WORLDWIDE SERVICE APPARATUS*

INSTALLATION AND SERVICE ENGINEERING DEPARTMENT | OVERSEAS OPERATIONS

FIELD TESTING OF OVERCURRENT TRIP DEVICES
(EC-1 AND EC-2)

Increased interest in breaker maintenance is evident by the increase in field inquiries concerning maintenance procedures. Since the majority of these inquiries concern checking the operation of overcurrent trip devices, the following factory advice is offered as an aid to those involved in that activity. The examples described here are EC-1 and EC-2.

Before attempting any field checks or adjustments, the tester should consult the maintenance manual to familiarize himself with the operating details of the specific breaker involved. See the back pages of this text for details of the specific overcurrent trip device. He should be certain the power voltage has been removed. Prior to checking the overcurrent trip device, the breaker contacts, mechanism and trip latch should be checked to assure their proper functioning so that the breaker can carry the required current and that the trip shaft is free of high friction loads. The trip latch should be checked for proper trip latch engagement.

OVERCURRENT TRIP DEVICE CHECKS

An adequate check to prove the overcurrent trip device functions properly consists of a mechanical check followed by an overcurrent operation.

MECHANICAL CHECK

A careful mechanical check should be made of any magnetic overcurrent trip device to assure a successful tripping operation just before the armature reaches the fully closed air gap condition. This can be done by manually pushing the armature toward the closed air gap position and determining how much further the armature moves after the breaker has tripped. This check to assure "positive trip" is within the tolerance specified in the breaker maintenance manual is important and can affect the apparent degree of time delay during a subsequent overcurrent timing test. If there is insufficient "positive trip" the armature may "bottom" on the magnet pole face without sufficiently displacing the trip latch. Slightly excessive "positive trip" may cause fast tripping while extremely excessive "positive trip" will allow the trip device armature to be loaded by the latch when the air gap is excessive. When the air gap is excessive, tripping force is at a low level compared to the force at short air gaps and the device may tend to stall or "ride the latch".

The armature of the EC-2, EC-2A, EC-1A and EC-1B of the AK breakers and the oil film (sticky disk) and Grade "B" time of AL-2 type breakers can be manipulated directly while observing the tripping. (See figures 2 and 3.) On the EC-1 device the trip arm is not fastened to the armature. To accurately determine the degree of positive trip on the EC-1, it is necessary to "probe" the armature through the holes provided in the case. A drill rod or short length of stiff wire will serve as a probe. See figure 2 for the specific procedure in detail.

While checking positive trip, the armature should be held in the tripped position sufficiently long to assure the time delay escapement is operative as follows:

a. As the armature is pushed to the closed air gap position, devices with instantaneous trip features will allow the instantaneous trip spring to stretch and allow temporary separation of the armature from the time delay dashpot. Maintaining the armature in the closed air gap condition will cause the instantaneous spring to pull the dashpot through its timing stroke. Devices with long delay characteristics will require considerable time to "time out." Failure of the dashpot to move at all warrants further investigation to see if a bind exists in the dashpot or connecting linkage. Similarly, lack of any time delay (when the device is so equipped) or a very fast "time out" will generally indicate lack of oil and again further investigation is warranted.

b. When releasing the armature after the device has "timed out" check the armature to be sure it returns to the fully open gap position and rests on the armature open air gap stop. An armature hanging half way closed indicates a possible bind in the armature pivot or dashpot or possibly the pickup setting has been reduced so far below the minimum setting that the calibration spring no longer provides resetting torque. Binds in the armature pivot of devices employing oil displacement type dashpots are generally detected by the armature failing to fully reset following a partial "timing out" operation (such as may occur from a motor starting operation). On the next overload the partially

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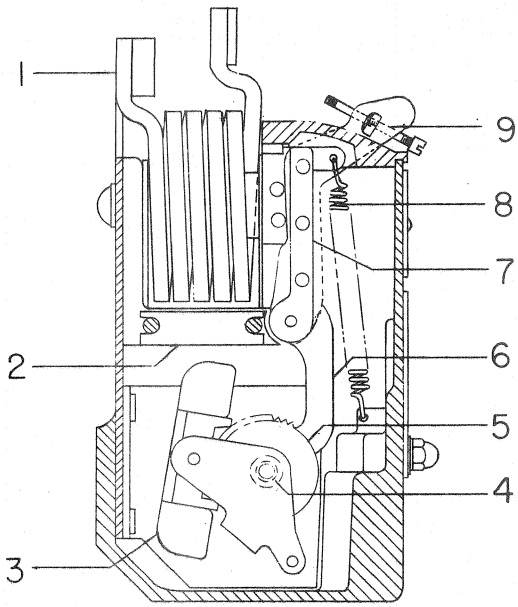
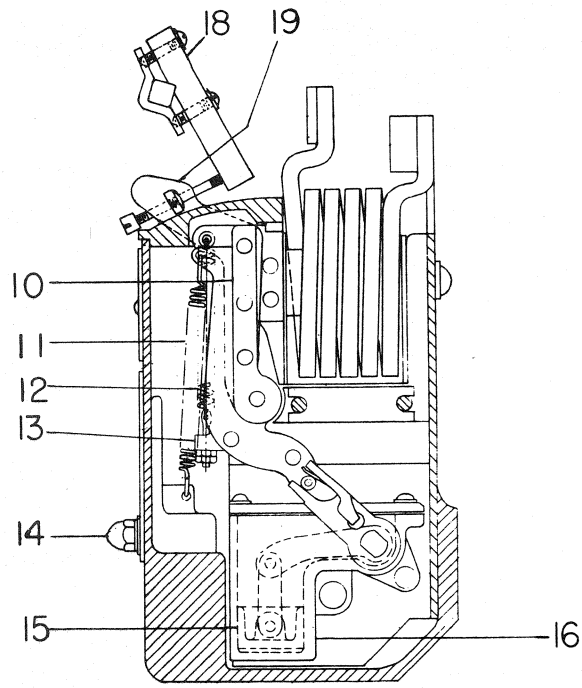
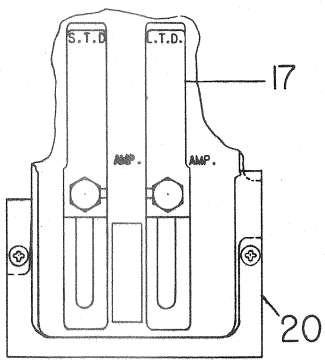


LEFT SIDE VIEW SHOWING
SHORT TIME DELAY MECHANISM
FIG. 24A



RIGHT SIDE VIEW SHOWING
LONG TIME DELAY MECHANISM
FIG. 24B



FRONT VIEW SHOWING
MOUNTING BRACKET

1. Series Coil
2. Magnet
3. Pallet
4. Pinion
5. Escape Wheel
6. Driving Segment
7. S.T.D. Armature
8. S.T.D. Calibration Spring
9. Trip Paddle Adjusting Screw
10. L.T.D. Armature
11. L.T.D. and Low-set Inst. Calibration Spring
12. Inst. Trip Spring (High Set)
13. Spring Holder
14. Calibration Clamp Nut
15. Plunger
16. Cylinder
17. Calibration Plate
18. Trip Paddle
19. Trip Arm
20. Clamping Bracket

Figure 1. Series Overcurrent Tripping Device – EC-1 (AK-50 Only)

closed air gap causes premature tripping. (Generally considered a fail safe condition.)

c. Visually check for missing hardware, clamping devices, evidence of leaking oil, broken cases, cracked breaker trip paddles. On oil film (sticky disk) devices and Grade B timers, the condition of the oil should be observed and changed if necessary. See maintenance manual for acceptable cleaning methods and type of oil.

OVERCURRENT CHECK

If desired, an overcurrent test can be made to assure the breaker will trip on overcurrent. The purpose of overcurrent testing of trip devices in the field should be to determine if the breaker will perform as required for that circuit to which it is applied. Since the trip device exhibits its lowest trip force levels when encountering low levels of overcurrent, an indication of adequate trip device performance can generally be assured by making an overcurrent check at approximately 150 to 300 percent of coil rating as shown in Table I. On dual magnetic trip devices, the armature and pivot pin is common to both the long time delay feature and the instantaneous trip. If the force generated across the air gap is sufficient to attract the armature for slight overcurrents in the long time region, tripping on short circuit by the same armature is assured. As the armature times toward the closed air gap position, the force across the air gap increases high enough to stretch the instantaneous spring and exercise the instantaneous trip parts. Similarly, the short time armature on selective trip devices is on the same pivot as the long time armature and the iron structure is comparable. Therefore, checking the long time delay feature affords reasonable assurance of all features successfully performing their trip functions. The long time delay pick-up should be set at 100% current.

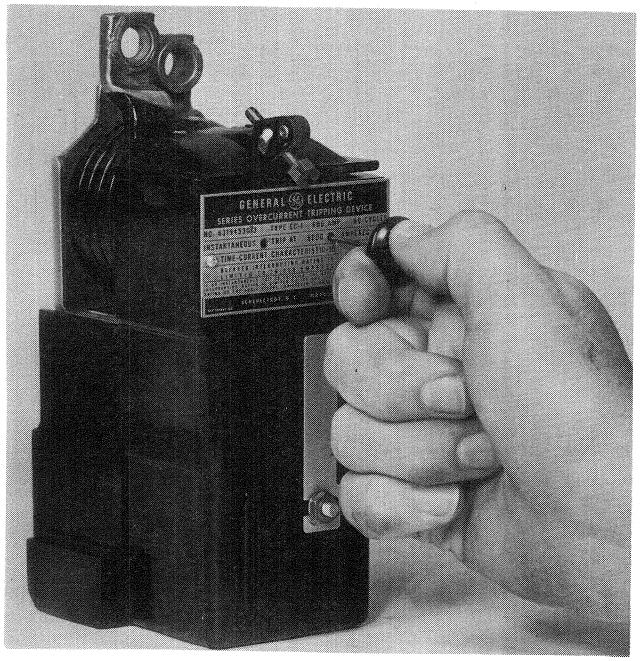


Figure 2. Checking Travel Distance of Series Overcurrent Tripping Device

OVERCURRENT TEST EQUIPMENT

In addition to being capable of producing current levels approximately 300% of trip coil rating, the current must be reasonably sinusoidal. Since overcurrent trip devices are designed to saturate slightly above continuous rating to avoid destructive

TABLE I

Breaker Type	Type Overcurrent Trip Device	Test Current in Percent of L. T. D. Pick-up*
AL-2	Oil film (sticky disk)	150
	Grade B	150
AK-15/25/50	EC-1	150
AK-15/25/50	EC-2, EC-2A (inst. @ 4X)	150
AK-15/25/50	EC-2, EC-2A (inst. 6X or higher)	300
AK-1-75-100	EC-1	150**
AK-2-75-100	EC-1A, EC-1B	150***

* Pick-up set at 100% of trip device rating.

** Characteristics having XX suffixes should have 147% correction factored into current. Correction factors for YY characteristics are 160% on left and right poles and 187% on center poles.

*** Correction factors of 93 and 107% for left and right poles respective must be factored into test currents.

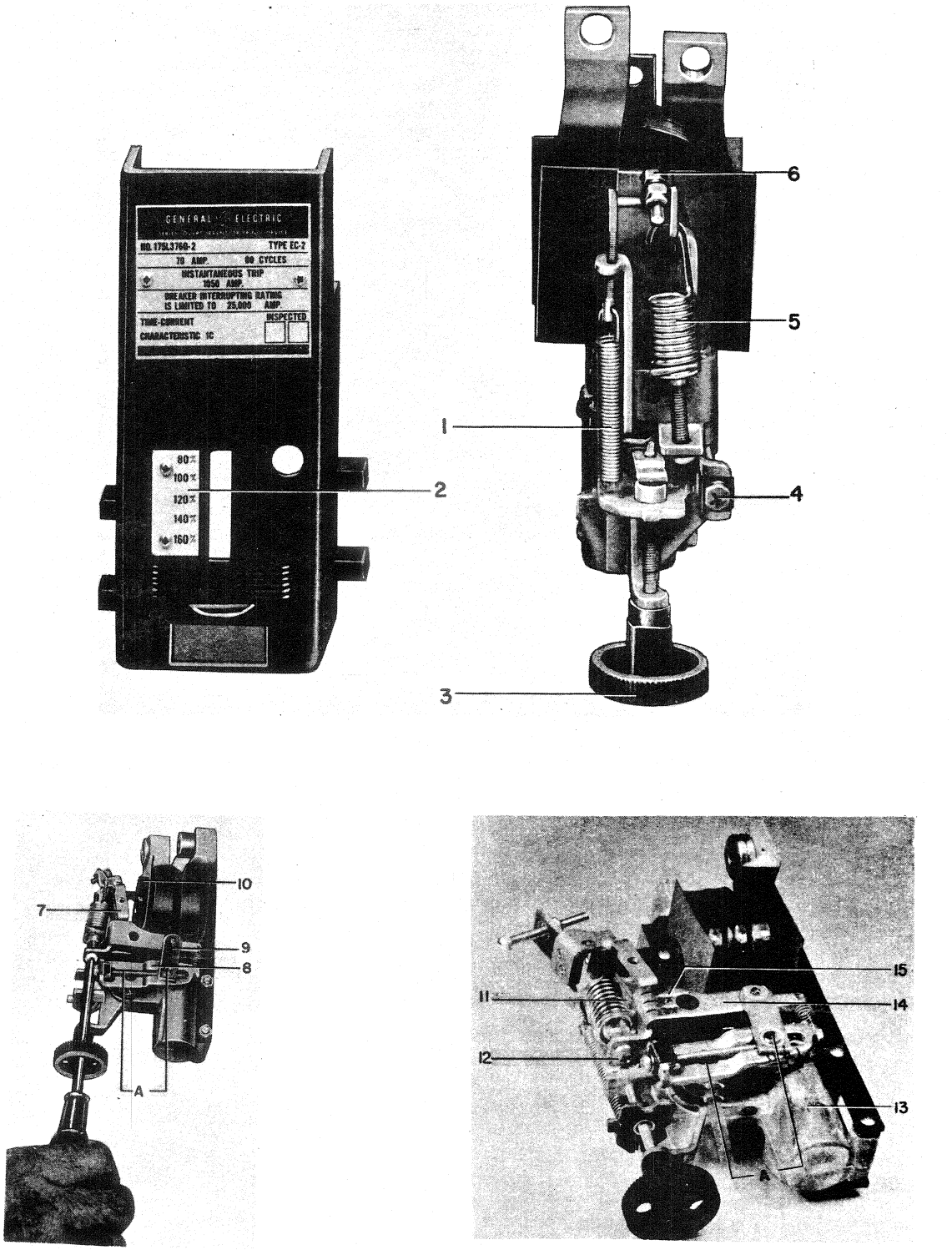


Figure 3. Overcurrent Tripping Device – EC-2

forces at short circuit levels of overcurrent, the devices represent a non-linear impedance at current levels recommended for time delay testing. If the trip device represents the predominant impedance in the test circuit, a non-sinusoidal current wave shape results. To maintain a reasonably sinusoidal wave shape of current, air core reactance should be inserted in the series circuit. The air core reactance must represent the predominant reactive (and linear) impedance to minimize the effect of the trip device impedance. Insertion of this additional impedance in turn requires an increase in test voltage. The minimum external impedance requirement varies for each coil size. The smaller the rating of the trip coil, the higher becomes its impedance, the more external impedance is required, hence the higher the required source voltage. Rather than specify the external impedance required for each coil rating, it is more convenient to indicate the open circuit voltage required for various coil ratings. The external impedance can then be inserted as required to control the test current. Figure 5 shows these open circuit voltage requirements for various coils. This voltage can be quickly checked after the current has been set by measuring the voltage with the breaker open and the test set "on" at the level required to produce 300% continuous current.

TEST PROCEDURE

1. With a test set meeting the minimum requirements outlined above and connected securely to the upper and lower studs of one pole of the breaker, set the long time pick-up setting on the trip device to 100%. The relative position of the adjustable time setting of EC-2 type devices should be noted. It is important that time adjusting screw is not forced to the limit of its travel; otherwise binding of the time delay linkage may result.

2. Close the breaker and adjust the current to the degree of overcurrent listed in Table I for the particular O. C. trip device.

3. Shut off the test set to allow the device to reset.

4. Reapply the power and record the trip time in the appropriate test log book.

If repeat tests are attempted, it will be necessary to allow a sufficient cooling time between tests so as not to exceed the thermal capacity of the circuit breaker.

The magnets of some overcurrent trip devices are oriented in such a direction that the flux across the air gap of the device of one pole effects the pick-up of the devices on adjacent poles. Generally, these breakers have correction factors applied to their single phase calibration currents to assure adequate performance when applied on 3 phase circuits. These correction factors should be similarly applied when field checking. Notes on Table I indicate the correction factors to be applied. Test data should be compared with acceptable or specified limits so that discrepancies can be verified immediately.

On completion of the overcurrent trip device test, it is important to carefully reassemble any accessories that were removed to facilitate the overcurrent trip device test or adjustments. Any adjustments to those accessories should be made as directed by the maintenance manual. Careless reassembly of accessories may result in subsequent serious damage to the breakers and the circuits they protect.

TEST RESULTS

The trip time measured for the trip device at the recommended overcurrent condition should be compared with the factory trip curve for new devices. In view of the wide variation in the parameters responsible for the apparent degree of time delay from a trip device, tripping times will often exceed the band width shown on the characteristic curves. These variations can be caused by variations in the current wave produced by test equipment, wide deviations in ambient temperature or high oil temperature caused by repetitive testing. Field adjustments, if necessary, should be confined within the adjustable range designed into the device for field adjustments. Replacement parts (other than cases or clamping hardware) are not generally available for overcurrent devices. When replacement devices are required, complete nameplate information extracted from the overcurrent

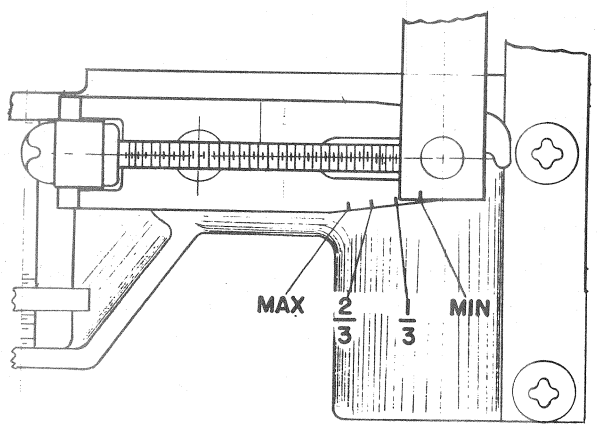


Figure 4. Time-adjustment Indexing

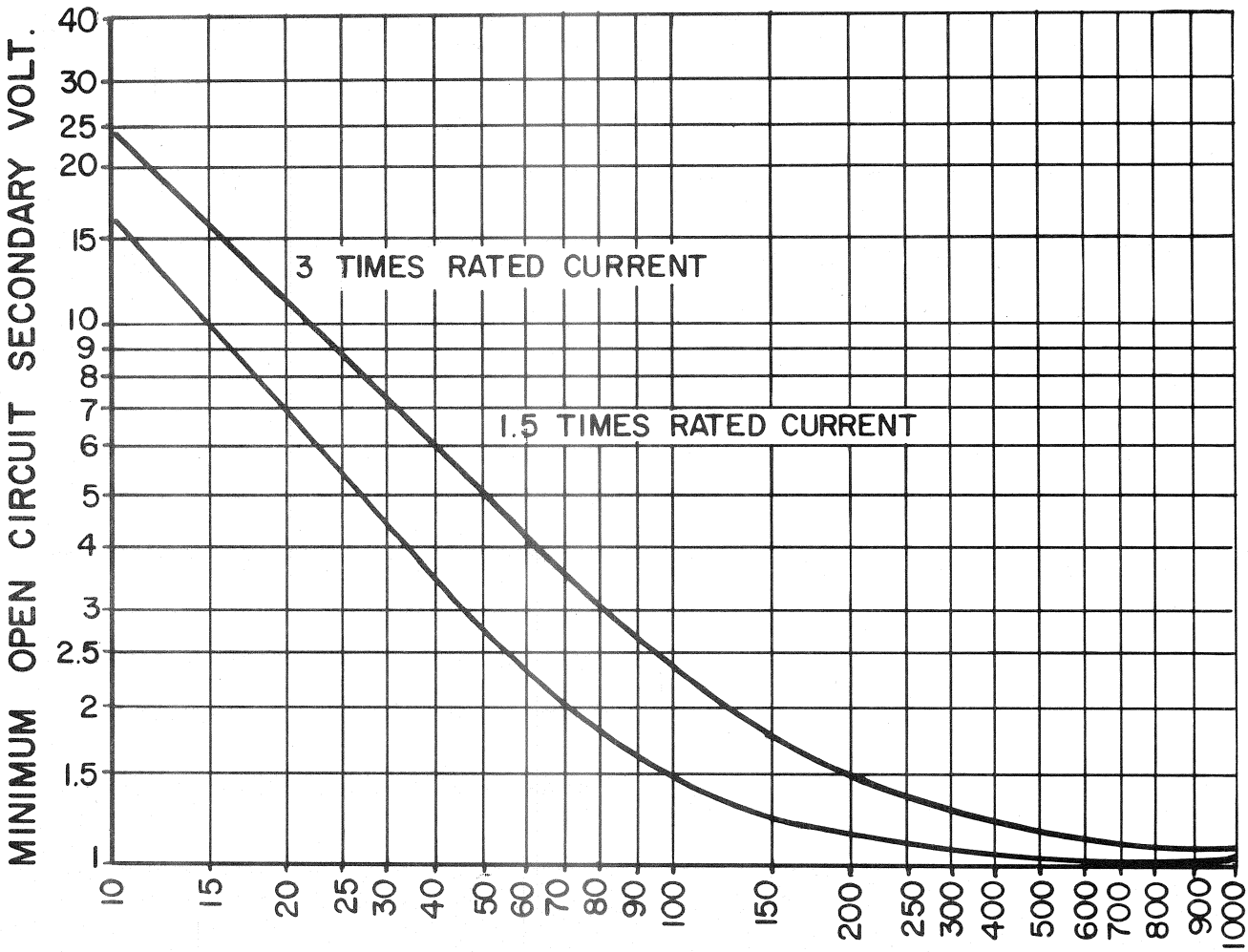


Figure 5. Ampere Rating of Trip Devices

trip device and the involved breaker should accompany the order.

SERIES OVERCURRENT TRIPPING DEVICE EC-1 (Fig. 1)

Each series overcurrent tripping device is enclosed in a molded case and mounted by three screws and a bracket to the lower part of the pole unit base.

The device can be provided with the same tripping combinations as the EC-1 direct acting device.

SHORT TIME-DELAY TRIPPING (Fig. 1)

The armature (7) is restrained by calibrating spring (8). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by an escapement mechanism which produces an inverse time delay characteristic.

LONG TIME-DELAY TRIPPING (Fig. 1)

The armature (10) is restrained by the calibration spring (11). After the magnetic force produced by an overcurrent condition overcomes this restraining force, the armature movement is further retarded by the flow of silicone oil in a dashpot, which produces an inverse time delay characteristic. The mechanism is shown on Fig. 24B.

INSTANTANEOUS TRIPPING (Fig. 1)

(a) Adjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition, overcomes the restraining

force of the calibration spring which can be adjusted by the calibration clamp nut (14).

(b) Non-adjustable instantaneous tripping takes place after the magnetic force produced by an overcurrent condition overcomes the restraining force of a non-adjustable spring.

ADJUSTMENTS (Fig. 1)

Calibration clamping nuts (14) are used to set the desired pickup for the adjustable elements.

To adjust for approximately 1/32 in. overtravel of trip arm (19) after tripping:

1. Check trip latch engagement. See ADJUSTMENTS - OPERATING MECHANISM.

2. Loosen the locknut* and turn the adjusting screw (9) on the trip arm (19). The screw should not touch the trip paddle when the breaker is "open" and the latch is reset but should have a clearance not exceeding 1/32 in.

3. Tighten the adjusting screw locknut* on the trip arm.

*NOTE: In lieu of locknuts, some devices are equipped with self-locking nylon insert nuts.

REPLACEMENT (Fig. 1)

1. Remove front frame (see SEPARATION OF FRONT AND REAR FRAMES).

2. Remove the bolts holding the coil to the lower stud.

3. Remove bracket and mounting screws.

4. Before installing a new device, check the travel of the trip arm with a rod or wire and push the armature solidly against the magnet (see Fig. 2). The trip arm should travel at least 5/32-in.

5. Replace new device in reverse order.

6. Adjust device as described above.

NOTE: Component parts of any overcurrent tripping devices are not replaceable. It will be necessary to install a new device when parts are worn or damaged.

SERIES OVERCURRENT TRIPPING DEVICE EC-2, EC-2A, AK-50

The Type EC-2, EC-2A (see Fig. 3) overcurrent tripping device is available in three forms:

1. Dual overcurrent trip, with long-time delay and high-set instantaneous tripping.

2. Low-set instantaneous tripping.

3. High-set instantaneous tripping.

The dual trip has adjustable long-time and instantaneous pick-up settings and adjustable time settings. Both forms of instantaneous trip have adjustable pick-up settings.

LONG TIME-DELAY AND HIGH-SET INSTANTANEOUS TRIPPING (Fig. 3)

By means of the adjustment knob (3), which can be manipulated by hand, the current pick-up point can be varied from 80 to 160 percent of the series coil rating. The indicator and a calibration plate (2) on the front of the case provide a means of indicating the pick-up point setting in terms of percentage of coil rating. The calibration plate is indexed at percentage settings of 80, 100, 120, 140, and 160.

As in the case of the EC-1 overcurrent trip, the long-time delay tripping feature can be supplied with any one of three time-current characteristics which correspond to the NEMA standards maximum, intermediate and minimum long-time delay operating bands. These are identified as 1A, 1B and 1C characteristics, respectively. Approximate tripping time for each of these, in the same order are 30, 15, and 5 seconds at 600 percent of the pick-up value of current. (See time-current characteristic curves, Fig. 6.)

The tripping time may be varied within the limits shown on the characteristic curves by turning the time adjustment screw (4). Turhing in a clockwise direction increases the tripping time; counterclockwise motion decreases it. The dashpot arm (8) is indexed at four points, MIN-1/3-2/3-MAX, as indicated in Fig. 4. When the index mark on the connecting link (9) lines up with a mark on the dashpot arm, the approximate tripping time as shown by the characteristic curve is indicated. The 1A and 1B characteristic devices are shipped with this setting at the 2/3 mark and the 1C characteristic at the 1/3 mark. The standard characteristic curves are plotted at these same settings.

Time values are inversely proportional to the effective length of the dashpot arm. Therefore, the linkage setting that gives the shortest time value is the one at which dimension "A", Fig. 3, is greatest. The time adjustment screw (4) may be turned by inserting a Phillips head screwdriver through the hole in the front of the case. If it is desired to relate the linkage setting to the index marks on the linkage it will be necessary to remove the case. This may be done by removing the two mounting screws, one on each side of the case, which may be taken off without disturbing the trip unit itself.

If the breaker is provided with a shunt trip or undervoltage device, the EC-2, EC-2A, case on the center pole must be taken off first before the cases on the outer poles can be removed.

INSTANTANEOUS LOW-SET TRIPPING (Fig. 3)

The low-set instantaneous pick-up point may be varied by the adjustment knob (3). The calibration in this case usually ranges from 80 percent to 250 percent of the series coil rating, with the calibration plate indexed at values of 80, 100, 150, 200, and 250 percent of the rating.

INSTANTANEOUS HIGH-SET TRIPPING (Fig. 3)

The high-set instantaneous pick-up value may have one of the following three ranges: 4 to 9 times coil rating; 6 to 12 times coil rating or 9 to 15 times coil rating. The pick-up setting may be varied by turning the instantaneous pick-up adjusting screw (12).

Three calibration marks (15) will appear on the operating arm (14) and the value of these calibration marks will be indicated by stampings on the arm as follows: (4X - 6.5X - 9X) or (6X - 9X - 12X) or (9X - 12X - 15X).

At the factory, the pick-up point has been set at the nameplate value of the instantaneous trip current. (Usually expressed in times the ampere rating of the trip coil.) The variation in pick-up setting is accomplished by varying the tensile force on the instantaneous spring (5). Turning the adjustment screw changes the position of the movable nut (11) on the screw. The spring is anchored to this movable nut so that when the position of the nut is changed, there is a corresponding change in the spring load. As the spring is tightened, the pick-up point is increased.

The top edge of the movable nut (11) serves as an index pointer and should be lined up with the center of the desired calibration mark (15) to obtain the proper instantaneous trip setting.

The trip screw (6) on the end of the armature (7) should be set so that it does not contact the trip paddle on the trip shaft until the air gap between armature and pole piece is reduced to 3/32 in. or less, measured at the rivet in the pole piece. Also, the armature must have a minimum of 1/32 in. of travel beyond the point in its motion at which the breaker is tripped.

Replacement of the EC-2, EC-2A device is accomplished by the same procedure described for the EC-1 series trip device: however, in some cases, when replacing an EC-1 device with an EC-2, EC-2A it will be necessary to replace the trip paddles on the trip shaft with ones which are slightly longer. When required these will be provided with the replacement trip units.

NOTE: Pickup settings on the cover of the EC-2, EC-2A device are calibrated for the specific device. When replacing covers, replace on associated device.