INSTRUCTIONS

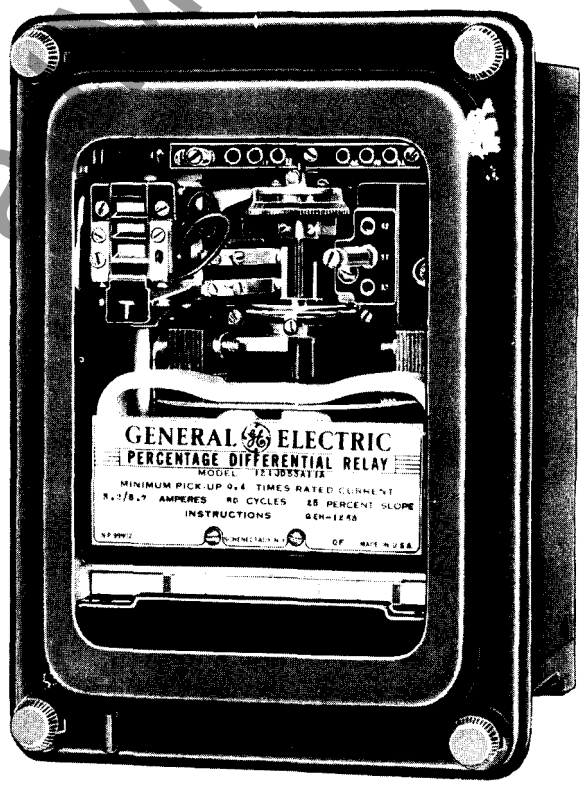
GEH-1268D

Supersedes GEH-1268C and GEI-33878

PERCENTAGE DIFFERENTIAL RELAYS

Types

IJD52A IJD53B
IJD52B IJD53C
IJD53A IJD53D



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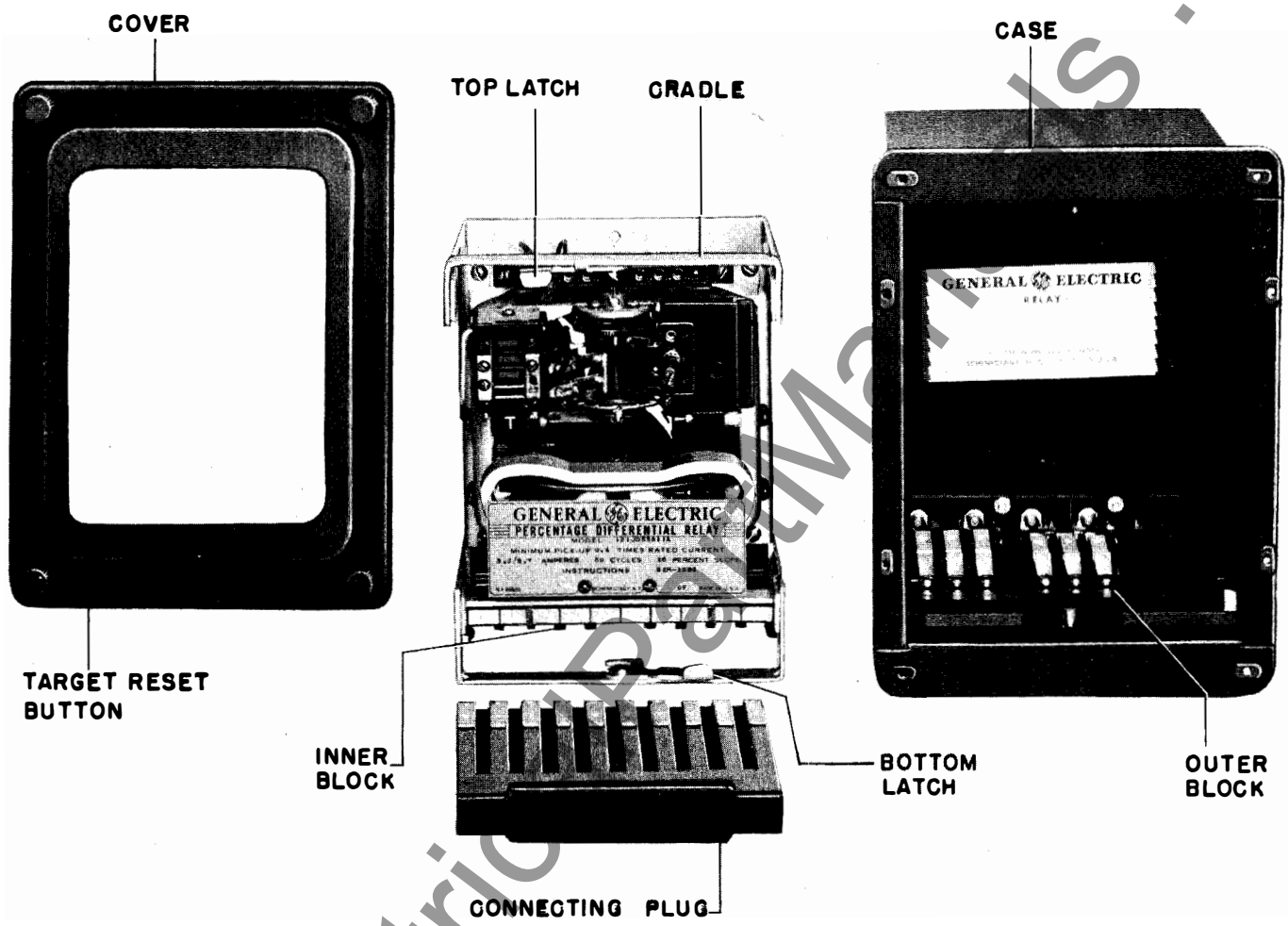

Fig. 1 (800720)

Fig. 1 The Type IJD53A Relay Disassembled

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PERCENTAGE DIFFERENTIAL RELAYS

TYPE IJD

INTRODUCTION

Type	Elements	For Protecting	Outline & P.D. Fig.	Inter. Conn. Fig.
IJD52A	1	Generators	21	5
IJD52B	3	Generators	22	6
IJD53C	1	Transformers	21	16
IJD53D	3	Transformers	22	17

The Type IJD relays comprise a group that is used for differential protection of alternating current equipment. There are two general types--those used for generator and reactor protection and those used for transformer protection. Both of these types are available in either the one-or the three-unit cases. Other variations such as current ratings and minimum operating current will be covered by specific model numbers under these types.

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

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

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

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

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

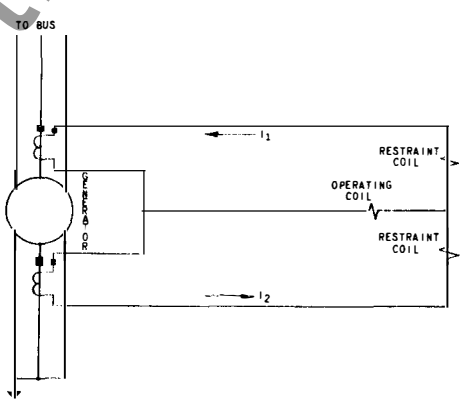

Fig. 2 Principle of Differential Protection

PRINCIPLE OF DIFFERENTIAL PROTECTION

When a Y-connected a-c generator is operating properly the currents in the three conductors at the junction are, of course, equal to the currents in the corresponding line conductors. Now, if the system is grounded, either at this junction or at some other point, then the equality of the currents will be disturbed if a ground fault occurs in one of the generator windings. Protection against such faults can be afforded by a relay which compares the magnitudes of the two currents in each phase and closes its contacts whenever the ratio of the larger to the smaller exceeds some predetermined value. Fig. 2 shows schematic connections for the application of such a relay. It is evident that no current will flow through

Fig. 2 (K-6400174) Fig. A

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

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the operating coil as long as the CT secondary currents are equal and flow in the same direction.

In order to apply the above principle to the protection of transformers, it is necessary to provide taps on the two coils in such a way as to compensate for the inequality of the corresponding phase currents under normal conditions. This will be discussed more fully in the section on transformer relays.

A certain amount of caution must be used in selecting current transformers for use with Type IJD relays. If the CT error on through faults exceeds the percentage-slope characteristic of the relay then false tripping may occur. For instance, if the relay has a 10 percent slope characteristic, the two secondary currents should not differ by more than 10 percent of the smaller when maximum fault current is flowing.

To help prevent current transformer errors from being excessive, it is recommended that burdens imposed be kept to a minimum. It is preferable to have no burden other than that of the differential relay.

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 the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident, a claim should be filed at once with the transportation company and the nearest Sales Office of the General Electric Company notified promptly.

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.

GENERATOR AND REACTOR RELAYS

DESCRIPTION

The Type IJD52A relay is a single unit generator differential relay. The Type IJD52B relay has three units, each of which is equivalent to that of the IJD52A. The induction unit of these relays consist of two coils assembled on laminated-iron U-magnets in such a way as to produce torque on a disk when current flows through them. The disk shaft carries a contact which is intended to energize the trip coils of two breakers.

The Type IJD53A and IJD53B relays have been superseded by Type IJD53C and IJD53D relays respectively.

A seal-in element is provided on each unit with its coil in series and its contacts in parallel with the contacts of the induction unit. When the seal-in unit picks up it raises a target into view. This target latches and remains in place until released by the reset button at the bottom of the cover.

OPERATING CHARACTERISTICS

The percentage slope characteristic of these relays refers to the ratio of the differential current to the smaller of the two phase currents, which will just cause the relays to close its contacts. Fig. 3 shows the operating characteristic for a relay with 10 percent slope and 0.1 ampere minimum pickup current.

The operating times for different values of differential current and of load current are shown in Fig. 4.

RATINGS

The restraining coils of these relays will carry five amperes continuously without overheating. The operating coils of the models with 0.1-amperes minimum pickup will carry 0.6 amperes continuously without overheating.

The current-closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying ratings are affected by the selection of the tap on the target and seal-in coils as indicated in the following table. When two trip circuits are closed, these limits are for total current.

	Amperes, AC or DC	
Function	2-Amp Tap	0.2 Amp Tap
Tripping Duty	30	5
Carry Continuously	4	0.8

The 2-ampere tap has a d-c resistance of 0.13 ohms and a 60 cycle impedance of 0.53 ohms while the 0.2-ampere tap has a 7 ohm d-c resistance and a 52 ohm 60 cycle impedance. The tap setting used on the seal-in element is determined by the current drawn by the trip coil.

The 0.2-ampere tap is for use with trip coils that operate on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage. If this

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tap is used with trip coils requiring more than 2 amperes, there is a possibility that the 7-ohm resistance will reduce the current to so low a value that the breaker will not be tripped.

The 2-ampere tap should be used with trip coils that take 2 amperes or more at minimum control voltage, provided the tripping current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes an auxiliary relay should be used, the connections being such that the tripping current does not pass through the contacts or the target and seal-in coils of the protective relay.

BURDENS

The burdens of the two coils at 60 cycles are as follows:

Coil	Amp	Volt-amp	Ohms	Power Factor
Restraining	5.0	17.55	0.7	0.27
Operating	0.6	26.1	72.5	0.27

Of course there is no current flow through the operating coil under normal conditions, hence the high burden is not usually objectionable.

Fig. 3 (K-6375795)

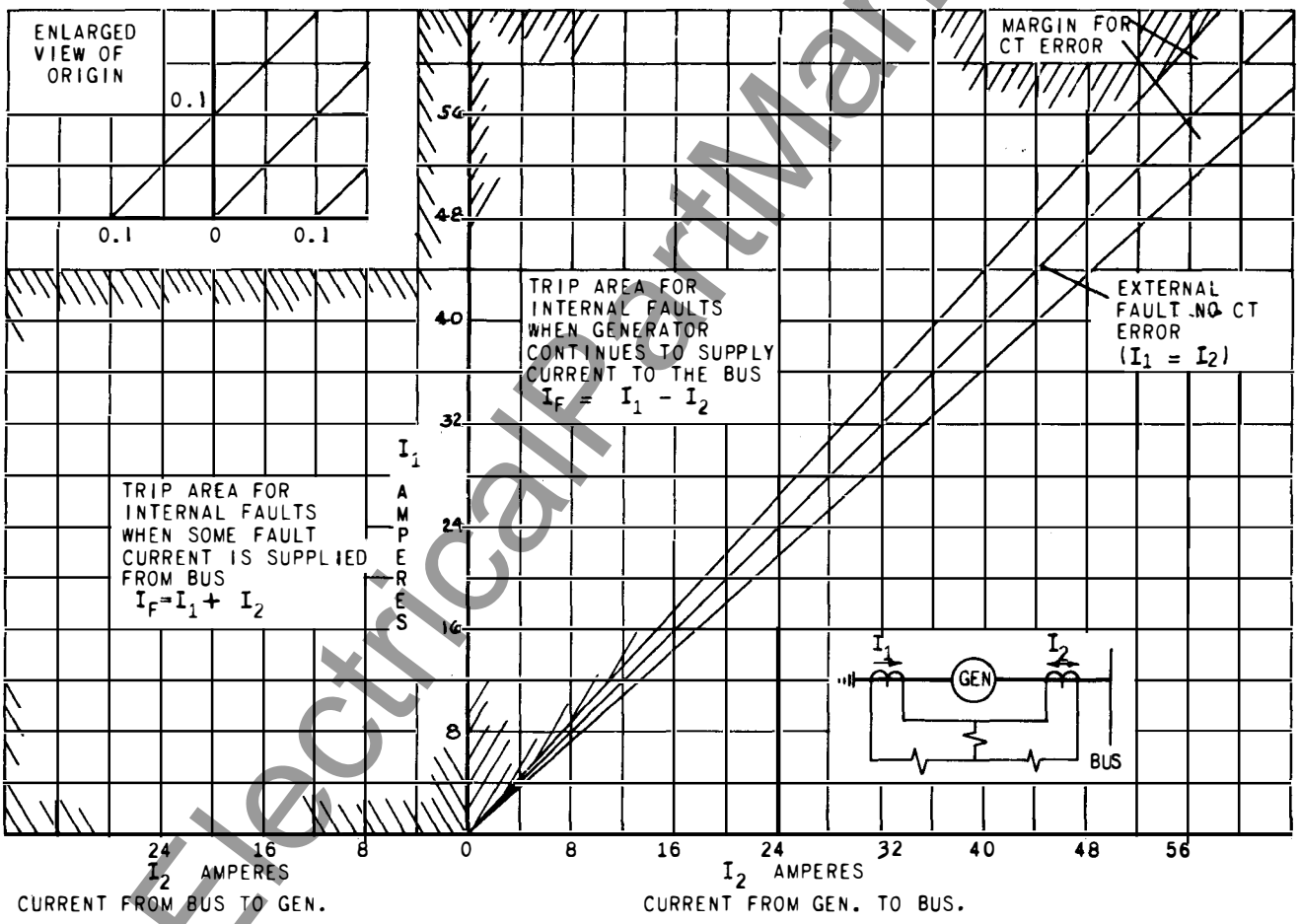

Fig. 3 Operating Characteristics of Type IJD52A and IJD52B Relays With 10 Per Cent Slope

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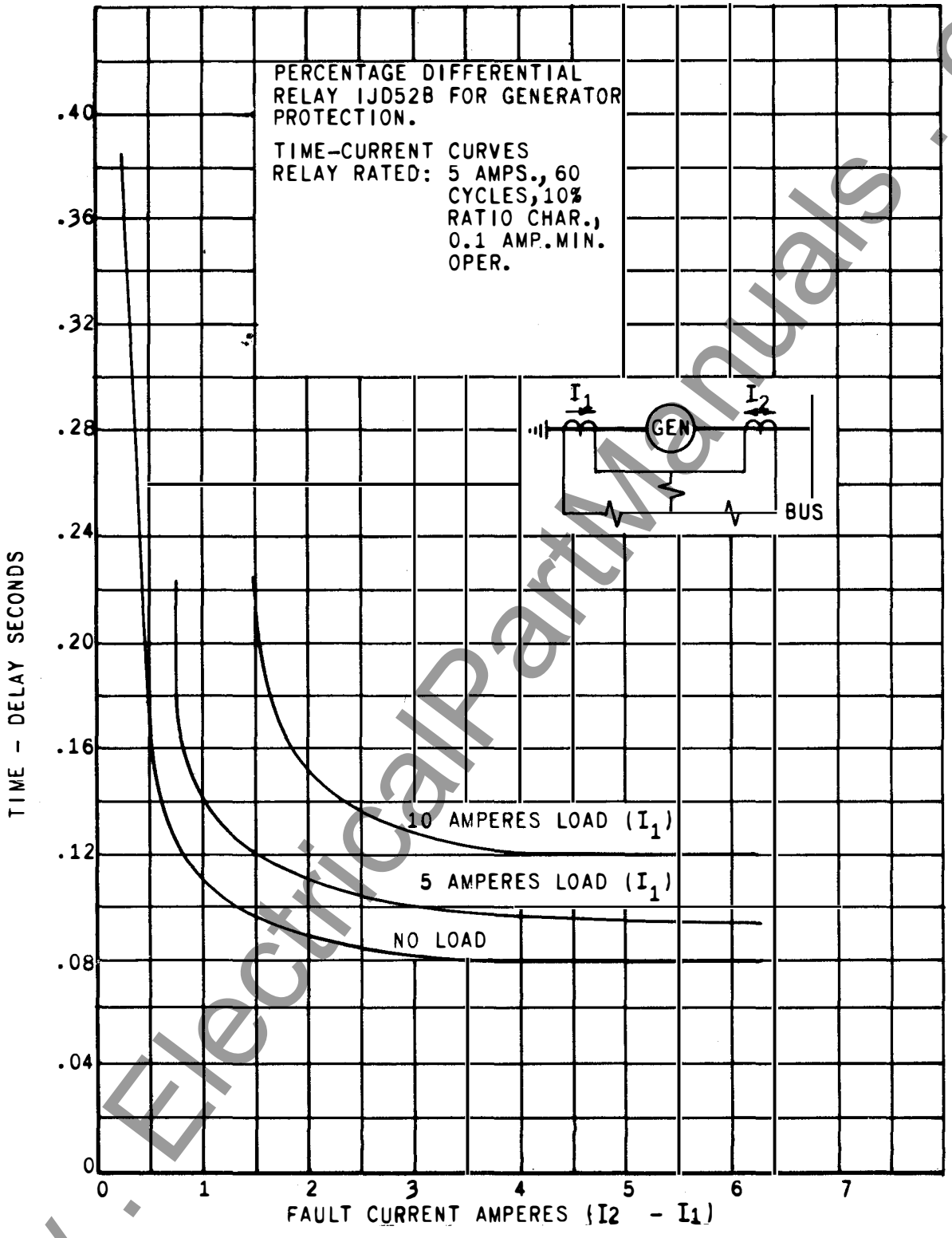

Fig. 4 (K-6400172)

Fig. 4 Typical Time-Current Characteristics of Type IJD52A and IJD52B Relays

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Fig. 5 (K-6209677)

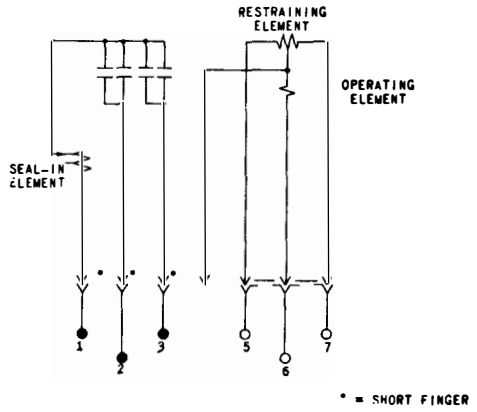

Fig. 5 Type IJD52A Relay, Internal Connections (Front View)

Fig. 6 (K-6209678)

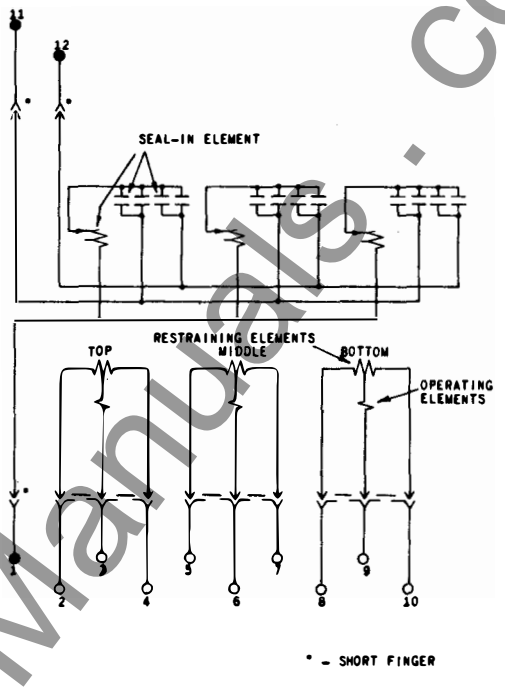

Fig. 6 Type IJD52B Relay, Internal Connections (Front View)

Fig. 7 (K-6154157)

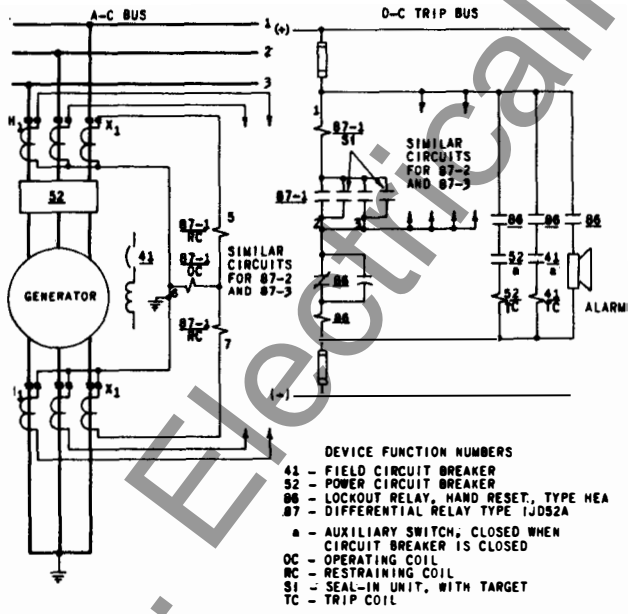

Fig. 7 Differential Protection of a Generator Using Type IJD52A Relays

Fig. 8 (K-6154219)

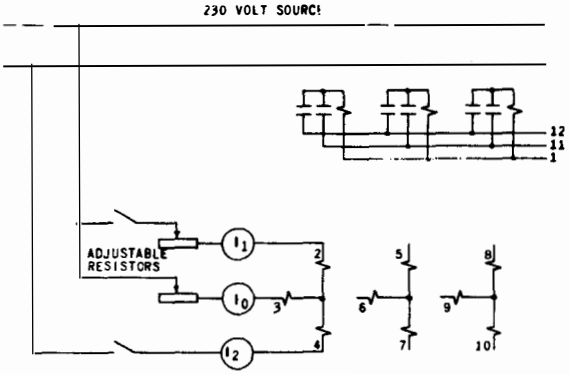

Fig. 8 Test Connections for the Type IJD52B Relay

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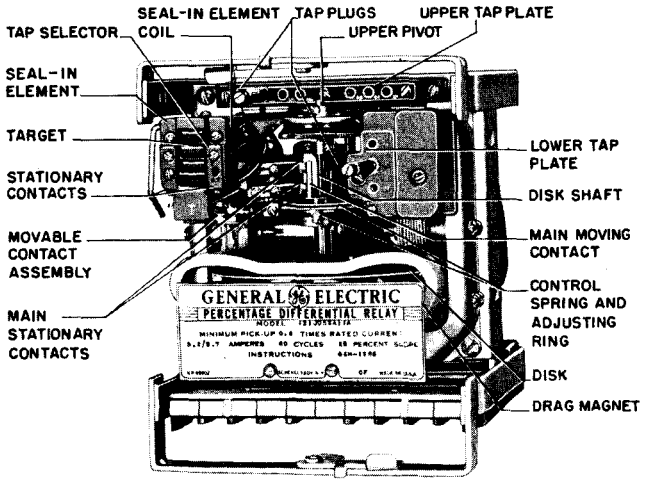

Fig. 9 Type IJD53C Relay Mounted in Cradle (Front View)

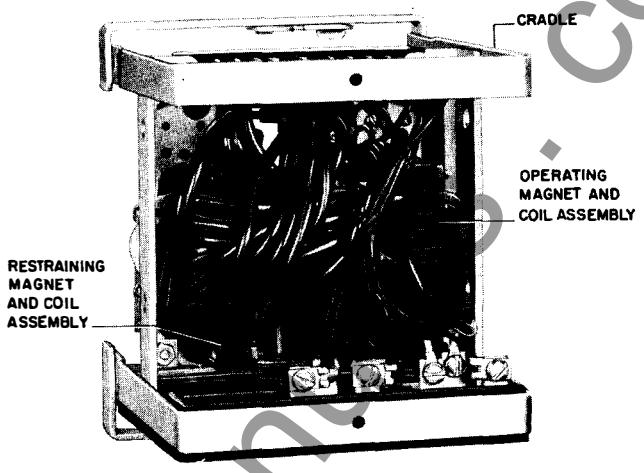

Fig. 10 Type IJD53C Relay Mounted in Cradle (Rear View)

TRANSFORMER RELAYS

DESCRIPTION

The Type IJD53C is a single unit transformer differential relay. It is usually applied for differential protection of a single-phase transformer, or in a set of three for protection of a three-phase transformer. The Type IJD53D has three units similar to that of the Type IJD53C, with their contacts connected in parallel. The single unit relay is shown on the cover page and in Figs. 1, 9, and 10.

The induction unit of these relays consists of two coils assembled on laminated U-magnets in such a way as to produce torque on a disk when current flows through them. The disk shaft carries a contact which is intended to complete the trip circuits for two breakers.

A seal-in element is provided on each unit to protect the main contacts. When the seal-in picks up it operates a target which remains visible until released by the rest button at the bottom of the cover.

OPERATING CHARACTERISTICS

The characteristics of these relays are such that when the current in the two circuits are in the same ratio as the two tap-plug position numbers, there is no operating torque produced. A numerical example of this statement will help to explain this.

Suppose the tap plugs of a Type IJD53C relay are set in the 3.2 tap of the upper tap block and in the 5.0 tap of the lower tap block. Now, with polarities of the currents as indicated in the diagram with the curves of Fig. 13, assume that 3.2 amperes flow out terminal 5, 5.0 amperes in terminal 7, and the difference, 1.8 amperes, out terminal 6. Under these conditions no torque will be produced by the operating U-magnet, but considerable torque will be produced by the restraining U-magnet. Furthermore, as long as the two currents in terminals 5 and 7 remain in the ratio of 3.2 to 5 and are 180 degrees apart in time phase, there will be no operating torque.

These relays are built with two types of percent-slope characteristics; 25% slope, and 50% slope. The significance of the percent-slope characteristic can best be understood from an extension of the example above. Taking the 25% slope relays as an example, suppose that the current into stud 7 increases to 125% of 5.0 or to 6.25 amperes while the current out of stud 5 remains at 3.2 amps, this represents a condition of 25% unbalance. The same thing would be true if the 5 amp value were held constant while the 3.2 value was increased 25% or to 4 amperes.

It should not be inferred from this discussion that the relay will necessarily close its contacts under the conditions described as 25% unbalance. At low current values considerable more unbalance is necessary to overcome the effect of the spring. However, at current values of twice tap value and above, the unbalance required for operation will not greatly exceed 25%. Fig. 11 and 12 show these relationships graphically for currents several times rated values. In explaining these graphs, the same tap ratio of 3.2/5 will be used. If I_2 were 50 amperes there would be no operating torque developed if $I_1 = \frac{3.2}{5} \times 50 = 32$ amperes. This relationship is shown by the dotted lines running diagonally across the graphs in Fig. 11 and 12. If I_1 were to increase above the no torque condition by 25%, it would now

Fig. 9 (8007205)

Fig. 10 (8007208)

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be 1.25 x 32 = 40 amps. Fig. 11 shows this condition for values of I_2 between 0 and 70 amps. If on the other hand, I_1 were to remain constant at 32 amps and I_2 were to increase 25%, I_2 would go to 50X1.25= 62.5 amps. Fig. 12 shows this condition for values of I_1 between 0 and 70 amperes. These curves show the minimum current on the ordinate to close the relay contacts for a given current on the abscissa when the various tap ratios shown are used. The time characteristic is shown in Fig. 13.

Fig. 14 and 15 show curves for the relays with 50% slope characteristics.

MINIMUM PICKUP

These relays are adjusted at the factory to close their contacts at 40 percent of tap value in one circuit with no current in the other. This pickup may be increased by means of the control spring to 125 per cent of tap value as described under "Adjustments".

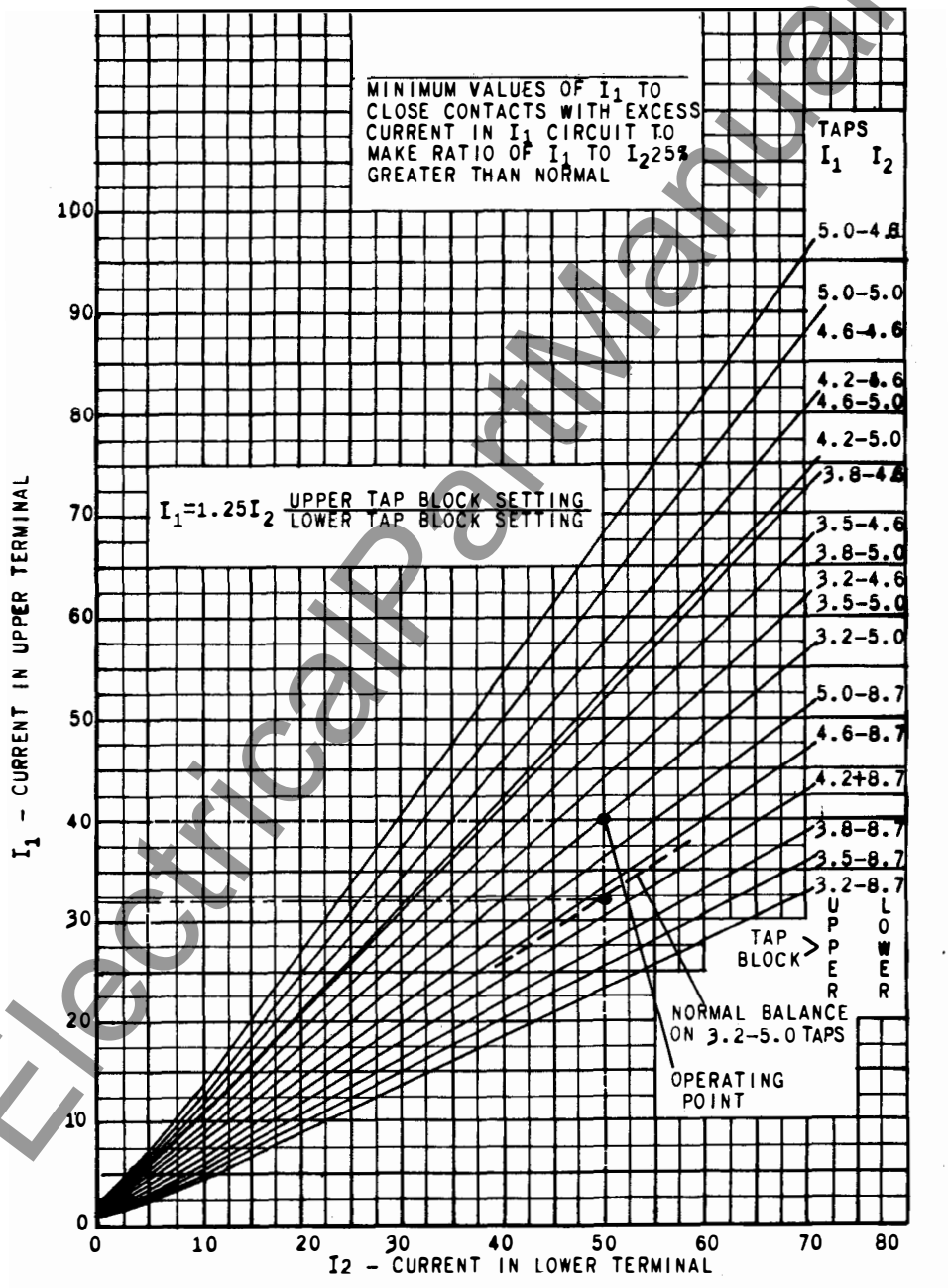

Fig. 11 (K-6400169) Sht.

Fig. 11 Operating Characteristics of Type IJD53C and IJD53D Relays With 25% Slope When I_1 is Excessive

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RATINGS

The standard models of these relays have a tap range of 3.2 to 8.7 amperes. Any of the circuits will carry twice the tap setting or 10 amperes, whichever is less, continuously on any current tap without overheating.

The current ratings of the contact circuits are discussed fully in the section on generator relays. This discussion applies to the transformer relays also.

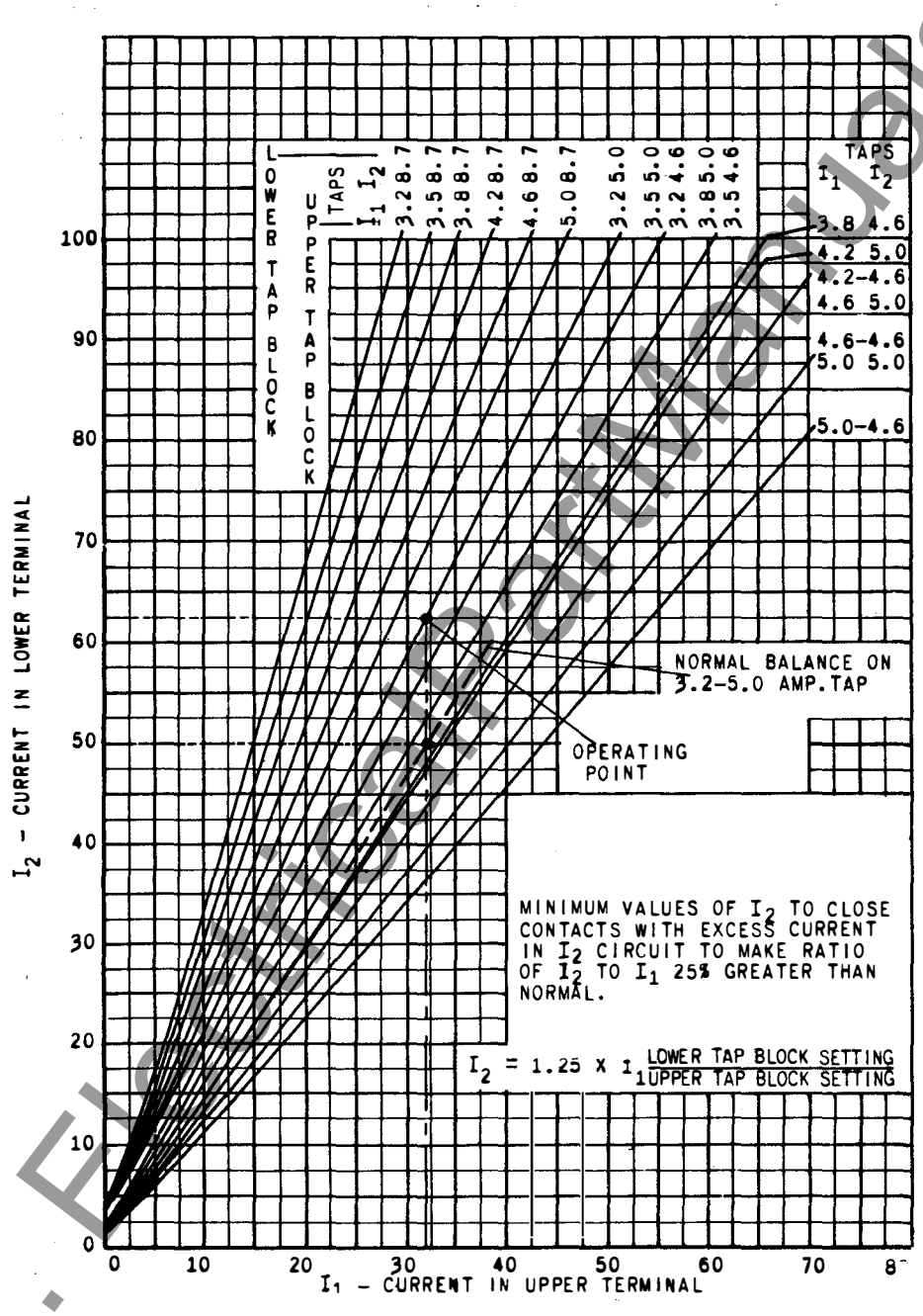

Fig. 12 Operating Characteristics of Type IJD53C and IJD53D Relays With 25% Slope When I_2 is Excessive

Fig. 12 (K-6400169)

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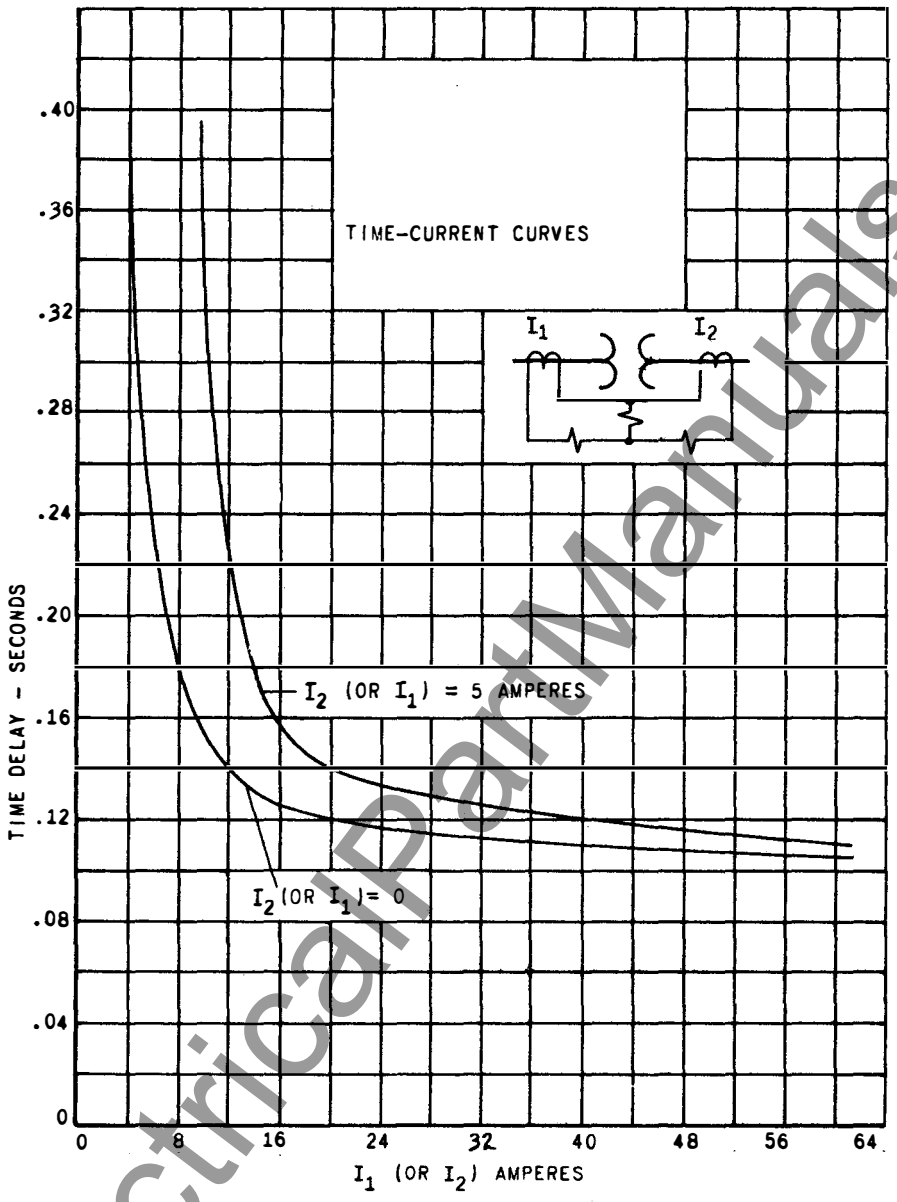

Fig. 13 (K-6400171)

Fig. 13 Typical Time-Current Characteristics of Type IJD53C and IJD53D Relays

BURDENS

Burdens for the standard coils at five amperes and rated frequency are given in the table on the right. Operating coil burdens are for the minimum current tap, 3.2 amperes, while restraint coil burdens are with the 5.0 ampere tap on both tap blocks.

Impedance of the operating coil on any other tap is inversely proportional to the square of the tap value. The impedance of the restraint circuit with unequal tap settings is difficult to calculate, but in general will be quite low.

Freq.	Coil	Volt-amp	Imp. Ohms	PF
60	Operating	20.5	0.82	0.33
	Restraining	1.1	0.043	0.94
50	Operating	17.5	0.70	0.35
	Restraining	1.0	0.041	0.96
25	Operating	10.5	0.42	0.41
	Restraining	0.9	0.037	0.98

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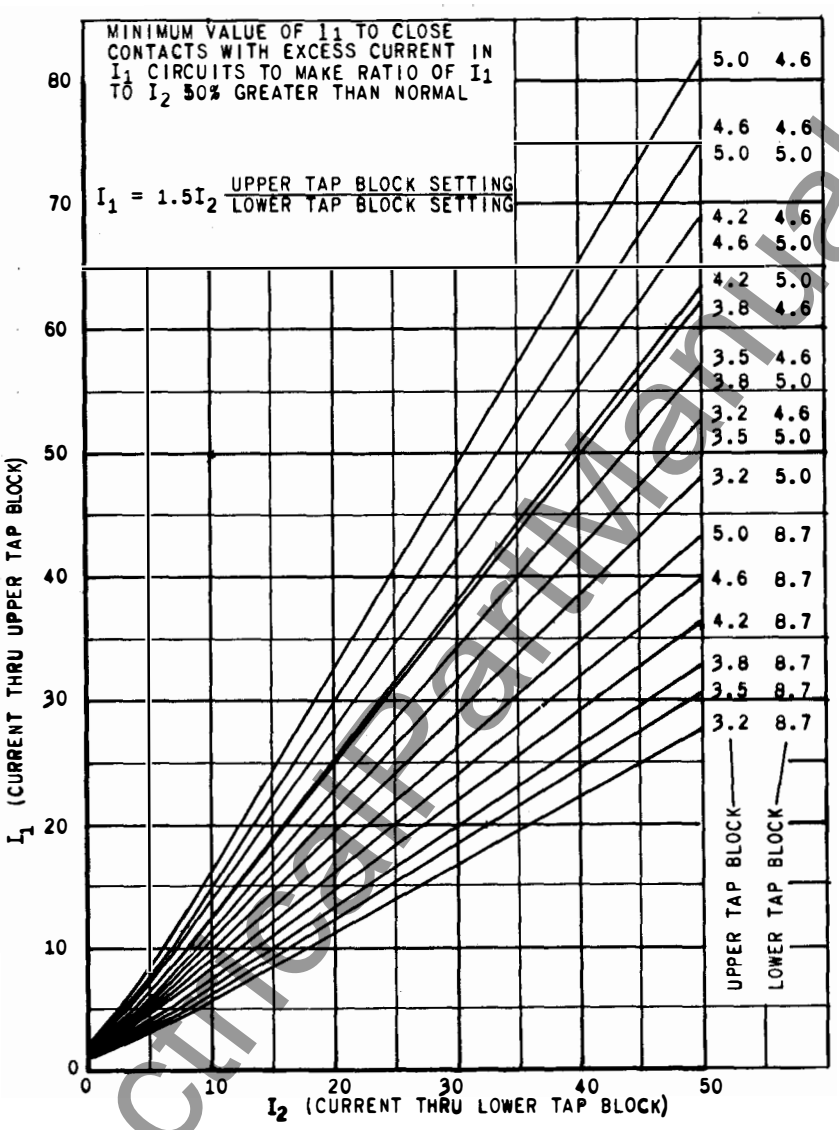

Fig. 14 (K-6400379) Sht. 1

Fig. 14 Operating Characteristics of Type IJD53C and IJD53D Relays With 50% Slope When I_1 is Excessive

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 diagrams are shown in Fig. 21 and 22.

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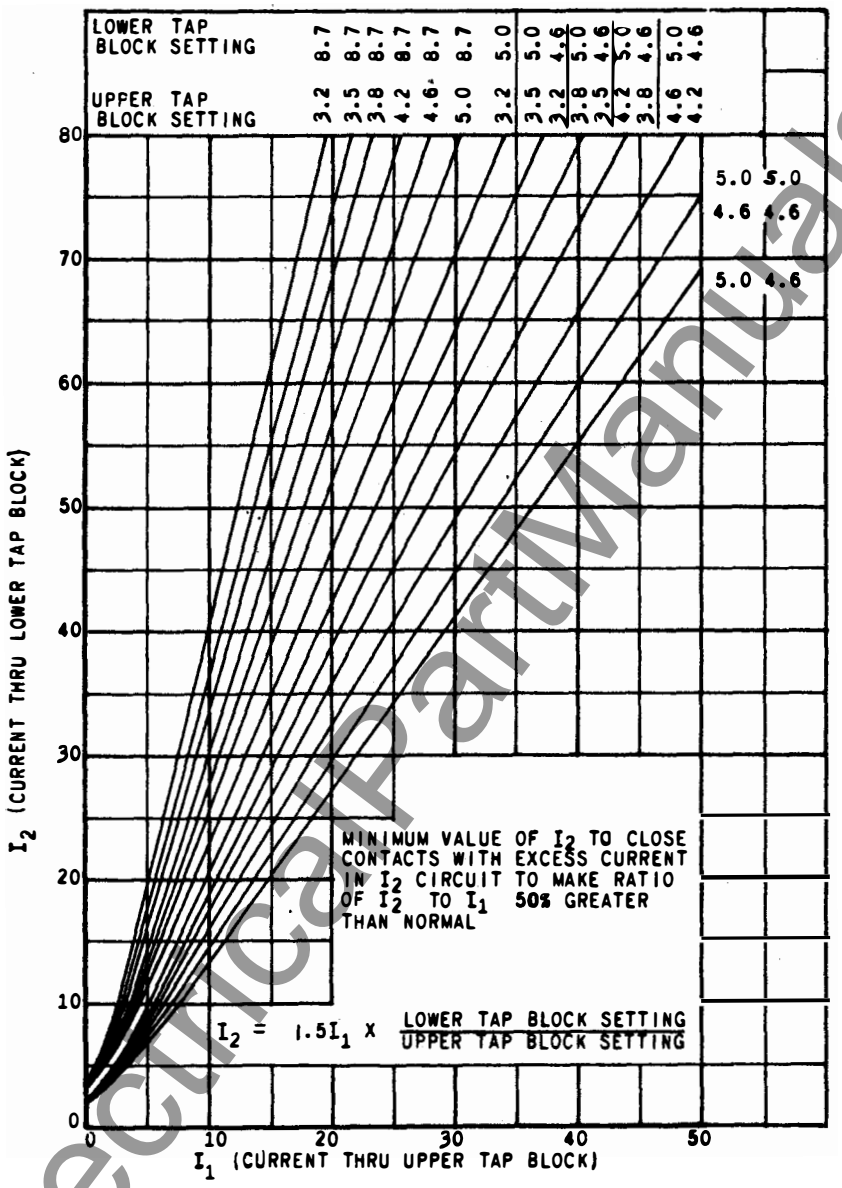

Fig. 15 (K-6400379)

Fig. 15 Operating Characteristics of Type IJD53C and IJD53D Relays With 50% Slope When I_2 is Excessive

CONNECTIONS

GENERATOR RELAYS

Internal connections for the Type IJD52A are shown in Fig. 5, and for the Type IJD52B in Fig. 6.

Typical external connections for the Type IJD52A are shown in Fig. 7. It will be noted that contacts are provided for closing two trip circuits, namely the line breaker and the field breaker. Connections for the Type IJD52B will correspond to these except that the stud numbers will be different.

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TRANSFORMER RELAYS

Internal connections for the Type IJD53C are shown in Fig. 16 and for the Type IJD53D in Fig. 17.

Typical external connections for the type IJD53B are shown in Fig. 18 and 19. It will be noted that this figure shows connections to be used when the transformer bank is Delta-Wye, or Wye-Delta. If the bank is Wye-Wye with grounded neutrals, then the connections shown in Fig. 7 for the generator relay can be applied to the transformer relay provided the transformer consists of three, single-phase transformers. This connection cannot be used if a three-phase core-type transformer is used since the case acts in a manner similar to the delta insofar as it is a source of zero-phase sequence current. Also, the wye-wye arrangement cannot have a delta winding, even though that winding is not used for load purposes, for the same reason.

External connections for the Type IJD53C relay should correspond to the connections for a single-phase of the generator relay shown in Fig. 7.

In each case, the smaller of the two secondary current should pass through the right-hand stud on the relay (back view), that is, stud 2, 5, or 8.

There is a useful rule which can be applied to determine whether delta or wye current-transformer connections should be used for differential relaying of a 3-phase transformer bank composed of three similar single-phase transformers, each having two or more windings. This rule is as follows: The current transformers in the leads to a wye connected winding should be connected in delta; current transformers in the leads to a delta-connected winding should be connected in wye.

Since there are several ways of connecting the current transformers in wye or delta, the following additional rule should be noted: Make the delta connection of the current transformers a replica of the delta connection of the power transformers; the wye connections of the current transformers should be a reversal of the wye connection of the power transformers.

GROUND CONNECTIONS

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

ADJUSTMENTS

TARGET AND SEAL-IN ELEMENT FOR BOTH TYPES

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2-ampere tap.

For trip coils operating on currents ranging from 2 to 30 amperes at the minimum control voltage, place the tap plug in the 2-ampere tap.

The tap plug is the screw holding the right-hand stationary contact of the seal-in element. To change the tap setting, first remove the connecting plug. Then, take a screw from the left-hand stationary contact and place it in the desired tap. Next remove the screw from the other tap, and place it in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Screws should not be in both taps at the same time as pickup for d-c will be the highter tap value and a-c pickup will be increased.

GENERATOR RELAYS

No adjustment of the relay is necessary other than the setting of the target and seal-in element tap plug described above. However, the relay should be inspected for any loosening of the screws that may have occurred during shipment.

TRANSFORMER RELAYS

These relays have been adjusted at the factory to operate as indicated by the characteristic curves. However, it is necessary to make the proper tap selections for the particular application. The taps chosen should be such that the ratio of tap settings is equal to the ratio of currents to the corresponding tap blocks. It is also desirable that the tap settings should be equal as nearly as possible to the respective currents which will flow under normal conditions. The normal currents at the relay terminals can be readily calculated from the current transformer ratio and the normal load on the power transformers.

The tap settings will, of course, usually be made before the relay is energized in its circuit. If, however, it is necessary to change the tap settings after the relay has been installed, the connection plugs should be removed from the case before proceeding. When the tap plugs are inserted into the tap blocks, caution should be exercised to screw them all the way down until the lock washer is flattened between the plug and plate. These precautions are necessary to avoid opening the current transformer secondary circuits.

A further adjustment that may be necessary at the time of installation is the setting of minimum pickup current. The relays are adjusted at the factory so that with no current in one circuit, 40 per cent of tap current is required in the other circuit to close the contacts. This value can be increased by turning the control spring adjusting ring (see Fig. 9) in a counter-clockwise direction. Pickup should not be increased to more than 125 percent of tap value, or the control spring may be damaged.

At the time of installation, the relay should be inspected for any loosening of the screws that may have resulted from vibration or rough handling during shipment.

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Fig. 16 (K-6556496

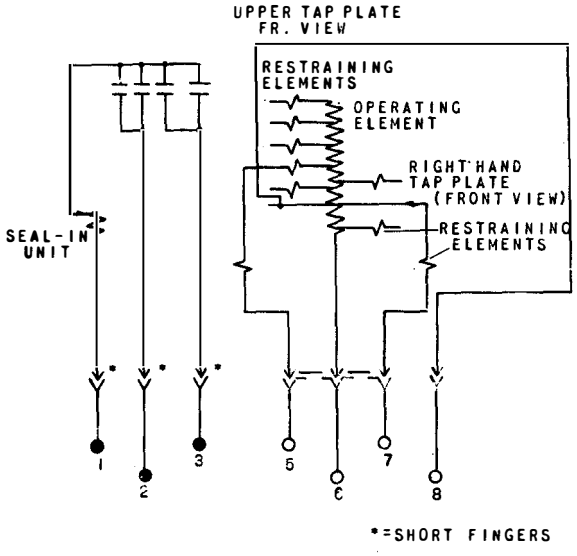

Fig. 16 Type IJD53C Relay, Internal Connections (Front View)

Fig. 17 (K-6556497)

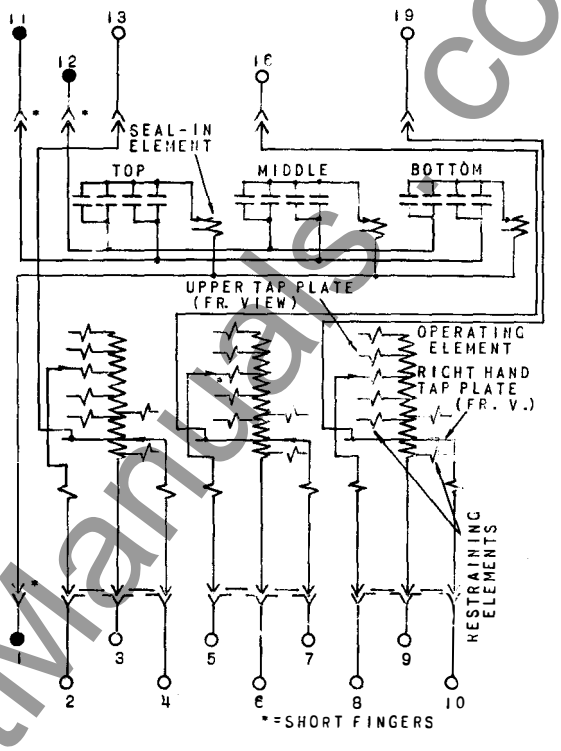

Fig. 17 Type IJD53D Relay, Internal Connections (Front View)

Fig. 18 (K-6154207)

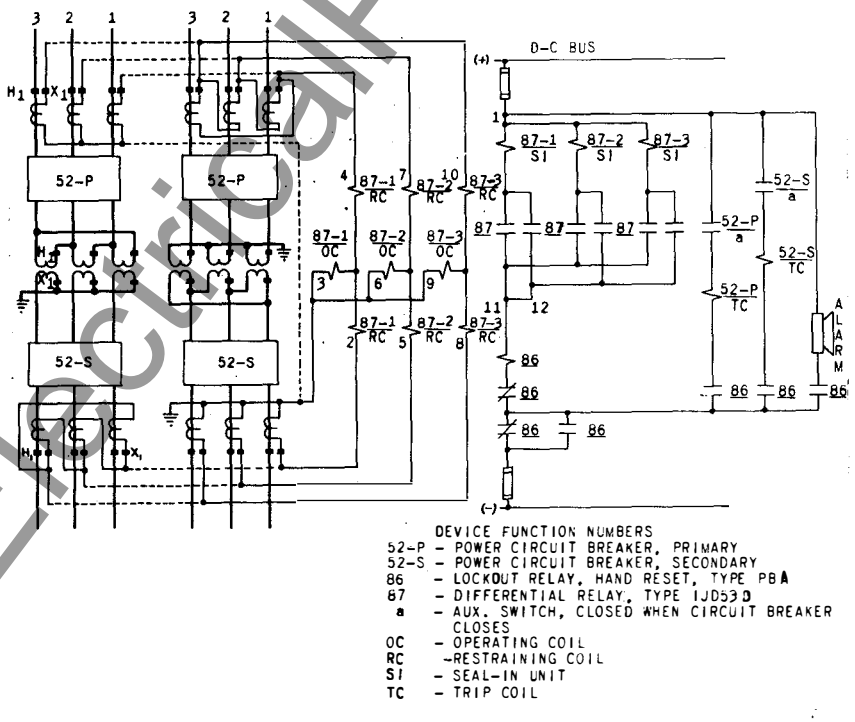

Fig. 18 Differential Protection of a Power Transformer Using a Type IJD53D Relay

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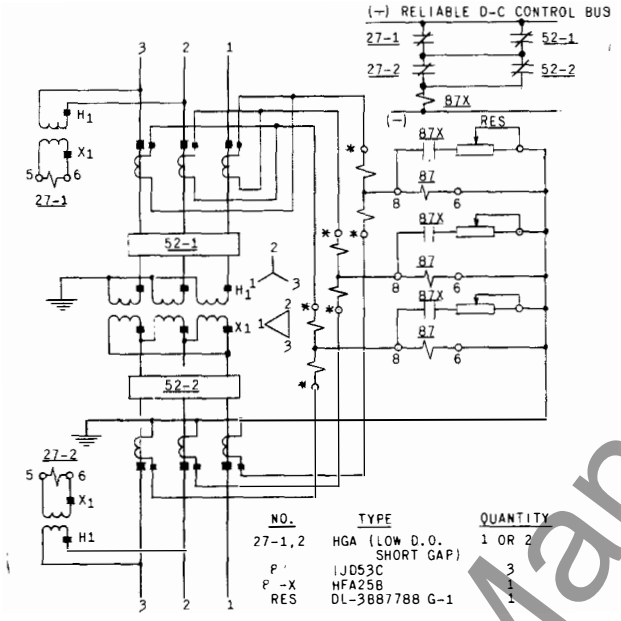

Fig. 19 (K-6556545)

Fig. 19 Differential Protection of a Power Transformer Using a Type IJD53D Relay With Densensitizing Equipment

OPERATION

Under certain circumstances, false operation may occur when large external fault currents are cleared. This would be due to the sudden release of reverse torque on the relay shaft. If this trouble is encountered it probably can be corrected by one or more of the following adjustments

1. Increasing the disk travel by loosening the two set screws and turning the Textolite dial, mounted at the top of the shaft, counter-clockwise. The dial should not be turned beyond the number two setting inscribed in the dial or to a position where the slot in the disk is allowed to pass under the pole of the operating coil. The relay will not operate properly when the slot is under the pole since the two fluxes from the pole cannot inter-act in the disk because of the slotted separation.

2. Moving the drag magnet out from the center of the shaft.

3. Increasing the wind-up of the spiral control spring. This should not be increased more than 90 deg. over the original factory setting.

Any of these adjustments will increase the operating time on internal faults, and the third also will increase the minimum current required for operation.

DESENSITIZATION

In some instances it may be that the maximum current setting of these relays will not be high enough to prevent them from operating on magnetizing inrush current. If such a condition should exist, it is recommended that the IJD relay be used with an auxiliary desensitizing equipment consisting of an auxiliary relay, a potential transformer, and three external resistors connected as shown in Fig. 19.

To facilitate the connection of the desensitizing equipment the relay is provided with an extra stud which terminates at the junction of the two 5.0 amp. taps.

This permits the external connection of auxiliary desensitizing equipment to the operating coil only, without affecting the restraining torque. When the desensitizing equipment is connected in this manner, the pick-up value of the relay is raised the same amount regardless of the direction from which the transformer is energized.

The following table shows the factor by which the nominal pickup must be multiplied when the desensitizing resistor DL-3887788 G-1 is connected as described above.

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RESISTOR TAP	0.05	0.1	0.2	0.3
MULTIPLIER	8.0	4.0	2.1	1.65

Since the resistance shunting the operating coil determines the pick-up value of the relay, it is important that the lead resistance from the relay to the desensitizing resistor be kept as low as possible. The auxiliary relay is time opening and instantaneous closing, and its contacts are closed when the relay is de-energized. The external resistors are connected across the operating coils of the IJD relays through the contacts of the auxiliary relay. When the first transformer breaker is closed, the auxiliary relay is energized from the potential transformer secondary, but does not open its contact immediately. This permits a momentary raising of the IJD relay setting as part of the current which would normally flow through the operating coils is shunted through the external resistors. When the contacts of the auxiliary relay open, the shunt circuit is removed and the IJD relay functions at normal rating.

The Type HDD Percentage Differential Relay, with harmonic restraint is available for transformer protection and is inherently insensitive to inrush current owing to its harmonic restraint feature.

MAINTENANCE

The 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

The lower jewel may be tested for cracks by exploring its surface with the point of a fine needle. If it is necessary to replace the jewel a new pivot should be screwed into the bottom of the shaft at the same time. A very small drop of General Electric meter-jewel oil, or fine watch oil, should be placed on the new jewel before it is inserted. The jewel should be turned up until the disk is centered in the air gaps, after which it should be locked in this position by the set screw provided for this purpose. The upper bearing pin should next be adjusted until very little end play can be felt; about .015 inch is correct.

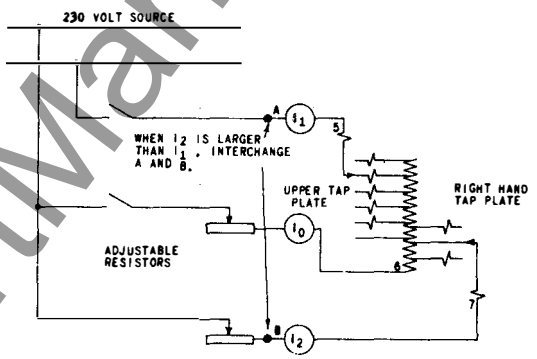

Fig. 20 Test Connections for the Middle Unit of the Type IJD53B Relay

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine 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.

PERIODIC TESTING

An operation test and inspection of the relay at least once every six months are recommended. Test connections are shown in Fig. 8 and Fig. 20.

RENEWAL PARTS

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

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

Fig. 20 (K-6154218)

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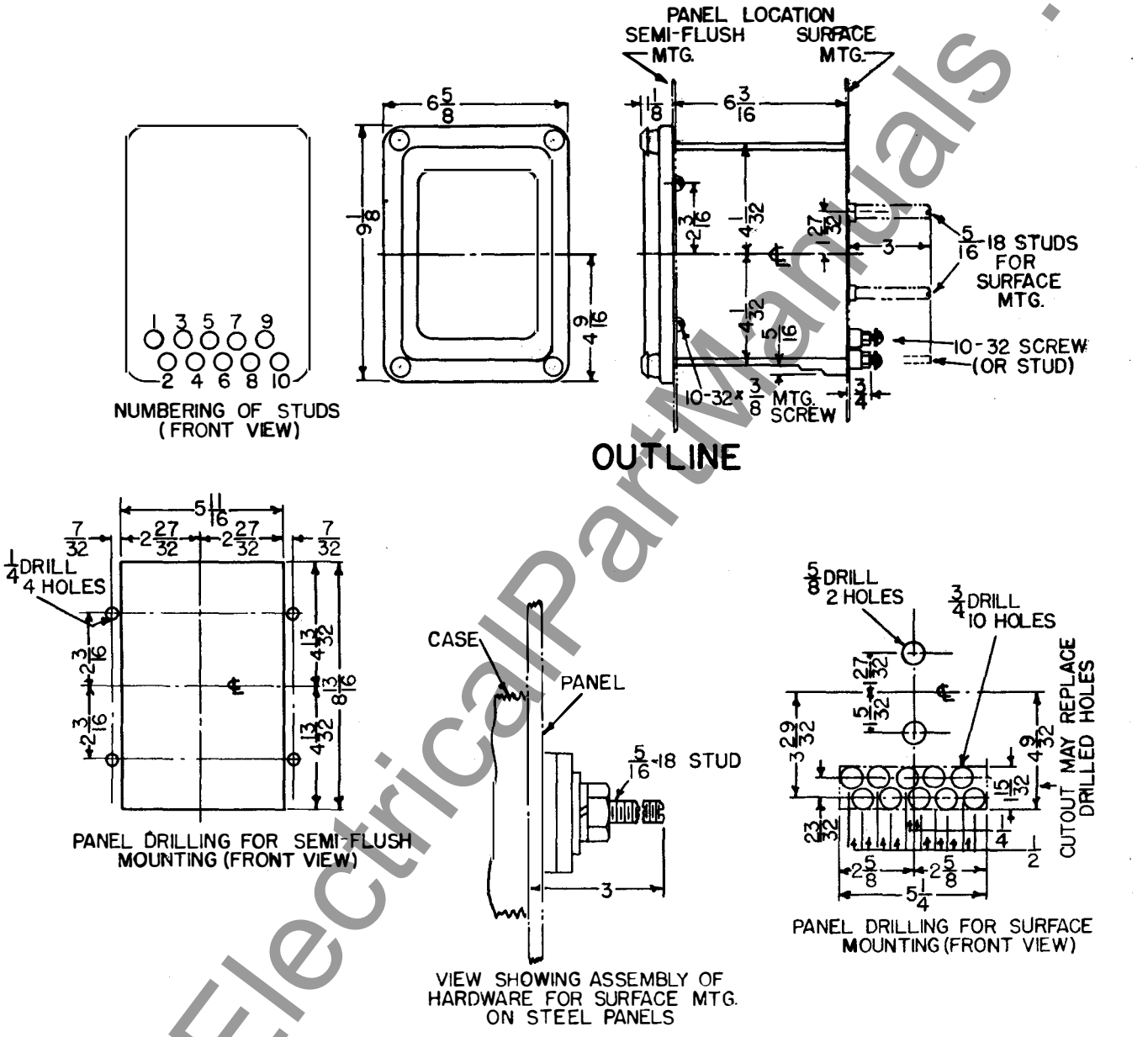

Fig. 21 (K-6209271)

Fig. 21 Outline and Panel Drilling Dimensions for Type IJD52A and IJD53C Relays

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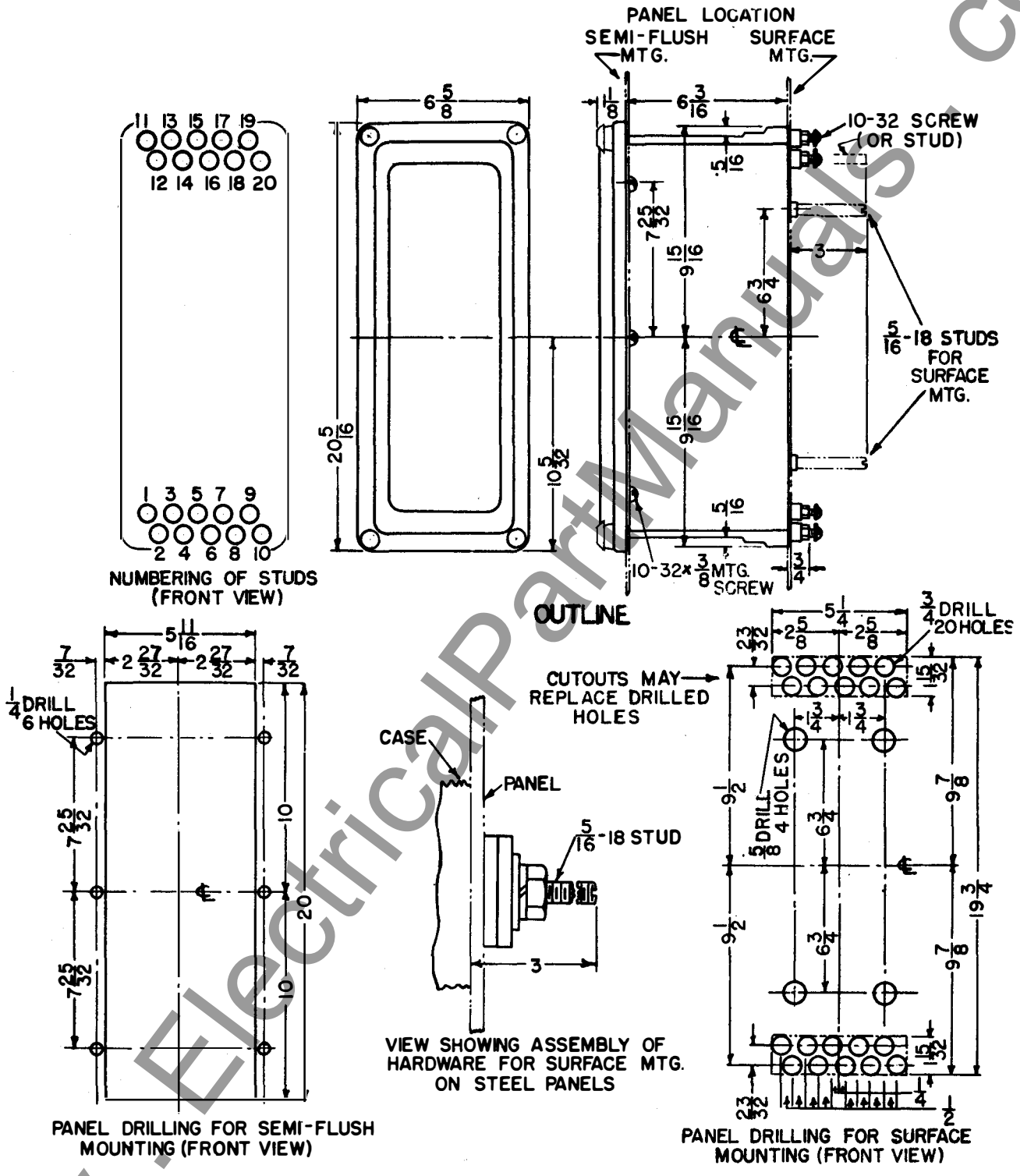

Fig. 22 (K-6209276)

Fig. 22 Outline and Panel Drilling Dimensions for Type IJD52B and IJD53D Relays

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