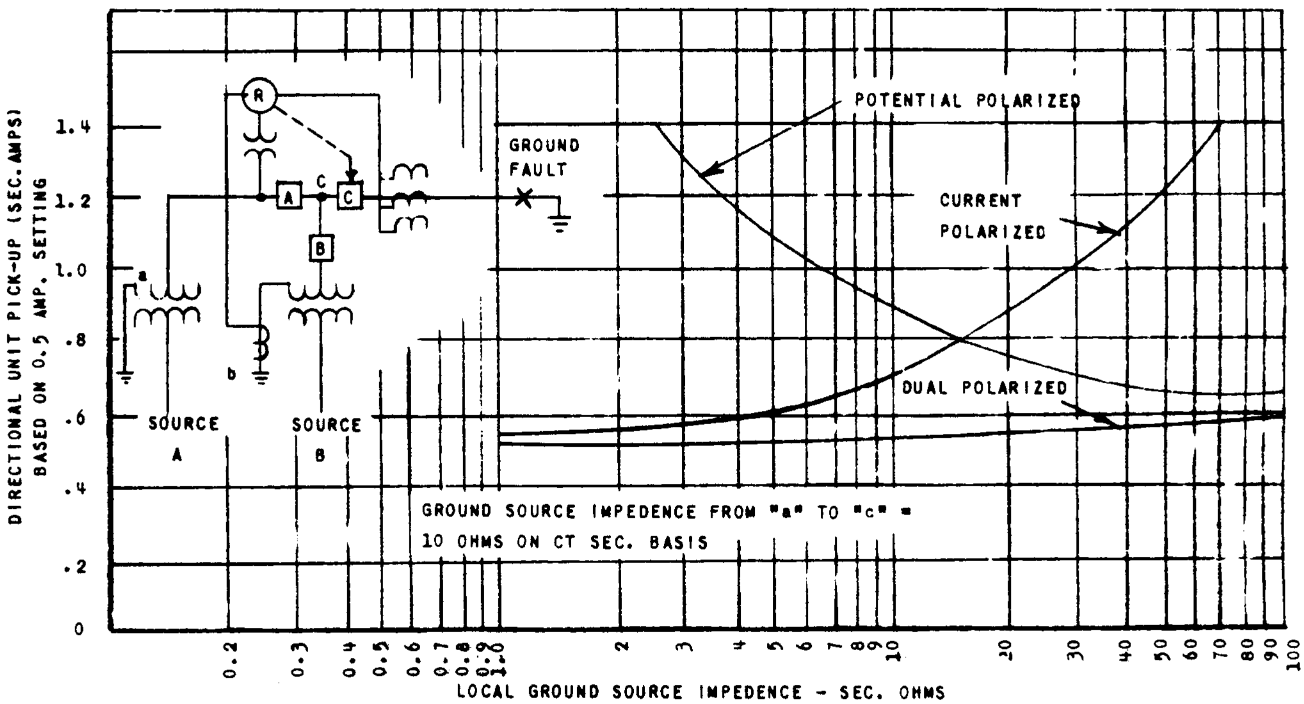


FIG. 4 (362A0684-1) A Typical Comparison of Current, Potential or Dual Polarization Showing Effect of Local Ground Impedance on Directional Unit of Type JBCG Relay

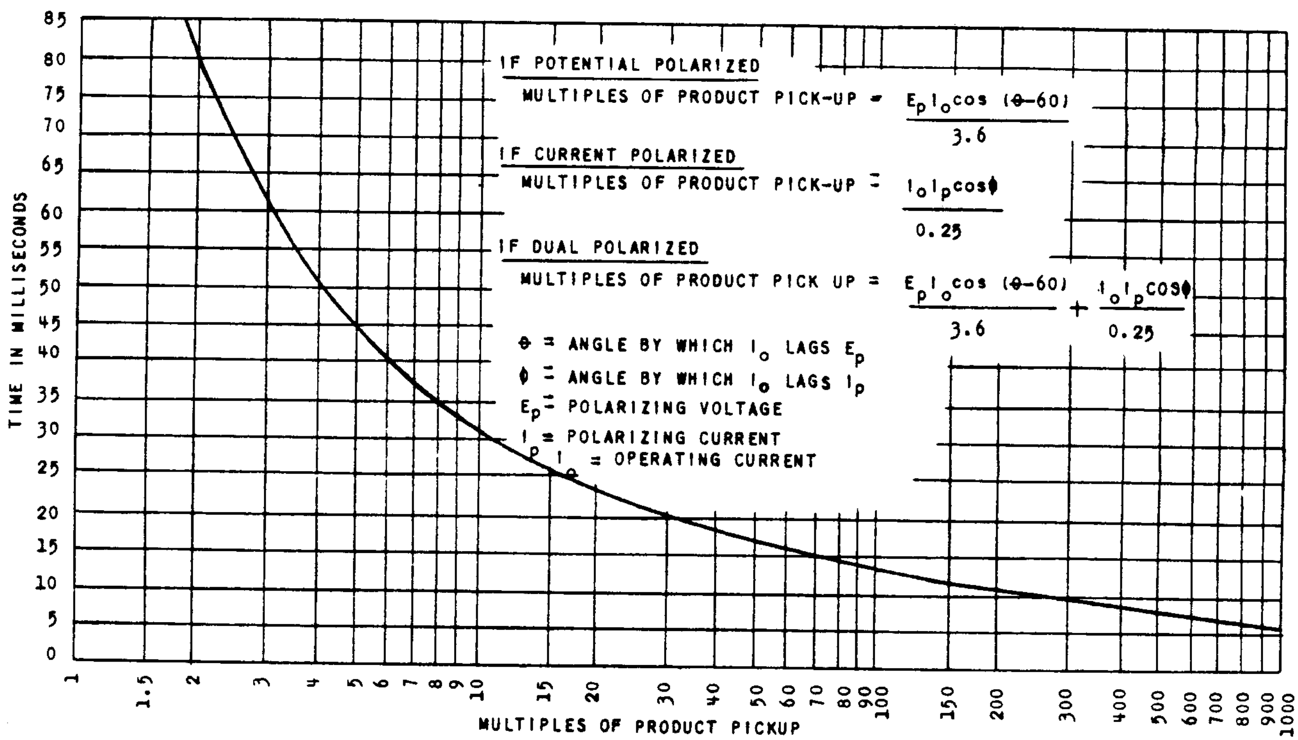


FIG. 5 (376A0934-0) Time Characteristic of Dual Polarized Directional Unit in Type JBCG Relay

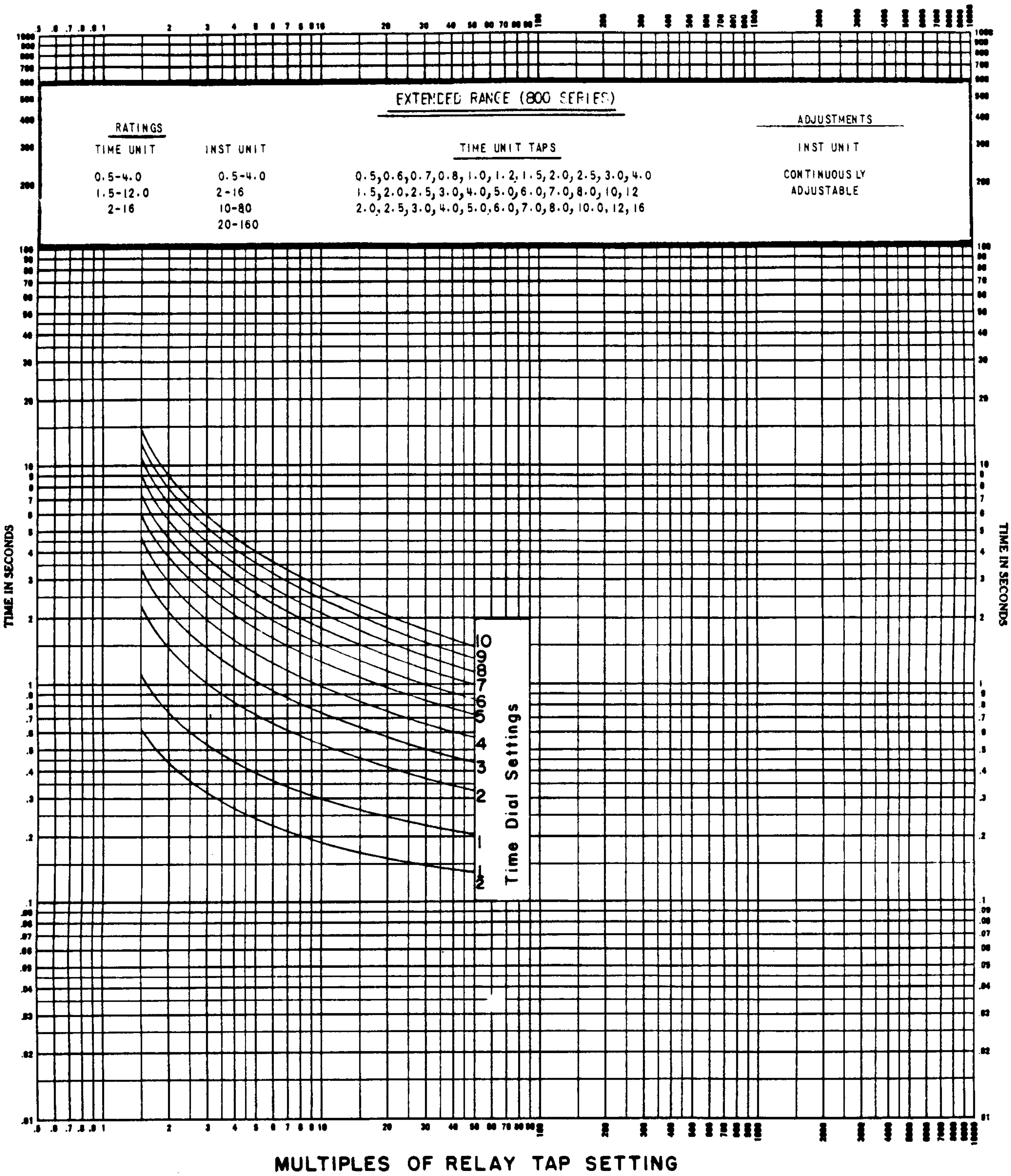


FIG. 6 (0888B0269-3) Time-current Curves for Inverse Time Overcurrent Unit (JBCG51, JBCG52, and JBCG61)

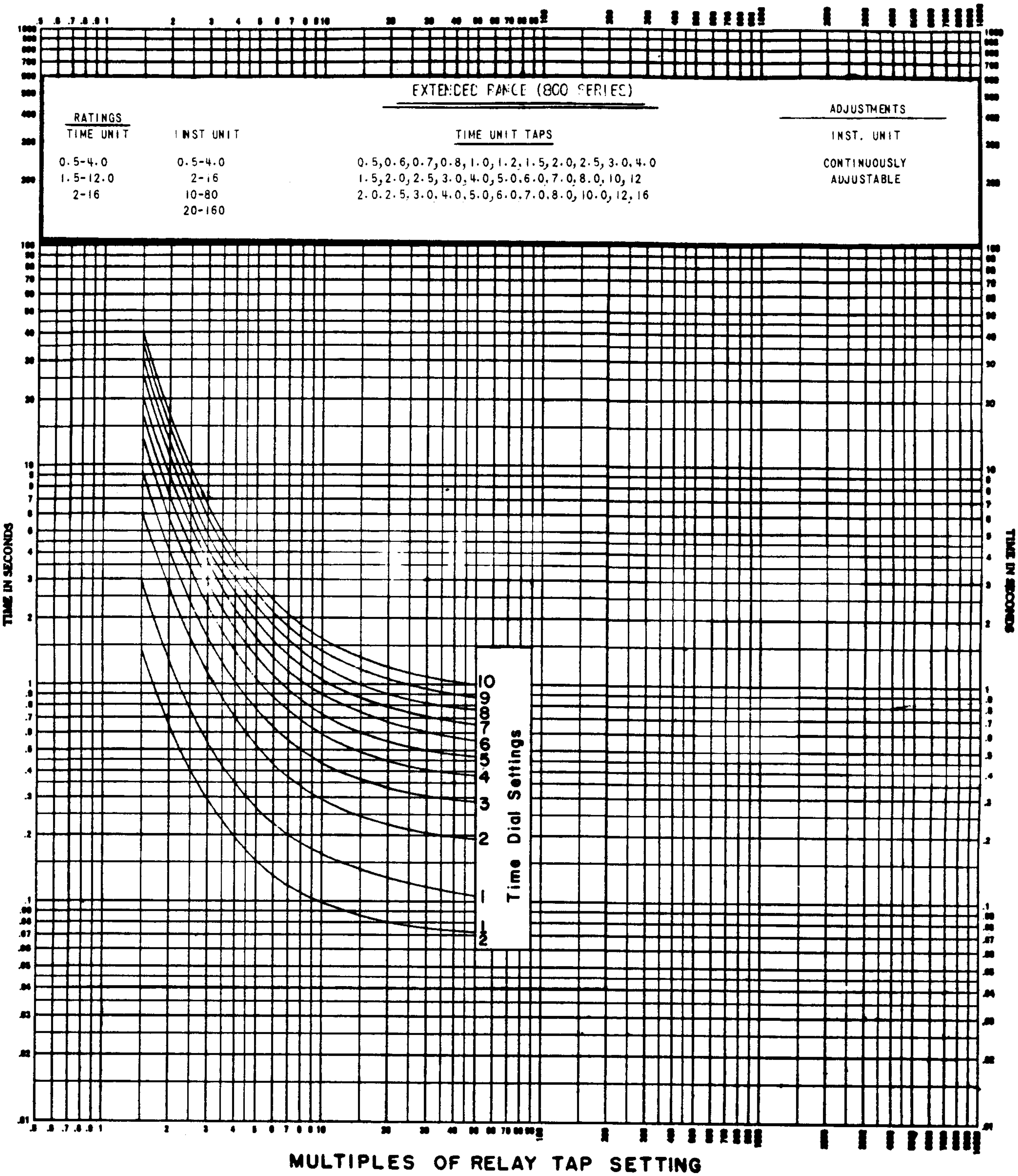


FIG. 7 (0888B0270-3) Time-current Curves for Very Inverse Time Overcurrent Unit (JBCG53, JBCG54, and JBCG63)

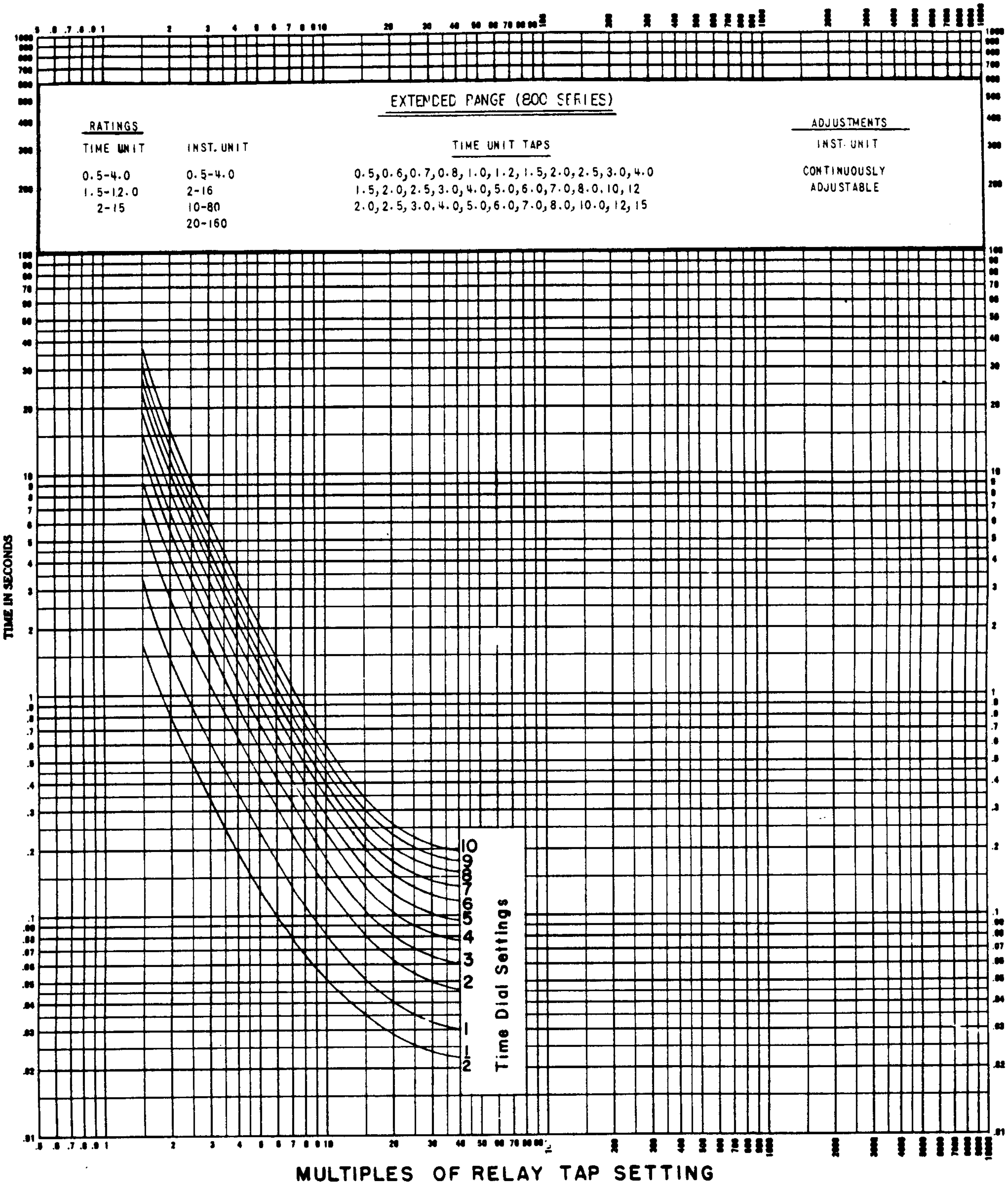


FIG. 8 (0888B0274-5) Time-current Curves for Extremely Inverse Time Overcurrent Unit (JBCG77 and JBCG78)

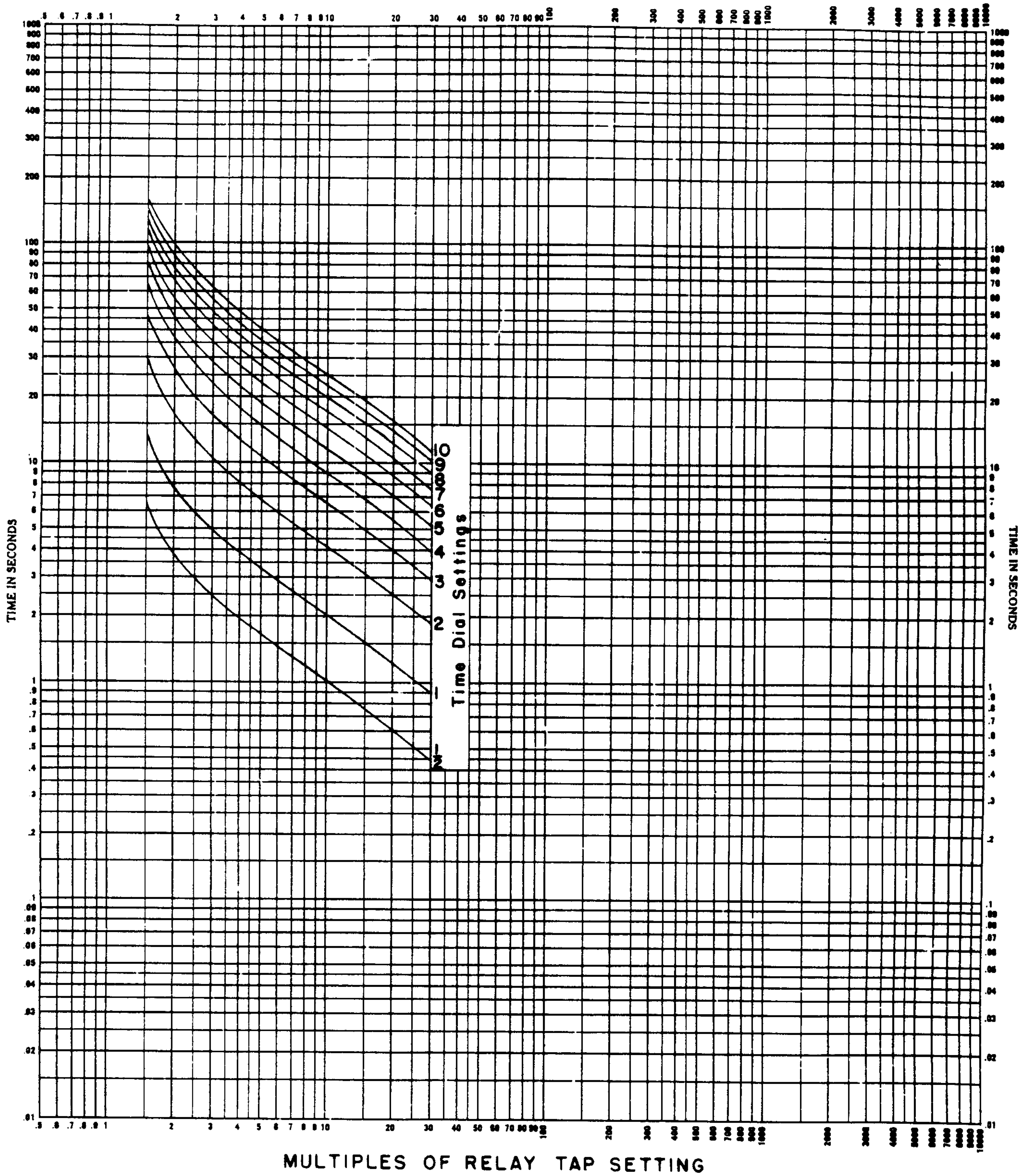


FIG. 9 (0888B0273-0) Time-current Curves for Long Time Overcurrent Unit (JBCG70)

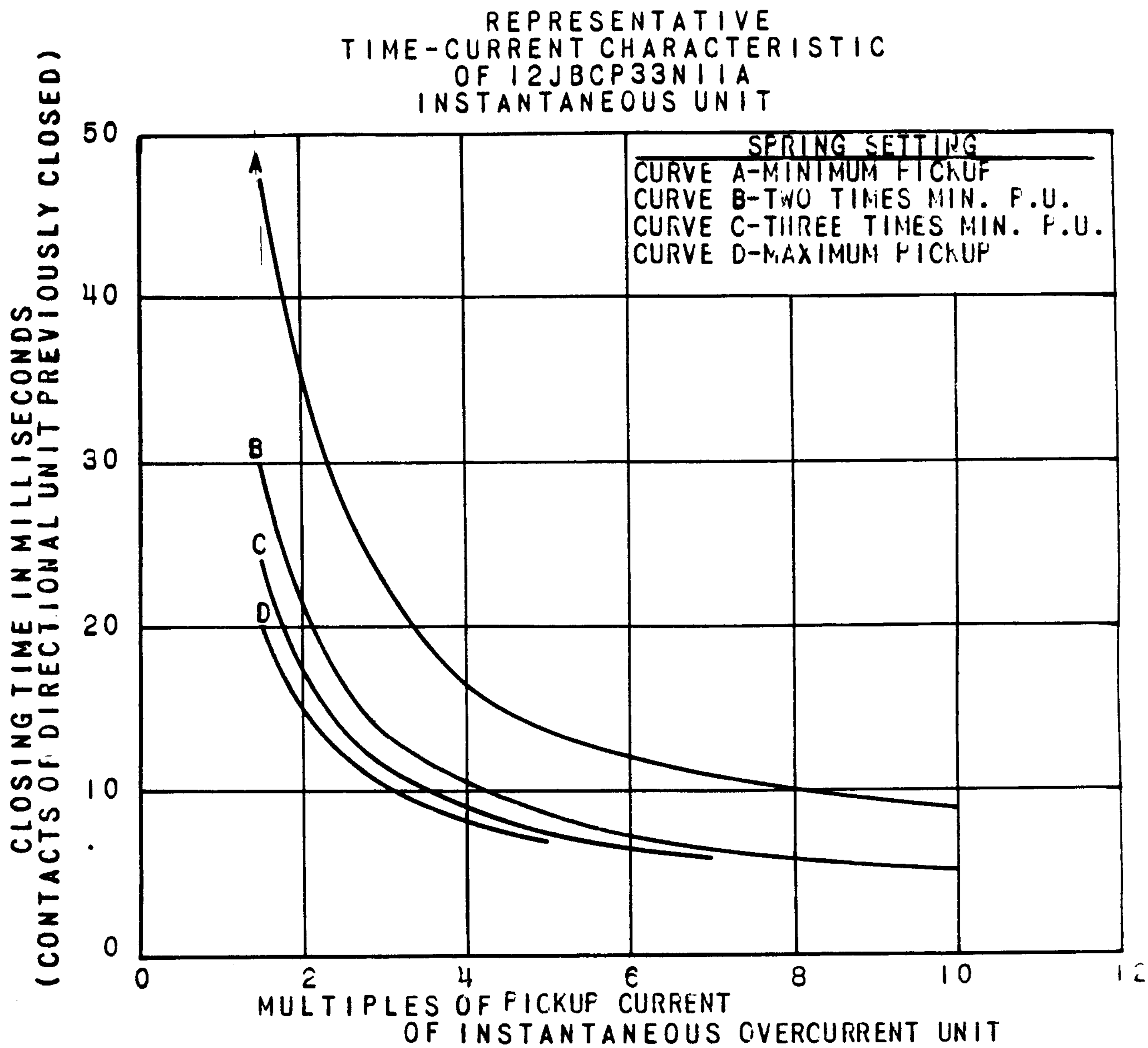
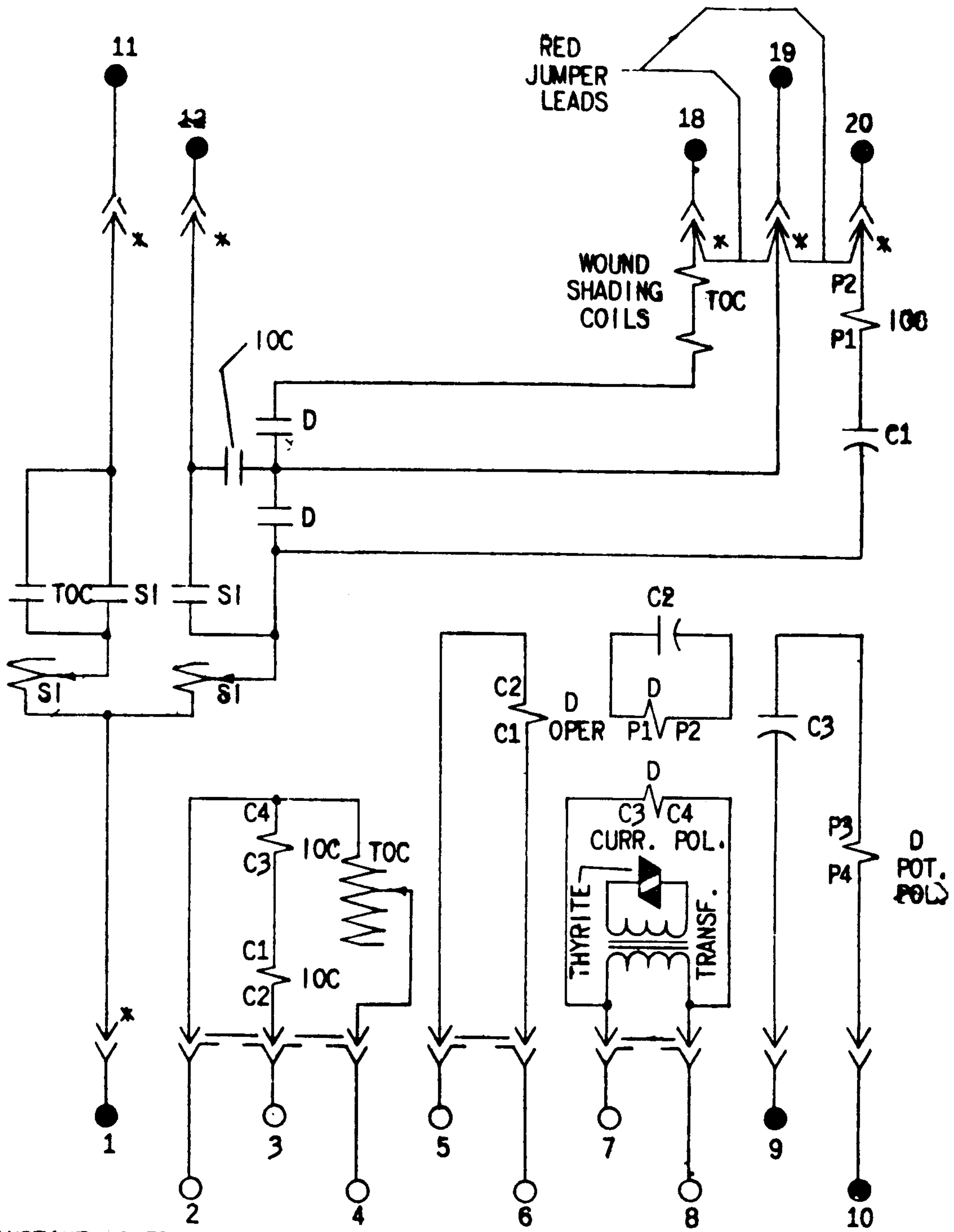


FIG. 10 (6556439-2) Instantaneous Overcurrent Unit Time Curve



IOC–INSTANT. OVERCURRENT UNIT (TOP)
TOC–TIME OVERCURRENT UNIT (MIDDLE)
D–DIRECTIONAL UNIT (BOTTOM)
SI–SEAL-IN UNIT

*: SHORT FINGER

FIG. 11 (0104A8978-1) Internal Connections for JBCG51K and JBCG53K Relays (Front View)

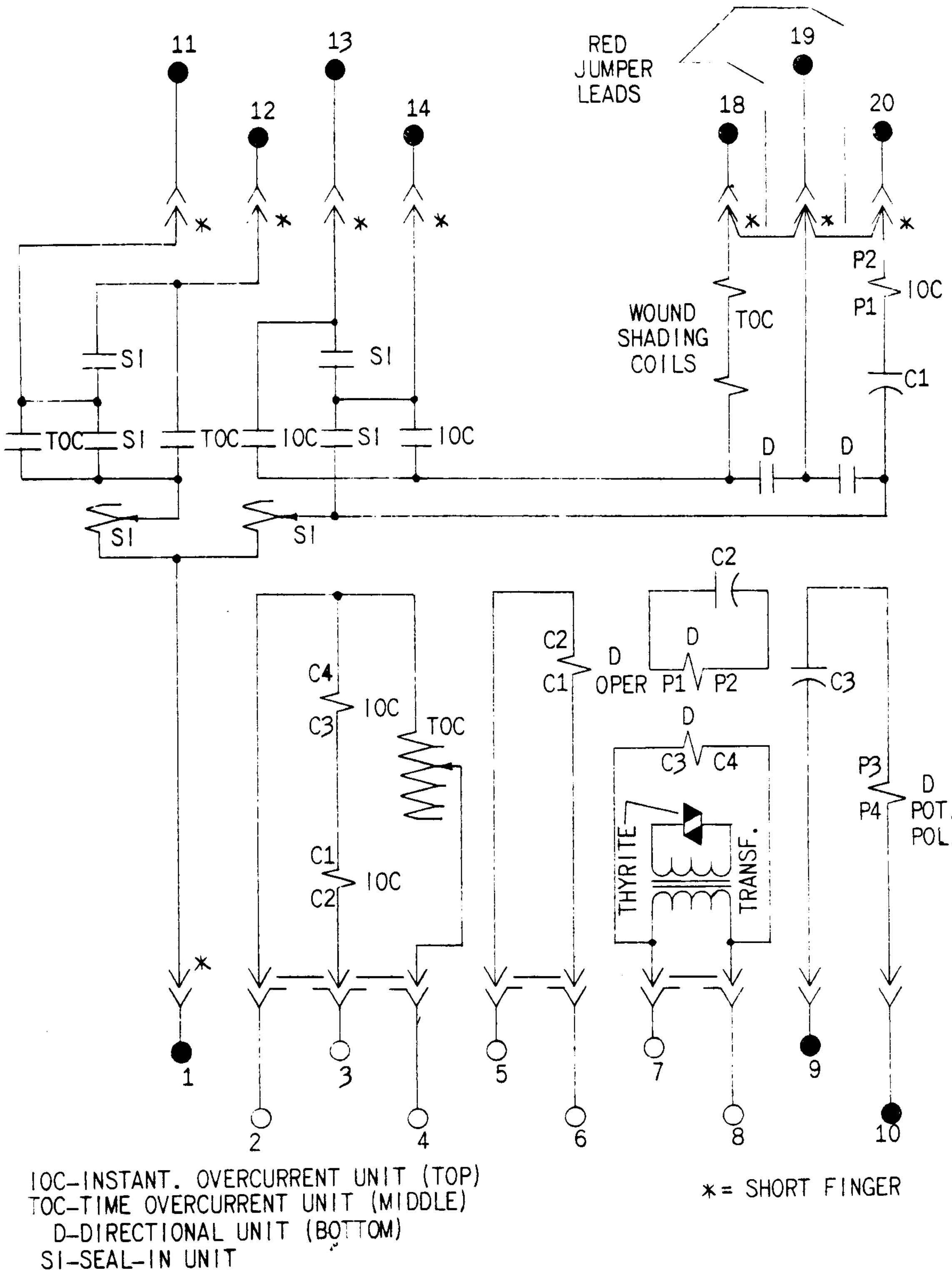


FIG. 12 (0104A8979-0) Internal Connections for JBCG52K, JBCG54K, and JBCG70K Relays (Front View)

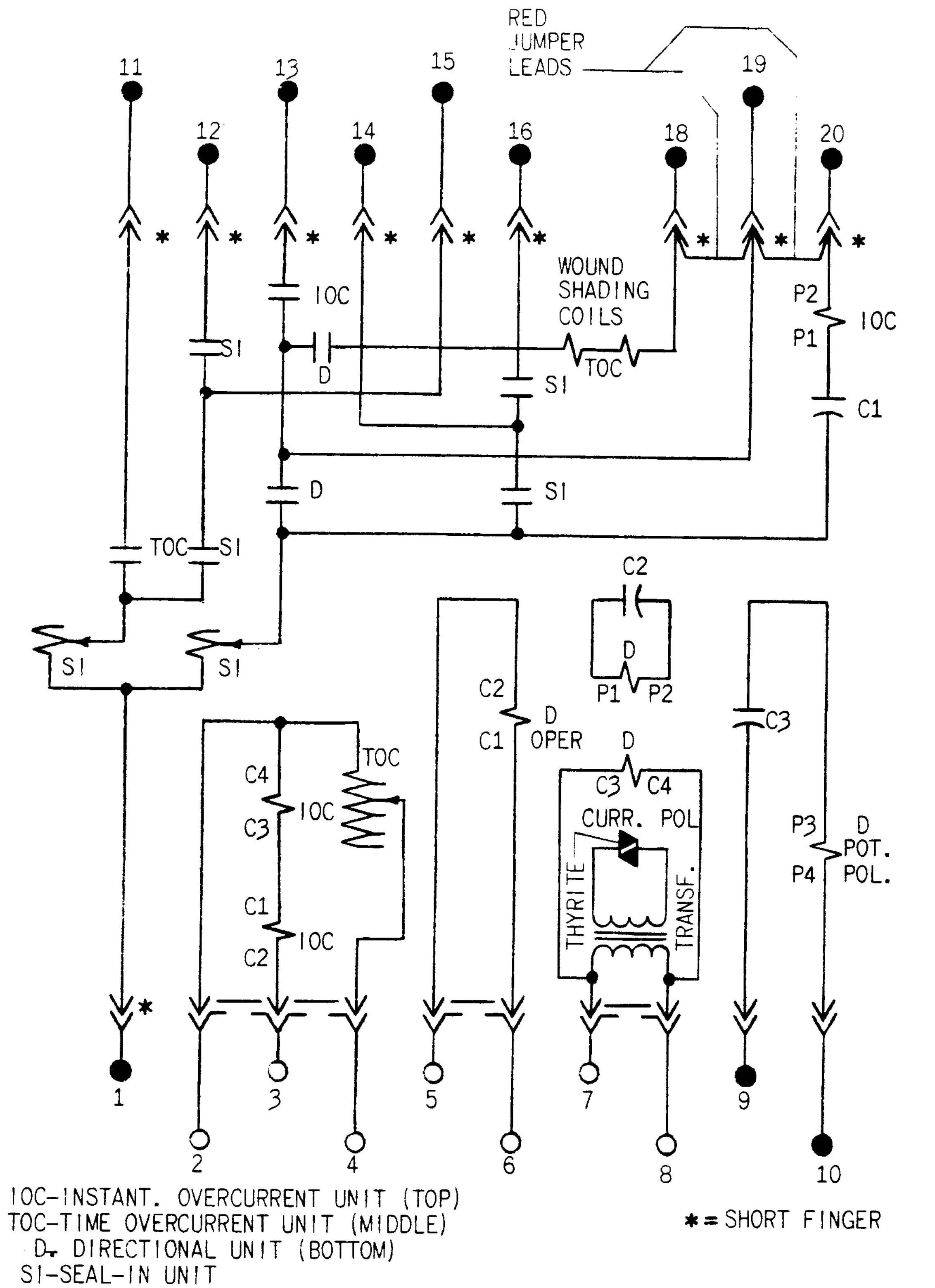
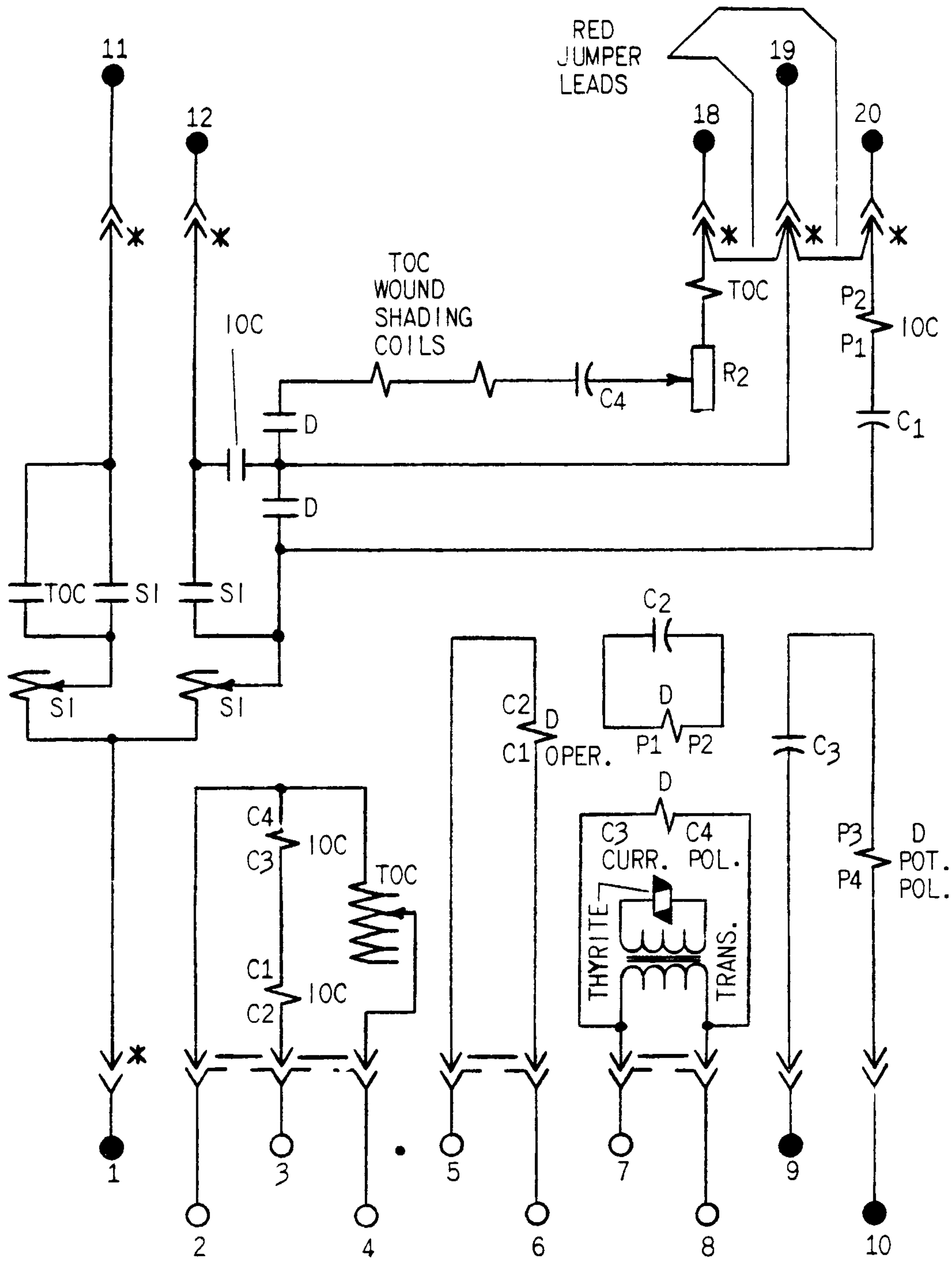


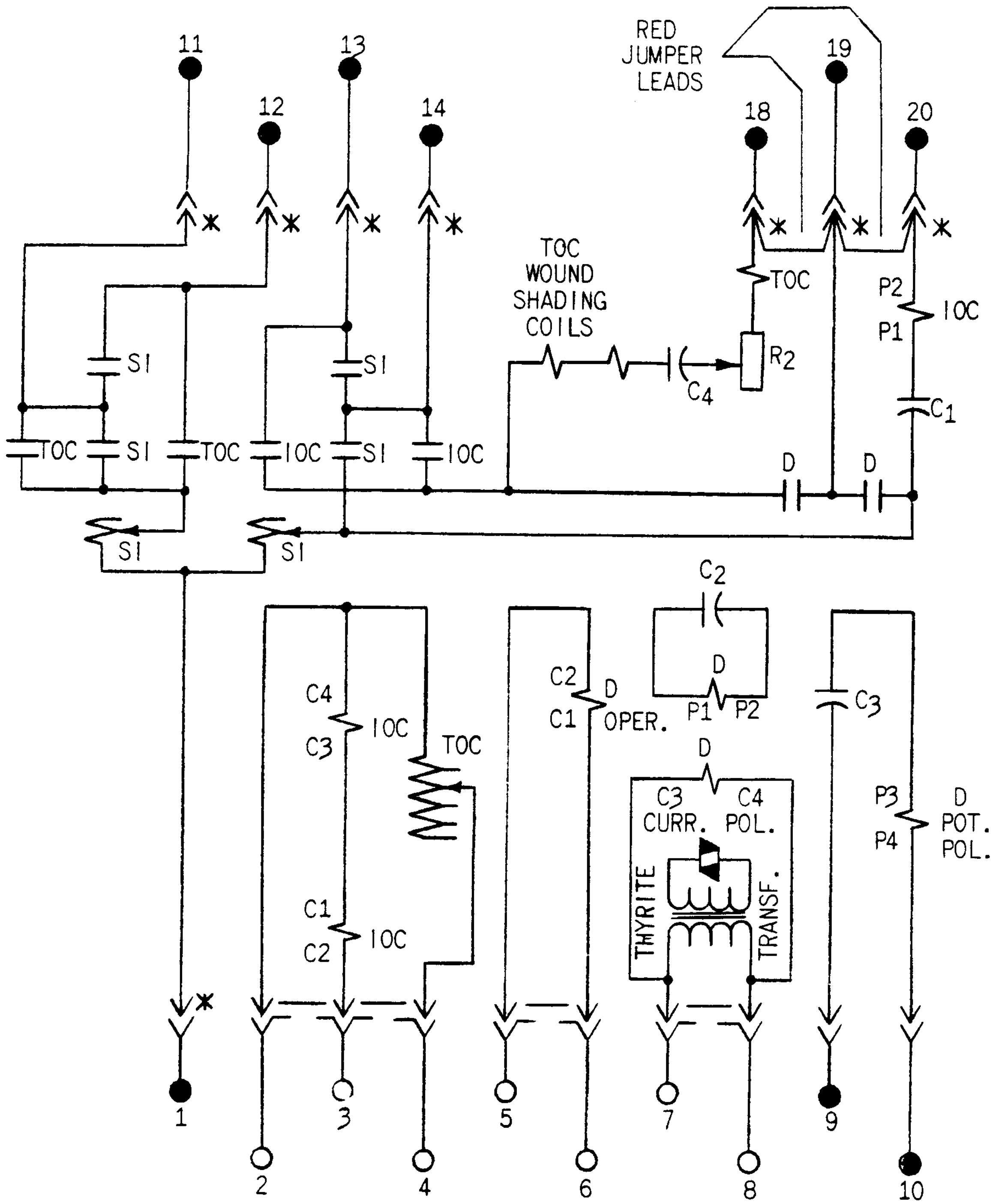
FIG. 13 (0127A9469-1) Internal Connections for JBCG61K and JBCG63K Relays (Front View)



IOC = INSTANT.OVERCURRENT UNIT (TOP)
TOC = TIME OVERCURRENT UNIT (MIDDLE)
D = DIRECTIONAL UNIT (BOTTOM)
SI = SEAL-IN UNIT

* = SHORT FINGER

FIG. 14 (0127A9429-1) Internal Connections for the JBCG77K Relay (Front View)



IOC = INSTANT. OVERCURRENT UNIT (TOP)
TOC = TIME OVERCURRENT UNIT (MIDDLE)
D = DIRECTIONAL UNIT (BOTTOM)
SI = SEAL-IN UNIT

✱ = SHORT FINGER

FIG. 15 (0127A9430-0) Internal Connections for the JBCG78K Relay (Front View)

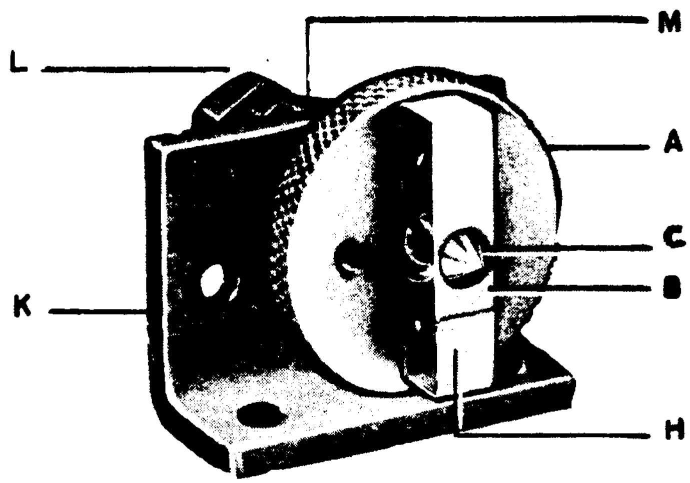


Fig. A

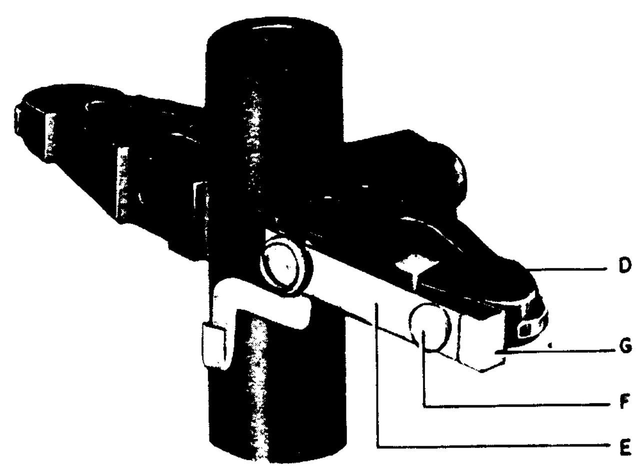
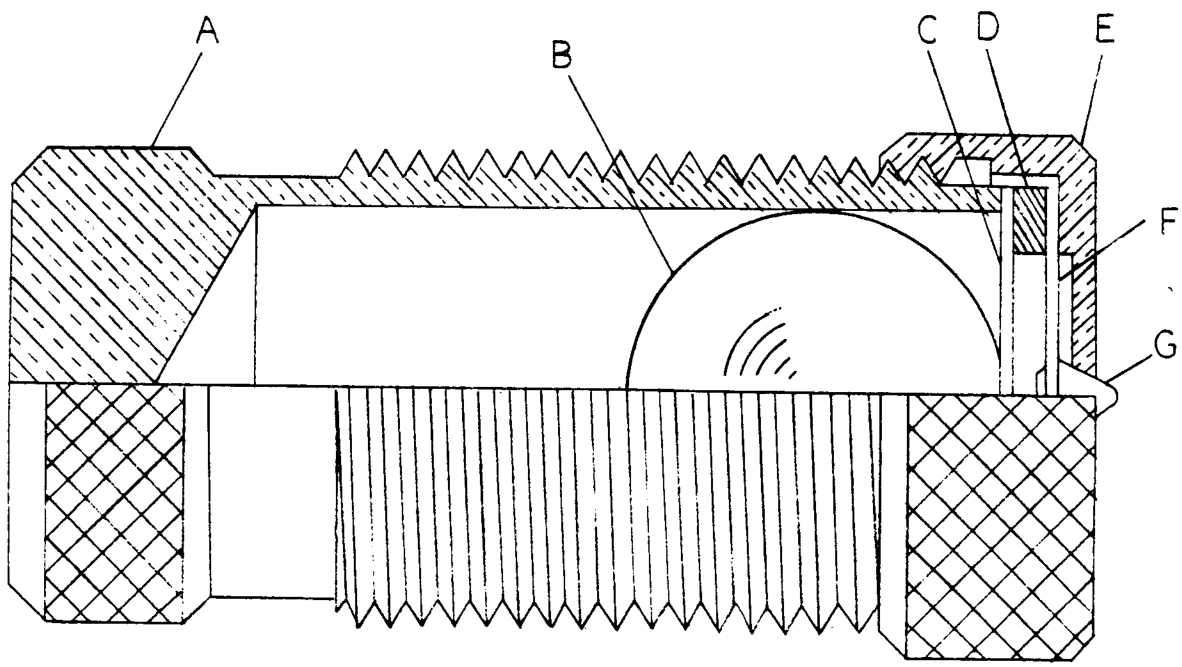


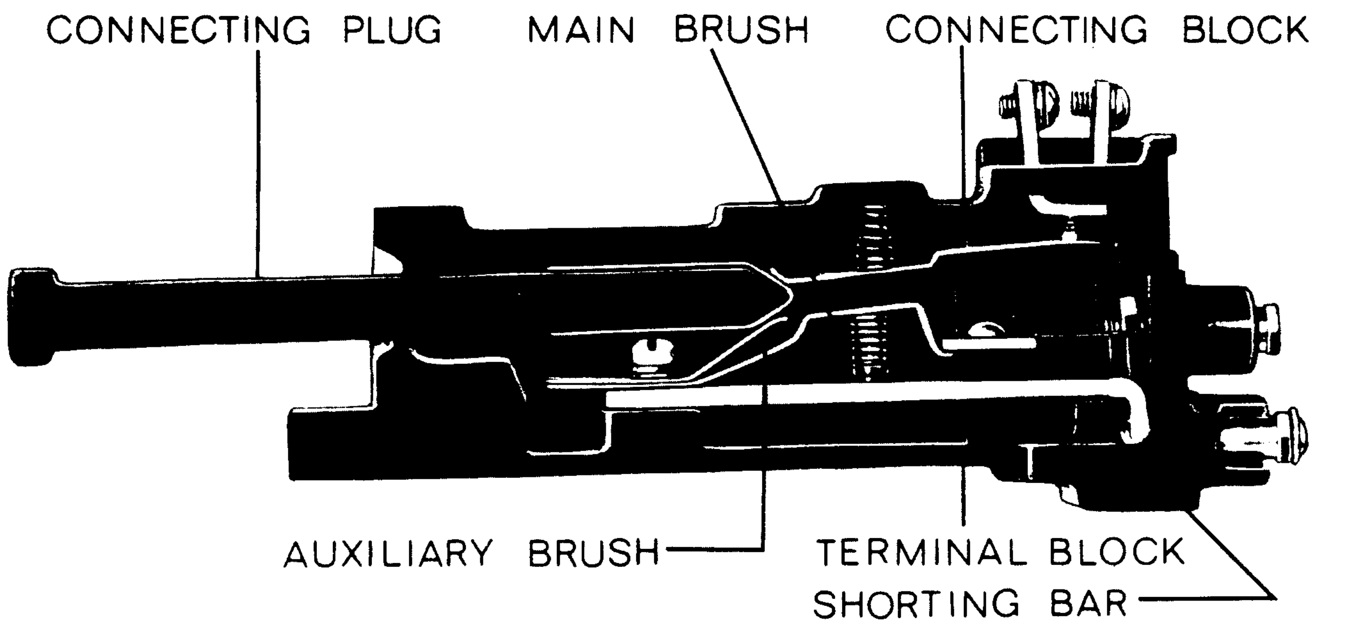
Fig. B

FIG. 16 (A-8023401, B-8023399) Low Gradient Contact Assembly for the Directional Unit



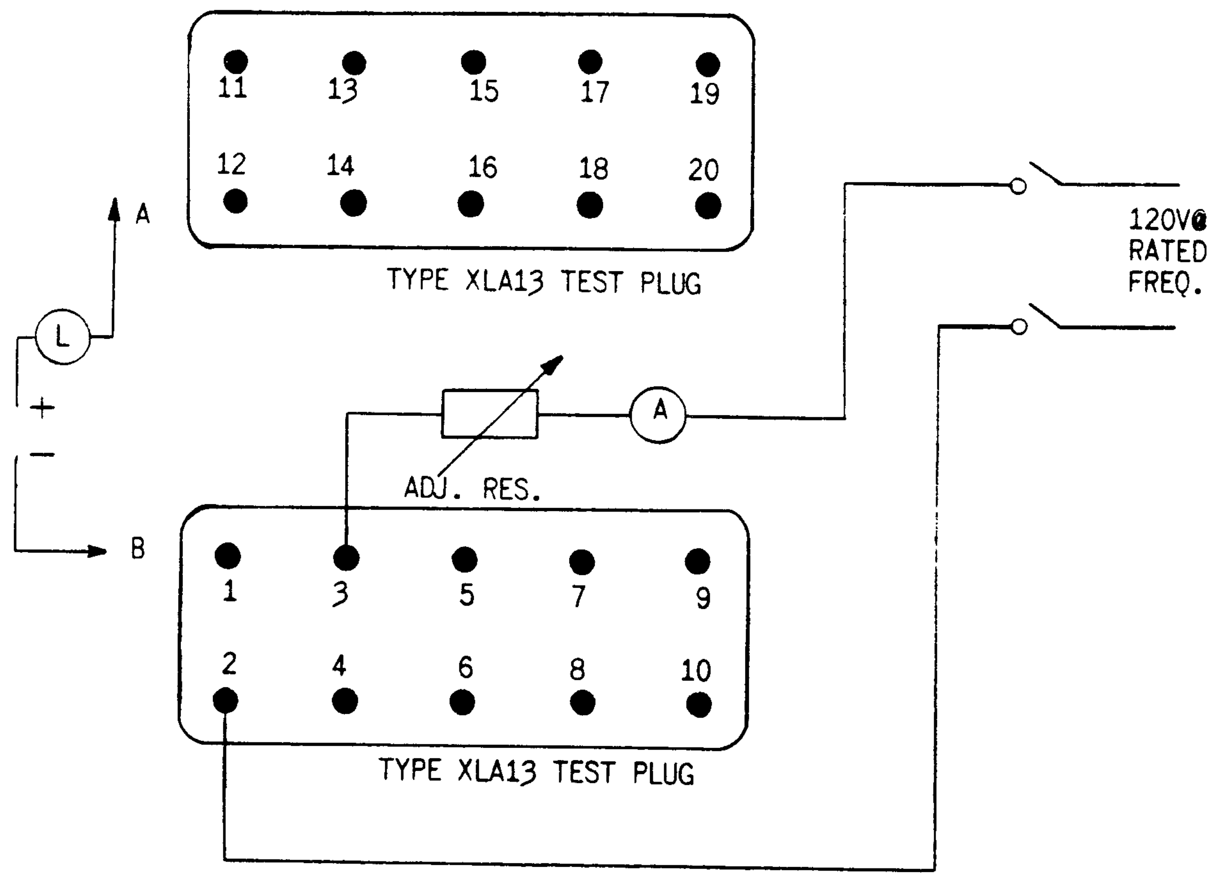
A - INCLINED TUBE
B - STAINLESS STEEL BALL
C - DIAPHRAM
D - SPACER
E - CAP
F - FLAT SPIRAL SPRING
G - CONTACT

FIG. 17 (6077069-3) Barrel Contact Assembly for Directional Unit and Instantaneous Overcurrent Unit



NOTE: AFTER ENGAGING AUXILIARY BRUSH CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK

FIG. 18 (8025039) Cross Section of Drawout Case Showing Position of Auxiliary Brush and Shorting Bar



RELAY TYPE	CONNECT	
	A	B
JBCG 51	12	19
53	12	19
77	12	19
52	13	19*
54	13	19*
78	13	19*

*BLOCK DIRECT. UNIT CONTACTS CLOSED

FIG. 19A (0178A9035-0) Test Connections for Checking Pickup of IOC Unit

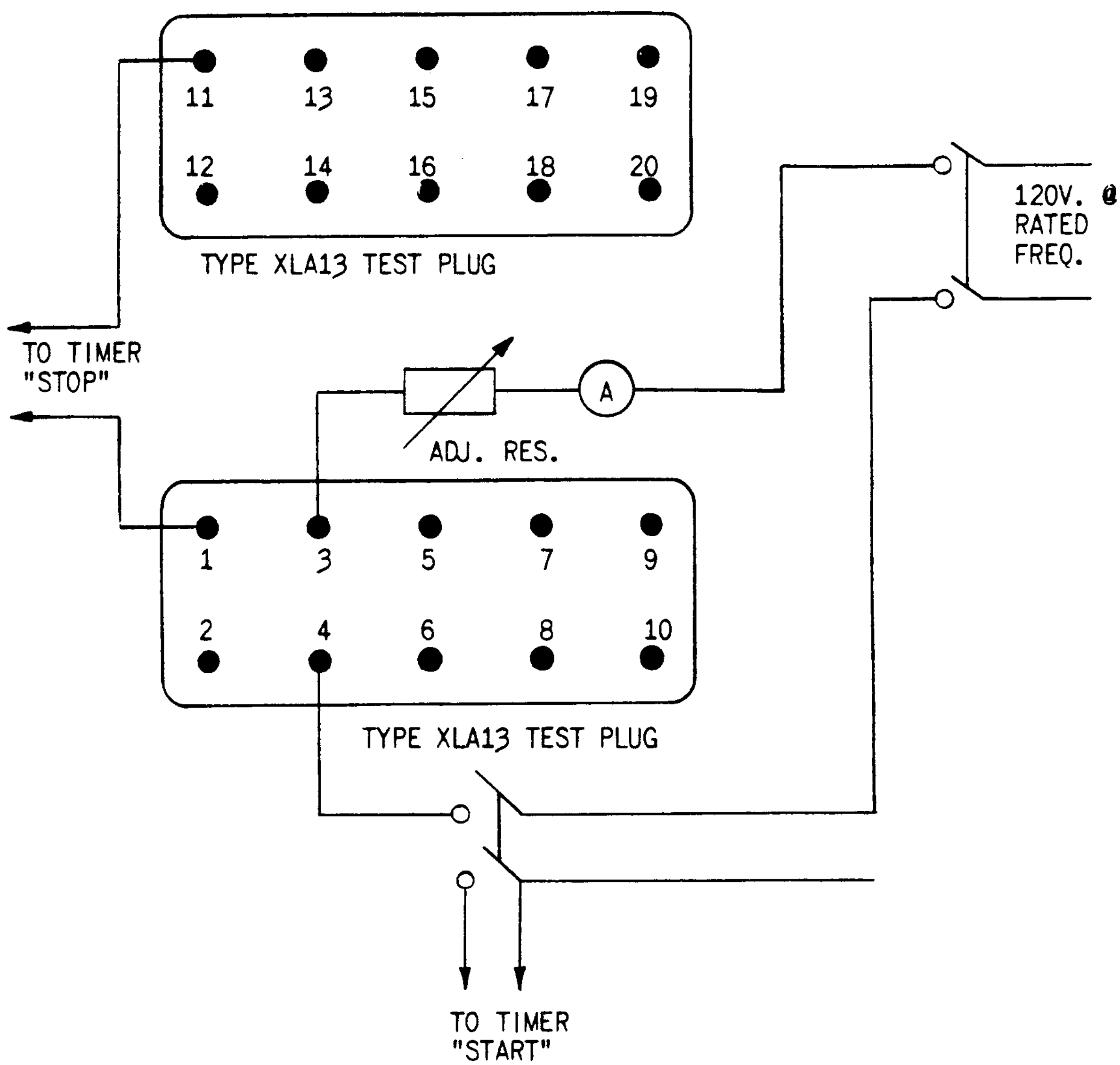


FIG. 19B (0178A9036-0) Test Connections for Checking TOC Unit

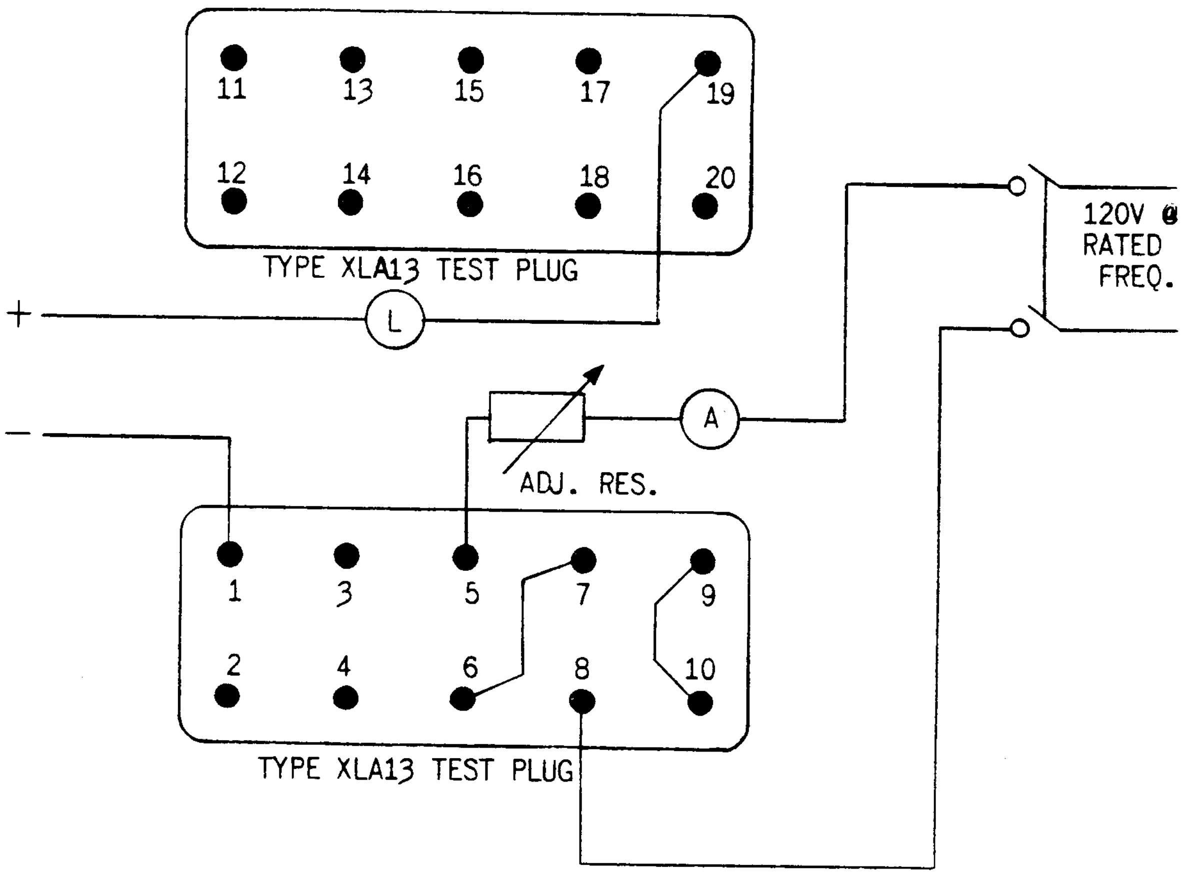


FIG. 19C (0178A9037-0) Test Connections for Checking Pickup of Directional Unit Using Current Polariz...

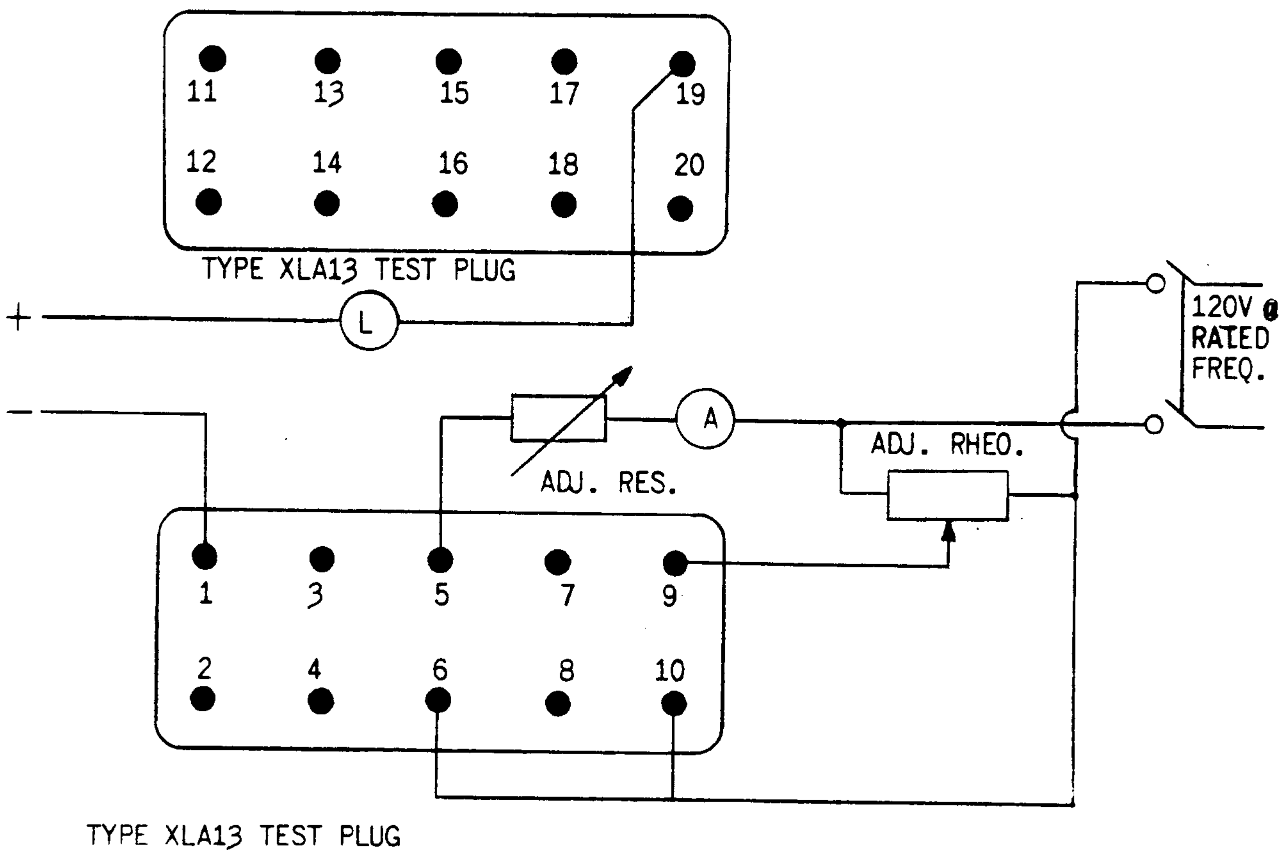


FIG. 19D (0178A9038-0) Test Connections for Checking Pickup of Directional Unit Using Potential Polarization

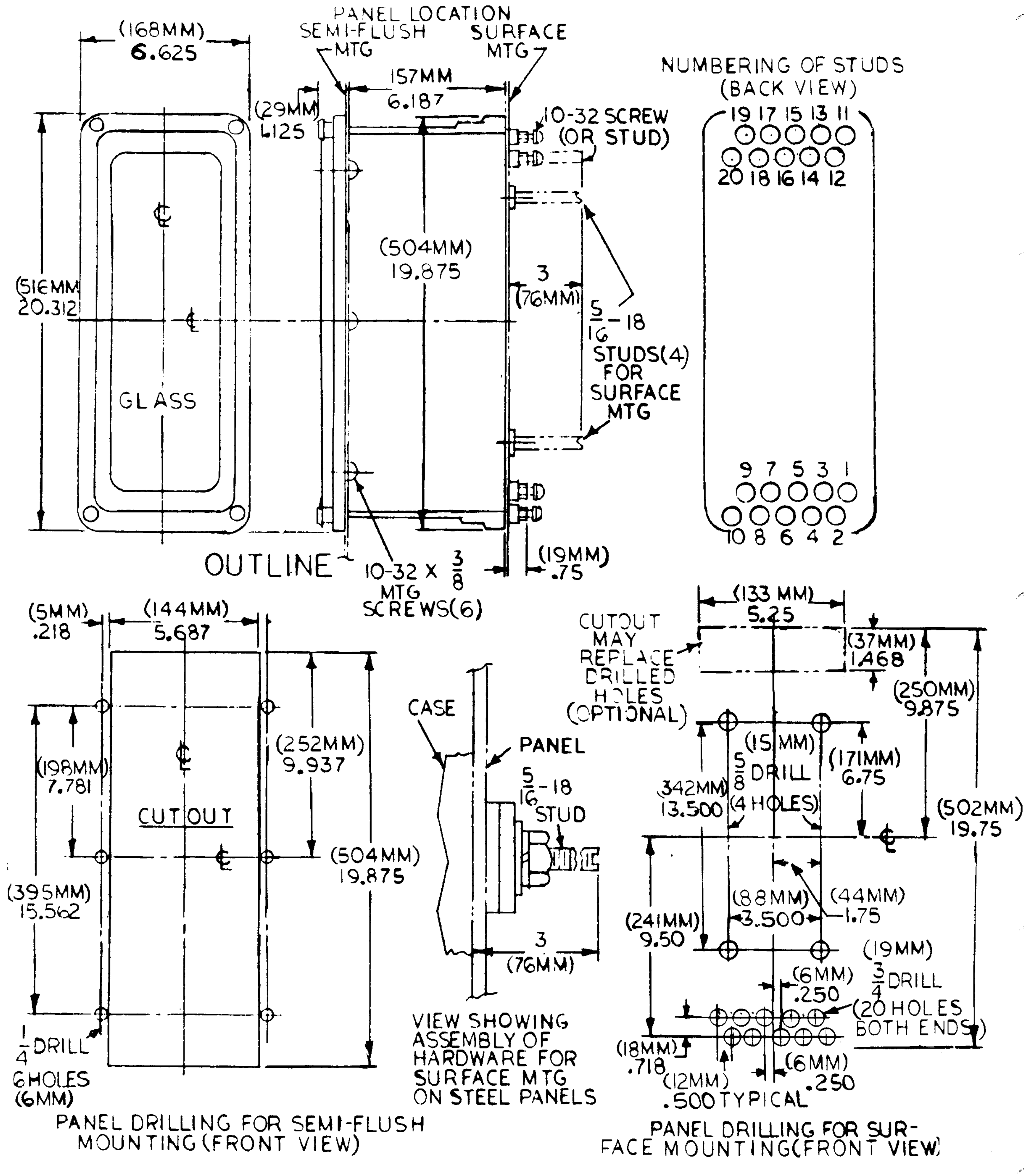


FIG. 20 (6209276-3) Outline and Panel Drilling Dimensions for Type JBCG Relays