

**Model CB-100  
Vacuum Circuit Breaker**

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# 1. Introduction

The first model of AMR's vacuum circuit breaker, the CB-1000-450, was designed for use in mining applications. It provides a safer and more reliable circuit control system than the mechanical circuit breaker in use in power distribution centers. It can also be used as the belt or pump controller, replacing the mechanical circuit breaker, control contactor and overcurrent relay. Later, the CB-1000-300 and the CB-1000-600, were developed.

The CB-100 is a simplified version of the CB-1000. Currently, there are three models available. They are:

- CB-100-300, 300 amperes continuous current rating;
- CB-100-450, 450 amperes continuous current rating;
- CB-100-600, 600 amperes continuous current rating.

The vacuum breaker panel contains the following units:

- Vacuum Bottle Contactor with DC solenoid - switches three phase power to the load.
- Current Limiting Fuses - limit three phase fault current and disconnect the load under extreme fault currents.
- Phase Current Transformers - monitor phase current level for thermal and magnetic trips.
- Ground Fault Current Transformer - monitors circuit for a phase conductor to ground conductor fault condition.
- Auxiliary Contacts Interface - interfaces the vacuum contactor with the circuit control unit.
- Cable Receptacle - provides three phase power to the load.
- Circuit Control Unit - consolidates in one package all of the electronic circuitry needed to monitor and control the three phase circuit.

## 2. SPECIFICATIONS AND FEATURES

### A. SPECIFICATIONS

Item	CB-100-300	CB-100-450	CB-100-600
Operation voltage	1000 VAC	1000 VAC	1000 VAC
Operation current	100 - 300 A	100 - 450 A	100 - 600 A
Interrupting current	300,000 Amp	300,000 Amp	300,000 Amp
Operation Life	1 Million	1 Million	0.5 Million
Control voltage	120 VAC	120 VAC	120 VAC
Ambient temperature range	-40 to 135 °F	-31 to 185°F	14 to 122°F

### B. FEATURES

- Thermal overload protection.
- Instantaneous overload protection.
- Ground fault protection (4 Amp, 6 Amp, 12 Amp setting).
- Undervoltage protection.
- Continuous self-test (unit fault).
- Blown fuse detection and contactor bottle failure detection.
- Phase current imbalance protection (adjustable).
- Indicator lights for all faults on the front panel of the control unit.
- Remote open, close and reset.
- No external arcing.
- Extreme long life operations.
- Easily tested by Breaker Test Unit (BT-1000).
- Compact size.
- Lightweight.

### 3. DESCRIPTION

The model CB-100-300 vacuum circuit breaker is packaged on a 12 inch wide panel. The model CB-100-450 vacuum circuit breaker is packaged on a 14-1/2 inch wide panel commonly used in power distribution centers. The model CB-100-600 vacuum circuit breaker is packaged on a 17-1/2 inch wide panel. This allows for easy retrofit of a mechanical breaker panel with a vacuum breaker panel.

**Custom designed packages are available.**

#### A. Vacuum Bottle Contactor

The Vacuum Bottle Contactor provides the primary means for interrupting three phase fault currents. The unit consists of three vacuum bottle interrupters driven by a DC solenoid and insulating rod actuator assembly. Control voltage is derived from rectified 120 VAC through a diode bridge. The control line is driven on the DC side of the bridge by a solid state switch to achieve fast interrupt times.

The terminal block of the Contactor is connected to the CB-100 circuit control unit as shown in Figure 1. Two normally open and normally closed contact modules are located on each side of the contactor and are used by the CB-100 to determine the state of the vacuum bottles. The Auxiliary Contact Interface is connected to these contacts and to the CB-100 circuit control unit as shown in Figure 1.

The Vacuum Bottle Contactor used on each model is:

- CB-100-300, Joslyn Clark VC77U03515;
- CB-100-450, Jennings RP133-2332-00;
- CB-100-600, Toshiba CV212

## **B. Current Limiting Fuses**

The Current Limiting Fuses are state of the art semiconductor protection type devices selected for their high current disconnect, high voltage rating and fast disconnect time. Bussman Semitron type SPJ-6E600 (with a voltage rating of 1000 VAC) 600 Amp current limiters with indicators are used to interrupt the circuit for fault currents of 5000 amperes to 300,000 amperes on model CB-100-300. Bussman Semitron type SPJ-6E700 (with a voltage rating of 1000 VAC) 700 Amp current limiters with indicators are used to interrupt the circuit for fault currents of 6000 amperes to 300,000 amperes on models CB-100-450 and CB-100-600. The fuses must be mounted directly to the load side tabs of the vacuum contactor with the indicators visible from the cutout window. An insulator assembly is used to isolate the fuses from each other. The fuse monitor wires (P4-21, P4-22, and P4-23 shown in Figure 1) should be attached to the receptacle bolts so that during fuse replacement they do not have to be disconnected.

MSHA requires that a window be installed on the front panel to allow the fuses to be viewed from outside the enclosure which contains the vacuum breaker. This is to insure the operator that the fuses are in place and have not been jumpered out.

## **C. Phase Current Transformers**

An AMR current transformer (P/N 130-0079) is placed around each phase conductor as shown in Figure 1. The current transformer provides an output voltage which is a linear representation of the phase current. This output voltage is applied to the circuit control unit where electronic circuitry processes the voltage. Should the phase current exceed a preset long-term average level or a short-term peak level, the electronic circuitry causes the vacuum bottle breaker to interrupt the three phase circuit and indicate an overcurrent.

#### **D. Ground Fault Current Transformer**

An AMR current transformer (P/N 130-0032) is placed around all three phase conductors as shown in Figure 1. Since the circuit is three phase and under normal conditions currents are balanced, the ground fault current transformer provides an output when an imbalance in the three phase current exists. A phase to ground fault produces a three phase current imbalance that is detected by the transformer. The transformer output voltage is applied to the circuit control unit where electronic circuitry processes the voltage and causes the vacuum bottle breaker to interrupt the three phase circuit, and indicating a ground fault.

#### **E. Circuit Control Unit**

The circuit control unit is a removable assembly that contains all the controls, indicators, and two printed circuit boards that are necessary to control the operation of the vacuum circuit breaker. All indicators and controls are placed on the front panel for easy operator use. (See Table 1 for a description of the front panel controls and indications.)

The front panel printed circuit board assembly provides the following functions:

- This board contains the circuitry which processes the input from the various fault transducers. Phase overcurrent signals from the phase current transformers are compared with preset, thermal and magnetic trip levels. Thermal levels are set by a plug-in module on the front, while magnetic levels are established from the front panel magnetic current trip adjust. Should the over current signals exceed the preset levels, this board will send a contactor interrupt signal to the back panel printed circuit board assembly.
- Ground fault signals from the ground fault current transformer are compared with preset ground fault trip level. The trip level is set by means of the front panel ground fault trip DIP switch. It can be set as 4 Amp, 6 Amp or 7.5 Amp.

- The undervoltage condition signals are taken from the control voltage and compared with a regulated voltage.

The back panel printed circuit board assembly provides the following functions:

- Converts the incoming 24VAC to 30VDC and 12VDC to power the circuit control unit's electronic circuitry.
- Contains a solid state DC switch that interrupts DC power to the vacuum bottle contactor DC solenoid when a fault signal is received from the fault detector PC board.
- Monitors the three phase current imbalance. The setting of phase current imbalance can be adjusted by R84 and R123 on this board (see Figure 2).
- Monitors an open fuse or frozen contactor.
- Performs the unit self-test function. It generates the signals used to test the proper operation of the control unit. The test signals simulate fault conditions as received from the appropriate transducer, i.e., phase over current, ground fault or under voltage. These test signals are periodically applied to the control unit to test for proper processing. If the simulated fault conditions are not processed properly the contactor is interrupted and the unit fault LED is activated.
- Interfaces the circuit control unit to another controller, system, or monitor such as ground monitor and PLC. When this optional function is used a jumper on the right side of back panel printed circuit board must be removed.

## 4. OPERATION

Since the vacuum bottle contactor is limited to disconnecting faults less than 6000 amperes (or 5000 amperes), coordination of the disconnect time between the vacuum bottles and the fuses is crucial to the protection of the vacuum bottles and the prevention of nuisance fuse disconnects. The CB-100 Circuit Control Unit is designed to always open the vacuum bottle contactor before the fuses open for faults below 6000 amperes (or 5000 amperes). Fault currents above 6000 amperes (or 5000 amperes) generate a disconnect time faster than the contactor disconnect time, thus protecting the vacuum contactor bottles. Figure 3, Figure 4, and Figure 5 shows the coordination of the disconnect times between the fuses and vacuum bottle contactor for various fault currents.

Before turning the power on, the proper rating plug must be selected and installed. Set the magnetic trip adjustment to the proper level. Set the ground fault trip adjustment to the level as required.

When the power is initially turned on, some fault indicator lights may come on. By pushing the fault reset pushbutton on the front panel, all the fault indicator lights should go off if the unit is working correctly.

To prevent accidentally closing the vacuum circuit breaker, a close time delay is built into the circuit control unit. To close the vacuum circuit breaker, push and hold the close pushbutton switch for 3 seconds. Also, a "one shot circuit" is built into the circuit control unit to prevent a close switch failure. Push and hold the close switch for 3 seconds. If the breaker does not close, the close pushbutton switch must be released. Wait for 3 seconds, then again push and hold the switch for 3 seconds. Repeat again if the vacuum circuit breaker still does not close.

The CB-100 Circuit Breaker has front panel indicators to point the operator in the direction of a problem with either the power source (phase undervoltage or loss); the load (phase overcurrent, ground fault, fuse open or phase imbalance); or the circuit control unit (unit fault).

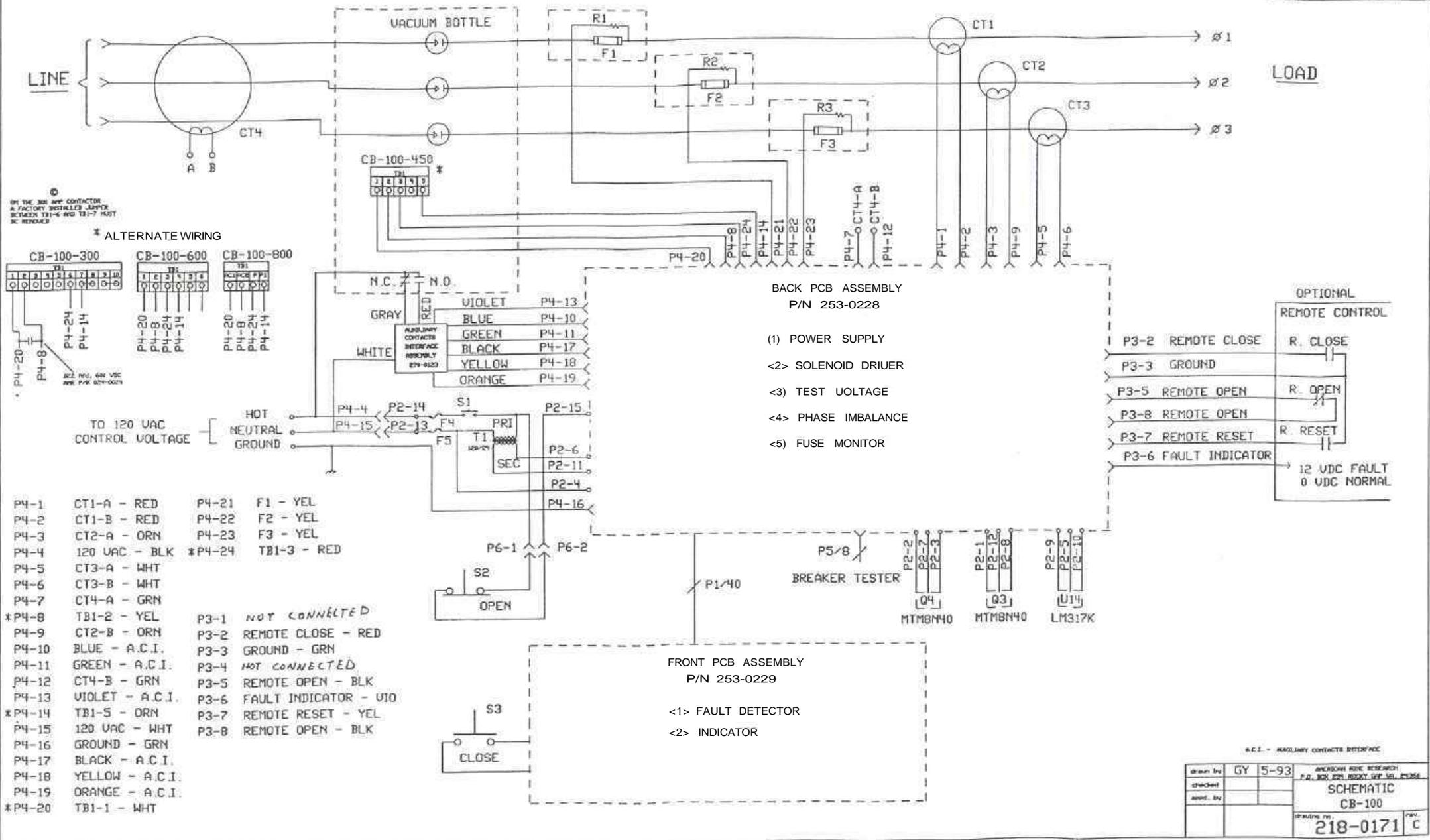
## 5. Caution

If "Fuse/Contact Failure" indicator is on, be sure to turn off the incoming power before troubleshooting.

Turn off the incoming power when checking fuses, current transformers, and vacuum contactor.

Figure 1, CB-100 Circuit Breaker

REVISION	DESCRIPTION	DATE	BY
B	ADDED WIRE COLORS, ADDED OPTIONAL REMOTE CONTROL, ADDED BUNA WIRING	8/78	
C	ADDED NOTE FOR 300 AMP CONTACTOR APPROX	7/79	RAY



A.C.I. - AUXILIARY CONTACTS INTERFACE

Drawn by	GY 5-93	APPROVED FOR REVISION
Checked by		P.A. BOYD, R.D. ROBERTS, W.E. WELLS
Approved by		
<b>SCHEMATIC</b>		
<b>CB-100</b>		
REVISION NO.	218-0171	REV. C

Figure 2, Phase Imbalance Setting

## PHASE IMBALANCE SETTING

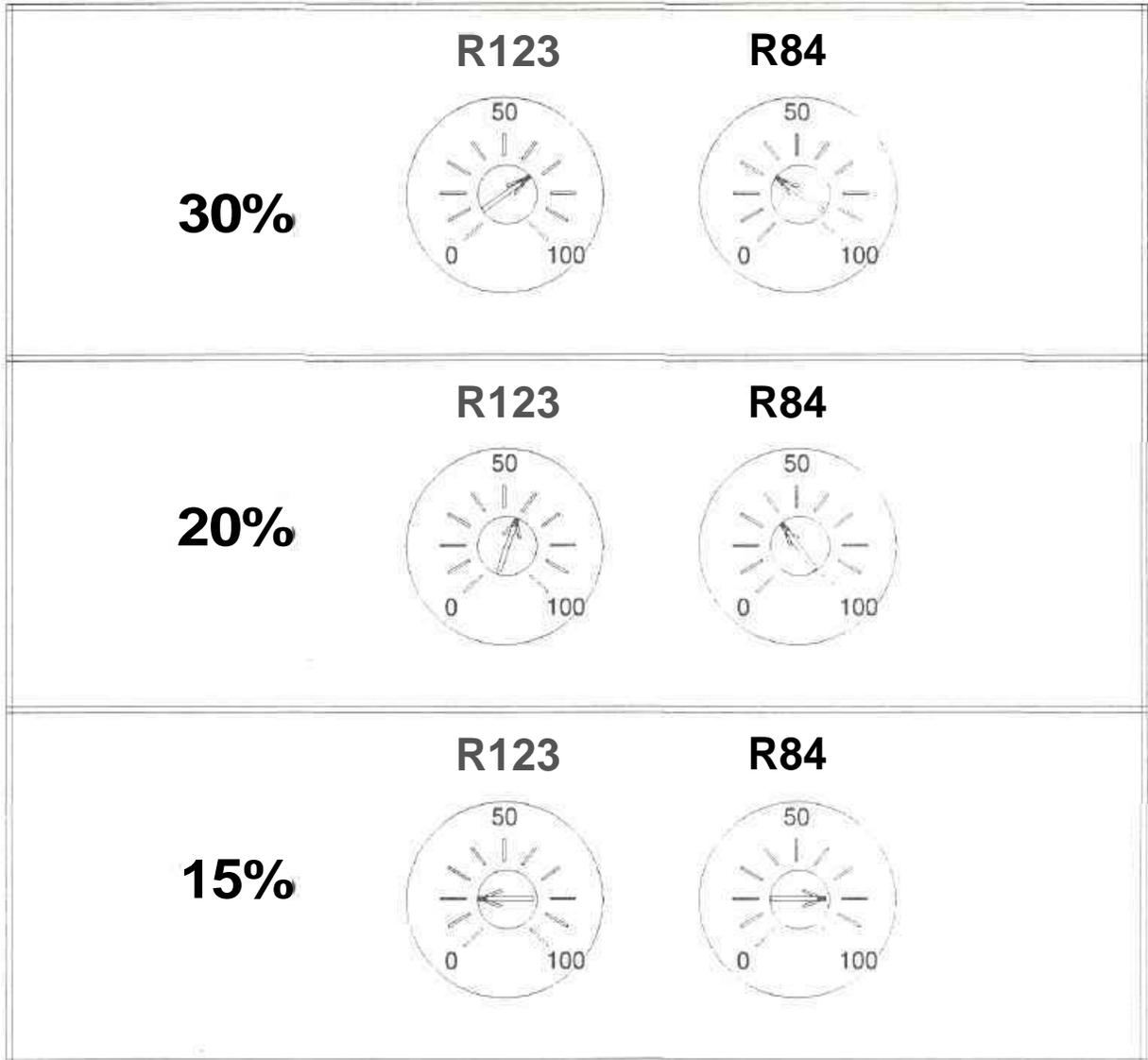


Figure 3. Clear Time vs. Current (Model CB-100-300)

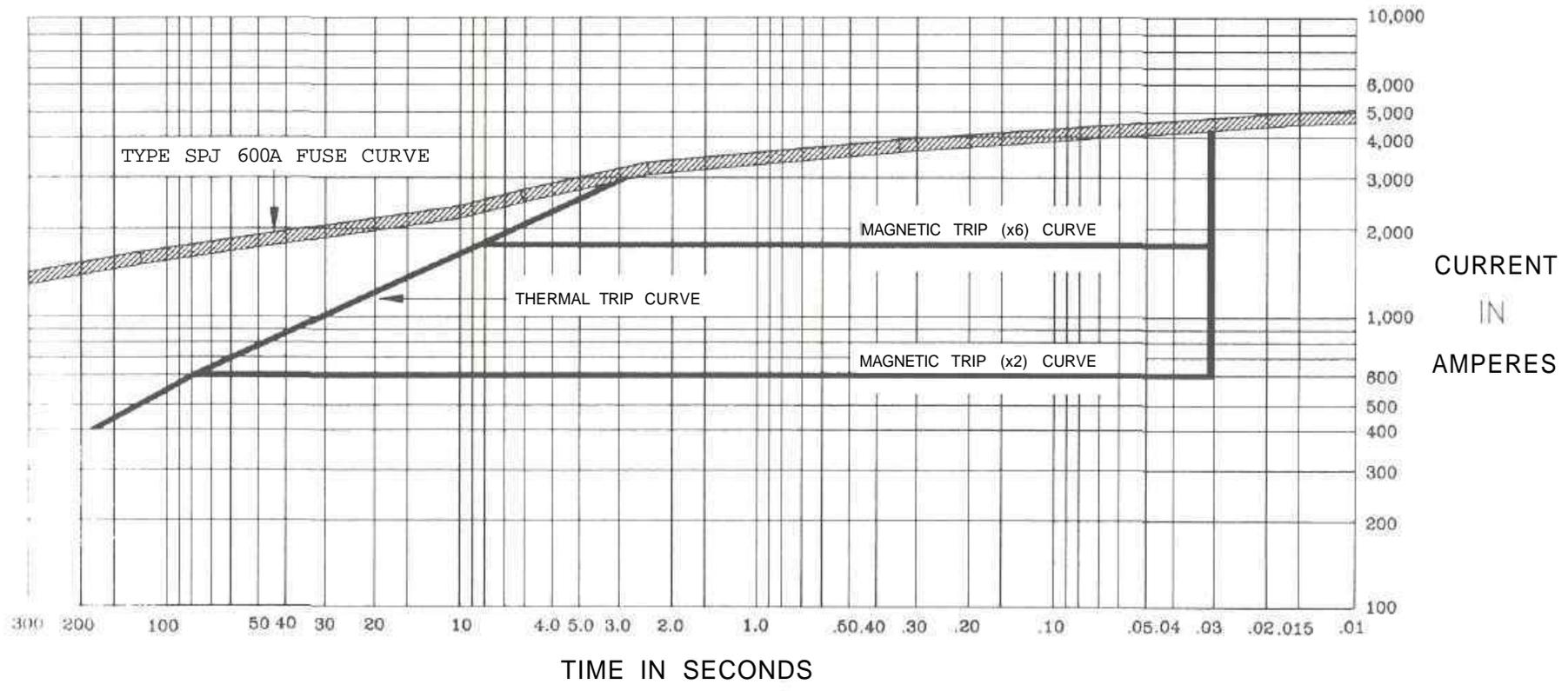


Figure 4, Clear Time vs. Current (Model CB-100-450)

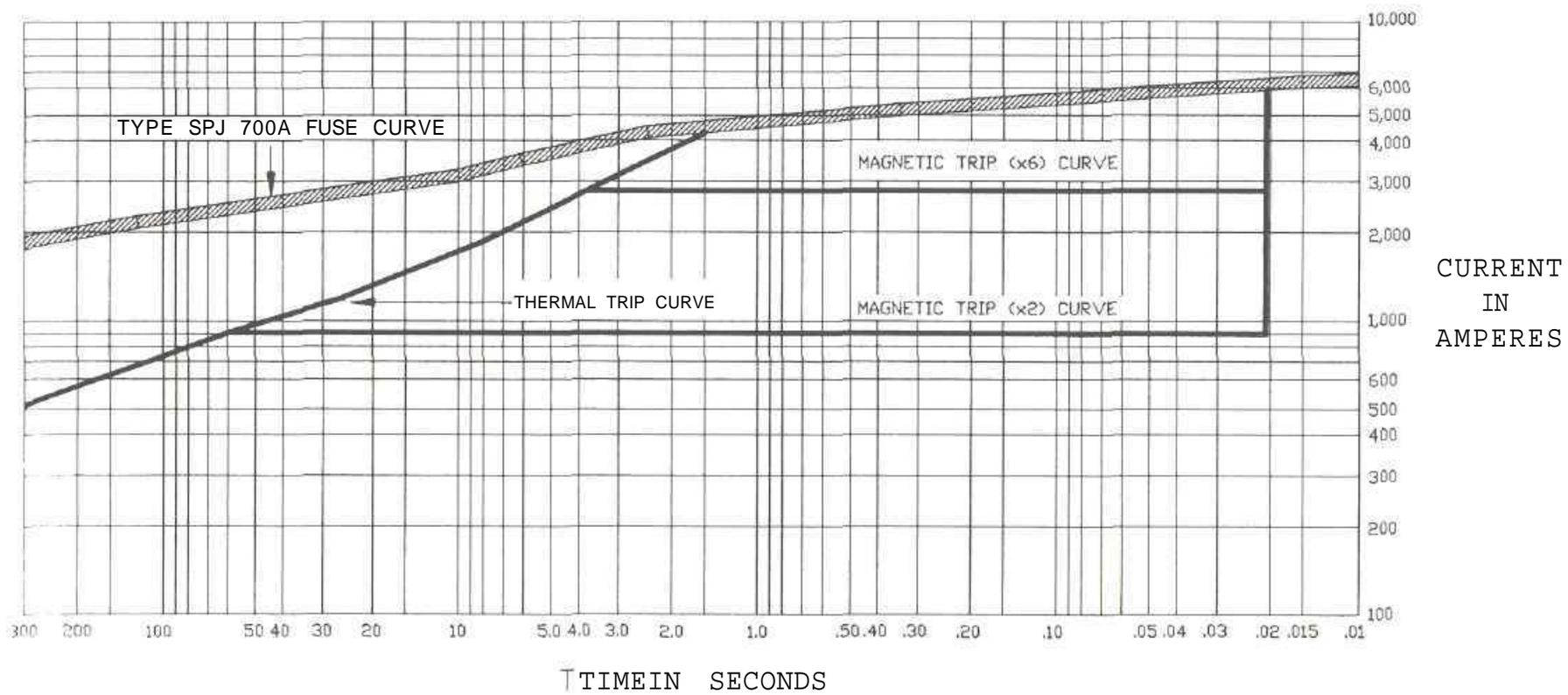
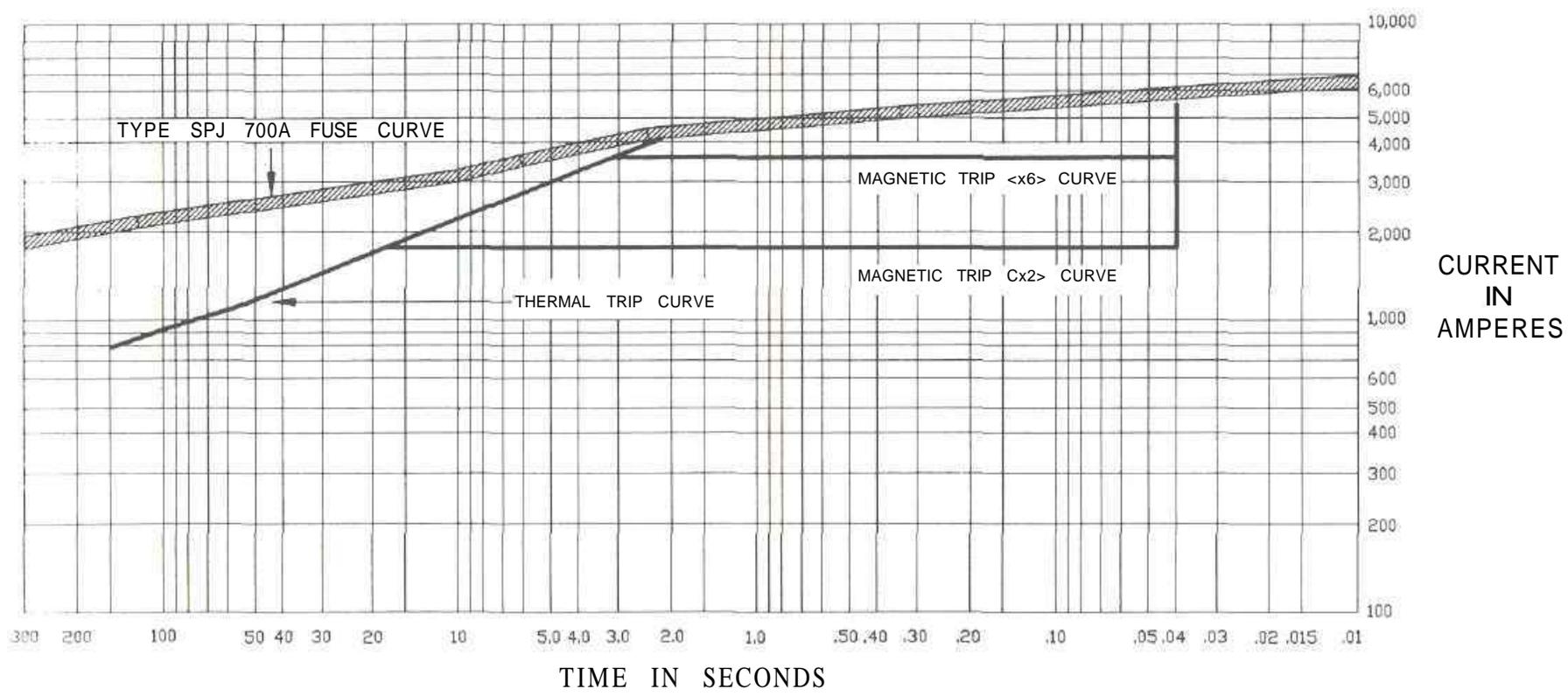


Figure 5, Clear Time vs. Current (Model CB-100-600)



**Table 1. Front Panel Controls and Indicators (continued)**

<b>Item</b>	<b>Description and Function</b>
Ground Fault Trip Setting	Two position DIP switch that allows the operator to set the breaker ground fault current trip level to 4 amperes, 6 amperes or 7.5 amperes.
Unit Test Receptacle	Receptacle for connecting the circuit control unit analyzer to the circuit control unit. The analyzer allows the operator to easily test the circuit control unit and contactor for proper operation under all fault conditions.
Current Rating Plug	Defines the thermal or continuous current trip level, used in conjunction with the magnetic trip adjust to set the magnetic trip level.

**Table 2. Available Current Rating Plugs**

<b>Model</b>	<b>Amperage Rating</b>
CB-100-300	100,150,200,250, 300
CB-100-450	100, ISO, 200,250, 300, 375, 400, 450
CB-100-600	100,150,200, 250, 300,375,400,450,500, 600

ADDENDUM

72996

VACUUM CIRCUIT BREAKER

- Model: CB-100 Joslyn Clark 300-AMP CONTACTOR
- Scope: The purpose of this addendum is to notify factory personnel, installers and users of the AMR Circuit Breaker of a revision change to AMR Schematic # 218-0171A to # 218-0171-C
- Reference: Schematic # 218-0171 -A  
AMR Manual Part # 180-0206
- Description: AMR drawing # 218-OI71-A, installation of the Vacuum Circuit Breaker, was revised to C on 7/29/96. The purpose of this revision is to show the proper "terminal block jumper configuration" for the Joslyn Clark 300 amp contactor. Contactors are shipped from Joslyn to AMR configured for 120 volt ac and with a jumper installed from Terminal 6 to 7. This jumper disables the EXTERNAL CONTROL used by the AMR Control Unit to operate the contactor. **THE JUMPER BETWEEN TERMINALS 6 AND 7 MUST BE REMOVED FOR THE VACUUM BREAKER TO FUNCTION PROPERLY. FAILURE TO REMOVE THIS JUMPER RESULTS IN AN UNSAFE CONDITION!** The breaker will immediately close when 120 volts ac is applied if the jumper is not removed.

Additionally, a capacitor must be added to the contactor between terminals TB1-1 and TB1-2. The capacitor is a .022mfd 600 VDC 10% film. (AMR P/N 024-0024)

For further information or questions pertaining to this matter please contact your AMR representative or call our Service Department at (540)-928-1712.

# APPENDIX A

## RECOMMENDED SPARE PARTS

<u>Parts Number</u>	<u>Description</u>	<u>Quantity</u>
253-0228	Back panel PCB assembly	1
253-0229	Front panel PCB assembly	1
270-0123	Aux. contactor interface	1
130-0079	Phase CT	3
130-0032	Ground fault CT	1
160-0024	Fuse, 15 Amp, slow blow	5
For model CB-100-300 only:		
160-0029	Fuse, 600 Amp, 1000V	3
011-0025	Rating plug, (300 Amp)	1
280-0077	Phase Assembly	3
280-0078	Control module	1
For model CB-100-450 only:		
160-0022	Fuse, 700 Amp, 1000 V	3
011-0002	Rating plug, (450 Amp)	1
For model CB-100-600 only:		
160-0022	Fuse, 700 Amp, 1000 V	3
011-0026	Rating plug, (600 Amp)	1
280-0072	Vacuum Interrupter	3
280-0073	Coil set	1
280-0074	Resistor assembly	1
280-0075	Rectifier assembly	1
280-0076	Contact wear guage	3
150-0043	Aux. terminal block	1
100-0007	Contact spring	3

## **APPENDIX B**

### **RECOMMENDED TESTING UNIT**

Model BT-1000 Circuit Breaker Tester.

# WARRANTY

American Mine Research Inc., warrants that each product manufactured by it is free from defects in material and workmanship under normal usage and service. The obligation under this warranty shall be limited to the repair or exchange of any part or demonstrated to be defective; provided, such part or parts is returned to American Mine Research, Inc.'s plant or to an authorized agent of American Mine Research, Inc., within ninety (90) days after delivery of the product to the original purchaser; such return to be made at the sole expense of the original purchaser.

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