INSTRUCTIONS

TYPE IJC51E

CURRENT BALANCE RELAY

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CONTENTS

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CURRENT BALANCE RELAY

DESCRIPTION

The Type IJC51E current balance relay consists of three mechanically-separate but electrically interconnected induction-disk units mounted in a large size, single-end drawout case. The outline and panel drilling dimensions for the Type IFC51E are shown in Figure 13. Each unit consists of a disk and shaft assembly which carries the moving contact. Each disk is actuated by two U-magnet and coil assemblies, the operating coil on the left-hand side and the restraint coil on the right-hand side (front view). Each disk shaft is restrained by a spiral spring which holds the contact open when the relay is de-energized.

There is a target seal-in unit mounted on the front and to the left of the shaft of each induction-disk unit. This unit has its coil in series and its contacts in parallel with the contacts of the main unit.

APPLICATION

The Type IJC51E relay is recommended for the protection of three-phase lines and machines against damage from phase unbalance or single-phase operation. The relay is typically applied where currents in the three phases are normally balanced. The external connection in Figure 14 illustrates a typical application. The relay compares the currents in each phase with those in each of the other phases. Any increase in current in the protected circuit, regardless of magnitude, will not cause a relay operation as long as the unbalance does not exceed the slope setting of the relay, 115, 125, 135 or 150%.

When a fault or unbalance occurs in the machine or line, and causes the current in one of the phases to exceed that in the others by more than the slope setting, the torque produced by the operating coil will be greater than that of the restraint coil, and the relay will operate to trip the breaker.

The IJC51E relay can be classified as a relay which protects against discontinuity of balanced-phase conditions, rather than as a fault-protective relay. When used for protection against single-phase operation of a machine, it must have a time setting of such length that it will not trip the machine on an external single-phase fault. Such a time delay must permit selective tripping by the relays protecting the faulted circuit.

RATINGS

The IJC51E is a three-phase relay rated at 5 amperes, 50 or 60 hertz, with a minimum pickup of 1 ampere with zero restraint current. There are four slope selections available, at 115, 125, 135 and 150%. The relay has three target/seal-in units, one per phase, rated at 0.2/2.0 amperes. The induction-disk units and target/seal-in units are contained in a large, L1 size, drawout case.

CONTACTS

The main unit contacts have a maximum current-closing rating of 30 amperes at voltages not exceeding 250 volts DC for tripping duty.

The main unit contacts, when used without the target/seal-in unit contact, do not have an interrupting rating; therefore, the trip current must be interrupted by some other suitable means.

TARGET/SEAL-IN UNIT

The target/seal-in units are Hi-G units with 0.2 and 2.0 ampere taps. The 0.2 ampere tap can be used for trip circuits that have 2 amperes or less of tripping current. The 2.0 ampere tap is used in trip circuits that have at least 2 amperes and up to 30 amperes of trip current available at the maximum control voltage. If the tripping current exceeds 30 amperes, an auxiliary relay and contact must be used to carry the trip current. The connections should be made so that the trip current does not pass through the IJC contacts or seal-in unit.

The target ratings are shown in Table I.

TABLE I

		TAPS	
		0.2 Amp	2.0 Amp
DC Resistance	(ohms)	8.30	0.24
Minimum Operating	(amperes)	0.2	2.0
Carry Continuously	(amperes)	0.37	2.3
Carry 30 amperes	(seconds)	0.05	2.2
Carry 10 amperes	(seconds)	0.45	20
60 Hertz Impedance	(ohms)	50	0.65

BURDENS

The burdens imposed on the current transformers by the operating and restraining coils are listed in Table II.

TABLE II

	1 Amp		5 Amp		10 Amp		20 Amp		40 Amp	
	Z	Pf	Z	Pf	Z	Pf	Z	Pf	Z	Pf
Operating Coil	0.74	0.32	0.62	0.32	0.50	0.279	0.335	0.30	0.225	0.39
Restraint Coil										
115% Slope	0.99	0.358	0.868	0.325	0.636	0.310	0.40	0.366	0.283	0.50
125% Slope	1.06	0.34	0.928	0.31	0.65	0.30	0.41	0.345	0.29	0.47
135% Slope	1.20	0.33	1.05	0.30	0.716	0.29	0.448	0.345	0.292	0.474
150% Slope	1.46	0.32	1.24	0.29	0.835	0.28	0.54	0.32	0.355	0.46

V_A can be calculated from the equation: $V_A = I^2Z$

TARGET/SEAL-IN UNIT

For the burdens of the target/seal-in units, see Table I.

OPERATING PRINCIPLES

The operating and restraining units consist of U-magnets similar to those used on time-overcurrent relays. The operating U-magnet is located on the left side of the relay, front view, and the restraining U-magnet is located on the right side, front view. Torque is produced by phase shifting one flux away from the other by use of shading rings on one half of the U-magnet pole face; the other half is unshaded. The operating U-magnet produces torque to close the normally-open contact, while the restraining U-magnet produces torque to open the contact. The relay will close its contact when the restraining quantity is some percentage plus or minus a tolerance of the slope tap selected on the tap block.

There is a built-in time delay produced by the permanent Alnico drag magnet, which is secured to the shelf of the unit frame. The drag magnet can either be moved inward or outward on this shelf to make the corresponding time delay shorter or longer. This procedure sets the time delay according to the time curves of Figures 9 and 10.

CHARACTERISTICS

The relay is used as a current-balance detector on a three-phase system. The relay will operate to close its normally-open contact to trip a breaker when the unbalance between any two currents of the three-phase system exceeds the slope tap setting and its tolerance.

The slope characteristics are shown in Figures 1 through 8. These are typical slope curves obtained from actual relay tests. The factory tested relay, as received by the customer, should operate within ± 7% of the actual slope tap setting.

The slope characteristics were determined by using the test circuit shown in Figure 15. If the relay is tested with the connections as shown in the external connections diagram, Figure 14, where $I_{Restraint}$ is leading $I_{Operating}$ by 120°, the slope characteristic increases drastically at the higher restraint currents. The change, for example, at 40 amperes restraint at 125% slope, tested per Figure 15, will increase to approximately 180% slope when tested with I_R leading I by 120°. This change is of no consequence because the relay is not a fault relay and is only used for balanced-current protection. The slopes are correct within the tolerance up to 10 amperes restraint for the 120° out-of-phase currents.

The operating times of the 115% slope at 0, 2.5 and 5.0 amperes restraint are shown in Figures 9 and 10.

CONSTRUCTION

The Type IJC51E relays are assembled in a large size, single-end (L1) drawout case having terminals in the rear for external connections. The electrical connections between the relay units and the case studs are made through stationary molded inner and outer blocks, between which nests a removable connecting plug to complete the circuit. The outer block attached to the case has the studs for the external connections, and the inner blocks have the terminals for the internal connections.

Every circuit in the drawout case has an auxiliary brush, as shown in Figure 11, to provide adequate overlap when the connecting plug is withdrawn or inserted. Some circuits are equipped with shorting bars (see internal connections in Figure 12) and on those circuits, it is especially important that the auxiliary brushes make contact (as indicated in Figure 11) with adequate pressure to prevent the opening of important interlocking circuits.

The relay mechanism is mounted in a steel framework called the cradle, and is a complete unit with all leads terminated at the inner blocks. This cradle is held firmly in the case with a latch at both top and bottom, and by a guide pin at the back of the case. 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 drawn to the case by thumbscrews, holds the connecting plug/s in place. The target reset mechanism is part of the cover assembly.

The relay case is suitable for either semi-flush or surface mounting on all panels up to 2 inches thick and appropriate hardware is available. However, panel thickness must be indicated on the relay order, to ensure that proper hardware will be included.

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 if desired, the relay can be drawn out and replaced by another which has been tested in the laboratory.

Figures 1 and 2 show the relay removed from its drawout case with all major components identified. Symbols used to identify circuit components are the same as those which appear on the internal connection diagram in Figure 14.

The relay includes three similar subassembly elements called induction units, mounted on the front of the cradle.

The induction unit is the basic unit in all IJC relays. These units are of the induction-disk construction. The disk is actuated by a current operating coil assembled on a laminated U-magnet. The disk shaft carries the moving contact, which completes the alarm or trip circuit when it touches the stationary contact. The disk 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 give the correct time delay.

There is a seal-in unit mounted on the front, to the left of the shaft. This unit has its coil in series and its contacts in parallel with the main contacts, such that when the main contacts close, the seal-in unit picks up and seals in. When the seal-in unit picks up, it raises a target into view, which latches up and remains exposed until released by pressing a button beneath the lower left corner of the cover.

NOTE: All tests must be performed with the relay in its case or in an equivalent case.

TESTS

DRAWOUT RELAYS, GENERAL

Since all drawout relays in service operate in their cases, it is recommended that they be tested in their cases or an equivalent steel case. In this manner, any magnetic effects of the enclosure will be accurately duplicated during testing. A relay may be tested without removing it from the panel by using a 12XLA13A test plug. This plug makes connections only with the relay and does not disturb any shorting bars in the case. The 12XLA12A test plug may also be used. Although this test plug allows greater testing flexibility, it also requires CT shorting jumpers and the exercise of greater care, since connections are made to both the relay and the external circuitry.

POWER REQUIREMENTS, GENERAL

All alternating-current-operated devices are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that alternating-current devices (relays) will be affected by the applied waveform.

Therefore, in order to test alternating-current relays properly, it is essential to use a sine wave current and/or voltage. The purity of the sine wave (i.e., its freedom from harmonics) cannot be expressed as a finite number for any particular relay; however, any relay using tuned circuits, RL or RC networks, or saturating electromagnets (such as time-overcurrent relays), would be essentially affected by non-sinusoidal waveforms.

Similarly, relays requiring DC control power should be tested using DC and not full wave rectified power. Unless the rectified supply is well filtered, many relays will not operate properly due to dips in the rectified power. Zener diodes, for example, can turn off during dips. As a general rule, the DC source should not contain more than 5% ripple.

TARGET/SEAL-IN UNIT TEST

Set up a DC-current circuit capable of controlling the current over a range of 0.02 to 3.0 amperes. Connect the circuit to studs 1 and 2 of the IJC51E relay. Check the tap that the target/seal-in unit is in. The tap, as received from the factory, will normally be in the 2.0 ampere tap position. Check each of the units (top-middle-bottom) separately as follows:

Reduce the current to approximately zero amperes. Place a jumper from stud 2 to the target/seal-in current tap used, and gradually increase the current until the target/seal-in unit picks up. This should occur at the value listed in Table III. Remove the jumper and note that the contact of the target/seal-in unit remains closed. Reduce the current gradually and note the value of current needed to drop out the target/seal-in contacts. This should occur as listed in the dropout portion of Table III. The target/seal-in flag should remain latched-in. It can only be reset with the reset arm located on the left side of the unit.

TABLE III

TARGET TAP	PICKUP AMPERES	DROPOUT AMPERES
0.2 amp	0.120 - 0.195	0.060 or higher
2.0 amps	1.20 - 1.95	0.60 or higher

The target taps are located on the right tap plate (front view) and are clearly marked. There should only be **one** screw in this plate.

The contact plate on the left side of the target/seal-in unit should have two screws. One screw is used to hold the plate in place. The other screw is used when the target tap (right side) must be changed. This is accomplished by taking one of the screws from the left plate and putting it into the alternate tap of the right plate. The original tap screw on the right plate then can be removed and placed in the left plate. This procedure ensures that the mechanical adjustments on the right plate are not disturbed when the tap screw is changed to the other tap position.

INDUCTION UNIT

Pickup

The relay must be tested in its own case or equivalent steel case. Connect the relay as shown in the test diagram of Figure 15 for the A and B connections only.

Set the time dial at the 1/2 time dial position. Apply 110% of the pickup current listed on the nameplate. After the contact makes, reduce the current slowly until the contact just opens, increase the current slightly, and the relay contact should just make. A flickering indicating light is considered a contact closure. The pickup should be within ± 2% of nominal, and can be adjusted with the control spring sprocket located between the control spring and moving contact. There are notches in the sprocket that can be used to turn the assembly with a screw driver. Turning the sprocket to the right increases the pickup value. Turning it to the left decreases the pickup.

Reset

Remove the pickup current. Turn the time dial to the No.10 position. Turn the disk by hand to close the normally-open contacts.

Release the disk, and it should reset to the stop at the No.10 time dial position. If the disk stops somewhere in its travel, look for excessive friction, parts that may be touching, or foreign matter in the drag magnet air gap.

Time Tests

Figure 9 is the operating-time curve with zero-restraint current.

Figure 10 is the operating-time curve with 2.5 and 5.0 amperes restraint current with the relay set in the 115% slope tap.

The time-curve settings can be verified using the connections for pickup for the Figure 9 curve and the slope connections for the Figure 10 curve. The time curve can be varied by moving the drag magnet on the shelf of the relay unit frame. Moving the magnet inwards towards the disk shaft makes the time faster; moving it away from the shaft makes the time longer. Do not move the magnet outward past the serrations on the disk, because it begins to loose its effectiveness beyond that point.

Slope Tests

Refer to Table IV and Figure 15. Connect the relay as shown in Figure 15. Set the slope at 115%. Set the time dial to the 1/2 time dial position.

Set the restraint current (I_R); then apply the operating current (I_O) as listed in Table IV. It is best if this test is done on a "go - no go" basis because the magnitude of the test currents will overheat the units and lower the actual slope setting. The "go - no go" method is as follows:

Set the restraint current (I_R).

Apply the minimum operating current (I_O) and note that the disk does not move in the direction to close the normally-open contact. Apply the maximum operating current and note that the disk moves in the direction to close the normally-open contact. It is best not to wait for a contact closure at the higher values because of the overheating effect.

The above tests can also be performed on the other slope taps as mentioned above, using Table IV for the I_R and I_O values.

TABLE IV

RESTRAINT CURRENT	OPERATING CURRENT I_O SLOPE IN PERCENT 115	125	135	150
I_R = 5.0A	5.4 - 6.1	5.9 - 6.6	6.4 - 7.1	7.15 - 7.85
I_R = 8.0A	8.64 - 9.76	9.44 - 10.56	10.24 - 11.36	11.44 - 12.56
I_R = 20.0A	21.6 - 24.4	23.6 - 26.4	25.6 - 28.4	28.6 - 31.4

RECEIVING, HANDLING AND STORAGE

These relays, when not included as 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 damage due to rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

Exercise care when handling or unpacking the relay to avoid disturbing adjustments or damaging the relay.

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 particles. Foreign matter collected on the outside of the case may find its way to the inside of the case when the cover is removed, creating the possiblity of relay misoperation.

ACCEPTANCE TESTS

Immediately upon receipt of the relay, an inspection and acceptance test should be made to make sure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If the examination or the test indicates that readjustment is necessary, refer to the section on **SERVICING.**

These tests may be performed as part of the acceptance tests or of the installation tests, at the discretion of the user. Since most operating companies use different procedures for acceptance and installation tests, the following section includes all applicable tests that may be performed on these relays.

VISUAL INSPECTION

Check the nameplate stamping to make sure 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.

MECHANICAL INSPECTION

1. There should be no noticeable friction when the disk is slowly rotated clockwise. The disk should return by itself to the reset position.

2. Make sure the control spring is not deformed, and that spring convolutions are not tangled and do not touch each other.

3. The armature and contacts of the seal-in unit should move freely when operated by hand. There should be at least 1/32 inch wipe on the seal-in contacts.

4. The targets in the seal-in unit must come into view and latch when the armature is operated by hand, and should unlatch when the target release lever is operated.

5. Make sure that the fingers and shorting bars agree with the internal connections diagram, Figure 12.

CAUTION:

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

Pickup

Connect the relay per Figure 15 for the A and B connections.

The pickup of the relay is adjusted at the factory for a nominal pickup of ± 2%. The pickup is the magnitude of current necessary to close the normally-open contacts with zero restraint current. The pickup can be adjusted by turning the adjusting sprocket located just above the control spring that has the outer turn of the spring soldered to it. Turn the adjusting sprocket to the right to increase the pickup, and to the left to decrease the pickup.

Time

Time can be varied by moving the drag magnet inward or outward on the shelf of the die-cast aluminum frame. Move the magnet inward to decrease the time. Move it outward to increase the time. The leading edge of the magnet should not be moved outward further than the serrations on the disk.

Slope

Set the slope tap in the proper tap for your application. Refer to Figure 15 and Table IV for the values of I_R and I_0 as listed. There are no adjustments for the slope characteristic in the field on the IJC51E relay. It is done by design, and therefore not easily adjustable.

INSTALLATION PROCEDURE

LOCATION

The relay should be installed in a clean, dry location, 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 dimensions are shown in Figure 13.

CONNECTIONS

The internal connections diagram for the relays is shown in Figure 12. Typical external connections are shown in Figure 14.

One of the mounting studs or screws should be permanently grounded by a conductor not less than #12 B&S gage copper wire, or its equivalent.

ADJUSTMENTS

Target/Seal-in

There are no adjustments available on the target/seal-in unit in the field to easily vary the pickup or dropout values. The unit should function as described in **ACCEPTANCE TESTS**.

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. 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 under **ACCEPTANCE TESTS** be checked at an interval of from one to two years.

CONTACT CLEANING

A flexible burnishing tool should be used for cleaning relay contacts. This is a flexible strip of metal with an etched-roughened surface, which in effect resembles a superfine file. The polishing action of this file is so delicate that no scratches are left on the contacts, yet it cleans off any corrosion thoroughly and rapidly. The flexibility of the tool ensures the cleaning of the actual points of contact. Do not use knives, files or abrasive paper or cloth of any kind to clean relay contacts.

SERVICING

If it is found during the installation procedure, or during periodic testing and routine maintenance, that the relay has damaged parts or is out of calibration, the following procedures must be performed.

Check the U-magnet and drag magnet gaps for foreign matter, and remove it from the relay. Dirt or foreign matter can cause binding.

Contacts should be cleaned periodically to remove any foreign materials. Check the paragraph on "Contact Cleaning" for this procedure.

Damaged parts can be replaced by purchasing the replacement part through the General Electric Company District Sales office. If either the operating or restraining U-magnets must be replaced, the relay must be retested. If the control spring is replaced, at least the operating pickup must be retested and reset, as described in the section on **ACCEPTANCE TESTS**.

Relays that are out of calibration can be returned to satisfactory operation by making some minor adjustments. Pickup can be reset by adjusting the control spring with the adjusting sprocket. The time can be varied with the drag magnet. By design, the slopes have no adjustment other than that which was performed at the factory. U-magnet air gaps have a significant effect on the slope characteristic; therefore, the U-magnet gaps should never be disturbed. If a U-magnet is replaced, first measure the air gap of the U-magnet to be removed, then set the new U-magnet to the same air gap. The air gaps are maintained by the four mounting screws which secure the U-magnet to the frame. The air gap is held by inserting a spacer between the U-magnet poles to maintain the correct gap, with the disk removed, while the four mounting screws are tightened. Always replace the screws in the same location as they were when removed. A minor slope adjustment can be accomplished by varying the screws from steel to brass, etc. This is a factory adjustment, and the screw locations should remain as received from the factory.

RENEWAL PARTS

Sufficient quantities of renewal parts should be kept in stock for 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 the name of the part wanted, quantity required, and complete nameplate data, including the serial number, of the relay.

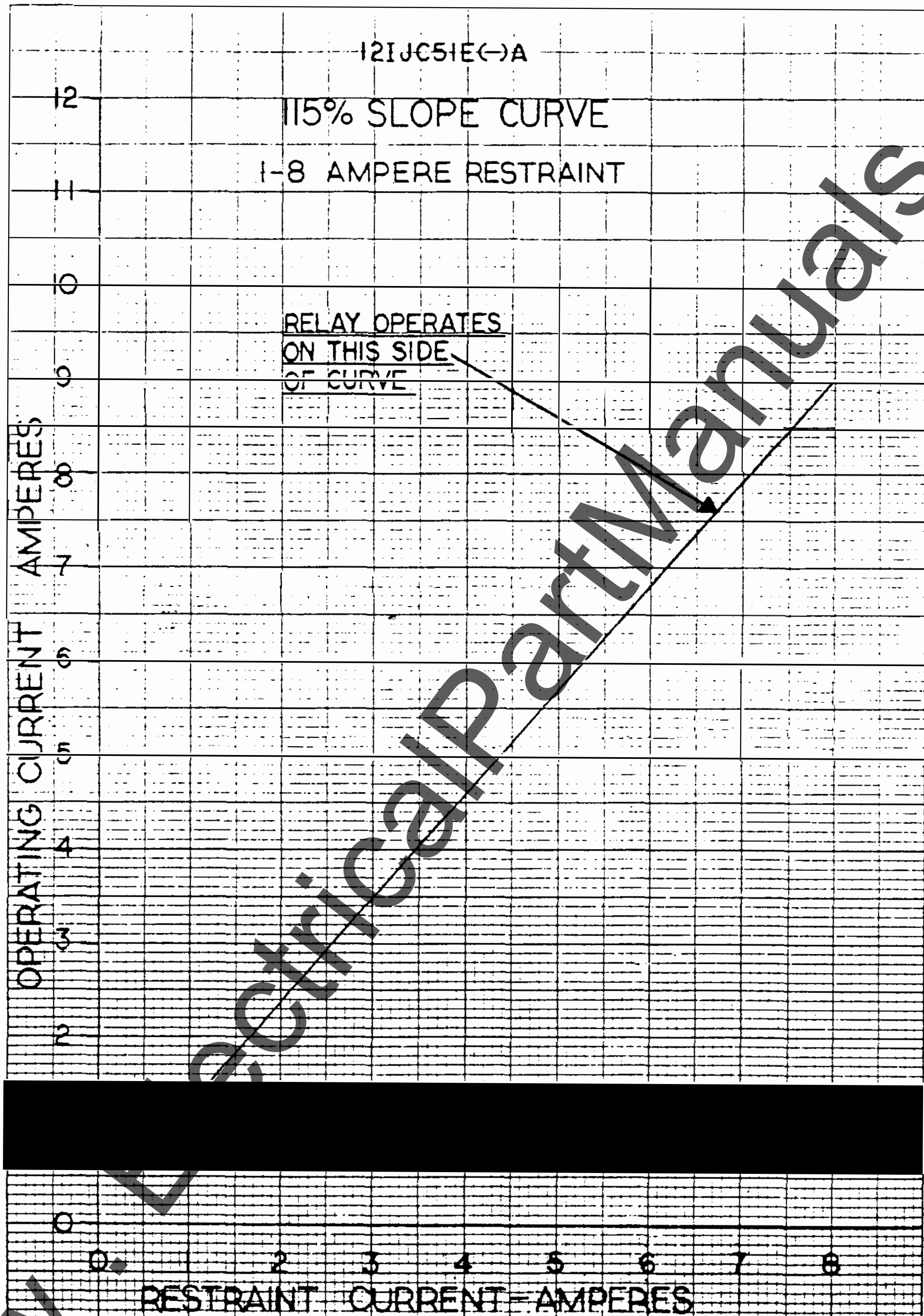


Figure 1 (0285A6670-1) Slope Curve for 115 Percent Slope at One to Eight Amperes Restraint

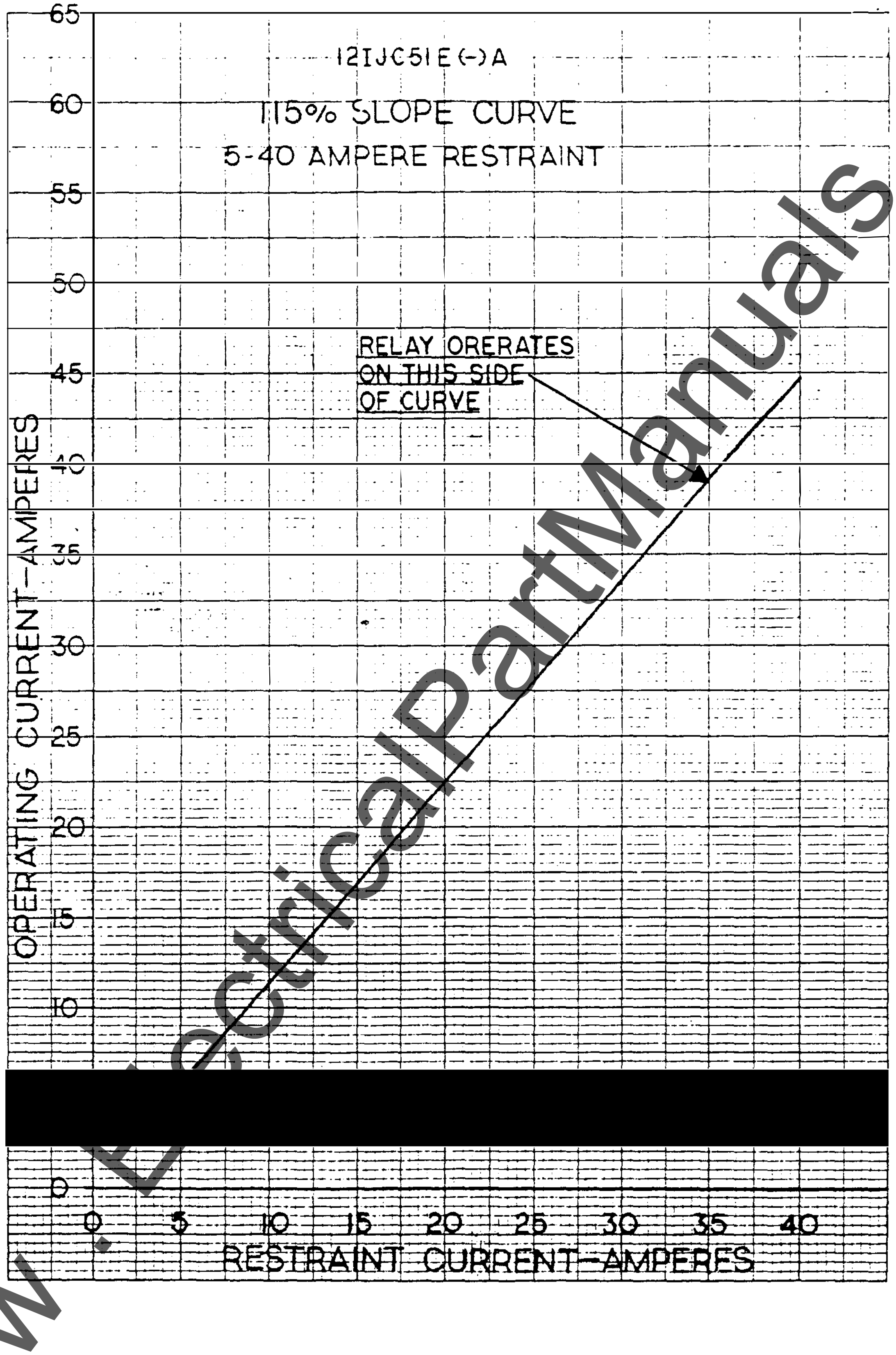


Figure 2 (0285A6674-1) Slope Curve for 115 Percent Slope at Five to Forty Amperes Restraint

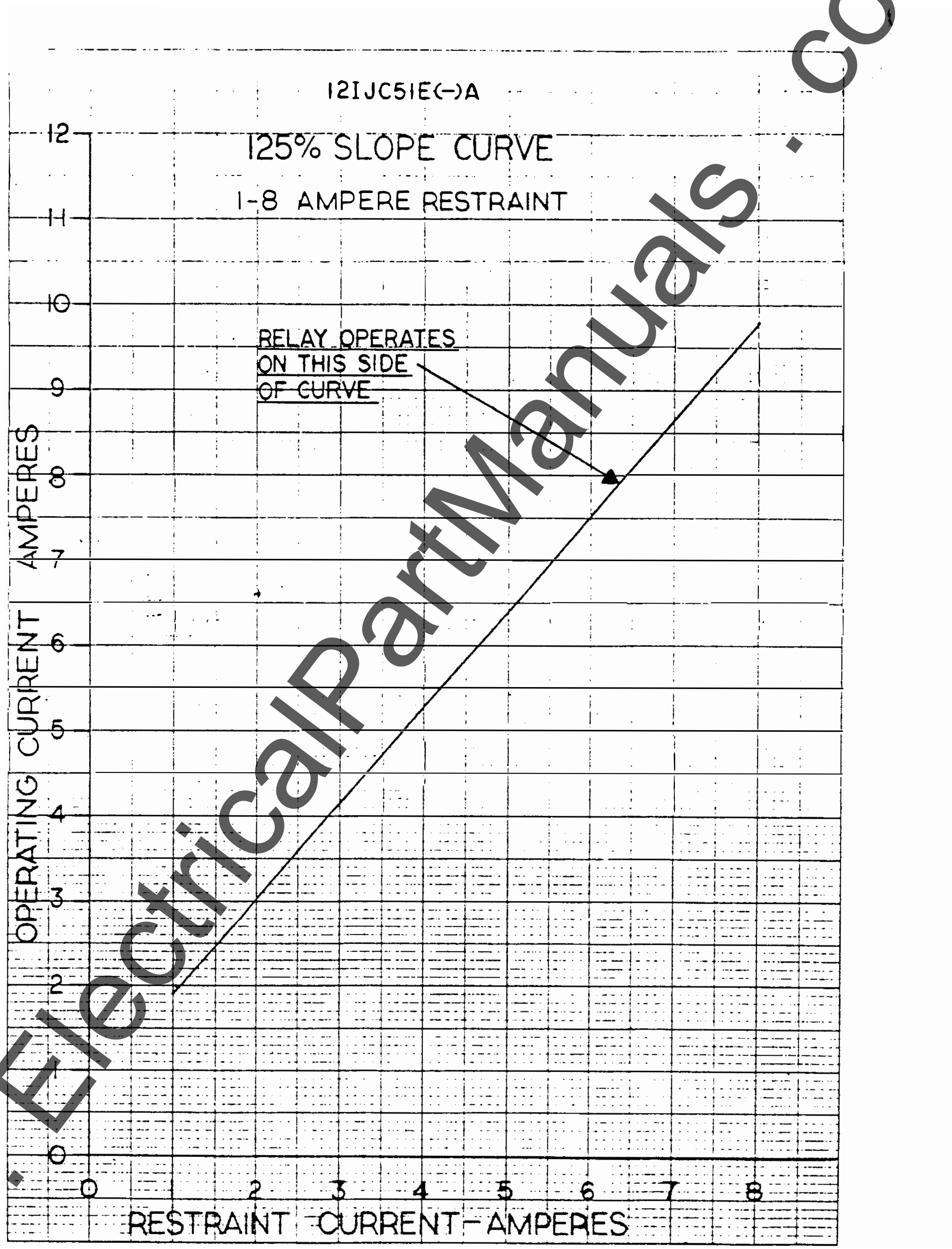


Figure 3 (0285A6671-1) Slope Curve for 125 Percent Slope at One to Eight Amperes Restraint

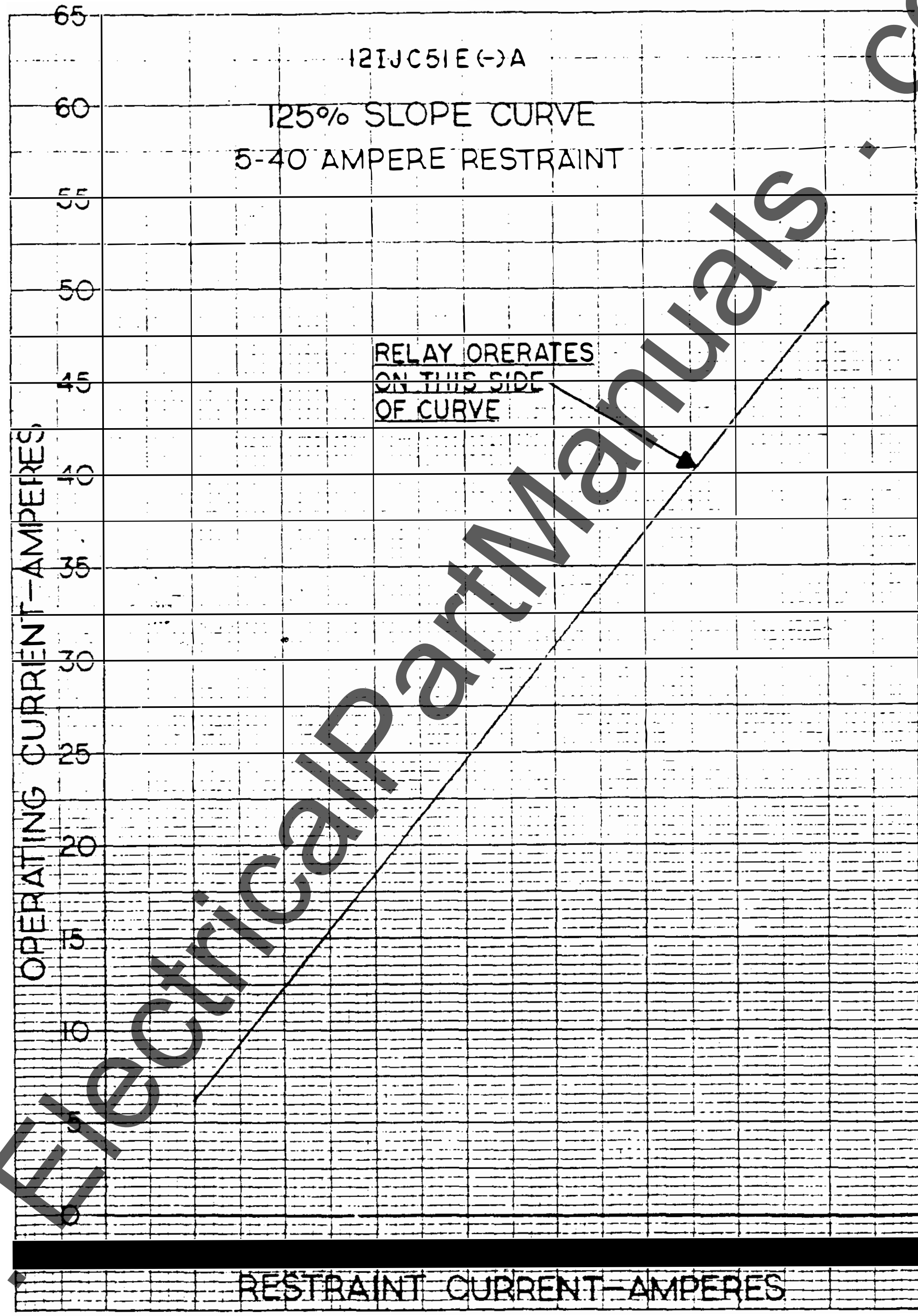


Figure 4 (0285A6675-1) Slope Curve for 125 Percent Slope at Five to Forty Amperes Restraint

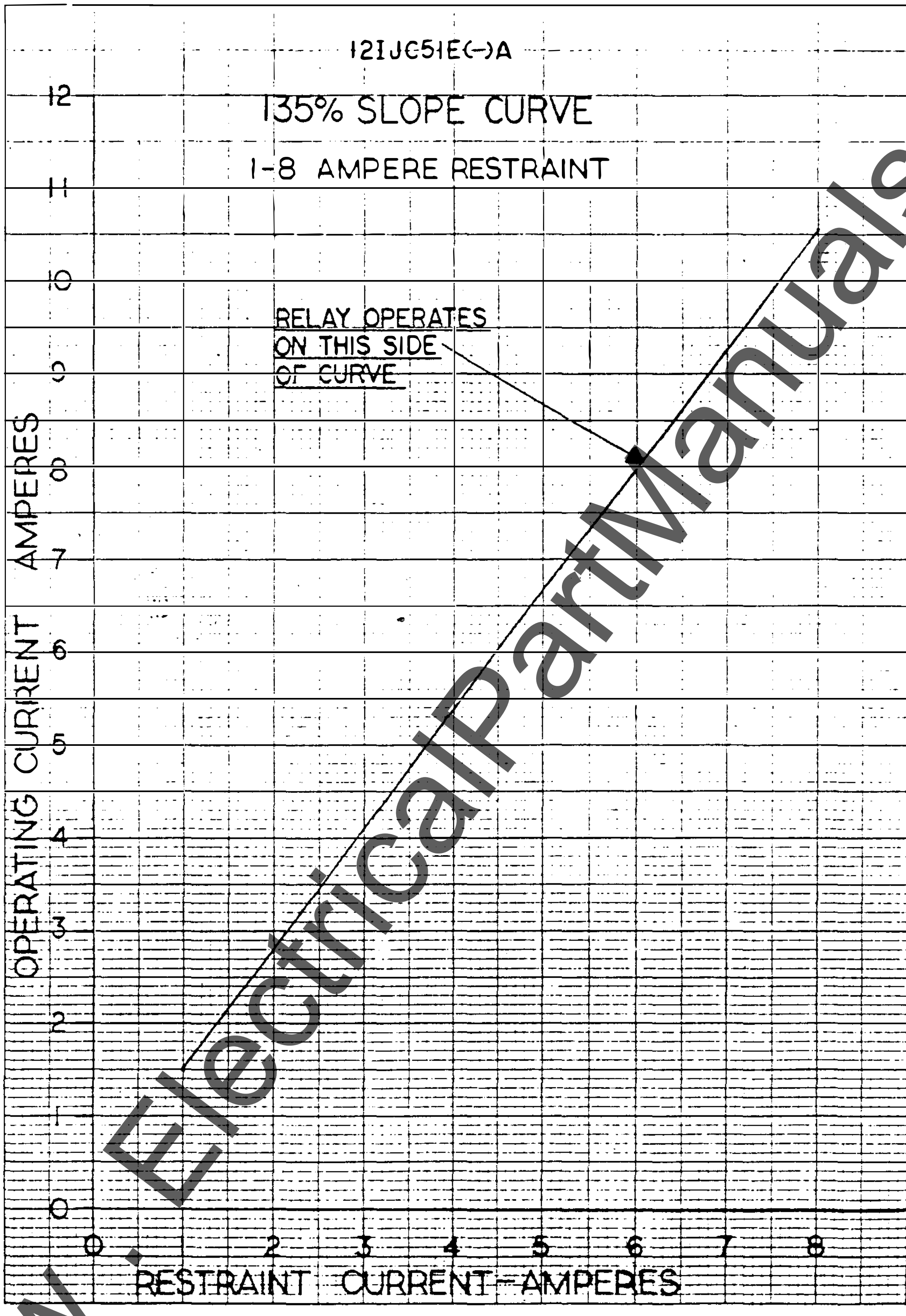


Figure 5 (0285A6672-1) Slope Curve for 135 Percent Slope at One to Eight Amperes Restraint

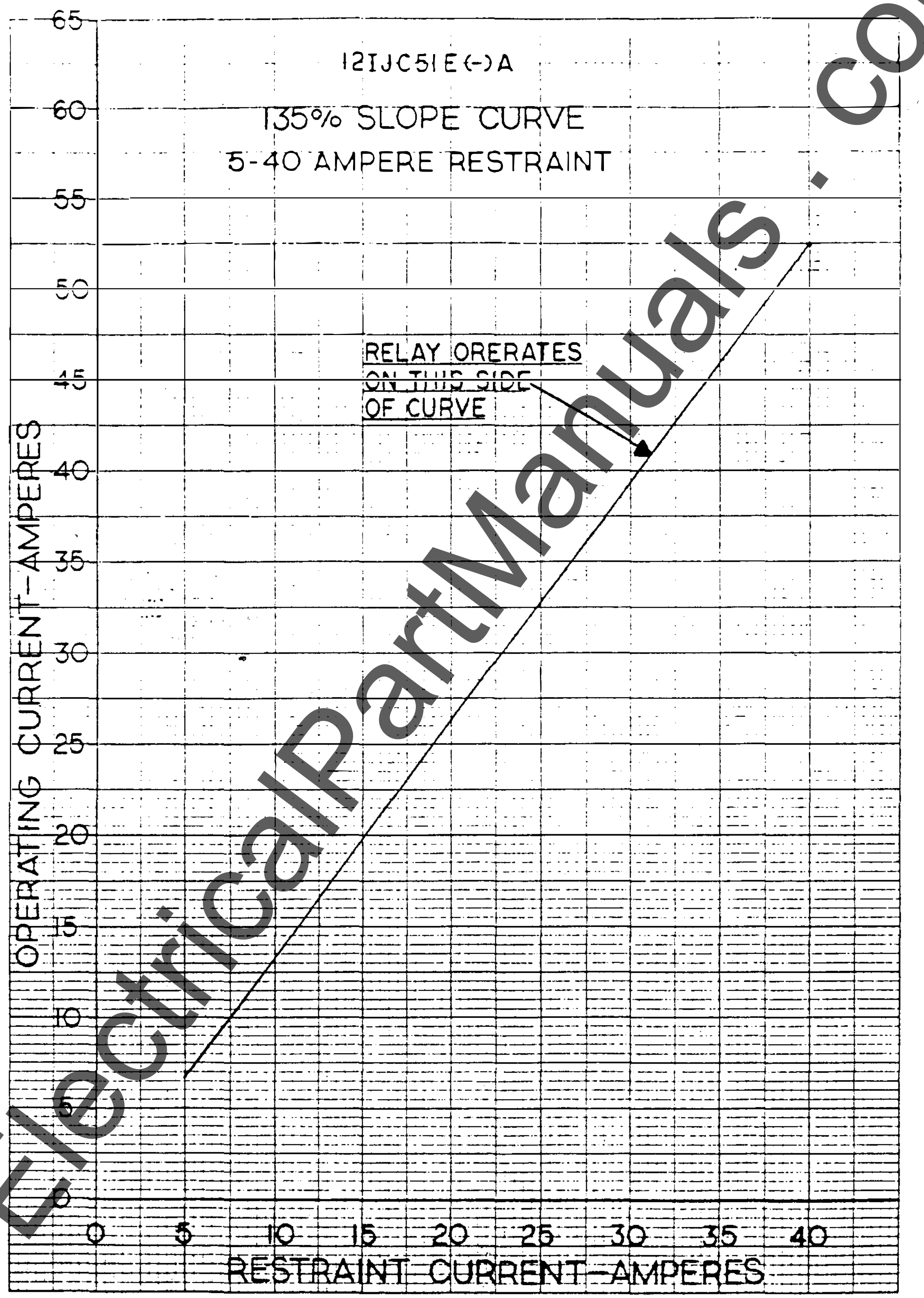


Figure 6 (0285A6676-1) Slope Curve for 135 Percent Slope at Five to Forty Amperes Restraint

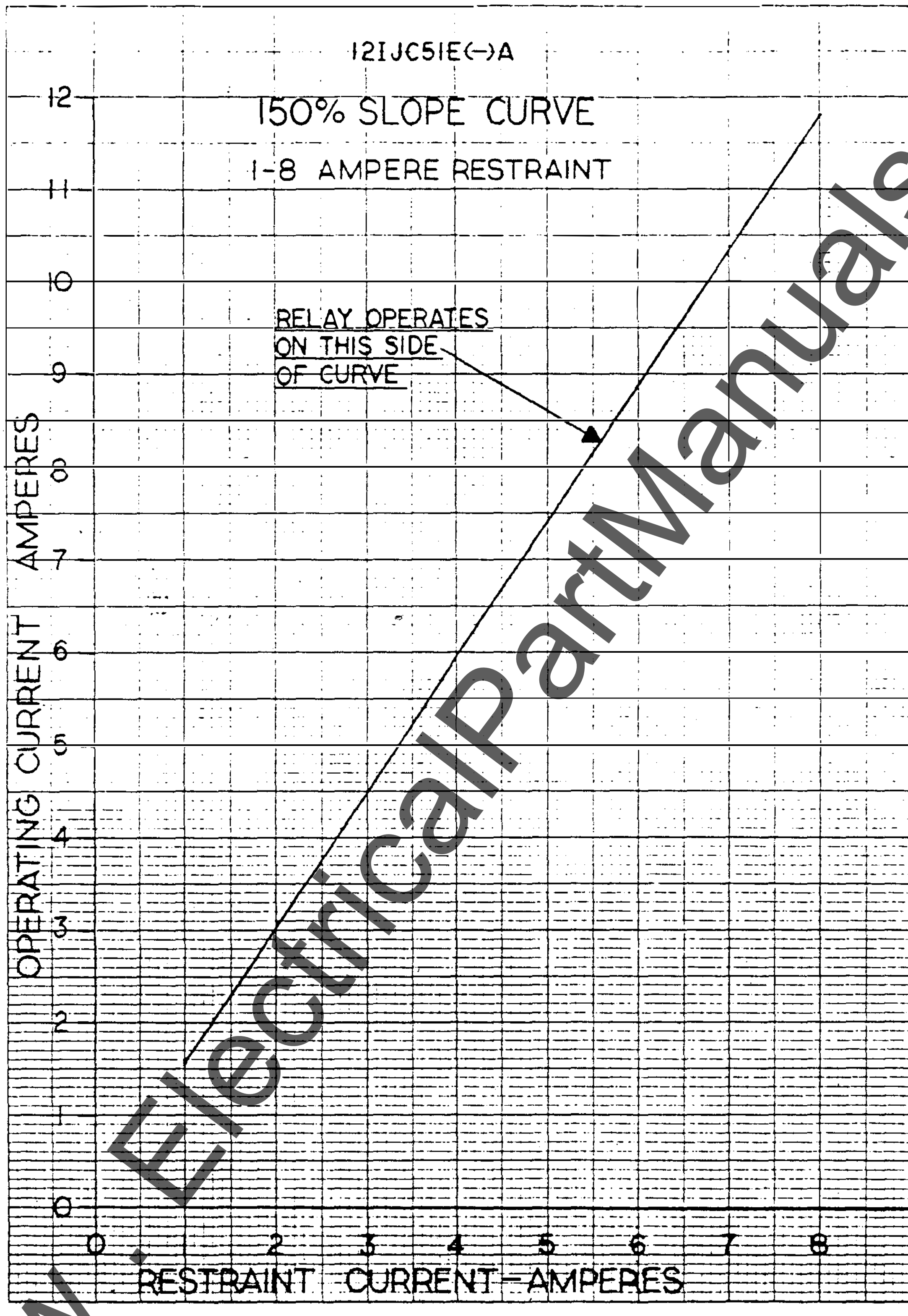


Figure 7 (0285A6673-1) Slope Curve for 150 Percent Slope at One to Eight Amperes Restraint

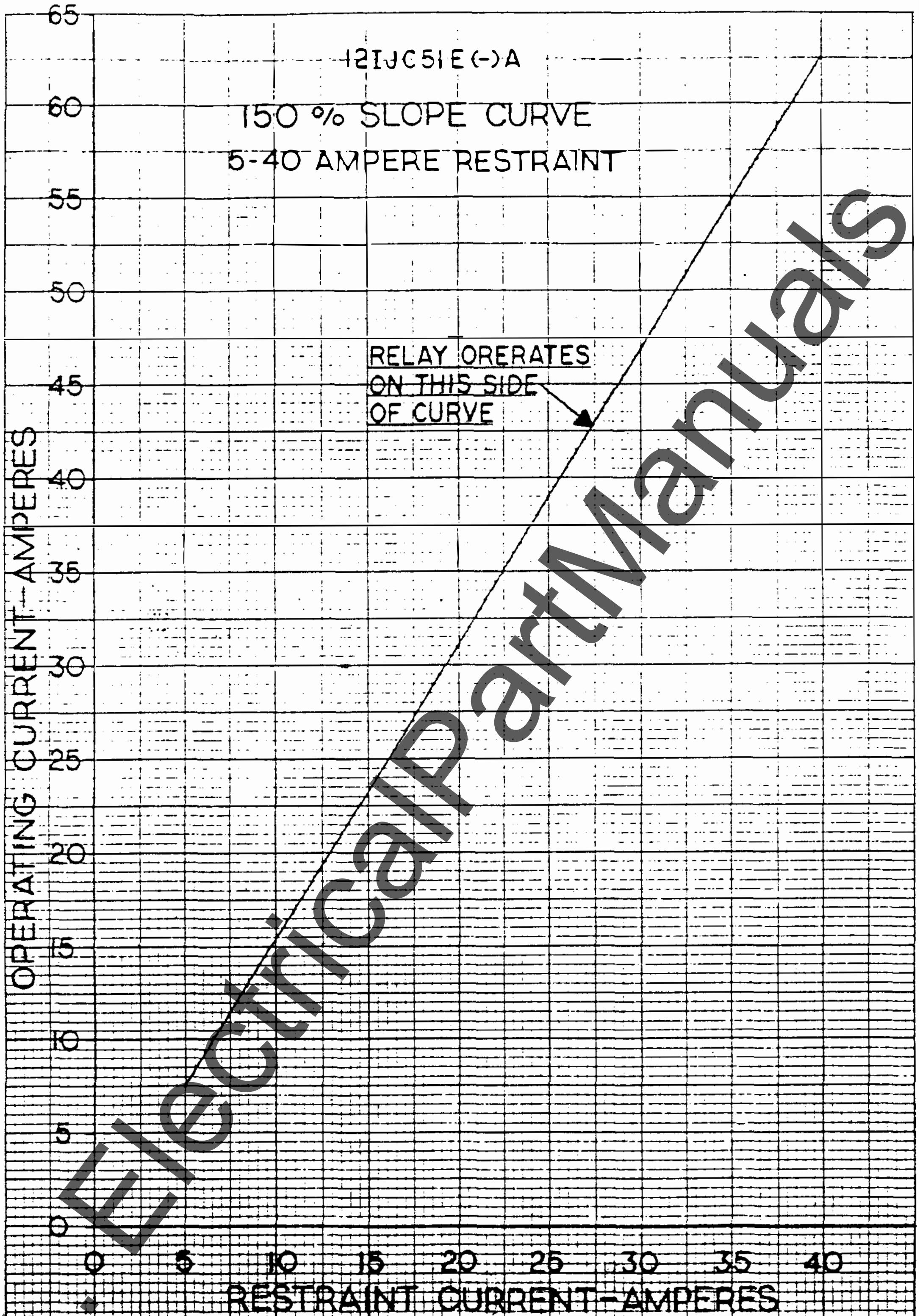


Figure 8 (0285A6677-1) Slope Curve for 150 Percent Slope at Five to Forty Amperes Restraint

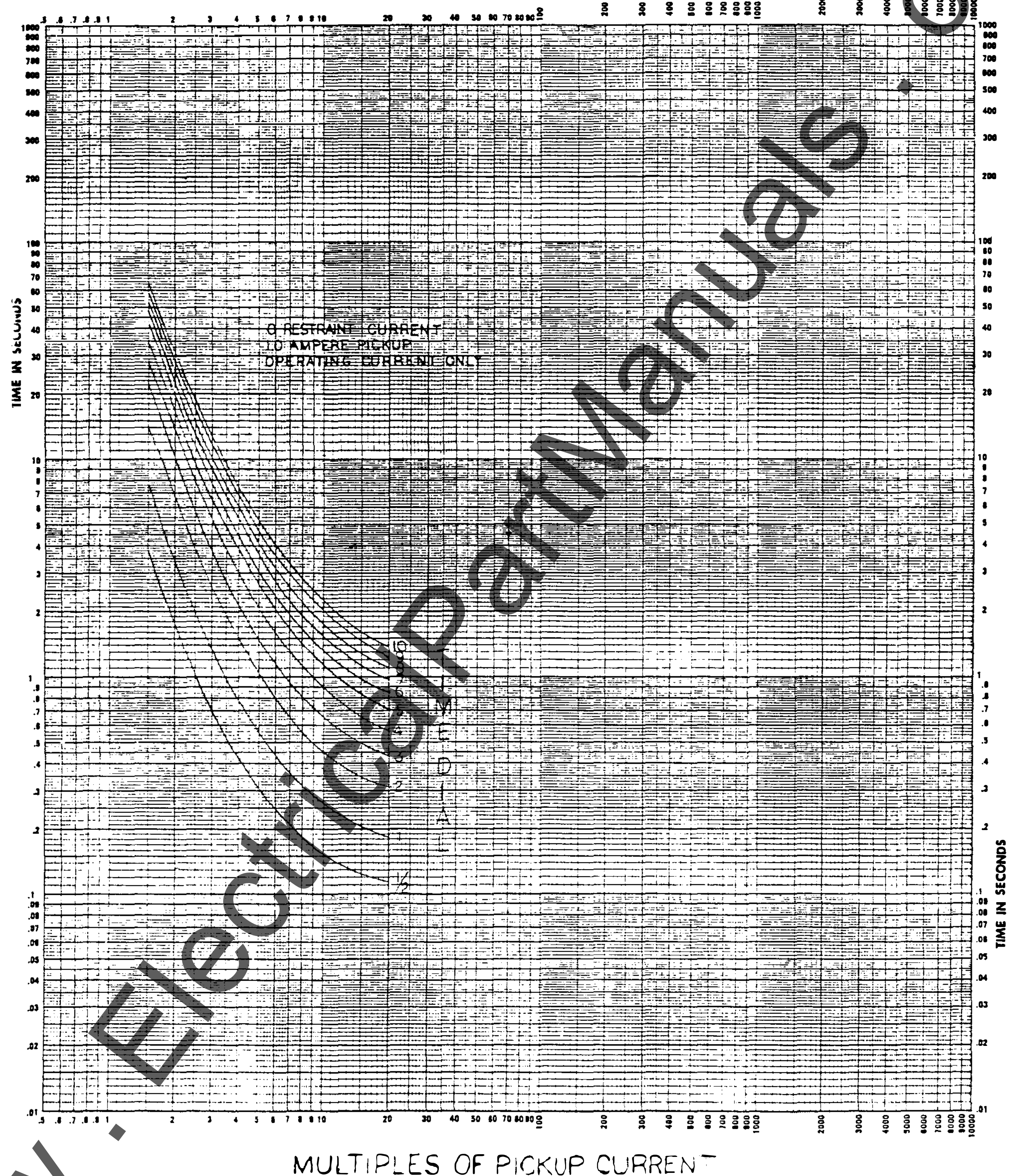
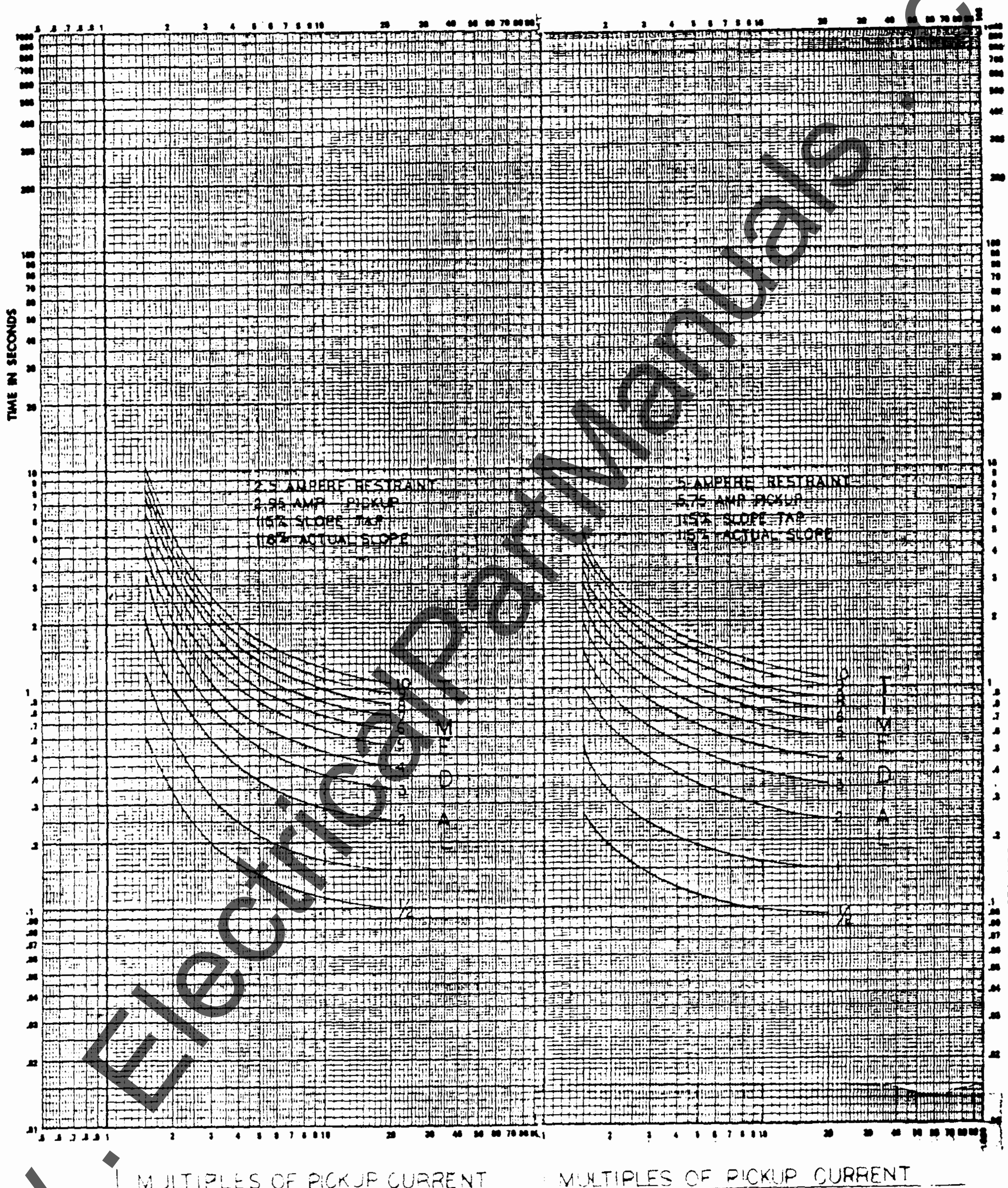


*Figure 9 (0138B7643-0) Operating Time Curve for the 115 Percent Slope at Zero Restraint Current

* Revised since last issue



* Figure 10 (0138B7644-0) Operating Time Curve for the 115 Percent Slope at 2.5 and 5.0 Amperes Restraint

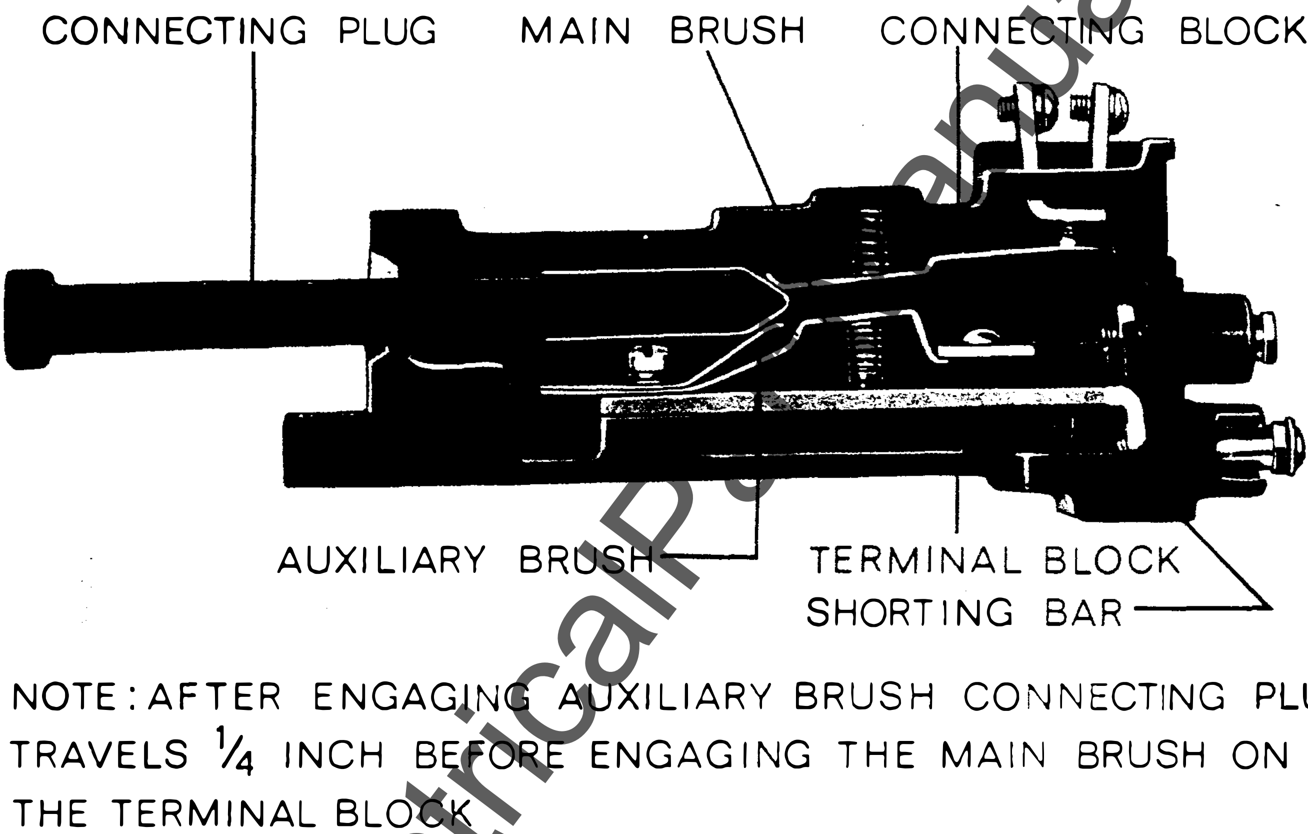


Figure 11 (8025039) Cross Section of Case and Cradle Block Showing the Auxiliary Brush and Shorting Bar

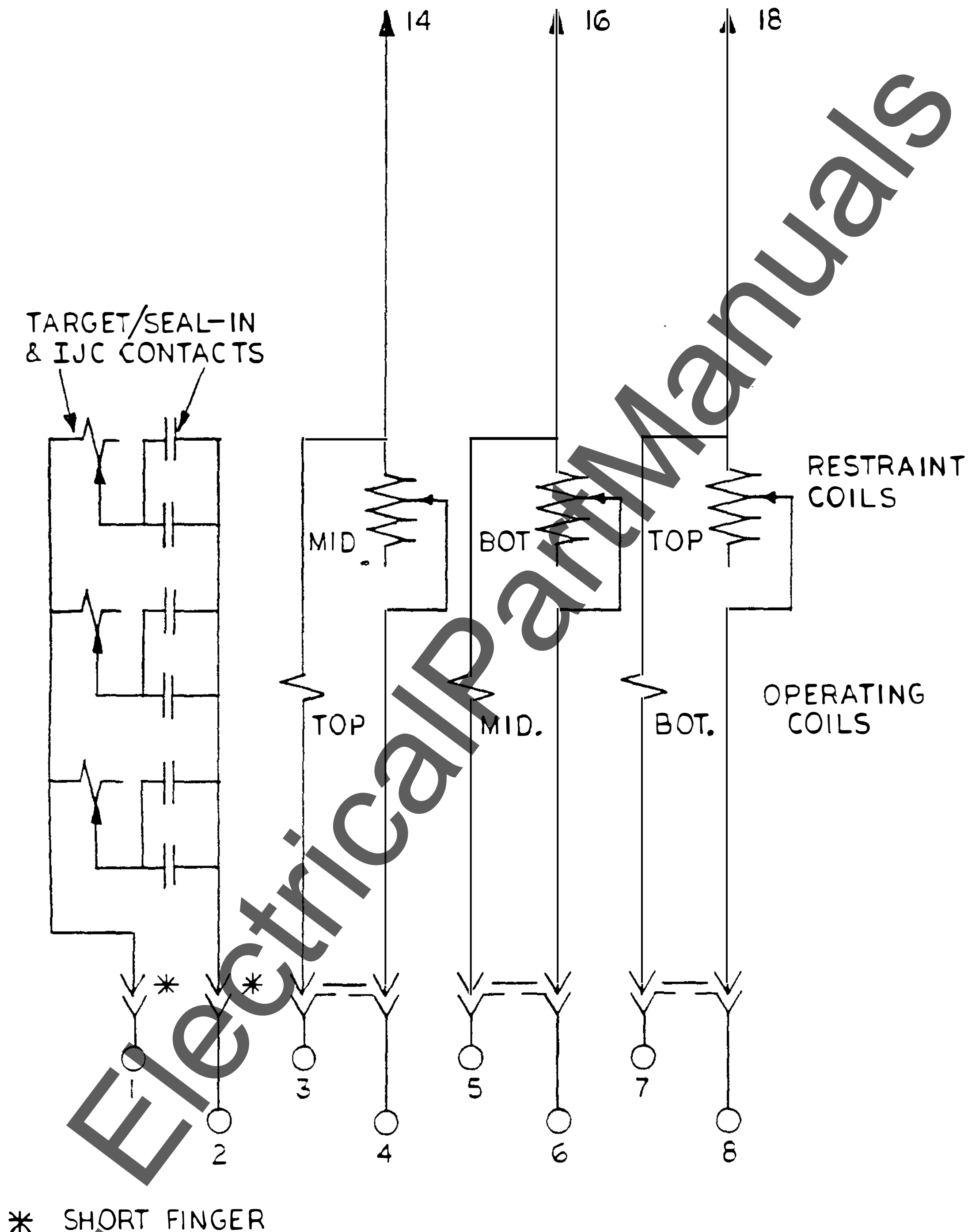
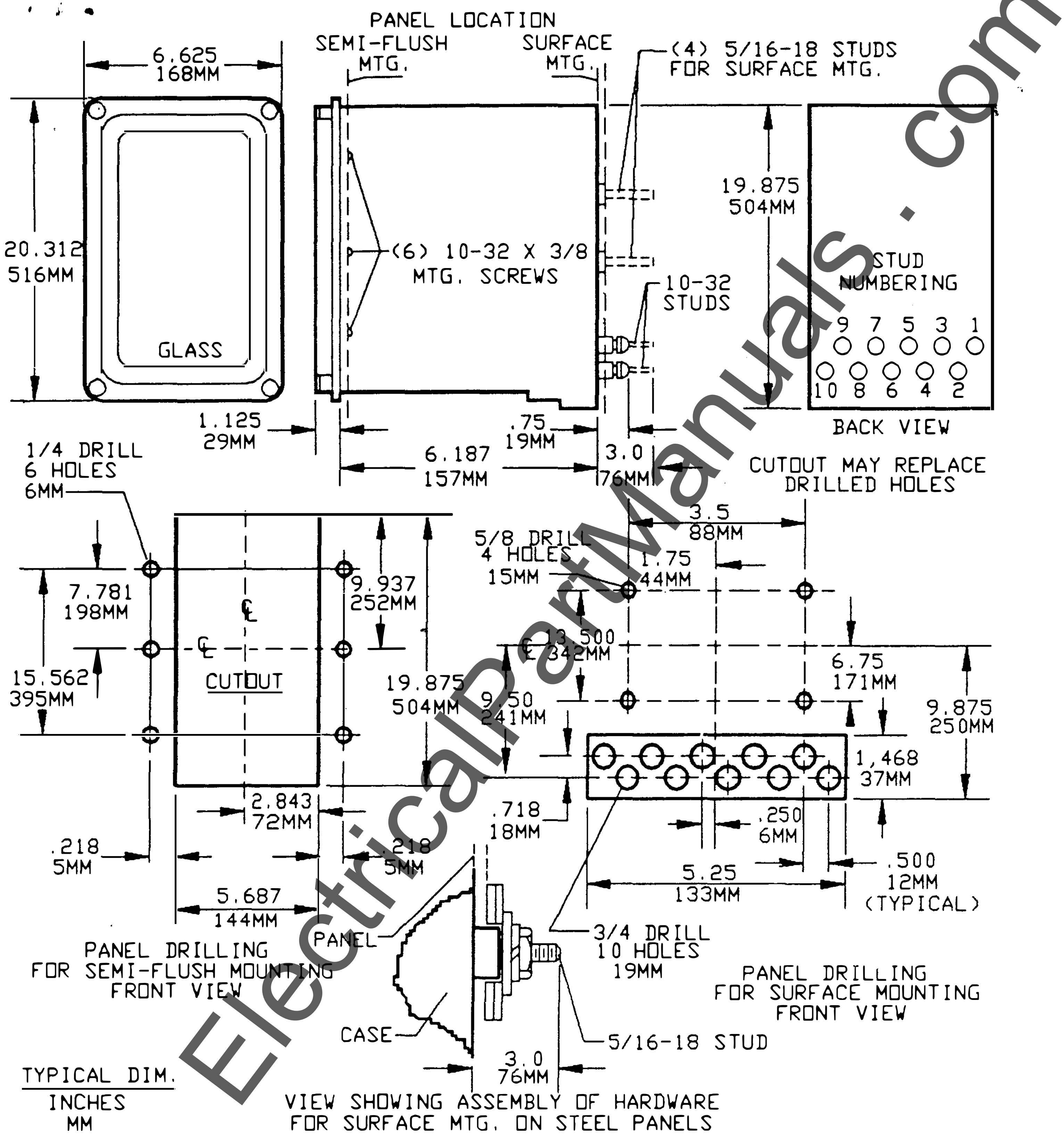
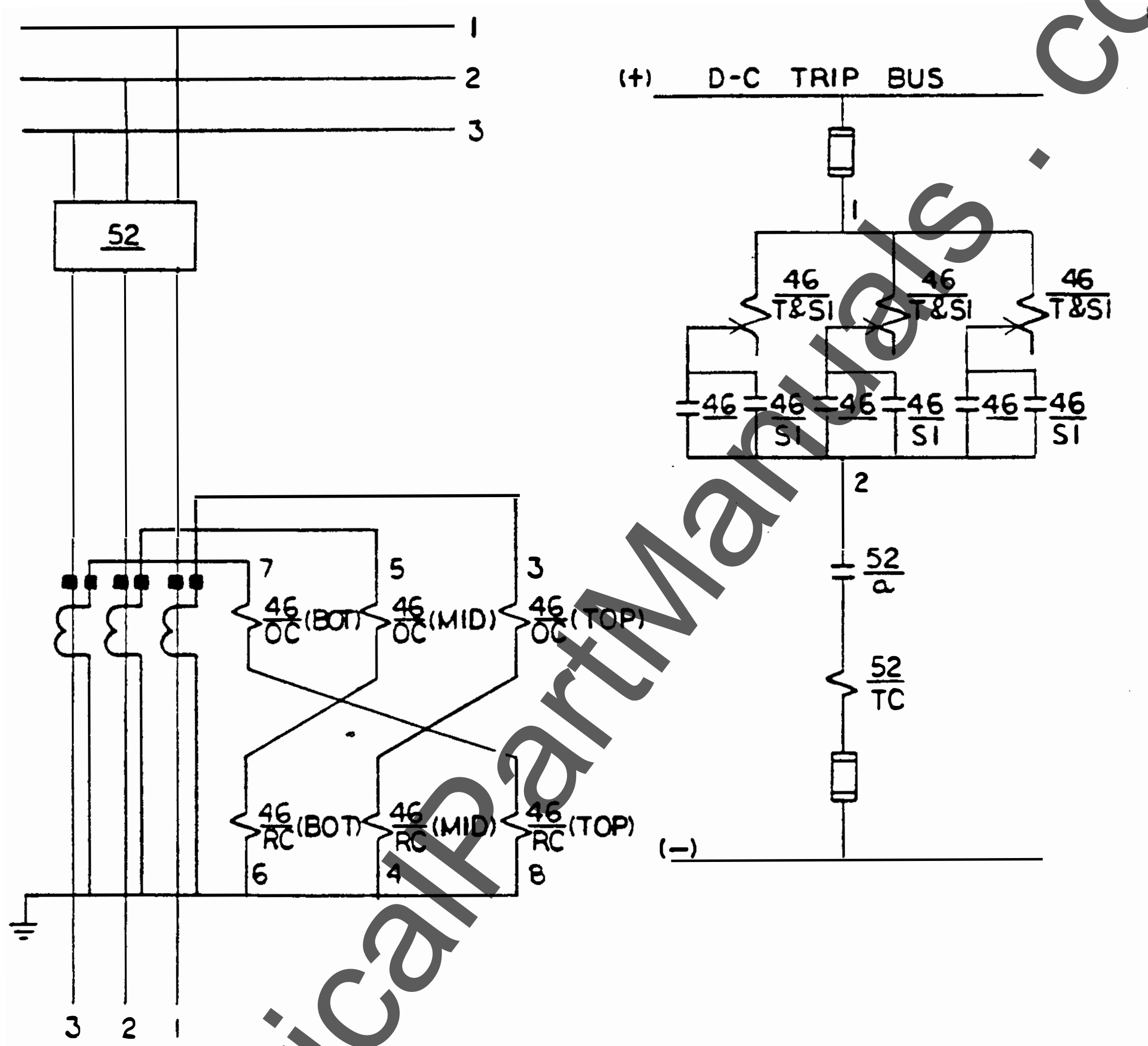


Figure 12 (0285A5621-0) Internal Connections Diagram for the IJC51E Relay



* Figure 13 (6209275-5) Outline and Panel-Drilling Dimensions for the IJC51E Relay

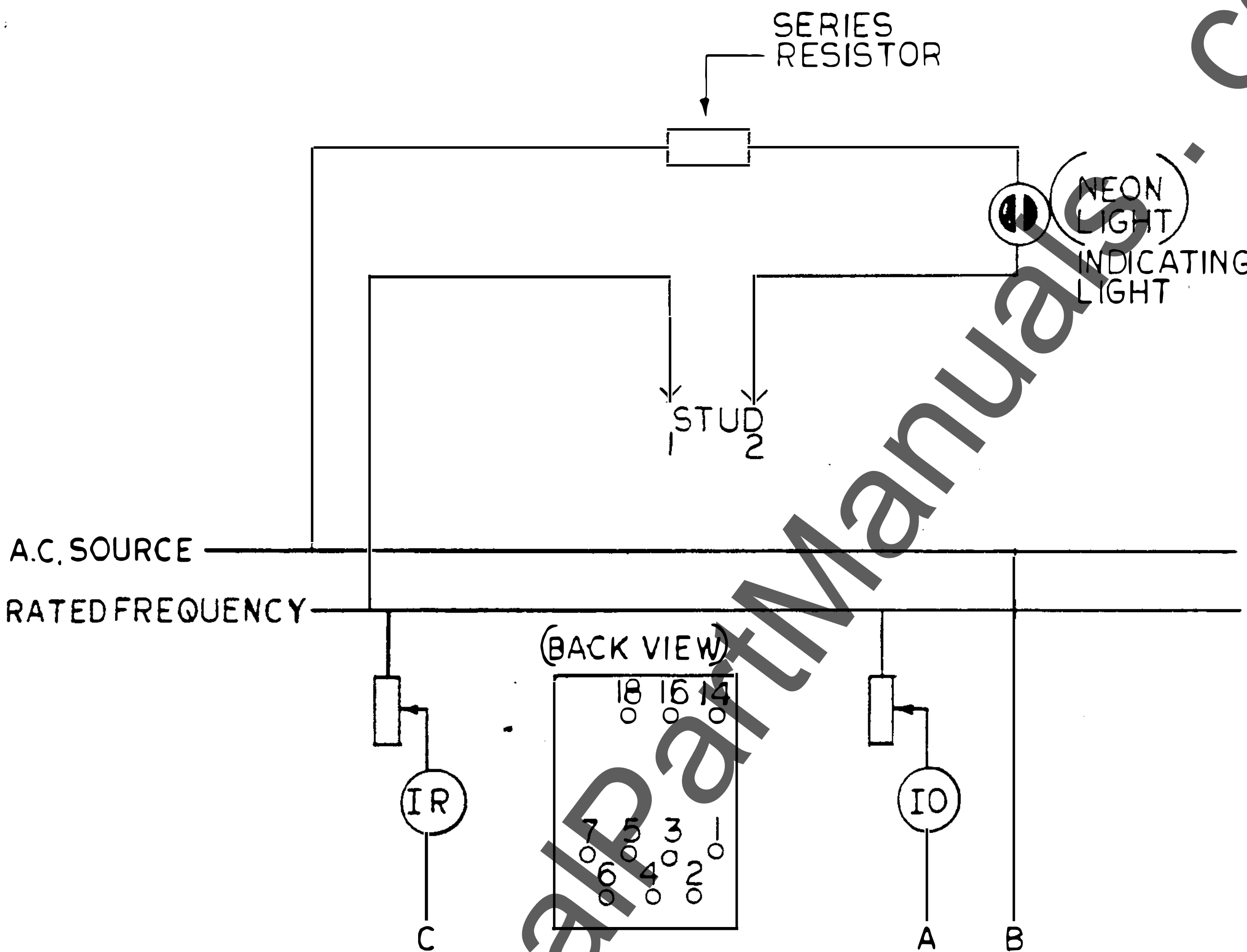
Revised since last issue



DEVICE FUNCTION NUMBERS

52 — POWER CIRCUIT BREAKER
a — AUX. CONTACT, CLOSED WHEN BRKR. IS CLOSED.
TC — TRIP COIL
46 — CURRENT BALANCE RELAY, TYPE IJC51E
OC — OPERATING COIL
RC — RESTRAINING COIL
T&SI — TARGET SEAL-IN

Figure 14 (0285A6789-0) External Connections Diagram for the IJC51E Relay



12 IJC51E(-)A
TEST CONNECTIONS

LEAD	TOP	MID.	BOT.
A	STUD 3	STUD 5	STUD 7
B	STUD 14 TO 18	STUD 14 TO 16	STUD 16 TO 18
C	STUD 8	STUD 4	STUD 6

Figure 15 (0285A5110-1) Test Connections for the IJC51E Relay

(6/91) (500) GENERAL ELECTRIC METER AND CONTROL BUSINESS DEPT., MALVERN, PA 19355