AC STATIC KIT 3 LI #1696 1600
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ALLIS-CHALMERS CONTROLS

INSTRUCTIONS

model "A"
B

STATIC OVERCURRENT TRIP DEVICES

used with

TYPE LA POWER CIRCUIT BREAKERS

BWX-6678-1 18X4392

INDEX

ILLUSTRATIONS

KEN COOK TRANSNATIONAL PRINTED IN U.S.A.

INTRODUCTION

This instruction manual contains descriptive, operating, testing and maintenance information for Allis-Chalmers static overcurrent trip devices used with 600-volt class type LA power circuit breakers.

WARRANTY

The sales contract carries all information on warranty coverage.

DESCRIPTION

GENERAL

Allis-Chalmers overcurrent trip devices are completely static--there are no moving parts or contacts. Components used are semi-conductors, capacitors, transformers, etc. The circuits are designed for conservative loading of components for long life and little maintenance.

Although designed primarily for use with type LA circuit breakers, static overcurrent trip devices are not limited to that class of equipment. They perform the same functions--with greater accuracy and versatility--as electro-mechanical series overcurrent trip devices.

Static overcurrent trip devices operate to open the circuit breaker when the circuit current exceeds a preselected current-time relationship. Depending on the selected settings, tripping may be instantaneous or time delayed.

Energy to operate the tripping system is obtained solely from the circuit being protected. Batteries or other power sources are not needed.

The complete static overcurrent trip system consists of three parts--(1) primary circuit current transformers (2) the static overcurrent trip device (3) a magnetically held circuit breaker latch release device.

Current Transformers

Toroidal current transformers--similar to standard bushing current transformers--are mounted one per phase on the primary studs of the circuit breaker. They provide a signal to the static trip device in relation to the condition of the primary circuit and are used only for that purpose. The transformers selected for a specific circuit breaker establish the current rating of that breaker. Each transformer usually provides a choice of five ratings, which are listed on the breaker rating plate (Figs. 5, 6, 7).

Static Trip Device

The static trip device receives the signal from the current transformers. It monitors the signal, senses overloads and faults and determines the required action in accordance with preselected instructions. It is the "brains" of the tripping system.

A metal enclosure, attached to the breaker, houses the trip device and its electronic circuits. On the front of the metal enclosure is a calibration plate with the necessary adjusting knobs. Although several types of static trip devices are available, all are similar in size and appearance (Fig. 2).

Magnetic Latch Release

When the static trip device senses a circuit condition that requires the circuit breaker to open, it produces an output that is fed to the magnetic latch release device. This device then causes the circuit breaker contacts to open and isolate the circuit.

Mounted on the circuit breaker, the magnetic latch release is held in a charged position by a permanent magnet. It contains a coil that is energized by the output of the static trip device. When energized, the coil causes the magnetic flux to shift to a new path, releasing the stored energy of a spring located inside the magnetic latch release. The spring provides the energy to trip the breaker.

Variations of the magnetic latch release are used. Detailed descriptive information is included in specific circuit breaker instruction books. A typical release is shown in Fig. 1.

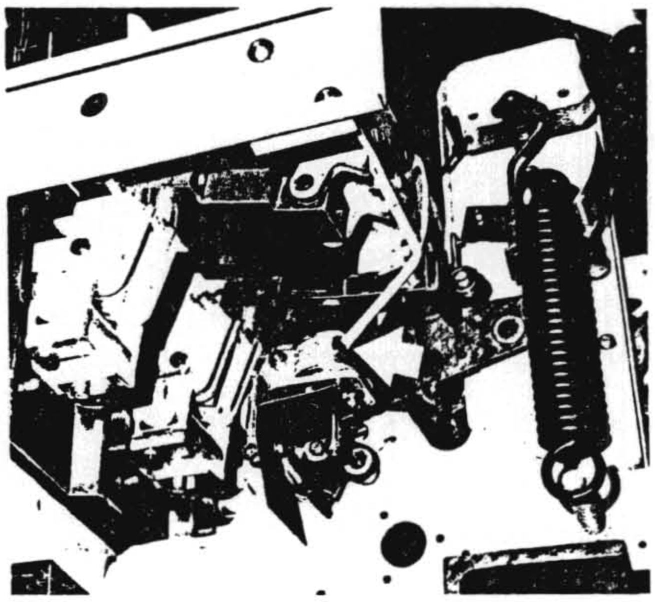


Fig. 1 — Typical magnetic latch release.

TYPES OF TRIP DEVICES

Six types of static trip devices are available. Similar in many respects, they differ only in their ultimate function. All use identical current transformer inputs and provide output signals to the magnetic latch release.

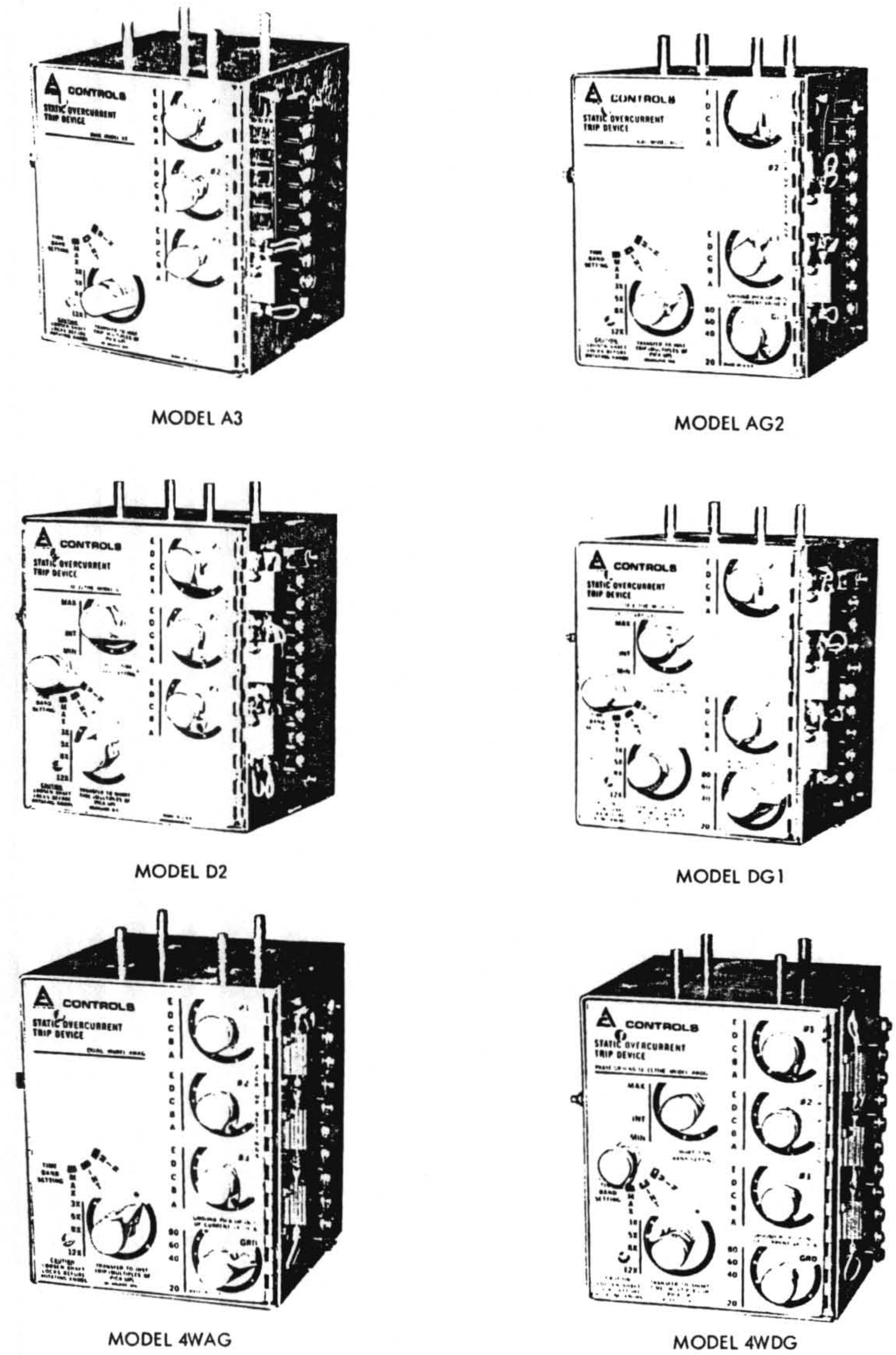


Fig. 2 — Typical overcurrent static trip devices.

Dual Models A1, A2, A3

Furnished with one non-adjustable time-current curve. The curve may be either for the minimum, the intermediate or the maximum curve as shown in Fig. 3. Time delay up to 12 times pickup and instantaneous trip adjustment between 3 and 12 times pickup is standard on current models. On older models time delay is up to 15 times and instantaneous adjustment between 5 and 15 times. These models monitor the current in each of the three phases.

Dual Models AG, AG1, AG2

Similar to the Models A1, A2 and A3 except that their circuits are arranged to monitor current in two phases and current in the neutral of the primary current transformers. In addition to providing normal overload and short circuit protection, these models also detect ground fault currents as low as 20% of the current required to operate the phase circuits. Ground fault tripping is through the normal time delay and instantaneous circuits.

Dual Model 4WAG

Provides protection on 4-wire circuits against ground faults as well as normal overloads. Current is monitored in all three phases and neutral. Ground current sensitivity same as for the AG2, but ground fault tripping is instantaneous at any value above pickup.

Selective Models D, D1, D2

These models available with three long time delay curves and three short time delay curves. Any of these combinations may be selected through settings on the device's calibration plate. Selectivity between coordinated circuit breakers can be maintained throughout the full interrupting range of the breakers. Model D devices monitor the currents in each of the three phases. The arrangement of the time-current curves is shown in Fig. 3.

Selective Models DG, DG1

Similar to the Models D, D1 and D2 except that their circuits are arranged to monitor current in two phases and current in the neutral of the primary current transformers. In addition to providing normal overload and short circuit protection, these models also detect ground fault currents as low as 20% of the current required to operate the phase circuits. Ground fault tripping is through the normal time delay and instantaneous circuits.

Selective Model 4WDG

Provides protection on 4-wire circuits against ground faults as well as normal overloads. Current is monitored in all three phases and neutral. Ground current sensitivity same as for the DG1, but tripping is through the short time band circuit at any value above pickup.

OPERATION

GENERAL

Basic operation of static trip devices can be understood for most applications without discussing technical aspects of the semi-conductor devices. A detailed technical description is covered in Bulletin 18X4433, "Description of Operation".

Functional block diagrams for all models are shown in Fig. 4. Differences between models is indicated in these illustrations.

There are three current transformers on the circuit breaker--one for each phase of the primary circuit (Fig. 4). On the 4-wire models, there is also a current transformer on the neutral. The current transformers supply a signal to the static trip device which is proportional to the current in the primary circuit. This signal passes through the power supply transformers to establish the self-contained regulated power supply for operating the static trip device and for tripping the circuit breaker. The signal then goes to the auxiliary transformers where it is modified by the pickup adjustment potentiometers. The pickup adjustment is the means by which a specific pickup current is selected by referring to the breaker rating plate (Figs. 5, 6, 7).

The three individual ac signals then go to the signal rectifier and filter circuit where they are combined into a single dc signal, which is compared to a standard preset value. If the signal is below the preset value nothing further happens and the static trip device continues to monitor it. If the signal exceeds the preset value, the trigger circuit is immediately turned on. This in turn allows the timing circuit to start functioning.

Meanwhile, the signal is also being fed into the time shaping circuit which determines the shape and slope of the time-current curve. The output of the time shaping circuit is stored in the timing circuit until the proper time delay--depending on the magnitude of the signal--has been reached. When the proper time delay is reached, the timing circuit will cause the static switch to turn on and energize the circuit breaker trip coil.

When the breaker opens, the signal to the trip device disappears. Then, the trip device automatically resets itself and turns off the trigger circuit.

If the signal exceeds a value established by the preselected adjustments, it will bypass the timing circuit entirely and go directly to the static switch, turn it on and trip the breaker. This is the instantaneous trip feature of Dual models (A, A1, A2, AG, AG1, AG2, 4WAG), shown on the time-current curve (Fig. 3).

Trip Rating Table

Breaker Type	Models A3, AG2, 4WAG, D2, DG1, 4WDG — Long Time Delay Elements Available Pickup Settings (Amperes)					Tripping Transformer Group No.	Models AG2 and DG1 — Long Time Delay Element Available Ground Fault Settings (Amperes) — Percent of "A" Pickup				Models 4WAG and 4WDG — Inst. or Short Time Delay Available Ground Fault Settings (Amperes) — Percent of "A" Pickup			
	A	B	C	D	E		20%	40%	60%	80%	20%	40%	60%	80%
LA-600	40	50	60	70	80	I	–	–	–	–	–	–	–	–
LA-600	75	95	110	130	150	II	–	–	–	–	–	30	45	60
LA-600 LA-1600	125	155	175	220	250	III	–	–	–	–	25	50	75	100
LA-600 LA-1600	200	250	300	350	400	IV	40	80	120	160	40	80	120	160
LA-600 LA-1600	300	375	450	525	600	V	60	120	180	240	60	120	180	240
LA-600 LA-1600	400	500	600*	700	800	V-x	80	160	240	320	80	160	240	320
LA-1600	500	625	750	875	1000	VI	100	200	300	400	100	200	300	400
LA-1600	800	1000	1200	1400	1600	VII	160	320	480	640	160	320	480	640
LA-1600	1000	1250	1500*	1750	2000	VII-x	200	400	600	800	200	400	600	800
LA-3000	1200	1500	1800	2100	2400	VIII	240	480	720	960	240	480	720	960
LA-3000 LA-4000	2000	2500	3000			IX	400	800	1200	1600	400	800	1200	1600
LA-3000	2000	2500	3000	3500*	4000*	IX-x	400	800	1200	1600	400	800	1200	1600
LA-4000	2000	2500	3000	3500	4000	X	400	800	1200	1600	400	800	1200	1600

* Maximum continuous current for LA-600 is 600A, LA-1600 is 1600A, LA-3000 is 3000A and LA-4000 is 4000A.

GENERAL NOTES

1. Types

   A – Dual Static (long time and instantaneous elements).

   D – Selective Static (long time and short time elements).

   AG – Dual Static with ground fault element for 3-wire circuits.

   DG – Selective Static with ground fault element for 3-wire circuits.

   4WAG – Dual Static with ground fault element for 4-wire or 3-wire circuits.

   4WDG – Selective Static with ground fault element for 4-wire or 3-wire circuits.

2. The pickup settings of the instantaneous and short time delay elements are calibrated at 3, 5, 8 and 12 multiples of the long time delay pickup setting.

3. The maximum interrupting time is the maximum length of time that fault current flows, including arcing time.

4. Instantaneous maximum interrupting time may be greater when breakers are closed in on a fault depending on actual fault conditions. The maximum potential increase for a 3-phase fault is 0.01 seconds and for a single-phase ground fault is 0.02 seconds.

5. The lower limit of ground fault recognition is 25 amperes for an LA-600 breaker. For an LA-1600 breaker the lower limit is 40 amperes. Application of Models 4WAG and 4WDG is not recommended for LA-600 breakers having a minimum continuous current setting of less than 75 amperes or an LA-1600 breaker with a minimum continuous current setting of less than 200 amperes.

DUAL DEVICE

Model A – a general purpose device normally used for phase overcurrent protection. The pickup range is selected from the trip rating table and is continuously adjustable from "A" through "E" in the field. The instantaneous element is continuously field adjustable from 3 to 12 multiples of the long time delay pickup settings selected. The time delay band is selcted and set at the factory – it is not field adjustable. Available time delays are minimum, intermediate and maximum.

Model AG (optional) – provides phase overcurrent protection plus sensitive ground fault overcurrent protection for systems with phase-to-phase loading. Ground current pickup settings are independent of the phase pickup settings, and continuously adjustable in the field from 20% through 80% of the minimum phase pickup setting shown in column "A."

Model 4WAG (optional) – provides phase overcurrent protection plus sensitive ground fault overcurrent protection for 3-wire and 4-wire circuits for systems with phase-to-neutral loading. Ground current pickup settings are independent of the phase pickup settings, and continuously adjustable in the field from 20% through 80% of the minimum phase pickup setting in column "A."

Model D (optional) – an overcurrent trip device which provides time delay tripping only. It allows field adjustment of long time delay and pickup and short time delay and pickup. The continuous adjustment feature allows a setting selection anywhere within calibrated points. The user can adjust the current at which the device transfers from long time to short time delay between these limits. Any one of the three short time delay curves can be chosen to be used with any of the three long time delay curves.

Model DG (optional) – provides phase overcurrent protection plus sensitive ground fault overcurrent protection for systems with phase-to-phase loading. Ground current pickup settings are independent of the phase pickup settings, and continuously adjustable in the field from 20% through 80% of the minimum phase pickup setting shown in column "A."

Model 4WDG (optional) – provides phase overcurrent protection plus sensitive ground fault overcurrent protection for 3-wire and 4-wire circuits for systems with phase-to-neutral loading. Ground current pickup settings are independent of the phase pickup settings and continuously adjustable in the field from 20% through 80% of the minimum phase pickup setting in column "A."

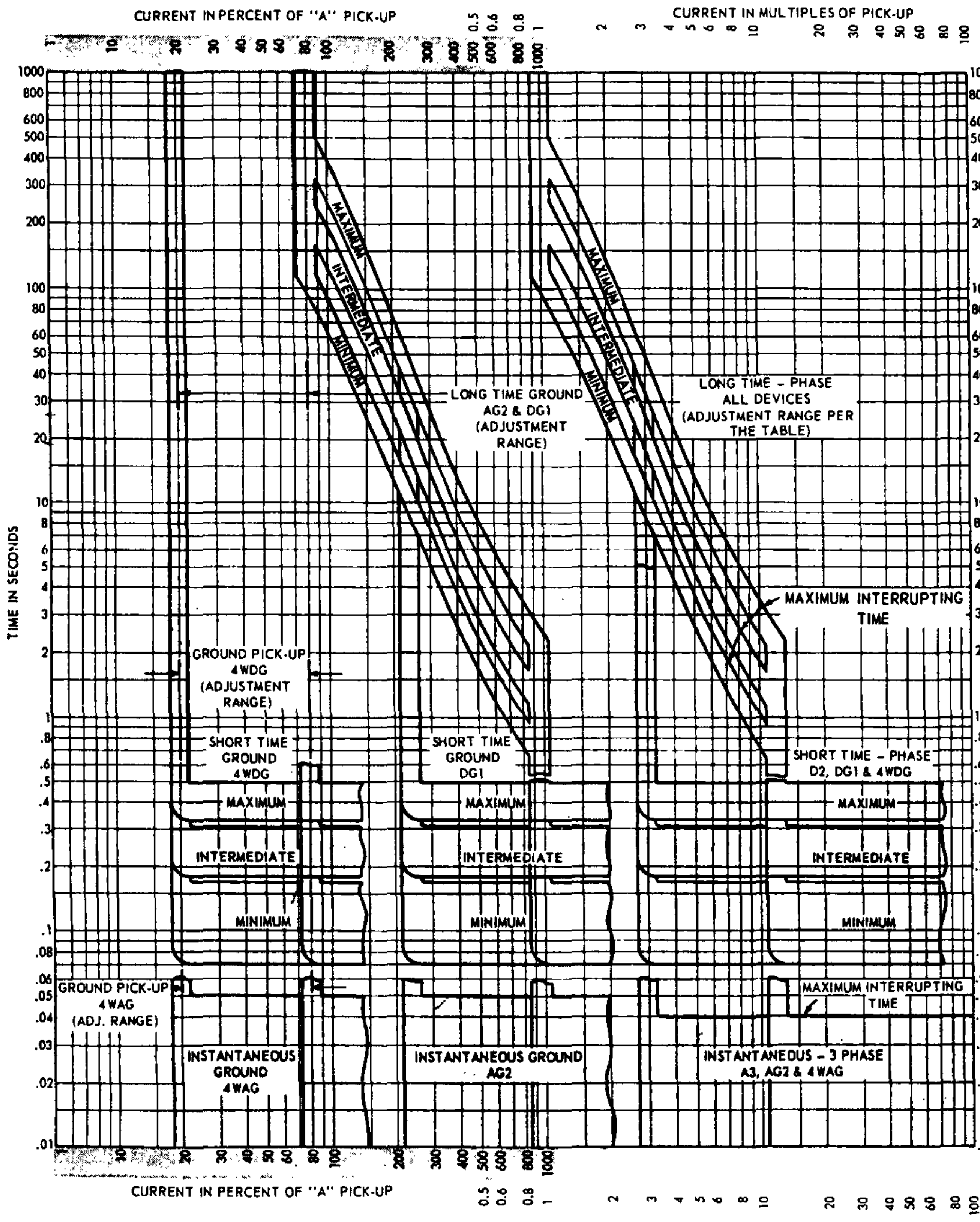


Fig. 3 — Time current characteristic curves

The Selective models (D, D1, D2, DG, DG1, DG2, 4WDG) do not have an instantaneous trip feature. Instead they have selective short-time delay curves. The circuits (dotted lines in Fig. 4) establish the timing characteristics for the short-time function. The signal will automatically activate either the long-time or short-time trigger circuits, depending on the magnitude of the signal and the setting of the pre-selected adjustments. The short-time circuits do not require a time shaping circuit because they are constant-time curves (Fig. 3).

Operation of the DG and AG models is identical to the D and A models, respectively, except that one set of transformers and pickup adjustments--designed to provide a more sensitive response than that of the phase circuits--are located in the neutral circuit of the primary current transformers.

The specific amount of time delay in all models is controlled by the values of components in the timing circuit. These components determine the location of the minimum, intermediate and maximum time bands on the time scale. The components are fixed on A models to provide one time band. D models can be adjusted to a choice of any long-time plus any short-time band.

The trigger circuit is turned on when the signal exceeds a pre-set standard value and allows timing to take place. If the signal decreases because of the primary current fault or overload being reduced to less than about 95% of the selected pickup value during a timing operation, the trigger will shut off and the timing circuit will revert to its original steady state condition. Thus, loss of the fault or overload before the trip device has completed its timing function will cause it to reset and prevent the breaker from receiving a tripping signal.

SELECTING SETTINGS

Static trip devices have a number of knobs and switches that can be arranged to select specific conditions to cause the breaker to open. Selection of settings is usually made when the breaker is placed in service. Future changes are unnecessary unless load condition or other primary circuit changes are made.

> All selection knobs have shaft locks to assure retention of settings. Turning the knob of a locked shaft will cause loss of calibration. Refer to page 18 for instructions on restoring lost calibration.

Pickup Selection

The knobs arranged vertically on the right hand side of the device are used to select the current at which a time delay tripping will start. This is the pickup current. One knob is provided for each phase on A and D models. On AG and DG models, the center knob is for ground current pickup. Models 4WAG and 4WDG have a knob for each of the three phases plus a fourth knob at the bottom for ground current pickup.

Pickup selection dials are marked with the letters "A" through "E." The pickup current defined by each letter is listed on the circuit breaker rating plate (Figs. 5, 6, 7). This is the minimum primary circuit current which will cause the circuit breaker to open.

Example A circuit breaker has a rating plate as shown in Figure 5. The pickup settings are at point "A." Therefore, the circuit will carry up to 200 amperes without tripping the circuit breaker. Above 200 amperes a trip operation will occur.

The pickup selection is continuous and may be set between marks if desired. Usual practice is to set all pickup knobs at the same mark, but this is not necessary and different phases can have different pickup settings.

The rating of the circuit breaker depends solely on the primary current transformers selected for the application and is limited only by the circuit breaker frame size. The rating of a circuit breaker may be changed by replacing the current transformers and the breaker rating plate. The trip device or other components remain unchanged. Figures 5, 6 and 7 show breaker ratings available with various current transformers.

Example The transformers on the breaker represented by the rating plate in Figure 5 are changed to have 600 maximum rated amperes (A=300, B=375, C=450, D=525, E=600). The pickup settings are still on "A." The circuit will now carry up to 300 amperes and will trip on anything above 300 amperes in the primary circuit.

Ground Pickup Selection – AG and DG Models

The middle knob on the right hand side of AG, AG1, AG2, DG and DG1 models is used to select the sensitivity of ground current detection. It is calibrated as a percentage of the minimum available pickup current shown on the breaker rating plate (Fig. 6). It does not have any relationship to the pickup current selected for the phase settings. Calibrations are marked at 20%, 40%, 60% and 80% but adjustment is continuous. Figure 6 shows available ground current pickup settings for various primary current transformers.

Example (1) A circuit breaker has a rating plate per Fig. 6. The pickup settings are on "C" to select 300 amperes pickup. The ground pickup is set at 40%. The ground current that will cause tripping is, therefore, not less than 40% of 200 amperes, or 80 amperes.

Example (2) Same conditions except pickup settings are on "E" to select 400 amperes pickup. The ground pickup is still 80 amperes, based on the minimum available pickup of 200 amperes.

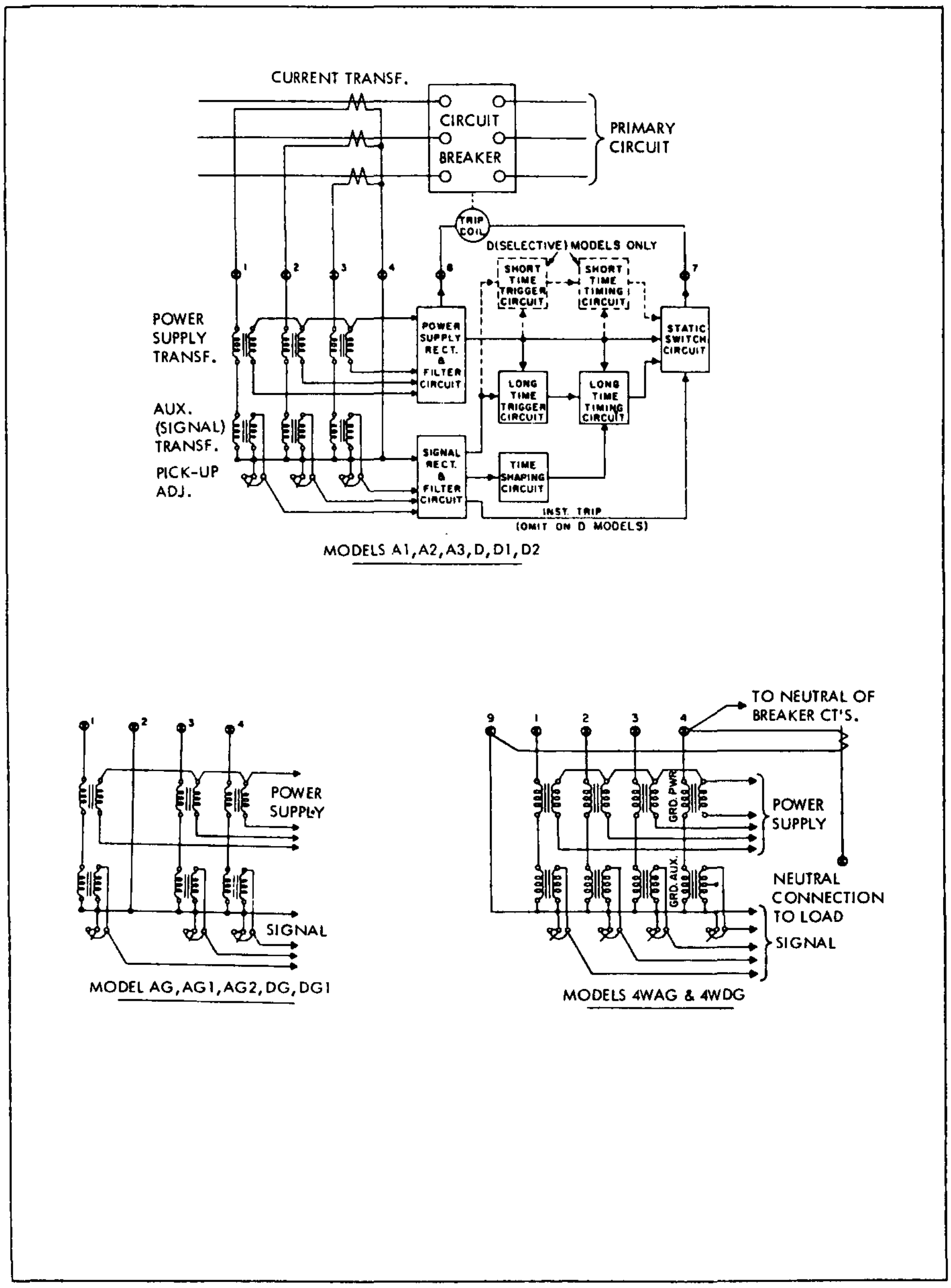


Fig. 4 — Functional block diagrams.

Ground current pickup on AG and DG devices is treated in the same manner as phase current pickup when using the time-current curve and the same curve (Fig. 3) is used for defining time delay.

Example (3) Breaker rating per Figure 6. Phase pickup setting "E" (400 amperes). Transfer to instantaneous setting - 5X. Ground pickup setting 40% (80 amperes). An actual ground current of 320 amperes is flowing. 320 amperes ground current is four times (4X) pickup and will cause a trip operation in 3-1/2 seconds (on the minimum time band) as shown on the time-current curve (Fig. 3). However, if transfer to instantaneous setting were less than 4X, tripping would be instantaneous. Note that this ground current is much less than the phase pickup setting and would not be recognized on the phase pickups.

The lower limit of ground fault recognition on the AG and DG models is <u>40</u> amperes ground current. Primary current transformers that provide a minimum continuous setting of less than 200 amperes should not be used for ground fault detection. LA-1600 breakers using the DG device will have the limitation of <u>80</u> amperes minimum ground fault recognition and will require primary current transformers that provide a minimum continuous current setting of 400 amperes or more (Fig. 5).

Ground Pickup Selection – 4WAG and 4WDG Models

The bottom knob on the right hand side of 4WAG and 4WDG models is used to select the sensitivity of ground current detection. It is calibrated as a percentage of the <u>minimum</u> available pickup current shown on the breaker rating plate (Fig. 7) and is independent of the pickup current selected for the phase settings. Calibrations are marked at 20, 40, 60, and 80% but adjustment is continuous. Figure 7 shows available ground current pickup settings for various primary current transformers.

The lower limit of ground fault recognition for 4-wire ground models (4WAG and 4WDG) is 25 amperes. This sensitivity would be obtained with a primary current transformer that provides a minimum continuous current setting of 125 amperes and with a ground pickup setting of 20%.

Instantaneous Trip Selection – Dual Models

The "Instantaneous Trip Setting" knob of dual models (A, A1, A2, A3, AG, AG1, AG2 and 4WAG) selects a current value above which tripping takes place instantaneously instead of on time delay. The calibration is marked in multiples of pickup and allows selection between three (3X) and twelve (12X) times pickup. Thus, it is dependent on the settings selected for phase pickup and also for ground pickup on the AG, AG1, AG2, and 4WAG models. The time-current curve (Fig. 3) shows how the time delay on all models except 4WAG will follow the appropriate time band curve until the instantaneous setting is reached, then will go to the instantaneous value for all currents above that setting. On model 4WAG ground tripping is always instantaneous.

Transfer to Short Time Selection

D, DG, and 4WDG models. The knob on D, DG, and 4WDG models marked TRANSFER TO SHORT TIME selects the value of primary current above which the time delay will follow the selected short-time band. It is calibrated in multiples of the selected phase pick-up current. Markings are provided at 3, 5, 8, and 12 times pickup. The primary current value of this adjustment depends on the phase pickup setting that has been selected.

Example Breaker rating as per Fig. 5. Phase pickup settings "A" (200 amps). Long time band setting is on "maximum." Short time band setting is on "minimum." Transfer to short time is set at 12X.

Currents between 200 and 2400 amperes will trip the breaker after a time delay defined by the maximum long time curve (Fig. 3). Currents above 2400 amperes will trip the breaker in the time indicated by the minimum short time curve.

If the phase pickup settings were changed to "B" (250 amperes), then the short time band would be used for currents of 3000 amperes and above.

Example Breaker rating as per Figure 7. Phase pick-up setting "E" (400 Amps). Instantaneous setting 8X (3200 amps).

Current above 3200 Amps will cause instantaneous tripping to occur; currents below 3200 Amps will follow the appropriate time delay curve.

Example Breaker rating as per Figure 6A. Phase pick-up setting "E" (400 Amps). Ground pick-up setting 40% (80 Amps). Instantaneous setting 8X.

In this example using a Model AG, the breaker will trip without time delay if the phase current exceeds 3200 Amps, or if the ground current exceeds 640 Amps.

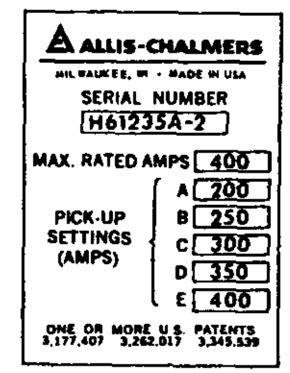
Time Band Selection

The time bands on the A, AG, and 4WAG models are set during manufacture and cannot be changed. The legend on the left side of the static trip device indicates whether the particular device is set for minimum, intermediate, or maximum time band, corresponding to the curves on Figure 3.

The D, DG, and 4WDG models are arranged so that any of the time bands may be selected. There are two groups of time bands provided; one for long time delay and one for short time delay, corresponding to the curves on Figure 3.

The D, DG, and 4DWG models have a three position switch marked LONG TIME BAND SETTING

CIRCUIT BREAKER RATING PLATE (MAX. RATED AMPERES)	AVAILABLE CONTINUOUS CURRENT SETTINGS (AMPS) MODELS A1, A2, D, D1				
	A	B	C	D	E
80	40	50	60	70	80
150	75	95	110	130	150
250	125	155	175	220	250
400	200	250	300	350	400
600	300	375	450	525	600
800	400	500	600	700	800
1000	500	625	750	875	1000
1600	800	1000	1200	1400	1600
2000	1000	1250	1500	1750	2000
2400	1200	1500	1800	2100	2400
4000	2000	2500	3000	3500	4000



Notes: a) Primary current transformers are related to the circuit breaker type and frame size.

b) Ground current settings (models AG, DG) are independent of the continuous current settings.

Fig. 5 — Current settings Models A1, A2, D, D1.

CIRCUIT BREAKER RATING PLATE (MAX. RATED AMPERES)	AVAILABLE CONTINUOUS CURRENT SETTINGS (AMPS) MODELS AG, AG-1, DG*					AVAILABLE GROUND CURRENT SETTINGS (AMPS) MODELS AG, AG-1, DG*			
	A	B	C	D	E	20%	40%	60%	80%
400	200	250	300	350	400	40	80	120	160
600	300	375	450	525	600	60	120	180	240
800	*400	500	600	700	800	80	160	240	320
1000	500	625	750	875	1000	100	200	300	400
1600	800	1000	1200	1400	1600	160	320	480	640
2000	1000	1250	1500	1750	2000	200	400	600	800
2400	1200	1500	1800	2100	2400	240	480	720	960
4000	2000	2500	3000	3500	4000	400	800	1200	1600

Notes: a) Primary current transformers are related to the circuit breaker type and frame size.

b) Ground current settings (model AG) are independent of the continuous current settings.

*c) "The lower limit of ground fault recognition on the models AG, AG-1, DG static trip devices is 40 amps ground current. Primary current transformers that provide a minimum continuous setting of less than 200 amps should not be used for ground fault detection. LA-1600 breakers using the DG static trip device will have the limitations of 80 amps minimum ground fault recognition and will require primary current transformers that provide a minimum continuous current setting of 400 amps or more."

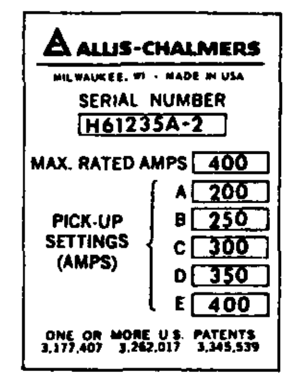


Fig. 6 — Current settings Model AG, AG1, DG.

CIRCUIT BREAKER RATING PLATE (MAX. RATED AMPS)	AVAILABLE CONTINUOUS CURRENT SETTINGS (AMPS)*					AVAILABLE GROUND CURRENT TRIP SETTINGS (AMPS)				
	A	B	C	D	E	20%	40%	60%	80%	
150	75	95	110	130	150	-	30	45	60	LA600 ONLY
250	125	155	175	220	250	25	50	75	100	LA600 ONLY
400	200	250	300	350	400	40	80	120	160	
600	300	375	450	525	600	60	120	180	240	
800	400	500	600	700	800	80	160	240	320	
1000	500	625	750	875	1000	100	200	300	400	
1600	800	1000	1200	1400	1600	160	320	480	640	
2000	1000	1250	1500	1750	2000	200	400	600	800	
2400	1200	1500	1800	2100	2400	240	480	720	960	
4000	2000	2500	3000	3500	4000	400	800	1200	1600	

Notes: a) Primary current transformers are related to the circuit breaker type and frame size.

b) Ground current settings are independent of the continuous current settings.

c) The lower limit of ground fault recognition is approx. 25 amperes for LA600 breakers. See table above. For LA1600 breakers the minimum recognizable ground fault is approximately 40 amperes because of the larger window opening of the current transformers. Therefore, application of 4WAG and 4WDG is not recommended for LA600 breakers having a minimum continuous current setting of less than 75 amperes or LA1600 breakers with a minimum continuous current setting less than 200 amperes.

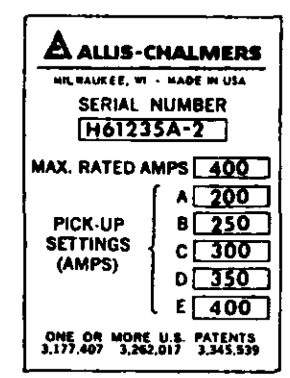


Fig. 7 — Current settings Model 4WAG and 4WDG.

providing for selection of a minimum, intermediate, or maximum time band, as shown on Figure 1.

The knob at the upper middle of the front plate marked SHORT TIME BAND SETTING on D, DG, and 4WDG models provides for selection of either a minimum, intermediate, or a maximum short time band setting.

The two groups of time bands are independent of each other. Any long-time band can be selected to work with any short-time band.

PERFORMANCE IN SERVICE

Ambient conditions and length of service will have little effect on the performance of static overcurrent trip devices. The circuits are stable and will show excellent repeatability over long periods of time. Service involving frequent operations will not cause the characteristics to change or drift, since there are no moving mechanical parts to wear or bearings to lubricate.

For the same reason, the static trip devices are tolerant of dusty conditions and will function properly in many areas that would affect the serviceability of electro-mechanical trip devices.

The temperature at the static trip device does have some effect on the characteristics due to changes in response of some of the components. However, the changes are small and will not be a factor in most applications. Over the range of -40 C to 55 C (-40 F to 131 F), the variation from performance at room temperature is very small, amounting to less than 5% of long time, instantaneous and transfer to short time pickup values, and 10% in timing of long time band.

Operation should not be permitted beyond this range without control of the temperature, such as by heaters or ventilation.

TESTING

GENERAL

Testing of trip devices is easily accomplished under field conditions with a minimum of equipment and preparation. Various tests can be made, and in a manner that makes them suitable for use during routine maintenance. Calibration cannot normally be done under field conditions.

The tests that will be described can be done on a complete breaker assembly located in the disconnect position in the cubicle, on the complete breaker away from its cubicle, or on a trip device completely removed from the breaker. It is not necessary to remove permanent wiring in order to make tests. Testing can be done on a breaker exactly as it is used in normal service.

Good test results, particularly on those tests involving the measurement of time delay, require careful attention and proper use of facilities. The ammeters used to measure test current should be accurate and recently calibrated; and should be read carefully. Any error in current measurement will cause an apparent error in timing of double magnitude. Fluctuations in the test supply voltage will change the test current, and this too can cause an apparent error in timing. Currents should be monitored during test, and the test repeated if the set current varies.

Knob settings on the trip device can cause apparent errors if the pointers are not aligned with the calibration marks. Large errors may be found if the knob has been moved relative to its shaft. However, correction is easily accomplished as described on page 18.

Although the test equipment and procedures described here do not permit testing at high multiples (above approximately 10X) of pick-up current, this is not a detriment to satisfactory confidence in the use of the test results. The tests allow all circuits of the trip device to be checked. If they are functioning properly and in calibration at low multiples, it is practically impossible for the high end to be in error. A broader range of test values can be obtained if more test power is available, but this is not necessary or recommended.

Production procedures involve adjustment, calibration, and test throughout the full range of adjustment on equipment much more elaborate and precise than that suggested for field use. Prior to shipment, additional proof testing is done by other persons using equipment fundamentally similar to that suggested for field tests. Throughout the manufacturing cycle, the equipment and procedures are rigidly specified and closely controlled to assure continuing accuracy. Consequently if a field test discloses an apparent minor deviation from the expected test result, it is advisable to rely on the calibrations as marked on the trip device, and not to assume that the calibrations are in error.

If large deviations and improper functions should occur, it is recommended that the local office of Allis-Chalmers be contacted for advice. The nature of electronic devices of this type, using special quality components and closely controlled selection and adjustment techniques, precludes reliable repair in the field.

DESCRIPTION OF TESTS

A number of tests can be made to verify the proper operation of the device, or to establish the accuracy of the various functions. The user will normally establish test routines to suit the particular application and his standard operating procedures. Following is a list of tests and their purposes.

Function Tests

In many cases this is the only test that need be done. Using a minimum of equipment, it determines that the static trip device is operating. It gives the device an input above the pick-up setting and establishes that an output (tripping of the circuit breaker) is produced. It does not check calibration, although it will show that timing is generally in the right area.

Power Supply Test

Verifies that the internal power supply of the static device is functioning normally and is adjusting itself properly to changes in input.

Pick-Up Test

Shows that the pick-up current properly corresponds to the pick-up dial setting. It checks the turn-on of the trigger circuit to assure that a timing operation will start when the input signal has reached the proper magnitude.

Time Delay Test

The actual time-to-trip is carefully measured to assure that the selected settings will produce time delays as specified on the current-time characteristic curve. Also useful in establishing time delay for non-standard settings between the calibrated pick-up points if such settings are desired.

Transfer Test

Verifies that the circuits used to transfer from long time delay curve to the instantaneous trip (dual A models) and to the short time delay curve (selective D models) are functioning properly.

Trip Signal Test

Determines that the static overcurrent trip device produces a proper output for tripping the circuit breaker. It is usually used as a simple test to isolate the cause of unknown tripping trouble, since if a proper trip signal is obtained, the trouble is limited to the latching system on the circuit breaker.

TEST EQUIPMENT

Simple, readily available equipment is used in the testing of trip devices. The following equipment is required for performing the FUNCTION Test.

1. A 115 VAC variable voltage transformer with at least 3 Amps output.

2. An ammeter which will indicate 1 to 3 Amps with reasonable accuracy.

3. An air-core reactor of 35 milli-henries or more with a DC resistance of 20 ohms or less. A standard 125 V DC power circuit breaker solenoid trip coil (such as Allis-Chalmers No. 71-200-745-501) may be used, as may other similar coils. However, a reactor designed for the purpose is available, and is also suitable for the more accurate requirements of time delay testing. It may be ordered as - REACTOR - 71-142-395-501.

The connections for the FUNCTION test are shown in Figure 8. Test procedures are described on Pages 14 and 15.

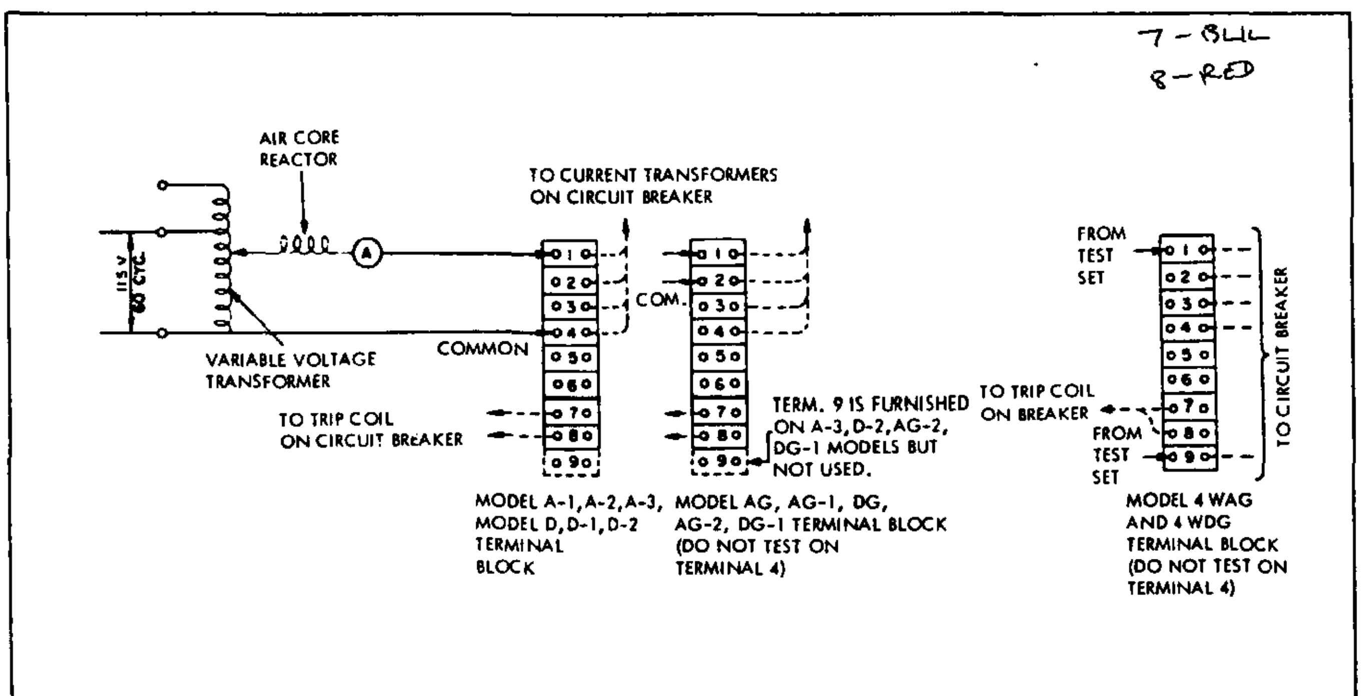


Fig. 8 — Connections for function tests.

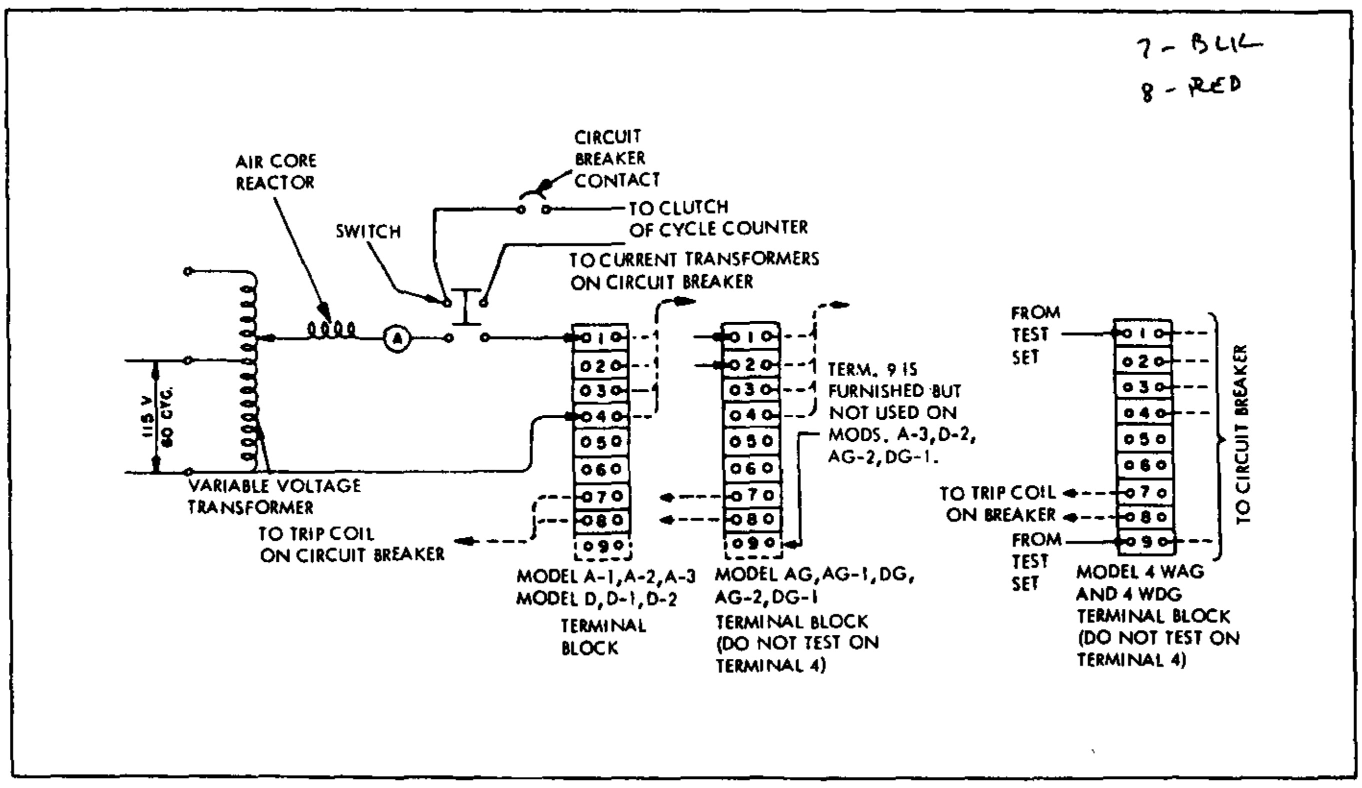


Fig. 9 — Connections for calibration tests.

To perform TIME-DELAY tests, similar equipment is used except that better accuracy is required and a timing device is needed. The required equipment is as follows:

1. A 115 VAC variable voltage transformer with 5 Amps output.

2. An air-core reactor of at least 60 milli-henries and 6 ohms or less DC resistance. (Allis-Chalmers Reactor 71-142-395-501 may be ordered for this purpose.)

3. Ammeters which are accurate in the range of 0.5 to 5 Amps.

4. A DC voltmeter with high resistance - at least 20,000 ohms per volt, such as a good multimeter.

5. A double-pole, single-throw switch.

6. A cycle counter or similar timing device.

The connections for the TIME-DELAY test are shown in Figure 9. Test procedures are described on page 14.

A complete portable test set containing the required equipment is available as illustrated in Figure 10. Contact the local Allis-Chalmers office for further information.

TEST PROCEDURES

This section will describe in detail the steps to be taken to carry out the tests previously described. Tests may be conducted on the completed circuit breaker, either in the disconnected cubicle position, or removed from the cubicle. It is not necessary to remove or disconnect any permanent wiring on the circuit breaker as long as primary and control circuits are not connected to the breaker. It will usually be advantageous to perform normal routine maintenance on the circuit breaker before testing the static trip device.

Although the following descriptions relate to a completed circuit breaker unit, the tests can also be carried out on a static trip device by itself.

Function Test

Connect test circuit as shown in Figure 8.

Loosen shaft locks.

Set pick-up knobs at "A."

Set instantaneous (or transfer) knob at 8X or higher.

Close breaker.

Quickly increase current to 1.5 Amps (3X pick-up) and hold.

Breaker should trip in approximately 10 to 45 seconds, depending on the time band (see current-time curve, Figure 3).

Reduce or shut off current.

Repeat as desired.

Set instantaneous (or transfer) knob at 5X.

Close breaker.

Quickly increase current to 2.5 Amps.

Breaker should trip instantly at 2.5 Amps or a little less.

Reduce or shut off current.

Repeat as desired.

Restore original settings and tighten shaft locks.

This function test will show that the time delay circuit and the short time circuit are functioning. Repeatability should be good, but the specific value of time delay should not be judged except in the broad sense.

While other parameters can be used for this test, those described will give a reasonably fast test with minimum test power. Higher currents at the "A" setting will give faster trip times. Settings other than "A" require more current to get the desired multiples of pick-up (e.g. 3 Amps at "E" setting is required for 3X pick-up).

The FUNCTION test may be repeated for the other phases using terminals 2 to 4 and 3 to 4 on all models without ground trip; terminal 3 to 2 on models AG, AG1, AG2, DG, DG1; terminals 2 to 9 and 3 to 9 on models 4WAG and 4WDG. It is not recommended to test terminals 2 to 4 on the three wire ground models or 2 to 4 and 3 to 4 on the four wire ground models, because the ground circuit transformer impedance is too high for this test facility.

Since the function circuits are common for all input terminals, little is gained in testing more than one input terminal.

If the breaker does not trip on the FUNCTION tests, a TRIP-SIGNAL test may be made to determine whether the trouble is in the trip device or in the circuit breaker.

The FUNCTION test is the only test usually desirable for routine service. The other tests described are for specific requirements, or for trouble shooting.

Power Supply Test

Connect test circuits as shown in Figure 8. Connect voltmeter leads to terminals 8 and 4 (terminals 8 and 2 on Models AG, AG1, AG2, DG, DG1 and terminals 8 and 9 on Models 4WAG and 4WDG) (8 is positive). Adjust variable voltage transformer until ammeter reads about 0.5 Amps. The voltmeter should read approximately 20 to 24 volts. The actual value is not critical and varies with each device. Increase the current briefly to about one Amp and note that the voltage does not change. This indicates that the power supply is normal.

Pick-Up Test

Connect test circuit as shown in Figure 9. Connect voltmeter to terminals 5 and 4 (terminals 5 and 2 on the Models AG, AG1, AG2, DG, DG1, 5 and 9 on 4WAG and 4WDG). (5 is positive.) Set pick-up adjustment at "A." Increase the current slowly until the voltmeter suddenly jumps from a very low value to 6 volts or more. This is the pick-up point and the ammeter should read 0.5 Amps. The test currents for other pick-up settings and various multiples of pick-up are listed at top of page 16.

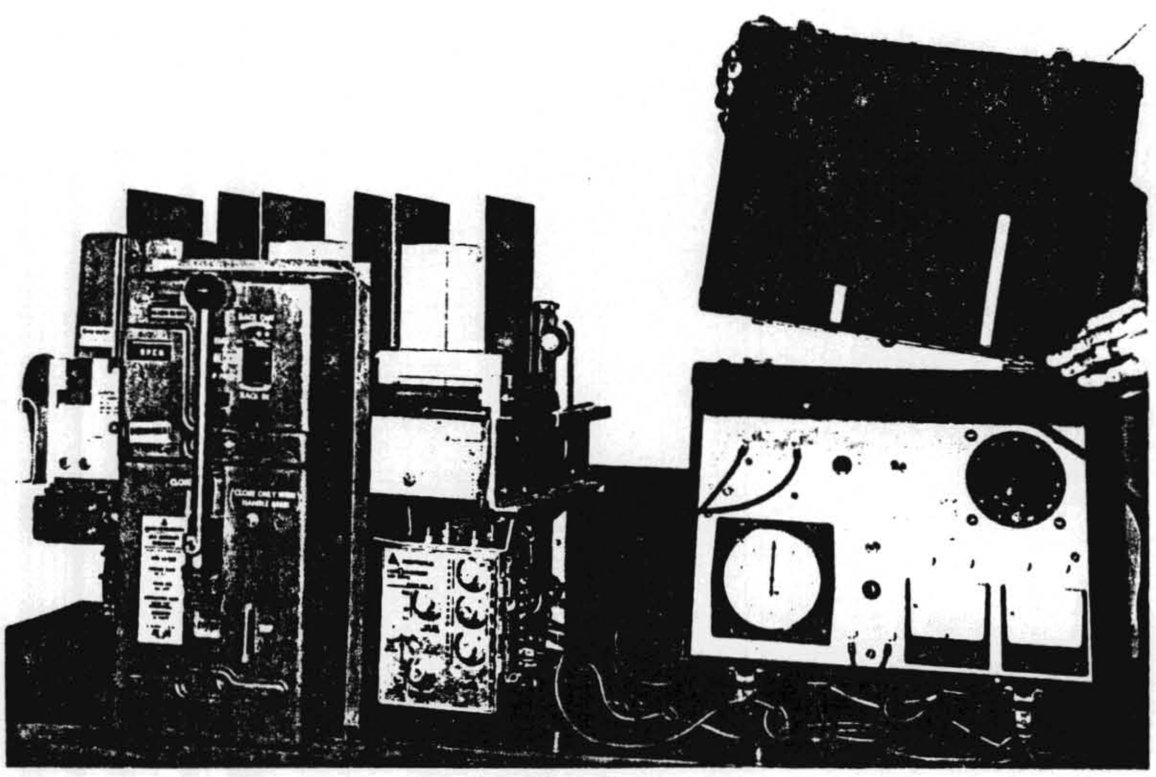


Fig. 10 — Portable test set.

PICK-UP SETTING	PICK-UP CURRENT AMPS	3X PICK-UP AMPS	5X PICK-UP AMPS	8X PICK-UP AMPS
A	0.5	1.5	2.5	4.0
B	0.625	1.875	3.125	5.0
C	0.75	2.25	3.75	6.0
D	0.875	2.625	4.375	7.0
E	1.0	3.0	5.0	8.0

This test may also be made on the other phases of the static trip device as described in the Function Test section, page 15.

The pick-up test is quite sensitive to the wave shape of the test current, which will not be perfect in most field test equipment. This may cause an apparent low reading which may be in the order of 10%, in addition to the production tolerance of plus or minus 10%. Thus, if the test shows that pick-up is within these limits, the pick-up calibration marks can be relied upon.

Time Delay Test

Connect test circuit as shown in Figure 9. Since the same timing circuit is used for all phases, it is not necessary to test more than one phase.

Set pickup on minimum ("A" setting). The pickup current is then 0.5 Amps. Settings other than "A" may be used, but will not permit the range of test that is possible with the minimum pick-up setting. Refer to the table for actual test currents at various pick-up settings and various multiples of pick-up current.

Set instantaneous (or transfer) at 12X so that the long-time bands may be tested. Any multiple of the pick-up current may be tested within the limits of the test equipment.

Close the circuit breaker.

Close the double-pole switch and set the desired test current.

Open the switch and reset the cycle counter.

Close the switch and, holding the current steady, wait for the circuit breaker to open.

Open the switch and read time delay on the cycle counter.

Repeat as desired.

Repeat as desired with other combinations of test current and/or pick-up setting.

Repeated tests at the same settings should agree very closely and show good agreement with the time band used during the tests. Usually the time delay will fall within the width of the time band, however, minor deviations may sometimes occur and may be acceptable as discussed on page .

On the selective D models it is possible to test for time delay on the short-time bands also. Connect test circuit as shown in Figure 9. Set the pick-up at "A," set the transfer knob at 5X, and adjust the test current to 5 Amps. Close the circuit breaker, then close the switch. The circuit breaker should trip very quickly, the actual time delay being as shown on the time-current curve (Figure 3) for the time-band tested. Although only a small part of the curve can be tested with the equipment described, the test is a valid one since it does show the short-time circuits to be functioning and in calibration.

On the models having ground tripping (indicated by the letter G) it is not recommended to test for time delay or pick-up on the ground pick-up circuit because of the high saturated reactance in that circuit, and because tests on the phase circuit (terminals 1 and 2, or 3 and 2) also prove the timing and pick-up of the ground pick-up circuit. Such tests can be made, however, if facilities are available. Equipment required would be a 230 V AC supply, a 230 V variable transformer, and an air core reactor of about one Henry inductance. Pick-up currents for the ground pick-up circuit (terminals 4 and 2) are 0.1 Amp for the 20% setting, 0.2 for 40%, 0.3 for 60% and 0.4 for 80%. Procedure is the same as outlined above.

Transfer Test

Connect test circuit as shown in Figure 9. For dual models (indicated by the letter A) set pick-up at "A" setting and instantaneous at 5X. Increase current rapidly until the circuit breaker trips, which should be at 2.5 Amps. Other combinations of current and settings may also be tried.

For models D, D1, and D2, connect test circuit as shown in Figure 9. Connect voltmeter leads to terminals 4 and 6. Set pick-up at "A" setting and transfer at 5X. Increase the current until the voltmeter suddenly goes to a reading of 6 to 8 volts at 2.5 Amps. test current. This indicates that transfer to the short-time band has occurred.

For Model DG connect test circuit as shown in Figure 9. Connect voltmeter leads to terminals 2 and 6. Set pick-up at "A" setting and transfer at 5X. Increase the current until the voltmeter suddenly goes to a reading of 6 or more volts at 2.5 Amps test current. This indicates that transfer to the short-time band has occurred. Follow the same instructions for model 4WDG except connect the voltmeter to terminals 9 and 6.

Other settings may also be tested. For example, with "A" pick-up setting and 8X transfer setting, the test current at which transfer to the short-time band takes place will be 4 Amps. A tolerance of 10% on transfer is permissible.

Trip Signal Test

This test may be made in conjunction with any other test that produces a circuit breaker tripping signal, and is particularly useful when static trip devices are being tested without the circuit breaker or the circuit breaker tripping device.

Connect a 100 ohm, one watt resistor across terminals 7 and 8 of the static trip device when the circuit breaker tripping device is not connected to the static trip to simulate a load during this test.

Connect the voltmeter to terminals 7 and 8 (8 is positive). When the test being conducted produces a trip signal, the voltmeter will suddenly jump to a reading of approximately 8 to 10 volts. This voltage will disappear when the test current is shut off.

The time delay before obtaining a trip signal can easily be predicted from the known trip device settings, known test current, and the appropriate current-time curve.

HIGH CURRENT TESTING

The static overcurrent trip system may be tested by passing high current through the circuit breaker primary circuit. However, the equipment required for such testing is normally of a special nature and not readily available, whereas the equipment and procedures described in this instruction are universally applicable.

Because the usual high current test equipment operates at very low voltage, it may not drive a sinusoidal current through the trip device, and the test results will show an apparent error. Current wave shape should be checked and allowances made for distortion if such equipment is used.

The basic concepts outlined in this instruction are valid for testing with other kinds of equipment and will require only minor detail changes to adapt to different test circuits.

ACCURACY OF TESTS

A bushing type current transformer on a power circuit is essentially a constant current device, and will drive a sine wave of current through a saturable reactance and resistance load, such as the static trip device. Therefore, a pure sine wave of current is used during manufacturing tests and calibrations.

For field testing a variable voltage transformer is used as a source of test current. This is essentially a constant voltage device, and will not drive a sine wave of current through the static trip device load. The resulting distortion of the current wave shape causes the test ammeter to read incorrectly and causes an apparent decrease in the expected time delay, since the time-current curves are based on pure sine wave currents.

Another way to look at it is that a bushing type current transformer will faithfully follow the current wave shape in the primary circuit (as long as the transformer does not saturate). Since the primary current is usually a sine wave, the same wave shape will be produced in the load. The circuit will provide whatever voltage is necessary to drive the current, and the resulting voltage at the load may be very different from a sine wave.

A variable voltage transformer on the other hand, when connected to the same load will produce a sinusoidal voltage wave shape and the current will not be sinusoidal. Since the current and voltage are in phase, the voltage will be zero when the current is passing through zero, and there will be no voltage to drive the current just at the time when the rate of change should be very high in order to maintain a sinusoidal current.

By inserting an air core reactor of sufficient size, the phase angle between current and voltage can be altered so that the voltage at current zero is high enough to support the rate of change of current required for a sinusoidal current wave shape. The reactors suggested in this instruction are adequate for the purpose described, although they do not produce a total correction of the current wave shape. They represent a compromise between degree of correction and magnitude of test currents available from a 115 V source that is satisfactory for all practical purposes.

MAINTENANCE

GENERAL

Each trip device is adjusted, calibrated, and tested before shipment. It is ready for use after the appropriate settings have been selected and the potentiometer shafts have been locked.

No cleaning, readjusting, lubricating, etc. is required. The only maintenance that is recommended is periodic verification that the device is functioning. This may be supplemented as desired by checking the calibration, inspection for loose or broken external wiring, restoring lost calibration, etc.

Restoring Lost Calibration

Calibration of the trip device depends on the knobs being properly oriented on their shafts. If the knobs are forced by neglecting to loosen the shaft locks, calibration will be lost, but can readily be restored.

A knob will be in proper calibration if, when turned counterclockwise as far as it can go, the pointer lines up precisely with the red calibration dot on the idal, or with the end of the block annular band. Refer to Figure 11.

If the above check shows the calibration to be in error, remove the knob by loosening its set screw and slipping it off the shaft. Then be sure the shaft lock is loosened (see Figure 11) and turn the shaft counterclockwise as far as it will go. Keep the shaft in that position and replace the knob so that it is directly over the red calibration dot and tighten the set screw.

With the shaft lock loosened, the knob may now be turned to the selected dial position, the shaft locked, and the device returned to service.

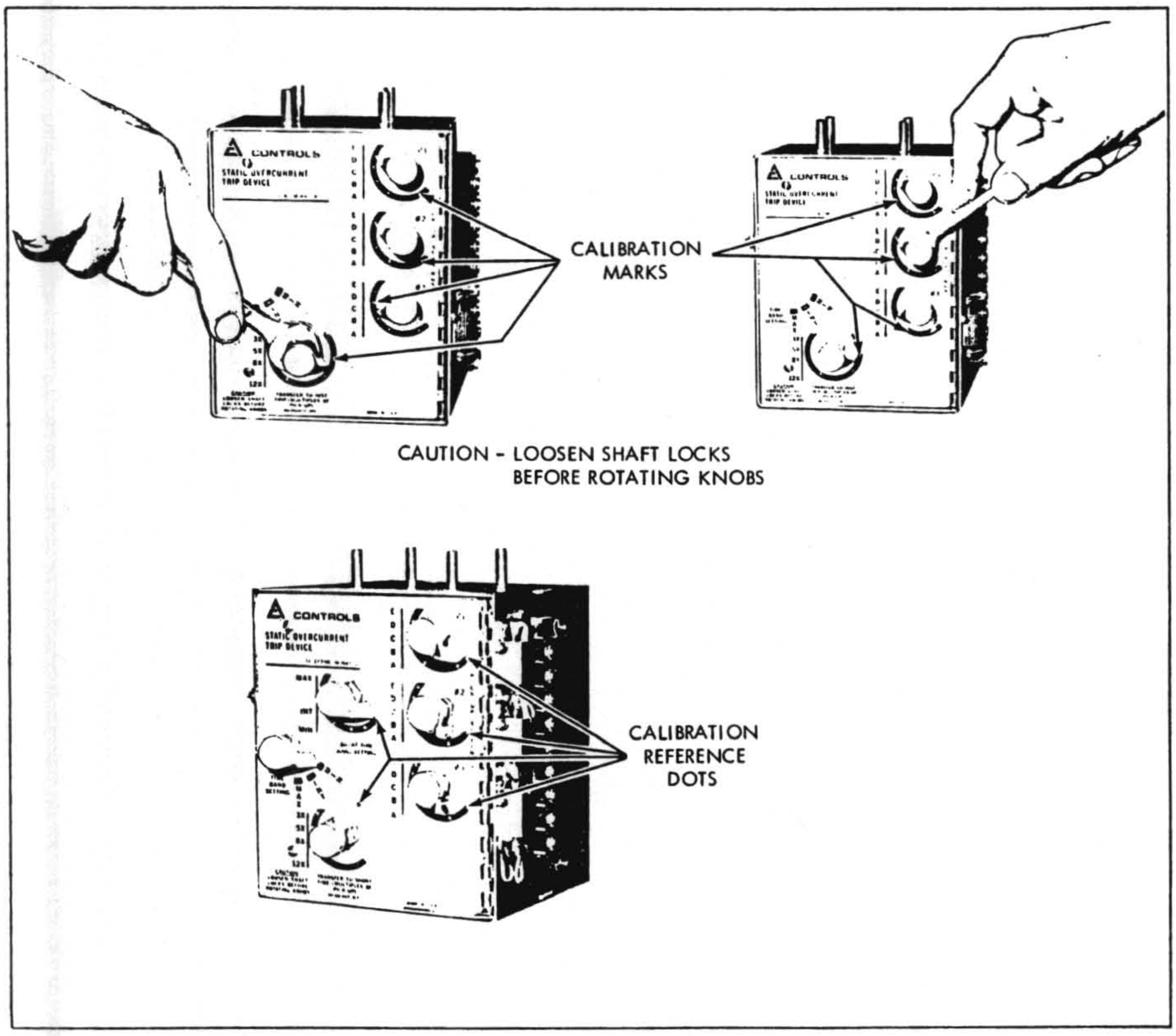


Fig. 11 — Shaft locks and calibration marks.

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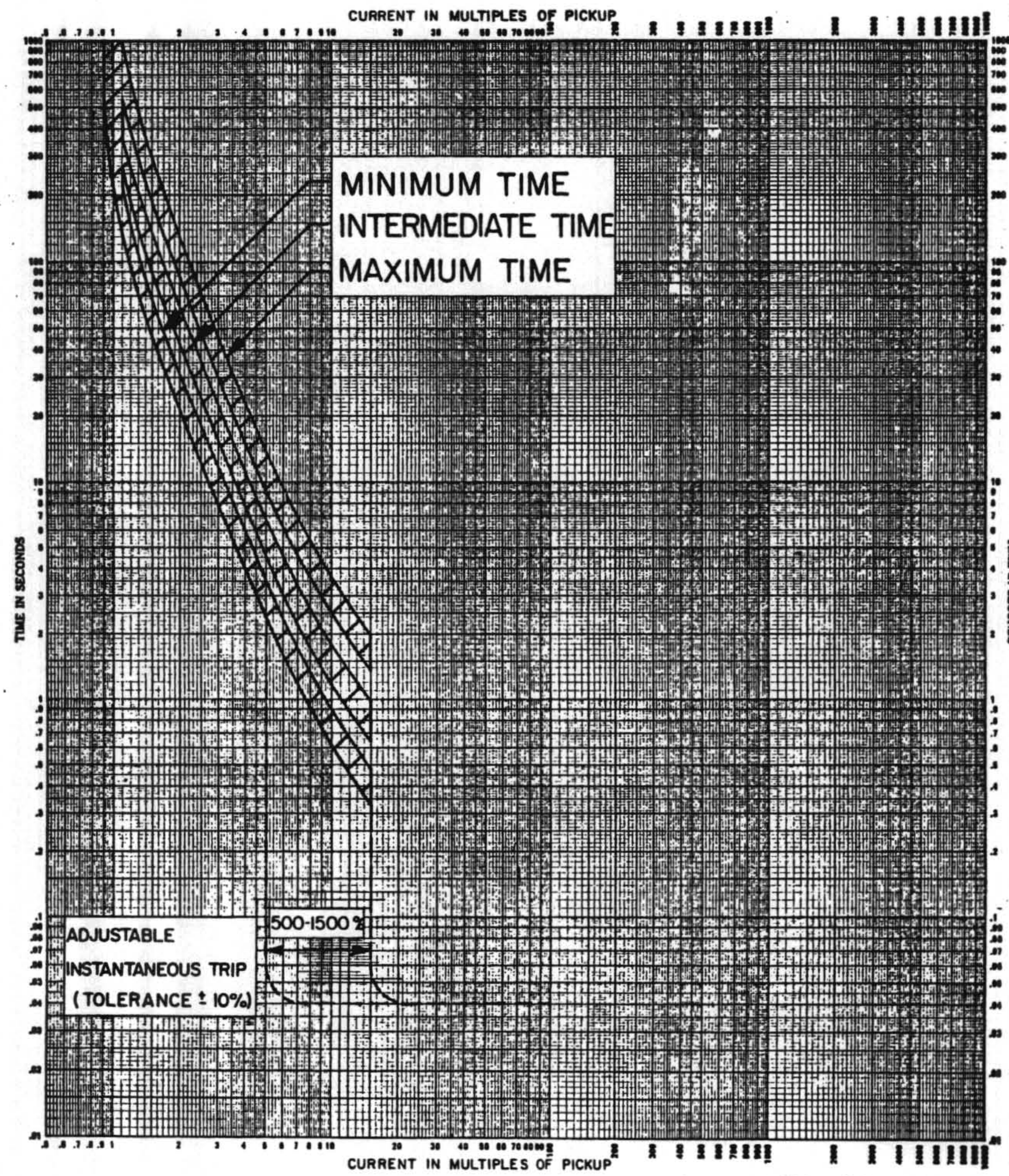

DUAL STATIC OVERCURRENT TRIP DEVICE - MODEL "A", "A-1", "A-G", "A-2", "AG-1"

JANUARY 13, 1964 TYPICAL CURVE 71-240-558-404

FIG. 7E