INSTRUCTION MANUAL

For

MODEL CB-7120A

CIRCUIT BREAKER

TEST SET

SERIAL NO.

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

APPRECIATION

We are indebted to the manufacturers of circuit breakers and motor overload relays, who have given their time and advice in the preparation of this instruction book.

IMPORTANT

Please contact factory for additional copies of this manual and current price.

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USING THIS MANUAL

This manual has been written specifically for Multi-Amp® Model CB-7120A Universal Circuit Breaker Test Set. All features of this test set are covered in this Instruction Manual. However, this manual is, in general, applicable to other models based on the CB-7120A which will differ slightly in design and some have options available that may be included or excluded as specified by the purchaser. If this Instruction Manual is utilized for models other than the CB-7120A and confusion arises regarding which features and specifications apply, please refer to the product bulletin, specifications of the unit at time of order, and the schematic diagram supplied with the test set.

Every effort has been made to present the information in this Instruction Manual as accurately as possible. If the user identifies errors in content or text, please notify Multi-Amp Corporation, Attention: Product Management Department, Dallas, Texas. Complete address and other contact information are provided on the product bulletin.

Various methods are used in the text to assist the user in identifying features of the test set and to emphasize important information. When features of the test set are printed in upper case letters (i.e., POWER ON) in the text, this denotes the names of these features exactly as they are shown on the test set. Entire statements, and words not related to features of the test set, are printed in upper case, italics or boldface print for emphasis. Particular attention should be given to these items since they will refer to safety or operating information that will prevent injury to personnel, damage to equipment or errors in operation.

Some terminology used in this manual may differ according to local usage. As an example, "ground" and "grounding" are used interchangeably with the terms "earth" and "earthing." "Field adjustments" refer to adjustments that may be made on site as opposed to the factory or a calibration laboratory. Other terms may also differ. If any confusion arises regarding terminology used in this manual, please contact the factory for clarification.

When American Standard measurements have been converted to metric equivalents in the text, they are given in the closest, most commonly used metric equivalent and rounded to the nearest one tenth.

NOTE: All wire and cable referred to in this manual are to be insulated for **hard service** with have finely stranded, **copper** conductors for high conductivity and flexibility. *No other types of cable and conductors should be used.*

SAFETY PRECAUTIONS

Please read this instruction manual carefully and completely, and thoroughly understand all safety precautions, warnings and operating instructions prior to operating this test set. If a situation arises that is not covered in the manual, contact your Multi-Amp Representative or Multi-Amp Corporation, Dallas, Texas, U.S.A.

The design of the CB-7120A test set permits it to be operated beyond its minimum specifications. However, operation beyond minimum specifications and to maximum limits of operation are the responsibility of the purchaser. Since the input power source, input cables and test specimens are provided by the user, suitability and/or protection of them, and any damage to them or to the CB-7120A that may result from their use in conjunction with the test set is the responsibility of the user. Although the circuitry of the CB-7120A is well-protected, all possible causes of damage cannot be completely anticipated. It is incumbent upon the user to be familiar with the content of this Instruction Manual, the warranty limitations described herein, and to exercise good judgement in proper operation and application of the unit (see WARRANTY Section).

WARNING

DO **NOT** CONNECT THE MODEL CB-7120A TEST SET TO A POWER SOURCE UNTIL YOU HAVE READ THIS INSTRUCTION MANUAL COMPLETELY AND HAVE THOROUGHLY FAMILIARIZED YOURSELF WITH THE TEST SET'S OPERATION. THIS TEST SET IS CAPABLE OF DANGEROUS OUTPUT CURRENT AND POTENTIALLY LETHAL OUTPUT VOLTAGE. IMPROPER OPERATION COULD CAUSE DAMAGE TO THE TEST SET AND TO THE DEVICE UNDER TEST, AND CREATE AN UNSAFE CONDITION FOR PERSONS OPERATING THE TEST SET.

CAUTION

*When this test set is energized, all control circuitry is energized and should **always** be considered a shock hazard. Always regard output terminals of the test set as an energized circuit whether or not the output control system has been initiated.*

Each Model CB-7120A is provided with a power input plug. Always use a line cord having sufficient conductor size for expected input current, the correct voltage rating and an installed grounding conductor. The chassis of the test set is connected to the input power inlet receptacle grounding connection. For the safety of the operator and personnel in the vicinity of this test set, it must *always* be grounded when it is connected to a power source. If the power source receptacle is ungrounded, provision *must* be made for a grounding connection. The grounding circuit *must never* be defeated, bypassed, or otherwise modified as an operational shortcut. Additionally, do not depend solely upon the grounding circuit or other safety features of the test set for protection. Read and follow operating procedures to insure personal safety.

WARNING

NEVER BYPASS OR DEFEAT THE GROUNDING CIRCUIT OF THIS TEST SET OR IT MAY RESULT IN SERIOUS PERSONAL INJURY.

Do not operate this test set in wet areas, or outdoors when the possibility of inclement weather exists.

CONTROL PANEL DIAGRAM

MULTI-AMP® MODEL CB-7120A
CIRCUIT BREAKER TEST SET

FUNCTIONS 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 test sets incorporate a variable high current ac output, control circuitry, electronic digital timer, multi-range ammeter, and circuitry to monitor contact closure and opening. The test sets are self-protected against overloads and short circuits.

CONTROLS & INSTRUMENTATION (refer to illustration on previous page)

OUTPUT CONTROL:	The OUTPUT CONTROL is used to provide continuous control of the selected external output tap from zero to maximum.
VERNIER Control:	The VERNIER control is used for fine adjustment of the output current and is intended for <u>minor</u> current output adjustments.
INITIATE Pushbutton Switch:	Energizes the output and starts the timer.
EXT. INIT. (External Initiate) Jack:	This jack is wired in parallel with the INITIATE button and can be connected to an external switch to provide remote initiation of the test set.
CONTACTS Binding Posts:	These binding posts facilitate connection to a set of contacts on 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:	Measures output current.

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

Vernier Fuse (1.5A): Protects the vernier control circuit.

TIMER CIRCUIT: 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 (open-to-close, such as an overcurrent relay), this type of operation is used. In this position, the timer will run from the initiation of the test set until closure of the contacts connected to the CONTACTS binding posts.

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

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

The three operating modes above can be used in either MAINT. (Maintained) or MOM. (Momentary) positions.

(1) MAINT. (Maintain): In this position, when the INITIATE switch 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. (Momentary): In this position, the output of the test set is on only as long as the INITIATE switch 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® Model CB-7120A Circuit Breaker Test Set 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 to the circuit. See SELECTION OF COMMON TERMINAL.

The meter is a 4.5 inch (114.3 mm) square, iron-vane instrument of ±1% full scale accuracy. Whenever an indicating instrument of full scale accuracy is used, the user should choose a range that will give an indication as close to full scale as possible (upper 1/3 of scale). Note that there is no relationship between 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-preset mechanism which may be used to preset the ammeter pointer to any position on the scale and held there with no current in the meter circuit. The preset mechanism is adjusted with the insulated knob on the front of the meter. This device is used to overcome inertia of the moving system of the meter so that currents of short duration can be read accurately.

The pointer is positioned approximately 1/8 inch (3.2 mm) below the desired current with the preset knob. The device under test is connected to the test set and the output is slowly increased while the INITIATE switch is pressed in quick pulses to sample current level. The pointer will quiver as 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 switch long enough to be certain the ammeter pointer has stabilized.

INPUT AND OUTPUT CIRCUITS

INPUT

INPUT VOLTAGE: The Multi-Amp® Model CB-7120A Circuit Breaker Test Set is 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. This change is made on a terminal board located inside the top access panel.

WARNING

THE TEST SET MUST BE DISCONNECTED FROM THE POWER SOURCE BEFORE CHANGING THE INPUT TERMINAL CONNECTIONS.

INPUT LEADS: Due to the wide variation in individual user requirements with regard to wire sizes, terminations and length of leads, the test set is supplied with an 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 set is 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 input terminals during the test.

SELECTION OF INPUT LEADS: When utilizing maximum output from the test set, the input line current 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. (18.3 m)
(Distance from test set to input power source.)
Step 4 - # 2 AWG (33.6 sq mm) wire size (selected from chart)

NOTE: For input currents exceeding 600 amperes, it is recommended that # 2/0 (67.4 sq mm) cable be used and not exceed 50 feet (15.2 m) in length.

GROUNDING: For safety, a ground wire should be connected to the test set frame. The size of this conductor should not be less than 1/2 the cross sectional area of the current carrying input leads (three AWG wire-sizes less) and in no event smaller than # 10 (5.3 sq mm) (or the minimum size in accordance with local electrical codes and/or safety standards).

CAUTION

For safety of the operator, it is absolutely essential that the test set be properly and effectively grounded.

INPUT LEAD SELECTION CHART

WIRE SIZE: Conductor sizes referred to in this manual are common trade sizes given in AWG (American Wire Gage). AWG equivalents in circular mils and outside diameter (rounded to usual limits of commercial accuracy) are listed below:

American Wire Gage (AWG)	Circular Mils	Approximate O.D. in inches
4/0	211,600	0.73
3/0	167,800	0.61
2/0	133,100	0.55
1/0	105,500	0.49
1	83,690	0.44
2	66,370	0.39
4	41,740	0.31
6	26,250	0.22
8	16,510	0.17
10	10,380	0.12
12	6,530	0.10
14	4,107	0.08

CONVERSION TABLES

Wire sizes listed above can be converted to other measurements using the following factors:

1 cir mil	= 0.7854 sq mil	= 0.0005067 sq mm	= 0.00000007854 sq in.
1 sq mil	= 1.273 cir mil	= 0.000645 sq mm	= 0.000001 sq in.
1 sq mm	= 1,973 cir mil	= 1,550 sq mil	= 0.00155 sq in.
1 sq cm	= 197,300 cir mil	= 0.155 sq in	= 0.00108 sq ft.

Wire size varies with the type and style of conductor. Conversion to metric equivalents or other wire gage measurements should be considered approximate. When in doubt, use the next standard wire size larger.

Conversion factors for common linear measurements are as follows:

1 cm	= 0.3937 in	
1 mm	= 39.37 mils	= 0.03937 in.
1 in	= 25.4 mm	= 2.54 cm.
1 m	= 39.37 in	= 3.28 ft.
1 ft	= 30.48 cm	= 0.3048 m

OUTPUT

SELECTION OF THE OUTPUT TERMINAL: Several output terminals at various voltage and current ratings are provided to adapt the Multi-Amp® CB-7120A Circuit Breaker Test Set to a wide variety of test circuit impedances.

The test set 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 auto-transformer range. Even the smallest currents can be obtained from the highest current terminals. The *lower* current terminals should be used only when testing high impedance devices where the higher current terminals do 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 the Model CB-7120A 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: The test set is provided with a variety of high current test leads to connect a test specimen to the output terminals of the test set. 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 than 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 (107.2 sq mm) 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 of the test set and the device under test.

The two cables between the test set and the test specimen should be twisted together or bundled with tape, wire ties 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.

DUTY RATINGS AND OVERLOAD CAPACITIES: The Model CB-7120A is rated on a continuous duty basis as described by NEMA for test equipment in intermittent service; that is, 30 minutes ON followed by 30 minutes OFF. In other words, the equipment can supply rated output current for a maximum period of 30 minutes ON provided a 30 minute cooling OFF period follows. This is a satisfactory basis of rating for testing of circuit breakers and primary injection testing of relay and current transformers. When the test set is being used for heat runs on cables, bus bars, terminations, etc., the 30 minute ON time will be exceeded. In such cases, the output current should be limited to 70% of the rated current of the output terminal and may be continued for an indefinite time.

In addition to the continuous duty rating defined above, the Model CB-7120A has considerable short-time overload capability. Duration of the overload is governed by thermal considerations within the test set. The maximum current available is determined essentially by the impedance of the load. The duty cycle of the test set is as follows:

DUTY CYCLES OF MODEL CB-7120A
CIRCUIT BREAKER TEST SET

PERCENT RATED CURRENT	MAXIMUM TIME ON	MAXIMUM 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

TEST PROCEDURES FOR 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 for electro-mechanical devices.

If a thermal overload relay is not operating properly, or tripping too soon or too late, remove the heater element. Note its type, rating, etc., and compare this with the 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 of 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
OUTPUT CONTROL	Zero (counterclockwise)
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 relay control wiring 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 test leads from the CONTACTS binding posts to a N.C. set of control circuit contacts of the relay being tested.

5. Turn the test set's circuit breaker ON. The POWER ON lamp should light.

6. Select proper ammeter range. Adjust the pointer pre-set so that the ammeter needle is approximately 1/8 inch (3.2 mm) below the desired test current (see AMMETER CIRCUIT).

7. Set the desired test current by rotating the OUTPUT CONTROL clockwise 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 the procedure.

NOTE: If a small increase in the output current is desired, rotate the VERNIER control clockwise. At current levels above 100% of the current rating of the selected output tap, the VERNIER control should not be rotated more than the minimum amount necessary to make the desired adjustment. This is to prevent excessive load being transferred to the VERNIER control circuit. If it is necessary to rotate the VERNIER control more than 50% to obtain the desired current adjustment, rotate the VERNIER control counterclockwise to zero. Further increase the current with the OUTPUT CONTROL and repeat the procedure.

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

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

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

11. Initiate the test set by pressing the 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 and/or VERNIER control while the test is in progress.

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

TEST PROCEDURE FOR TESTING OF MOLDED CASE AND LOW VOLTAGE POWER 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 breakers.

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 of the time delay element is three times (3x) the current rating of the breaker; for low voltage power circuit breakers, suggested test current is three times (3x) the pick-up setting of the long time delay element and one and one half times (1.5x) the short time delay setting where the type of trip characteristics 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 instantaneous trip elements, run the test to find the minimum current required to trip the breaker instantaneously and compare to the setting. Remember that the 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 time delay elements be tested before any instantaneous tests are performed.

Most modern low voltage power circuit breakers are of the "draw-out" type and utilize "stab" connections. However, these breakers can still be tested with the CB-7120A by adapting the test cables to the breaker stabs with pieces of bus bar and/or C-clamps. When testing molded case breakers or any other breaker with bolted connections, the test leads supplied with the test set can be used to connect the breaker to the test set. In either case, the test leads should be as short as possible and twisted to minimize losses (see OUTPUT CONNECTIONS).

SETUP OF CONTROLS BEFORE TESTING

CONTROL	POSITION
Circuit Breaker	OFF
OUTPUT CONTROL	Zero (counterclockwise)
VERNIER Control	Zero (counterclockwise)
TIMER OPERATION SELECTOR Switch	C.A. 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. 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 in series with one pole of the breaker to be tested (see SELECTION OF COMMON TERMINAL and SELECTION OF OUTPUT TERMINAL).

4. If either a N.O. or N.C. contact is to be used for timing the breaker, select the appropriate TIMER OPERATION and connect a set of test leads from the CONTACTS binding posts to *another* pole of the breaker under test or the desired auxiliary contact.

5. Turn the test set's circuit breaker ON. The POWER ON lamp should light.

6. Select proper ammeter range. Adjust the pointer pre-set so that the ammeter needle is approximately 1/8 inch (3.2 mm) below the desired test current (see AMMETER CIRCUIT).

7. Set the desired test current by rotating the OUTPUT CONTROL clockwise 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 the procedure.

NOTE: If a small increase in the output current is desired, rotate the VERNIER control clockwise. At current levels above 100% of the current rating of the selected output tap, the VERNIER control should not be rotated more than the minimum amount necessary to make the desired adjustment. This is to prevent excessive load being transferred to the VERNIER control circuit. If it is necessary to rotate the VERNIER control more than 50% to obtain the desired current adjustment, rotate the VERNIER control counterclockwise to zero. Further increase the current with the OUTPUT CONTROL and repeat the procedure.

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

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

   NOTE: This is not necessary for breakers with solid-state overcurrent devices.

10. Change the TIMER OPERATION SELECTOR switch to the C.A. MAINT. position, or N.O. or N.C. MAINT. (as appropriate) if another pole of the breaker or an auxiliary contact is used for timer control.

11. Initiate the test set by pressing the INITIATE button. The timer will stop and the 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 and/or VERNIER control while the test is in progress.

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

TESTING OF INSTANTANEOUS PICK-UP

NOTE: To set up controls, see "SETUP OF CONTROLS BEFORE TESTING" on previous page.

1. Connect the test set to a suitable source of power. 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 OUTPUT CONNECTION).

4. If the N.O. or N.C. positions are used, connect a set of test leads from the CONTACTS binding posts to another pole of the breaker under test or the desired auxiliary contact.

NOTE: Not applicable when testing single-pole breakers using the C.A. Mode.

5. Turn the test set's circuit breaker ON. The POWER ON lamp should light.

6. Select the proper ammeter range so that the instantaneous pick-up current of the instantaneous element can be read as near to full scale as possible.

7. Set the desired test current by rotating the OUTPUT CONTROL clockwise 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 the procedure.

   NOTE: If fine adjustment of the output current is desired, use the OUTPUT CONTROL. Due to the high current levels involved in instantaneous pick-up tests, fine current adjustments utilizing the VERNIER control are not recommended.

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 it to the manufacturer's specifications and tolerances.

MAINTENANCE OF MOTOR OVERLOAD RELAYS

APPLICATION

The primary 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 requirements, 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 of 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. 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.

DESCRIPTION

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.

TYPES

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 dampened 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 solidify 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 the bimetallic unit and eventually open a set of contacts in the motor control, 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. **Electro-magnetic:** 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 electro-magnetic 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 insure continued, reliable operation. It is possible for dirt or dust created by conditions in the plant to prevent parts of 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 sectional area. 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 of the relay's time-current curves to make certain that the relay is operating properly. A tolerance of ±15% 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

APPLICATION

Molded case circuit breakers are used primarily for fault protection, protection for circuits with additional protection downstream, such as motor starters or thermal overloads, circuits that do not require frequent or remote operation and as a main disconnecting means. They are also used to protect general use circuits that do not have a defined characteristic other than the current rating of the conductor.

DESCRIPTION

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. Some newer styles include solid-state trip elements and operate very similar to low voltage power circuit breakers.

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 has been factory set and sealed, and is not adjustable. In larger molded case breakers, the instantaneous pickup of the trip may be adjustable and is set with an adjustment screw. This type of 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 six months or as long as every three or four 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. They are especially useful when more sophisticated protection is needed, especially at high currents. They can include many additional features for remote control and automatic operation.

DESCRIPTION

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.

TYPES

1. **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.

2. **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 the 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 characteristics 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 their 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 environmental conditions can render the breaker inoperable. Manually opening or closing the main contacts of the breaker does not "exercise" the overload trip device.

SUGGESTED RECORD FORMS

INSPECTION AND TEST RESULTS

SERVICE AND REPAIR DATA

SERVICING

The test set utilizes straightforward circuits and components which require little or no service except for routine cleaning, tightening of connections, etc. 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/dust
   b. moisture
   c. corrosion

2. Remove dirt/dust with dry, compressed air.

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

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

5. Check wiring and cable connections for solid connections (look for loose pin connections) and printed circuit boards for tightness.

6. Check enclosure and structure nuts, bolts, screws and other fasteners for tightness.

7. Contacts on open relays can be *carefully* burnished with an extra fine relay contact burnishing tool. No attempt should be made to service sealed relays. Do not attempt to adjust or repair any of the relays.

REPAIRS

The majority of operating problems are corrected by the general servicing mentioned above or by the adjustment procedure on the next page. Occasionally, however, repairs may be necessary. See RETURN AUTHORIZATION Section for further information.

Both the solid-state timer and analog ammeter may be removed as complete units and returned to the factory for repair and/or calibration. In some cases, the solid-state timer may be repaired on site by replacing printed circuit boards and certain individual components. However, this is not recommended unless sufficient equipment and technical expertise are available. Factory service, and at the minimum -- factory guidance, is highly recommended.

Most other parts in the test set are easily serviced or 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% of full scale deflection of the ammeter.

The "firing" point may be adjusted in the field 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 test set.

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

3. Set the AMMETER RANGE switch to any position.

4. Turn the test set's circuit breaker ON and allow 30 seconds for the thyratron tube to warm up.

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

6. Repeat Step 5, except that the output current is set at 20% of full deflection of the ammeter. When the INITIATE button is released, output should be maintained.

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

8. If proper adjustment cannot be accomplished, check the condition of components and connections in the circuit. If results do not improve, 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.

RETURN AUTHORIZATION INSTRUCTIONS

If factory service is required or desired, contact the factory for return instructions.

A Repair Authorization (RA) number will be assigned for proper handling of the unit when it arrives at the factory. A letter with the RA number and instructions can be provided, if desired.

Provide the factory with the Multi-Amp model number and serial number, nature of the problem or service desired, return address, your name, and where you can be reached should the factory need to contact you. If you wish, you may also provide a purchase order, cost limit, billing, and return shipping instructions.

If desired, National Institute of Standards and Technology (NIST) traceable calibration and certification of two types is available at additional cost.

Class One: A certificate is provided that verifies the traceability and calibration of the equipment.

Class N: That which is required by nuclear power plants. A certificate of traceability and calibration, and "as found" and "as left" data are provided.

NOTE

The equipment will receive normal factory calibration following repairs. However, *no documentation will be provided* with the equipment *unless* Class One or Class N calibration has been requested.

If an estimate is requested, provide the name and contact information of the person with approval/disapproval authority.

Pack the equipment appropriately to prevent damage during shipment. If you ship your equipment in a reusable crate or container and the container arrives in suitable condition, we will return the equipment in the same container. It is recommended that the container your Multi-Amp equipment arrived in from the factory not be discarded. It can be reused to return the equipment to the factory, should the need arise.

When returning equipment to the factory, put the RA number on the address label of the shipping container for proper identification and faster handling.

NOTE

When returning equipment to the factory, please *do not* include instruction manuals or nonessential items such as test leads, spare fuses, etc. These items are not needed at the factory to perform service or repairs. Please *do* include *all* interconnection cables, etc. which are required to make the unit operational.

WARRANTY

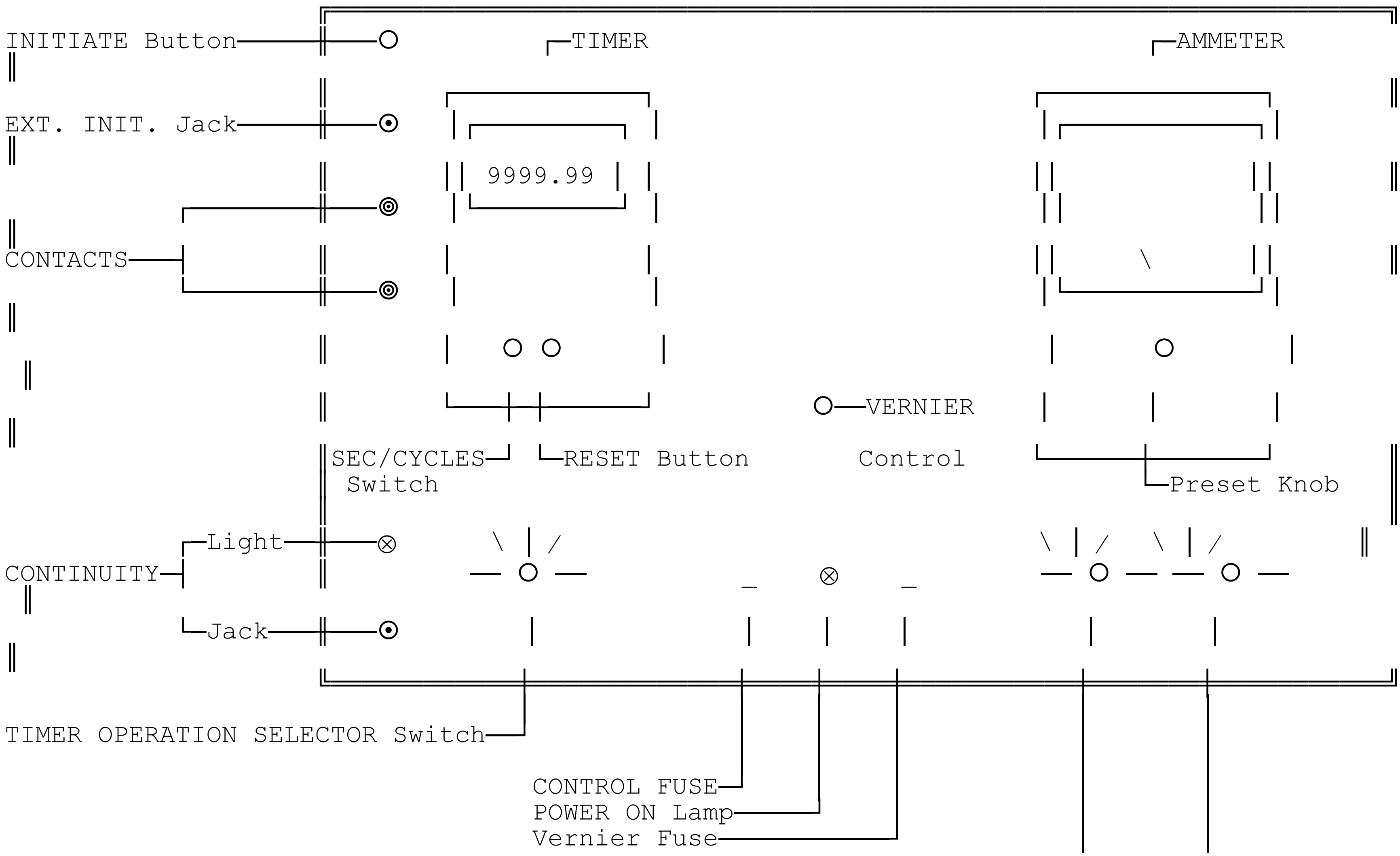
Multi-Amp Corporation warrants to the *original* purchaser that the product is free from defects in material and workmanship for a period of one (1) year from date of shipment. This warranty is **limited** and shall not apply to equipment which has damage or cause of defect due to accident, negligence, unauthorized modifications, improper operation, faulty installation by purchaser, or improper service or repair by any person, company, or corporation not authorized by the Multi-Amp Corporation.

Multi-Amp Corporation will, at its' own option, either repair or replace those parts and/or materials that it deems to be defective. Any costs incurred by the purchaser for the repair or replacement of such parts and/or materials shall be the sole responsibility of the *original* purchaser.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, ON THE PART OF MULTI-AMP CORPORATION. IN NO EVENT SHALL THE MULTI-AMP CORPORATION BE LIABLE FOR CONSEQUENTIAL DAMAGES DUE TO THE BREACH THEREOF.

CONTROL PANEL DIAGRAM

MULTI-AMP® MODEL CB-7120A
CIRCUIT BREAKER TEST SET



AMMETER RANGE Switch (COMMON 1)
AMMETER RANGE Switch (COMMON 2)