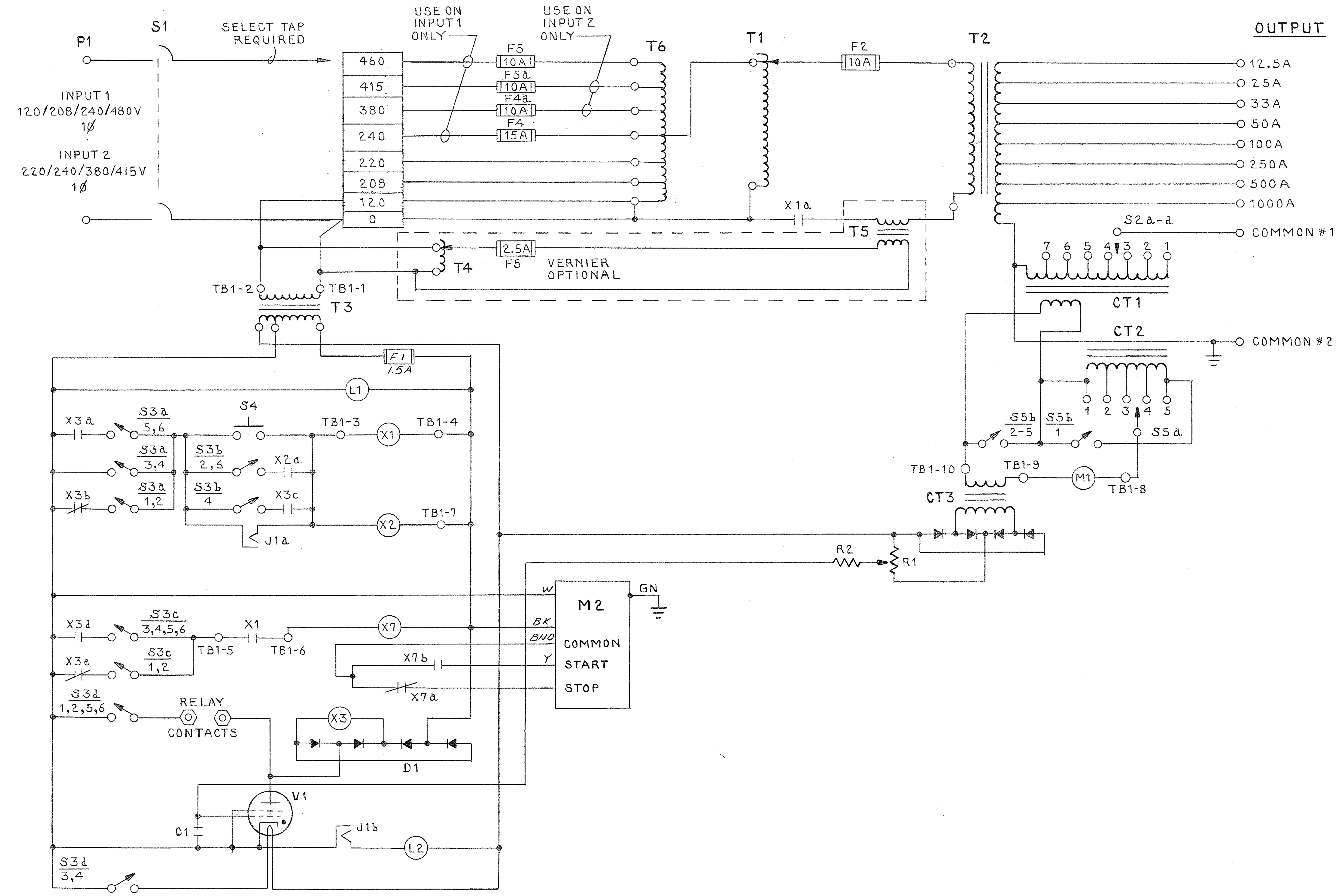
| DWG. NO. | 12309D | | |
|---|---|---|---|
| REV. | E.C.N. | DATE | REMARKS |
| 8 | 13928 | 8-23-83 | REDRAW FROM C TO D SIZE |
| 9 | 14175 | 9-27-83 | CHG. BOOST TRANS |
| 10 | 20751 | 7-6-87 | CORR X1, X7 |




AMMETER RANGE

| S2-COMMON 1 | S5-COMMON 2 |
|---|---|
| POS. 1-2.5A. | 1-COMMON 1 |
| 2-5A. | 2-250A. |
| 3-10A. | 3-600A. |
| 4-25A. | 4-1000A. |
| 5-50A. | 5-2500A. |
| 6-100A. | |
| 7-COMMON 2 | |

S4 TIMER OPERATIONAL SELECTOR SWITCH

POS. 1-N.O.-MOM.
2-N.O.-MAINT.
3-C.A.-MOM.
4-C.A.-MAINT.
5-N.C.-MOM.
6-N.C.-MAINT.

| ITEM | PART NO. | DESCRIPTION |
|---|---|---|
| X7 | 3848 | SEAL IN RELAY |
| X3 | 3849 | CURRENT ACTUATOR RELAY |
| X2 | 3848 | RELAY |
| X1 | 840 | CONTACTOR |
| V1 | 1 | THYRATRON |
| T6 | 4478 | INPUT AUTOTRANSFORMER |
| T5 | 6068 | VERNIER TRANSFORMER |
| T4 | 2683A | VARIABLE AUTOTRANSF. "VERN" |
| T3 | 6043 | CONTROL TRANSFORMER |
| T2 | 604 | OUTPUT TRANSFORMER |
| T1 | 611 | VARIABLE AUTOTRANSF. "MAIN" |
| S5 | 708 | AMMETER RANGE SWITCH |
| S4 | 73 | INITIATING SWITCH |
| S3 | 776 | TIMER OPERATION SELECTOR SW. |
| S2 | 64 | AMMETER RANGE SWITCH |
| S1 | 3398 | CIRCUIT BREAKER |
| R2 | 1252 | GRID RESISTOR |
| R1 | 1268 | POTENTIOMETER |
| P1 | 1297 | INPUT SOCKET |
| M2 | 581A | TIMER |
| M1 | 519A | AMMETER |
| L2 | 28/29 | INDICATOR LIGHT "CONTINUITY" |
| L1 | 3/6 | INDICATOR LIGHT "POWER ON" |
| J1 | 1287 | JACK |
| F4a,5,5a | 926 | FUSE 10A |
| F4 | 798 | 15A |
| F3,4 | 924 | HOLDER |
| F2 | 961 | |
| F1,5 | 949 | FUSE HOLDER |
| D1 | 2204 | RECTIFIER ASSEMBLY |
| CT3 | 6099 | C.A. CURRENT TRANSF. |
| CT2 | 6083 | HIGH RANGE TRANSF. |
| CT1 | 6122 | LOW RANGE CURRENT TRANSF. |
| C1 | 1301 | CAPACITOR |
| B1 | 1355 | BRIDGE RECTIFIER |

**multi-amp** CORPORATION
4271 BRONZE WAY, DALLAS, TEXAS 75237 (214) 333-3201

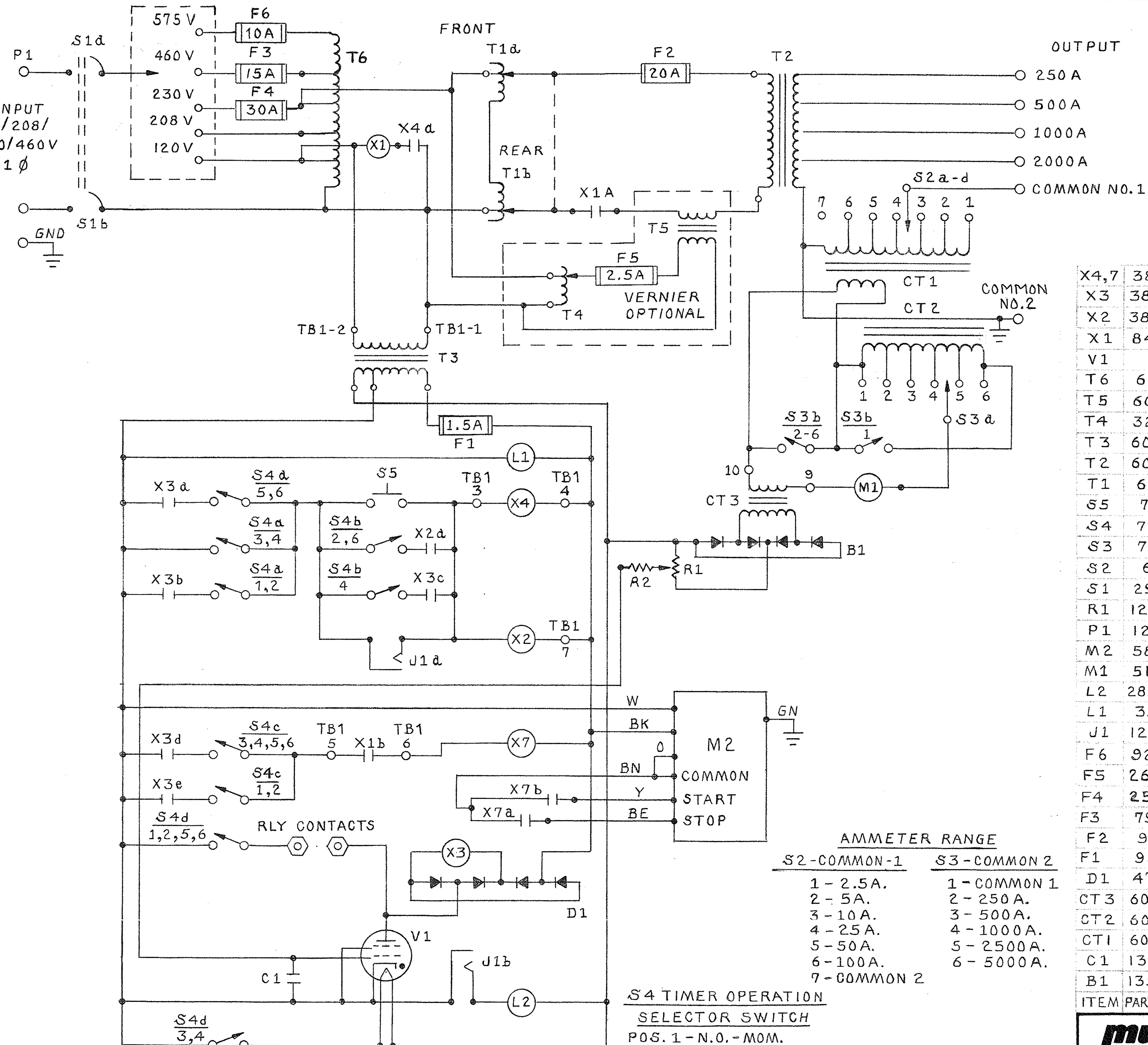
TOLERANCES: DECIMAL ±.010 FRACTIONAL ±1/64 UNLESS NOTED | DWN. RMD | APPD. | SCALE: N
CHKD. | DATE 8-24-83 | SH. 1 OF 1

TITLE SCHEMATIC CB-7110

PART NO. INPUT: 120/208/240/480V. 220/240/380/415V. | DWG. NO. 12309D | REV. 10



12309D 1 of 1 10




AMMETER RANGE

| S2-COMMON-1 | S3-COMMON 2 |
|---|---|
| 1 - 2.5A. | 1 - COMMON 1 |
| 2 - 5A. | 2 - 250A. |
| 3 - 10A. | 3 - 500A. |
| 4 - 25A. | 4 - 1000A. |
| 5 - 50A. | 5 - 2500A. |
| 6 - 100A. | 6 - 5000A. |
| 7 - COMMON 2 | |

S4 TIMER OPERATION SELECTOR SWITCH

POS. 1 - N.O. - MOM.
2 - N.O. - MAINT.
3 - C.A. - MOM.
4 - C.A. - MAINT.
5 - N.C. - MOM.
6 - N.C. - MAINT.

DWG. NO. 12317 C

| REV. | ECN | DATE | REV. | ECN | DATE |
|---|---|---|---|---|---|
| 1 | — — | 2-7-73 | 7 | 20298 | 2-7-87 |
| 2 | 1295 | — — — | 8 | 22170 | 8-10-89 |
| 3 | 4022 | 8-14-78 | 9 | 22735 | 5 7 90 |
| 4 | 5329 | 4-23-80 | 10 | 23115 | 10 12 90 |
| 5 | 10085 | 8-26-81 | 11 | 24081 | 12 3 91 |
| 6 | 17251 | 5-3-85 | | | |

| ITEM | PART NO. | DESCRIPTION |
|---|---|---|
| X4,7 | 3848 | SEAL-IN RELAY |
| X3 | 3849 | CURRENT ACTUATOR RELAY |
| X2 | 3848 | AUXILIARY RELAY |
| X1 | 840 | CONTACTOR |
| V1 | 1 | THYRATION |
| T6 | 6061 | INPUT AUTOTRANSFORMER |
| T5 | 6066 | VERNIER TRANSFORMER |
| T4 | 3294 | VARIABLE AUTOTRANSF. |
| T3 | 6043 | CONTROL TRANSFORMER |
| T2 | 6091 | OUTPUT TRANSFORMER |
| T1 | 614 | VARIABLE AUTOTRANSF. "MAIN" |
| S5 | 73 | INITIATING SWITCH |
| S4 | 776 | TIMER OPERATION SELECTOR SW. |
| S3 | 708 | AMMETER RANGE SWITCH |
| S2 | 64 | AMMETER RANGE SWITCH |
| S1 | 2977 | CIRCUIT-BREAKER |
| R1 | 1268 | POTENTIOMETER |
| P1 | 1281 | INPUT SOCKET |
| M2 | 581A | TIMER (DIGITAL) |
| M1 | 519A | AMMETER |
| L2 | 28/29 | INDICATOR LIGHT "CONTINUITY" |
| L1 | 3/6 | INDICATOR LIGHT "POWER ON" |
| J1 | 1287 | JACK |
| F6 | 926 | FUSE 10A 600V. |
| F5 | 2632 | 2.5A MDA 250V. |
| F4 | 2595 | 30A FRS 600V. |
| F3 | 798 | 15A |
| F2 | 980 | 20A |
| F1 | 950 | FUSE 1.5A |
| D1 | 4708 | RECTIFIER BRIDGE |
| CT3 | 6099 | C.A. CURRENT TRANSFORMER |
| CT2 | 6084 | HIGH RANGE CURRENT TRANSF. |
| CT1 | 6040 | LOW RANGE CURRENT TRANSF. |
| C1 | 1301 | CAPACITOR |
| B1 | 1355 | BRIDGE RECTIFIER |



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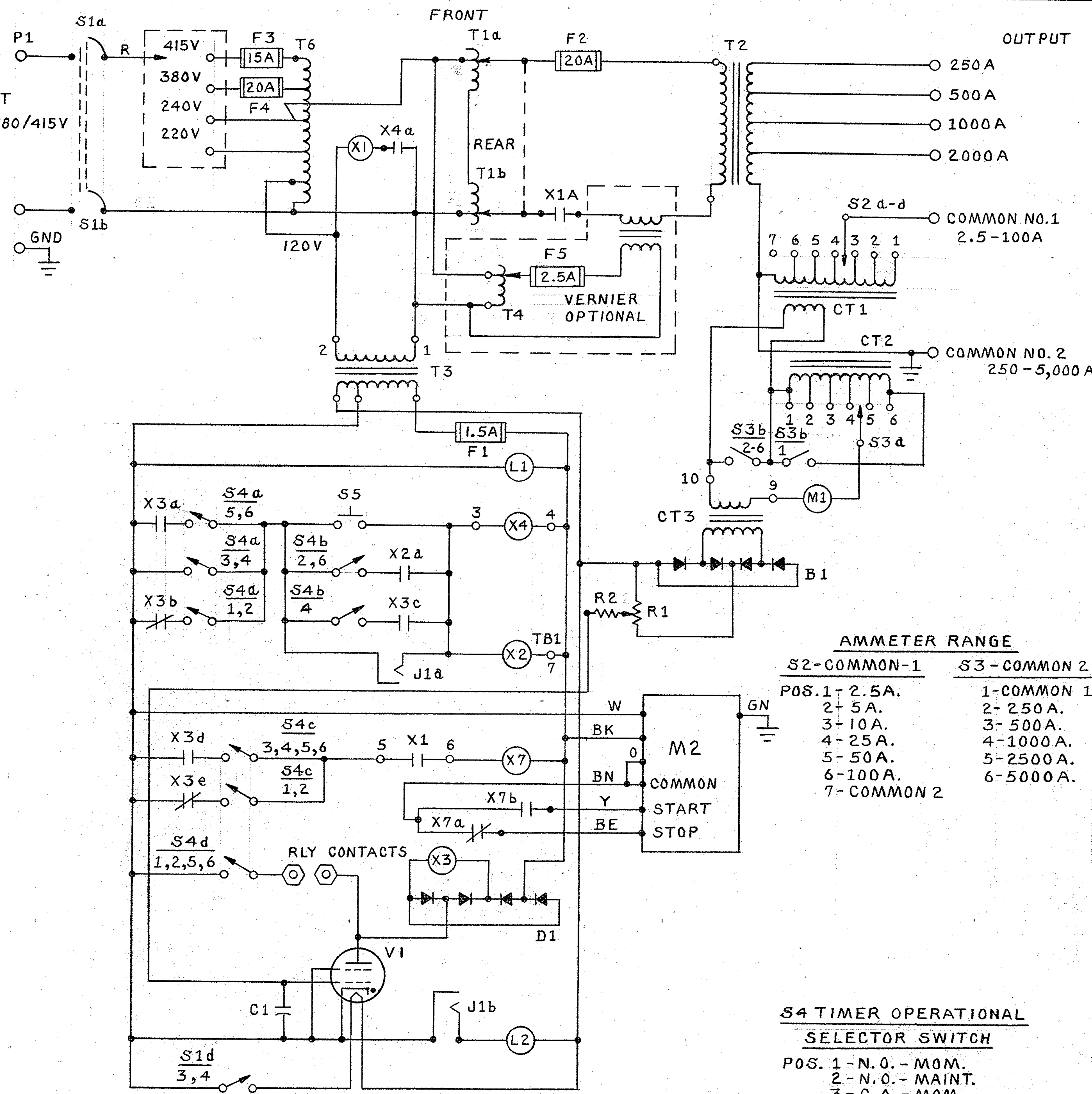
| | | | |
|---|---|---|---|
| TOLERANCES: DECIMAL ±.010 FRACTIONAL ±1/64 UNLESS NOTED | DWN. RMD | APPD. [signature] | SCALE N |
| | CHK'D. | DATE 8-26-81 | SHT. 1 OF 1 |

TITLE SCHEMATIC CB-7120

PART NO. 120/208/230/460/575V | DWG. NO. 12317 C | REV. 11




**AMMETER RANGE**

| S2-COMMON-1 | S3-COMMON 2 |
|---|---|
| POS.1 - 2.5A. | 1-COMMON 1 |
| 2 - 5A. | 2- 250A. |
| 3 - 10A. | 3- 500A. |
| 4 - 25A. | 4-1000A. |
| 5 - 50A. | 5-2500A. |
| 6 - 100A. | 6-5000A. |
| 7 - COMMON 2 | |

**S4 TIMER OPERATIONAL SELECTOR SWITCH**

POS. 1 - N.O. - MOM.
2 - N.O. - MAINT.
3 - C.A. - MOM.
4 - C.A. - MAINT.
5 - N.C. - MOM.
6 - N.C. - MAINT.

SERIAL # 20776 & UP

DWG. NO. 12455 C

| REV. | ECN | DATE |
|---|---|---|
| 1 | 1304 | --- |
| 2 | 1305 | --- |
| 3 | 4022 | 8-14-78 |
| 4 | 5329 | 4-23-80 |
| 5 | 10085 | 8-26-81 |
| 6 | 20298 | 2-7-87 |
| 7 | 22170 | 8-10-89 |
| 8 | 23115 | 10 12 90 |
| 9 | 24081 | 12 3 91 |

| ITEM | PART NO. | DESCRIPTION |
|---|---|---|
| X4,7 | 3848 | SEAL IN RELAY |
| X3 | 3849 | CURRENT ACTUATOR RELAY |
| X2 | 3848 | AUXILIARY RELAY |
| X1 | 840 | CONTACTOR |
| V1 | 1 | THYRATRON |
| T6 | 2963 | INPUT AUTOTRANSFORMER |
| T5 | 6066 | VERNIER TRANSFORMER |
| T4 | 3294 | VARIABLE |
| T3 | 6043 | CONTROL TRANSFORMER |
| T2 | 6091 | OUTPUT TRANSFORMER |
| T1 | 614 | VARIABLE AUTOTRANSF. "MAIN" |
| S5 | 73 | INITIATING SWITCH |
| S4 | 766 | TIMER OPERATION SELECTOR SW. |
| S3 | 708 | AMMETER RANGE SWITCH |
| S2 | 64 | AMMETER RANGE SWITCH |
| S1 | 3000 | CIRCUIT-BREAKER |
| R1 | 1268 | POTENTIOMETER |
| P1 | 1281 | INPUT SOCKET |
| M2 | 581A | TIMER (DIGITAL) |
| M1 | 519A | AMMETER |
| L2 | 28/29 | INDICATOR LIGHT "CONTINUITY" |
| L1 | 3/6 | INDICATOR LIGHT "POWER ON" |
| J1 | 1287 | JACK |
| | | |
| F5 | 2632 | FUSE 2.5 |
| F4 | 2966 | 20A |
| F3 | 798 | 15A |
| F2 | 980 | 20A |
| F1 | 950 | FUSE 1.5A |
| D1 | 2204 | RECTIFIER ASSEMBLY |
| CT3 | 6099 | C.A. CURRENT TRANSFORMER |
| CT2 | 6084 | HIGH RANGE CURRENT TRANSF. |
| CT1 | 1687 | LOW RANGE CURRENT TRANSF. |
| C1 | 1301 | CAPACITOR |
| B1 | 1355 | BRIDGE RECTIFIER |

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TOLERANCES: DECIMAL ±.010 FRACTIONAL ±1/64 UNLESS NOTED | DWN. RMD | APPD. [signature] | SCALE N | CHK'D. | DATE 12-20-77 | SHT. 1 OF 1

TITLE: SCHEMATIC CB-7120E

PART NO.: INPUT 220/240/380/415V | DWG. NO. 12455 C | REV. 9

# INSTRUCTION MANUAL

For

# CIRCUIT BREAKER TEST SETS

# MODEL CB-71XX

SERIAL NO.

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

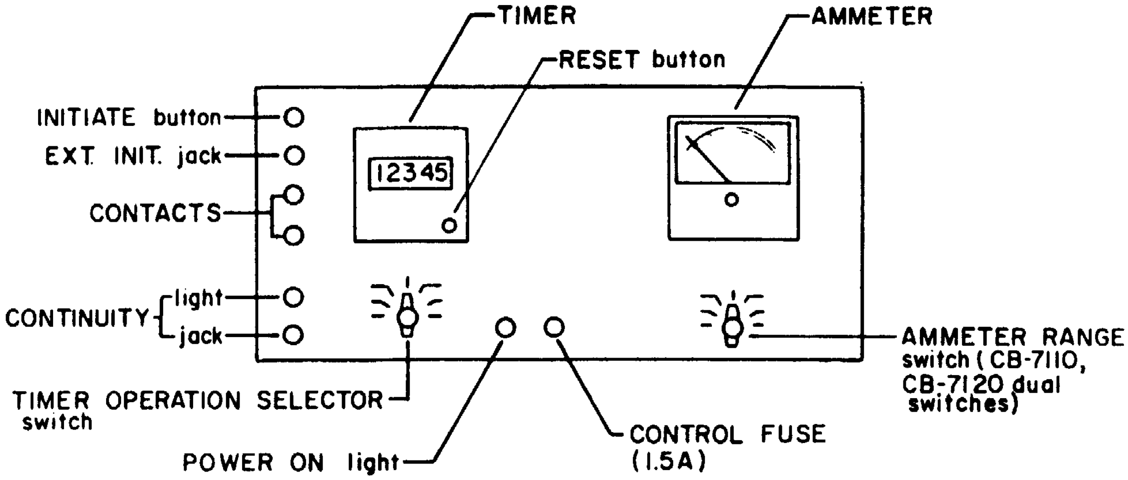
Part _ 12436
Rev. 0

*IMPORTANT*

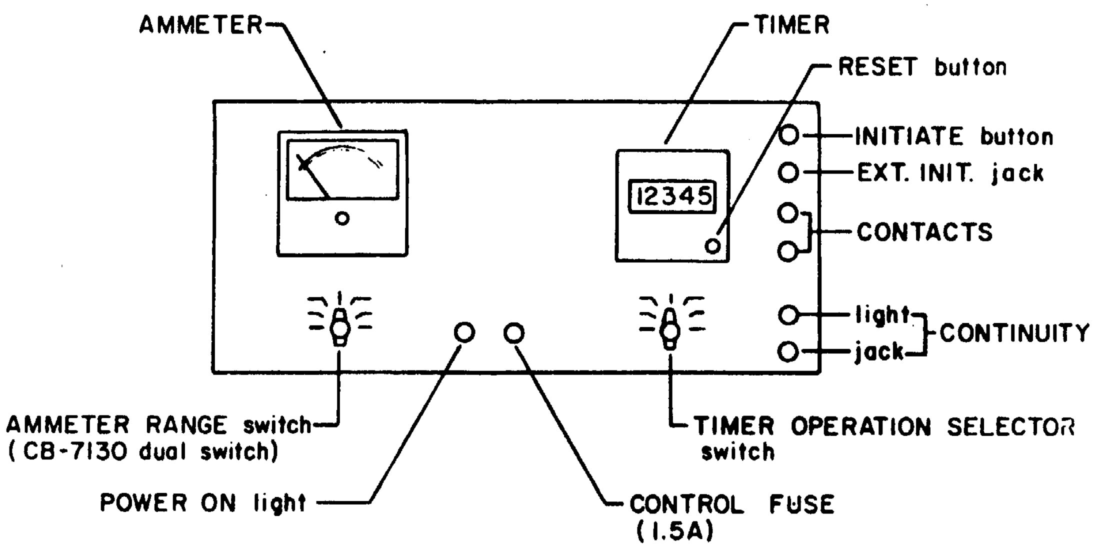


**TABLE OF CONTENTS**

## CONTROL PANEL MODELS CB-7110, CB-7120, CB-7150




## CONTROL PANEL MODELS CB-7130, CB-7140




Part _ 12436
Rev. 0

## FUNCTION OF CONTROLS & INSTRUMENTATION

**GENERAL DESCRIPTION:**
Multi-Amp Circuit Breaker Test Sets are portable high current units designed for testing and adjusting low voltage circuit breakers and other current actuated devices. The units incorporate a variable high current ac output, control circuitry, electronic digital timer, multi-range ammeter and circuitry to monitor contact closure or opening. The units are self protected against overloads and short circuits.

**CONTROLS & INSTRUMENTATION (Refer to illustrations on opposite page):**

**OUTPUT CONTROL:**
Models CB-7110, CB-7120 & CB-7130 — These units use a variable autotransformer to provide continuous control of the output from zero to maximum.

**OUTPUT CONTROLS:**
Models CB-7140 & CB-7150 — Adjustment of the output on these units is accomplished by the combination of the OUTPUT SELECTOR switch and VERNIER CONTROL.

OUTPUT SELECTOR Switch — This is an eight-position switch which provides coarse adjustment of the output. Minimum output, Position l; Maximum output. Position 8. The OUTPUT SELECTOR switch is interlocked with the output initiating circuit. Depressing the switch to change positions operates the interlock and de-energizes the output.

VERNIER CONTROL — Provides fine adjustment of the output between steps of the OUTPUT SELECTOR switch.

**INITIATE Button:** Energizes the output and starts the timer.

**EXT. INIT. (External Initiate) Jack:** An external switch can be plugged into this jack to provide remote initiation of the test set. The jack is wired in parallel with the INITIATE button.

**CONTACTS Binding Posts:** These binding posts facilitate connection to a set of contacts on the device under test to monitor contact opening or closure. The timer stops and the test set is de-energized when the device operates.

**CONTINUITY Panel Lamp and Jack:** This jack is wired in series with a green panel lamp so that contact action or circuit continuity can be monitored.

**Circuit Breaker:** Functions as the input POWER ON/OFF switch and also provides short-circuit and overload protection.

**POWER ON Panel Lamp:** Indicates when the circuit breaker is ON and input power is available.

**AMMETER RANGE Switch:** Selects the full scale range of the ammeter.

**AMMETER:** Indicates output current.

**CONTROL FUSE (1.5A):** Protects the control circuit.

**TIMER:** This is a specially designed electronic digital timer for indicating the elapsed time of the test in either seconds or cycles. The timer automatically starts at the beginning of each test and stops when the device under test operates.

**TIMER OPERATION SELECTOR Switch:** This six-position switch selects which of the three modes of operation is to be used to control the output and timer operation. The three modes of operation are described below:

(1) N.O. (Normally Open): When the device to be tested has normally open contacts (such as an overcurrent relay) this type of operation is used. In this position, the timer will run from the initiation of the test until closure of the contacts connected to the CONTACTS binding post.

(2) N.C. (Normally Closed): When the device to be tested has normally closed contacts (such as a multi-pole circuit breaker), this type of operation is used. In this position, the timer will run from the initiation of the test until the opening of the contacts connected to the CONTACTS binding post.

**(3) C.A. (Current Actuator):** When the device to be tested has no contacts other than those involved in the passing of test current (such as a single pole circuit breaker), this type of operation is used. In this position, the timer will run from the initiation of the test until the test circuit is interrupted. See Service Data section for information on sensitivity and adjustment of current actuator

**The above three modes of operation can be used in either the MAINT. (maintained) or MOM. (momentary) positions.**

**(1) MAINT.** In this position, when the INITIATE button is pressed, the control circuit is sealed-in to maintain the output of the test set until the device under test operates. This is the normal position for timing tests.

**(2) MOM.** In this position, the output of the test set is on only as long as the INITIATE button is held closed. This position is normally used when setting the test current prior to the timing test.

**AMMETER CIRCUIT:** The output current of Multi-Amp Circuit Breaker Test Sets is read on an ammeter connected to the output circuit by appropriate current transformers and an AMMETER RANGE switch. The desired full scale value of the ammeter is selected by means of the AMMETER RANGE switch and by utilizing the correct common terminal. The proper common terminal must be utilized in order to connect the correct current transformer into the circuit. See SELECTION OF COMMON TERMINAL.

The meter is a 4.5 inch square iron-vane instrument of ±1% full scale accuracy. Whenever using an indicating instrument of full scale accuracy, the user should choose a range to give an indication as close to full scale as possible (upper 1/3 of scale). It should be noted that there is no relationship between the ammeter ranges and the rating of the output terminals. ANY AMMETER RANGE CAN BE USED WITH ANY OUTPUT TERMINAL.

The ammeter is equipped with an adjustable pointer pre-set mechanism, by which means the ammeter pointer may be preset to any position on the scale and held there with no current in the meter circuit. This is a mechanical operation accomplished by means of an insulated knob on the front of the meter. It is used to overcome the inertia of the moving system of the meter so that currents of short duration can be set or read accurately.

In use, the pointer is mechanically preset approximately 1/8 inch below the desired current. The device under test is connected to the test set and the output is slowly increased while the INITIATE button is periodically pulsed. Some quivering of the pointer will be seen as the output current approaches the preset value. Continue to increase the output until the meter pointer lifts off the preset mechanism and moves up scale to the desired test current. Hold the INITIATE button long enough to be certain the ammeter needle has stabilized.

## INPUT AND OUTPUT CIRCUITS

### INPUT:

**INPUT VOLTAGE:** Multi-Amp Circuit Breaker Test Sets are designed to operate from any of several input voltages in order to accommodate the various voltages encountered by users in the field. It is necessary to change the input terminal connections to match the available input voltage. For all units except Model CB-7150, this change is made on a terminal board located inside the top access panel. On Model CB-7150, this terminal board is located inside the left hand door of the Instrumentation and Control section. It is recommended that the test set be disconnected from the source before changing input terminals.

NOTE: On Model CB-7150, input voltages of 240 volts and below are not recommended for obtaining the maximum output because of the high input line currents involved.

**INPUT LEADS:** Due to the wide variation in individual user requirements with regard to wire sizes, terminations and length of leads, all units are supplied with input socket and matching plug only. The plug will accept a wide range of wire sizes more than adequate for the duty required. The power source must have sufficient capacity, and the input leads must be large enough to maintain RATED input voltage at the INPUT terminals of the test set. Although the test sets are designed to operate satisfactorily at 95-105% of rated voltage, any drop in voltage below RATED at the input terminals will result in a proportional decrease in the maximum available output.

NOTE: To achieve published output currents, the rated input voltage must be maintained at the test set terminals during the test.

**SELECTION OF INPUT LEADS:** When utilizing maximum output from the test sets, the input line currents may be as high as 400% of nameplate rating. The following table has been prepared to aid in selecting the proper wire size for the input leads. To use the table, follow the four steps listed below:

1. Determine the rated input current from the nameplate on the test set. Be sure to choose the correct current for the input voltage being used.

2. Multiply this value by four.

3. Determine the length of input lead required. This is in circuit-feet, therefore it is the one-way distance from the test set to the power source.

4. Select the proper wire size from the table using factors 2 and 3 above.

Example:Step 1 - 100 amperes (from nameplate)
Step 2 - 4 x 100 = 400 amperes
Step 3 - 60 ft. (Distance from test to input power source.)
Step 4 - #2 wire (from chart)

For safety, a ground wire should be connected to the test set frame. The size of this conductor should be not less than 1/2 the cross section of the current carrying input leads (three-wire sizes less) and in no event smaller than #10.

## SELECTOR CHART FOR INPUT LEADS

LENGTH OF INPUT LEADS
DISTANCE FROM TEST SET TO POWER SOURCE

| FOUR (4X) TIMES RATED INPUT CURRENT | 20 | 40 | 60 | 80 | 100 | 120 | 140 FEET |
|---|---|---|---|---|---|---|---|
| | MINIMUM WIRE SIZE A.W.G. | | | | | | |
| 50 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 75 | 8 | 8 | 8 | 8 | 8 | 8 | 6 |
| 100 | 8 | 8 | 8 | 8 | 6 | 6 | 4 |
| 125 | 8 | 8 | 8 | 6 | 6 | 4 | 4 |
| 150 | 8 | 8 | 8 | 6 | 4 | 4 | 2 |
| 175 | 8 | 8 | 6 | 4 | 4 | 2 | 2 |
| 200 | 8 | 8 | 6 | 4 | 4 | 2 | 2 |
| 225 | 8 | 8 | 6 | 4 | 2 | 2 | 1 |
| 250 | 8 | 6 | 4 | 4 | 2 | 2 | 1 |
| 275 | 8 | 6 | 4 | 2 | 2 | 1 | 1/0 |
| 300 | 8 | 6 | 4 | 2 | 2 | 1 | 1/0 |
| 325 | 8 | 6 | 4 | 2 | 1 | 1 | 2/0 |
| 350 | 8 | 4 | 2 | 2 | 1 | 1/0 | 2/0 |
| 375 | 8 | 4 | 2 | 2 | 1/0 | 2/0 | 2/0 |
| 400 | 8 | 4 | 2 | 1 | 1/0 | 2/0 | |
| 425 | 8 | 4 | 2 | 1 | 1/0 | 2/0 | |
| 450 | 8 | 4 | 2 | 1 | 2/0 | | |
| 475 | 6 | 4 | 2 | 1/0 | 2/0 | | |
| 500 | 6 | 4 | 2 | 1/0 | 2/0 | | |
| 525 | 6 | 2 | 1 | 1/0 | 2/0 | | |
| 550 | 6 | 2 | 1 | 1/0 | | | |
| 575 | 6 | 2 | 1 | 2/0 | | | |
| 600 | 6 | 2 | 1 | 2/0 | | | |

THE WIRE SIZES IN THIS CHART WILL RESULT IN VOLTAGE DROPS OF TEN VOLTS OR LESS.

## OUTPUT:

**SELECTION OF OUTPUT TERMINAL:** Several output terminals at various voltage and current ratings are provided to adapt Multi-Amp Circuit Breaker Test Sets to a wide variety of test circuit impedances.

The test sets can be operated most efficiently by utilizing the terminal with the HIGHEST CURRENT rating consistent with being able to obtain the desired test current. In this way, finer adjustment can be obtained by making maximum use of the variable autotransformer range. Even the smallest currents can be obtained from the highest current terminals. The LOW CURRENT terminals should be used only when testing high impedance devices where the HIGH CURRENT terminal(s) does not have sufficient voltage to "push" the desired test current through the device. The operator should start with the highest current terminal and move to a lower current terminal only when necessary. IT SHOULD BE NOTED THAT THERE IS NO RELATIONSHIP BETWEEN THE AMMETER RANGES AND THE RATING OF THE OUTPUT TERMINAL. ALL AMMETER RANGES CAN BE USED IN CONJUNCTION WITH ANY OF THE OUTPUT TERMINALS.

**SELECTION OF COMMON TERMINAL:** The ammeter circuit of Models CB-7110, CB-7120 and CB-7130 utilizes two current transformers to measure both the very low and high currents available from these units. For the ammeter to correctly read the output current of the test set, the proper common terminal must be selected. When utilizing an ammeter range associated with the COMMON 1 portion of the AMMETER RANGE switch, COMMON 1 terminal must be used; and, similarly, when utilizing an ammeter range associated with the COMMON 2 portion of the AMMETER RANGE switch, COMMON 2 terminal must be used.

**OUTPUT CONNECTIONS:** Models CB-7130, CB-7140 and CB-7150 are equipped with Multi-Amp Stab Adapter Board and Multi-Amp CBS-1 and CBS-2 Stab Sets which accommodate direct engagement of many drawout type circuit breakers to the test set without the use of leads. Additionally, stabs are available for breakers not accommodated by the CBS-1 and CBS-2 stabs. Contact the factory for further details.

On Models CB-7110 and CB-7120, or when testing devices which cannot be connected directly to the stabs of Models CB-7130. CB-7140 and CB-7150, it will be necessary to use test leads. The following information on the selection of output leads will provide the user with a guide for choosing the proper test leads for his application.

> Due to the voltage drop from the inductive reactance of the test circuit, a significant loss of current will result for each inch of test lead. Therefore, when choosing test leads, the length and size of lead chosen will determine the maximum available test current. It is worthwhile to sacrifice cross section of test leads for the sake of reducing length. Every inch of lead that can be eliminated provides worthwhile increases in available test current. Heating is not a significant problem in testing, even though the leads become hot. The use of 4/0 welding or motion picture cable is convenient for constructing test leads. Paralleling of sufficient cables provides higher test currents. Each cable can be fitted with a compression lug on each end, then bolted to the output terminals or stab board of the test set and the breaker.
>
> The two cables between the test set and the breaker should be twisted together or bundled with tape or cord to maintain the close proximity which minimizes inductive reactance.
>
> It is sometimes necessary to use bus bar in order to obtain the desired maximum current. When using bus bar the buses should be run in parallel and kept as close to one another as possible.

## TESTING OF MOTOR OVERLOAD RELAYS:

Always refer to the manufacturer's literature applicable to the particular overload relay before testing. The test operator should be familiar with the operating characteristics of the relay, the tolerances applicable to the operating characteristics and any means of adjusting the relay.

The test usually performed on these devices is to verify the time delay characteristics of the relay when subjected to an overload. One test point is usually suggested to establish whether the relay is operating correctly and within the band of the time-current curve for the relay. The suggested test current is three times (3x) the normal current rating of thermal overload relays or three times (3x) the pick-up current (setting) of magnetic overload relays.

It is, of course, easiest to make the connections and perform the tests on the relays if they are removed from the starter. However, it is not necessary to remove the relay as long as the power circuit is de-energized and the test leads can be connected to the device. The high current leads from the test set to the relay under test should be kept as short as possible and should be twisted to minimize losses caused by inductive reactance.

Run the test and note the time required for the overload relay to trip. If the tripping time exceeds the desired value, or if the relay does not trip at all, the relay may not be protecting the motor properly. If the relay operates too quickly, it may result in unnecessary nuisance trips. It should be remembered that these devices operate over a wide band and precise results should not be sought. A tolerance of ±15% is usually acceptable.

If a thermal overload relay is not operating properly, tripping too soon or too late, remove the heater element. Note its type, rating, etc., and compare with manufacturer's data for operating characteristics of the motor. If correct for the application, substitute a new heater of the same rating and retest. If either under- or over-sized heater elements are being used, replace with the proper size heater and retest.

If a magnetic overload relay is not operating properly, refer to the relay manufacturer's literature for instructions on making adjustments to the time delay. If the relay is operating improperly, it also may be desirable to verify the pickup point (minimum operating point) of the relay. To perform this test, it is necessary to disengage the time delay feature of the overload relay. Refer to the manufacturer's literature for detailed instructions.

## SETUP OF CONTROLS BEFORE TESTING

| CONTROL | POSITION |
|---|---|
| Circuit Breaker | OFF |
| Models CB-7110, CB-7120, and CB-7130 | |
| OUTPUT CONTROL | Zero (counterclockwise) |
| Models CB-7140 and CB-7150 | |
| OUTPUT SELECTOR Switch | 1 |
| VERNIER CONTROL | Zero (counterclockwise) |
| TIMER OPERATION SELECTOR Switch | N.C. MOM |

AMMETER RANGE Switch So that test current can be read in the upper 1/3 of the ammeter scale.

### TESTING OF TIME DELAY:

1. Connect the test set to a suitable source of power to match the input voltage terminal being used. Be sure that the circuit breaker on the test set is off.

2. Make sure the motor circuit is de-energized.

3. Connect the output of the test set to the terminal of the heater or operating coil to be tested. (See SELECTION OF COMMON TERMINAL and SELECTION OF OUTPUT TERMINAL.)

4. Connect a set of light leads from the binding posts marked CONTACTS to the control circuit contacts of the relay being tested.

5. Turn test set's circuit breaker "ON". The POWER ON light should glow.

6. Select proper ammeter range. Adjust the pointer pre-set so that the ammeter needle is approximately 1/8-inch below the desired test current (See AMMETER CIRCUIT).

7a. (For Models CB-7110, CB-7120 and CB-7130): Set desired test current by clockwise rotation of the OUTPUT CONTROL, while pulsing the INITIATE button. If at full rotation of the OUTPUT CONTROL the desired test current is not obtained, return the control to zero and move the output lead to the next lower rated current terminal. (See SELECTION OF OUTPUT TERMINAL). Repeat procedure.

7b. (For Models CB-7140 and CB-7150): Set desired test current by clockwise rotation of the VERNIER CONTROL while pulsing the INITIATE button. If at full clockwise rotation of the VERNIER CONTROL the desired current is not obtained, return the VERNIER CONTROL to "0" and turn the OUTPUT SELECTOR switch to the next higher position. Repeat until desired test current is reached. If at position 8 the desired test current still is not reached, connect breaker to the lower rated current output terminal (See Selection OF OUTPUT TERMINAL). Repeat procedure.

8. Reset timer to zero by pressing RESET button.

9. Wait several minutes to allow the overload relay to cool or the plunger to settle in the dash pot.

10. Change TIMER OPERATION SELECTOR switch to N.C. MAINT. position.

11. Initiate unit by pressing INITIATE button. The timer will stop and the output will automatically de-energize when the overload relay operates.

    NOTE: Check the ammeter reading during the test for accuracy; minor adjustments may be made with the OUTPUT CONTROL while the test is in progress.

12. Record the results and compare them to the manufacturer's specifications.

## TESTING OF LOW VOLTAGE CIRCUIT BREAKERS

Always refer to the manufacturer's literature applicable to the particular circuit breaker before testing. The test operator should be familiar with the operating characteristics of the circuit breaker, the tolerances applicable to the operating characteristics and any means for adjusting the circuit breaker.

Molded case breakers are usually tested for verification of the time delay characteristics and the minimum operating point (pick-up point) of the instantaneous element. Low voltage power breakers with solid state or electro-mechanical trip devices are usually tested for verification of the time delay characteristics of the long time delay and short time delay elements and for the minimum operating point (pick-up point) of the instantaneous element. Each breaker pole should be tested independently so that all trip devices are tested.

One test point is usually sufficient to establish whether the long time delay or short time delay element is operating properly and within the band width of its time-current characteristics. For molded case breakers the suggested test current for the time delay element is three times (3x) the current rating of the breaker; for low voltage power breakers, suggested test current is three times (3x) the pick-up setting of the long time delay element and one and one half (1.5x) times the short time delay setting where the type of trip characteristic is incorporated on the trip device.

On both molded case and low voltage power breakers, the instantaneous element is tested to verify the minimum current necessary to cause the breaker to consistently trip instantaneously.

When testing time delay elements, run the test, note the time required for the breaker to trip and compare to the specified operating time. It should be remembered that the trip devices of low voltage circuit breakers operate within a relatively wide time band; therefore precise test results should not be sought. If the breaker trips within the time band, it is considered satisfactory; a tolerance of ±15% is usually acceptable on molded case breakers.

When testing instantaneous trip elements, run the test to find the minimum current required to trip the breaker instantaneously and compare to the setting. Remember that instantaneous elements have an operating tolerance of from ±10% to ±25% of setting, depending on the particular trip device. On molded case circuit breakers, it is suggested that the instantaneous elements be tested before any time delay tests are performed.

Most modern low voltage power circuit breakers are of the "draw-out" type. These breakers should be tested using Models CB-7130, CB-7140 or CB-7150 equipped with the appropriate stabs to directly connect the breaker to the test set. When testing molded case breakers or any other breaker where leads are required to connect it to the test set, the leads should be as short as possible and twisted to minimize losses. See section on OUTPUT LEADS.

## SETUP OF CONTROLS BEFORE TESTING

| CONTROL | POSITION |
|---|---|
| Circuit Breaker | OFF |
| Models CB-7110, CB-7120, and CB-7130 | |
| OUTPUT CONTROL | Zero (counterclockwise) |
| Models CB-7140 and CB-7150 | |
| OUTPUT SELECTOR Switch | 1 |
| VERNIER CONTROL | Zero (counterclockwise) |
| TIMER OPERATION SELECTOR Switch | a) N.C. MOM (For Multi-Pole Breaker), or<br>b) C.A. MOM (For single pole breaker) |
| AMMETER RANGE Switch | So that test current can be read in the upper 1/3 of the ammeter scale. |

**TESTING OF TIME DELAY:**

1. Connect the test set to a suitable source of power to match the input voltage terminal being used. Be sure that the circuit breaker on the test set is off.

2. Make sure the line side circuit of the breaker to be tested is de-energized or disconnected. Close the breaker to be tested.

3. Connect the test set output terminals to one pole of the breaker to be tested. (See SELECTION OF COMMON TERMINAL and SELECTION OF OUTPUT TERMINAL).

4. Connect a set of light leads from the binding post marked CONTACTS to another pole of the breaker being tested. NOTE: Not applicable when testing single pole breakers.

5. Turn test set circuit breaker ON. POWER ON light should glow.

6. Select proper ammeter range. Adjust the pointer pre-set so that the ammeter needle is approximately 1/8 inch below the desired test current (See AMMETER CIRCUIT).

7a. (For Models CB-7110, CB-7120 and CB-7130): Set desired test current by clockwise rotation of the OUTPUT CONTROL while pulsing the INITIATE button. If at full rotation of the output control the desired test current is not obtained, return the control to zero and move the output lead to the next lower-rated current terminal (See SELECTION OF OUTPUT TERMINAL). Repeat procedure.

7b. (For Models CB-7140 and CB-7150): Set desired test current by clockwise rotation of the VERNIER CONTROL while pulsing the INITIATE button. If, at full clockwise rotation of VERNIER CONTROL the desired current is not obtained, return VERNIER CONTROL to "0" and turn the OUTPUT SELECTOR switch to the next higher position. Repeat until desired test current is reached. If at position 8 the desired test current still is not reached, connect breaker to the lower-rated current output terminal (See SELECTION OF OUTPUT TERMINAL). Repeat procedure.

8. Reset timer to zero by pressing the RESET button.

9. Wait several minutes to allow thermal, hydraulic or other actuating device of the breaker to cool.

10. Change TIMER OPERATION SELECTOR switch to N.C. MAINT. (or C.A. MAINT. if testing a single pole breaker).

11. Initiate unit by pressing INITIATE button. The timer will stop and output will automatically de-energize when the circuit breaker operates.

    NOTE: Check the ammeter reading during the test for accuracy; minor adjustments may be made with the output control while the test is in progress.

12. Record the results and compare them to the manufacturer's specifications.

**TESTING OF INSTANTANEOUS PICK-UP:**

1. Connect the test set to a suitable source of power to match the input voltage terminal being used. Be sure that the circuit breaker on the test set is off.

2. Make sure the line side circuit of the breaker to be tested is de-energized or disconnected. Close the breaker to be tested.

3. Connect the output of the test set to one pole of the breaker to be tested. (See SELECTION OF COMMON TERMINAL and SELECTION OF OUTPUT TERMINAL).

4. Connect a set of light leads from the binding post marked CONTACTS to another pole of the breaker being tested. NOTE: Not applicable when testing single-pole breakers.

5. Turn test set circuit breaker ON. POWER ON light should glow.

6. Select the proper ammeter range for the pick-up current of the instantaneous element (See AMMETER CIRCUIT).

7a. (For Models CB-7110, CB-7120 and CB-7130): Increase the output current by clockwise rotation of the output control while pulsing the INITIATE button until the test set is delivering the minimum current which will consistently trip the breaker instantaneously. If at full rotation of the output control the required test current is not obtained, return the control to zero and move the output lead to the next lower rated current output terminal, (See SELECTION OF OUTPUT TERMINAL). Repeat procedure.

7b. (For Models CB-7140 and CB-7150): Rotate VERNIER CONTROL clockwise while pulsing INITIATE button until the circuit breaker under test trips instanteously. If breaker does not trip instantaneously with VERNIER CONTROL fully clockwise, return it to "0", turn OUTPUT SELECTOR switch to next higher position and repeat. If at position 8 the required test current still is not reached, connect breaker to the lower rated current output terminal and repeat procedure. (See SELECTION OF OUTPUT TERMINAL).

8. DO NOT MOVE the output control setting. Using the ammeter pointer pre-set mechanism adjust the ammeter needle so that it indicates a value near the breaker's instantaneous pick-up setting. Close the breaker and press the INITIATE button while observing the ammeter. If the ammeter needle moves off the preset value, the test current tripping the breaker is higher than the value set. If the ammeter needle does not move, then the test current tripping the breaker is less than the value set.

9. Adjust the ammeter pointer pre-set mechanism higher or lower as required by movement or non-movement of the needle in Step 8, and trip the breaker again. Repeat this procedure until the needle just quivers when the breaker trips.

10. Record this value as instantaneous pick-up current and compare to manufacturer's specifications and tolerances.

## ADDENDA

### MAINTENANCE OF MOTOR OVERLOAD RELAYS:

### APPLICATION:

The prime function of the motor overload relay is to prevent operation of a motor for too long a period of time when an overload condition exists.

In general, motor starters are applicable to a given horsepower range of motors. The voltage and current requirements of the application will "size" the starter under NEMA require- ments, but the actual starting current, running current, ambient temperature and severity of atmospheric conditions will determine the overload relay rating required to protect the motor without nuisance tripping.

Selection of the properly rated overload relay heater or coil can be made by reference to tables or charts supplied by the manufacturer of the overload relays. Whenever a motor trips out it is poor practice to indiscriminately install a larger heater or coil, since the motor may actually be working under an overload condition or the overload relay may be operating improperly. Installing a larger heater or coil could allow an overloaded motor to continue to run, resulting in deterioration of the motor insulation and reduction in motor life. Therefore, careful analysis should be made as to the cause of the trip before changing the rating of the overload relay heater. Operating characteristics of the motor overload relay should be verified at regular intervals. Typical practice dictates inspection of overload relays at periods of one to two years, with an actual test of tripping time to be made at intervals of two years. The inspection and test interval can vary widely depending on the type of service involved, the importance of the motor to process or production, and environmental conditions.

### TYPES:

Motor overload relays incorporate an element which actuates a set of contacts connected to the motor control circuit. These contacts open the circuit of the holding coil in the motor starter and interrupt the power to the motor.

In general, there are three types of motor overload relays in use:

1. Thermal - melting alloy or solder pot.

2. Thermal - bimetallic strip.

3. Electromagnetic.

In thermal type relays, time-current characteristics are obtained by the thermal properties of the melting alloy or bimetallic strip. In the magnetic type, a damped plunger or moving iron device is used to produce time delays.

1. **Thermal - melting alloy or solder pot:**

   In this type, tripping is the result of heat generated by the motor overload current passing through a "heater" in the overload relay. This overload relay consists of a brass shaft which is surrounded by solder. Fixed to one end of the shaft is a small ratchet wheel. As long as the solder is solid, this assembly is immobile. When the motor control circuit contacts are closed, a spring in the motor overload relay is held compressed by the immobility of the ratchet wheel. An overload condition in the motor increases the current through the heater, thus melting the solder allowing the ratchet wheel to move, and releasing the energy in the spring. This interrupts the circuit of the holding coil in the motor starter and shuts down the motor.

   The starter may be reset only after the heater has cooled sufficiently to permit the solder to reset and again make the ratchet and shaft immobile. Reset is usually accomplished by an external pushbutton on the face of the starter. Many motor overload relays offer a selection of either manual or automatic reset.

2. **Thermal - bimetallic strip:**

   This type uses a bimetallic strip-two pieces of dissimilar metal bonded together. An increase in heat will cause movement of this bimetallic unit and eventually open a set of contacts in the motor control circuit, thus opening the holding coil circuit and shutting down the motor.

   The principle of operation is the same as the melting alloy type. When the bimetallic element has cooled sufficiently, the motor control circuit may be reset either manually or automatically.

3. **Electromagnetic:**

   In this type of motor overload relay, a damped plunger or moving iron device is used to produce the delays required and initiate the trip signal to the interrupting device. In the most common type of magnetic relay, movement of an armature or piston rod is delayed by a dashpot.

   When the electromagnetic field produced by the operating coil is strong enough, the piston in the dashpot moves through the oil to trigger the opening of the relay contacts, shutting down the motor. Usually magnetic overload relays with oil dashpots have facilities which permit adjusting their minimum operating current (pick-up point) and their time delay characteristics.

**Planned Maintenance Program:**

**A scheduled program for maintenance of motor overload relays consists primarily of "good housekeeping" in conjunction with visual inspections, tightening of electrical connections, and electrical testing. A brief outline is given below:**

1. **Clean - All types of motor overload relays should be cleaned periodically to ensure continued, reliable operation. It is possible for dirt or dust created by conditions in the plant to prevent parts or the relay from moving. Also these same conditions can prevent the proper dissipation of normal heat, resulting in unnecessary operation of thermal type overload relays.**

2. **Tighten Connections - This is particularly important in thermal overload relays. Loose electrical connections can cause extra heat which may result in a nuisance operation of the relay.**

3. **Inspect Heater Size - Determine that the specified heater is used in thermal overload relays. Too often, oversized heaters are arbitrarily installed to eliminate unexplained trips. Actually, the original heaters may have oxidized over a period of time, becoming smaller in cross section. Then, the heat required to operate the relay is provided by a smaller amount of current than that intended by the original design. This may make the relay trip prematurely and the heater appear undersized.**

4. **Inspect Settings (Where applicable) - Most magnetic overload relays have adjustable settings for minimum operating current and time delay characteristics. These should be adjusted to the specified settings.**

5. **Test - The motor overload relay should be subjected to a simulated overload and the tripping time measured. This time should be compared to the manufacturer's specifications or the relay's time-current curves to make certain that the relay is operating properly. A tolerance of ±5% is usually acceptable. If the relay's curves or specifications are not available, it is suggested that the Heat Damage Curve of the motor be used as a guide for maximum trip time at 300% of motor full load current.**

**MAINTENANCE OF MOLDED CASE CIRCUIT BREAKERS:**

**The molded case circuit breaker essentially consists of two separate elements. One element is a set of contacts and suitable mechanical linkage for manual operation of the breaker as a switch in an electric circuit. The other element is a device to sense and react to an overload or short circuit. Normally, the time delay overload device is thermal and the instantaneous overload device, when supplied, is magnetic.**

**The thermal element uses a bimetallic strip--two pieces of dissimilar material bonded together. An overload causes an increase in heat which will result in moving the bimetallic unit, releasing a latching spring which trips the circuit breaker.**

A small percentage of molded case circuit breakers achieve their time delay through the use of an electromagnet, whose operation is opposed by a fluid filled dash pot.

The magnetic element operates with no intentional time delay to provide instantaneous protection against high magnitude faults.

In small molded case circuit breakers, the instantaneous element is not adjustable as it is factory set and sealed. In larger molded case breakers, the instantaneous pickup of the trip unit may be adjustable and is set with an adjustment screw. This type breaker may be shipped from the factory with the instantaneous element set at maximum if the setting is not specified by the purchaser; therefore, it is necessary to check these adjustable instantaneous settings before putting the breaker in service.

## Planned Maintenance Program

A scheduled program for maintenance of molded case circuit breakers consists primarily of "good housekeeping" in conjunction with visual inspections, tightening of connections and electrical testing. A brief outline is given below:

1. Clean - All types of molded case circuit breakers should be externally cleaned periodically so that the heat produced in normal operation can be dissipated properly. It is possible for dirt or dust caused by normal plant conditions to accumulate and prevent proper dissipation of heat, resulting in a nuisance operation of the breaker.

2. Tighten Connections - This is particularly important, because loose electrical connections will cause deterioration of the breaker terminals and an eventual phase to phase or phase to ground fault.

3. Test - The molded case circuit breaker should be subjected to a simulated overload and the tripping time measured. This is important because after a period of inactivity, the overload device may become stiff or inoperable. The only way to determine this condition and eliminate the stiffness is to electrically operate the breaker on a periodic basis. Manually opening and closing the main contacts of the breaker does not move any of the mechanical linkage associated with the overload device. Testing may be as often as every 6 months or as long as every 3 or 4 years, depending upon conditions where the breaker is installed.

## MAINTENANCE OF LOW VOLTAGE POWER CIRCUIT BREAKERS:

### Application:

The low voltage power circuit breaker has a wide application and may be used to protect circuits up to 600 volts ac or 250 volts dc. These devices are essentially two separate elements. One element is a set of contacts with suitable mechanical linkage for operating the breaker as a switch. The other element is a device to sense and react to an overload or short circuit condition. Low voltage power circuit breakers are manufactured with either electro mechanical or solid state trip devices.

Solid State Trip Elements - This type of breaker uses a sample of the load current to supply a signal to an electronic sensing element. When an overload or short circuit condition exists, the solid state sensing element sends a signal to a solenoid which releases the latching mechanism and trips the circuit breaker. This type eliminates the magnetic coil and dashpot mechanism of the electro-mechanical trip device.

Electro-mechanical Trip Elements - Series tripped, direct acting low voltage power circuit breakers are tripped by the movement of an armature which strikes the trip bar of the breaker. The trip bar operates a latch which releases stored energy to rapidly open the breaker contacts. The armature of the trip unit is attracted to a pole piece through the magnetic field set up by current through a coil. The current through the coil is either the actual load current or the secondary output of a current transformer. For time delay the armature is restrained mechanically. Tripping time is a function of magnitude of current through the breaker.

Low Voltage Power Circuit Breakers are available with three types of tripping characteristics:

1. Long Time Delay - The long time delay characteristic provides overload protection with typical time delays of approximately 10-60 seconds at 300% of pickup.

2. Short Time Delay - The short time delay characteristic provides protection for short circuit or fault conditions. It is used whenever a small delay is necessary for coordination or selectivity with other protective devices. Typical delays of this type characteristic are approximately 6-30 cycles.

3. Instantaneous - The instantaneous trip characteristic is used for short circuit or fault protection and has no intentional time delay.

**Planned Maintenance Program**

A scheduled program for maintenance of low voltage power circuit breakers consists primarily of "good housekeeping" in conjunction with visual inspection, tightening all connections and non-pivotal joints, and electrical testing.

1. Clean and tighten - Low voltage power circuit breakers should be periodically cleaned, tightened and inspected. The manufacturer's instruction book for the breaker should be read thoroughly and his recommendations for lubricating and clearances should be followed closely.

2. Test - The low voltage power circuit breaker should be subjected to simulated overload conditions to verify that the breaker is operating within its specifications and tolerances. This is important because, after a period of time, vibration and environment conditions can render the breaker inoperable. Manually opening or closing the main contacts of the breaker does not "exercise" the overload trip device.

# SUGGESTED TEST FORMS

## SUGGESTED RECORD FORM
## INSPECTION AND TEST RESULTS

**INSPECTION**

Circuit No ____________ Trip Device Mfg. ____________
Location ____________ Trip Device Type ____________
Breaker Mfg. ____________ Long Time Delay Range ____________
Breaker Type ____________ Short Time Delay Range ____________
Instantaneous Range ____________

| | | | | | | |
|---|---|---|---|---|---|---|
| Date | | | | | | |
| Process Clearance | | | | | | |
| Circuit De-energized | | | | | | |
| Circuit Properly Tagged | | | | | | |
| Breaker Removed | | | | | | |
| Primary Fingers | | | | | | |
| Arc Chutes | | | | | | |
| Contacts | | | | | | |
| Clean | | | | | | |
| Aligned | | | | | | |
| Pressure | | | | | | |
| Mechanical Operation | | | | | | |
| Proper Lubrication | | | | | | |
| Racking Device | | | | | | |
| Rollers | | | | | | |
| Trip Mechanism | | | | | | |
| Tightened Bolted and Screwed Connections | | | | | | |
| Trip Bar | | | | | | |
| Trip Arm | | | | | | |
| Electrical Tests | | | | | | |
| Inspector | | | | | | |

**TEST RESULTS**

Circuit No. ____________ Trip Device Type ____________
Circuit Location ____________ Long Time Delay Range ____________
Breaker Mfg. ____________ Short Time Delay Range ____________
Breaker Type ____________ Instantaneous Range ____________
Mfg. Serial No. or Shop Order No. ____________

| Date | | | | Specified | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SETTINGS | PH-A | L.T.D. | | | | | | | | |
| | | Std/Inst | | | | | | | | |
| | PH-B | L.T.D. | | | | | | | | |
| | | Std/Inst | | | | | | | | |
| | PH-C | L.T.D. | | | | | | | | |
| | | Std/Inst | | | | | | | | |
| TEST RESULTS | PHASE A | LTD | Curr | | | | | | | |
| | | | Time | | | | | | | |
| | | STD | Curr. | | | | | | | |
| | | | Time | | | | | | | |
| | | Inst. Curr. | | | | | | | | |
| | PHASE B | LTD | Curr. | | | | | | | |
| | | | Time | | | | | | | |
| | | STD | Curr. | | | | | | | |
| | | | Time | | | | | | | |
| | | Inst. Curr. | | | | | | | | |
| | PHASE C | LTD | Curr. | | | | | | | |
| | | | Time | | | | | | | |
| | | STD | Curr. | | | | | | | |
| | | | Time | | | | | | | |
| | | Inst. Curr. | | | | | | | | |

## SERVICE DATA

The test set utilizes straightforward circuits and components which require little or no service except for routine cleaning, tightening of connections, and checking contact conditions. The test set should be serviced in a clean atmosphere away from energized electrical circuits. The following maintenance is recommended:

1. Open the unit every six months and examine for:
   a. dirt
   b. moisture
   c. corrosion
   d. condition of contacts

2. Remove dirt with dry, compressed air.

3. Remove moisture as much as possible by putting test set in a warm, dry environment.

4. As corrosion may take many forms, no specific recommendations can be made for its removal.

5. The contacts of the main contactor should be examined. This contactor utilizes special silver-tungsten contacts which have been properly sized. With proper operation and maintenance, they should show only slight pitting or burning. Should pitting or burning become excessive, the contacts should not be filed or dressed. Replacement contacts and arc-chutes are available from the factory.

6. The contacts on all control relays should be examined for pitting and burning. These contacts may be burnished with a diamond dressing tool if not too badly damaged. If excessive pitting or burning has occurred, the relay should be replaced.

### Adjustment of Current Actuator (C.A.) Circuit

The heart of the current actuator is a 2D21 thyratron tube. This tube is energized through auxiliary circuitry associated with the secondary of a current transformer. Therefore, the magnitude of energy in the thyratron tube is proportional to output current of the test set. When a minimum predetermined amount of current passes through the output terminals of the test set, the thyratron tube "fires" and a relay in the plate circuit of the tube operates to hold the main contactor of the test set in a closed position until output current ceases. The factory calibration of minimum output current which will cause the thyratron tube to "fire" and operate the relay is between 10% and 20% full scale deflection of the ammeter.

The "firing" point may be field adjusted by means of the potentiometer on the control chassis. This potentiometer is located next to the thyratron tube and has a screwdriver slot and shift lock. Pickup of the current actuator can be adjusted as follows:

1. With the output control(s) at zero connect a short circuit across the output of the

unit.

2. Set TIMER OPERATION SELECTOR switch to C.A. MAINT. position.

3. Set AMMETER RANGE switch to any position.

4. Turn test set on and allow 30 seconds for the thyratron tube to warm up.

5. Press INITIATE button and hold. Rotate output control clockwise until ammeter indicates 10% of full scale deflection. Release INITIATE button and test set output should de-energize.

6. Repeat Step 5 except value of current should be 20% full scale deflection of ammeter. When INITIATE button is released, output should be maintained.

7. If C.A. does not pick up and hold-in in Step 6, adjust potentiometer until C.A. pickup is between limits of current in Steps 5 and 6.

8. If proper adjustment cannot be accomplished, replace the thyratron tube.

NOTES:

1. If the pickup of the current actuator circuit is set too low, the test set will "chatter" when the load circuit is interrupted.

2. The sensitivity of the current actuator circuit will vary slightly due to the aging of the thyratron tube and the phase angle of the load.

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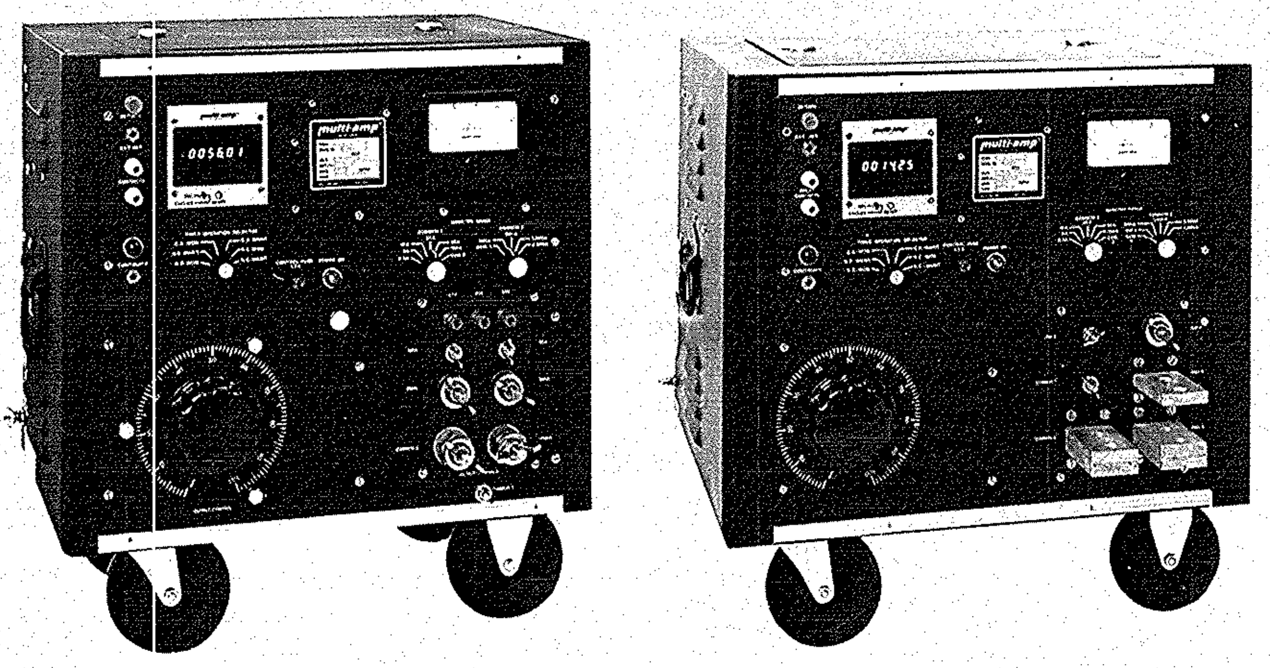
# UNIVERSAL CIRCUIT BREAKER TEST SETS
# Model CB-7110 4000 Amperes
# Model CB-7120 6000 Amperes



## General Description

Multi-Amp® Models CB-7110 and CB-7120 are specifically designed to test the thermal, magnetic or solid-state trip devices of molded case circuit breakers by simulating an overload or fault condition. These test sets provide a variable high current output and incorporate all control circuitry and instrumentation necessary to accurately, efficiently and safely test breakers and other current responding devices. Models CB-7110 and CB-7120 also may be used for other high current applications such as ratioing current transformers, testing thermal or magnetic motor overload relays, performing heat runs, or primary injection testing of high voltage breakers and their associated protective relays.

Both units, Models CB-7110 and CB-7120, have identical features, instrumentation and operational characteristics ... the only changes in specifications among the two units are their size, weight and output current circuits. Rugged and reliable, Models CB-7110 and CB-7120 will provide years of trouble-free operation.

## Standard Features

- **Initiating Control Circuit:** Provides both "momentary" and "maintained" modes to control output duration. The momentary mode permits "pulsed" application of the output to perform instantaneous trip tests or to avoid damage or overheating of the device under test while setting the test current. In the maintained mode, the output remains energized until manually turned off or, when performing timing tests, until the device under test operates ... which both stops the timer and de-energizes the output.
- **Solid-State Digital Timer:** Crystal-controlled time base accurately measures elapsed time of the test in seconds or cycles.
- **Protection:** Overload and short-circuit protection incorporated.
- **External Initiate Circuit:** Provisions to initiate the test set from a remote location.
- **Continuity Indicator:** Panel lamp indicator and appropriate circuitry for checking the continuity of external circuits.



(over)

## Specifications

**Rated Input Voltage:** To facilitate operation from a variety of power sources, the test set can operate from several different voltages. The unit will operate over a nominal range of ±10% of rated input voltage.

**Specify one of the following groups:**
120/208/230/460 volts, 1$\phi$, 50/60 hz
**OR**
220/240/380/415 volts, 1$\phi$, 50/60 hz

**Output Circuit:** In order to meet a wide variety of test circuit impedances, the output is continuously adjustable from zero up to the maximum available from the test set in the following ranges:

| Model CB-7110 | Model CB-7120 |
|---|---|
| 0-2.5 volts at 1000 amps | 0-2.5 volts at 2000 amps |
| 0-5 volts at 500 amps | 0-5 volts at 1000 amps |
| 0-10 volts at 250 amps | 0-10 volts at 500 amps |
| 0-25 volts at 100 amps | 0-20 volts at 250 amps |
| 0-50 volts at 50 amps | |
| 0-75 volts at 33 amps | |
| 0-100 volts at 25 amps | |
| 0-200 volts at 12.5 amps | |

**Duty Cycle:** The test set will supply the rated output current indicated above for 30 minutes, followed by 30 minutes off.

**Overload Capability:** To increase utilization of the test set, it is designed so that the current ratings may be exceeded for short durations. Since the magnitude of the output current is determined by the impedance of the load circuit, the voltage rating must be sufficient to "push" the desired current through the device under test and the connecting test leads. The overload capability is:

| Percent Rated Current | Maximum Time On | Minimum Time Off |
|---|---|---|
| 100 (1x) | 30 minutes | 30 minutes |
| 200 (2x) | 2 minutes | 8 minutes |
| 300 (3x) | 40 seconds | 4 minutes |
| 400 (4x) | 20 seconds | 1 minute |
| 500 (5x) | 9 seconds | 18 seconds |

**Maximum Output Current (short-circuit):** At rated input voltage and with a short circuit connected directly across the output terminals of the test set, the maximum output current is in excess of 4,000 amperes for Model CB-7110 or 6,000 amperes for Model CB-7120.

**Maximum Output Current (circuit breaker):** At rated input voltage and with a typical 225 ampere molded case circuit breaker connected to the test set by 4/0 test cables five feet (1.52m) long, Model CB-7110 will produce 2,000 amperes *through the breaker* for performing instantaneous tests. Model CB-7120 will produce 4,000 amperes through a typical 400 ampere molded case circuit breaker connected to the test set by double 4/0 test cables five feet (1.52m) long.

**Timer:** A special Multi-Amp® solid-state digital timer is incorporated to measure the elapsed time of the test in either seconds or cycles. It features extensive shielding and noise suppression circuitry to ensure accurate and reliable operation under the most demanding field conditions. Incorporating a crystal-controlled oscillator, accuracy of the timer is independent of the power line frequency.

**Digital Display:** 6 digit display with .375-inch (9.53 mm) numerals

**Ranges (switch-selected):**
a. 0-9999.99 seconds
b. 0-999,999 cycles

**Accuracy:**
**Seconds Mode:** ± least significant digit or ± 0.0025% of reading, whichever is greater
**Cycles Mode:** ± 1 cycle

**Timer Control Circuit:** Circuitry is provided to start and stop the timer and de-energize the output of the test set under a variety of test conditions. Among these are:
1. For testing a circuit breaker or a device which has no auxiliary contacts to monitor (such as a single-pole circuit breaker), the timer starts when the output current starts to flow and stops when the output current is interrupted.
2. For testing a device and monitoring normally closed contacts, the timer starts when the output current is initiated and stops when the contacts open.
3. For testing a device and monitoring normally open contacts, the timer starts when the output current is initiated and stops when the contacts close.

**Ammeter Circuit:** The test set incorporates a multi-tapped current transformer and a true rms responding panel meter with mirrored scale, knife edge pointer and a pointer preset mechanism to measure the short duration currents involved in testing the instantaneous trip of circuit breakers.

**Scales:** 5/10/25 amperes
**Ranges (switch selected):**
0-2.5/5/10/25/50/100/250/500/1000/2500 amperes *plus* 5000 ampere range on Model CB-7120

**Overall Ammeter System Accuracy:**
**Panel Meter:** ± 1% full scale
**Current Transformer:** ± 0.5% full scale

**Protection:** Overload and short-circuit protection is provided by built-in circuit breaker and fuses.

**Leads:** The following extra-flexible test leads and cables are supplied:
One pair 4/0, five feet (1.52 m) long
One pair #6, five feet (1.52 m) long
One pair timer leads five feet (1.52 m) long
One pair continuity leads five feet (1.52 m) long
**Plus** one pair double 4/0, 5 feet (1.52 m) long with Model CB-7120

**Housing:** Rugged, one-piece sheetmetal enclosure with casters and carrying handles.

**Overall Dimensions:**

| | Model CB-7110 | Model CB-7120 |
|---|---|---|
| Height: | 24 in. (609 mm) | 24 in. (609 mm) |
| Depth: | 18 in. (457 mm) | 23 in. (584 mm) |
| Width: | 22 in. (559 mm) | 23 in. (584 mm) |

**Net Weight:**

**Model CB-7110:** 245 lbs. (111 kg)
**Model CB-7120:** 410 lbs. (186 kg)

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