multi-amp CORPORATION

4271 Bronze Way Dallas, Texas 75237-1088 U.S.A.
Ph. (214) 333-3201 Telex 163548 MULAM DL Fax (214) 333-3533

Multi-Amp Canada, 445 Finchdene Square, Scarborough, Ontario, M1X 1B7
Ph. (416) 298-6770 Telex 065-25453 Fax (416) 298-7214

INSTRUCTION MANUAL FOR:

MODEL CTER-83

SERIAL NO._____

Be sure to reference Serial Number in all correspondence.

IMPORTANT

The information and data contained within this instruction manual are proprietary with MULTI-AMP Corporation. The equipment described herein may be protected by one or more U.S. letters patent. MULTI-AMP specifically reserves to itself all rights to such proprietary information as well as all rights under any such patent, none of which is waived by the submission of this instruction manual to anyone.

It is essential that this instruction book be read thoroughly before putting the equipment in service.

Printed in U.S.A.

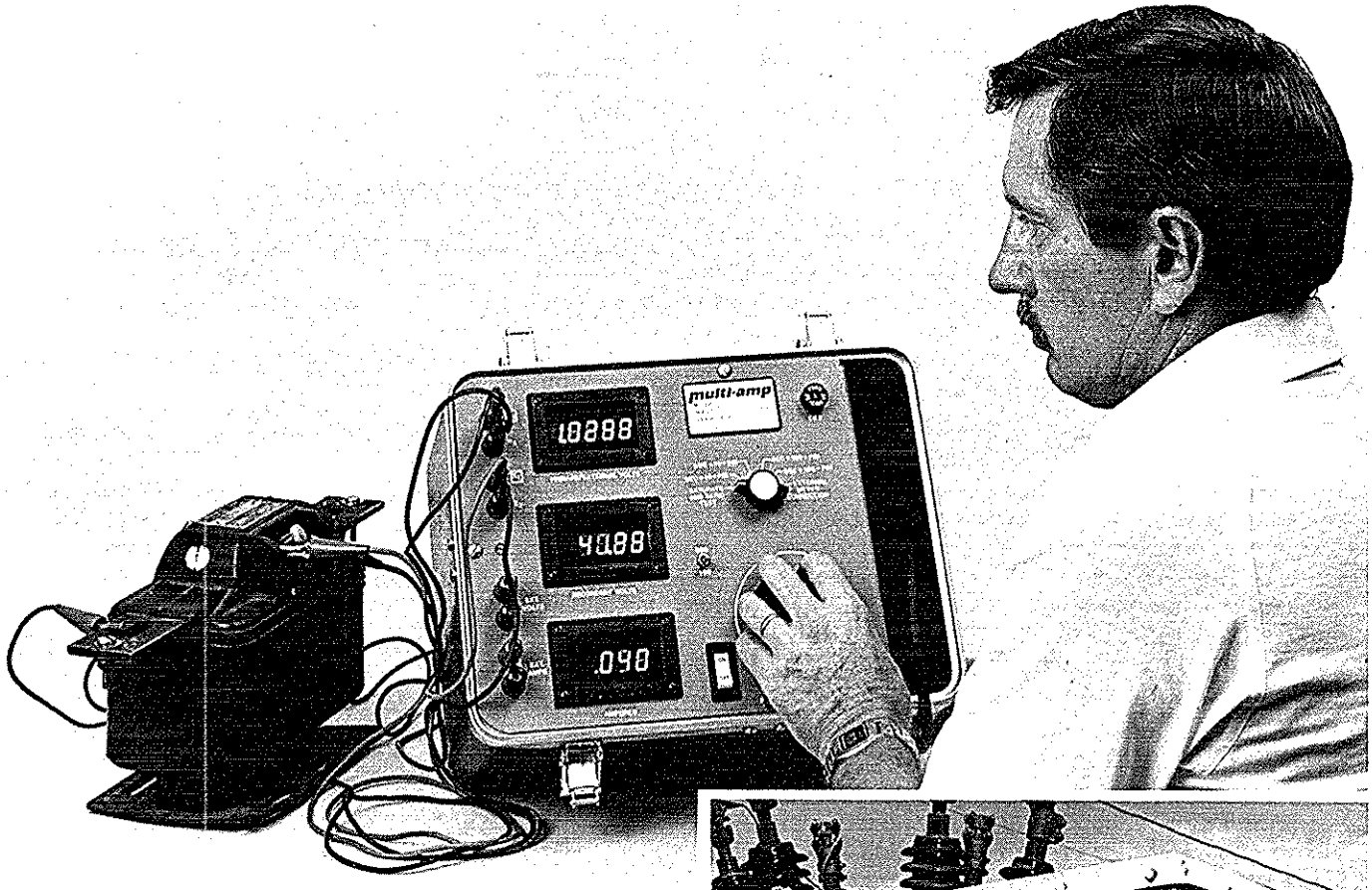
multi-amp CORPORATION

4271 Bronze Way Dallas, Texas 75237-1088 U.S.A.
Ph. (214) 333-3201 Telex 163548 MULAM DL Fax (214) 333-3533

Multi-Amp Canada, 445 Finchdene Square, Scarborough, Ontario, M1X 1B7
Ph. (416) 298-6770 Telex 065-25453 Fax (416) 298-7214

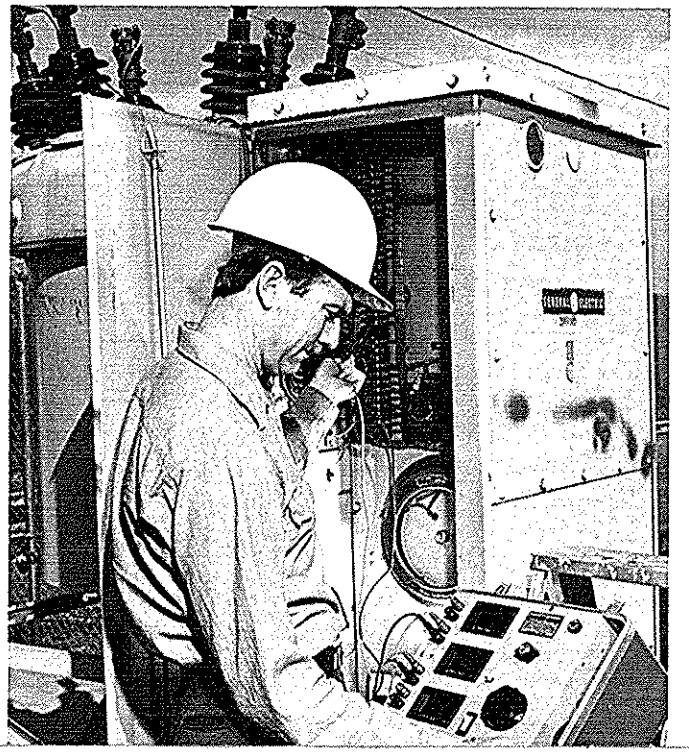
Bulletin 5-CTER-83

CURRENT TRANSFORMER EXCITATION, RATIO AND POLARITY TEST SET
Model CTER-83



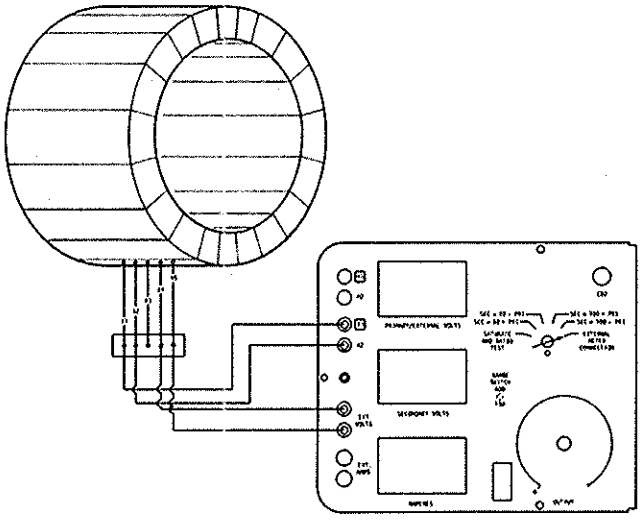
Description

Multi-Amp® Model CTER-83 is a lightweight, portable unit for performing excitation, ratio and polarity tests on current transformers using the voltage comparison method. Utilizing the latest technology, Model CTER-83 provides a variable voltage output and precision instrumentation for testing single and multi-ratio CTs. All three tests — excitation, ratio and polarity — can be performed without changing any leads. Current transformers may be tested in their equipment configuration, such as being **mounted in transformers,** oil circuit breakers or switchgear. This eliminates the need to remove bushings or remove CTs from switchgear. Of course, it is necessary for the equipment to be totally isolated from the electrical system prior to testing.

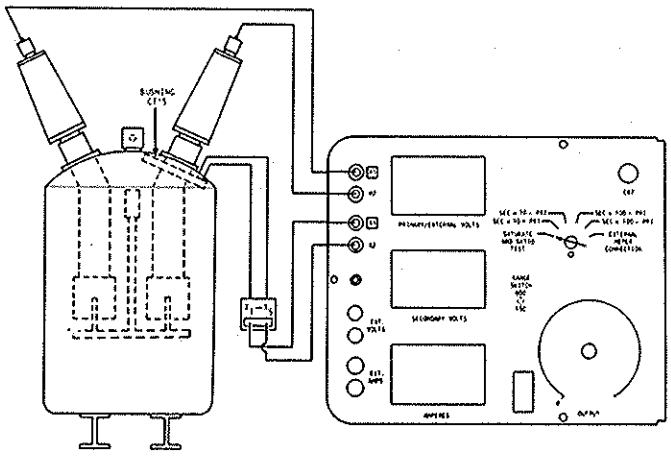


Testing bushing CTs from panel.

(over)



Connections for verifying all ratios of a multi-ratio CT.



Connections for performing saturation, ratio and polarity tests.

Principle of Operation

Saturation Test:
CTER-83 provides a variable voltage output and digital instrumentation which measures exciting voltage and the excitation current which results as the voltage applied to the CT under test is increased. As the CT under test begins to saturate, a large increase in current will be detected for a small increase in voltage.

Ratio Test:
The ratio test is performed by comparing a voltage applied to the secondary winding to the resulting voltage produced on the primary winding. As an example, if one volt per turn is applied to the secondary winding, the voltage present on the primary winding would be one volt. More specifically, if 120 volts is applied to the secondary of 600/5 CT (120:1 ratio), one volt would be present on the primary winding.

Polarity Test:
Polarity of the current transformer under test is determined by special circuitry which divides the voltage applied to the secondary winding by either 10 or 100 (depending on magnitude) and then adds the result to the primary voltage. An increase in magnitude indicates correct polarity and a decrease shows incorrect polarity.

Features

- Bushing CTs can be tested while mounted inside transformers or switchgear.
- Excitation, ratio and polarity tests are all performed without changing test lead connections.
- Digital instruments read exciting current, secondary excitation voltage and primary voltage.
- Overload and short circuit protection is incorporated.
- Voltmeter can be used to measure external voltages up to 600 volts AC.
- Lead compartment for storage of test leads.

Specifications

Input (specify one): 120V, 50/60 Hertz, 1ϕ
OR
240V, 50/60 Hertz, 1ϕ

Output: Continuously variable 0 to 600 volts AC at 1.5 amperes maximum

Voltmeters: Two 4.5-digit autoranging, solid-state instruments
Ranges: 0.0000 to 1.9999/19.999/199.99/600.0 volts
Accuracy: ± 0.25% of reading ± 1 digit.

Ammeter: One 3.5-digit, solid-state instrument
Range: 0.000 to 1.999 amperes
Accuracy: ± 0.85% of reading ± 1 digit.

Interlock: A zero-start interlock is incorporated to minimize the possibility of energizing the CT under test with a sudden high voltage.

Test Leads:
One pair No. 18AWG leads each 5 ft. (1.5m) long, Part No. 1282
One pair No. 18AWG leads each 12 ft. (3.7m) long, Part No. 2997

Housing: The test set is housed in a high-strength, molded suitcase-type enclosure with carrying handle and removable cover. Storage space is provided for test leads.

Dimensions:
Height: 9⅞ in. (25.1 cm)
Width: 14 1/16 in. (35.7 cm)
Depth: 11 5/16 in. (28.7 cm)

Net Weight: 33 lbs. (15 kg.)

Polarity

1. Switch Test Selector Switch to "SEC ÷10 + PRI" position.
2. Slowly increase main power control to a known voltage per turn. Read on the secondary voltmeter. Primary voltmeter should read the voltage being applied divided by ten plus voltage feeding back from the primary.
3. Slowly decrease main power control to zero.
4. Switch Test Selector Switch to "SEC ÷ 10 - PRI" position.
5. Repeat step 2. Primary should read applied voltage divided by 10 minus primary voltage.
6. Slowly decrease main power control to zero. NOTE: For divide by 100 positions, use same procedure.

INSTRUCTION MANUAL FOR CTER-83
CURRENT TRANSFORMER EXCITATION RATIO TEST SET

Controls and Instrumentation

Power ON/OFF	Energize the test set
Output Control	A variable autotransformer with two ranges, 0-150 volts and 0-600 volts which provides continuous control of the output voltage. The variable transformer must be at zero before unit can be initiated.
AC Ammeter	Measures current in the output circuit.
AC Secondary Voltmeter	Measures voltage in the output circuit that is connected to the secondary of the CT under test.
AC Primary Voltmeter	Measures voltage on primary of CT under test.
Selector Switch	Selects desired test to be performed.
X1, X2, H1, H2, Binding Posts	Connects the CT under test to the test set.
External Voltmeter Binding Posts	Enables the primary voltmeter to read an external ac voltage or 0-600 volts when the selector switch is in the exteral voltmeter position.
Range Switch	Selects 150 or 600 volt range.
External Ammeter Binding Posts	Provides a means of connecting an external ammeter in the circuit. It is not to be used to measure an external ac circuit.
CB-2	1 1/2 amp "Push to Reset" breaker which protects the variable transformer.

Description of Tests

Saturation Test

IEEE defines saturation as the maximum value of induced voltage possible in a material.

With the test set secondary binding posts X1 and X2 connected to the CT secondary and the H1 and H2 binding posts connected to the CT primary, increase output observing the ammeter and secondary voltmeter. Increase voltage until a small increase in voltage causes a large increase in current. Most CT's will saturate at 1 amp or less and 600 volts or less.

> Note: It may be necessary to plot a curve to detect the saturation point. See Figure 7 which illustrates typical curves for class C transformers.

Ratio Test

The ratio is defined as the number of turns in the secondary as compared to the number of turns in the primary.

Apply one volt per turn to the secondary of the CT under test. Raise voltage slowly while observing meters. When one volt per turn has been reached on the secondary voltmeter, one volt should appear on the primary meter. If the CT saturates before one volt per turn is reached, apply a voltage of smaller magnitude at some convenient fraction of one volt per turn. (e.g. .5v per turn). The primary voltmeter should read that fraction of a volt. If a multi-ratio CT is being tested, the selector switch can be placed in the "External meter" position. The primary voltmeter can be used to read the voltage between taps on the secondary winding while a known voltage per turn is applied to the winding, either between taps or to the full winding.

> Caution: To protect against insulation failure, do not exceed more than 600 volts on any of the secondary windings of the CT under test.

> Leads should be connected to the test set "external volts" binding posts only when the selector switch is in the "external meter" position.

Polarity Test

Indicates the designation of the relative instantaneous directions of the currents entering the primary terminals and leaving the secondary terminals during most of each 1/2 cycle.

Switch the rotary switch to the "SEC ÷ 10 + primary" position. Raise the secondary voltage to a known voltage per turn or to a percent of volts per turn that will not saturate the CT. Voltage displayed on the primary meter should be secondary voltage divided by 10 plus the primary voltage. Switch the rotary switch to sec ÷ 10 - primary position voltage displayed on the primary meter should be secondary voltage divided by 10 minus primary voltage.

> Example: For a CT with a ratio of 120/1 apply 1/2 voltage or 60 volts. If the polarity is correct the primary meter should read 6.5 which is 60 divided by 10 plus the voltage from the primary winding. Switch the rotary to "SEC ÷ 10 - primary" and reading should be 5.5. The divide by 100 positions may be used in the same manner.
>
> SEC ÷ 100 + Primary = (.6 + .5) = 1.1 volts
> SEC ÷ 100 - Primary = (.6 - .5) - .1 volts

TEST PROCEDURES

CAUTION: For operator and equipment saftey, make sure current transformers are de-energized before any testing is started.

Refer to Figures 1 through 6 for test connections.

Types of Tests

Saturation
Ratio
Polarity

SET-UP OF CONTROLS BEFORE TESTING

Control	Position
Power ON/OFF	OFF
Output Control	Zero (counterclockwise)
Test Selector Switch (Rotary)	Saturate and ratio test
Range Switch	As required

Saturation Test

1. Connect the test set to a suitable source of power (as indicated on the nameplate), and ground. Be sure that the Power ON switch is OFF.
2. Connect the test set secondary output binding post X1 and X2 to secondary of current transformer X1 and X2. Observe polarity marks on CT. (X1 is polarity.)
3. Connect test set primary binding posts H1 and H2 to CT primary busings H1 and H2. Observe polarity marks. (H1 is polarity.)
4. Turn "Power ON Switch" ON.
5. Slowly increase main power control observing ammeter and voltmeter secondary. When a very small increase in voltage causes a large increase in current, the CT has reached the saturation point. (Usually less than one amp.) Record voltage and current readings.
6. Slowly decrease main power control to zero.

Ratio

1. Slowly increase main power control applying 1 volt per turn to the transformer under test. When correct value is read on secondary voltmeter, one volt should appear on primary voltmeter. (Note: If CT saturates, apply a fraction of a volt per turn.) That fraction of a volt should then appear on the primary voltmeter.
2. Slowly decrease main power control to zero.

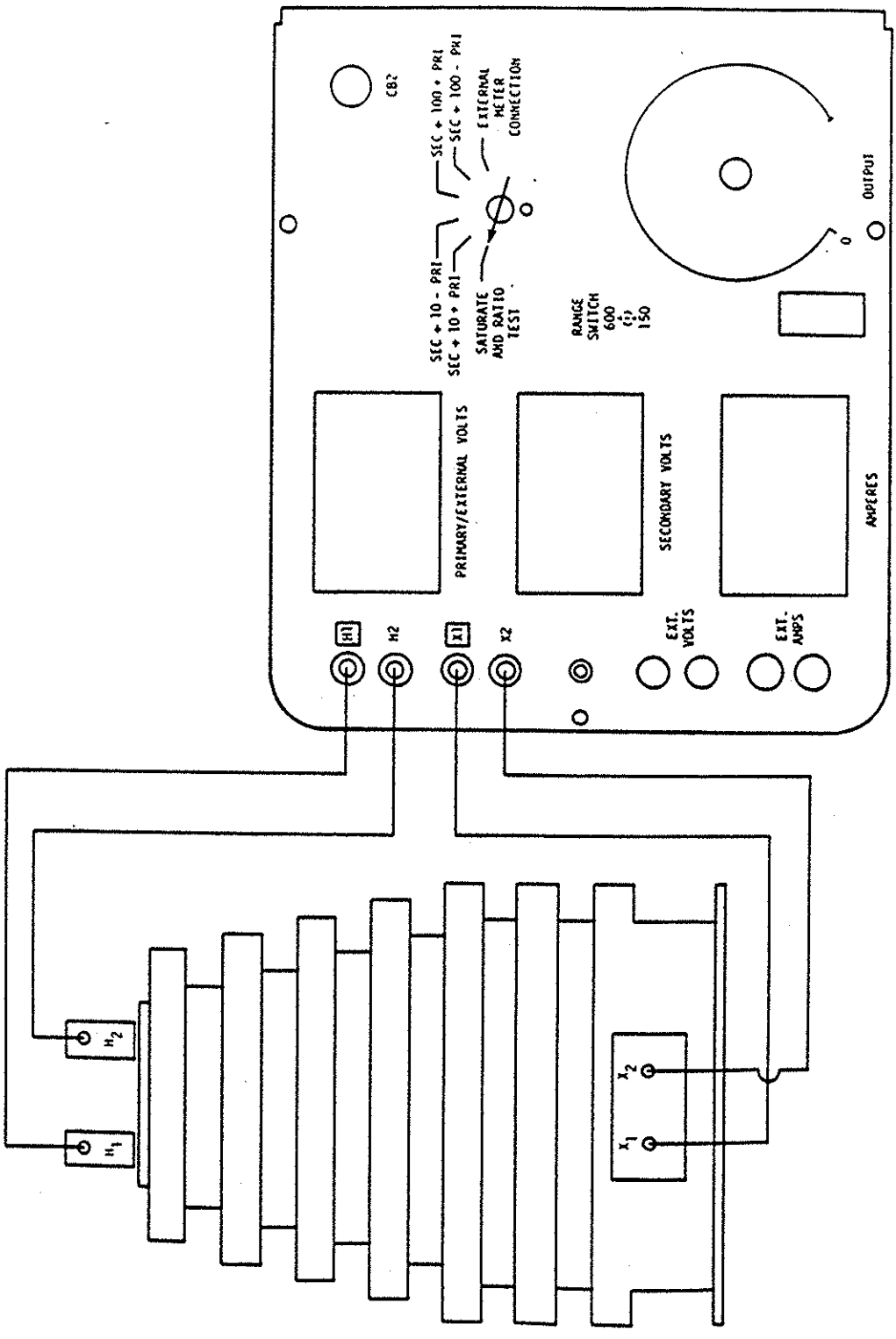


FIGURE 1

SATURATE AND RATIO TEST

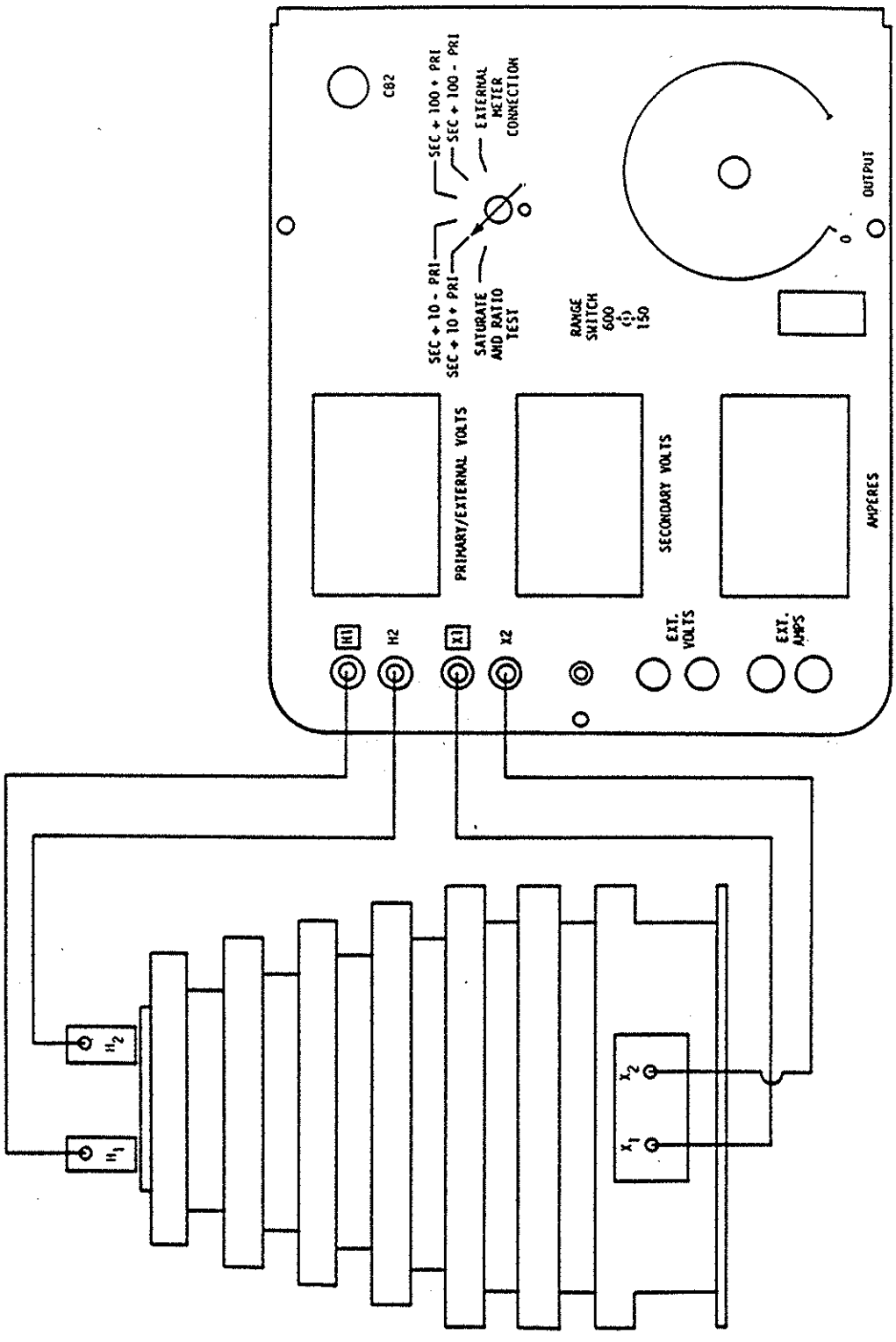


FIGURE 2

POLARITY TEST

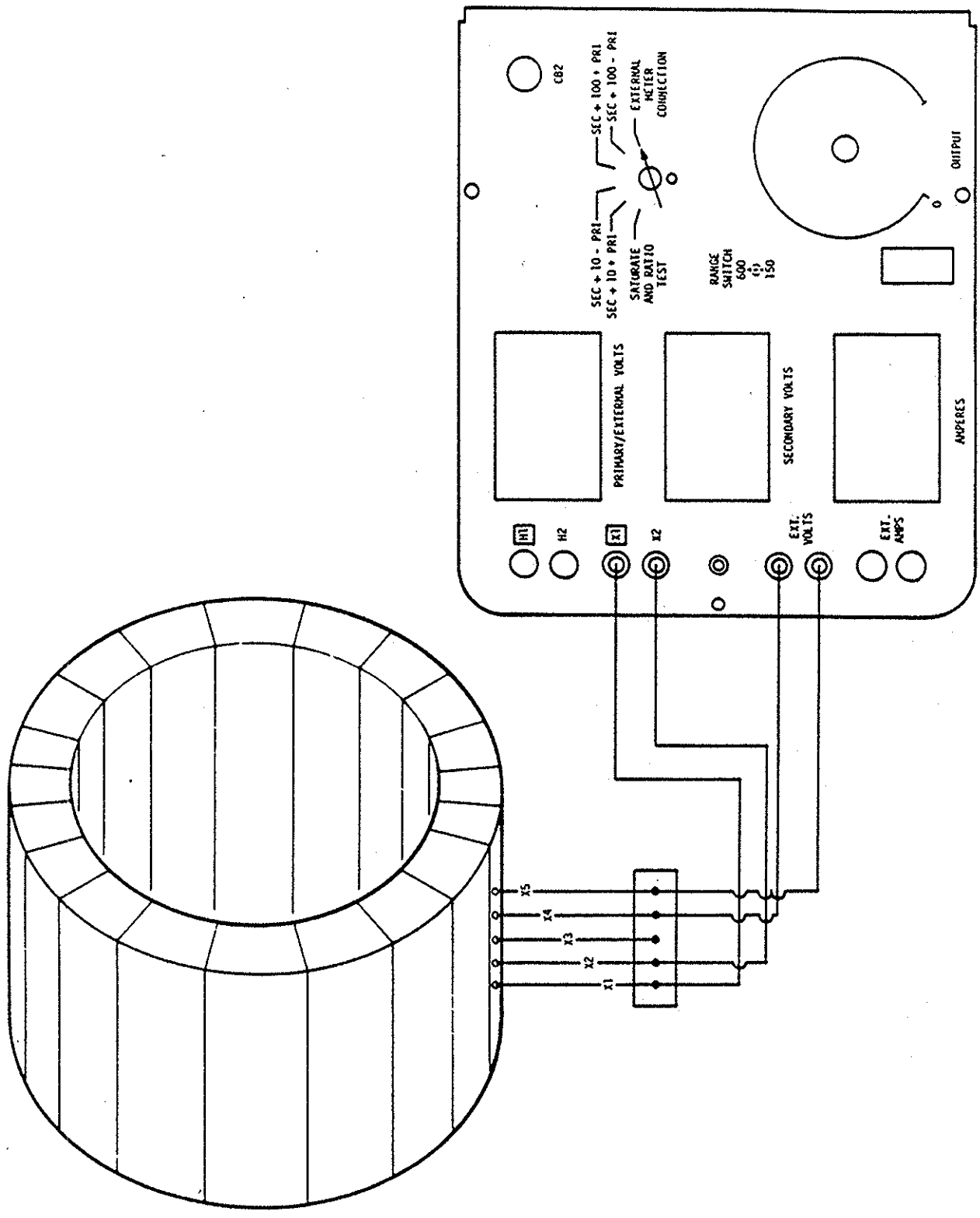


FIGURE 3

MULTI-RATIO CT TEST

Bushing CT's can be tested in a de-energized circuit breaker which has been totally isolated from the power system. The breaker must be closed to perform ratio and polarity tests.

Note: The breaker does not have to be closed to perform the voltage tests. See figure 3.

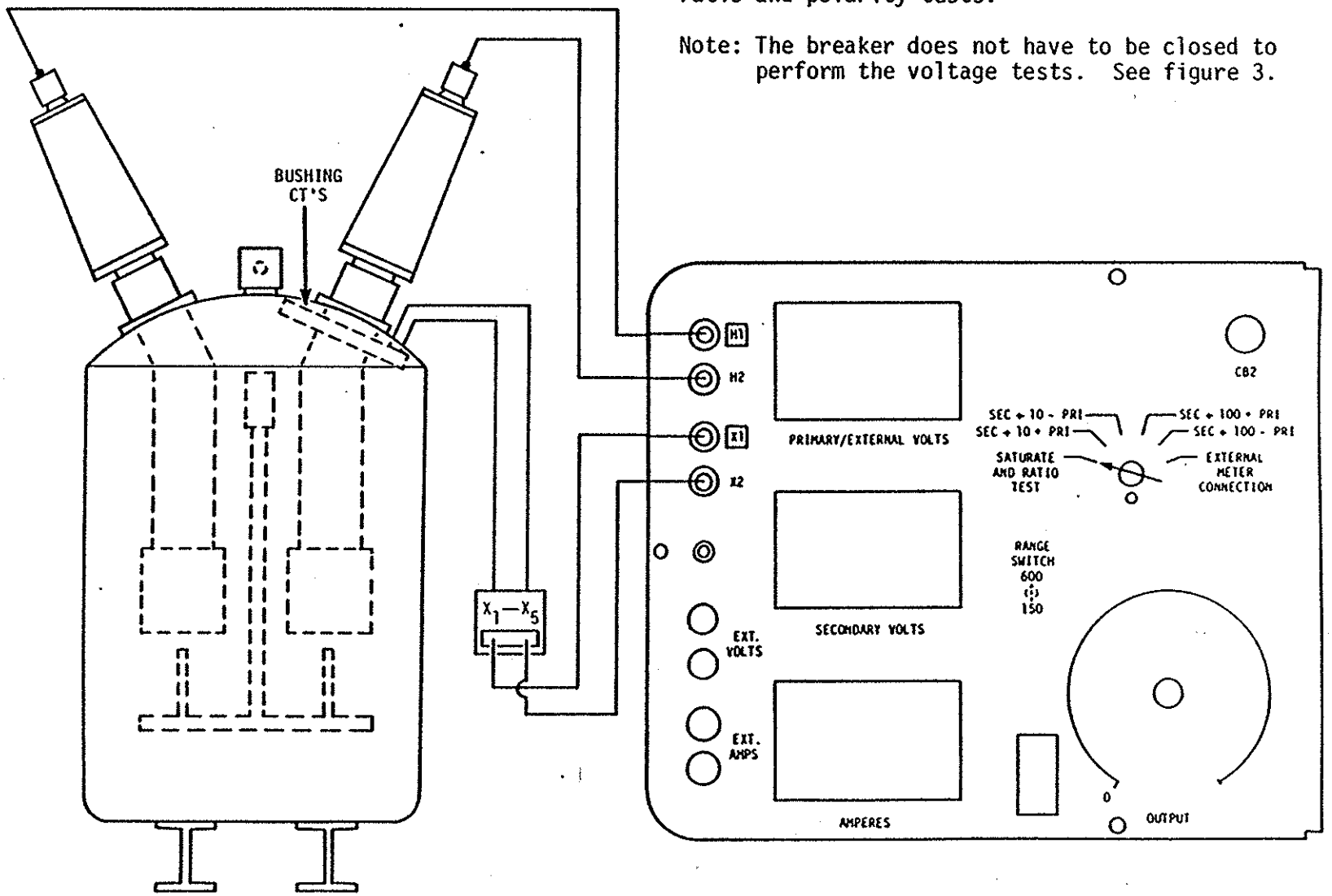


FIGURE 4

Bushing CT's can be tested in a de-energized power transformer which has been totally isolated from the power system. CT secondary leads will normally terminate in the control cabinet. Refer to the chart on figure 6 for connections.

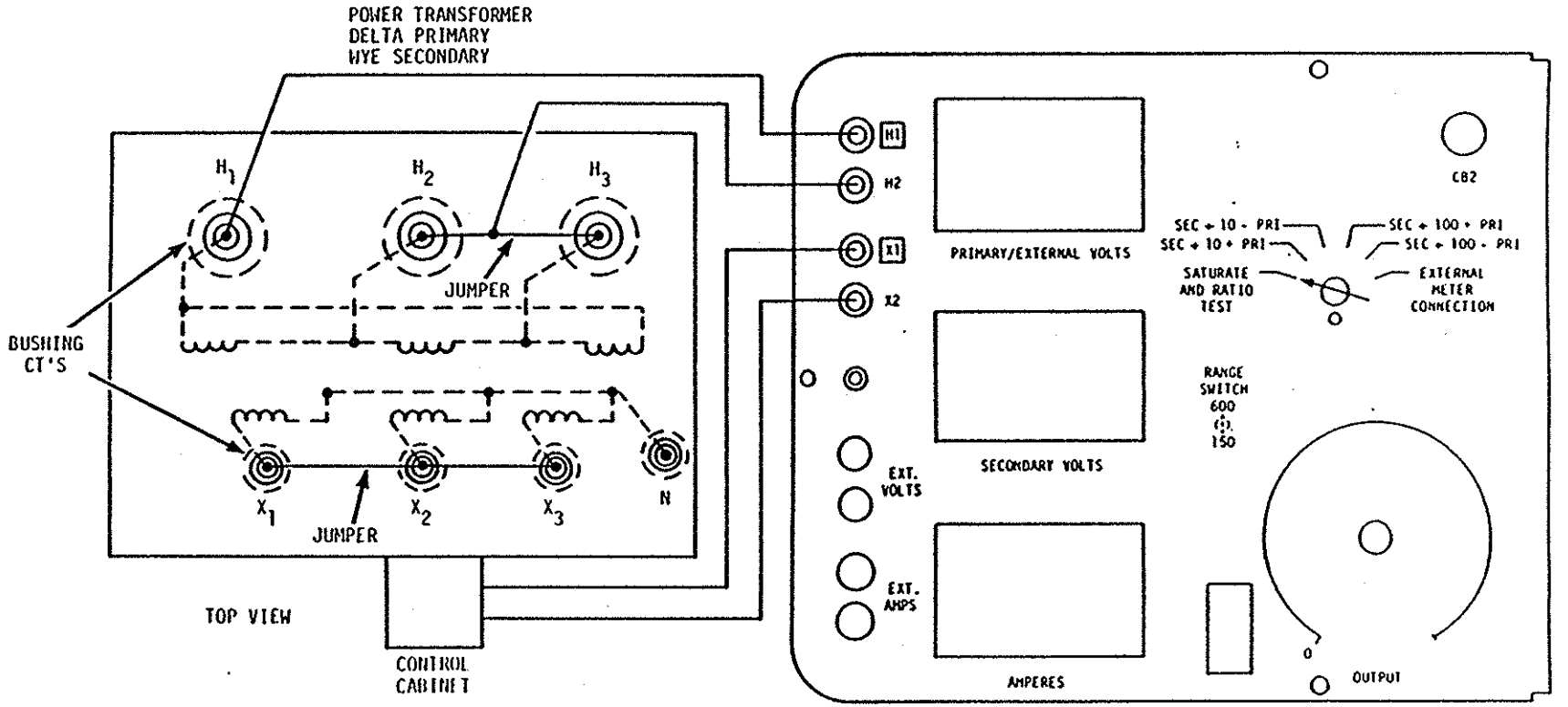


FIGURE 5

CT LOCATION	TESTS SET CONNECTIONS X1 X2	H1	H2	JUMPERS
H1 Bushing	Secondary of H1 CT located in control cabinet	H1 Bushing	H2 Bushing	H2 - H3 X1 - X2 - X3
H2 Bushing	Secondary of H2 CT located in control cabinet	H2 Bushing	H3 Bushing	H3 - H1 X1 - X2 - X3
H3 Bushing	Secondary of H3 CT located in control cabinet	H3 Bushing	H1 Bushing	H1 - H2 X1 - X2 - X3
X1 Bushing	Secondary of X1 CT located in control cabinet	X1 Bushing	Neutral Bushing	H1 - H2 - H3
X2 Bushing	Secondary of X2 CT located in control cabinet	X2 Bushing	Neutral Bushing	H1 - H2 - H3
X3 Bushing	Secondary of X3 CT located in control cabinet	X3 Bushing	Neutral Bushing	H1 - H2 - H3

Figure 6

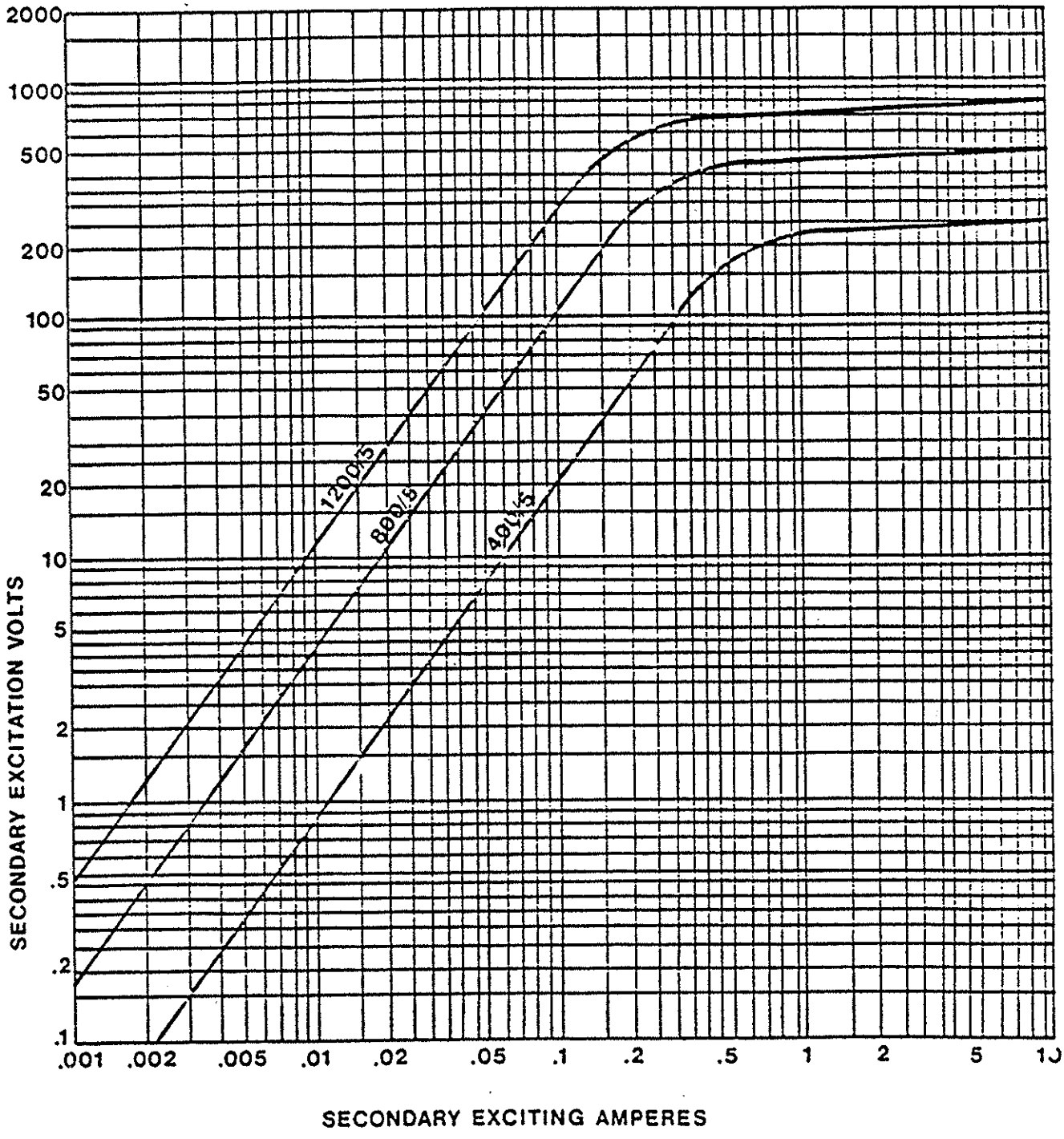
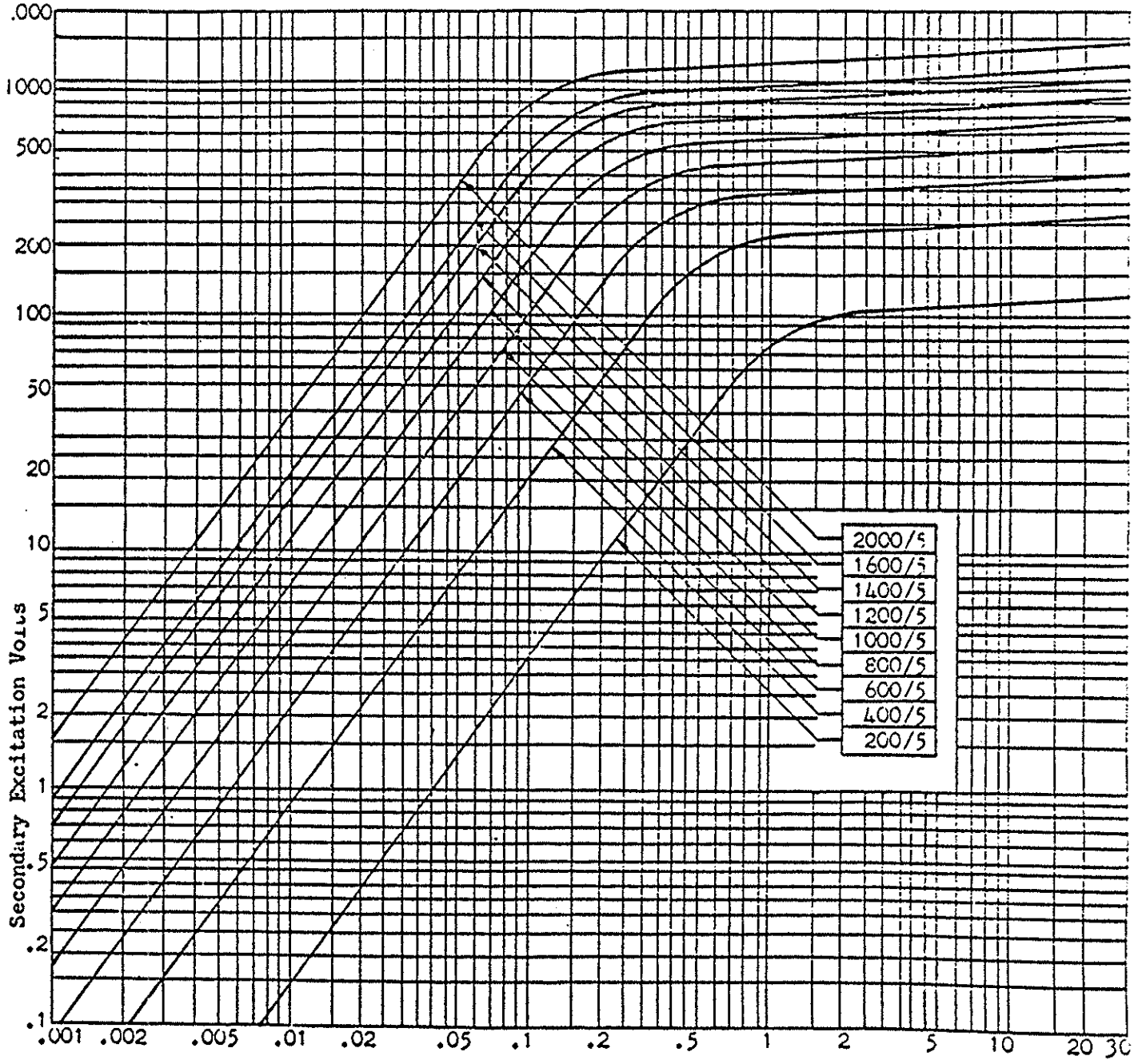

2000
1000
500
200
100
50
20
10
5
2
1
.5
.2
.1
SECONDARY EXCITATION VOLTS
1200/5
800/5
400/5
.001
.002
.005
.01
.02
.05
.1
.2
.5
1
2
5
10
SECONDARY EXCITING AMPERES

Fig. 7



Secondary Exciting Amperes

Maximum Ratio - 2000/5 ASA Accuracy - 10L800

Typical CT Exciting Current Curves.

Figure 4.

Saturation Test.

This test considers the CT as a reactor. Voltage is applied to the secondary winding and the exciting current is measured. The voltage is raised until the CT saturates if this is within the capability of the test equipment.

The test leads should be connected to the CT secondary leads at the terminal block closest to the CT's. All wiring to the burden or switchboard must be disconnected and pulled clear to prevent high test voltages from endangering personnel or damaging equipment.

Using a Variac to control the voltage into a 240/480 or 120/480 volt test transformer, connect the 480 volt winding of the transformer to the *full winding* of a CT. Apply voltage in increasing steps, measuring the exciting current at each step. For these measurements, the ammeter must be connected directly in series with the CT secondary, so that it reads the CT exciting current only. The voltmeter must be connected between the 480 volt winding and the ammeter, *not* between the ammeter and the CT. Plot the results on log-log paper. The plot will be a straight line as long as the CT has not saturated. Continue to raise the voltage until either the CT starts to saturate or 500 volts is reached. CT's used in a PVD bus differential scheme must be tested to at least 300 volts.

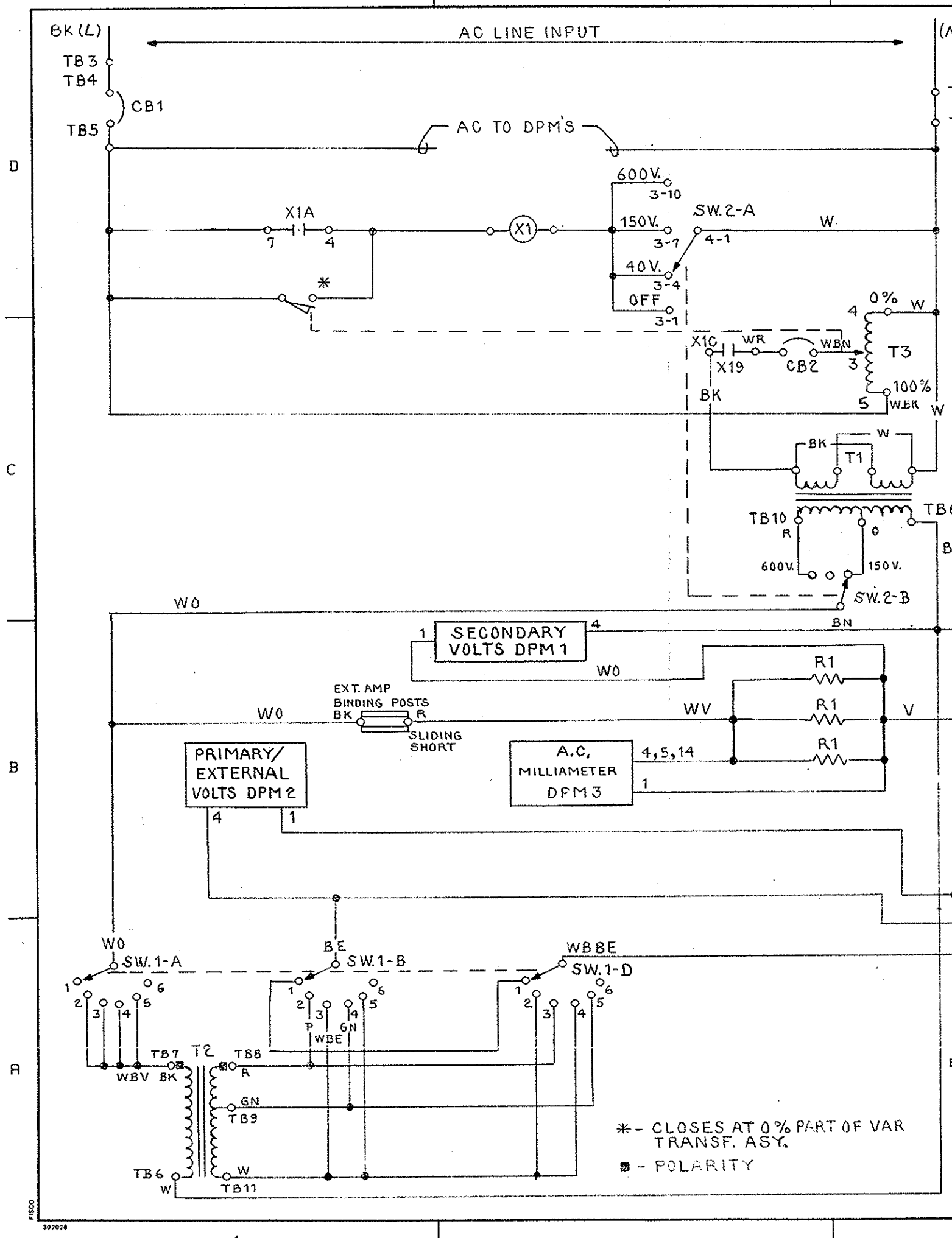
If the CT has not saturated before maximum test voltage is reached, reconnect the test leads to the CT taps giving half ratio (e.g., 1000/5 taps on a 2000/5 full ratio CT). Repeat the test, increasing voltage and recording the voltage and current until saturation is reached. Be aware that the CT secondary acts as an auto-transformer, and that double the applied voltage will appear across the full CT winding during this test.

When the highest test voltage has been reached on any CT, the voltage *must* be *gradually* reduced to zero over a period of several seconds to prevent leaving residual magnetism in the CT core. Residual magnetism can cause poor CT performance, including saturation at low current values during faults. The plotted excitation curve should be compared with the manufacturer's curve for that type of CT, or with a previous test curve. A typical set of excitation curves for a CT is shown in Figure 4. The accuracy class of the CT gives a rough approximation of the voltage at which the CT will saturate. For example, a 2000/5 multi-ratio CT rated 10L800 will saturate at around 800 volts on the full winding (2000/5 ratio). If connected 1000/5, it will saturate at around 400 volts.

A CT which saturates at a voltage lower than normal is faulty. Raise the voltage to drive the CT well into saturation and then gradually reduce the voltage to zero to remove any residual magnetism which may have been present. If the CT still tests bad, it must be replaced.

If the current into the CT is higher than normal excitation current at a given voltage, look for extraneous conducting loops around the CT core. The problem may be caused by personal grounds on both sides of the CT primary, allowing current to circulate in the primary. It is also possible that CT mounting clamps on bushing or slip-on CT's are improperly installed, allowing current to circulate through a metallic path around the CT core.

When the saturation tests are complete, be sure to reconnect the lifted leads. If any doubt exists as to where each lead should be connected, ratio and/or load checks must be conducted to prove correct reconnection.



DWG. NO. 20594C		
REVISIONS		
REV	ECN	DATE
1	13899	8-18-83
2	14822	2-17-84
3	15105	3-27-84
4	16576	2-5-85
5	18748	1-29-86
6	21405	3-18-88
7	21574	6-23-88
8	21701	10-4-88
9	23065	10-8-90

REF DES	PART NO	DESCRIPTION	QTY
X1	3849	RELAY 3P DT 120V.AC 10A.	1
	8914	ASY. WIRE HARNESS CTER-83	1
TB	190	TERM. BLK. 15P, 20A. 671-15	1
* T3	9891	TRANSF. VAR. ASY. 0 START 240V.	1
* T3	8829	VAR. ASY. 0 START 120V.	1
T2	8828	RATIO	1
T1	8827	TRANSF. ISOLATION 120/600V.	1
SW.2	8125	SWITCH 2 P DT	1
SW.1	709	SWITCH 4 P 6 POS. 30°	1
R1	8861	RESISTOR 30.1Ω 30 W.	3
DPM3	9372	DPM ASY. - AC MILLIAMPS AUTO	1
DPM1,2	9056	DPM ASY. - AC VOLTS AUTO	1
CB2	8836	CKT. BKR. HEINEMANN KD1-5	1
CB1	8173	CKT. BKR. 1P 10A	1

multi-amp CORPORATION
(214) 333-3281
4271 BRONZE WAY DALLAS, TEXAS 75237

DWN. RMD	APPD. Paul Rumsey	SCALE NONE
CHKD.	DATE 7-13-88	SH. 1 OF 1

TITLE: SCHEMATIC CTER-83

PART NO. | DWG. NO. 20594C | REV 9

302028