FEDERAL PACIFIC - Breakers and Switchgear

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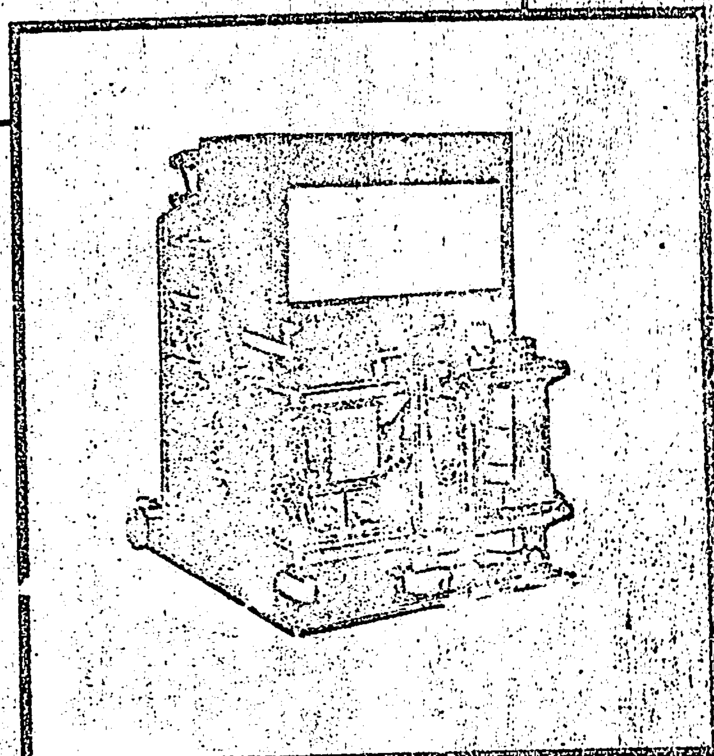
Selection and Application of FEDERAL PACIFIC Air Circuit Breakers



Federal Pacific Electric Company • Manual No. 3-407

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Selection and Application of Federal Pacific Air Circuit Breakers

SELECTION

The problem of selecting air circuit breakers for the protection of low voltage circuits is similar to the problem of selecting other types of equipment such as motors or relays. As in the application of motors and relays, the circuit breaker should be compatible with the power system with which it is to be associated; it should be able to withstand the conditions imposed during operation in the field. Most of these requirements will be obvious upon inspection of the power system and the field conditions, and should be evaluated with reference to the text of this manual. The maximum short circuit current available at the point of application will not be so self-evident; it is usually necessary to calculate this value. The available short circuit current which the circuit breakers must carry and interrupt, is unique with the power system and the point of application of the circuit breaker.

This publication is intended for use in the selection and application of general purpose low voltage air circuit breakers and the trip devices associated with these circuit breakers, as recommended by the NEMA Standards for Large Air Circuit Breakers.

The factors which will affect the selection of air circuit breakers are as follows:

1. Circuit load current.
2. Circuit voltage.
3. Available short circuit current at the point of application.
4. System frequency.
5. Local electrical codes.
6. Limits of observable temperature rise.
7. Unusual service conditions.

These factors and conditions should be referred to the particular sections dealing with them in this manual.

1. Circuit Load Current

The rated continuous current of Federal Pacific circuit breakers is the designated limit in rms amperes or D.C. amperes which they will carry continuously without exceeding the limit of observable temperature rise. After a fault current interruption the current carrying ability of a circuit breaker may be materially reduced. Table No. 2, page 16, shows the continuous current ratings of Federal Pacific large air circuit breakers and series trip coil ratings.

2. Circuit Voltage

The voltage rating of the circuit breaker should equal or exceed the nominal voltage of the circuit to which it is to be applied. Table No. 1, page 16, lists the greatly increased interrupting ratings available at voltages lower than 600v.

3. Available Short-Circuit Current

The available short-circuit current at a given point in a power system is the maximum current which the power system, when operating with maximum generating capacity and connected motor load, can deliver to zero impedance short circuits simultaneously applied from all phases or polarities to ground. For a-c systems the rms value of the maximum asymmetrical current available must be less than the interrupting rating and short time rating of the circuit breaker. For d-c systems the maximum steady state current should be less than the interrupting rating of the circuit breaker.

For further discussion of the selection of air circuit breakers with respect to their interrupting capacity, reference should be made to the tables on pages 18 and 19 on interrupting capacity and the discussion on calculation of available short-circuit current on page 10.

4. System Frequency

The frequency rating of the circuit breaker should agree with the nominal frequency of the power system. Federal Pacific circuit breakers are rated for frequencies of 60-25 cycles or d-c. For frequencies other than frequencies available as standard or for circuits on which higher order harmonics are present, special recommendations should be requested from the Federal Pacific Electric Company (hereafter called the Company).

5. Local Electrical Codes

Federal Pacific breakers are designed to comply with the National Electrical Code. Where City or State Codes are more restrictive than the National Electrical Code, the Company should be consulted for its recommendations. Unless such recommendations are obtained in advance of placing orders, the Company will not assume responsibility for compliance with such codes.

6. Limits of Observable Temperature Rise

Federal Pacific air circuit breakers are designed in accordance with the NEMA Standards SG3-3.04 on Limits of Observable Temperature Rise above the Ambient Temperature, the latter defined in the NEMA Standard SG3-3.15.

7. Unusual Service Conditions

When unusual environmental conditions or unusual duty conditions are encountered, it is recommended that these conditions be nullified at the site of the installation. Unusual conditions referred to are those considered by NEMA under SG3-2.02. When such action is not possible and standard equipment adaptable to the condition is not listed, recommendations for special features necessary to adapt standard equipment to the conditions should be obtained from the Company in advance of placing the order.

INTERRUPTING RATINGS

The interrupting rating of a circuit breaker is the highest current (rms if alternating current) at a specified operating voltage which the breaker is required to interrupt under the operating duty specified and with a normal frequency recovery voltage equal to the specified operating voltage.

Interrupting ratings of Federal Pacific air circuit breakers are based on test procedure, applicable operating duty (duty cycle), performance, and conditions given in paragraphs SG3-3.07, SG3-3.08 and SG3-3.19 of the NEMA Standard for large air circuit breakers These paragraphs read essentially as follows:—

Short-Circuit Interrupting Tests

The test procedure and characteristics of the test circuit to be used for verifying the ability of the circuit breaker to interrupt the total amperes (rms if alternating current) given by the interrupting rating for the applicable operating duty shall be as follows:

A. RMS Total Amperes

The rms total amperes shall be determined by measuring the current flow in the test circuit as follows:

The circuit breaker shall be short circuited or omitted.

In alternating-current circuits, the current measured shall be the rms total current including if any, the direct-current component. It shall be measured at an instant one-half cycle after the short circuit occurs and shall be calculated in accordance with American Standard Methods for Determining the Rms Value of Sinusoidal Current Wave and a Normal-frequency Recovery Voltage. (For a 3-phase test circuit the rms total current shall be the average of the currents in all 3 phases. For a single-phase test circuit, 3 successive tests shall be made to determine the average current in that circuit.)

The circuit constants for the test circuit, with the required current flowing, shall be such that the X/R ratio is at least 11.72.

In direct-current circuits, the current measured shall be the maximum value.

The transient characteristics of the testing circuit for a circuit breaker with delayed tripping in the fault current range shall be such that the 3-phase average current at the end of 30 cycles (based on a 60-cycle frequency) shall be not less than 75 per cent of the average rms total current at the end of the first half cycle.

B. Performance

At the end of any performance at or within its interrupting rating, the circuit breaker shall be in the following condition:

1. *Mechanical—The circuit breaker shall be in substantially the same mechanical condition as at the beginning.*
2. *Electrical—The circuit breaker shall be capable of withstanding rated voltage in the*

open position and of carrying rated current at rated voltage for a limited time but not necessarily without exceeding the rated temperature rise.

After performance at or near its interrupting rating, it is not to be inferred that the circuit breaker can again meet its interrupting rating without being inspected and, if necessary, repaired.

C. Conditions

The conditions which are assumed in assigning an interrupting rating to a circuit breaker include the stored electrostatic and magnetic energy of the system, the re-establishment of an arc under transient voltage conditions, the decrement of the systems, and other variable conditions. These conditions are considered as not differing widely in average systems and are to be taken into account in the factor of safety employed in the rating of the circuit breakers.

Determination of Interrupting Rating

A. Operating Duty for Determining the Interrupting Rating (Duty Cycle)

The operating duty for determining the interrupting rating of circuit breakers with instantaneous overcurrent trip devices for fault currents shall consist of an opening operation, followed after a 15-second interval by a close-open operation.

The operating duty for determining the interrupting rating of circuit breakers with delayed overcurrent trip devices for fault currents shall consist of an opening operation, followed after a 15-second interval by a close-open operation, the tripping being delayed by the associated tripping devices.

B. Interrupting Ratings for Circuit Breakers with Instantaneous Overcurrent Trip Devices for Fault Currents

The interrupting ratings given in SG3-3.05 are based on direct-acting overcurrent tripping.

For circuit breakers with direct-acting overcurrent trip devices, current values in excess of the following shall cause instantaneous operation:

1. *Circuit breakers having a continuous current rating of 2000 amperes and below — 15 times the rated continuous current of the circuit breaker.*
2. *Circuit breakers having a continuous current rating above 2000 amperes —*
   a. *12 times the rated continuous current of the circuit breaker, or*
   b. *75 per cent of the interrupting rating, or*
   c. *the short-time rating,*

   whichever is lowest.

C. Interrupting Ratings for Circuit Breakers with Direct-Acting Delayed Overcurrent Trip Devices for Fault Currents

The interrupting ratings are based on the maximum, intermediate and minimum short-time delay bands associated with selective trip devices.

Interrupting ratings of Federal Pacific air circuit breakers are shown in Table No. 1, page 16.

SHORT-TIME RATINGS

The rated short-time current of a circuit breaker is the highest rms current, including the d-c component, which it will be required to carry for specified short-time intervals.

Short-time rating of Federal Pacific air circuit breakers is based on test procedure, operating duty (duty cycle), performance, and conditions given in paragraphs SG3-3.10 and SG3-3.16. The paragraphs read essentially as follows:—

Short-Time Current Tests

Short-time current tests are made to determine the ability of a circuit breaker to carry its rated short-time current without injury.

A. RMS Total Amperes

Determined same as for interrupting rating.

B. Performance

At the end of any performance at or within its short-time rating, the circuit breaker shall be capable of carrying rated continuous current without exceeding the rated temperature rise of its various parts and shall be capable of meeting its interrupting rating.

Short-Time Duty Cycle

The short-time duty cycle shall consist of maintaining rated short-time current for two periods of one-half second each, with a 15-second interval of zero current between the one-half second periods.

Short time ratings of Federal Pacific air circuit breakers are shown in Table No. 3, page 17. Application of breakers and series trip devices, where tripping is delayed to provide selective tripping, is further discussed on pages 11 and 12.

OPERATING MECHANISMS

When the breaker is closed full contact should be established quickly and positively. This is required since hesitation or slowness on closing, particularly when closing the circuit breaker against a short circuit, causes excessive arcing, consequently burning of the contacts, and other damage to the breaker. When closing manually, the operator may hesitate or be uncertain in his efforts to close the breaker, giving rise to the conditions described.

To insure greater safety, as well as ease of operation, the following limitation recognized by the AIEE and NEMA applies to manually operated breakers:

Manually operated circuit breakers shall be limited to applications where the interrupting requirements do not exceed 50000 amperes and where tripping is instantaneous for current above 15000 amperes for dead-front and enclosed breakers or where interrupting requirements do not exceed 10000 amperes for live-front breakers and rated continuous current does not exceed 1600 amperes. For selective tripping, manually operated circuit breakers shall be limited to application in which delayed tripping requirements do not exceed 15000 amperes. All circuit breakers subjected to fault currents in excess of their interrupting rating shall be electrically operated from a remote position only, to provide protection for the operator when closing against fault current.

1. Direct Manual-Operating Mechanism

Direct manual-operating mechanisms are integral with the breaker structure in DMB15, DMB25-1, DMB50 circuit breakers. The operating handle of the mechanism protrudes through the dead front panels or the doors of the metal enclosed drawout switchgear units, depending on the enclosure.

2. Electrical Operating Mechanisms

Electrical closing of DMB 15, 25-1 and 50 circuit breakers is accomplished by a solenoid actuated mechanism. The solenoid is controlled by closing the control relay provided for this purpose.

CONTROL CIRCUIT POWER

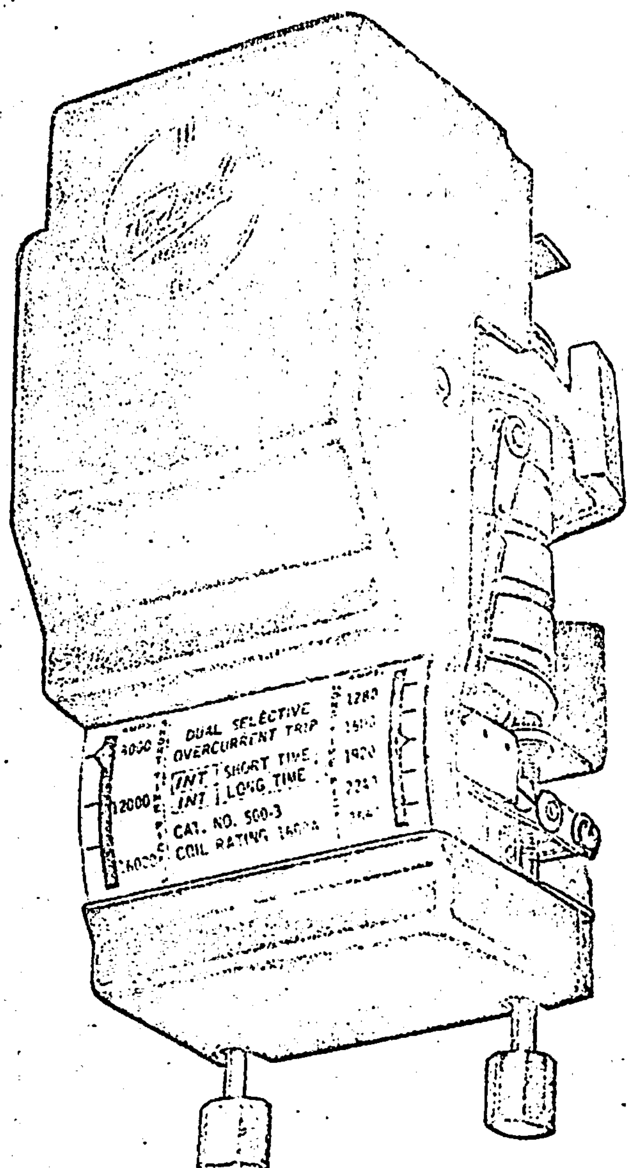
The control circuit must have a reliable source of power for successful operation of the control components. The control circuit power source should be independent to the degree that the voltage is maintained constant, particularly when fault conditions are encountered, and should never be allowed to fall below the minimum value required for successful operation of the components.

The following table lists rated control voltages and minimum and maximum ranges. These voltages are to be measured at the terminals of the various control mechanisms with full operating current flowing.

FEDERAL PACIFIC AIR CIRCUIT BREAKERS
Rated Control Voltages and Ranges

Rated Control Voltage, Volts	Closing Voltage Range, Volts		Tripping Voltage Range, Volts
	Control Devices	Solenoid	
	DIRECT CURRENT *		
24†	....	....	14-30†
48	....	....	28-60
125	90-130	90-130	70-140
250	180-260	180-260	140-280
	ALTERNATING CURRENT		
115	95-125‡	....	95-125
230	190-250‡	190-250	190-250
460	380-500‡	380-500	380-500

† 24-volt tripping is not recommended.
‡ Includes heater circuits.
* Control from exciter circuits is not recommended.



TRIPPING DEVICES

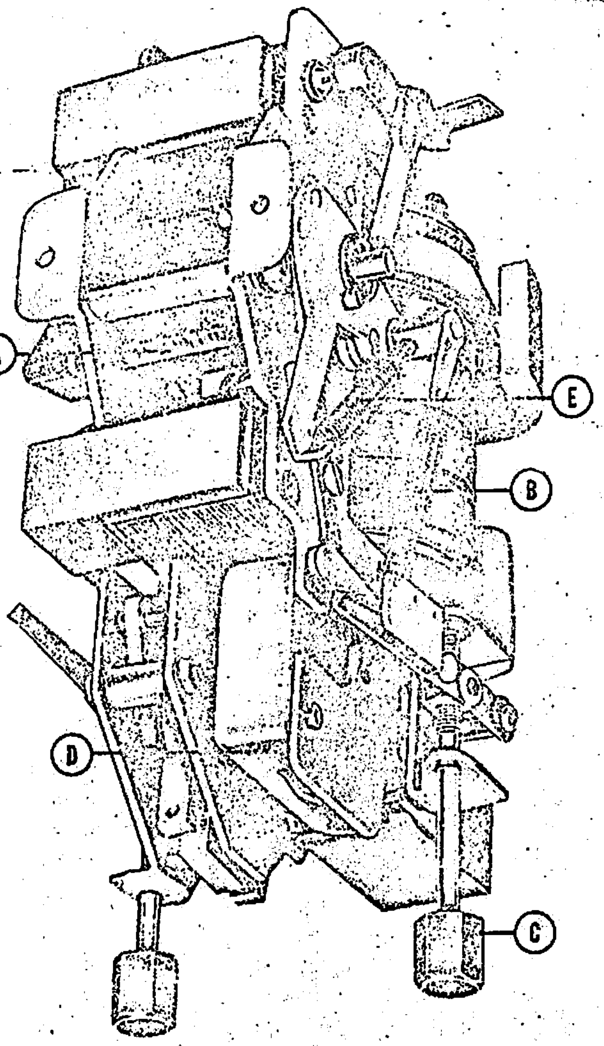
Tripping devices in DMB breakers have two distinct functions:

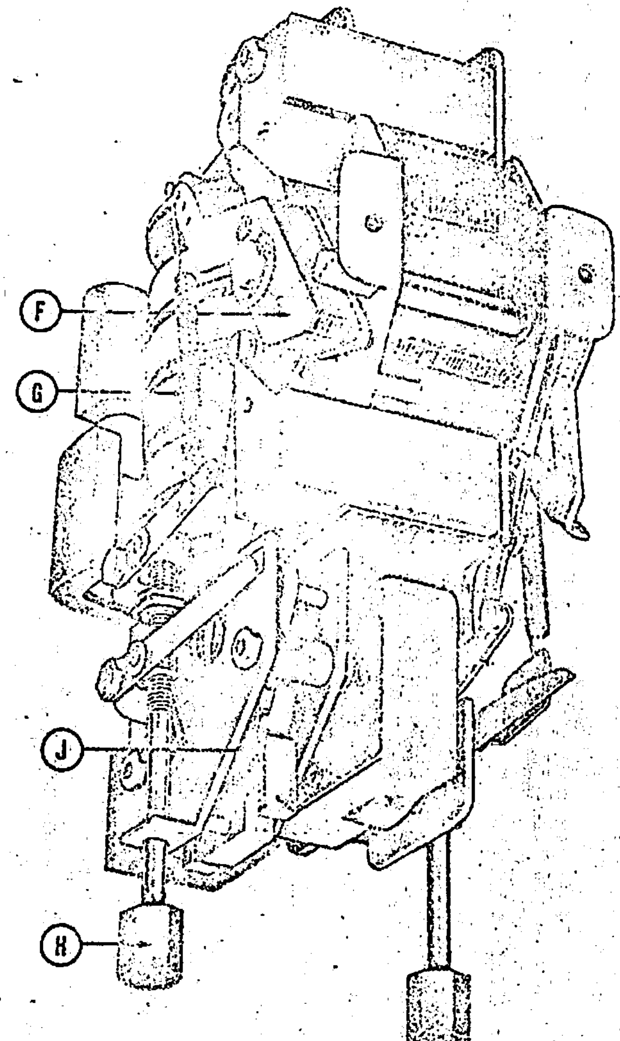
a. To perform the normal switching operations either manually or from a remoted source.

b. To protect the circuit when abnormal conditions exist.

The normal switching tripping operation is performed by a shunt trip which is energized by a constant potential source. Automatic protective trip is of three types; undervoltage trip, shunt trip, and overcurrent trip.

1. The undervoltage device is a spring mechanism retained by a shunt holding coil. Upon a reduction in voltage, the mechanism is released to trip the breaker.
2. The shunt trip device is energized from a control source through an auxiliary switch which is closed when the breaker is closed. The control source may be from a current transformer in the main circuit.
3. The series overcurrent trip device is in series with the power circuit and is actuated by the main circuit. A more detailed description of various methods and their associated systems follows.





SERIES OVERCURRENT TRIPPING DEVICE FOR DMB 15, DMB 25-1, DMB 50

The series overcurrent tripping device consists of a series coil and a magnetic circuit with two armatures; one activating a long time delay escapement mechanism and the other a short-time delay escapement mechanism. These armatures, though in the same magnetic circuit, act independently at selected currents to trip the circuit breaker. Instantaneous tripping may be used in conjunction with either long-time-delay or short-time-delay. The *long-time-delay armature* (A) is restrained by a *spring* (B), the tension of which may be set by a calibration *knob* (C) beneath the device. The calibration of this spring provides pickup current adjustment of from 80% of the continuous current rating of the trip coil, to 160% of that current. The armature is further restrained by a *mechanical escapement* (D) which provides for a long-time-delay before tripping of from 3 minutes at 125% of the pickup current to the time indicated by the curve of the band specified at 600% of the pickup current. The linkage between the armature and the timer is a heavy factory-set *spring* (E). Depending on the setting of this spring, currents in excess of from 8-15 times the breaker's continuous current rating will overcome the tension of this spring to trip the breaker instantaneously.

Restraining the *short-time-delay armature* (F) is a second calibrating *spring* (G), the tension of which may be adjusted by another *knob* (H) beneath the device. The setting of this spring provides pickup current adjustment of 5, 7½, and 10 times the continuous current rating of the coil. Also restraining this armature is a simple *mechanical escapement* (J) which is factory-set to provide a short time delay in the order of 7, 14 or 21 cycles at 250% of the current required to pickup the armature.

TRIPPING CHARACTERISTICS PRODUCED

1. Long-Time-Delay:

Alone or in combination with the non-adjustable instantaneous trip and/or short-time-delay. The long-time-delay pickup is adjustable in the field at the calibrated setting of 80, 100, 120, 140 and 160% of the trip-coil rating. Long-time-delay pickup adjustments in excess of 100% of the trip coil rating do not provide protection for the breaker and should be used only on selective systems. Selection of time-current characteristics should be made from Table A or appropriate curves.

2. Short-Time-Delay:

Alone or in combination with the non-adjustable instantaneous trip and/or long-time-delay for selective tripping. The short-time-delay is field adjustable at the calibrated settings of 5, 7½, and 10 times the trip coil rating. Selection of the time-current characteristics should be made from Table B or appropriate curves.

3. Instantaneous:

Alone or in combination with the short-time-delay and/or the long-time-delay. Available from 8-15 times the continuous current rating of the trip coil or in special settings, but not exceeding 90% of the interrupting rating of the breaker. Unless otherwise specified, the standard setting of 10 times the trip coil rating will be suppiied.

Adjustments:

Both the long-time-delay pickup current and the short-time-delay pickup current are field adjustable by adjusting the corresponding calibration knob to the desired setting. Actual time delays corresponding to the three NEMA bands for both long-time-delay and short-time-delay are factory set according to specification. Instantaneous tripping is also factory set to specification. Unless otherwise indicated on order, the instantaneous trip setting will be at 10 times the continous current rating of the trip coil. The armature air gap is factory set and should not be changed.

The preceding characteristics produced are the same for the DMB-15, DMB-25-1, and DMB-50 large air circuit breakers since the same type series overcurrent trip-device is used. However, the devices are not interchangeable from one interrupting rating to another.

Table No. 3 shows permissible interrupting rating range of various series trip coils.

Time-Current Characteristic Curves

The long-time-delay curves are shown as the summation of the tripping device timing plus the breaker clearing time. The broken line below the operating curve indicates the reset time, i.e., the maximum time for which the overcurrent can be maintained through the series trip device without ultimately tripping the breaker. If the current is instantaneously reduced to and maintained at 80% of the long time delay pickup current, at or below this broken line, the tripping device will automatically reset.

The short-time-delay curves are also shown as the

TABLE A

Type of Breaker	Time Characteristic	Pickup Tolerance	Lower limit of band † at 600% of Pickup Setting*
DMB-15, 25-1, 50	Min. Inter. Max.	± 10% ± 10% ± 10%	5 seconds 15 seconds 30 seconds

* Field adjustable from 80 to 160% of trip coil rating.

TABLE B

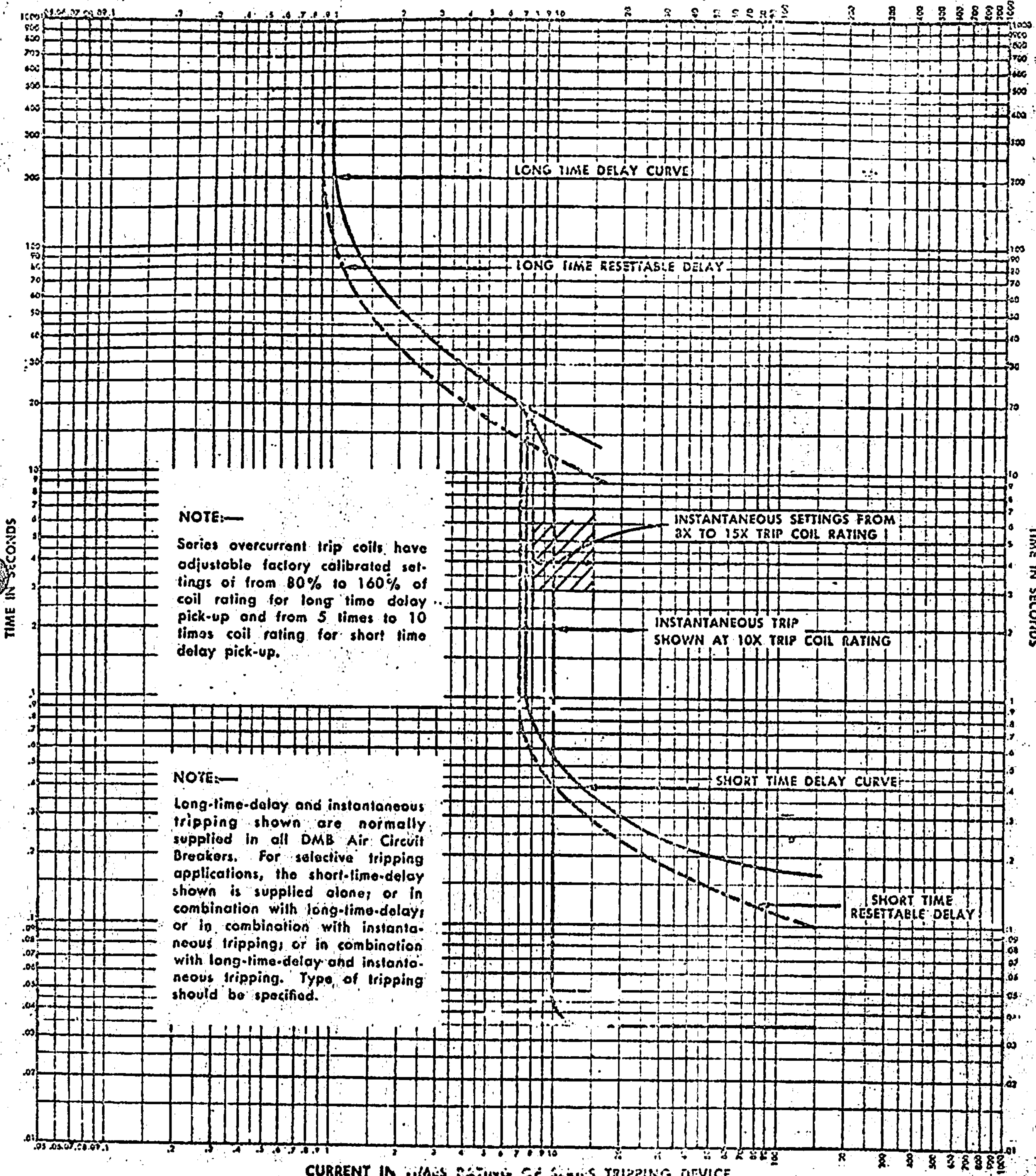
Type of Breaker	Time Characteristic	Pickup Tolerance	Lower limit of [illegible] ‡ 250% of Pickup Setting**
DMB-15, 25-1, 50	Max. Inter. Min.	± 10% ± 10% ± 10%	21 cycles 14 cycles 7 cycles

**Field adjustable 5, 7½, and 10 times the trip coil rating.

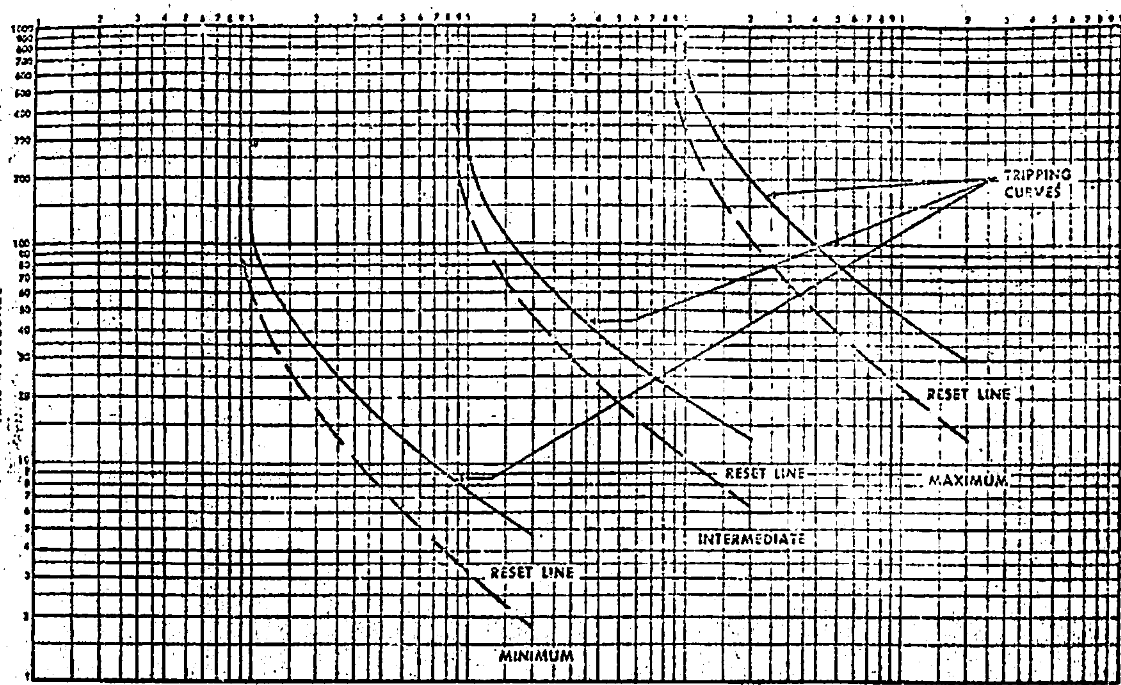
† The lower limit of the band is the time for which the overcurrent may persist at the given value and then drop to 80 percent of the long time delay pickup current without tripping the circuit breaker. (See Curves, pages [illegible]).

‡ The lower limit of the band is the time for which the overcurrent may persist and then drop to 20 per cent of the short time delay pickup current without tripping the circuit breaker. Bands are factory set. (See Curves, pages 8 and 9).

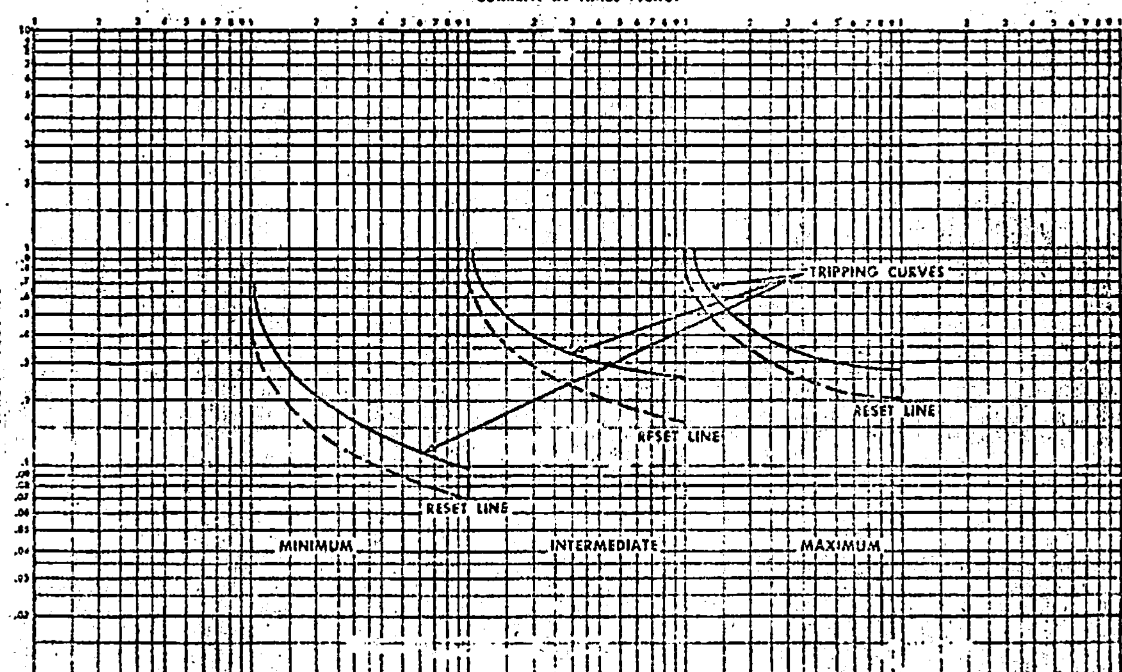
Time Current Characteristic Curves



Typical Dual Selective Overcurrent Tripping Curve



Long-Time Delay Curves
Nema Standard SG3-3.25A



NOTE: THE PICK-UP CURRENT SETTING FOR EACH BAND IS ADJUSTABLE TO 5, 7½, and 10 TIMES THE RATING OF THE SERIES OVERCURRENT TRIPPING DEVICE.

Short-Time Delay Curves
Nema Standard SG3-3.25B

summation of the timing of the tripping device plus the breaker clearing time. The broken line below the operating curve indicates the reset time, i.e., the time for which an overload may persist through the device without ultimately tripping the breaker. If the current is instantaneously reduced to and maintained at 20% of the short-time-delay pickup current at or below this line, the device will automatically reset.

Both the long-time-delay curves and the short-time-delay curves are average curves and include the variations between individual units, the manufacturing tolerances, and the differences between single phase and three phase tripping.

Where calibration adjustment has been set so as to co-ordinate devices properly in a selective system, the calibration should not be disturbed for proper operation of the system.

CONTINUOUS CURRENT RATINGS

Continuous current of circuit breakers and series trip coils, in amperes, is shown in Table No. 2, page 16.

DEFINITION OF TERMS

Selective Overcurrent Tripping:

The operation of circuit breakers in series so that, of the breakers carrying the fault current, only the breaker nearest the fault operates to remove the overcurrent conditions and the breakers nearest the source shall remain closed and continue to carry the remaining load current.

Cascading:

The application of air circuit breakers in which the breakers nearest the source of power shall have interrupting ratings equal to, or in excess of, the obtainable fault current and where one or more breakers further removed from the power source have interrupting ratings less than the obtainable fault at the point of their application.

Instantaneous:

A qualifying term indicating that no delay is purposely introduced in the action of the device.

Pickup Current:

"Pickup current" as applied to an overcurrent tripping device (for a given calibration setting) is the minimum current which will cause operation of the tripping device, resulting in the subsequent tripping of the circuit breaker with which the trip device is associated.

Calibration:

Circuit breakers with adjustable overcurrent trip shall be calibrated at 80, 100, 120, 140, and 160 per cent of their continuous current rating. The tolerance shall be plus or minus 10%.

Overcurrent trip coils shall be selected so as to provide the minimum trip setting required.

Short Time Delay Pickup:

Shall be set at 5, 7½, and 10 times the ampere rating of the overcurrent trip coil.

Series Overcurrent Tripping:

Trip coil in series with main circuit.

Instantaneous Overcurrent Trip:

Functions above a predetermined value of current without any purposely delayed action.

Delayed Overcurrent Trip:

Functions above a predetermined value of overcurrent with a purposely delayed action.

Dual Overcurrent Trip:

Combines the function of a delayed and an instantaneous overcurrent trip.

Selective Overcurrent Trip:

Functions with a purposely delayed action at all values of current between a predetermined value and the rated interrupting current of the circuit breaker with which it is associated, and which will automatically reset when the current is reduced within a prescribed time to a value within the rated continuous current.

Dual Selective Overcurrent Trip:

Combines the function of a delayed overcurrent trip and a selective overcurrent trip.

DETERMINATION OF SHORT-CIRCUIT CURRENTS:

Low-voltage air circuit breakers are to be applied to circuits in the usual manner by observing that the ratings defined as standard are not exceeded. The interrupting ratings, given as the standard, assume that the maximum short-circuit current available at the point of application of the circuit breaker is calculated according to the following outline.

(a) For d-c circuits, the current calculated shall be the maximum value, taking into account all resistance up to the source side of the circuit breaker but not including any of its own resistance.

For d-c faults of 100,000 amperes and above, consideration should be given to the rate of rise of the current as compared with the interrupting speed and rating of the circuit breakers.

(b) For three-phase a-c circuits, the current calculated shall be the average value of the three phases of the total current, including the d-c component, at an instant one-half cycle after the short circuit occurs. This value is computed by first determining the total symmetrical current from all sources, including synchronous motors and induction motors. Then this total symmetrical current is multiplied by a factor to determine the average three-phase current at an instant one-half cycle after the short circuit occurs.

Determination of Symmetrical Current. The symmetrical current consists of the sum of system and motor contributions, calculated in the following manner:

1. System contribution is determined for all sources and all impedances up to the source side of the circuit breaker, but not including any of the circuit breaker impedance. At 600 volts and below, even small impedances should be taken into account as they may greatly affect the result.

2. Induction and synchronous motors connected to the bus act as generators, and at one-half cycle after the short circuit occurs, contribute current which may be calculated from the subtransient reactance of the motor. Where the reactances of the motors are not known, values are assumed for induction motors of 3.6 times motor full-load current, and for synchronous motors of 4.8 times motor full-load current.

When the motor load of the installation is not known, assumptions may be based on system voltages.

For system voltage of 120 and 120/208 volts, it is usual to assume that the connected load is 50 percent lighting and 50 percent motor load. This corresponds to an equivalent symmetrical contribution of twice the full connected load.

For system voltage of 240 to 600 volts, it is usual to assume that the load is 100 percent motor load and, in the absence of exact information, that the motors are 25 per cent synchronous and 75 percent induction. This corresponds to an equivalent symmetrical contribution of four times the full connected load.

Determination of the Asymmetrical Current. The asymmetrical or total rms current, including the direct-current component, is determined by multiplying the symmetrical current as obtained from the preceding method by a factor to account for the increase in the average three-phase current caused by the presence of the direct-current component. While this factor depends on the X/R ratio of the total impedance to the point of fault, a good approximation is obtained by the use of a multiplying factor of 1.25. The use of this approximate factor, in preference to the determination of the exact factor obtained for the specific X/R ratio for each low voltage circuit breaker application, is generally accepted practice. This factor of 1.25 corresponds to a ratio of 11.72.

(c) For single-phase a-c circuits, the current is calculated in the same manner as that used for three-phase circuits, as the maximum asymmetrical current in a single-phase circuit is identical with the current in the highest phase of a three-phase circuit. (See American Standard on Low Voltage Air Circuit Breakers C37.13)

THE SELECTIVE SYSTEM*

When service to a number of circuits is to be maintained, despite a fault in any one of the circuits and protection to all circuits must be provided, the selective system is applicable. In Figure 1 the main breaker A, the tie breakers B, and the feeder breakers C are between the source and the loads. In the selective system, a fault at any load will trip the feeder breaker C which is between the load and the circuit tie breaker B. The remaining loads, however, will still

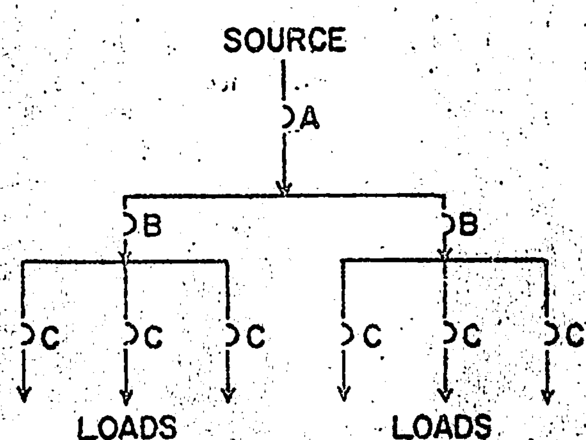


FIGURE 1

* Selective trip and short time delay applications limited to interrupting current ratings shown in table No. 3, Page 17.

be fed even though the faulted circuit is cleared. This is accomplished by delaying the tripping time of the tie breaker B to the extent that the feeder breaker C serving the faulted circuit, will clear the circuit before B trips. Correspondingly, the tripping time of the main breaker A is still further delayed so that in the event that any tie breaker B clears the circuit as the result of an overload between it and the load, the remaining tie circuit is being fed. All the breakers in the system are timed so as to protect their associated circuits and to trip in sufficient time to protect the breakers themselves within their respective interrupting capacities. The following are requirements for breakers in a selective arrangement, as outlined in the American Standard on Low Voltage Air Circuit Breakers:—

Requirements for Circuit Breakers in Selective Trip Arrangement

Properly selected air circuit breakers may be applied to low voltage circuits to obtain selective tripping. The following requirements shall be observed:

(a) Each air circuit breaker must have an interrupting rating equal to or greater than the available fault current at the point of application.

(b) Except for the one farthest removed from source of power, each air circuit breaker must have a short-time rating equal to or greater than the available current at the point of application.

(c) The time-current characteristic of each air circuit breaker, at all values of available overcurrent, shall be such as to insure that the circuit breaker nearest the fault shall function to remove the overcurrent conditions. Those nearer the source shall remain closed and continue to carry the remaining load current.

(d) To insure that each circuit breaker shall function to meet these requirements, the time-current characteristics of associated circuit breakers must not overlap. The pickup settings and time delay bands of both the long-time and short-time delay elements must be properly selected.

(e) Manually-operated circuit breakers shall be limited to applications in which delayed tripping requirements do not exceed 15,000 amperes or 15 times the trip-coil rating, whichever is greater.

(f) The time-current characteristics of circuit breakers in a selective system shall be such that four circuit breakers may be operated selectively in series when required. One of these shall be a load circuit breaker equipped with an instantaneous trip element.

Note: Attention is directed to the fact that operation of selective tripping requires coordination with the rest of the system. As an example, the low-voltage side of a transformer bank requires that, in the application of relays or fuses on the high-voltage side, proper coordinating steps should be taken.

Examples of application of Federal Pacific air circuit breakers on typical selective trip systems are given in Table No. 4, page 18.

CASCADE SYSTEM*

Although the selective system is the best recommendation in all cases, there are applications where it is not feasible, economically, to use feeder breakers with full interrupting capacity at all loads. In such cases the cascade system may be employed. This means that only the breakers nearest the source of power must have interrupting ratings equal to the average total calculated rms current, as stated for breakers between the source and the load. Breakers further from the source may have lower interrupting ratings. The following are requirements for breakers in cascade as outlined by the American Standard on Low Voltage Air Circuit Breakers:—

Requirements for Circuit Breakers in Cascade Arrangement

Circuit breakers are considered to be in cascade when a plurality of low voltage air circuit breakers are connected in series in a distribution system, and the circuit breakers beyond those nearest to the source are applied in the following correlated manner.

In this cascade arrangement, circuit breakers toward the source are provided with instantaneous tripping devices for current values which may occur for faults beyond other circuit breakers nearer the load. Hence, circuit breakers in the series other than the circuit breaker closest to a fault may trip and interrupt loads on other than the faulty circuit. Such arrangements are used only where the consequent possible sacrifice in service continuity is acceptable.

(a) *Cascading shall be limited to two or sometimes three steps of interrupting rating.

1. The interrupting rating of a circuit breaker or breakers nearest the source of power shall be equal to at least 100 percent of the short-circuit current as calculated in accordance with preceding paragraphs of this guide. The circuit breaker or breakers in this

* Cascading at 240v. and 480v. maximum interrupting ratings is limited to two steps of interrupting rating.

step shall be equipped with instantaneous trips set to trip at a value of current that will give back-up protection whenever the circuit breaker in the next lower step carries current greater than 80 percent of its interrupting rating.

2. The circuit breaker or breakers in the second step shall be selected so that the calculated short-circuited current through the first step, plus motor contribution in the second step, will not exceed 200 percent of their interrupting rating.

For the second step of a 2-step cascade, the circuit breakers shall have an instantaneous trip set above the starting inrush current of the load. For the second step of a 3-step cascade, the circuit breakers shall be equipped with instantaneous trips set to trip at a value of current that will give back-up protection whenever the circuit breaker in the next lower step carries current greater than 80 percent of its interrupting rating.

3. The circuit breaker or breakers in the third step shall be selected so that the calculated short-circuit current through the first step, plus motor contribution of the second and third step, will not exceed 300 percent of their interrupting rating. They shall have instantaneous trips set above the starting inrush current of the circuit.

(b) All circuit breakers subjected to fault currents in excess of their interrupting rating shall be electrically operated from a remote position only, to provide protection for the operator when closing against fault current.

(c) Where cascading is proposed, recommendations shall be obtained from the Company in order to insure proper coordination between circuit breakers. Molded case circuit breakers are not recommended for use in cascade.

(d) The operation of circuit breakers in excess of their interrupting rating is limited to one interruption, after which inspection or replacement may be required.

Examples of application of Federal Pacific air circuit breakers in typical 2-step cascade systems are given in Table No. 4, page 18.

NATIONAL ELECTRICAL CODE 1953

The rules of the National Electrical Code cited here are those which apply specifically to air circuit breakers and air circuit breaker application. These rules refer to the number of poles per breaker, the calibration of overcurrent devices and the location of breakers, etc. References to the National Electrical Code are not a modification of the rules, with regard to voltage, current, and interrupting rating, previously cited herein.

Service Circuits (Sections 2351, 2354, 2356, 2357, 1953 Code)

The NEC Rules require that "each set of service-entrance conductors shall be provided with a readily accessible means of disconnecting all conductors from the source of supply." Air circuit breakers approved for this application are specified as "manually operable, . . . equipped with a handle or lever for mechanical operation by the hand." A push-button type of electrical remote control may be used in addition to the manual handle. This means that the use of electrically operated breakers is permitted if the breaker can be operated manually, in case of an emergency, by means of an operating lever. Such a lever is available with Federal Pacific electrically operated breakers. An enclosed breaker must be "externally operable," or capable of being operated without exposing the operator to contact with live parts. The Code recommends that a service circuit breaker shall have a rating not less than 50 amperes.

The requirement that each conductor be disconnected means that the breaker should be supplied with as many poles as there are conductors. It further specifies that "each ungrounded service-entrance conductor shall have overcurrent protection." This means that for a three-phase, three-wire entrance circuit, a three-pole breaker—each pole having an overcurrent trip device—will be required.

The code also requires that "not more than six circuit breakers may serve" for the service-entrance protection, when these breakers are "in a common enclosure, or in a group of separate enclosures, located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall." This means that if there are not more than six feeder circuits the feeder-circuit breaker in each circuit will also serve as the service breaker. In each case, each breaker must be considered as an incoming-line breaker, and must be provided with an overcurrent device in each ungrounded conductor. If there are more than six feeder circuits, there must be a separate or main service breaker.

The object of the limitation is to provide, under the condition of a common "available space," not more than six circuit breakers which would have to be operated to cut off the entire system served (especially a residence or other building).

Feeder Circuits (Sections 2403 and 2405, 1953 Code)

The general requirements for circuit breakers and feeder circuits are that each ungrounded conductor be disconnected when the breaker opens, and that the rating of the overcurrent trip device be as follows:

Adjustable-trip circuit breakers of the time-delay, magnetic-trip type, or of the instantaneous-trip type, shall have a setting of not more than 150 per cent of the allowable carrying capacity of the conductors.

Motor circuits are exceptions to these requirements.

Motor Circuits (Section 430, 1953 Code)

Motor circuits are classified as "motor feeders" and "motor-branch circuits." A motor-branch circuit may serve only one motor or it may serve two or more motors.

For an individual motor, "the motor-branch-circuit overcurrent device" (that is, circuit breaker) (Section 4342, 1953 Code) "shall be capable of carrying the starting current of the motor. Overcurrent protection shall be considered as being obtained when this overcurrent device has a rating or setting not exceeding the values" given below:

Single-phase "Code Letter A" (where the locked rotor current is not in excess of 3.14 times the normal current) 150%

Single-phase "Code Letters B to E" (where the locked rotor current exceeds 3.14, but is not more than 4.99 times normal current) 200%

Single-phase—all other 250%

Polyphase squirrel-cage and synchronous motors with full-voltage, resistor or reactor starting:

"Code Letter A" (locked rotor current not exceeding 3.14 times normal current) 150%

"Code Letters B to E" (locked rotor current exceeds 3.14, but not more than 4.99 times normal current) 200%

All others 250%

Polyphase squirrel-cage and synchronous motors with auto-transformers starting "Code Letter A" (locked rotor current not more than 3.14 times normal) 150%

All others 200%

Wound-rotor motors 150%

Direct-current motors 150%

An exception to the settings specified above is "that where the overcurrent protection specified in the table is not sufficient for the starting current of the motor, it may be increased, but shall in no case exceed 400 percent of the motor full load current."

For motor-feeders, (Section 4362, 1953 Code) the circuit breaker setting "shall not be greater than the largest rating or setting of the branch-circuit protective device, for any motor of the group (based on Tables 26 & 27, Chapter 10), plus the sum of the full-load currents of the other motors of the group.

"If two or more motors of equal horsepower rating are the largest in the group, one of the motors should be considered as the largest for the above calculations.

"If two or more motors of a group must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection."

Power and light loads. If a feeder supplies a motor load, and, in addition, a lighting or a lighting and appliance load, the feeder circuit breaker should have a rating or a setting sufficient to meet the requirements of the motors [a single motor (Section 4342) or a group of motors (Section 4362)], plus the normal load current of the lighting and other loads. (Section 4363, 1953 Code)

Motor controllers. From the Code "the term 'controller' includes any switch or device normally used to start or stop the motor." (This refers to devices connected in the main circuit.)

"A branch-circuit type circuit breaker may be used as a controller. When this circuit breaker is also used for overcurrent protection, it shall conform to the appropriate provisions . . . governing overcurrent protection." (Section 4383d, 1953 Code)

Section 4331 (1953) — RATING OF PROTECTIVE DEVICE. Motor-running overcurrent devices other than fuses shall have a rating of at least 115 per cent of the full-load current rating of the motor.

Section 4347 (1953) — RATING OF CIRCUIT-BREAKER. Circuit-breakers for motor-branch-circuit protection shall have a continouous current rating of not less than 115 per cent of the full-load current ratings of the motors.

Section 4403 (1953)—CARRYING CAPACITY AND INTERRUPTING CAPACITY.

a. The disconnecting means shall have a carrying capacity of at least 115 per cent of the nameplate current rating of the motor.

ACCESSORIES FOR FEDERAL PACIFIC LARGE AIR [illegible] BREAKERS

A large number of accessories are available for use with both manually and electrically operated Federal Pacific DMB breakers. These accesories are factory-installed in the breaker, and wired and tested to perform correctly their function within their rated operating range. Rated control voltages and ranges are tabulated on page 4.

The following tables show standard and optional accessories available with the various sizes of DMB breakers. These accessories are available with draw-out type or fixed mounted (stationary-type) breakers used in metal enclosed switchgear and also with individual, wall mounted DMB circuit breakers.

STANDARD ACCESSORIES

FEDERAL PACIFIC CIRCUIT BREAKERS	DMB 15		DMB 25-1		DMB 50		DMB 75 DMB 100
Operating Mechanisms	Man.	Elec.	Man.	Elec.	Man.	Elec.	Electrical
Dual-magnetic time over-current trip devices—one per pole	X	X	X	X	X	X	X
Manual Trip	X	X	X	X	X	X	X
Position Indicator	X	X	X	X	X	X	X
Terminal Connectors	X	X	X	X	X	X	—
Attached Manual Closing Handle	X	X	X	X	X	X	—
Electrical Closing Mechanism	—	X	—	X	—	X	X
Closing relay with cut off, seal-in and anti-pump features for maintained contact control	—	X	—	X	—	X	X
Padlocking Provision			X	X	X	X	—
Shunt trip device—4 circuit Auxiliary Switch	—	X	—	X	—	X	X

OPTIONAL ACCESSORIES

	DMB 15 Man.	DMB 15 Elec.	DMB 25-1 Man.	DMB 25-1 Elec.	DMB 50 Man.	DMB 50 Elec.	DMB 75 / DMB 100 Electrical
Auxiliary Switch—4 or 8 Circuits	X	X	X	X	X	X	X
Undervoltage device—instantaneous or time delay	X	X	X	X	X	X	X
Overcurrent bell alarm—hand reset	X	X	X	X	X	X	X
Overcurrent lockout device—hand reset	X	X	X	X	X	X	X
Electrical lockout device	X	X	X	X	X	X	X
Key lock	X	X	X	X	X	X	X
Key Interlock	X	X	X	X	X	X	X
Shunt Trip Device—4 circuit auxiliary switch	X	—	X	—	X	—	—
Closing Switch (mounted or unmounted)	—	X	—	X	—	X	X
Field discharge contact	X	X	X	X	X	X	—
Capacitor trip	X	X	X	X	X	X	X

SERIES OVERCURRENT TRIP DEVICES

	DMB 15 Man.	DMB 15 Elec.	DMB 25-1 Man.	DMB 25-1 Elec.	DMB 50 Man.	DMB 50 Elec.	DMB 75 / DMB 100 Electrical
Long time delay and instantaneous (standard)	X	X	X	X	X	X	X
Long time delay only (optional)	X	X	X	X	X	X	X
Long time delay and short time delay (optional)	X	X	X	X	X	X	X
Any combination of long time delay, short time delay, and instantaneous tripping or any one of these alone (optional)	X	X	X	X	X	X	X

NUMBER OF CONTROL CIRCUIT CONTACTS AVAILABLE

Breakers	DMB 15	DMB 25-1	DMB 50	DMB 75	DMB 100
Auxiliary Switch	4 or	4 or 8	4 or 8	10	10
Secondary Contacts (drawout type)	12 or 8 24	12 or 24	12 or 24	13 or 26	4000 A 16 or 32

TABLE NO. 1. INTERRUPTING RATINGS OF FEDERAL PACIFIC AIR CIRCUIT BREAKERS

These Currents Calculated in Accordance with AIEE and NEMA Standards.

INTERRUPTING RATINGS OF FEDERAL PACIFIC DMB AIR CIRCUIT BREAKERS

Circuit Breaker	Voltage	INTERRUPTING RATING (RMS. Amperes)	Range of Continuous Rating in Amperes	CASCADE SYSTEM: Maximum Short Circuit Current at Which Breaker Can be Applied (RMS Amperes)	SELECTIVE SYSTEM *: Maximum Short Circuit Current at Which Breaker Can be Applied (RMS Amperes)
DMB 15	240 & Below	30,000	30- 225	60,000	15,000
DMB 25-1	240 & Below	50,000	150- 600	100,000	25,000
DMB 50	240 & Below	75,000	600-1600	120,000	50,000
DMB 75	240 & Below	100,000	2000-3000	150,000	75,000
DMB 100	240 & Below	150,000	4000	150,000	100,000
DMB 15	241-480	25,000	20- 225	50,000	15,000
DMB 25-1	241-480	35,000	100- 600	70,000	25,000
DMB 50	241-480	60,000	400-1600	100,000	50,000
DMB 75	241-480	75,000	2000-3000	100,000	75,000
DMB 100	241-480	100,000	4000	100,000	100,000
DMB 15	481-600	15,000	15- 225	30,000	15,000
DMB 25-1	481-600	25,000	40- 600	50,000	25,000
DMB 50	481-600	50,000	200-1600	100,000	50,000
DMB 75	481-600	75,000	2000-3000	100,000	75,000
DMB 100	481-600	100,000	4000	100,000	100,000

* Selective feeder breakers. Final load breakers may have higher ratings. See table 4.

STANDARD CONTINUOUS CURRENT RATINGS

TABLE NO. 2

DMB 15	DMB 25-1	DMB 50	DMB 75	DMB 100
15				
20				
30				
40	40			
50	50			
70	70			
90	90			
100	100			
125	125			
150	150			
175	175			
200	200	200		
225	225	225		
	250	250		
	300	300		
	350	350		
	400	400		
	500	500		
	600	600		
		800		
		1,000		
		1,200		
		1,600		
			2,000	
			2,500	
			3,000	4,000

The values underlined are continuous ratings of circuit breakers exclusive of series trip coils.

TABLE NO. 3. SHORT TIME AND SELECTIVE TRIP RATINGS OF FEDERAL PACIFIC AIR CIRCUIT BREAKERS

These Currents Calculated in Accordance with AIEE and NEMA Standards.

Frequency—60 cycles
Maximum Design Voltage—625 Volts
Dielectric Withstand Test Voltage—2200 Volts

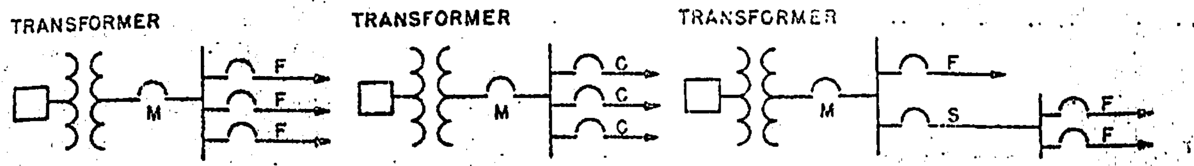
Federal Pacific Air Circuit Breakers	Interrupting Rating 3 Phase, Amps	Short-time Rating, Amps	Continuous Current Ratings, Amperes				
			Max. Current Rating	Series Trip Coil Rating[1]	Coil Ratings Applied if Tripping is Delayed to Provide Selective Tripping[2]		
					Minimum Time Band	Intermediate Time Band	Maximum Time Band
DMB 15	15000	15000	225	15 to 225	100 to 225	125 to 225	150 to 225
DMB 25-1	25000	25000	600	40 to 600	175 to 600	200 to 600	250 to 600
DMB 50	50000	50000	1600	200 to 1600	350 to 1600	400 to 1600	500 to 1600
DMB 75	75000	75000	3000	2000 to 3000	2000 to 3000	2000 to 3000	2000 to 3000
DMB 100	100000	100000	4000	4000	4000	4000	4000

1. If tripping instantaneous above 1500% coil rating for DMB 15, DMB 25-1 and DMB 50; 1200% for DMB 75 and DMB 100.
2. On currents above 1500% of coil rating for DMB 15, DMB 25-1 and DMB 50; 1200% for DMB 75 and DMB 100.

TABLE NO. 4. SHORT CIRCUIT CURRENT APPLICATION AND CIRCUIT BREAKER TABLE

Transformer Rating 3-ph. KVA and Impedance Percent	Max. Short-Circuit KVA Available from Primary System	Normal Load Continuous Current Amp.	Short-Circuit Current Total RMS Amperes (Average 3-Phase Amp.)			RECOMMENDED FEDERAL PACIFIC AIR CIRCUIT BREAKER -- Feeder Trip Range is shown within the Parenthesis ( ).						
						FULLY-RATED SYSTEM		CASCADE SYSTEM		SELECTIVE SYSTEM		
			Transformer Alone	Motor Load 50%	Combined	M Main Breaker	F Fully-Rated Feeder	M Main Breaker	C Cascade Feeder	M Main Breaker	F Fully-Rated Feeder	S Selective Feeder
208 VOLTS — 3 Phase												
300 5%	50000 100000 150000 250000 500000 Unlimited	834	18600 19600 20000 20300 20500 20800	2100	20700 21700 22100 22400 22600 22900	DMB 50	DMB 15 (30-225)	DMB 50	DMB 15 (30-225)	DMB 50	DMB 15 (30-225)	DMB 25-1
500 5%	50000 100000 150000 250000 500000 Unlimited	1388	28900 31500 32500 33300 34000 34600	3500	32400 35000 36000 36800 37500 38100	DMB 50	DMB 25-1 (150-600)	DMB 50	DMB 15 (30-225)	DMB 50	DMB 25-1 (150-600)	DMB 50
750 5½%	50000 100000 150000 250000 500000 Unlimited	2080	37100 41600 43300 44800 46100 47300	5200	42300 46800 48500 50000 51300 52500	DMB 75	DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 50 (600-1600) DMB 50 (600-1600)	DMB 75	DMB 15 (30-225)	DMB 75	DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 50 (600-1600) DMB 50 (600-1600)	DMB 50 DMB 50 DMB 50 DMB 50 DMB 75 DMB 75
1000 5½%	50000 100000 150000 250000 500000 Unlimited	2780	46300 53400 56300 58900 60900 63200	7000	53300 60400 63300 65900 67900 70200	DMB 75	DMB 50 (600-1600)	DMB 75	DMB 15 (30-225) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600)	DMB 75	DMB 50 (600-1600)	DMB 75
1500 5½%	50000 100000 150000 250000 500000 Unlimited	4160	61100 74300 80100 85200 89500 94500	10500	71600 84800 90600 95700 100000 105000	No Main Breaker Available	DMB 50 (600-1600) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 100 (4000)	No Main Breaker Available	Cascade not Possible since No Main Breaker Available	No Main Breaker Available	DMB 50 (600-1600) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 100 (4000)	DMB 75 DMB 100 DMB 100 DMB 100 DMB 100 No Bkr. Avail.
240 VOLTS — 3 Phase												
				100%								
300 5%	50000 100000 150000 250000 500000 Unlimited	722	16100 17000 17400 17600 17900 18100	3600	19700 20600 21000 21200 21500 21700	DMB 50	DMB 15 (30-225)	DMB 50	DMB 15 (30-225)	DMB 50	DMB 15 (30-225)	DMB 25-1
500 5%	50000 100000 150000 250000 500000 Unlimited	1203	25100 27300 28200 28900 29500 30100	6000	31100 33300 34200 34900 35500 36100	DMB 50	DMB 25-1 (150-600)	DMB 50	DMB 15 (30-225)	DMB 50	DMB 25-1 (150-600)	DMB 50
750 5½%	50000 100000 150000 250000 500000 Unlimited	1804	32300 36100 37600 39000 40000 41100	9000	41300 45100 46600 48000 50000 50100	DMB 75	DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 50 (600-1600)	DMB 75	DMB 15 (30-225)	DMB 75	DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 50 (600-1600)	DMB 50 DMB 50 DMB 50 DMB 50 DMB 50 DMB 75
1000 5½%	50000 100000 150000 250000 500000 Unlimited	2406	40200 46300 48300 51000 52800 54700	12000	52200 58300 60800 63000 64800 66700	DMB 75	DMB 50 (600-1600)	DMB 75	DMB 15 (30-225) DMB 15 (30-225) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600) DMB 25-1 (150-600)	DMB 75	DMB 50 (600-1600)	DMB 75
1500 5½%	50000 100000 150000 250000 500000 Unlimited	3609	53200 64500 69500 74000 77900 82000	18000	71200 82500 875[illegible] 92000 95900 100000	DMB 100	DMB 50 (600-1600) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000) DMB 75 (2000-3000)	DMB 100	DMB 25-1 (150-600)	DMB 100	DMB 50 (600-1600) DMB 75 (2000-3000) DMB 75 (2000-3000) [illegible] [illegible] [illegible]	DMB 75 DMB 100 [illegible] [illegible] [illegible] [illegible]

Application



FULLY-RATED SYSTEM **CASCADE SYSTEM** **SELECTIVE SYSTEM**

Transformer Rating 3-ph. KVA and Impedance Percent	Max. Short-Circuit KVA Available from Primary System	Normal Load Continuous Current Amp.	Short-Circuit Current Total RMS Amperes (Average 3-Phase Amp.)			RECOMMENDED FEDERAL PACIFIC AIR CIRCUIT BREAKER — Feeder Trip Range is shown within the Parenthesis ( ).						
						FULLY-RATED SYSTEM		CASCADE SYSTEM		SELECTIVE SYSTEM		
			Transformer Alone	100% Motor Load	Combined	M Main Breaker	F Fully-Rated Feeder	M Main Breaker	C Cascade Feeder	M Main Breaker	F Fully-Rated Feeder	S Selective Feeder
480 Volts												
300 5%	50000 100000 150000 250000 500000 Unlimited	361	8100 8500 8700 8800 8900 9000	1800	9900 10300 10500 10600 10700 10800	DMB 25-1	DMB 15 (20-225)	DMB 25-1	DMB 15 (20-225)	DMB 25-1	DMB 15 (20-225)	DMB 15
500 5%	50000 100000 150000 250000 500000 Unlimited	601	12500 13700 14100 14500 14800 15100	3000	15500 16700 17100 17500 17800 18100	DMB 50	DMB 15 (20-225)	DMB 50	DMB 15 (20-225)	DMB 50	DMB 15 (20-225)	DMB 25-1
750 5½%	50000 100000 150000 250000 500000 Unlimited	902	15100 18000 18800 19500 20000 20500	4500	20600 22500 23300 24000 24500 25000	DMB 50	DMB 15 (20-225)	DMB 50	DMB 15 (20-225)	DMB 50	DMB 15 (20-225)	DMB 25-1
1000 5½%	50000 100000 150000 250000 500000 Unlimited	1203	20100 23200 24400 25500 26400 27400	6000	26100 29200 30400 31500 32400 33400	DMB 50	DMB 25-1 (100-600)	DMB 50	DMB 15 (20-225)	DMB 50	DMB 25-1 (100-600)	DMB 50
1500 5½%	50000 100000 150000 250000 500000 Unlimited	1804	26600 32300 34800 37000 38900 41100	9000	35600 41300 43800 46000 47900 50100	DMB 75	DMB 50 (400-1600)	DMB 75	DMB 15 (20-225) DMB 15 (20-225) DMB 15 (20-225) DMB 15 (20-225) DMB 15 (20-225) DMB 25-1 (100-600)	DMB 75	DMB 50 (400-1600)	DMB 50 DMB 50 DMB 50 DMB 50 DMB 50 DMB 75
2000 5½%	50000 100000 150000 250000 500000 Unlimited	2406	31700 39400 44100 47700 50700 54700	12000	43700 51400 56100 59700 62700 66700	DMB 75	DMB 50 (400-1600) DMB 50 (400-1600) DMB 50 (400-1600) DMB 50 (400-1600) DMB 75 (2000-3000) DMB 75 (2000-3000)	DMB 75	DMB 15 (20-225) DMB 25-1 (100-600) DMB 25-1 (100-600) DMB 25-1 (100-600) DMB 25-1 (100-600) DMB 25-1 (100-600)	DMB 75	DMB 50 (400-1600) DMB 50 (400-1600) DMB 50 (400-1600) DMB 50 (400-1600) DMB 75 (2000-3000) DMB 75 (2000-3000)	DMB 50 DMB 75 DMB 75 DMB 75 DMB 75 DMB 75
600 Volts												
300 5%	50000 100000 150000 250000 500000 Unlimited	289	6450 6850 6950 7050 7150 7250	1450	7900 8300 8400 8500 8600 8700	DMB 25-1	DMB 15 (15-225)	DMB 25-1	DMB 15 (15-225)	DMB 25-1	DMB 15 (15-225)	DMB 15
500 5%	50000 100000 150000 250000 500000 Unlimited	481	10000 11000 11300 11600 11800 12000	2400	12400 13400 13700 14000 14200 14400	DMB 25-1	DMB 15 (15-225)	DMB 25-1	DMB 15 (15-225)	DMB 25-1	DMB 15 (15-225)	DMB 15
750 5½%	50000 100000 150000 250000 500000 Unlimited	722	12900 14500 15100 15600 16000 16400	3600	16500 18100 18700 19200 19600 20000	DMB 50	DMB 25-1 (40-600)	DMB 50	DMB 15 (15-225)	DMB 50	DMB 25-1 (40-600)	DMB 25-1
1000 5½%	50000 100000 150000 250000 500000 Unlimited	952	16100 18500 19500 20500 21100 21900	4800	20900 23300 24300 25300 25900 26700	DMB 50	DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600)	DMB 50	DMB 15 (15-225)	DMB 50	DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600)	DMB 25-1 DMB 25-1 DMB 25-1 DMB 50 DMB 50 DMB 50
1500 5½%	50000 100000 150000 250000 500000 Unlimited	1444	21300 25900 27900 29700 31200 32900	7200	28500 33100 35100 36900 38400 40100	DMB 50	DMB 50 (200-1600)	DMB 50	DMB 15 (15-225) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600)	DMB 50	DMB 50 (200-1600)	DMB 50
2000 5½%	50000 100000 150000 250000 500000 Unlimited	1924	25300 31600 35300 37500 40500 43800	9600	34900 41200 44900 47100 50100 53400	DMB 75	DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 75 (2000-3000) DMB 75 (2000-3000)	DMB 75	DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 25-1 (40-600) DMB 50 (200-1600) DMB 50 (200-1600)	DMB 75	DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 50 (200-1600) DMB 75 (2000-3000) DMB 75 (2000-3000)	DMB 50 DMB 50 DMB 50 DMB 50 DMB 75 DMB 75

SPECIFIC PROCEDURES

LOW VOLTAGE POWER AIR CIRCUIT BREAKERS (DRAWOUT TYPE)

Drawout air circuit breakers shall be tripped open and withdrawn from cell. Fixed mounted circuit breakers shall be inspected in place, completely de-energized, unless repairs warrant removal.

Arc chutes and interphase barriers are removed and inspected for burning, cracking, chipping and misalignment. A detailed listing will be compiled of any interrupting components which have sustained damage or wear i.e. accumulation of scale on ceramic plates sufficient to render their respective efficiency questionable.

All contacts (Main, Arcing, Auxiliary, etc.) are inspected for burning and pitting and will be cleaned, dressed, adjusted for wipe, travel, pressure as required.

Operating mechanism and linkages are cleaned, lubricated and adjusted for proper operation, clearance, pressures and tensions. All retaining rings, pins, springs, screws and bolts are checked to be certain they are in place and tight.

Control coils, closing coils, shunt trip coils, charging motors, integral control relays and auxiliary switches and relays are cleaned, lubricated, adjusted and inspected to be in proper working order. Contacts are burnished or replaced as required.

The primary disconnect stabs on drawout circuit breakers are inspected for wear, pitting or burning and cleaned and adjusted.

The circuit breaker frame, insulators, and main copper details are cleaned of all extraneous foreign material (dust, dirt, carbon, moisture, etc.).

Insulating material is tested for adequate dielectric strength from phase to phase and phase to ground with a megger type insulation tester.

When a recalibration of the circuit breaker is also specified, in addition to cleaning, inspecting, adjusting and minor repairing, the trip unit on each pole is tested by applying necessary current to cause the circuit breaker to trip open. The time to trip is compared to the characteristic curves and, if required, adjustments are made to insure operation within specified limits.

This quotation includes current vs. time calibration on all low voltage drawout air circuit breakers.

SC:SP-LV-CB-2

PROPOSAL

SPECIFIC PROCEEDURES:

LOW VOLTAGE POWER AIR CIRCUIT BREAKERS (DRAWOUT TYPE)

In general, the list of major points that are included in a calibration test are as follows:

1. Long Time Delay Pick-up.
2. Long Time Delay Resetable Point.
3. Instantaneous Pick-up.
4. Long Time Delay Time to Trip Check.
5. Short Time Delay Pick-up.
6. Short Time Delay Time to Trip Check.

SC:SP-LV-CB-3

INSTRUCTION LEAFLET 12-957

SELENIUM RECTIFIERS FOR CIRCUIT BREAKER OPERATION, INTERMITTENT DUTY

A-C INTERRUPTED TYPE

FEDERAL PACIFIC ELECTRIC COMPANY
SCRANTON, PENNSYLVANIA

SELENIUM RECTIFIERS FOR CIRCUIT BREAKER OPERATION
INTERMITTENT DUTY

General

This rectifier is designed to deliver direct-current at approximately 120 volts at any commercial frequency. The D-C voltage will depend on the A-C voltage which can be anywhere from 208 to 240, and also on the D-C load of the circuit breaker solenoid.

The complete unit consists of a full-wave rectifying element in the A-C line. RED is positive. BLACK is negative, and YELLOW is A-C.

The rectifier units should not be immersed in oil.

Disassembly

Selenium rectifier stacks cannot be considered a simple assemblage of individual components. Disassembly or reassembly of selenium rectifier stacks will almost certainly result in permanent damage or total failure. The assembly nuts should not be tightened or loosened under any circumstances.

Exposure to Mercury Vapors

Selenium rectifiers should not be used or stored where mercury vapor is present. Deterioration of rectifying properties and ultimate burn-out will result. Special protective measures can be taken where Hg vapors may occur. Our engineering staff should be consulted in such cases.

Soldering

Care is necessary in soldering leads to rectifier terminals. The rectifier should be shielded from hot drops of solder which may fall between the cells. Hot soldering irons should be handled carefully to avoid touching the selenium cells.

Refinishing

No finish should be applied over the factory finishes already present on the selenium rectifier, because such coatings can permanently damage the rectifier. Paints, laccuers, and varnishes may have solvent or chemical effects on the finish or may damage the rectifier directly, and the additional coatings may decrease the ability of the cells to dissipate heat.

SELENIUM RECTIFIERS FOR CIRCUIT BREAKER OPERATION
INTERMITTENT DUTY

Handling

Selenium rectifiers should be handled and transported with care. Dropping the rectifier or scratching its protective coating is to be avoided. When cells are bent, damage may be done to the rectifying surface, decreasing the forward current capacity or even shorting the cell.

Dust Removal

Compressed air can be used to clean rectifiers which have accumulated dust between the cells. Dust interferes with the circulation of cooling air. Experience shows that, other than checking for dust at fairly long intervals, once a selenium rectifier is installed, it requires no further care or attention.

De-forming

Upon storage or disuse for a long period of time, selenium rectifiers may de-form to a certain extent. The effect is opposite to that of the forming process during fabrication, and is manifested by a larger than normal momentary reverse current when AC is initially applied. Within seconds, the rectifier re-forms and permanently reestablishes its normal rectifying characteristics. This phenomenon rarely has any significance in practical applications. For applications where de-forming would be objectionable, special manufacturing techniques can be used to greatly reduce the de-forming effect.

Operation

The rectifier is designed for intermittent operation only, and must not be used to supply loads other than the breaker solenoid.

The A-C voltage must not be applied to the rectifier for longer than 1 second nor for more than 10 operations within a 5 minute period.

The rectifier rating must not be exceeded, as for instance by the operation of 2 solenoids at once.

Overloads

The criterion for overloads is that overheating of the cells must be prevented. The RMS voltage rating of the rectifier should not normally be exceeded. Reverse losses increase very rapidly as voltage is increased above the normal rating due to the non-linear reverse resistance characteristic. Overvoltage must be limited to very short durations and small excesses, otherwise overheating and possible failure will result.

Overloads (Cont'd.)

Current overloads can be borne much better by selenium rectifiers than voltage overloads, since the forward resistance decreases as the current increases. Current overloads of several times the normal rating can be handled by selenium rectifiers for short durations without causing overheating of the cells.

Maintenance and Adjustment

a. Fuses

Use current limiting fuses having rating of approximately 1/3 of the maxium d-c load current drawn by the breaker solenoid. Fuses of this rating are used in order to protect the rectifying unit in case load should remain connected to the outfit for longer than the permissible time.

b. Rectifier

When the rectifier is shipped from the factory, it is set to give proper breaker operating speed at rated a-c. line voltage. Upon installation, the breaker closing-time should be checked to see that correct operation is obtained, since line voltage conditions may be different from those at the factory. This should be done by means of a cycle counter after all mechanical and dashpot adjustments have been checked.

If closing time is incorrect, the A-C voltage must be changed.

To obtain quicker breaker operation, raise the A-C voltage.

To obtain slower breaker operation, lower the A-C voltage.

Note

Approximately 30 days after the unit has been installed, the breaker closing time should be again checked under the same conditions of supply voltage as existed during installation. Adjustment to take care of any change during the first 30 days is made by adjusting the A-C voltage. Following this adjustment no further attention should be necessary except at normal periods of breaker maintenance, say every 6 months.

Maintenance and Adjustment - Cont'd.

Current and Voltage Measurements

Considerable care is necessary in making measurements on account of the limited time available. It is preferable to check the rectifier performance by measuring the closing time of the breaker with a cycle counter, making rectifier adjustment according to whether the closing time is greater or less than normal.

If this method is not practicable, an ammeter reading may be taken of the current in the closing circuit. Adjustments of the rectifier can then be made to get correct closing current.

Under no conditions should voltage be applied to rectifier more than 3 seconds while taking a reading.

Investigation of Troubles

If the unit fails to close the breaker, proceed as follows:

a. Check the a-c supply source to see that adequate voltage is available when the full-load is being drawn.

b. Check the rectifier fuses to see that they are not blown.

c. Inspect all connections to see that none are open.

d. If all of the above appear to be satisfactory then probably a rectifier unit has failed unless the breaker mechanism is out of adjustment.

A. The failed unit may be detected as follows:

a. Disconnect the rectifier from the a-c and d-c circuits.

b. Apply 110 volts a-c with a 100 watt lamp in series to the a-c terminals of the rectifier for not more than one second.

c. If the lamp lights, one or more of the individual stacks have failed.

d. Do not attempt to disassemble the stack, and install new cells. Supply a complete new stack.

B. If the installation consists of several stacks connected by wires, as in a bridge circuit:

a. Disconnect all the stacks from each other.

b. Apply to the a-c. terminals of each stack in turn the 110 volt a-c. with the 100 watt lamp in series as before.

c. All units which light up the lamp should be removed.

INSTALLATION SHEET

FOR DMB-15 and DMB-25-1 AIR CIRCUIT BREAKERS

Before inserting breaker in cubicle or cabinet:

Inspect contacts
1. Remove screws in arc chutes.
2. Pull arc-chute forward and out of breaker, thus exposing contacts for inspection.

Check operation of breaker, slowly rotating the manual operating handle and observing the operation of all parts. If electrically operated, work the closing relay, the solenoid, shunt trip, undervoltage device, bell-alarm switch, Kirk interlock, etc. by hand to make sure that the action is free.

Replace arc-chutes and breaker is ready for installation.

Make sure that all connection-copper, cables and control wiring are de-energized until breaker installation is complete.

Installation - Fixed

After breaker has been bolted into position it may be necessary to center the face plate in the cutout in the door.

1. Loosen screws at top and bottom of face plate.
2. Close door and line-up face plate with cutout in door.
3. When faceplate is lined-up, move breaker handle to the right, exposing small Allen-Head set-screw.
4. Tighten set-screw, release handle and open door.
5. Tighten top and bottom screws in face plate.

Installation - Drawout

Insert breaker in cubicle or cabinet, first "test" position then "operating" position as follows:

Push breaker into cubicle until it stops and red button on lower left-hand side of breaker pops up. Breaker is now in "test" position. Primary disconnecting contacts are not engaged, but secondary disconnecting contacts are in contact with similar contacts in cubicle.

Press down on read button and push breaker in till it meets resistance. Release red button the moment breaker starts to move in. Insert 5/8" racking-in handle-bar in right-hand side of levering-in turret at bottom of carriage under the breaker face plate. Push handle-bar to [illegible] as it [illegible] go and breaker will [illegible], and [illegible] button will [illegible]. Bo[illegible] disconnecting contacts are now engaged. insert hooked end of handle-bar into turret.

Remove breaker from cubicle or cabinet:

To move breaker from "operating" position, insert handle-bar in turret, press down momentarily on red button, and push handle-bar to the right as far as it will go. Remove handle-bar and pull breaker forward gently until red button pops up. Breaker is now in "test" position.

To remove breaker from cubicle, press red button down, and pull breaker forward and out of the cubicle.

Note that pressing down on the red button always trips the breaker; It is impossible to move from "test" to "operating", or from "operating" to "test" without first tripping the breaker.

After the above test operations, the face plate should be adjusted in the same manner as described under Installation Fixed.

The breaker should now be pushed into "test" position, and secondary circuits checked. If it is a manual breaker with shunt-trip, or under-voltage, or bell-alarm, the control circuits can be energized and the above accessories checked. If it is an electrically operated breaker, the control circuits can be energized, and the breaker operated several times to make sure that it functions correctly. Any electrical accessories can be checked at the same time.

Rack the breaker into the "operating" position, and installation is complete.

For description and maintenance see:	DMB-15 and DMB-25-1 Instruction Book
For details and characteristic curves of overcurrent devices refer to:	Manual 3-260 (Selection and Application of Federal Pacific Air Circuit Breakers)

FEDERAL PACIFIC ELECTRIC COMPANY
Eastern Switchgear Division
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INSTRUCTIONS

for

INSTALLATION, OPERATION, AND MAINTENANCE

of

FEDERAL-PACIFIC AIR CIRCUIT BREAKERS
TYPES DMB-25 and DMB-50

RATINGS:

600 Volts A-C 250 Volts D-C

	Type DMB-25	Type DMB-50
Interrupting Rating:	25,000 amp	50,000 amp
Continuous Rating: Determined by series trip coil selection (amperes) from list at right	35, 50, 70, 90, 100 125, 150, 175, 200 225, 250, 300, 350 400, 500, 600 amp	100, 125, 150, 175 200, 225, 250, 300 350, 400, 500, 600 800, 1000, 1200, 1600 amp

FEDERAL ELECTRIC PRODUCTS COMPANY
EXECUTIVE OFFICES: 50 PARIS ST., NEWARK 5, N. J.

CONTENTS

Certain general instructions given herein contain extracts from Part 7 of Standards for Large Circuit Breakers, Pub. No. SG3-1951 of National Electrical Manufacturers Association.

INSTRUCTION SKETCHES

INSTRUCTIONS FOR INSTALLATION, OPERATION, AND MAINTENANCE

of

FEDERAL-PACIFIC AIR CIRCUIT BREAKERS

Type DMB-25: 35 to 600 Continuous Amp; 25,000 Interrupting Amp.

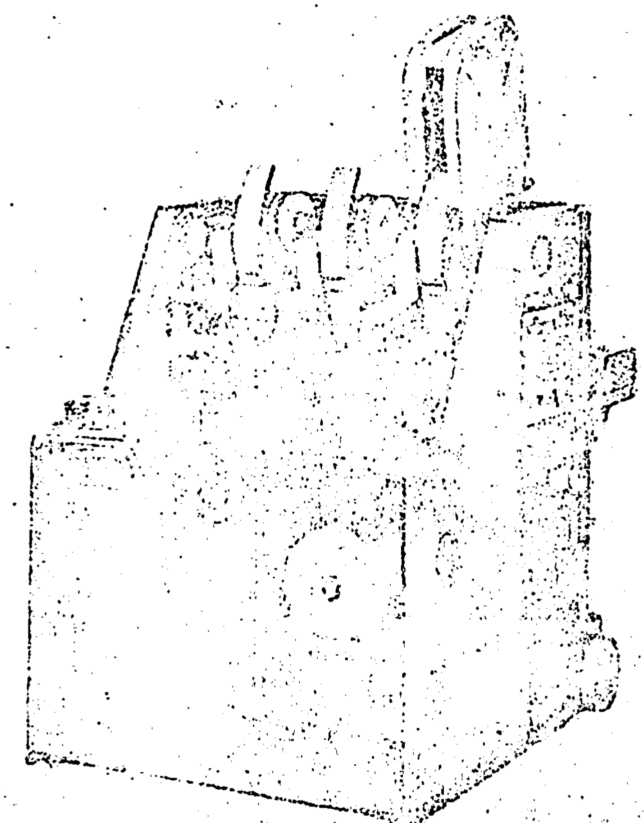
Type DMB-50: 100 to 1600 Continuous Amp; 50,000 Interrupting Amp.

600 Volts Alternating Current; 250 Volts Direct Current

The descriptions herein refer to 3-pole breakers. Two-pole breakers are the same as 3-pole breakers except that the center pole is omitted.

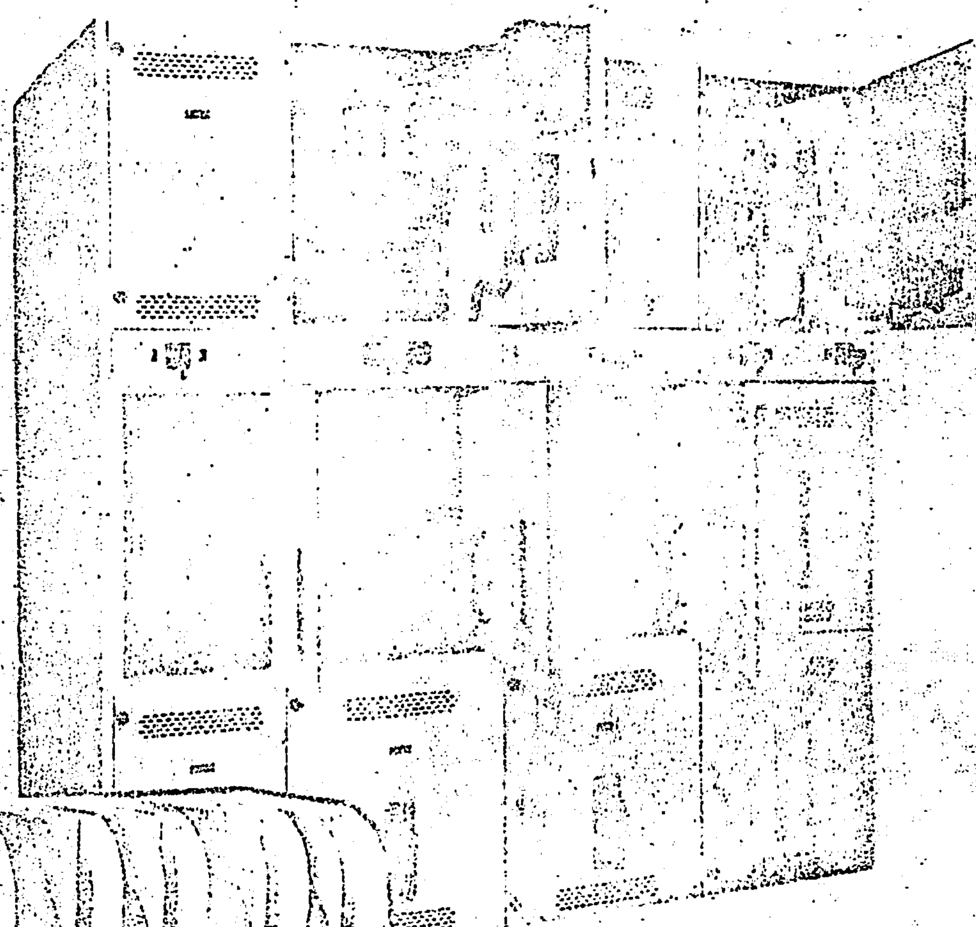
Note: This Instruction Manual does not necessarily describe all late improvements in construction nor all details or variations. Conditions may arise during installation, operation, or maintenance that are not covered herein. For information as to these or other points, refer to

Federal Electric Products Company
50 Paris St., Newark 5, N.J.
or to nearest branch office



Federal-Pacific Type DMB-25 Air Circuit Breaker with drawout mounting, as viewed when ready for contact inspection.

Two arc chutes have been removed, and the third is in its "up" position.



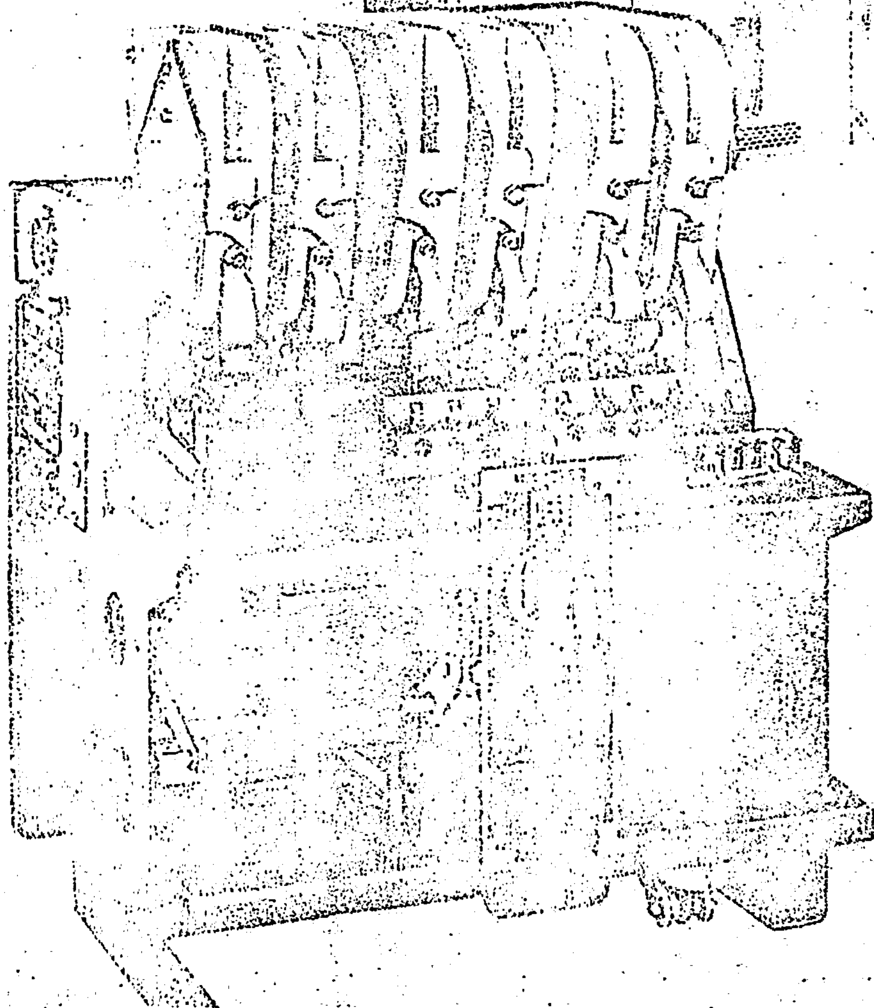


Fig. 1 (at left)
Federal-Pacific Type DMB-50 Circuit Breaker, with 8-stage auxiliary switch -- unmounted.

Fig. 2 (above)
Federal-Pacific Metal-Enclosed Switchgear Unit. One Type DMB-25 and two Type DMB-50's are shown with phase-isolating barriers in place.

FEDERAL-PACIFIC

TYPES DMB-25 AND DMB-50 AIR CIRCUIT BREAKERS

GENERAL DESCRIPTION

These circuit breakers are of exceptionally sturdy design, built for long service of frequent load switching and automatic interruption of overcurrents within rating. They embody features that have been field tested for many years in thousands of circuit breakers of this design. The circuit breakers are electrically and mechanically trip free in any position of the closing stroke, and they will also latch closed in the case of either electrical or manual operation when they are closed against a sustained fault the current of which does not exceed interrupting rating one-half cycle after contacts make. The interrupting rating of the breaker is not affected by the selected standard continuous rating; that is, the interrupting rating of the Type DMB-50, for example, is 50,000 amp even though the overcurrent coils have any of the standard continuous ratings from 100 to 1600 amp.

STANDARD EQUIPMENT

The following operating features are regularly supplied with all circuit breakers arranged for electrical control:

1. Dual-magnetic time overcurrent tripping -- one device per pole -- provides inverse time-delay tripping throughout the lower range of overcurrents and instantaneous tripping at the larger overcurrents. The percent of continuous current rating at which the device changes from time-delay to instantaneous tripping is adjustable. The usual pickup and timing adjustments are also included.

2. Manual tripping and closing from the operating handle, with provision for padlocking in open position. This padlocking prevents manual closing and it also maintains the breaker in trip-free condition so electrical closing cannot be completed. If the breaker is mounted in a cell, the door cannot be opened when handle is padlocked.

3. Electrical closing from solenoid. The control circuit energizes the operating coil of a relay, the main contacts of which establish the circuit through the solenoid. Seal-in and anti-pump features are provided for maintained contact control.

4. Shunt trip device for remote electrical tripping.

5. Four-circuit auxiliary switch of which one circuit is required for switch operation; the balance are available purchaser's use.

Suitable interlocking of operating and control functions as described herein are provided to protect the breaker from the effects of misoperation.

OPTIONAL ACCESSORY EQUIPMENT

Depending on the conditions of application, some or all of the following listed features are supplied as optional accessories. Most of them are described in detail elsewhere in this Instruction.

1. Eight-circuit auxiliary switch, instead of the four-circuit switch as regulurly supplied.

2. Undervoltage device -- instantaneous or time-delay type -- mechanical reset.

3. Overcurrent bell alarm device -- electrical and hand reset. Operates only when tripping is the result of overcurrent. If required, provision is also made so that electrical or manual closing is prevented until the bell alarm device has been reset.

4. Key interlock -- locks breaker in open position and also opens the solenoid control circuit so electrical closing cannot be initiated. The breaker must be in open position before the key can be removed.

5. Reverse current trip device -- direct current.

6. Mounted closing momentary button at the breaker.

7. Mounting interlocks and drawout platform -- for drawout-mounted breakers. Comprise mechanical interlocks that prevent breaker movement in the cell unless breaker is in open position. An auxiliary interlock also must be released before breaker may be withdrawn completely. If mounting is within cells provided by Federal-Pacific, a special levering-in device is included for ease of fixing final position.

8. Drawout terminal sets -- comprising high-pressure main terminals and moderate-pressure ground and control terminals of number specified. Supplied with the latter are the matching stationary terminals that permit withdrawal to test position without disengagement. The stationary main terminals that match the main terminals on the breaker and their insulated housings are supplied as a cell accessory; not as a circuit-breaker accessory.

9. Dead front, back box, and other mechanical features that have to do with housing the breaker are considered a part of the breaker mounting, and are supplied as specified.

10. Special overcurrent tripping devices. See Special Instruction or refer to factory for description of these devices of which a wide variety is available.

11. Rectifier for use when alternating current is used for solenoid supply. Note: If specified, a-c supply can be used for the shunt trip device without need of a rectifier.

SHIPMENT, RECEIVING, AND STORING

Each circuit breaker before leaving the factory is carefully inspected, tested, and packed. It is shipped in a wood crate. Hooks should not be used when handling. Approximate net weights are as follows (with regular accessories). Add 10 % for breakers mounted on drawout platforms.

	Type DMB-25		Type DMB-50	
	2-pole	3-pole	2-pole	3-pole
Manual	130 lbs.	150 lbs.	280 lbs.	310 lbs.
Electric	155 lbs.	170 lbs.	320 lbs.	350 lbs.

Upon receipt examine all equipment carefully for indication of damage sustained in transit. If damage is found call for inspection by the delivering carrier at once, and file claim with carrier. For assistance in filing claim it is advisable that information as to the extent of the damage be sent immediately to Traffic Manager, Federal Electric Products Company, 50 Paris St., Newark 5, N. J., giving description of the damage, identification of the breaker damaged, the delivering carrier's name, and if shipped by rail, the car number, waybill reference, and any other information that will enable the manufacturer to be of help in filing the claim.

When unpacking the circuit breaker, the crating or boxing must be removed carefully. Check all parts with packing list Avoid bending, breaking, or injuring any parts. Do not leave screws, bolts, nuts, etc., in the packing material. Clean all parts before assembling them; use compressed air, if possible. See that instruction books, drawings, and tags are kept with the breakers.

When the circuit breaker can be installed immediately in its permanent location, it is advisable to do so even though it will not be placed in service for some time. When set up in buildings under construction, it should be protected from dust, dirt, and moisture.

If the circuit breaker cannot be installed in its permanent location immediately and it is necessary to store it, it should be kept in a clean, dry place. It must not be exposed to dirt, to the action of corrosive gases, or to possible mechanical injury. Special care should be taken to prevent injury to the apparatus through shocks or jars due to rough handling. It is recommended that stored breakers be covered with paper instead of by materials that may absorb or retain moisture. Do not lubricate the breaker. Sufficient lubricant was applied at the factory; additional amounts only attract dirt.

INSTALLATION AND OPERATING INSPECTION

Indoor circuit breakers should be placed in a clean, dry location which is free from the destructive action of acids, alkalies, or gases, and where good ventilation can be secured. Open-type circuit breakers should be mounted high enough to prevent injury to the operator due to arcing or parts movement during automatic opening. Space must be provided for cleaning and inspection and for protection of adjacent apparatus from flashover. Enclosed breakers should be placed in cells or housings having minimum clearances as per Figs. 5 and 8.

INSPECTION OF MANUAL OPERATION:

The breaker should be inspected for manual operation before it is connected to the main and control circuits.

1. Check for removal of all tie wires, blocking, etc. See that breaker is in open position. Mechanism should be as in View A, Fig. 9; not as in View D.

2. Raise and lower the overcurrent trip shaft 52 (Figs. 12 and 13) to be sure it moves freely.

3. Turn handle slowly in a clockwise direction to move the contacts toward closed position. Note that all parts move freely except for spring resistance. Note that contacts touch approximately simultaneously toward end of closing stroke. Continue closing until completion of stroke. There should be a distinct drop-off of force required to turn the handle as end of stroke is approached. This is an indication that the linkage has properly moved "over toggle" so it is self-holding, sometimes referred to as "latched closed". Return handle to neutral position. Are clearances M and N (View B, Fig. 9) as specified? Is trip trigger 37 well clear of pin on end of trip lever 21 (Fig. 9) so normal vibration will not be likely to cause unexpected tripping? Check jam nuts on spring studs to see they are tight (part 22, Fig. 9A), for example. Visually check but do not measure clearance P (Fig. 9B). This clearance assures adequate pressure on lower main contacts 13 in case of normal expected wear of contacts. Check all compression springs 10 and 11 (Fig. 9). None should have coils solid.

4. Rotate handle counterclockwise until breaker trips. The mechanism assumes the position of View D, Fig. 9, for an instant, and then it returns to position of View A because of pull of opening reset spring 23. Return handle to neutral position. Did parts move freely? Check cotters, and all accessible screws, nuts, etc., for tightness. It is suggested that the section on Manual Operation on page 13 be studied for explanation of what happens during the preceding closing and opening.

5. So far as it may be done without electrical connections, check the action of the electrical devices and accessories. This will aid in assuring proper operation of the linkage to which they are attached when electrical operation can be effected. The explanation of how these parts normally operate as given in later pages will indicate what should be done. For example, after again closing the breaker move overcurrent trip shaft 52 (Figs. 12 and 13) in the tripping direction to see if tripping occurs. Similarly try the action of the shunt trip and overvoltage release if used, etc. In these cases trip trigger 37 moves clockwise sufficiently to engage pin of trip lever 21 so as to release the trip latch. The latch should always reset automatically so the final position of the mechanism should be as in View A, Fig. 9.

CONNECTIONS:

Before making electrical connections every precaution must be taken to see that all leads that are to be connected to the circuit breaker are de-energized and will remain so throughout the work. For non-drawout connections be sure that all joints are clean, bright, and free from dents or burrs and that fastenings of the connection studs are tight. All nuts on a current-carrying stud should turn freely; they should never be forced down with a wrench. If they cannot be turned freely by hand, tap them lightly on the outer surface with a hammer and turn by hand at the same time. A nut that cannot be worked down in this manner will ruin the thread if an attempt is made to force it. If the joints are not correctly made, dangerous heating of the circuit breaker may result.

Cables and connections should be properly supported so that the circuit breaker is not subjected to unnecessary strains. Any strain which at first has no apparent effect on the stud alignment may, in time, force the studs to take up a new alignment due to vibration during opening and closing of the circuit breaker, and poor contact may result.

To avoid overheating of the circuit breaker, the connecting leads must have a current-carrying capacity at least equal to that of the current-carrying parts of the circuit breaker. Control wiring should be so installed that trouble on one circuit breaker cannot be communicated to the control wiring of another breaker.

The control voltages and currents listed on the next page are a guide for determining conductor sizes for the control circuits.

In the case of drawout mountings, it is important that the non-movable parts of the main and control terminals be located accurately in order that the contact springs of the terminals will apply proper pressure. Even a slight variation of location may cause a large variation of contact pressure. Do not use the approximate dimensions as shown in Figs. 5 and 8 herein. Use only such dimensions as are shown on prints certified as correct for construction applying to the particular circuit breaker being installed.

This Instruction Manual shows several typical connection diagrams but not all variations are included. In all cases, a certified print of the applicable diagram should be used.

DRAWOUT MOUNTING

Figs. 3, 4, 5, and 8 show the circuit breaker mounted on drawout platform with support and side-guide rollers for use in the cell. A drawout locking device is attached to the lower part of the left side frame (Fig. 16 shows one form -- slightly modified on some models). Cell Interlock lever 58 should be kept pushed down so that interlock rod will not interfere with entry of the circuit breaker into the cell or cause it to be stopped in test position. When lever 58 is pushed down, trip trigger 37 moves to such position that the breaker will be tripped if it is not already in open position. Ease of movement complete to full-in position against the resistance of the springs of the terminal contacts is assured by the levering-in device (see the "turret" at front of platform in Fig. 3) that is used on circuit breakers in cases where Federal-Pacific supplies the enclosures. Insert a rod in the turret and turn it clockwise (looking down on the turret) for the final movement to full-in position.

If the platform is equipped with cell-catch lever 61, the end of the lever will be seen to move inwards slightly as a stop pin in bottom of cell is passed. When withdrawing breaker from the cell it is necessary to push lever 61 inward near the end of the withdrawal to release a catch before complete withdrawal can be accomplished. Some models have an equivalent device that is part of the side-frame interlock assembly.

VOLTAGES AND CURRENTS FOR CONTROL AND SOLENOID CIRCUITS

Normal Control Voltage	Type DMB-25: Minimum Volts at Coil Terminals		Type DMB-25: Current in Amp at Normal Voltage		Type DMB-50: Minimum Volts at Coil Terminals		Type DMB-50: Current in Amp at Normal Voltage	
	Close	Trip	Close	Trip	Close	Trip	Close	Trip
24v d-c	--	14	--	10	--	14	--	10
48v d-c	--	28	--	5	--	28	--	5
125v d-c	90	70	50	2	90	70	60	2
250v d-c	180	140	25	1	180	140	36	1
115v a-c	--	95	--	3.5	--	95	--	3.5
230v a-c	190	190	50*	1.7	190	190	60*	1.7
460v a-c	380	380	25*	.8	380	380	36*	.8

* By use of dry-metallic rectifier

PHASE-ISOLATING BARRIERS:

As an aid for assuring complete isolating of phases and as an added precaution under some conditions of installation, a barrier assembly, if supplied, is used to supplement the effectiveness of the arc chutes (see breaker installation of Fig. 2). If a barrier is supplied it is important that it be installed on the circuit breaker when it is ready for use.

ELECTRICAL-OPERATION INSPECTION:

After it is certain that the wiring connections have been tested for possible grounds or short circuits and that the circuits are correct in accordance with the certified print, the circuit breaker should be tested for electrical operation, but with the main leads opened at the disconnecting switches or by having the breaker in "test position" in its cell. This provides a complete check of the electrical control of the breaker.

1. Repeat the manual operation tests described on page 8 but without checking clearances, etc. Check to see that parts move freely and have not become affected by the installation work of connecting. Leave breaker in closed position.

2. Momentarily close the shunt trip circuit. The breaker should open and the latch should automatically reset. If the latch did not reset move handle to latch-reset position (see Figs. 5 and 8) and make a note to check the reason why it failed to reset (see page 19).

3. Momentarily close the closing-control circuit. The breaker should close from operation of the solenoid. Check to see that clearance between trip trigger 37 (Fig. 9B) and the pin on trip lever 21 is the same as when the breaker is closed manually (try all manual closing and compare the clearances).

4. Repeat shunt trip and electrical closing several times to make sure that operation is normal. Check clearance between contact kickoff 64 of control relay and top of collar 63 on stem 62 (see Fig. 17) to see if it is as specified. Place the mechanism in trip-free condition by holding trip trigger 37 so it engages pin of trip lever 21; meanwhile move handle to closing position. The handle and shaft action should be free without evidence of binding. The handle parts will move toward closed position but the shaft parts will move only slightly.

5. Check of accessories should then be made.

Bell Alarm: With breaker closed, move overcurrent trip shaft 52 (Figs. 12 and 13) in tripping direction. Breaker should open and alarm ring. Move handle to tripping position; the alarm should stop. Again close breaker and trip by turning shaft 52. Close shunt-trip circuit; the alarm should stop. This assumes that an auxiliary-switch contact momentarily completes the circuit through the shunt trip coil even though the breaker is in open position. This description applies to the usual normally open bell-alarm switch installation (see Figs. 20 and 21). Also trip by shunt trip and again by manual trip. In neither case should the alarm ring.

Kirk Key Interlock: The electrical feature of this device is that the closing-control relay circuit is opened when the breaker is key locked in the open position. Lock the breaker in open position by the Kirk key lock and close the closing-control circuit. There should be no operation of the control relay.

Undervoltage Device: If facilities permit, arrange for applying reduced voltage to the coil of the device and note the volts at which the breaker is tripped. Did the mechanical reset rod extending from arm on main shaft (see Figs. 10 and 11) properly reset the device? If the device is of the time-delay type, allow about one minute for resetting.

Other Accessories: Perform such operations as required to check the effectiveness of any other accessories that embody electrical features.

With the breaker in open position, close the disconnecting switch in the main leads or move the breaker to full-in position if it is in a cell. Apply some load and repeat manual and electrical closing and opening as a test of normal switching. Remove the breaker from its cell and completely check connections, bolts, and linkage to see that nothing has become loosened or displaced during the test operations. Reinstall circuit breaker; it is now ready for service.

METHOD OF OPERATION

Complete information as to how the circuit breaker operates is of help when trying to locate the cause of improper operation. It also serves as a guide for understanding the reasons for the adjustments and checks made during installation or maintenance inspections.

CLOSING:

Fig. 9A shows the position of the principal parts when the circuit breaker is open. To close the breaker, main shaft 1 is rotated clockwise by the closing solenoid or by the handle until the parts are as shown in Fig. 9B. During this operation trip link 5 and strut 6 move as one piece because they are latched together by the trip latch (in trip link 5). Because links 7 approach toggle position as closed position is reached, a large force is applied to turning square shaft 8. Contact springs 10 and 11 are thereby compressed to assure high pressure at main contacts 12 and 13, and moderate pressure at the auxiliary arcing contacts 15-16. A jumper 14 shunts contacts 13 and electrically connects all moving contacts to the lower main terminal as is necessary during arcing when opening. Contact 16 does not touch arcing horn 17 when in closed position. The arcing horn is electrically connected to the upper terminal through a magnetic blowout coil (shown diagramatically). On the Type DMB-50, jumper 36 shunts the main arc to energize the blowout coil, but there is an auxiliary air gap in the blowout-coil circuit (in the arc chute) that opens the blowout-coil circuit when the main arc is extinguished.

It is not necessary to apply closing force after the breaker is fully closed because in the final stage of closing, link 6, trip link 5, and main crank 48 are in a straight line; in fact, they are "over center" so the mechanism is positively held in closed position by the force of springs 10 and 11. Such action is sometimes referred to as "latching closed", although there is no closing latch in the usual sense.

The Type DMB-25 circuit breaker has one complete moving-contact structure per pole (see Fig. 3). Type DMB-50 has two such complete structures per pole and each structure also includes a shorter structure that comprises only an assembly of main contacts 12 and 13 and associated contact springs 10. Thus there are four spring-applied moving contact structures in parallel per pole in the larger circuit breaker (see Fig. 1).

Note that neither electrical nor manual closing can take place unless trip link 5 and strut 6 move rigidly as one piece. Therefore if for any reason the trip latch is released, or it did not reset properly during the previous opening, the straight-line relationship of the parts is no longer maintained and closing cannot occur. The breaker thus cannot be closed if the shunt trip coil is energized, the low-voltage release operates, or the breaker is not in its cell at least as far as test position. Also when closing against a faulted line sufficient to cause instantaneous tripping, the breaker will trip as soon as the circuit is established even before the breaker "latches closed" provided the overcurrent device acts instantaneously. The closing forces, however, are sufficiently large to cause the breaker to latch closed even when the fault current is as large as rated interrupting current, provided the overcurrent device permits sufficient time delay for complete closing to occur.

OPENING BY RELEASE OF TRIP LATCH:

Current above pickup amount through the series trip coil in each main lead causes either time-delay or instantaneous tripping according to the type and setting of the overcurrent device (see Figs. 12 and 13 for tripping action). Trip trigger 37 (Fig. 9B) moves clockwise to move trip lever 21 to release trip latch 38 (Fig. 9D), thereby collapsing the linkage and causing the mechanism to move to the position of Fig. 9D as a result of the force of contact springs 10. The upper main contacts 12 separate somewhat before the parting of arcing contacts 15-16 (see Fig. 9C). The mechanism is then rapidly brought to the position shown in Fig. 9A by action of reset spring 23 which turns main shaft 1 counterclockwise. The trip latch resets during this movement, thereby joining link 5 and strut 6 so they act as one piece.

Opening by release of the trip latch, as described, takes place in all cases of overcurrent tripping as well as when tripping is the result of the action of the shunt trip device, no-voltage release, reverse-current device (d-c only), the drawout locking device, or by any action that moves trip trigger 37 so it engages pin on lever 21. Tripping takes place at any point of the closing stroke because trip trigger 37 extends vertically alongside the path of vertical travel of trip link 5, so engagement will occur whenever trip trigger 37 is moved clockwise regardless of the position of trip link 5.

MANUAL OPENING:

The trip latch is not released during manual opening. Instead, the opening comes about from handle movement which causes main shaft 1 to rotate counterclockwise (viewed as in Fig. 9B) sufficiently to collapse the "over center" condition of main crank 48, trip link 5, and strut 6. The force exerted by springs 10 and 11, supplemented by the pull of spring 23 and other springs, completes the opening. The parts move directly to their position as shown in Fig. 9A without need of going through the intermediate step shown in Fig. 9D.

HANDLE-SHAFT ASSEMBLY:

The operation of this assembly on the Type DMB-25 circuit breaker is explained by reference to Fig. 10. The parts and their connection to each other are as follows:

Handle shaft 40 -- extends from handle 3 to alarm cam 72.

Coupling crank 44 -- turns loosely on shaft 40. Clutch jaws extend from the left hub of the crank. Also pin 82 extends from the left flange as shown. This pin has a flat surface that can be engaged by the clutch jaw of sliding-cam clutch 42.

Main clutch 43 -- fixed to shaft 40. Only a part of this shown in Fig. 10 because it is largely surrounded by sliding cam clutch 42. Jaw projections extend from the right of main clutch 43.

Sliding cam clutch 42 -- concentric with and loosely turns on main clutch 42. A vertical pin (not shown in Fig. 10) extends through shaft 40 and main clutch 43 into a slot in cam clutch 42. This pin serves to control part of the motion of sliding cam clutch 42 because the slot cut through its bottom and the pin permit the cam to move lengthwise along shaft 40 by a limited amount, and also assures that cam clutch 42 will rotate along with shaft 40 and main clutch 43.

The essential feature of cam clutch 42 is a groove cam recess in its outer surface. Fixed pin 50 extending from the frame into this groove cam holds cam clutch 42 without any movement lengthwise of the shaft during all normal closing and tripping movements of handle 3. However, if handle 3 is moved to latch reset position (see Fig. 5), then cam clutch 42 moves to the front because of the curve in its recessed groove cam.

Alarm cam 72 -- attached to left end of shaft 40 is bell-alarm accessory, if specified.

Position spring 41 and arm 83 and associated pins return handle assembly to neutral position at end of either an opening or closing stroke. Coupling crank 44, however, will remain in either open or closed position.

The operation of these parts is as follows:

<u>Normal Manual Closing:</u> Fig. 10 shows parts in normal open position of the circuit breaker. Shortly after start of turning handle 3 clockwise main clutch 43 engages the clutch portion of coupling crank 44 so it also rotates clockwise with the result that main crank 48 of main shaft 1 moves in a direction to close the breaker. After handle is released, return spring 41 moves the parts to neutral position, except that coupling crank 44 remains in "up" or closed position.

<u>Normal Manual Tripping:</u> Shortly after turning handle 3 counterclockwise, main clutch 34 engages the clutch of coupling crank 44 so it rotates counterclockwise with the result that main crank 48 moves beyond toggle position and the breaker opens. Coupling crank 44 rapidly moves during this opening because the contact springs of the breaker move it regardless of handle-shaft movement.

<u>Manual Control of Latch Reset:</u> If for any reason during normal manual tripping (or even during electrical tripping), the trip latch in trip link 5 becomes released and the pull of reset spring 23 (Fig. 9A) does not reset the latch, then movement of handle 3 to reset position (Fig. 5) will produce positive movement of main crank 48 somewhat beyond normal open position, thereby forcing the trip latch to reset. The action is as follows: Movement of handle 3 counterclockwise to reset position (Fig. 5) causes cam clutch 42 to rotate so far that fixed pin 50 and the curved groove cam move cam clutch 42 toward the front so its clutch engages pin 82 on coupling crank 44. This produces similar movement to that of normal manual tripping, but the motion is carried farther, thereby assuring latch resetting unless there is some condition in the latch assembly that prevents it.

****

The description of handle-shaft operation as given in the preceding applying to the Type DMB-25 circuit breaker also applies to the Type DMB-50 circuit breaker except that in the latter breaker the general arrangement of the parts is reversed: The coupling crank is in back of the main clutch, and the sliding cam clutch moves toward the rear of the breaker when it engages for resetting of the trip latch. The alarm cam is located in an intermediate position instead of being on the end of the shaft. Also instead of there being a pin attached to a flange of the coupling crank, the crank is of the two-arm type, only one of which is engaged through a long pin by the sliding cam clutch. Fig. 11 identifies the parts with numbers that generally correspond to those of similar parts as shown in Fig. 10.

HANDLE LOCKS:

Neutral Handle Lock: When handle is down, a pin enters the frame, so it is necessary to retract it by applying the thumb to the metal eye at top of handle before the handle can be turned. Padlocking at this point prevents withdrawal of the pin, thereby locking handle so it cannot be turned. The lock does not prevent electrical operation so it is useful principally to prevent handle movement by unauthorized persons.

Complete Open-Position Handle Lock: When handle is in padlock-open position (see Figs. 5 and 8), padlocking of the handle eye prevents manual or electrical closing because main clutch 43 engages and holds coupling crank 44 (Figs. 10 and 11) in the open position. The cabinet door of enclosed breakers cannot be opened when the handle is locked in this manner. There is no closed-position lock because the breaker must always be free to trip.

DUAL MECHANICAL OVERCURRENT TRIP DEVICE:

Figs. 22, 23, and 24 show the overcurrent trip device, comprising a coil in the main lead, an armature moved by the magnetic force in the coil when current exceeds pickup amount, an escapement-type mechanical time-delay device that delays movement of the overcurrent trip shaft 52 (Figs. 12 and 13), and an instantaneous magnetically operated element that moves the trip shaft immediately if current exceeds a scheduled percent of pickup amount.

As ordinarily supplied, an external knob is provided for adjustment of the current at which the device "picks up" and starts the time-delay device. The indicator for this adjustment is calibrated at 80, 100, 120, 140, and 160 percent of continuous current rating of the trip coil (tolerance plus or minus 10 percent). An internal setting provides for adjustment of the time after pickup at which tripping will occur, and another internal setting provides adjustment of the percent of pickup current at which the instantaneous element becomes effective.

Modifications of this basic device to meet various conditions of service are available. Information concerning them accompanies circuit breakers with which they are supplied, or it is available on application to the factory.

CLOSING-CONTROL RELAY:

In order to relieve the electric closing contact of carrying the large current required for the closing solenoid, the closing control circuit only energizes the operating coil of a control relay (see Figs. 5 and 8 and the connection diagrams). The closing-solenoid circuit is energized when the double contacts of the control relay close because of force exerted by the relay operating coil. A seal-in of the operating coil is provided through a resistor connected between the two main contacts (see connection diagram).

As soon as the circuit breaker closes, the double main contacts of the control relay are opened mechanically by upward movement of stem 62 (Fig. 17), which also de-energizes the seal-in circuit of the operating coil. Blowout coils aid in extinguishing the arc of interruption of the inductive current of the closing coil.

Should the breaker trip before the operator's finger is removed from the closing control contact, the breaker will not reclose because the main contacts of the control relay do not recouple to the armature of the relay operating coil after breaker opening unless the coil is de-energized. This prevents "pumping" (successive open and close) if the closing-control circuit remains energized under overcurrent conditions.

AUXILIARY SWITCH:

This switch is directly connected to the circuit-breaker mechanism so the switch position, open or closed, corresponds to the breaker position. The auxiliary-switch contacts thus provide a means of controlling circuits that are to be responsive to circuit-breaker position. Each switch unit has four stages, and one or two such switch units are mounted on the breaker depending on its specification. Each 4-stage unit normally has two "a" contacts (closed when the breaker is closed) and two "b" contacts (closed when the breaker is open). However, the contacts are convertible from one type to the other by removal of shaft assembly and changing contacts as required.

One "a" contact is required for use with shunt trip and one "b" contact if bell alarm is used, so with such devices it is often the practice to have two 4-stage auxiliary-switch units on the circuit breaker. No auxiliary-switch contact should be used in the circuit of an undervoltage device.

The contacts carry 15 amp continuously or 250 amp for three seconds. The interrupting rating of the auxiliary-switch contacts is as follows:

Volts	Interrupting Amp Non-inductive	Interrupting Amp Inductive
125v d-c	11	6.25
250v d-c	2	1.75
115v a-c	75	15
230v a-c	35	8
450v a-c	25	5

The drive shaft of the auxiliary switch is extended and connected to the ON-OFF indicator of the circuit breaker. Green and red signal lamps, if required, are supplied through auxiliary-switch contacts.

SHUNT TRIP:

The action of this device requires no explanation.

BELL ALARM:

The usual arrangement provides a normally open switch so connected mechanically that it closes when the overcurrent device opens the circuit breaker. An alternate arrangement sometimes used provides a normally closed switch connected in the same way; in this case the switch opens when the overcurrent device opens the breaker. The latter arrangement is useful when it is desired to block associated control circuits as a part of a general protective scheme, which may or may not include an alarm.

In either case, the switch is operated by mechanical means as shown in Figs. 20 and 21, according to type of circuit breaker. Drive rod 73 always moves when the breaker is opened by any method. However, if tripping is manual or from an electrical accessory (shunt trip, etc.) drive bar 81 is moved aside mechanically so it cannot engage switch plunger 76. In the case of manual trip, a cam on handle shaft actuates the rod or lever that deflects drive bar 81; and in the case of accessory trip, it is a similar rod or lever, as illustrated.

UNDERVOLTAGE TRIP:

The essential external features of the undervoltage trip device with mechanical immediate reset are shown in Fig. 25 in their position when the breaker is closed. When the coil is subject to line voltage above that for which the device is set, reset lever 85 and trip lever 84 are in the solid-line positions. The slot in the end of reset bar 57 is also positioned so that main shaft 1 can move between open and closed positions without lengthwise movement of bar 57.

When voltage is reduced so far as to cause the undervoltage device to operate, reset lever 85 moves down and trip lever 84 moves up to the dotted-line positions shown. Reset bar 57 is thereby caused to move to the left so its slotted opening will no longer permit free movement of the arm on main shaft 1 when breaker opens without movement of reset bar 57.

By the means previously described, the upward movement of trip lever 84 causes the circuit breaker to open with the result that the arm on main shaft 1 moves to the dotted-line position which again moves reset lever 85 to its solid-line position. The undervoltage device is thus reset and trip lever 84 will remain down provided the voltage is above that for which the device is set. If the voltage is still too low, trip lever 84 will remain up and the breaker will be trip free so it cannot be closed as long as the undervoltage condition continues.

The time-delay attachment to the undervoltage device, if supplied, comprises means for slowing down movement of the solenoid core pneumatically through an adjustable needle-valve opening. The device does not reset immediately, so one minute should elapse before the breaker can be restored to service after the undervoltage condition no longer exists.

Connection to the undervoltage device should be to the line side of the breaker if immediate reset is used, and to the load side if time-delay reset is used. As the undervoltage device is connected to the main leads, its coil must be suitable for the voltage and kind of current interrupted by the circuit breaker (a-c or d-c, as the case may be).

KIRK KEY INTERLOCK:

The application is as shown in Figs. 18 and 19. The lock plunger causes locking latch 69 to enter a slot in lower shaft 39 (Fig. 10) of Type DMB-25 circuit breaker or to enter handle shaft 40 (Fig. 11) of Type DMB-50, in either case locking them in the open position of the breaker. At the same time linkage opens an electrical contact in the closing-control relay circuit. The device embodies mechanical means for preventing completion of locking when the breaker is in closed position.

> To lock: With breaker in open position, handle neutral, key in place, turn key counterclockwise 180° to lock breaker in open position -- after which key can be removed. The breaker is locked in open position.
>
> To unlock: Insert key (unless already in place) and turn clockwise to unlock. The key cannot be removed. The closing-control-relay interlocked contact will be closed, so closing of the breaker may proceed either electrically or manually.

OTHER ACCESSORIES:

Instructions relating to accessories other than those described herein are supplied with all circuit breakers using such devices.

MAINTENANCE AND ADJUSTMENT

The safety and successful operation of connected apparatus depends on the proper action of the circuit breaker. Therefore the circuit breaker must have systematic care and inspection. The following points require special attention:

1. Be sure that the circuit breaker is in test position in its cell for all inspections in which it is necessary to have control current available, or disconnect the main leads if the breaker is not in an enclosure. Adjustments that can be made when the control circuits are energized may be performed when the breaker is in the test position, but if there is any doubt remove the breaker entirely from the cell -- or disconnect control leads if the breaker is not mounted in an enclosure.

2. Inspect the operating mechanism periodically and keep it clean.

3. Examine the contacts frequently. See that they are aligned and that contact surfaces bear with a firm, uniform pressure. Replace badly pitted or burned contacts before they are burned away so far as to prevent full contact or are likely to cause damage to other parts of the circuit breaker. All main and control leads should be disconnected when working on the contacts.

4. All contact members, both main and control, must be kept clean and bright to insure maximum operating efficiency. It has been found by experience that operating the circuit breaker several times at intervals of not over two weeks will reduce the effects of oxidation and materially prolong the effective life of the circuit breaker. It is recommended that this practice be followed except that a circuit breaker which is regularly operated every few days will not require such attention.

5. See that bolts, nuts, washers, cotter pins and all terminal connections are in place and tight.

6. Clean the circuit breaker at more frequent intervals than usual where abnormal conditions prevail, such as when near salt spray, cement dust, or acid fumes -- to avoid flashovers as a result of the accumulation of foreign substances on the surfaces of the circuit breaker.

Special Instructions relating to maintenance and adjustment of various units of the circuit breakers are given in the following:

CONTACT MECHANISM:

Perform steps 2, 3, and 4 of the Inspection for Manual Operation (see page 8), including check of clearances M, N, and P (Fig. 9B) and adjust if required. When the circuit breaker is in closed position, the pressure of the contact springs should be maintained at 50 lbs for the upper main contacts 12 (Fig. 9) and at 32 lbs for arcing contacts 9. Pressure should be measured by fish scale and pull-away sling attached to straddle the contact surface so the pull will represent average pressure at center of contact. The scale should be read just as the contacts part.

The contact surfaces should be dressed with a fine file or sandpaper. Each contact assembly is removable after disconnecting jumper and releasing the springs by unscrewing holding nuts. The lower end of the assembly has only a pin-in-slot connection.

The amount of effective toggle when handle moves to closed position is adjusted by the jam nut on the right-hand link of toggle links 7 (Fig. 9), but as this is carefully adjusted at the factory, it is unlikely that further adjustment will be required.

<u>Failure of Trip Latch to Reset:</u> If there is frequent failure of the trip latch to reset so it is found necessary to move handle to reset position to reset the latch more often than occasional intervals, the parts and linkage that produce tripping through movement of trip trigger 37 (Fig. 9) should be examined in detail. Check all clearances between parts where there should be clearance. Check fastenings for tightness. Check any condition in the mounting of the circuit breaker that would be likely to cause abnormal vibration during opening. Particularly see that trip trigger 37 is well clear of pin on trip lever 21 at all points of the stroke. Check condition of reset spring 23 (Fig. 9) and its fastenings.

If nothing can be found that would cause the latch failures, check the condition of the latch itself by inspecting the latching surfaces of trip latch 38 and latch prop 86 (Fig. 9). If the surfaces are worn or indicate the possibility of not holding firmly when reset, replace trip link 5 entirely; it includes the latch assembly. The removed trip link may then be repaired if practicable.

HANDLE-SHAFT ASSEMBLY:

See that sliding cam clutch 42 rides freely on main clutch 43 (Figs. 10 and 11) and that clutch engaging surfaces are not broken or blunted at edges.

CLOSING SOLENOID:

The solenoid is designed for intermittent duty. To remove the solenoid: Have breaker in open position. Disconnect leads to control relay and to terminal block. Remove pin in link that connects to the core. On Type DMB-50 remove three hex head cap screws at back of coil, and pull out horizontally. On Type DMB-25 remove four bolts underneath the coil. The disassembly of the device after removal from the circuit breaker is obvious. However, a list should be kept of the parts and of the order of removal so replacement may be made in the correct opposite manner.

OVERCURRENT TRIPPING DEVICE:

Each device is removable after withdrawing six bolts from back frame of the circuit breaker. The series coil and the overcurrent-device assembly are withdrawn as a unit. Do not remove the tripping unit from the coil.

There are several forms of overcurrent devices available, and suitable instructions accompany any that differ from Form A (see Figs. 22 and 24) to which the following instructions apply:

Pickup Adjustment: The percent of coil rating at which pickup takes place (the current at which timer starts its operation) is altered by turning the exposed knob. A pointer on a calibrated dial controls this adjustment.

Time-Delay Adjustment: Remove molded case, to expose the escapement timer at bottom of assembly. On the opposite side from that shown in Fig. 24 is a circular disk that has thin metal projections which can be altered by rotation so they may be brought near to or moved away from adjacent thick bosses. To increase the time of pickup, move the thin metal projections toward the thick bosses; to decrease the time, move them away from the thick bosses.

Instantaneous Adjustment: Refer to Fig. 24. Place spring end in slot No. 4 for greatest percent of coil rating at which the device changes from time-delay to instantaneous operation. Place spring in slot No. 1 for the smallest percent of coil rating at which the instantaneous element becomes effective.

CONTROL RELAY:

With all control circuits and main leads open, remove cover from relay housing, dress contacts, clean the interior, and check all connections for tightness. Reconnect the control leads.

With the circuit breaker in test position in the cell, or with main leads otherwise disconnected, momentarily energize the closing-control circuit. The breaker should close. Trip the breaker. Again energize the closing-control circuit, but this time keep it continually energized during both the closing of the breaker and a following trip. The breaker should not close after the tripping, thereby showing that the anti-pump feature of the relay is in operating condition. It will also show that the resistor which supplies the seal-in contact is intact.

Remove cover from front of control relay. Disconnect leads from the relay contacts that go to the closing solenoid and the terminal block. Energize the relay operating coil and close breaker slowly by handle. Note the point in the closing stroke at which the relay contacts are opened because of engagement of collar 63 with kickoff bar 64 (Fig. 17). The contacts should not open until it is no longer necessary to apply strong force to move the handle. The breaker is then just beyond the "snap-over" point very near the end of its stroke. If the condition is incorrect, adjust at jam nuts at top of stem 62 until it is correct. However, be careful to see that the contacts will open each time after several closings are made, because it is very important that enough leeway be left so there will never be an instance in which the contacts fail to open at the end of the closing stroke of the breaker, yet it must also be certain that the solenoid will remain energized as long as any force is required from it for breaker closing.

After being sure that the preceding adjustment is correct, trip the breaker and again energize the relay operating coil and keep it energized throughout a manual closing followed by manual tripping. With the operating coil still energized, check to see that the coupling link that connects the operating coil plunger to the relay contacts remains uncoupled. De-energize the operating coil and note that the link now couples the plunger to the contact frame. Again energize the operating coil, which should result in closing of the relay contacts. If an incorrect condition is found make such adjustment as is necessary.

AUXILIARY SWITCH:

Remove front cover and inspect contacts. Dress or replace as required. The switch is designed so that contacts close somewhat before the end of the stroke. This insures complete engagement even if there is some rebound of contacts of the circuit breaker during opening. The auxiliary-switch contacts should be so arranged on the shaft that they are squarely and firmly applied to the contact fingers of the switch when the circuit breaker is fully closed or open, as the case may be.

SHUNT TRIP ACCESSORY:

With breaker open, move the core of the coil against the trip frame assembly and slowly try to close the breaker manually. The breaker should not close because of being trip free. When the shunt trip is not energized there should be 1/32" minimum clearance between the small trip lever that extends from the bottom of the shunt trip assembly and the frame that it engages during tripping.

BELL ALARM, UNDERVOLTAGE DEVICE, KEY INTERLOCK,
AND OTHER ACCESSORIES:

The inspection of these accessories is made by performing the work described in the applicable paragraphs of the section, Electrical-Operation Inspection (page 10), after which remove covers of the devices, dress contacts, clean all parts, check for loose connections. The undervoltage trip lever 84 (Fig. 25) should have clearance at least 1/32" from the tripping frame that it engages. A measured undervoltage source should be available to make certain that the undervoltage device operates when the voltage is reduced to the amount at which the device is supposed to operate.

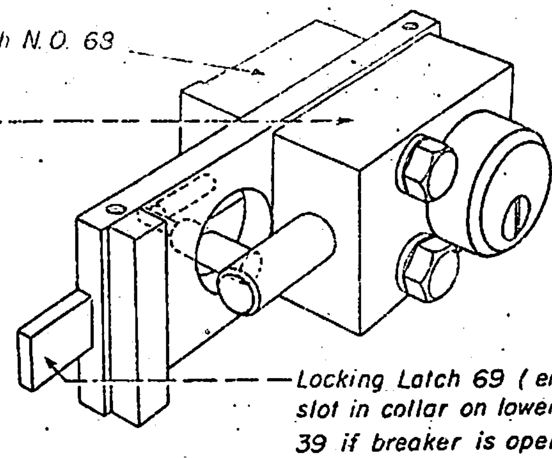


Fig. 18 – KEY INTERLOCK on TYPE DMB-25
Showing Parts in Lock Position

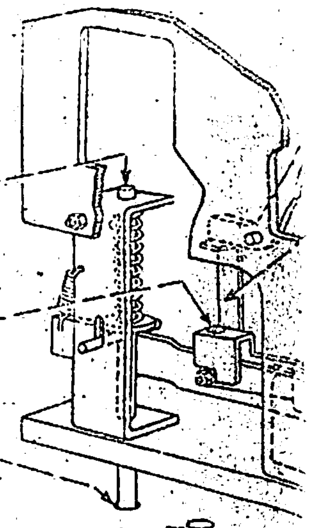


Fig. 16 – FORM A CELL INTERLOCK

Fig. 20 – BELL ALARM ASSEMBLY – TYPE DMB-25
Shown ready for tripping

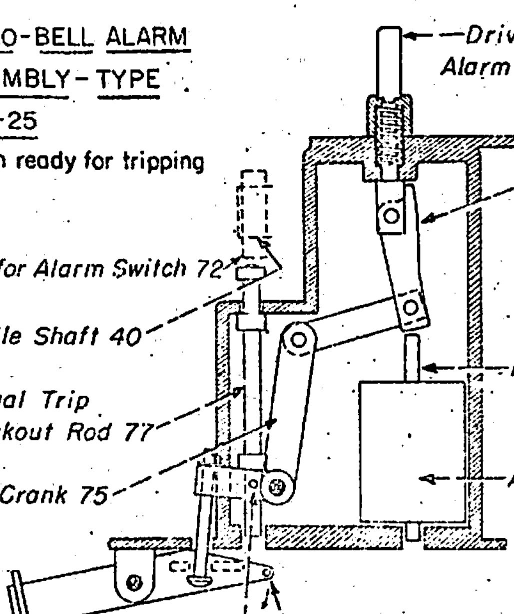
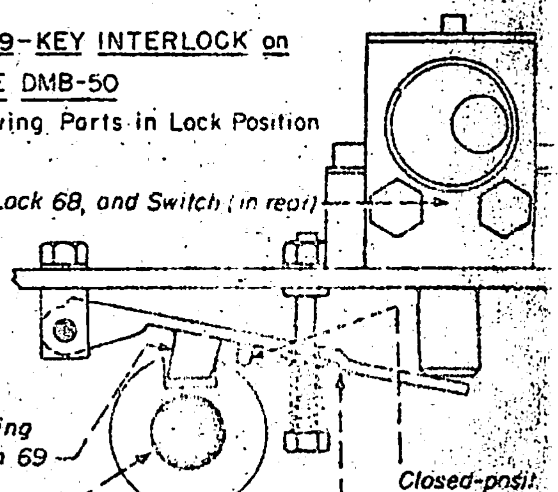


Fig. 19 – KEY INTERLOCK on TYPE DMB-50
Showing Parts in Lock Position



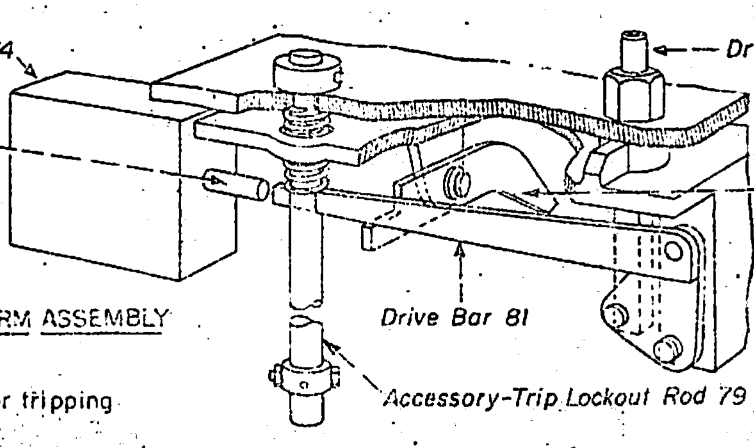
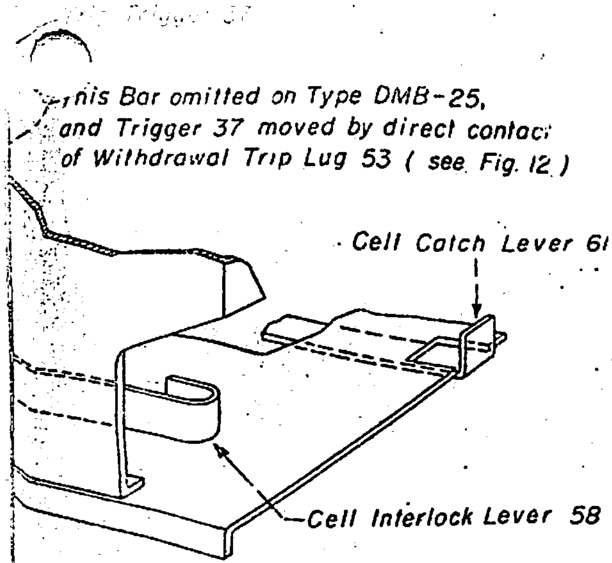


Fig. 21 – Bell ALARM ASSEMBLY TYPE DMB-50
Shown ready for tripping

Fig. 17 (
KICKOFF
TACTS
END of C
Type DMB



- TYPE DMB

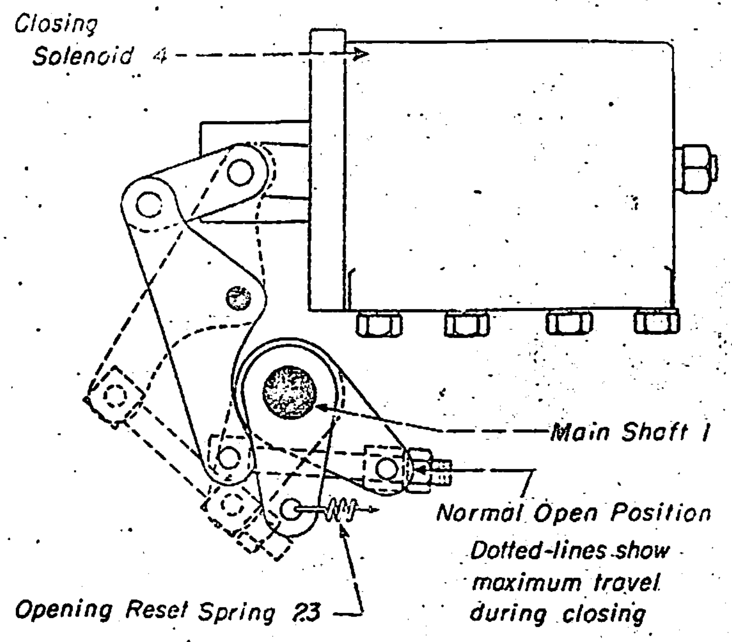
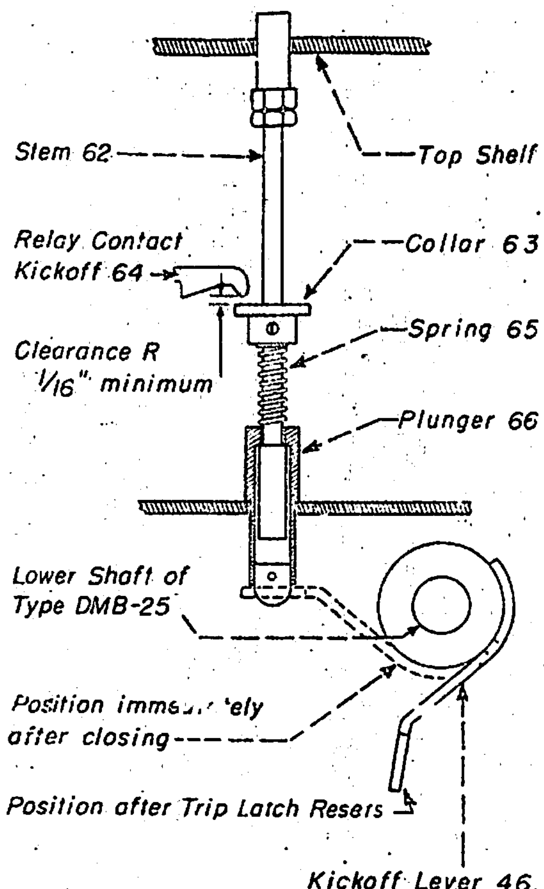


Fig. 14 - DETAIL of SOLENOID and LINKAGE
TYPE DMB-25



IN... N-
...RELAY at
STROKE.

Note: The action is similiar in Type DMB-50 except for method of upward movement, for which see Fig. II

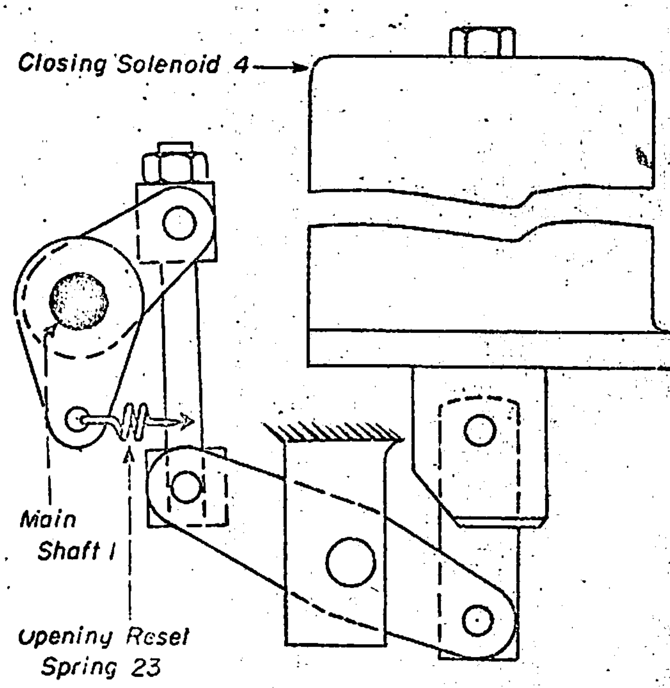
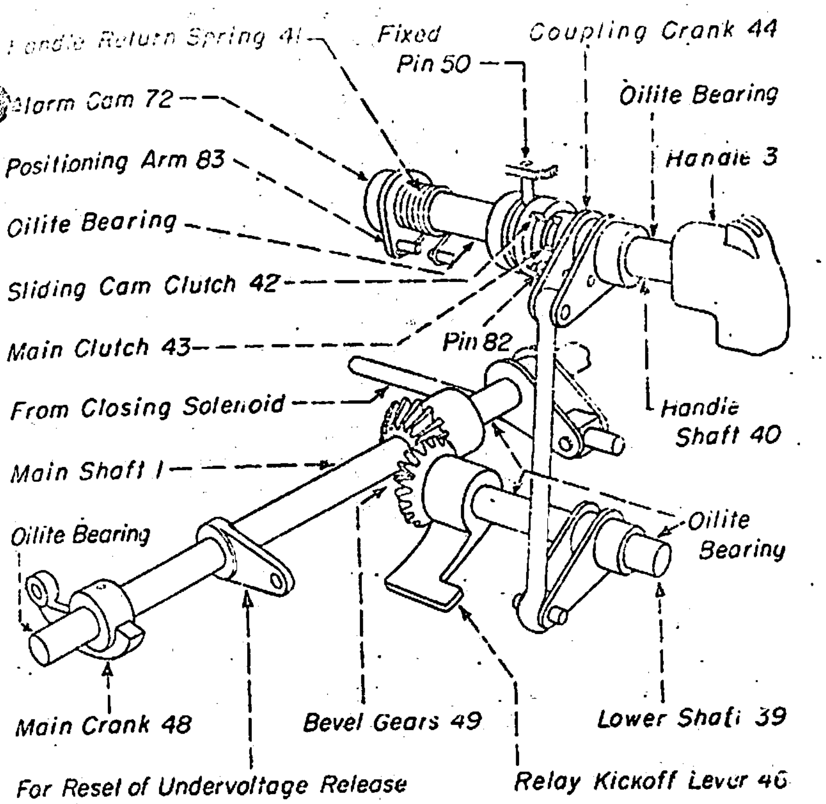


Fig. 15 - DETAIL of CLOSING SOLENOID and LINKAGE
TYPE DMB-50 In normal open position

FEDERAL ELECTRIC PRODUCTS CO. 50 PARIS STREET. NEWARK. N. J. U. S. A.	DATE	BY	APPR
TYPES DMB and DS CIRCUIT BREAKERS	5-28-51		
CLOSING COIL and INTERLOCKING DETAILS	3-31-54		
	A-9034		



10 - MANUAL DRIVE for TYPE DMB-25

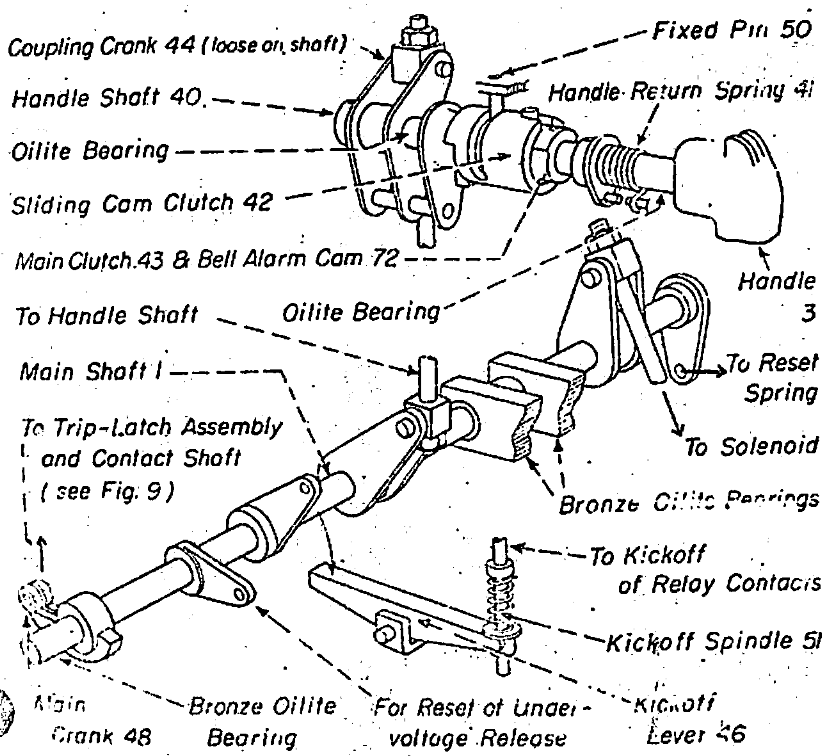


Fig. 11 - MANUAL DRIVE for TYPE DMB-50

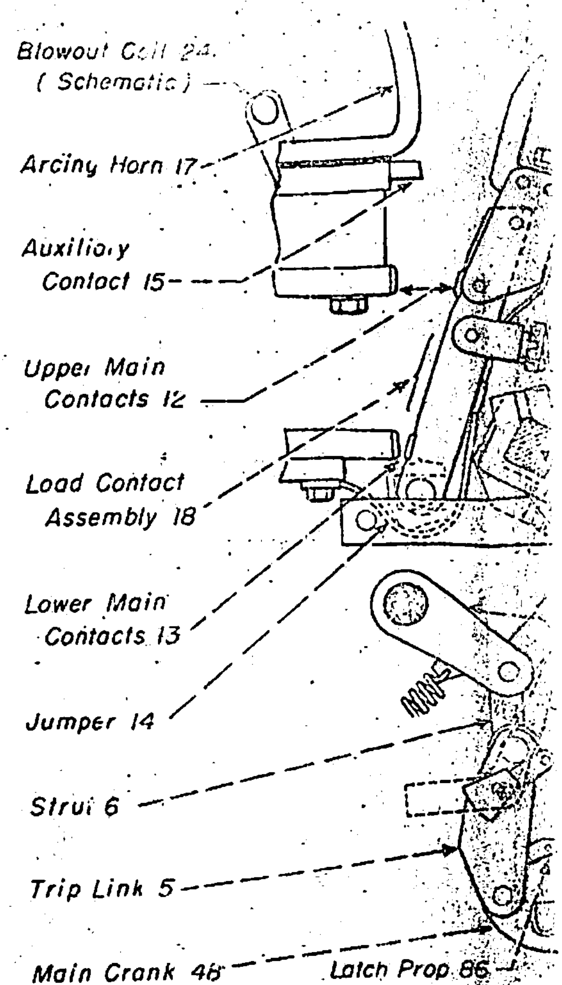
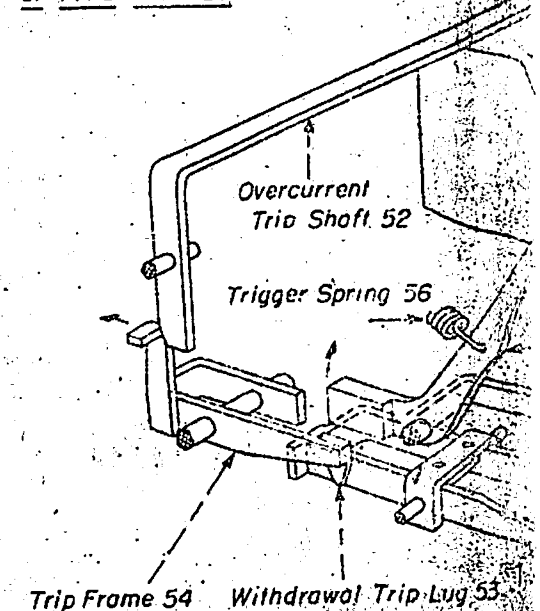


Fig. 9A - BREAKER

Fig. 12 - TRIGGER TRIPPING LINKAGE
of TYPE DMB-25



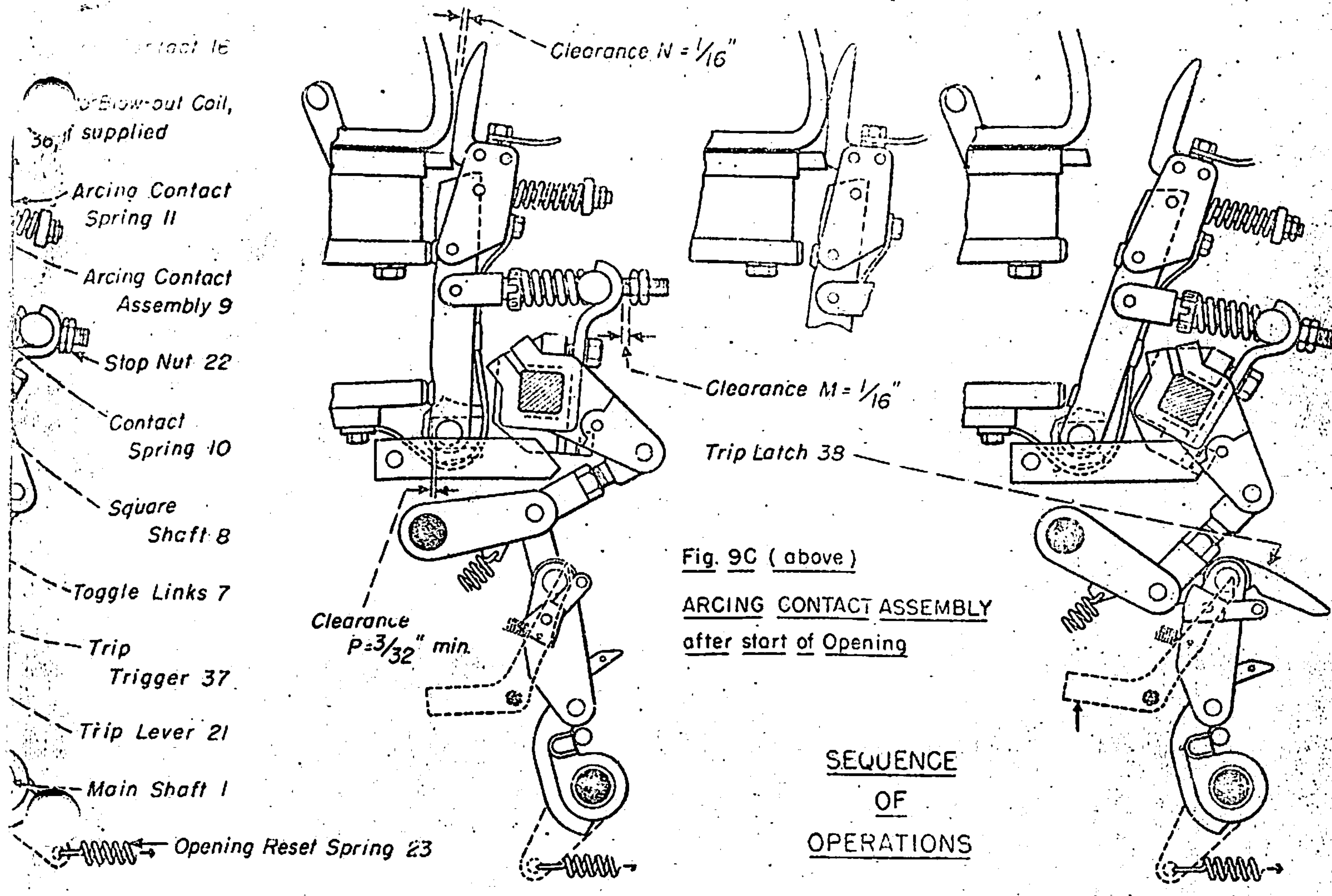
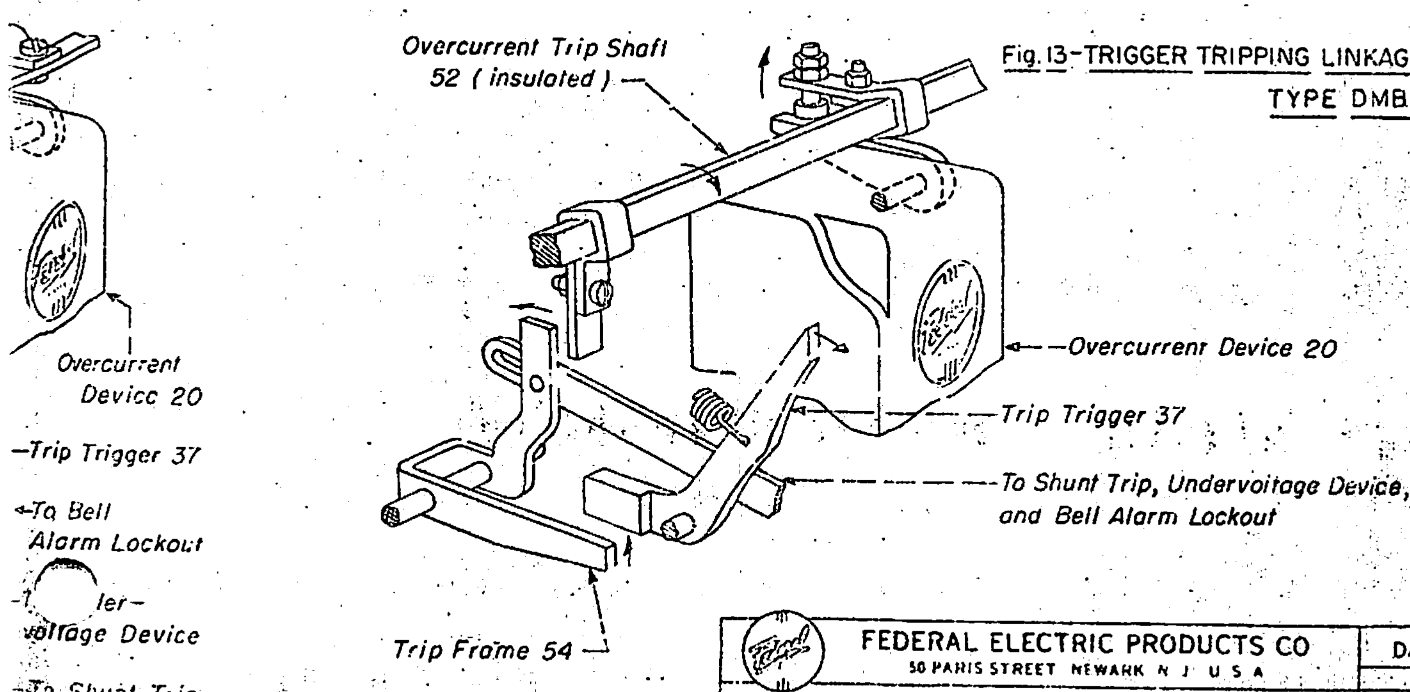


Fig. 9C (above) ARCING CONTACT ASSEMBLY after start of Opening

Fig. 9B-BREAKER CLOSED

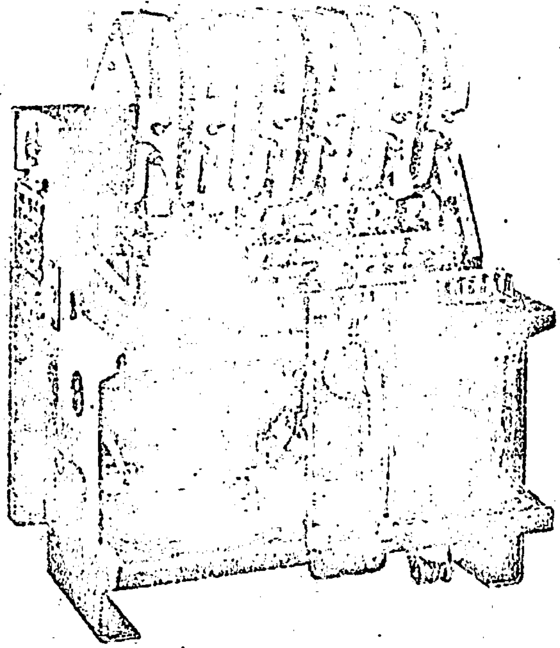
Fig. 9D-BREAKER OPEN, but Latch Not Reset

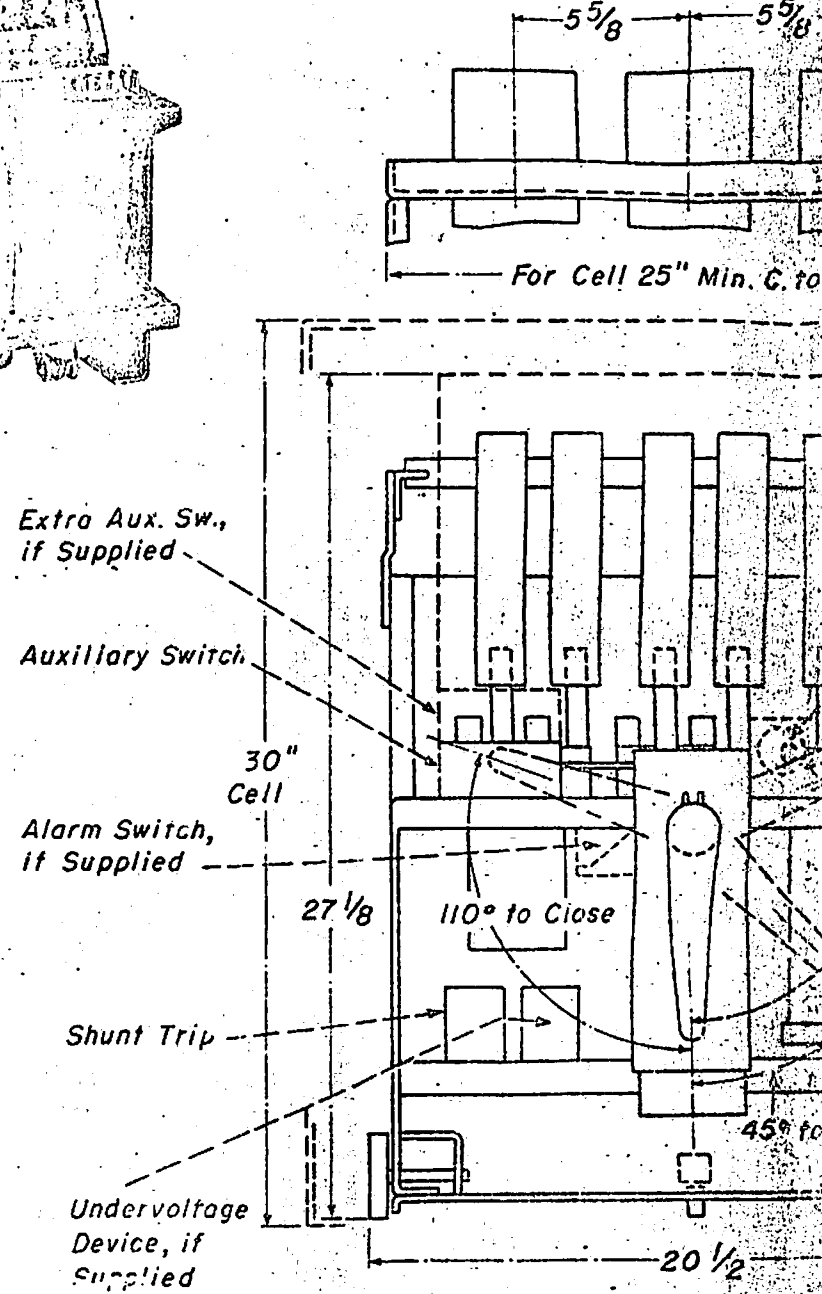
Fig. 13-TRIGGER TRIPPING LINKAGE of TYPE DMB-50



FEDERAL ELECTRIC PRODUCTS CO 50 PARIS STREET NEWARK N J U S A	DATE	BY	APPR
TYPE DMB CIRCUIT BREAKERS.	5-28-54		
OPERATING and TRIPPING DETAILS	3-31-54		
	A-9033		

Fig. 6
WITH ARC CHUTES
IN PLACE





FRONT ELEVATION

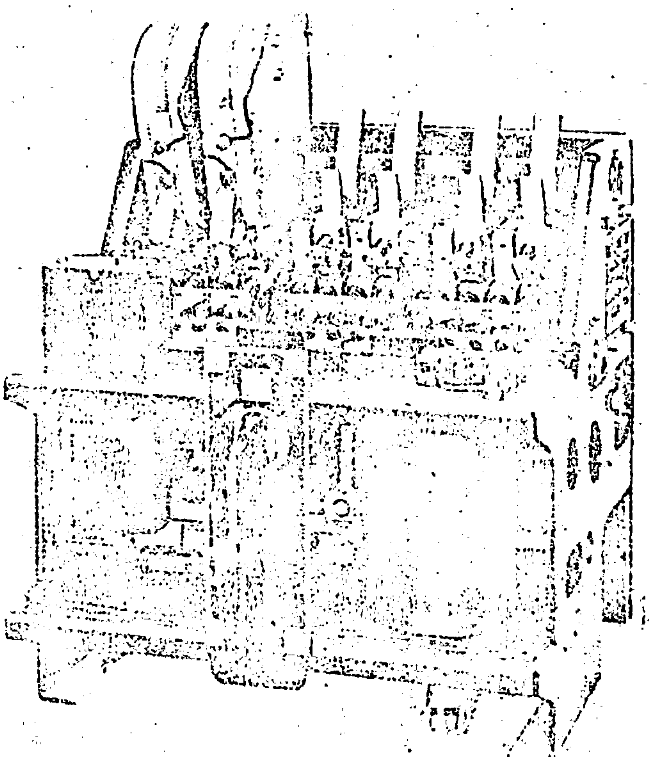


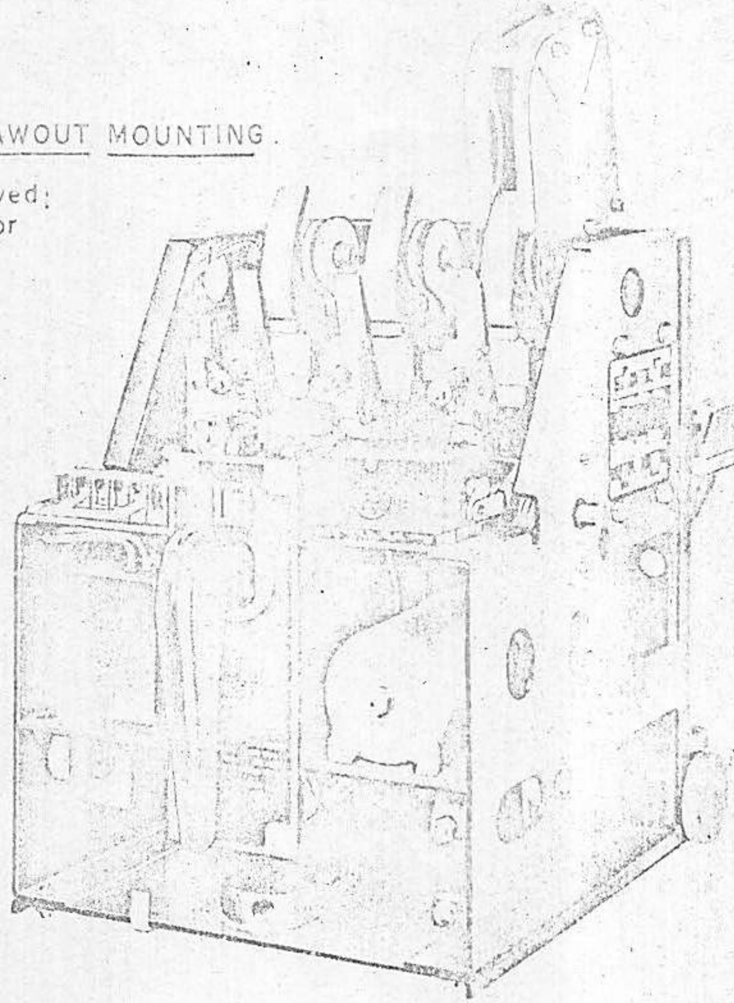
Fig. 7 — WITH ARC CHUTES of TWO POLES REMOVED

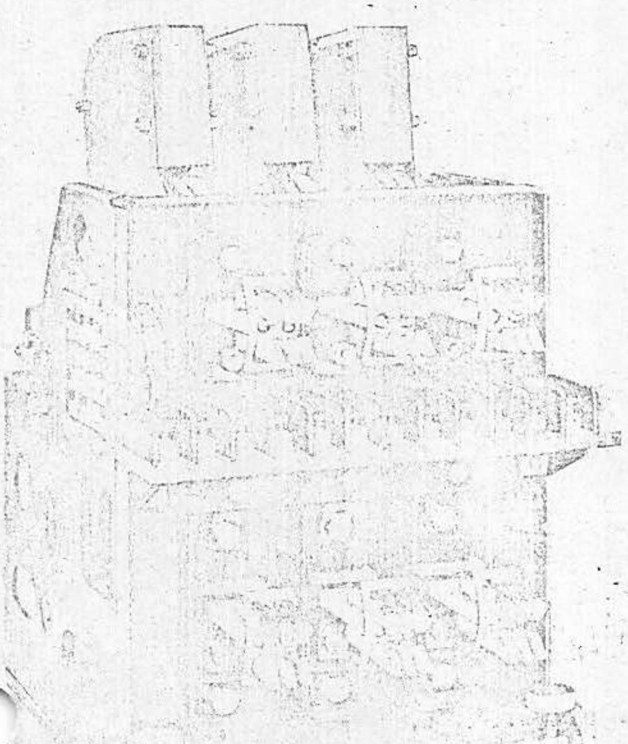
Fig. 8

Fig. 3

FRONT VIEW on DRAWOUT MOUNTING.

Two Arc Chutes removed; the third moved up for contact inspection





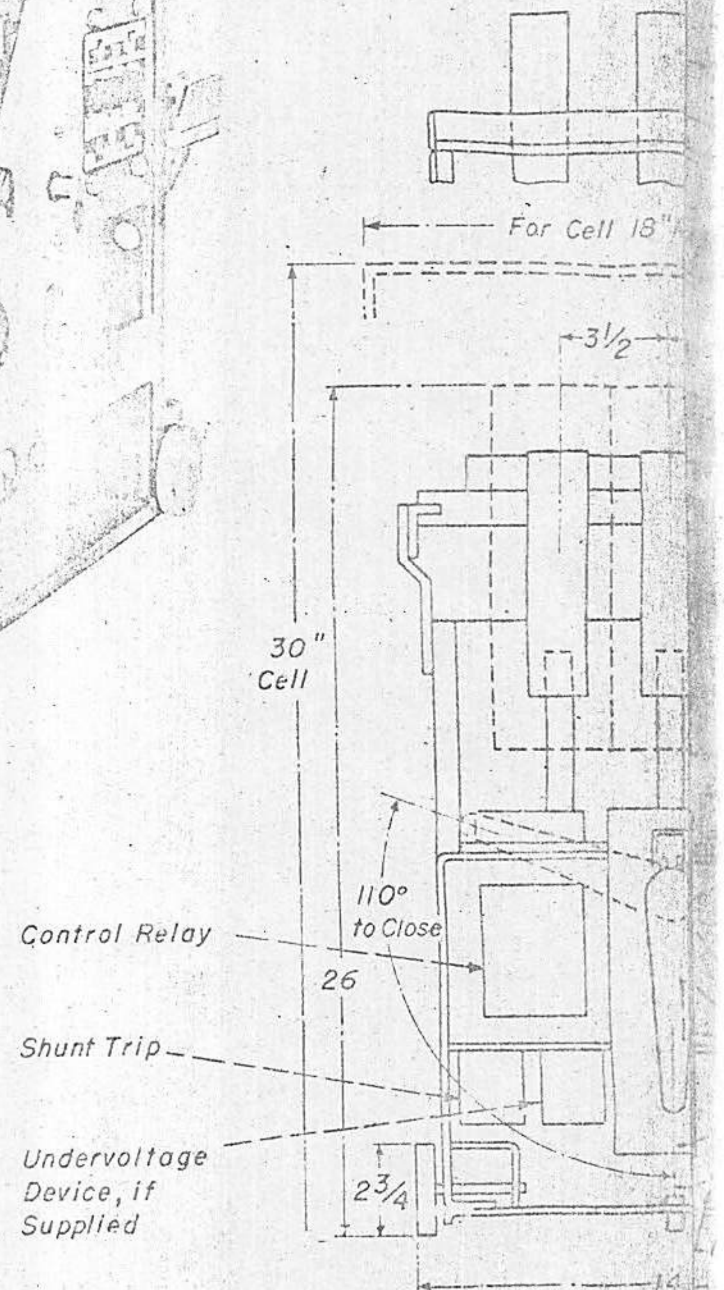
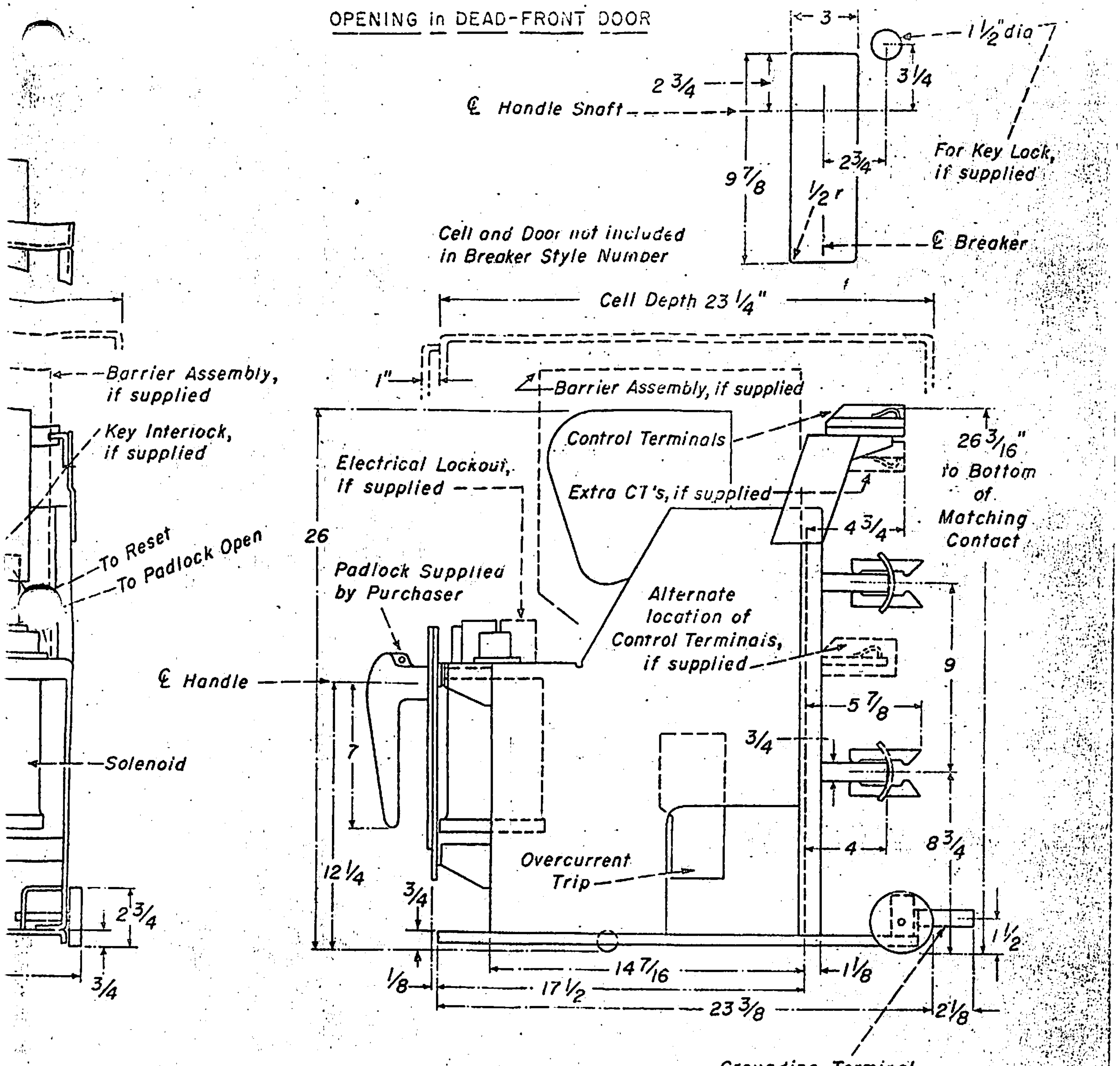


Fig. 4

REAR VIEW on DRAWOUT MOUNTING

Note: The control terminals are in the "alternate" location (see Fig. 5)



SIDE ELEVATION

...ensions in inches

FEDERAL ELECTRIC PRODUCTS CO. 50 PARIS STREET, NEWARK, N. J., U. S. A.	DATE	BY	APPR
TYPE DMB-50 CIRCUIT BREAKER	5-28-50		
Approx. Dimensions-Not for Construction	3-31-54		
	A-9032		

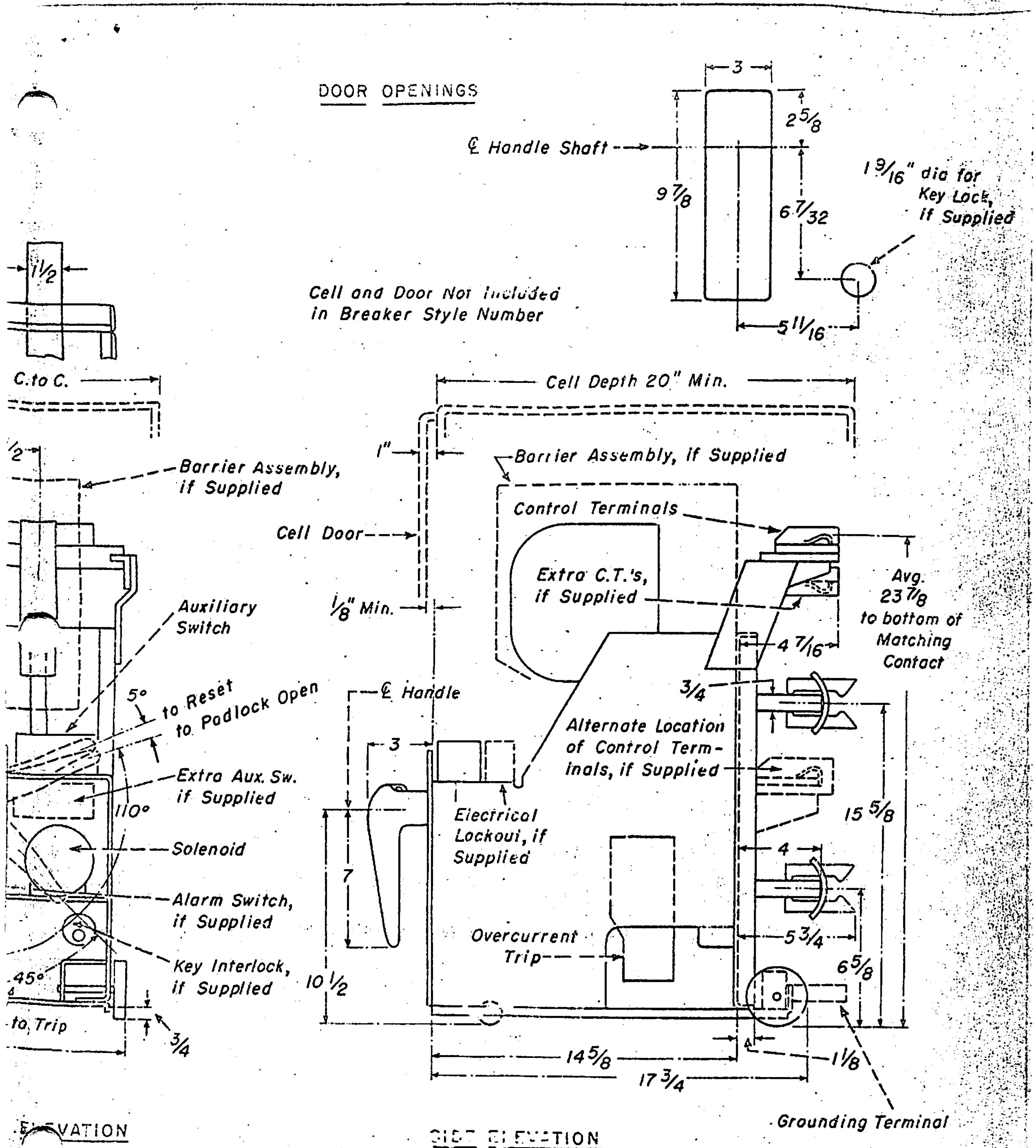


Fig. 5 Dimensions in inches

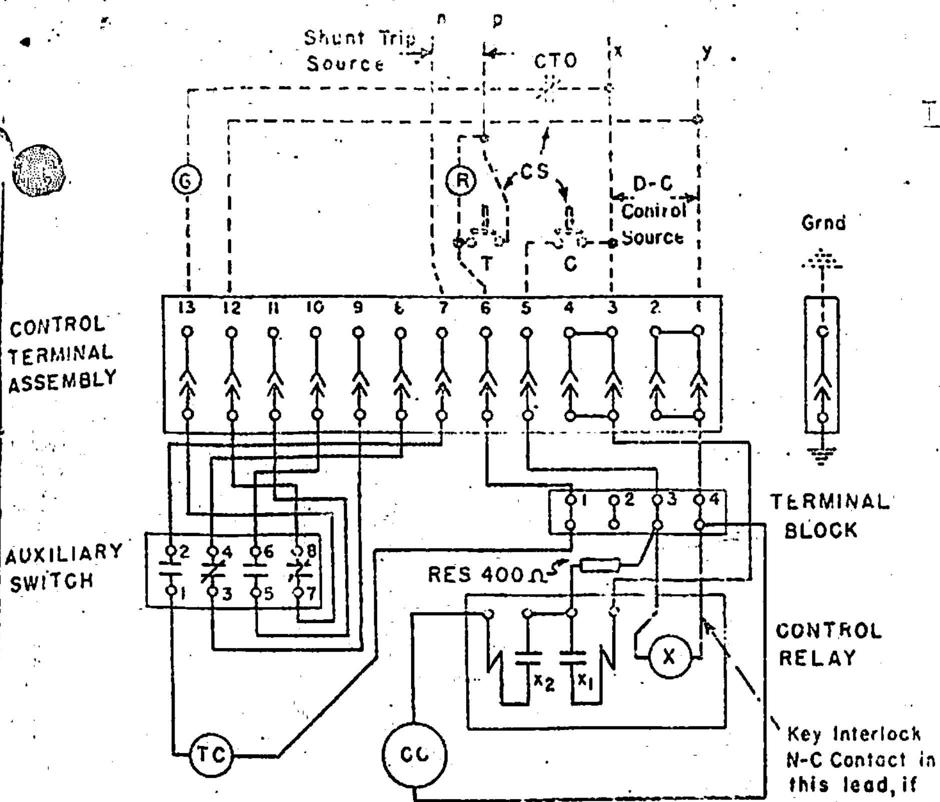
FEDERAL ELECTRIC PRODUCTS CO.
50 PARIS STREET, NEWARK, N. J., U. S. A.

TYPE DMB-25
CIRCUIT BREAKER
Approx. Dimensions-Not for Construction

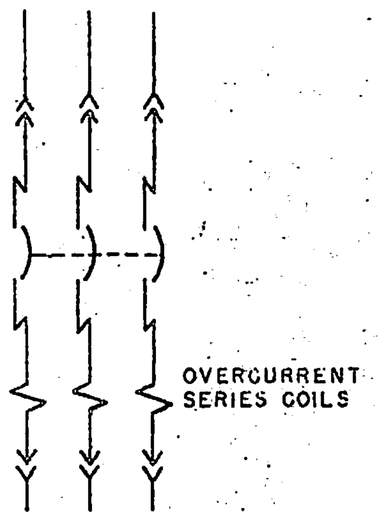
DATE	BY	APPR
5-28-54	MR	
3-31-54	MM	

A-9031

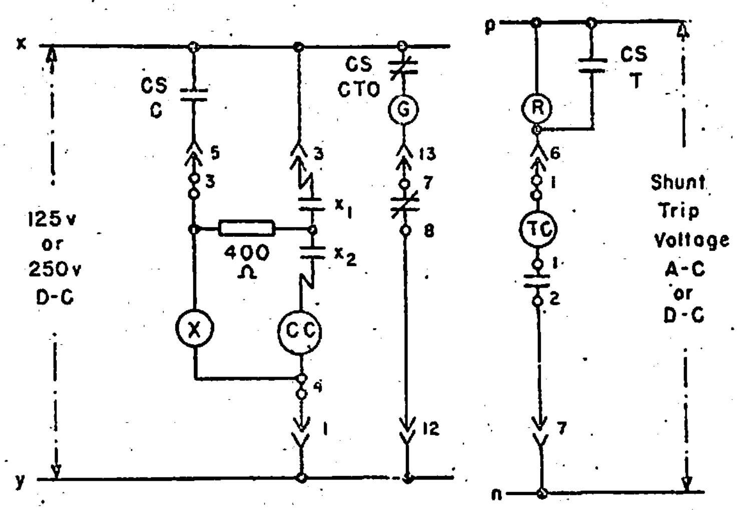
TYPICAL CONNECTION DIAGRAMS FOR DRAWOUT MOUNTING



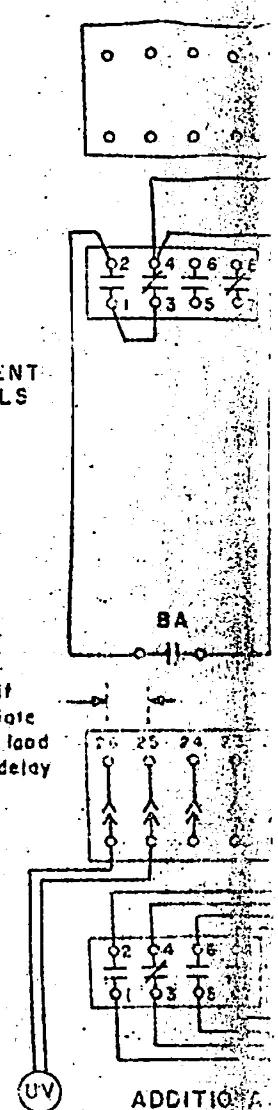
CONTROL CONNECTIONS



POWER SCHEMATIC



CONTROL SCHEMATIC



ADDITIO

LEGEND

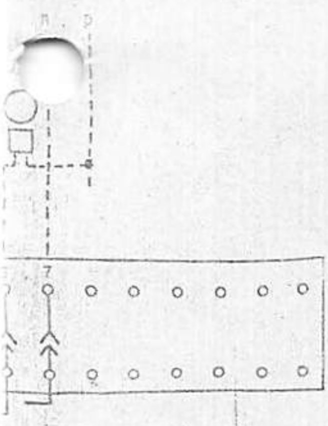
- Contact closed when breaker is open or device is de-energized ("b" switch)
- Contact open when breaker is open or device is de-energized ("a" switch)

CTO Contact closed when CS is operative
CS Electric control switch (station)
R Red lamp, indicates closed
G Green lamp, indicates open
CS/T Electric control trip contact
CS/C Electric control closing contact
TC Trip coil
Closing coil (solenoid)
X Control relay
x_1 and x_2 Responsive to X
BA Bell alarm contact. Closes only when breaker tripped from overcurrent
UV Undervoltage device

OPERATION

a) Control switch CS/C closed.
b) Control relay X closes x_1 and x_2 which seals-in X through x_1 and resistance.
c) Closing coil CC closes which closes the breaker.
d) During closing the breaker mechanically opens x_1 and x_2 so X drops out.
e) When breaker is in closed position, x_1 and x_2 are uncoupled from coil of X.
f) When breaker is tripped, x_1 and x_2 recouple to X provided X is not energized, thereby assuring no pumping.

NOTE: These connection diagrams are typical and for information only. Actual installations may differ considerably according to specification. ALWAYS USE THE CERTIFIED PRINT FOR MAKING CONNECTIONS.

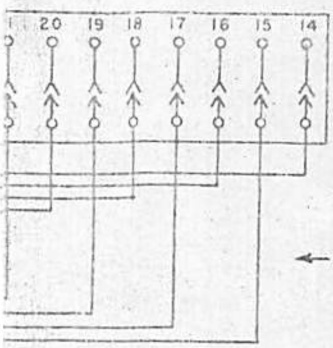


Note: When bell alarm is used omit lead from 3 of auxiliary switch to drawout terminal 9 and add new leads as shown.

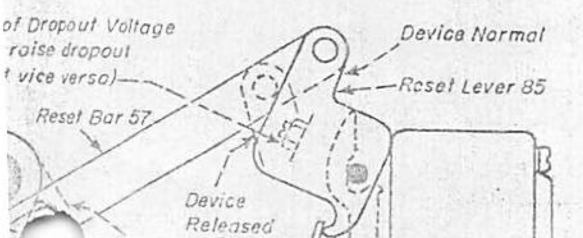
BELL ALARM CONNECTIONS for ELECTRICAL RESET from Shunt Trip circuit and mechanical reset from handle.

This scheme for d-c shunt trip. It requires modification for a-c.

BELL ALARM



AUXILIARY SWITCH and TERMINALS
UNDERVOLTAGE DEVICE

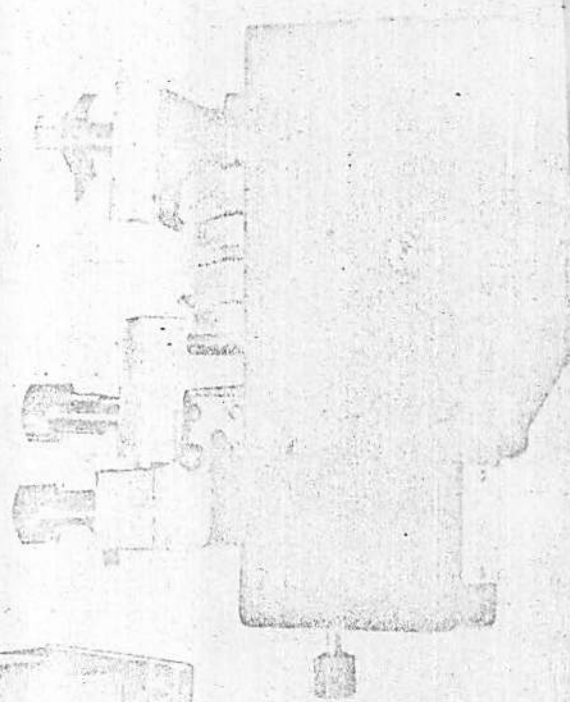


VOLTAGE DEVICE

Showing Arrangement for Trip and Reset. Solid lines of Device show Reset Position

Fig. 22 – FORM A

DUAL OVERCURRENT TRIP DEVICE 225 amp



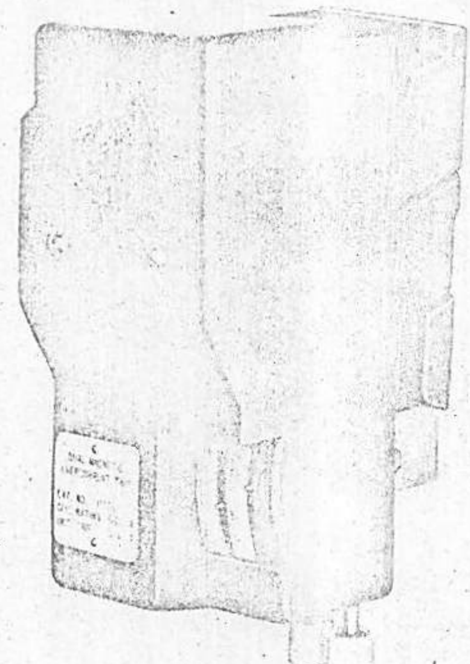


Fig. 23 – FORM B (left)

DUAL OVERCURRENT TRIP DEVICE – 600 amp

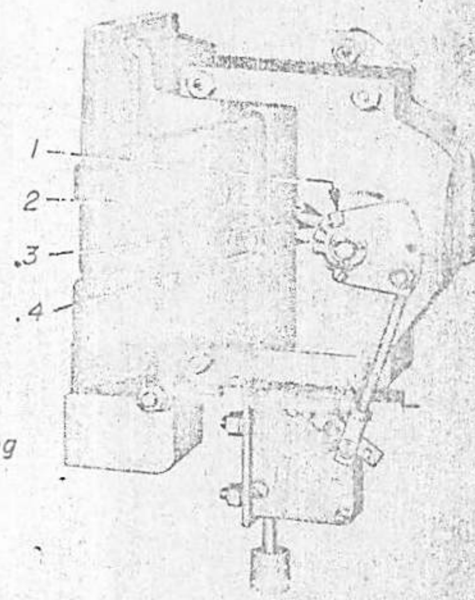


Fig. 24 – FORM A (right)

DUAL OVERCURRENT TRIP DEVICE – 600 amp

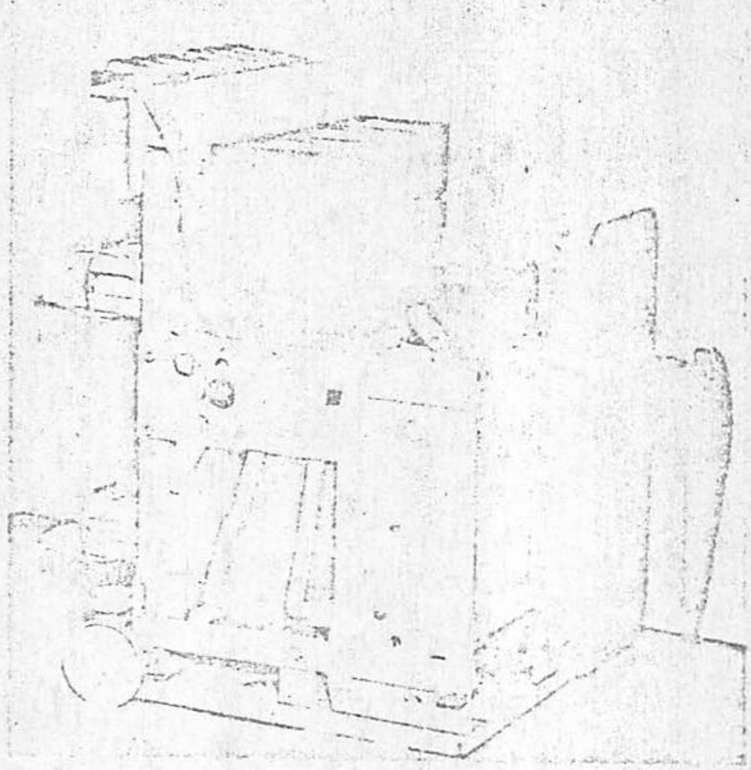
With Cover removed, showing instantaneous pickup adjustment

FEDERAL ELECTRIC PRODUCTS CO 50 PARIS STREET NEWARK N J U S A	DATE	BY	APP
TYPE DMB CIRCUIT BREAKER	5-22-54		
ACCESSORIES – CONNECTION DIAGRAMS	3-31-59		
	A-90[illegible]		

RENEWAL PARTS CATALOG AND
MAINTENANCE INSTRUCTIONS

Federal Pacific
TYPE DMB 15-T
Air Circuit Breakers

January 1960



RENEWAL PARTS DATA

This Renewal Parts Data will provide you with the proper identification of those Renewal Parts which you may require in the maintenance of your Federal Pacific equipment.

It is desirable to forecast as accurately as possible your requirements for Renewal Parts to assure that the necessary parts and materials will be available when needed to keep your equipment in efficient and continuous operating condition.

The recommendations for stock are the minimum quantities that should be available for servicing this equipment. We feel that you are in a better position than we to decide how much you wish to invest in Renewal Parts. The importance of minimizing shut-down time due to possible break-downs in operation, together with the distance from source of supply and transportation facilities, should be considered by you when ordering renewal parts.

Maintain the maximum operating characteristics of your apparatus and its dependability by using genuine Federal Pacific Renewal Parts.

The services of FPE engineers and Customer Service Centers are available to help with your maintanance problems.

PROCEDURE FOR IDENTIFYING RENEWAL PARTS

1. Obtain the complete nameplate reading of the apparatus for which the part is desired.
2. Turn to the Apparatus Index and with the nameplate reading find the page number of the Renewal Parts Data Sheet.
3. Turn to the indicated Renewal Parts Data Sheet where the desired part is described and identified.

ORDERING INSTRUCTIONS

Give the Part # or other identifying number and name the part. Give the complete nameplate reading of the apparatus. State whether shipment is desired by freight, express, or by parcel post. For maintenance Service contact your nearest FPE Sales Office to whom you should send all orders and correspondence. See last page of book for address of FPE Sales Office.

(1) Dielectric Test

(a) Voltage to be 1680 volts, 60 cycle (field test).
(b) Voltages will be applied for one (1) minute without arcing.
(c) Voltage to be applied to breaker as indicated:
1 – with contacts closed voltage to be applied between phase and ground and between phases.
2 – with contacts open voltage to be applied between line and load terminals and between line and load terminals and ground.
3 – voltage to be applied between control circuits and ground, and line terminals with contacts closed.

(2) Manual Operation

(a) Breaker will be manually closed and opened no less than twenty-five (25) times. Breaker shall not bind, handle should return to normal position.
(b) If the breaker is supplied with a Bell Alarm, see item 11.
(c) Trip breaker by manually activating shunt trip. Breaker should trip before plunger reaches end of its travel.

(3) Trip Free Operation

(a) With trip bar pushed upward breaker should not close.
(b) If drawout breaker carriage locking handle is depressed the breaker should trip free, before the pin releases breaker from cell.
(c) Trip breaker with trip lever moving it very gently.

(4) Electrical Operation

(a) Electrical accessories will operate satisfactory for at least five (5) operations with maximum and minimum voltages as given in following chart.
(b) Items to be checked are solenoid control relay, shunt trip and undervoltage trip which should operate satisfactory in the range of voltages shown.

Rated Control Voltage	Control Devices	Solenoid	Shunt Trip	Undervoltage	
				Trip	Reset
24 volt DC			14-30		
48 volt DC			28-60		Less than
125 volt DC	90-130	90-130	70-140	37.5-75	100
250 volt DC	180-260	180-260	140-260	75-150	200
115 volt AC	95-125		95-125	34.5-69	92
230 volt AC	190-250		190-250	69-138	184
460 volt AC	380-500		380-500		

(c) Undervoltage trip shall operate between 30-60% of voltage rating and mechanically reset undervoltage trips shall seal in at 80% of rated voltage (see table 4b).
(1) Time delay 3 to 4 seconds.
(d) Anti-pump feature of breaker shall be checked by operating closing switch 3 or 4 times while breaker is closed.
(e) If Bell Alarm is supplied refer to item 11.

(a) [illegible] inspected for signs of mechanical or electrical failure. Special attention should be given to see that retaining rings and E-rings on contacts, etc., are in place, springs are not unhooked on one end and cotter pins are opened.
(b) Arcing top on movable contacts should not touch arcing tip on snuffer when arcing top is pressed forward.
(c) Adjustable link (male) should not bind on crank on main shaft.
(d) Trip rod insulation should not slip.
(e) Insulation on shafts should not be scratched.

(6) **Contact Pressure**

(a) Tolerance on pressure to be + or –10%.

(7) **Contact Sequence**

(a) DMB 15 contact sequence.
  (1) Tips of movable contact and stationary contact touch.
  (2) Moving contact rocks on stationary with bottom contacting at end of closing operation and tips opening approximately 1/32 inch.

(8) **Contact Spacing & Angles**

(a) DMB 15 (Refer to Figure 1).
  (1) Breaker open.
    (a) 1-7/16 - 1-11/16 from center line of movable contact to stationary contact.
  (2) Breaker closed.
    (b) 1/64-3/64 Gap at top of contacts.

(9) **Check of Calibration of Coil after Assembly in Circuit Breaker**

(a) Long time delay.
  1 – Set indicator to 80% and pass 110% pick-up current indicated in table through each coil. Current should not be allowed to drop off. Tripping will occur in three (3) minutes.
  2 – Set current at 90% pick-up current indicated in table. Gear in trip unit should not move.
  3 – Reset calibration position of overcurrent trip unit to current value corresponding to breaker rating unless otherwise specified, before turning breaker over for shipment.

(10) **Kirk Key Interlock**

(a) When lock is installed on breaker check for following:
  1 – with breaker open turn key and remove. Key should not stick in lock. If electrically operated breaker, switch should be opened.
  2 – with breaker closed key cannot be removed.

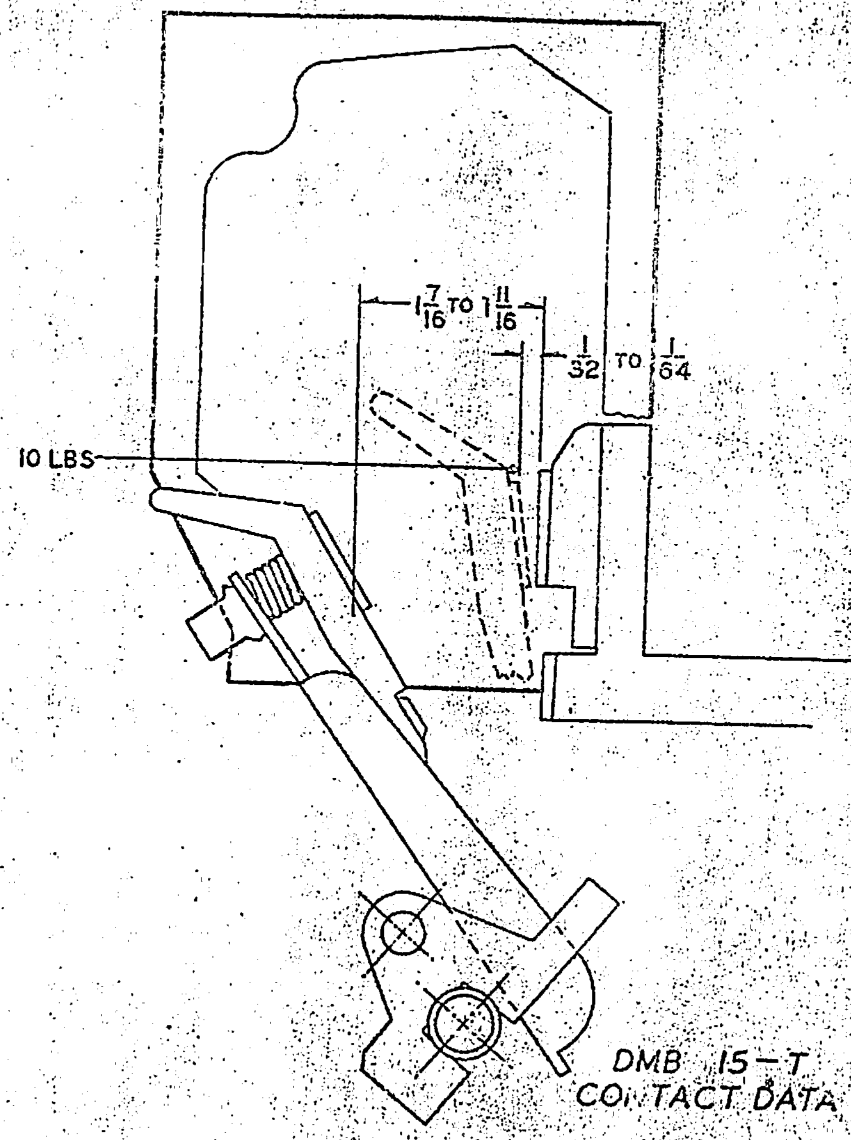
(11) **Bell Alarm**

(a) Trip breaker manually. Bell alarm should not operate.
(b) Trip breaker with shunt trip or undervoltage, if supplied on breaker. Bell alarm should not operate.
(c) Trip breaker with overcurrent trip lever. Bell alarm will operate.

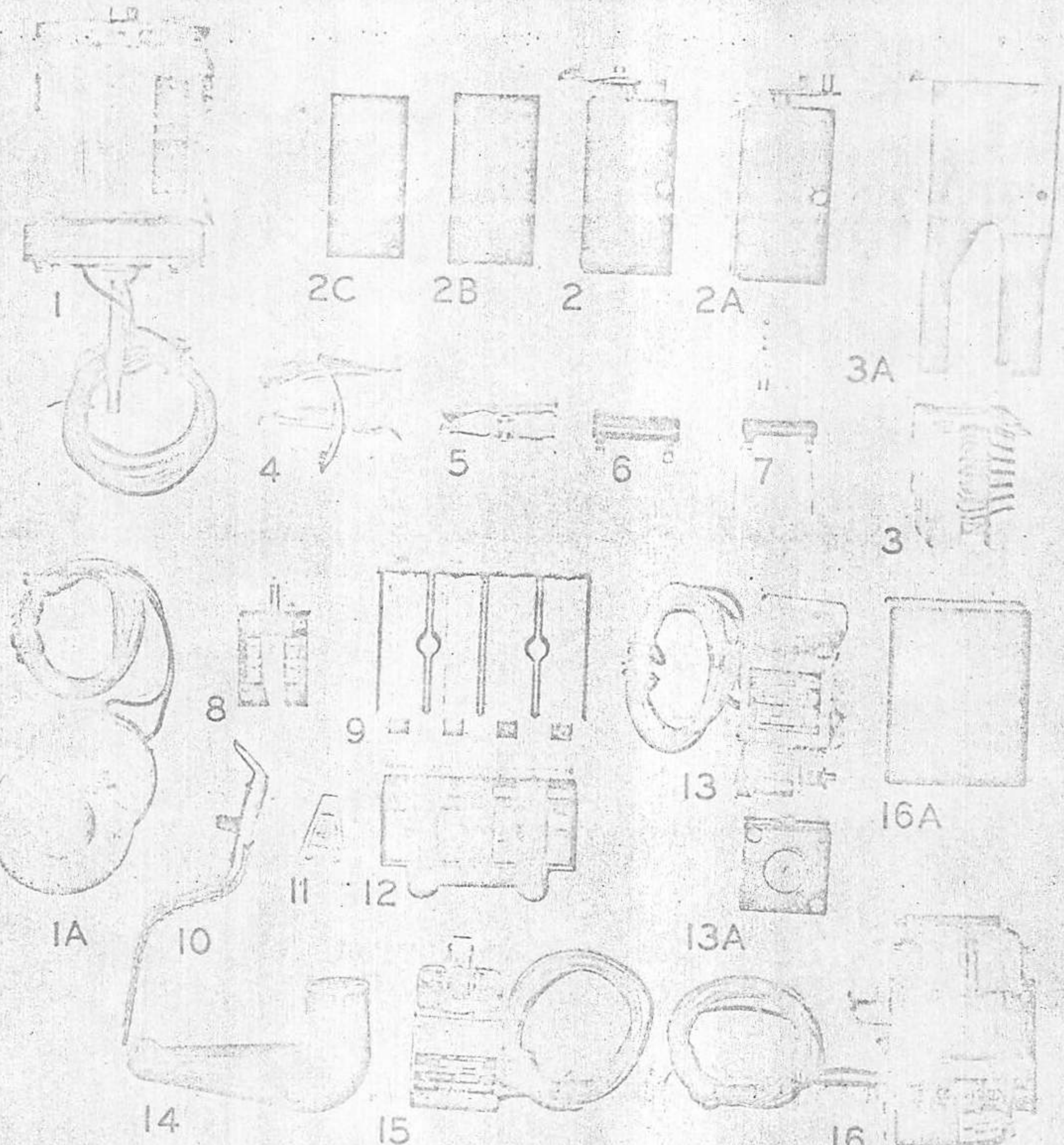
TABLE 1

Coil Rating	90% Pickup No Trip	110% Pickup Trip Within Three (3) Minutes	Coil Rating	90% Pickup No Trip	110% Pickup Trip Within Three (3) Minutes
100	72	88	175	126	154
125	90	110	200	144	176
150	108	132	225	172	198

FIG. 1



(Figure 1)



(Figure 2)

In ordering [illegible] on this list the Serial Number of the circuit [illegible] must be given.

RECOMMENDED SPARE PARTS FOR DMB 15-T BREAKERS

These Parts Are Illustrated, See Figure 2

1	– Solenoid Assembly 125V DC	1151-0968
	Solenoid Assembly 250V DC	1152-0968
1A	– Solenoid Coil 125V DC	1158-0581
	Solenoid Coil 250V DC	1159-0581
2	– Top Auxiliary Switch	1151-0973
2A	– Bottom Auxiliary Switch Assembly	1152-0951
2B	– Auxiliary Switch Front Cover	024-012
2C	– Auxiliary Switch Rear Cover	2701-0111
3	– Arc Chute Assembly	134-001
3A	– Arc Chute Cover	1101-0589
4	– Basket Assembly 225 Amp. (4 fingers)	1152-1106
5	– Breaker Grounding Contact	1101-0499
6	– 5 Ohm Resistor	099-004
7	– 400 Ohm Resistor	099-007
8	– Bell Alarm Switch (N.O.)	039-003
	Bell Alarm Switch (N.C.)	039-004
9	– 4-Point Secondary Contacts (cell)	2751-0068
10	– Arcing Tip (Movable)	1151-0776
11	– Arcing Tip (Stat.)	1151-0688
12	– 4-Point Secondary Contacts (breaker)	1151-0631
13	– Undervoltage Device 115V AC Instantaneous	1151-0952
	Undervoltage Device 230V AC Instantaneous	1152-0952
	Undervoltage Device 125V DC Instantaneous	1153-0952
	Undervoltage Device 250V DC Instantaneous	1154-0952
13A	– Time Delay Assembly used with Undervoltage Device	1151-0693
14	– Handle	1101-0541
15	– Shunt Trip Assembly 48V DC or 115V AC	1154-0757
	Shunt Trip Assembly 125V DC or 230V AC	1155-0757
	Shunt Trip Assembly 250V DC or 460V AC	1156-0757
16	– Control Relay Assembly 125V DC Continuous Duty	1158-0791
	Control Relay Assembly 250V DC Continuous Duty	1159-0791
	Control Relay Assembly 115V AC Continuous Duty	1166-0791
	Control Relay Assembly 220V AC Continuous Duty	1167-0791
	Control Relay Assembly 440V AC Continuous Duty	1168-0791
16A	– Control Relay Cover	1101-0592

PA[illegible] FOR DM[illegible]

NOTE: When ordering renewal parts give type of breaker and serial number shown on nameplate of breaker.
**Recommended Spare Parts, See Page 7

ITEM	DESCRIPTION	PART NUMBER
** 1	Handle	1101-0541
2	Closing Plate	1101-0964
3	Molded Escutcheon	1101-0960
4	Retainer	1101-1186
5	Indicator Nameplate Assembly	1151-1172
6	Indicator Pivot Shaft	1101-1043
7	Coil Spring	1101-1174
8	Indicator Retainer	1101-1188
9	Negator Spring	1101-0824
10	Connecting Strap	1102-1038
11	Connecting Strap	1101-1038
12	Molded Faceplate	1152-0708
13	Auxiliary Shaft Support	1101-0836
14	Shaft Auxiliary	1101-0487
15	Clutch Tubing	1101-0311
16	Cam Welded Assembly	1151-0661
17	Spacer	1101-0312
18	Link Rod	1101-0302
19	Latch	1101-0303
20	Coupling Lever Assembly	1151-0659
21	Ramp Assembly	1151-0700
22	Bell Crank Assembly	1151-0699
23	Rod	2701-0081
24	Spring	1101-0544
25	Link	2701-0080
26	Link	2702-0080
27	Pin	1101-0334
28	Mark "Q" Assembly (complete)	065-006
29	Crank Assembly	1151-0698
30	Rod	1101-0476
31	Link	1101-1223
32	Pin	1101-0335
33	Pin	1102-0335
34	Reset Coupling Tube	1101-0542
35	Pin (9/16 dia.)	1101-0313
36	Drawback Spring	1101-0137
37	Washer	1101-0171
38	Ball Bearing for Lower Sq. Shaft	1101-0328

		DESCRIPTION	[illegible] NUMBER
	39	Bearing Cover	1101-0337
	40	Handle Spacer	1101-0496
	41	Coil Spacer	1101-0433
	42	Lever Assembly	1151-0660
	43	Lever Weld Assembly	1151-0678
	44	Angle and Stud Assembly	1151-0677
	45	Mechanism Stop	1101-0511
	46	Spring	1101-0314
	47	Ring	1101-0315
	48	Stop Ring	1101-0316
	49	Lower Shaft	1101-0543
	50	Screw	1101-0338
	51	Sleeve	1101-0336
	52	Nameplate	1101-0564
	53	Adjustable Stop	1101-0478
	54	Pivot Pin	1101-0157
	55	Pin	1101-0334
	56	Eccentric Stop	1101-0474
	57	Auxiliary Shaft Support	1101-0340
	58	Pin	1101-0143
	59	Hair Pin Cotter	1101-0342
**	60	Contact & Flexible Connector	1151-0776
	61	Square Shaft Assembly	1151-0741
	62	Compression Spring	1101-0432
	63	Cup K Frame	1101-0431
	64	Clamp K Frame	1101-0445
	65	Crank	1101-0332
	66	Clip	1101-0333
	67	Contact Arm K Frame	1101-0595
	68	Leading Insulator	1102-0607
**	69	Arcing Contact Assembly	1151-0688
	70	Upper Terminal	1101-0422
	71	Lower Terminal Block	1101-0423
	72	Trip Bar	1101-0539
	73	Trip Bar Insulation	1101-0540
	74	Plate	1101-0301
	75	Trip Lever	1101-0327
	76	10 – 32 x 1/2 lg. rd. hd. nylon screw	
	77	10 – 32 x 1-1/8 lg. rd. hd. nylon screw	
	78	Trip Lever Assembly	1151-0662
	79	Rod	1101-0326
	80	Pin	1101-0369

	DESCRIPTION	PART NUMBER
** 81	Arc Chute	134-001
** 82	Arc Chute Cover	1101-0589
83	Steel Screw	1101-0343
84	Steel Screw	1101-0344
85	Rear Roller Welded Assembly	1151-0612
86	Guide Roller Welded Assembly	1151-0613
87	Lever Base Assembly	1151-0697
88	Retaining Ring	1101-0018
89	Lever Base Spring	1101-0019
90	Carriage Lever	1101-0021
91	Washer	1101-0465
92	Guide Rail	1101-0881
93	Main Stab	1101-0499
94	Clip	1101-0504
95	Carriage Plate Welded Assembly	1151-0918
96	Release Rod	1101-1111
97	Trip Rod Guide	1101-1011
98	Washer	1101-1022
99	Spring	1101-1025
100	Locking Pin	1101-1021
101	Stop Pin	1101-0063
102	Pin	1101-1023
103	Trip Rod-Weld Assembly	1151-1008
104	Spring Support	1101-1029
105	Spring	102-006
106	Basket Washer	1101-0173
107	Shoulder Screw	1101-1280
108	Spring	1101-0192
**109	Basket Assembly	1152-1106
110	Brass Tubing	2705-0339
111	Trip Trigger	1151-1037
112	Secondary Contact Support Weld. Assembly	1151-0756
**113	Movable Contact Assembly	1151-0631

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Cleveland, Ohio
Dallas, Texas
Granby, Quebec, Canada
Long Island City, New York
Los Angeles, California
Newark, New Jersey
Pittsburgh, Pennsylvania
St. Louis, Missouri
Santa Clara, California
Scranton, Pennsylvania
Seattle, Washington
Toronto, Ontario, Canada
Vancouver, B. C., Canada

FIELD OFFICES

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Boise, Idaho
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Buffalo, New York
Calgary, Alberta, Canada
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Cleveland, Ohio
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Shreveport, Louisiana
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Syracuse, New York
Toronto, Ontario, Canada
Tulsa, Oklahoma
Vancouver, B. C., Canada
Washington, D. C.
Wichita, Kansas
Winnipeg, Manitoba, Canada

Econ® Dual Element Cartridge Fuses

[illegible] Dimension Time Delay and [illegible]
[illegible]ing Capacity of 100,000 RMS Amperes
UL Class [illegible]

RATINGS, DIMENSIONS, PACKAGING—STANDARD SIZES

Amperes	Type	250 VOLTS Catalog Number	250 VOLTS Dimensions: Overall Length	250 VOLTS Dimensions: Cap Diameter	250 VOLTS Carton Quantity	250 VOLTS Lbs. per 100	600 VOLTS Catalog Number	600 VOLTS Dimensions: Overall Length	600 VOLTS Dimensions: Cap Diameter	600 VOLTS Carton Quantity	600 VOLTS Lbs. per 100
.1 .15 .2 .3 .4	FERRULE TYPE	ECN.1 ECN.15 ECN.2 ECN.3 ECN.4	2"	9/16"	10	5	ECS.1 ECS.15 ECS.2 ECS.3 ECS.4	5"	13/16"	10	15
.5 .6 .8 1.0 1.125	FERRULE TYPE	ECN.5 ECN.6 ECN.8 ECN1.0 ECN1.125	2"	9/16"	10	5	ECS.5 ECS.6 ECS.8 ECS1.0 ECS1.125	5"	13/16"	10	15
1.25 1.4 1.6 1.8 2.0	FERRULE TYPE	ECN1.25 ECN1.4 ECN1.6 ECN1.8 ECN2.0	2"	9/16"	10	5	ECS1.25 ECS1.4 ECS1.6 ECS1.8 ECS2.0	5"	13/16"	10	15
2.25 2.5 2.8 3.0 3.2	FERRULE TYPE	ECN2.25 ECN2.5 ECN2.8 ECN3.0 ECN3.2	2"	9/16"	10	5	ECS2.25 ECS2.5 ECS2.8 ECS3.0 ECS3.2	5"	13/16"	10	15
3.5 4.0 4.5 5.0 5.6	FERRULE TYPE	ECN3.5 ECN4.0 ECN4.5 ECN5.0 ECN5.6	2"	9/16"	10	5	ECS3.5 ECS4.0 ECS4.5 ECS5.0 ECS5.6	5"	13/16"	10	15
6.25 7 8 9 10	FERRULE TYPE	ECN6.25 ECN7 ECN8 ECN9 ECN10	2"	9/16"	10	5	ECS6.25 ECS7 ECS8 ECS9 ECS10	5"	13/16"	10	15
12 15 17.5 20 25 30	FERRULE TYPE	ECN12 ECN15 ECN17.5 ECN20 ECN25 ECN30	2"	9/16"	10	5	ECS12 ECS15 ECS17.5 ECS20 ECS25 ECS30	5"	13/16"	10	15
35 40 45 50 60	FERRULE TYPE	ECN35 ECN40 ECN45 ECN50 ECN60	3"	13/16"	10	11	ECS35 ECS40 ECS45 ECS50 ECS60	5½"	1 1/16"	10	24
				BLADE WIDTH					BLADE WIDTH		
70 80 90 100	KNIFE BLADE TYPE	ECN70 ECN80 ECN90 ECN100	5 7/8"	¾"	5	30	ECS70 ECS80 ECS90 ECS100	7 7/8"	¾"	5	48
110 125 150 175 200	KNIFE BLADE TYPE	ECN110 ECN125 ECN150 ECN175 ECN200	7 1/8"	1 1/8"	1	60	ECS110 ECS125 ECS150 ECS175 ECS200	9 5/8"	1 1/8"	1	122
225 250 300 350 400	KNIFE BLADE TYPE	ECN225 ECN250 ECN300 ECN350 ECN400	8 5/8"	1 5/8"	1	170	ECS225 ECS250 ECS300 ECS350 ECS400	11 5/8"	1 5/8"	1	315
450 500 600	KNIFE BLADE TYPE	ECN450 ECN500 ECN600	10 3/8"	2"	1	290	ECS450 ECS500 ECS600	13 3/8"	2"	1	500

MIDGET FUSES—Dimensions: Overall length, 1½"; Cap diameter 13/32". Carton quantity: 10

Amperes	Catalog Number	Amperes	Catalog Number	Amperes	Catalog Number	Amperes	Catalog Number
32 VOLTS		250 VOLTS		250 VOLTS		250 VOLTS	
20 25 30	MEN20 MEN25 MEN30	.1 .15 .2 .3 .4	MEN.1 MEN.15 MEN.2 MEN.3 MEN.4	1.25 1.4 1.6 1.8 2.0	MEN1.25 MEN1.4 MEN1.6 MEN1.8 MEN2.0	4 4.5 5 5.6 6.25	MEN4 MEN4.5 MEN5 MEN5.6 MEN6.25
125 VOLTS							
12 15	MEN12 MEN15	.5 .6 .8 1.0 1.125	MEN.5 MEN.6 MEN.8 MEN1.0 MEN1.125	2.25 2.5 2.8 3.2 3.5	MEN2.25 MEN2.5 MEN2.8 MEN3.2 MEN3.5	7 8 9 10	MEN7 MEN8 MEN9 MEN10

[illegible] Current Limiting Time Delay Fuses

Manufactured to Meet Proposed [illegible] Class K [illegible] Standards

RATINGS, DIMENSIONS, PACKAGING—STANDARD SIZES

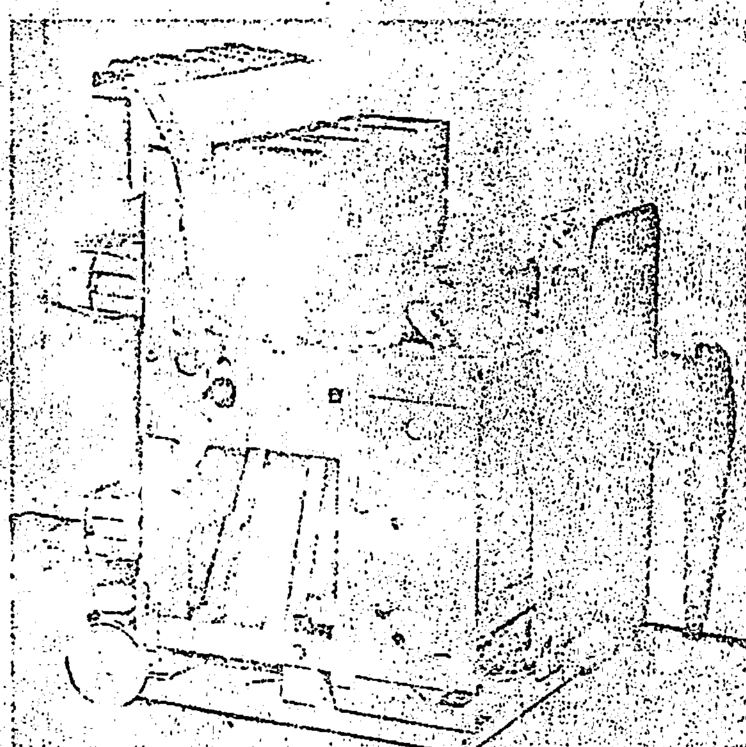
Amperes		250 VOLTS					600 VOLTS				
			Dimensions					Dimensions			
		Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100	Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100
.1 .15 .2 .3 .4	FERRULE TYPE	LEN.1 LEN.15 LEN.2 LEN.3 LEN.4	2"	9/16"	10	5	LES.1 LES.15 LES.2 LES.3 LES.4	5"	13/16"	10	15
.5 .6 .8 1.0 1.125		LEN.5 LEN.6 LEN.8 LEN1.0 LEN1.125	2"	9/16"	10	5	LES.5 LES.6 LES.8 LES1.0 LES1.125	5"	13/16"	10	15
1.25 1.4 1.6 1.8 2.0		LEN1.25 LEN1.4 LEN1.6 LEN1.8 LEN2.0	2"	9/16"	10	5	LES1.25 LES1.4 LES1.6 LES1.8 LES2.0	5"	13/16"	10	15
2.25 2.5 2.8 3.0 3.2		LEN2.25 LEN2.5 LEN2.8 LEN3.0 LEN3.2	2"	9/16"	10	5	LES2.25 LES2.5 LES2.8 LES3.0 LES3.2	5"	13/16"	10	15
3.5 4.0 4.5 5.0 5.6		LEN3.5 LEN4.0 LEN4.5 LEN5.0 LEN5.6	2"	9/16"	10	5	LES3.5 LES4.0 LES4.5 LES5.0 LES5.6	5"	13/16"	10	15
6.25 7 8 9 10		LEN6.25 LEN7 LEN8 LEN9 LEN10	2"	9/16"	10	5	LES6.25 LES7 LES8 LES9 LES10	5"	13/16"	10	15
12 15 17.5 20 25 30		LEN12 LEN15 LEN17.5 LEN20 LEN25 LEN30	2"	9/16"	10	5	LES12 LES15 LES17.5 LES20 LES25 LES30	5"	13/16"	10	15
35 40 45 50 60		LEN35 LEN40 LEN45 LEN50 LEN60	3"	13/16"	10	11	LES35 LES40 LES45 LES50 LES60	5½"	1 1/16"	10	24
				BLADE WIDTH					BLADE WIDTH		
70 80 90 100	KNIFE BLADE TYPE	LEN70 LEN80 LEN90 LEN100	5⅞"	¾"	5	30	LES70 LES80 LES90 LES100	7⅞"	¾"	5	48
110 125 150 175 200		LEN110 LEN125 LEN150 LEN175 LEN200	7⅛"	1⅛"	1	80	LES110 LES125 LES150 LES175 LES200	9⅝"	1¼"	1	122
225 250 300 350 400		LEN225 LEN250 LEN300 LEN350 LEN400	8⅝"	1⅝"	1	170	LES225 LES250 LES300 LES350 LES400	11⅝"	1⅝"	1	315
450 500 600		LEN450 LEN500 LEN600	10⅜"	2"	1	290	LES450 LES500 LES600	13⅜"	2"	1	500

IN-310.2

MAINTENANCE INSTRUCTIONS

Federal Pacific TYPE DMB 25-IT Air Circuit Breakers

January 1960



RENEWAL PARTS DATA

This Renewal Parts Data will provide you with the proper identification of those Renewal Parts which you may require in the maintenance of your Federal Pacific equipment.

It is desirable to forecast as accurately as possible your requirements for Renewal Parts to assure that the necessary parts and materials will be available when needed to keep your equipment in efficient and continuous operating condition.

The recommendations for stock are the minimum quantities that should be available for servicing this equipment. We feel that you are in a better position than we to decide how much you wish to invest in Renewal Parts. The importance of minimizing shut-down time due to possible break-downs in operation, together with the distance from source of supply and transportation facilities, should be considered by you when ordering renewal parts.

Maintain the maximum operating characteristics of your apparatus and its dependability by using genuine Federal Pacific Renewal Parts.

The services of FPE engineers and Customer Service Centers are available to help with your maintenance problems.

PROCEDURE FOR IDENTIFYING RENEWAL PARTS

1. Obtain the complete nameplate reading of the apparatus for which the part is desired.
2. Turn to the Apparatus Index and with the name-plate reading find the page number of the Renewal Parts Data Sheet.
3. Turn to the indicated Renewal Parts Data Sheet where the desired part is described and identified.

ORDERING INSTRUCTIONS

Give the Part # or other identifying number and name the part. Give the complete nameplate reading of the apparatus. State whether shipment is desired by freight, express, or by parcel post. For maintenance Service contact your nearest FPE Sales Office to whom you should send all orders and correspondence. See last page of book for addresses of FPE Sales Office.

TRIGGER ... PROCEDURE
FOR ... AIR CIRCUIT BREAKERS

(1) Dielectric Test

(a) Voltage to be 1650 volts, 60 cycle (field test).
(b) Voltages will be applied for one (1) minute without arcing.
(c) Voltage to be applied to breaker as indicated:
1 – with contacts closed voltage to be applied between phase and ground and between phases.
2 – with contacts open voltage to be applied between line and load terminals and between line and load terminals and ground.
3 – voltage to be applied between control circuits and ground, and line terminals with contacts closed.

(2) Manual Operation

(a) Breaker will be manually closed and opened no less than twenty-five (25) times. Breaker shall not bind, handle should return to normal position.
(b) If the breaker is supplied with a Bell Alarm, see item 11.
(c) Trip breaker by manually activating shunt trip. Breaker should trip before plunger reaches end of its travel.

(3) Trip Free Operation

(a) With trip bar pushed upward breaker should not close.
(b) If drawout breaker carriage locking handle is depressed the breaker should trip free, before the pin releases breaker from cell.
(c) Trip breaker with trip lever, moving it very gently.

(4) Electrical Operation

(a) Electrical accessories will operate satisfactory for at least five (5) operations with maximum and minimum voltages as given in following chart.
(b) Items to be checked are solenoid control relay, shunt trip and undervoltage trip which should operate satisfactory in the range of voltages shown.

Rated Control Voltage	Control Devices	Solenoid	Shunt Trip	Undervoltage Trip	Undervoltage Reset
24 volt DC			14-30		
48 volt DC			28-60		Less than
125 volt DC	90-130	90-130	70-140	37.5-75	100
250 volt DC	180-260	180-260	140-260	75-150	200
115 volt AC	95-125		95-125	34.5-69	92
230 volt AC	190-250		190-250	69-138	184
460 volt AC	380-500		380-500		

(c) Undervoltage trip shall operate between 30-60% of voltage rating and mechanically reset undervoltage trips shall seal in at 80% of rated voltage (see table 4 b).
(1) Time delay 3 to 4 seconds.
(d) Anti-pump feature of breaker shall be checked by operating closing switch 3 or 4 times while breaker is closed.
(e) If Bell Alarm is supplied refer to item 11.

(5) Visual Inspection

(a) Breaker will be inspected for signs of mechanical or electrical failure. Special attention should be given to see that retaining rings and E-rings on contacts, etc., are in place, springs are not [illegible] pins are opened.

[illegible] contacts should not touch arcing tip on snuffer when arcing tip pressed forward.

(c) Adjustable link (male) should not bind on crank on main shaft.
(d) Trip rod insulation should not slip.
(e) Insulation on shafts should not be scratched.

(6) Contact Pressure

(a) Tolerance on pressure to be + or – 10%.

(7) Contact Sequence

(a) DMB 25-1T contact sequence.
 (1) Arcing contacts touch. Gap between main contacts should be approximately 1/8 inch – it is important to keep gap at this part of closing as great as possible.
 (2) Main contacts close.
 (3) When main contacts are completely closed arcing contacts should be open no more than 1/16 inch.

(8) Contact Spacing & Angles

(a) DMB 25-1T (Refer to Figure #1.)
 (1) Breaker open
  (a) 1-1/8 between center line of movable main contact and stationary contact.
 (2) Breaker closed
  (a) 1/32-3/32 between arcing tips.

(9) Check of Calibration of Coil after Assembly in Circuit Breaker

(a) Long time delay
 1 – Set indicator to 80% and pass 110% pick-up current indicated in table through each coil. Current should not be allowed to drop off. Tripping will occur in three (3) minutes.
 2 – Set current at 90% pick-up current indicated in table. Gear in trip unit should not move.
 3 – Reset calibration position of overcurrent trip unit to current value corresponding to breaker rating unless otherwise specified, before turning breaker over for shipment.

(10) Kirk Key Interlock

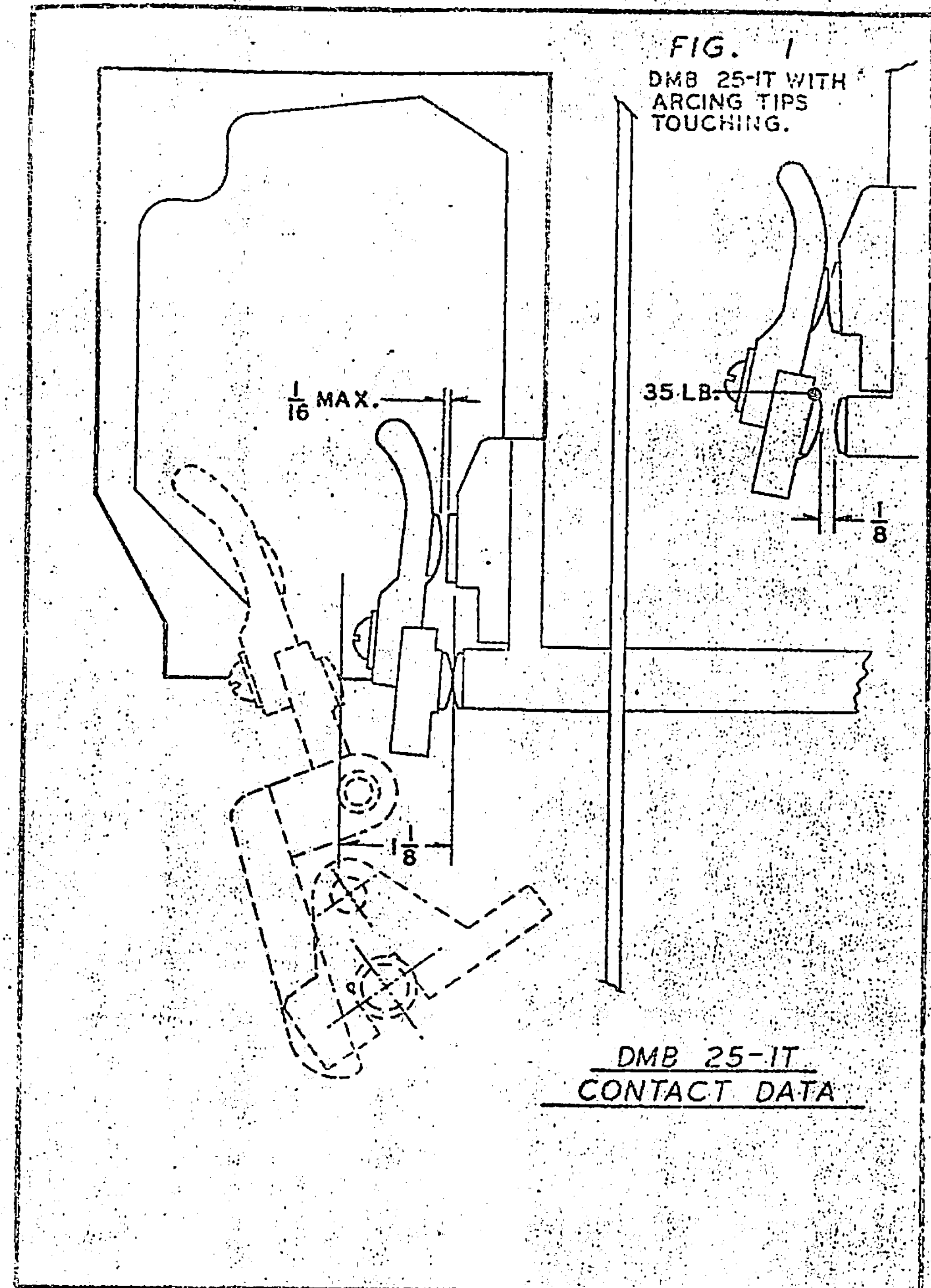
(a) When lock is installed on breaker check for following:
 1 – With breaker open turn key and remove. Key should not stick in lock. If electrically operated breaker, switch should be opened.
 2 – With breaker closed key cannot be removed.

(11) Bell Alarm

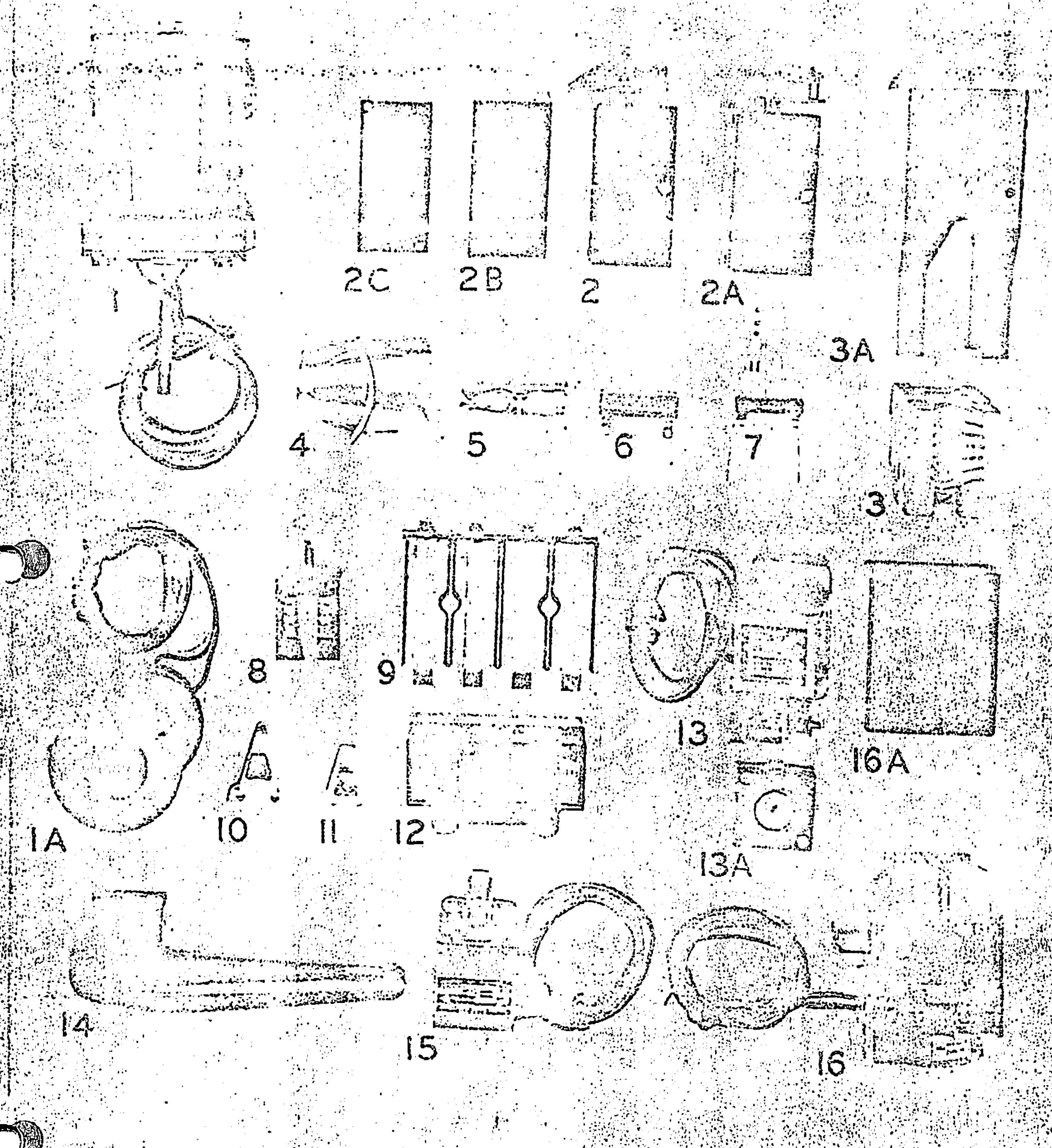
(a) Trip breaker manually. Bell alarm should not operate.
(b) Trip breaker with shunt trip or undervoltage, if supplied on breaker. Bell alarm should not operate.
(c) Trip breaker with overcurrent trip lever. Bell alarm will operate.

TABLE I

Coil Rating	90% Pickup No Trip	110% Pickup Trip Within Three (3) Minutes	Coil Rating	90 Pickup No Trip	110% Pickup Trip Within Three (3) Minutes
100	72	88	250	180	220
125	90	110	300	216	264
150	108	132	350	252	308
175	126	154	400	288	352
200	144	176	500	360	440
225	172	198	600	432	528



(Figure 1)



(Figure 2)

RECOMMENDED SPARE PARTS FOR DMB 25-1T BREAKERS

These parts are illustrated, See Figure 2

1	– Solenoid Assembly 125V DC	1151-0968
	Solenoid Assembly 250V DC	1152-0968
1A	– Solenoid Coil 125V DC	1158-0581
	Solenoid Coil 250V DC	1159-0581
2	– Bottom Auxiliary Switch Assembly	1152-0951
2A	– Top Auxiliary Switch	1151-0973
2B	– Auxiliary Switch Front Cover	024-012
2C	– Auxiliary Switch Rear Cover	2701-0111
3	– Arc Chute Assembly	134-001
3A	– Arc Chute Cover	1101-0589
4	– Basket assembly 600 Amp. (6 fingers)	1151-1106
5	– Breaker Grounding Contact	1101-0499
6	– 5 Ohm Resistor	099-004
7	– 400 Ohm Resistor	099-007
8	– Bell Alarm Switch (N.O.)	039-003
	Bell Alarm Switch (N.C.)	039-004
9	– 4-Point Secondary Contacts (cell)	2751-0068
10	– Arcing Tip (Movable)	1151-0667
11	– Arcing Tip (Stat.)	1151-0670
12	– 4-Point Secondary Contacts (breaker)	1151-0631
13	– Undervoltage Device 115V AC Instantaneous	1151-0952
	Undervoltage Device 230V AC Instantaneous	1152-0952
	Undervoltage Device 125V DC Instantaneous	1153-0952
	Undervoltage Device 250V DC Instantaneous	1154-0952
13A	– Time Delay Assembly used with Undervoltage Device	1151-0693
14	– Handle	1101-0580
15	– Shunt Trip Assembly 48V DC or 115V AC	1154-0757
	Shunt Trip Assembly 250V DC or 460V AC	1156-0757
16	– Control Relay Assembly 125V DC Continuous Duty	1158-0791
	Control Relay Assembly 250V DC Continuous Duty	1159-0791
	Control Relay Assembly 115V AC Continuous Duty	1166-0791
	Control Relay Assembly 220V AC Continuous Duty	1167-0791
	Control Relay Assembly 440V AC Continuous Duty	1168-0791
16A	– Control Relay Cover	1101-0592

[illegible] PARTS [illegible]

[illegible] type of [illegible] and serial number shown on nameplate of breaker.

**Recommended Spare Parts (See page 7)

ITEM	DESCRIPTION	PART NUMBER
** 1	Handle	1101-0580
2	Closing Plate	1101-0964
3	Molded Escutcheon	1101-0960
4	Retainer	1101-1186
5	Indicator Nameplate Assembly	1151-1172
6	Indicator Pivot Shaft	1101-1043
7	Coil Spring	1101-1174
8	Indicator Retainer	1101-1188
9	Negator Spring	1101-0824
10	Connecting Strap	1102-1038
11	Connecting Strap	1101-1038
12	Molded Faceplate	1152-0708
13	Auxiliary Shaft Support	1101-0836
14	Shaft Auxiliary	1101-0487
15	Clutch Tubing	1101-0311
16	Cam Welded Assembly	1151-0661
17	Spacer	1101-0312
18	Link Rod	1101-0302
19	Latch	1101-0303
20	Coupling Lever Assembly	1151-0659
21	Ramp Assembly	1151-0700
22	Bell Crank Assembly	1151-0699
23	Rod	2701-0081
24	Spring	1101-0544
25	Link	2701-0080
26	Link	2702-0080
27	Pin	1101-0334
28	Mark "Q" Assembly (complete)	065-006
29	Crank Assembly	1151-0698
30	Rod	1101-0476
31	Link	1101-1223
32	Pin	1101-0335
33	Pin	1102-0335
34	Reset Coupling Tube	1101-0542
35	Pin (9/16 dia.)	1101-0313
36	Drawback Spring	1101-0137
37	Washer	1101-0171
38	Ball Bearing for Lower Sq. Shaft	1101-0328

ITEM	DESCRIPTION	PART NUMBER
39	Bearing Cover	1101-0337
40	Handle Spacer	1101-0496
41	Coil Spacer	1101-0433
42	Lever Assembly	1151-0660
43	Lever Weld Assembly	1151-0678
44	Angle and Stud Assembly	1151-0677
45	Mechanism Stop	1101-0511
46	Spring	1101-0314
47	Ring	1101-0315
48	Stop Ring	1101-0316
49	Lower Shaft	1101-0543
50	Screw	1101-0338
51	Sleeve	1101-0336
52	Nameplate	1101-0564
53	Adjustable Stop	1101-0478
54	Pivot Pin	1101-0157
55	Pin	1101-0334
56	Eccentric Stop	1101-0474
57	Auxiliary Shaft Support	1101-0340
58	Pin	1101-0143
59	Hair Pin Cotter	1101-0342
** 60	Arcing Tip (Movable)	1151-0667
61	Square Shaft Assembly	1151-0741
62	Compression Spring	1101-0432
63	Cup K Frame	1101-0431
64	Clamp K Frame	1101-0445
65	Crank	1101-0332
66	Clip	1101-0333
67	Contact Arm K Frame	1101-0595
68	Leading Insulator	1102-0607
** 69	Arcing Contact	1151-0670
70	Upper terminal	1101-0422
71	Lower terminal Block	1101-0423
72	Trip Bar	1101-0539
73	Trip Bar Insulation	1101-0540
74	Plate	1101-0301
75	Trip Lever	1101-0327
76	10 – 32 x 1/2 lg. rd. nd. nylon screw	
77	10 – 32 x 1-1/8 lg. rd. hd. nylon screw	
78	Trip Lever Assembly	1151-0662
79	Rod	1101-0326
80	Pin	1101-0369
** 81	Arc Chute	134-001

RENEWAL PARTS FOR DHB 25-1T (Continued)

ITEM	DESCRIPTION	PART NUMBER
** 82	Arc Chute Cover	1101-0589
83	Steel Screw	1101-0343
84	Steel Screw	1101-0344
85	Rear Roller Welded Assembly	1151-0612
86	Guide Roller Welded Assembly	1151-0613
87	Lever Base Assembly	1151-0697
88	Retaining Ring	1101-0018
89	Lever Base Spring	1101-0019
90	Carriage Lever	1101-0021
91	Washer	1101-0465
92	Guide Rail	1101-0881
93	Main Stab	1101-0499
94	Clip	1101-0504
95	Carriage Plate Welded Assembly	1151-0918
96	Release Rod	1101-1111
97	Trip Rod Guide	1101-1011
98	Washer	1101-1022
99	Spring	1101-1025
100	Locking Pin	1101-1021
101	Stop Pin	1101-0063
102	Pin	1101-1023
103	Trip Rod Weld Assembly	1151-1008
104	Spring Support	1101-1029
105	Spring	102-006
106	Basket Washer	1101-0173
107	Shoulder Screw	1101-1280
108	Spring	1101-0192
**109	Basket Assembly	1152-1106
110	Brass Tubing	2705-0339
111	Trip Trigger	1151-1037
112	Secondary Contact Support Weld. Assembly	1151-0756
**113	Movable Contact Assembly	1151-0631

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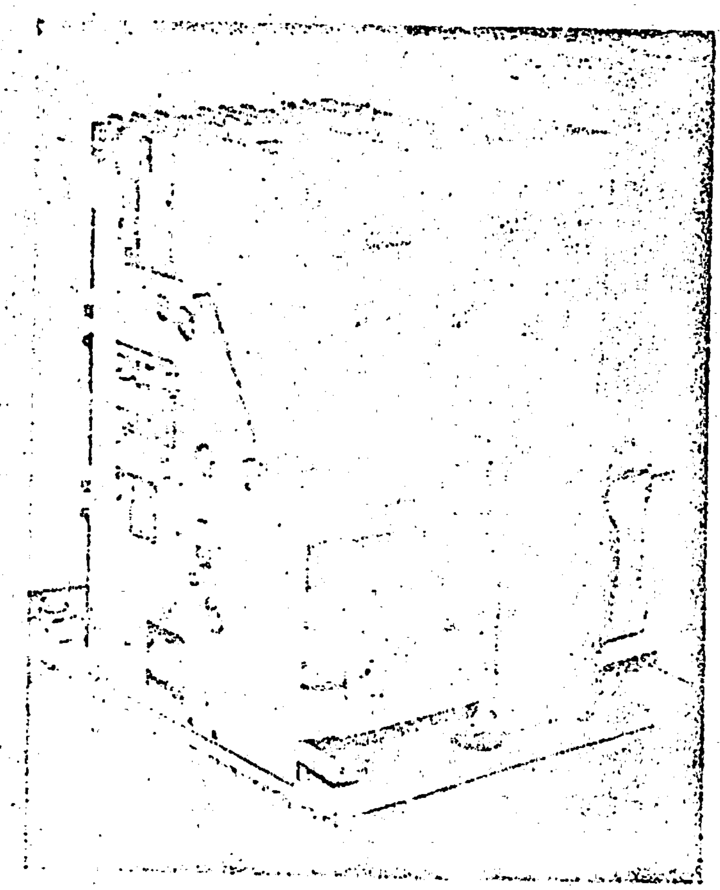
FEDERAL PACIFIC ELECTRIC COMPANY
GENERAL OFFICES: 50 PARIS STREET, NEWARK 1, NEW JERSEY

RENEWAL PARTS CATALOG AND
MAINTENANCE INSTRUCTIONS

Federal Pacific
TYPE DMB 50-T
Air Circuit Breakers

January 1960



RENEWAL PARTS DATA

This Renewal Parts Data will provide you with the proper identification of those Renewal Parts which you may require in the maintenance of your Federal Pacific equipment.

It is desirable to forecast as accurately as possible your requirements for Renewal Parts to assure that the necessary parts and materials will be available when needed to keep your equipment in efficient and continuous operating condition.

The recommendations for stock are the minimum quantities that should be available for servicing this equipment. We feel that you are in a better position than we to decide how much you wish to invest in Renewal Parts. The importance of minimizing shut-down time due to possible break-downs in operation, together with the distance from source of supply and transportation facilities, should be considered by you when ordering renewal parts.

Maintain the maximum operating characteristics of your apparatus and its dependability by using genuine Federal Pacific Renewal Parts.

The services of FPE engineers and Customer Service Centers are available to help with your maintenance problems.

PROCEDURE FOR IDENTIFYING RENEWAL PARTS

1. Obtain the complete nameplate reading of the apparatus for which the part is desired.
2. Turn to the Apparatus Index and with the nameplate reading find the page number of the Renewal Parts Data Sheet.
3. Turn to the indicated Renewal Parts Data Sheet where the desired part is described and identified.

ORDERING INSTRUCTIONS

Give the Part # or other identifying number and name the part. Give the complete nameplate reading of the apparatus. State whether shipment is desired by freight, express, or by parcel post. For maintenance Service contact your nearest FPE Sales Office to whom you should send all orders and correspondence. See last page of book for address of FPE Sales Office.

SUGGESTED MAINTENANCE PROCEDURE FOR DMB 50-T AIR CIRCUIT BREAKERS

(1) Dielectric Test

(a) Voltage to be 1650 volts, 60 cycle (field test)..
(b) Voltages will be applied for one (1) minute without arcing.
(c) Voltage to be applied to breaker as indicated;
1—with contacts closed voltage to be applied between phase and ground and between phases.
2—with contacts open voltage to be applied between line and load terminals and between line and load terminals and ground.
3—voltage to be applied between control circuits and ground, and line terminals with contacts closed.

(2) Manual Operation

(a) Breaker will be manually closed and opened no less than twenty-five (25) times. Breaker shall not bind, handle should return to normal position.
(b) If the breaker is supplied with a Bell Alarm, see item 11.
(c) Trip breaker by manually activating shunt trip. Breaker should trip before plunger reaches end of its travel.

(3) Trip Free Operation

(a) With trip bar pushed upward breaker should not close.
(b) If drawout breaker carriage locking handle is depressed the breaker should trip free, before the pin releases breaker from cell.
(c) Trip breaker with triplever, moving it very gently.

(4) Electrical Operation

(a) Electrical eccessories will operate satisfactory for at least five (5) operations with maximum and minimum voltage as given in following chart.
(b) Items to be checked are solenoid control relay, shunt trip and undervoltage trip which should operate satisfactory in the range of voltage shown.

Rated Control Voltage	Control Devices	Solenoid	Shunt Trip	Undervoltage	
				Trip	Reset
24 volt DC			14-30		
48 volt DC			28-60		Less than
125 volt DC	90-130	90-130	70-140	37.5-75	100
250 volt DC	180-260	180-260	140-260	75-150	200
115 volt AC	95-125		95-125	34.5-69	92
230 volt AC	190-250		190-250	69-138	184
460 volt AC	380-500		380-500		

(c) Undervoltage trip shall operate between 30-60% of voltage rating and mechanically reset undervoltage trips shall seal in at 80% of rated voltage (see table 4 b).
(1) Time delay 3 to 4 seconds.
(d) Anti-pump feature of breaker shall be checked by operating closing switch 3 or 4 times while breaker is closed.
(e) If Bell Alarm is supplied refer to item 11.

(5) Visual Inspection

(a) Breaker will be inspected for signs of mechanical or electrical failure. Special attention should be given to see that retaining rings and E-rings on contacts, etc., are in place, springs are not unhooked on one end and cotter pins are opened.
(b) Arcing top on movable contacts should not touch arcing tip on snuffer when arcing top is pressed forward.
(c) Adjustable link (male) should not bind on crank on main shaft.
(d) Trip rod insulation should not slip.
(e) Insulation on shafts should not be scratched.

(6) Contact Pressure

(a) DMB 50-T control pressure should be 50# on main contacts and 20# on arcing top. Refer to Fig. 1.
(b) Tolerance on pressure to be + or –10%.

(7) Contact Sequence

(a) DMB 50-T contact sequence.
 (1) Moving arcing horn touches stationary arcing horn.
 (2) Heel of moving arcing horn hits upper tungsten arcing tip.
 (3) Upper silver contacts hit.
 (4) When contacts are completely closed two arcing horns should be open approximately 1/64 inch at nearest points.

(8) Contact Spacing & Angles

(a) DMB 50-T (Refer to Fig. 1).
 (1) Breaker open.
  (a) 1-7/8-2" between top of movable arcing horn and stationary arcing horn.
  (b) 7/8-1" between center of upper main movable contact and upper main stationary contact.
  (c) Angle from vertical of contact shaft 35°.

 (2) Breaker closed.
  (a) 1/64 between arcing horns.
  (b) Angle from vertical of contact shaft 8°.

(9) Check of Calibration of Coil after Assembly in Circuit Breaker

(a) Long time delay.
 1 – set indicator to 80% and pass 110% pick-up current indicated in table through each coil. Current should not be allowed to drop off. Tripping will occur in three (3) minutes.
 2 – Set current at 90% pick-up current indicated in table. Gear in trip unit should not move.
 3 – Reset calibration position of overcurrent trip unit to current value corresponding to breaker rating unless otherwise specified, before turning breaker over for shipment.

(10) Kirk Key Interlock

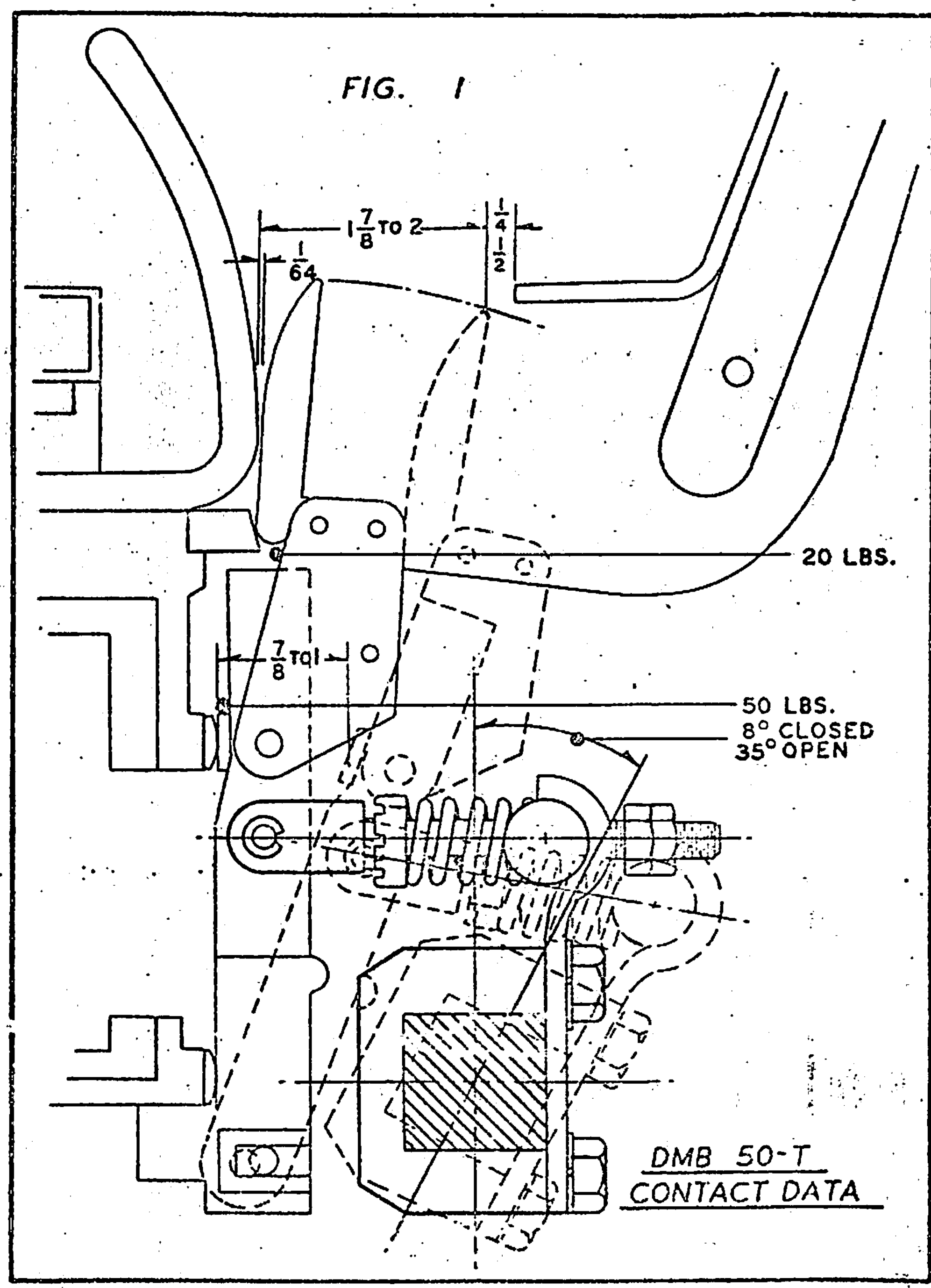
(a) When lock is installed on breaker check for following:
 1 – with breaker open turn key and remove. Key should not stick in lock. If electrically operated breaker, switch should be opened.
 2 – with breaker closed key cannot be removed.

(11) Bell Alarm

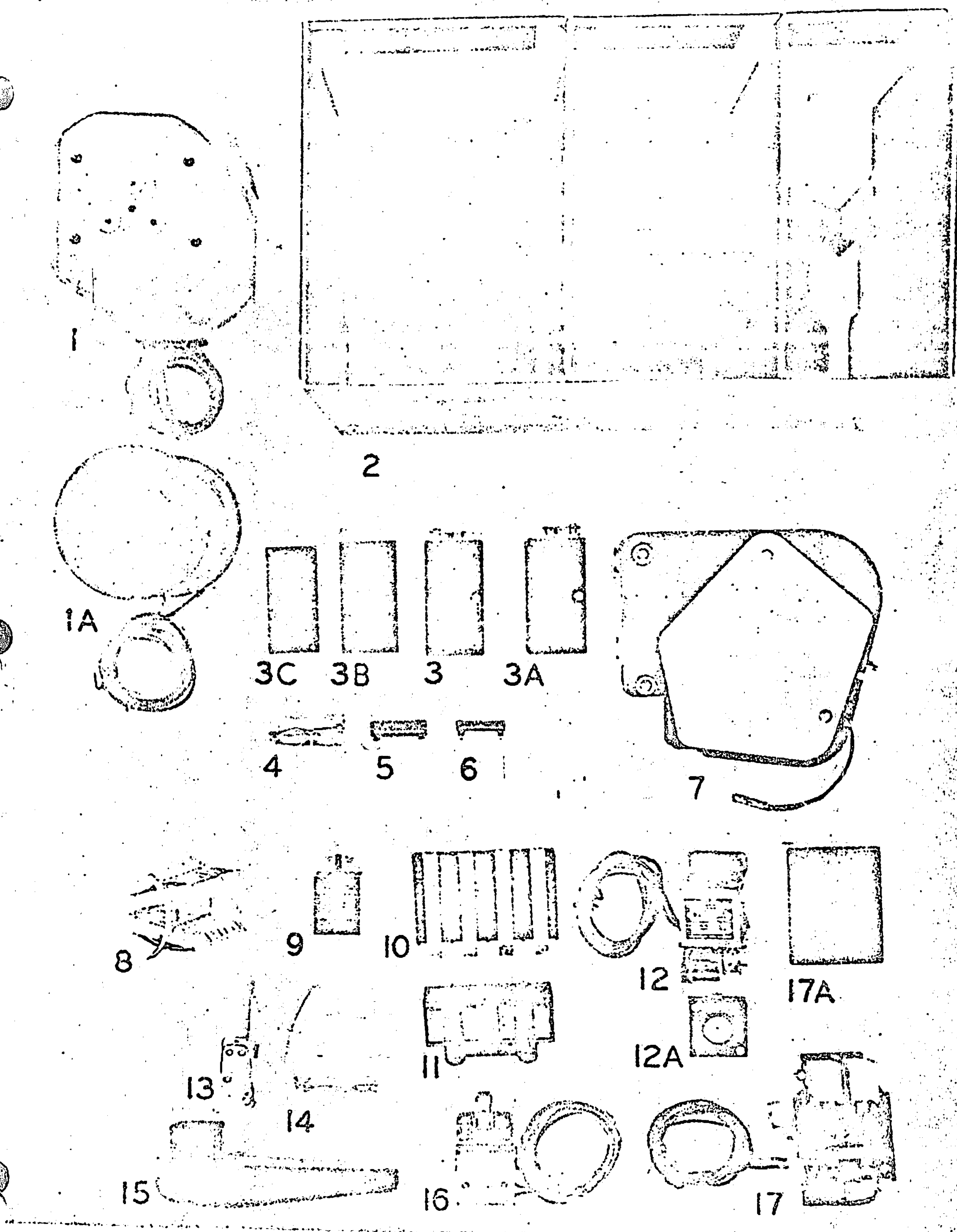
(a) Trip breaker manually. Bell alarm should not operate.
(b) Trip breaker with shunt trip or undervoltage, if supplied on breaker. Bell alarm should not operate.
(c) Trip breaker with overcurrent trip lever. Bell alarm will operate.

TABLE 1

Coil Rating	90% Pickup No Trip	110% Pickup Trip Within Three (3) Minutes	Coil Rating	90% Pickup No Trip	110% Pickup Trip Within Three (3) Minutes
200	144.	176	500	360	140
225	172	198	600	432	528
250	180	220	800	575	704
300	216	264	1000	720	880
350	252	308	1200	900	1050
400	288	352	1600	1150	1408



(Figure 1)



(Figure 2)

In ordering any items on this list the Serial Number of the circuit breaker *must* be given.

RECOMMENDED SPARE PARTS FOR DMB 50-T BREAKERS
(Basic breaker drawing 1153-0985 – see illustrations)
DMB 50 Electrically Operated, 1600 Amp. Drawout
See Figure 2

1-1A	– Solenoid Coil 125V DC	1105-0581
2	– Barrier Assembly	1151-0746
3	– Bottom Auxiliary Switch	1152-0773
3A	– Upper Auxiliary Switch	1151-0774
3B	– Auxiliary Switch Front Cover	1151-0773
3C	– Auxiliary Switch Rear Cover	2701-0111
4	– Breaker Grounding Contact	1101-0499
5	– 5 ohm Resistor	
6	– 400 ohm Resistor	
7	– Arc Chute with Braid (6 per breaker)	1151-0779
8	– Drawout Finger Assembly (14 fingers)	1151-0632
9	– Bell alarm switch (N.O.)	039-003
	Bell alarm switch (N.C.)	039-004
10	– 4-Point Secondary Contacts (cell)	2751-0068
11	– 4-Point Secondary Contacts (breaker)	1151-0631
12	– Undervoltage 115V AC instantaneous	1151-0777
	Undervoltage 230V AC instantaneous	1152-0777
	Undervoltage 125V DC instantaneous	1153-0777
	Undervoltage 250V DC instantaneous	1154-0777
	Undervoltage 115V AC with time delay	1155-0777
	Undervoltage 230V AC with time delay	1156-0777
	Undervoltage 125V DC with time delay	1156-0777
	Undervoltage 250V DC with time delay	1158-0777
	Undervoltage 460V AC instantaneous or time delay	SPECIAL
13	– Arcing Tip (Movable) (6 per breaker)	1151-0715
14	– Arcing Horn (Stat.) (6 per breaker)	1101-0515
15	– Handle	1101-0580
16	– Shunt trip 48V DC or 115V AC	1151-0758
	Shunt trip 125V DC or 230V AC	1152-0758
	Shunt trip 250V DC or 460V AC	1153-0758
17	– Control Relay 125V DC	1152-0791
	Control Relay 250V DC	1154-0791
	Control Relay 115V DC	1155-0791
	Control Relay 230V AC	1156-0791
	Control Relay 460V AC	1157-0791
	Control Relay Coil Only 125V DC	1151-0581
	Control Relay Coil Only 240V AC	1158-0581
17A	– Control Relay Cover	1101-0592

RENEWAL PARTS FOR DMB 50-T

NOTE: When ordering renewal parts give type of breaker and serial number whown on nameplate of breaker.
**Recommended Spare Parts, See Page 7

ITEM	DESCRIPTION	PART NUMBER
** 1	Handle	1101-0580
2	Handle Lock Assembly	1151-0635
3	Spring	1102-0162
4	Lockplate	1101-0161
5	Handle Tag	1101-0176
6	Nameplate	1103-0564
7	Face Plate Assembly	1151-0747
8	Cast Face Plate Assembly	1151-0708
9	Face Plate	1101-0572
10	"ON" Indicator	1101-0139
11	"OFF" Indicator	1101-0140
12	Pin	1101-0174
13	Auxiliary Switch Lever Adjustable Shunt	1101-0142
14	Indicator Pusher	1101-0138
15	Pin	1101-0143
16	Hair Pin	1101-0151
17	Auxiliary Shaft Support	1101-0144
18	Plain Cycle Bearing	1101-0136
19	Drawback Spring	1101-0137
20	Pin	1101-0172
21	Screw	1101-0127
22	Reset Coupling Tube	1101-0529
23	Coupling Crank Assembly	1151-0614
24	Bearing Thrust Type	1101-0128
25	Auxiliary Switch Lever Adjustable Long	1101-0141
26	Nut	1101-0129
27	Pin 7 & 16	1101-0130
28	Rod	1101-0131
29	Bell Crank Assembly	1151-0710
30	Spring	1101-0152
31	Shaft Drill Detail	1151-0785
32	Short Shaft Assembly	1152-0785
33	Stop	1101-0145
34	Ramp Assembly	1151-0722
35	Crank	1101-0525
36	Crank Assembly	1151-0633
37	Adjustable Female Link	1101-0123
38	Adjustable Male Link End	1101-0124
39	Mark "Q" Assembly Note	065-004
40	Low Pin Turn Buckle	1101-1195

RENEWAL PARTS FOR DMB 50-T (Continued)

ITEM	DESCRIPTION	PART NUMBER
41	Up Pin Turn Buckle	1101-1195
42	Pivot Pin	1101-0157
43	Spring	1101-0150
44	Spring	1101-0155
45	Auxiliary Trip Lever	1101-0149
46	Flanged Bearing	1101-0156
47	Ball Bearing	1101-0153
48	Cover	1101-0154
49	Stop	1101-0148
50	Bar Support	1101-0132
51	Clamp	1101-0111
52	Trip Bar and Insulation	1151-0720
53	Trip Lever	1101-0109
54	Truss Head Screw	1101-0110
55	Trip Bar Bearing	1101-0134
56	Crank	1101-0147
57	Clamp	1101-0146
58	Clamp	1101-1062
59	Lower Stud	1101-0579
60	Leading Insulator	1101-0578
61	Insulator	1101-0526
** 62	Snuffer Assembly	1151-0779
** 63	Barrier Assembly	1151-0746
64	Frame Assembly	1151-0783
65	Insulating Barrier	1101-0516
** 66	Arcing Horn	1101-0515
67	Clamp	1101-0514
68	Contact Fix Shaft Assembly	1151-0627
69	Upper Terminal Brazing Assembly	1151-0751
70	Low Contact Brazing Assembly	1151-0717
71	Contact Guide	1101-0518
72	Clamp	1101-0517
73	Contact Fix Shaft	1151-0627
74	Insulating Barrier	1101-0516
75	Lever	1101-0522
76	Removable Contact Braze Assembly	1151-0626
77	Flexible Connector	1151-0716
** 78	Movable Arcing Contact Assembly	1151-0715
79	Spring	1101-0084
80	Cup for Spring	1101-0085
81	Eye Bolt	1101-0086
82	Pivot Pin	1101-0087
83	Pivot Pin for Movable Arcing Contact	1101-0088
84	Movable Contact Shunt Brazing	1151-0625

RENEWAL PARTS FOR DMB 50-T (Continued)

ITEM	DESCRIPTION	PART NUMBER
85	Braid Assembly Shunt	
86	Pivot Pin	1151-0624
87	Special Screw	1101-0088
88	Pivot	1101-0104
89	Spring	1101-0101
90	Contact Arm Holder	1101-0100
91	Nut for Spring Adjustable	1151-0719
92	Contact Guide Pin	1101-0103
93	Washer	1101-0530
94	Arc Chamber Bracket	1101-0175
95	Main Shaft Assembly	1151-0750
96	Spacer	1151-0718
97	Connector	1101-0135
98	Filler DMB 50 Arc Chamber	1101-0527
99	Cover	1101-0531
100	Washer	1101-0532
101	Trip Lever	1101-0171
102	Latch Assembly	1101-0829
103	Plate Assembly	1151-0701
104	Spring	1151-0702
105	Hinge Plywood Assembly	1101-0492
106	Arm Assembly	024-014
107	Bolt	1151-9207
108	Switchette Cat. CR-1070A-102E G.E. Co.	1101-9210
109	Carriage Plate Assembly	
110	Rear Roll & Stud	1151-0745
111	Retaining Ring	1151-0612
112	Lever Base Spring	1101-0018
113	Front Roller	1101-0019
114	Carriage Lever Arm	1101-0020
115	Washer	1101-0021
116	Lever Base Assembly	1101-0465
117	Pair of Hinge Pin Support	1151-0697
118	Front Roller Shaft	1101-0022
**119	Main Stab Plug In Switch	1101-0023
120	KL Klip Main Stab	1101-0499
121	Trip Lever Stop Assembly	1101-0504
122	Brace	1151-0711
123	Trip Bar Assembly	1101-0507
124	Screw (Trip Bar Pivot)	1151-0713
125	Pivot Screw (Trip Bar Stop)	1101-0055
126	Washer (Lock Pin)	1101-0056
127	Spring Trip Lever Stop	1101-0057
128	Washer	102-0[illegible]
		1101-0059

RENEWAL PARTS FOR DMB 50-T (Continued)

ITEM	DESCRIPTION	PART NUMBER
129	Lock Pin	1101-0061
130	Spring	1101-0062
131	Lock Pin	1101-0063
132	Pin Support for Spring	1101-0065
133	Spring	1101-0093
**134	Basket Assembly	1151-0632
135	Basket Washer	1101-0173
136	Shouldered Screw	1101-0193
137	Spring	1101-0192

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GENERAL OFFICES: 50 PARIS STREET, NEWARK 1, NEW JERSEY

FPE

INSTRUCTION MANUAL

TYPE DST-2 5KV & 15KV MAGNETIC AIR CIRCUIT BREAKER IN-820.11 DATED APRIL, 1972

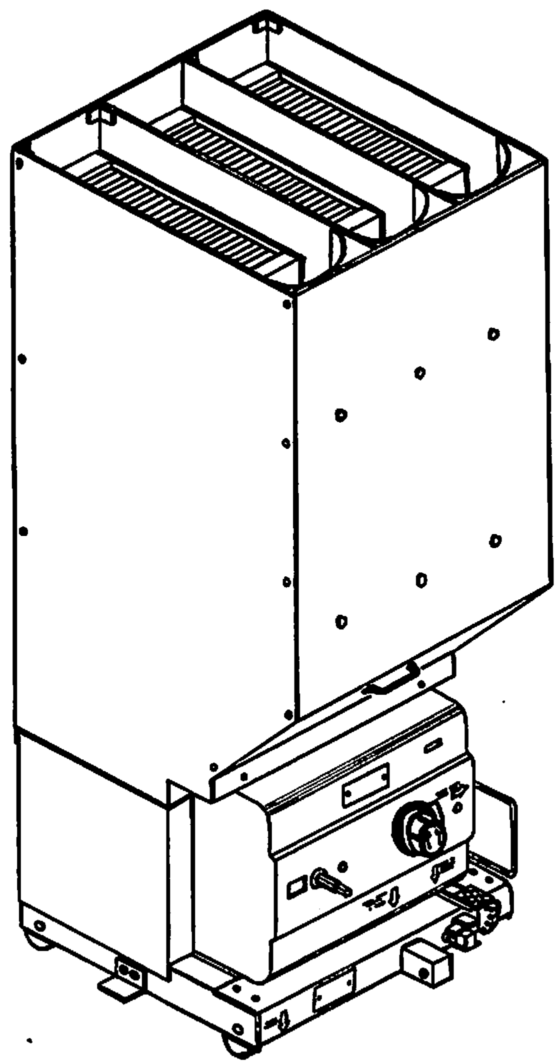

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TABLE OF CONTENTS

Refer to IN-820.4A for metal-clad switchgear installation, operation and maintenance instructions.

PART I — General Information

1 INTRODUCTION

1.1 FOREWORD

Federal Pacific Electric Company apparatus is built to the highest standard of quality to insure continuous reliable service with a minimum of maintenance. Some routine preventative maintenance is, however, required on semi-annual or annual basis in accordance with the various uses of the product. It is suggested that, due to the precision craftsmanship involved in the construction of this apparatus, no attempts (with the exception of few minor adjustments) should be made by the customer to fix or adjust clearances.

Should the need occur, the Field Service Department of the Power Equipment Systems Division of Federal Pacific Electric Company is equipped to assist you with any maintenance or repair which may be required throughout the anticipated long life of this equipment.

FPE "On-Site Test Facilities" are available to you. This service includes engineering inspection and testing of electrical equipment planned to supplement your regular maintenance program, to improve equipment reliability and to protect your investment. Such services, for Metal Enclosed, Metal Clad Switchgear, and other type Electrical Apparatus are as follows:

(a) Cleaning of cells with low pressure air or vacuum.

(b) Inspection of cell bushings, cable connections and bus joint connections.

(c) General inspection of control wiring and components.

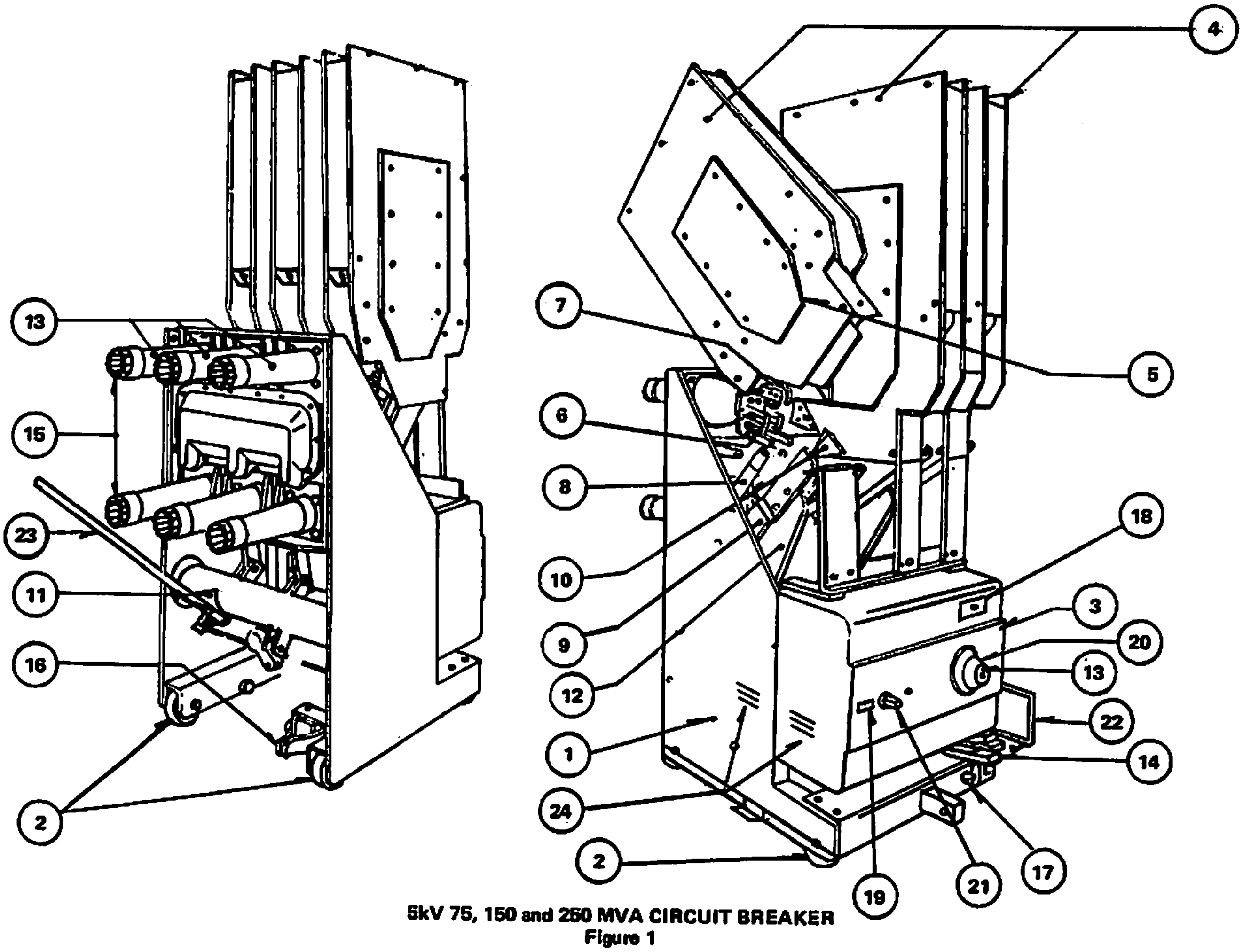
(d) 2500 Volt DC Megger Tests and DC Hi-pot Tests for Insulation Reliability.

(e) Protective Relay Calibration Tests for Response and Time Delay.

(f) 5KV and 15KV circuit breaker electrical and mechanical operating checks coordinated with relay response.

(g) Transformer oil or askarel dielectric Hi-pot Tests (also on minimum oil breakers and tank type oil breakers).

For further information regarding service, please contact the Manager of Field Service Department at Newark, New Jersey.



5kV 75, 150 and 250 MVA CIRCUIT BREAKER
Figure 1

1.2 GENERAL DESCRIPTION *(Figure 1)*

The DST-2 Magnetic Air Circuit Breaker is electrically operated, horizontal drawout for use in indoor and outdoor metal-clad switchgear.

It is designed for international application and service; therefore, the dimensional data is given in both the metric and English systems. The hardware is based on the metric system.

It is composed of three separate poles supported by a welded steel frame (1) and provided with wheels (2) so it can be easily moved in and out of its cell.

Each pole consists of two separate parts:

(a) Arc-chute (4) – is a chamber filled with ceramic baffles. It has a magnetic structure that forces the arc into constrictions provided by the baffling. The magnetic field is generated by coils (5) within the arc chute. Cooling and elongation of the arc within the baffle structure forces quick extinction of the arc.

(b) Contact unit – is made up of the main contacts, fixed (6) and moving (9) and the arcing contacts, fixed (7) and moving (10).

The main contacts, of silver plated copper, carry the normal service current. They are not affected by the interruption since they open before the arcing contacts separate.

The fixed and moving arcing contacts are made with tungsten-copper arc resistant inlays and are capable of interrupting high short circuit current without damage.

The puffer nozzles (8) are located under the fixed contacts.

The moving contact group is operated by the shaft (11), through insulated links (12). The metal frame is grounded through the ground contacts (16).

A welded sheet steel front barrier is grounded thus assuring safety to operating personnel. The contact structures are separated by insulated interphase barriers.

The breaker can be either manually operated by means of a knob (13) or remotely operated.

The motor charged spring closing mechanism (3) is especially designed for medium voltage circuit breakers. It is completely enclosed for safety and dirt exclusion.

1.3 CONSTRUCTION

The DST-2 is a drawout type breaker. It is built to allow ease of maintenance and operation. The breaker is available complete with cell or for insertion into a metal-clad breaker cell. The breaker can be positioned as follows:

1. "Connected" position – where primary and secondary disconnects are automatically connected.
2. "Test" position ("Isolated" position) – where primary disconnects are disconnected and secondary disconnects can be manually connected or disconnected.
3. Removed from the cell by operating the "racking in" lever. It is provided with a pedal operated interlocking device (14).

The circuit breaker is fitted with spring loaded, self aligning primary disconnects which engage the stationary studs mounted in insulating bushings in the cell (15).

When the breaker is in "Test Position" or drawn out of the cell, the cell shutter, operated by racking action of the breaker, covers the live parts providing protection to personnel.

1.4 DST-2 FEATURES *(Fig. 1 unless otherwise noted)*

All breakers are equipped with the following parts and provisions.

(1) Arc-chutes (4)
(2) Barrier (1, Fig. 2)
(3) 5 Unit auxiliary switch with 2"a" and 2"b" extra contacts (1, Fig. 5). Other types available upon request.
(4) Lockout switch. (Blocks closing and motor circuits) (17)
(5) Latch check switch (2, Fig. 5)
(6) Mechanical operation counter (counts trip operations) (18)
(7) "Y" relay (5, Fig. 5)
(8) TC trip solenoid and 52X close solenoid (3, Fig. 5)
(9) Charging motor (4, Fig. 5)
(10) Mechanical indication of "Charged" and "Discharged"
(11) Mechanical indication of "Open" and "Closed" (20)
(12) Mechanical indication of "Charged" and "Discharged" (19)
(13) Mechanical drawout interlock (prevents movement of breaker in or out of cell with contacts closed) (14)
(14) Mechanical interlock discharges closing spring when inserting or removing breaker from cell.
(15) Padlock provision. (Lock breaker tripped with pedal down or lock to prevent racking in or out with pedal up. (14)
(16) Provision for manual charging of springs (21)
(17) Manual trip – close control knob (13)
(18) Automatic Secondary contacts in "Connected" position (22)
(19) Manually operated secondary contacts in "Test" position.
(20) Mechanism is mechanically and electrically trip free.

2 SHIPPING

All circuit breakers are assembled and tested for optimum performance in the factory before shipment. The 5kV 250 MVA circuit breaker is shipped completely assembled in one crate. The 5kV 350 MVA and 15kV circuit breakers are shipped in two crates. The basic circuit breaker on its truck with interphase barrier is in one crate. The three arc chutes are packed in a second crate.

The serial number of each circuit breaker is on its nameplate. It is also stenciled on both breaker frame and operating mechanism frame as indicated in (24, Fig. 1). The crates are marked with the factory order number.

A copy of the packing list, enclosed in a waterproof envelope is nailed on the outside of the circuit breaker crate. Only one envelope is furnished with orders for more than one circuit breaker shipped to a single destination.

Each circuit breaker, in its crate, is enclosed in a polyethylene dust-and-moisture-proof bag.

3 INSPECTION UPON RECEIPT OF SHIPMENT

When a shipment of circuit breakers is received, each crate should be examined before it is removed from the railroad car or truck. If any damage or indication of rough handling is evident, a description of the condition should be written on the freight bill, a claim should be filed against the carrier immediately, and notice of the extent of damage sent without delay to Federal Pacific Electric Co. at the address from which shipment was made, giving serial number of the breaker, the carrier's name, and the car number if shipped by rail. This information enables the company to supply needed information to assist the purchaser in support of the claim. (See 6.1.1)

4 STORAGE PRIOR TO INSTALLATION

A breaker can be safely stored provided that the following instructions are observed:

(a) Handle the breaker with the utmost care, lift circuit breaker less arc chutes using a hoist or similar means and attach the sling hooks to the holes on the sides of the breaker. The 5 and 15kV circuit breakers with arc chutes are lifted by fitting the sling under the wheel channels and securing top to prevent tipping.

(b) Upon receipt of the breaker an inspection should be made. The circuit breaker should be stored, "Opened" and "Discharged", in its original shipping container. The 15kV and 5kV 350 arc chutes should be stored in the original shipping crate.

(c) Keep the breakers in a dry place, protected against dust and chemical agents, preferably in cells with cell or auxiliary heaters energized.

5 INSTALLATION

5.1 PRELIMINARY OPERATIONS

Before setting a breaker into operation, the following operations should be carried out:

(a) Carefully clean all parts of the breaker with a dry cloth.

(b) Check the condition of contacts and terminals. The main contacts are coated with a thin layer of contact lubricant. If the main contacts are dirty they should be cleaned with acetone and sparingly relubricated with FPE #1551 A 5853 contact grease. The terminals and arcing contacts should be cleaned with acetone. The three moving arcing contacts must close and open simultaneously. See section 6.1.3, Page 7 for adjustment specification.

Tighten all the parts listed in Appendix 8 under "Maintenance to be carried out."

5.2 SAFETY PRECAUTIONS

The following checks should be made before putting a breaker into service.

(a) Check the alignment between the ground contact (16, Fig. 1) and the grounding blade located on the cell floor.

(b) Insure that the arc chutes are properly connected.

(c) Check the main and secondary electrical connections.

(d) Never rack the breaker into the "Operate" position without the arc chutes and interphase barriers properly installed.

5.3 MECHANICAL CHECKING

Each circuit breaker is carefully inspected and operated at the plant before shipment; yet it is advisable to carry out some closing and opening operations before putting a breaker into service. For detailed inspection remove arc chutes and interphase barriers and follow the instructions for "Manual Checking of Operating Mechanism" (Section 5.6).

5.4 INSTALLATION

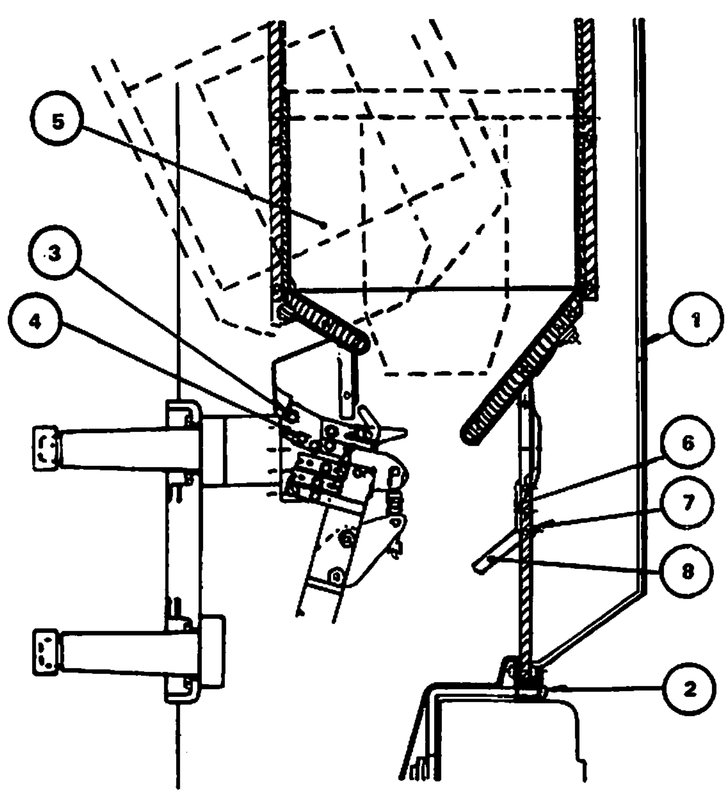
5.4.1 Lifting

Lifting is to be done as described in Section 4 (a). Handle the breaker with the utmost care, lift it using a hoist or similar means. Inspect for breakage. (See 6.1.1)

5.4.2 Arc chute Fitting (Fig. 2)

5kV 350 and 15kV Arc Chute Mounting

Arc chutes are shipped separately from circuit breaker and must be mounted before installation. Arc chute return connection and arc chute must be positioned as follows:



5kV 75, 150 AND 250 MVA
Figure 2a

It is imperative that arc chute return connection is securely against arc chute support plate. Check that both nuts are tight affording a good electrical connection.

Before fitting the arc chutes on the 15kV circuit breaker or 5kV 350, make sure there is no foreign matter inside them. Then:

(a) Remove screws (2) and remove the interphase barrier (1).

(b) Lift arc chute with lifting yoke (Page 18) and fit the conductor pin (3) into saddles (4). Arc chute lifting station is provided in aisle units.

(c) Rotate the arc chute downwards until plates (6) are fitted to stud (7).

(d) Fix the arc chute by means of nuts on studs (7), making sure that the connector (8) is assembled outside of the plates (6). See Fig. 2b and 2c.

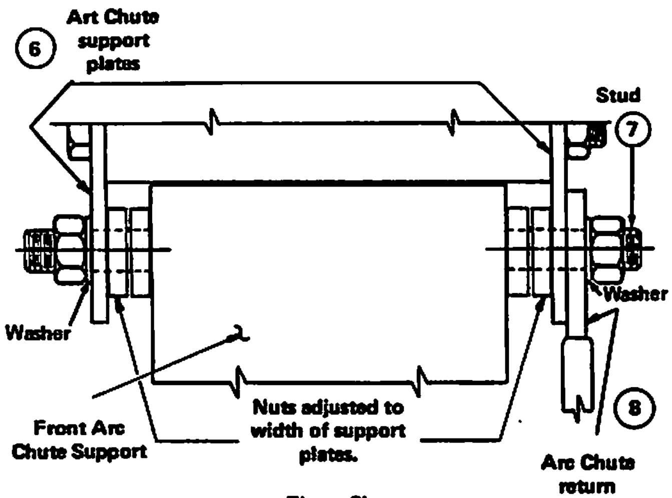


Figure 2b

5kV, 75, 150 and 250 Arc Chute Mounting

Arc chutes are shipped already assembled to circuit breaker. In the event of arc chute removal, the arc chute return connection and arc chute must be positioned as follows:

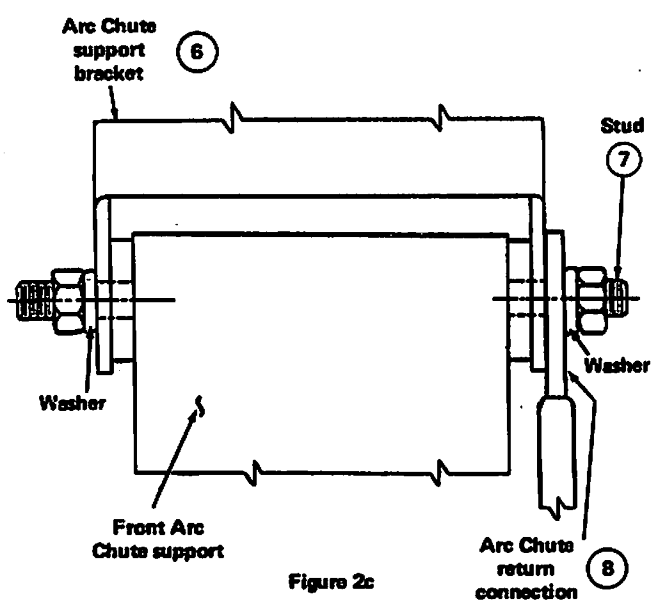


Figure 2c

It is imperative that the arc chute return connection is securely against arc chute support bracket. Check that both nuts are tight affording a good electrical connection.

5.5 RACKING OPERATIONS (Fig. 3a, 3b, 3c)

(a) Roll the breaker on the rails using handling dolly and check that it moves freely.

(b) Move the breaker to the "Test" position using the racking lever, as shown in Figure 3a. Shift lever back and forth until you hear the clicking sound of the lock engaging the interlock rail. Lockout switch, (3), must be reset if operating circuit breaker in "Test" position is desired.

(c) To continue racking, repeat the preceding operations after releasing the interlock bar (1) by pressing the pedal (2). Trip the circuit breaker before pressing the interlock pedal. Reset the lockout switch each time after pressing interlock pedal to permit electrical operation.

(d) To rack the breaker out; place the lever as shown in Fig. 3b and perform the same operations as above.

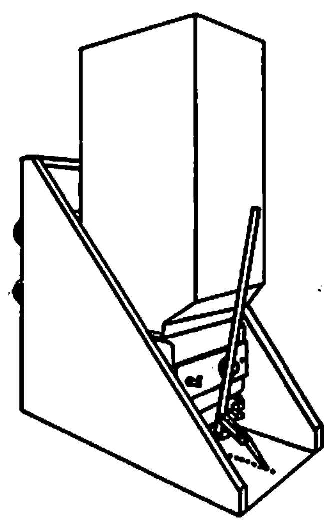


Figure 3a

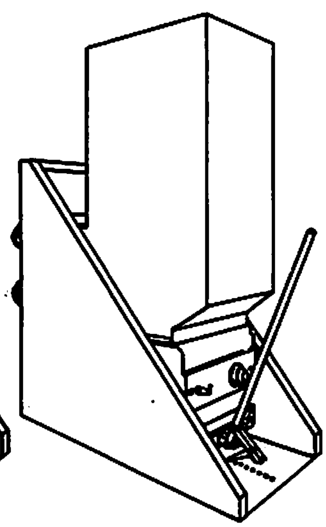


Figure 3b

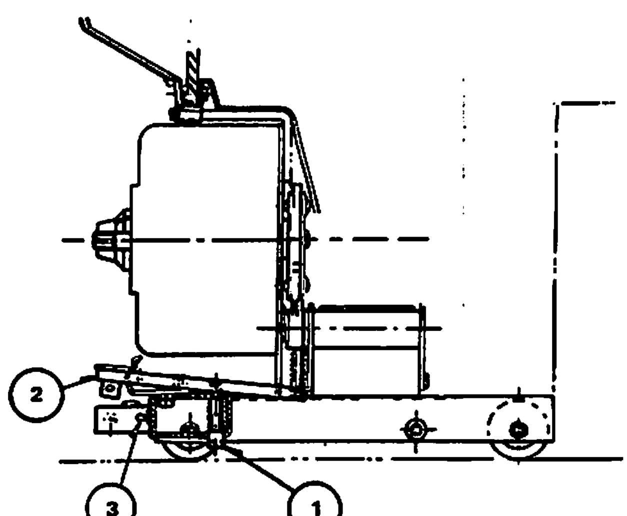


Figure 3c

5.6 MANUAL CHECKING OF OPERATING MECHANISM (Circuit Breaker Out of Cell)

Charge the closing springs by means of manual charging handle, then close and trip the breaker manually. Check mechanical operation of the mechanism. The breaker should operate smoothly and freely without any indication of binding.

Check that the control voltage agrees with the breaker nameplate and is within the limits specified in Appendix 10.

It is suggested that several mechanical closing and opening operations be performed.

5.7 CHECKING ELECTRICAL OPERATION OF MECHANISM

The circuit breaker may be electrically operated safely in the cell in the "Test" position. Move the breaker in the cell until the interlock bar drops into the first notch. This is the "Test" position. The shutter should remain down isolating the breaker from the high voltage bus. The secondary circuit is completed by manually pushing the secondary contact operating handle (right side of breaker frame) all the way in (22, Fig. 1). Reset the lockout switch (17, Fig. 1) by lifting the toggle handle. Close and trip the breaker several times from the control switch. After each closing operation the motor will recharge the closing springs.

PART II — General Maintenance

6.1 PERIODIC INSPECTION

A schedule for maintenance of a breaker in service is included in Appendix No. 8. In addition to the listed operation it is recommended to carefully clean the breaker at least every six months.

The contacts and arc chutes should be frequently and carefully inspected, as instructed in 6.1.1 – 6.1.5, if the breaker has been subjected to frequent operations on short circuits or overload.

The breaker, and in particular the operating mechanism, should be frequently inspected if the breaker has been subjected to dust or corrosive industrial atmospheres.

6.1.1 Arc Chute Inspection *(Figure 2)*

Draw the breaker out, remove the safety barrier (1) as instructed in 5.4.2, loosen the nuts of studs (7), rotate the arc chutes approximately 45° backward one at a time by rotating around pins (3) then check the conditions of the arc chute plates.

If any breakages or flaws on arc chutes or ceramic plates or burning on blow-out coils are found, it is advisable to replace the arc chute. Replacement arc chutes may be ordered direct from the factory, by contacting Switchgear Marketing, Newark, New Jersey.

6.1.2 Arcing Contact Inspection

Draw the breaker out, remove the interphase barrier and arc chutes.

The arcing contacts should be reasonably clean, without pits and deformations. Small pits can be filed without modifying the shape of the contacts. In normal use, when currents of approximately the rated value are being interrupted, the arcing contacts might be slightly worn; replacement, however, is unnecessary.

In more severe service when appreciable wear is noticed, the arcing contacts should be replaced as described in 6.1.3.

Appendix No. 8 indicates the maximum number of operations the breaker should be expected to perform without replacement of the contacts.

6.1.3 Replacement and Adjusting of Arcing Contact *(Figure 4)*

Draw the breaker out, remove the interphase barrier and arc chutes (Fig. 2). Replace the arcing contacts as follows:

(a) Open the breaker and discharge the closing springs.

(b) 5kV 250, 350 and 15kV 750 MVA – Remove nut from contact pivot pin and remove pin. Remove spring pin retainer and spring pin. Remove 2 shunt screws and remove moving arcing contact. Install new contact in reverse procedure.

15kV 500 – Remove 3 studs securing moving arcing contact to the blades. Install new contact making certain that nuts are securely tightened.

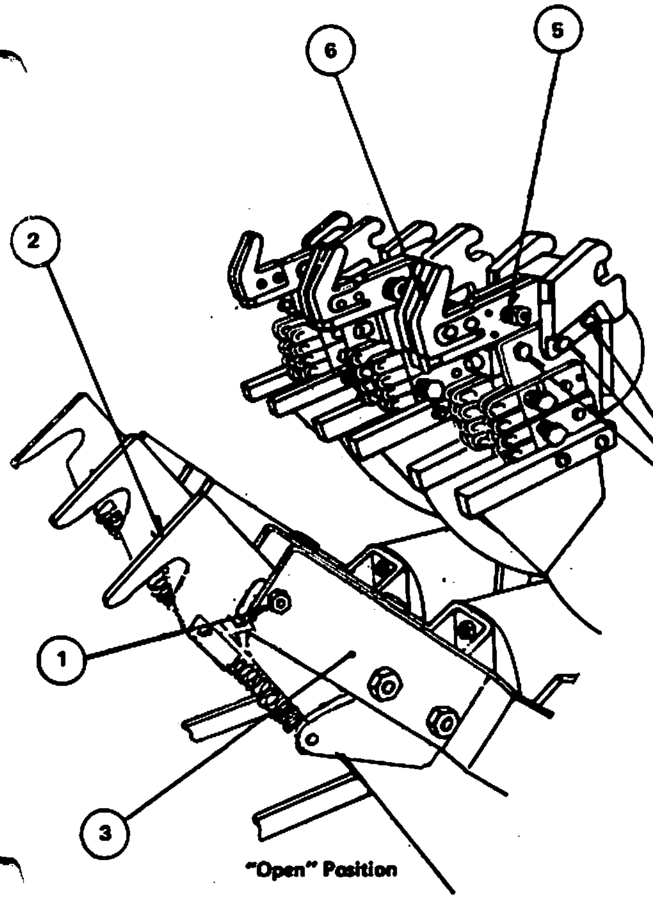
(c) Remove stationary arcing contact springs (5) (Fig. 4b and 4c) by removing adjusting nuts and stud. Remove upper shunt screw. Remove arcing contact assembly, remount shunt onto new arcing contacts and install in reverse procedure.

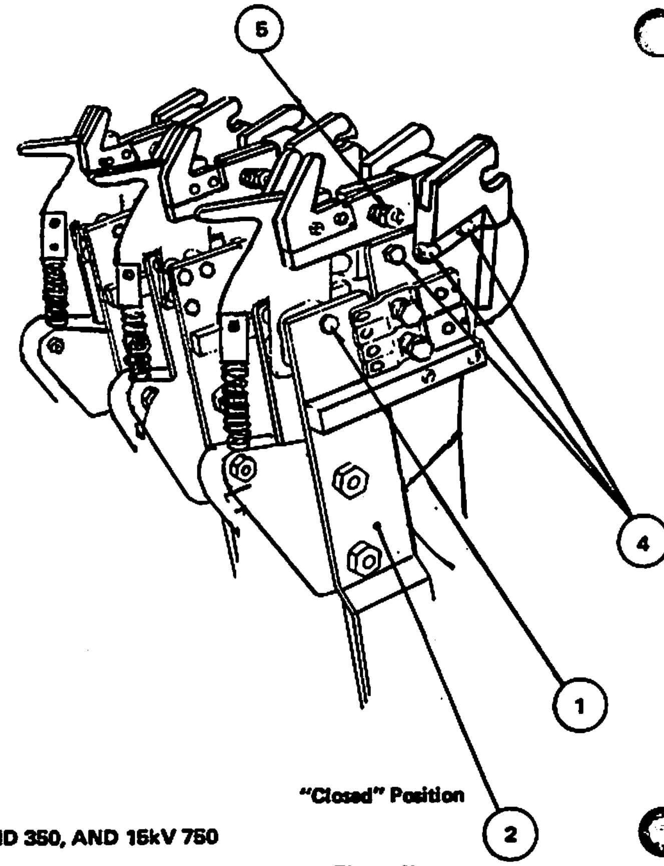
(d) Adjust the moving arcing contact, making sure that all 3 poles close simultaneously and fixed to moving main contact gap as arcing contacts touch: 5kV 250 = 8 ± 1mm (.32 ± .04 in.); 5kV 350 = 4 ± 1mm (.160 ± .04 in.); 15 kV = 11 $^{+2}_{-1}$ mm (.44 $^{+.08}_{-.04}$ in.). Contacts may be slowly closed using the maintenance bar (23, Fig. 1) for the 5kV breaker, and "Maintenance Close Device" (Page 19) for the 15kV breaker.

(e) Close the breaker (Fig. 4c) and adjust the length of springs (5) to 11mm (.44 inch) for 15kV 500 and 14.5mm (.57 inch) for other ratings.

(f) Open and close the breaker several times to check mechanical operation.

(g) Remount the arc chutes and the interphase barrier as instructed in 5.4.2.





5kV 75, 150, 250 AND 350, AND 15kV 750

Figure 4a

Figure 4b

6.1.4 Main Contact Inspection

Draw the breaker out, remove the interphase barrier, and tilt the arc chute back approximately 45° one at a time. Inspect the main contacts making sure they are in good condition and see that the face of the contact is coated lightly with FPE #1551 A 5853 Contact Lubricant. Use only minute quantity. Since these contacts do not break any current they should not be pitted or burnt.

(See Appendix 8 for the number of operations the main contact can withstand before replacement is necessary.)

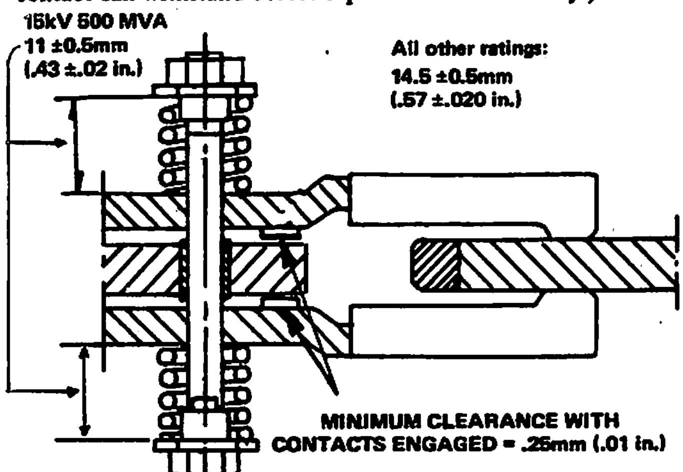
6.1.5 Main Contact Replacing

Draw the breaker out, remove the interphase barrier and arc chutes. Replace the main contacts as follows: (Fig. 4d)

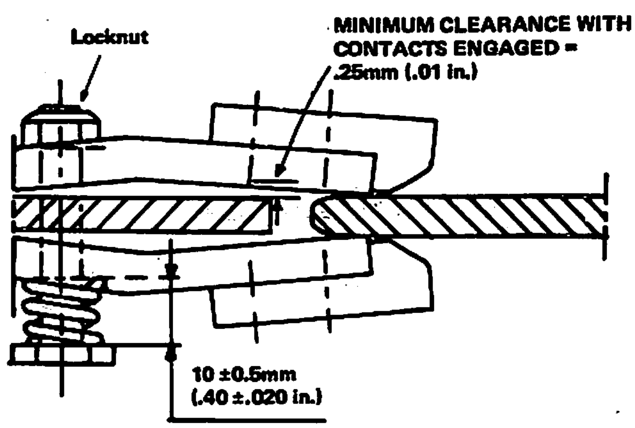
(a) Open the breaker and discharge the closing springs.

(b) Remove the spring by unscrewing the locknut and removing the adjusting screw. Remove main contact. Install new contacts in reverse procedure. NOTE: New self locking nut should be used.

(c) Adjust the main contact springs so that the length is 10 ±.2mm (.40 ±.008 in.) when the contacts are closed.



ARCING CONTACTS
Figure 4c



MAIN CONTACTS
Figure 4d

To check contact alignment, use maintenance close handles (see Accessories Section).

Primary Disconnect Inspection
Check primary disconnect fingers to assure that they are positioned in a circle, not bent, and clean of residue.

Secondary Disconnect Inspection
Check molded contact assembly and moving carriage assembly to assure they they are not damaged and that the contact pins are not bent.

6.2 OPERATING MECHANISM MAINTENANCE
(Figure 9a and 9b)

The operating mechanism is supplied thoroughly lubricated and does not need any special care during its lifetime. It is, however, advisable to clean it carefully after every 2000 operations or once a year, whichever comes first.

The cleaning should be done by means of a paint brush drenched with acetone or other similar solvent with the breaker "Open" and springs "Discharged".

The links, levers, pins and chain drive mechanism should be lubricated with good quality light grease SAE Grade 1.

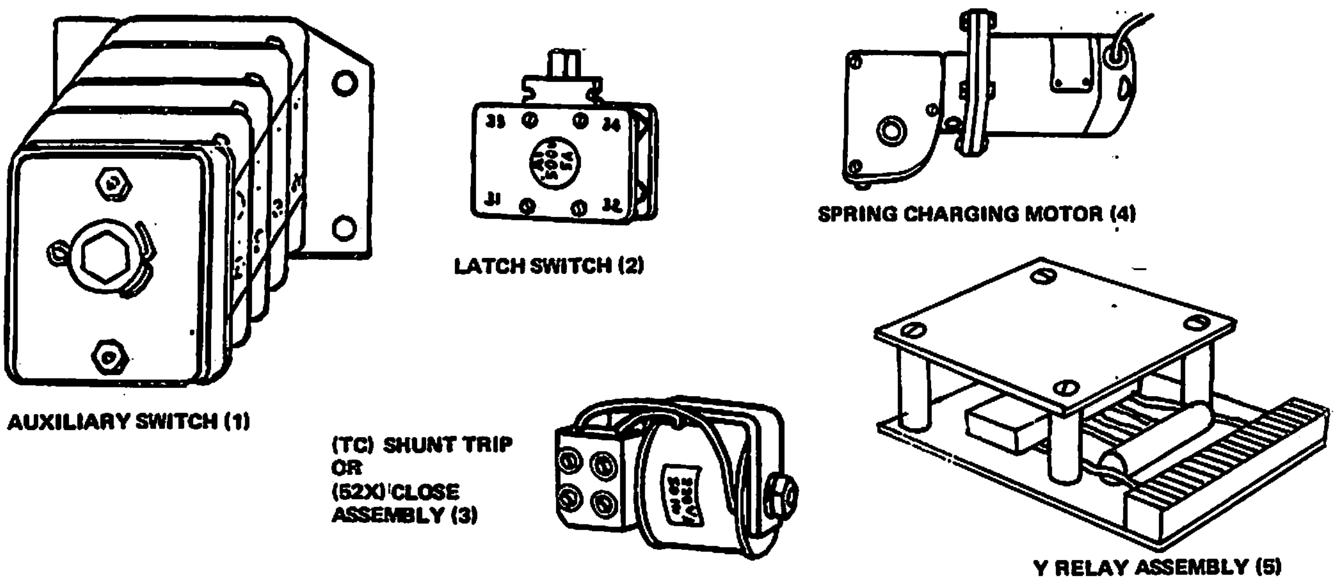


Figure 5

PART III — Detailed Maintenance Procedure

7 OPERATING MECHANISM (TYPE "AEM")

7.1 CHARACTERISTICS

The closing springs of the operating mechanism are charged by the motor. The spring charging time is approximately 10 seconds.

The mechanism performs the following cycles:

(a) Starting with the breaker open and springs charged:
CO ⟶ TC ⟶ CO ⟶ TC ⟶ CO
Where: CO is a "Close-Open" operation
TC is the Spring charging time

(b) Starting with the breaker closed and springs charged:
O ⟶ t ⟶ CO ⟶ TC ⟶ CO
Where: O is an "Open" operation
t is the reset time

7.2 PRINCIPLES OF OPERATION

The operating positions of the mechanism are described and shown in the following pages.

7.2.1 Breaker Open—Closing Springs (1) Discharged
(Figure 6a)

The breaker is in this position after each "Close-Open" cycle before recharging. This is a transient position.

7.2.2 Breaker Open — Closing Springs (1) Charged
(Figure 6b)

This is the usual operating position of the open breaker. The springs can be charged as follows: (Fig. 6a).

(a) Manual Charging.
Turn the shaft (3) half a turn clockwise using the crank (2). This corresponds to complete charging of the springs. When the shaft (3) is rotated, it drives the shaft (5) by means of the chain (4). The shaft, being connected to lever (6) through connecting rod (7) and crank, (8) causes, in its turn, the charging of the springs.

BREAKER OPEN: CLOSING SPRINGS DISCHARGED

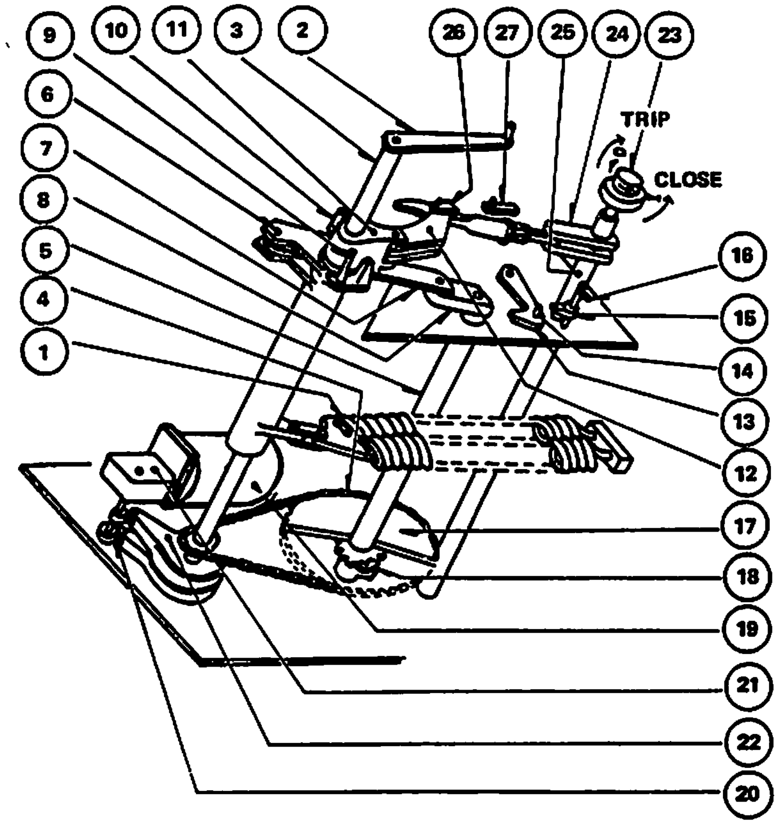


Figure 6a

BREAKER OPEN: CLOSING SPRINGS CHARGED

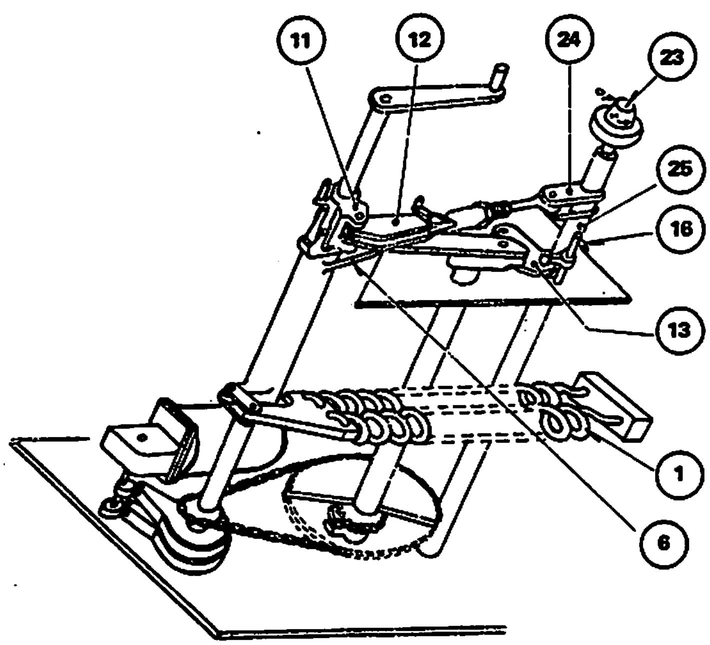


Figure 6b

BREAKER CLOSED: CLOSING SPRINGS CHARGED

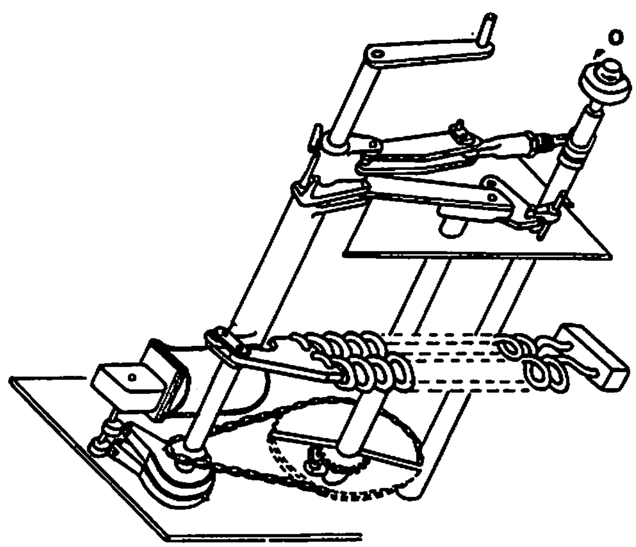


Figure 6d

BREAKER CLOSED: CLOSING SPRINGS DISCHARGED

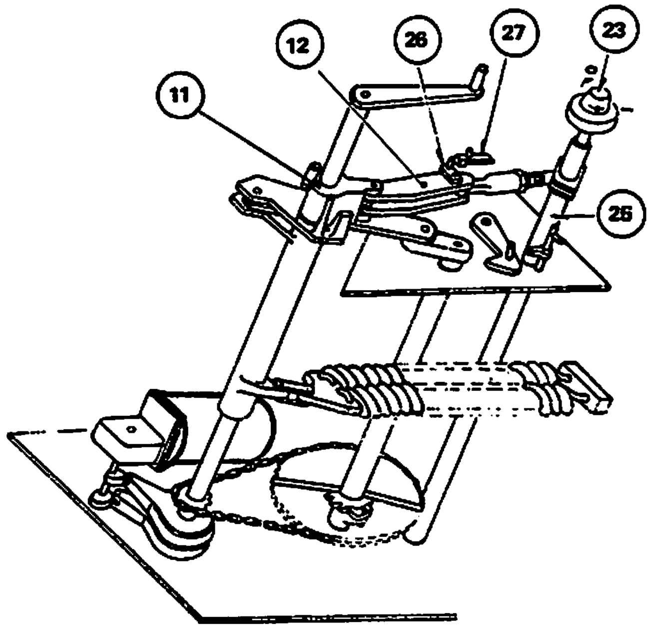


Figure 6c

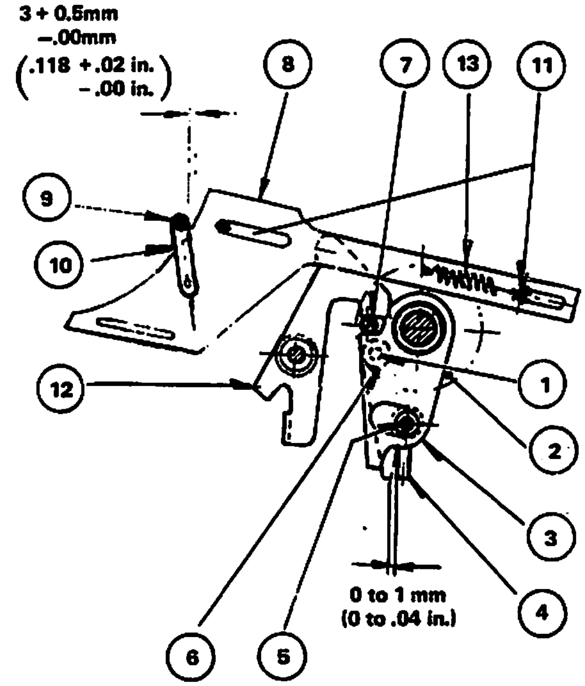


Figure 7

At the end of this motion the trip latch assumes the latch position.

When fully charged, the primary closing latch (13) is held fixed by the secondary closing latch (15) on shaft (16) by means of bearing (14) assuring the springs are kept charged. The sprocket wheel (17) is then free from ratchet (18) and idles. The breaker will not close if springs (1) are not completely charged.

Although the spring charging can be done manually as described above, the usual procedure is to perform this operation by means of a motor.

(b) Motor Charging.

When motor (19) is energized, it rotates camshaft (20) through the reduction gear (21); the clutches (22) are actuated in such a way as to charge the springs in the same way it is done manually (see 6a).

If during the operation, the voltage supply fails, the motor is always in a position to continue charging once the power is restored. Charging can of course be continued manually, if necessary.

7.2.3 Breaker Closed with Closing Springs Discharged *(Figure 6c)*

This is a transient state for the breaker. It occurs whenever the breaker is closed and before the springs are recharged.

The breaker mechanism is changed to this position as follows:

The shaft (16) is rotated either by the electrical close operation or manually with knob (23).

The latch (13) is released and springs (1) rotate the lever (6) counter-clockwise. This drives the shaft (25) clockwise through lever (11) and trip link and closes the breaker.

7.2.4 Breaker Closed with Springs Charged *(Figure 6d)*

This is the usual operating position of the closed breaker. The trip operation can be performed as follows:

(a) Manually, by rotating knob (23).

(b) Remote, through the shunt trip.

7.3 TROUBLE SHOOTING

7.3.1 When the Breaker Cannot be Closed

This may be due to the following:

(a) Looseness of the eccentric (6, Fig. 7) – adjust as instructed in 7.4.1.

(b) Warpage of the trip rod (8, Fig. 7) – check as instructed in 7.4.2.

(c) Wear of lever (7, Fig. 7, Page 10). – This trouble is very uncommon and may occur after a number of operations much greater than that recommended. The lever (7) is to be replaced at our plant or by an FPE Field Service Engineer.

(d) Clearance between the ratchet pawl (3, Fig. 8) and the sprocket wheel (4, Fig. 8) is different from the prescribed clearance. – See 7.4.4 for adjustment.

7.3.2 Problem with the Spring Charging Motor or in the Chain (16) *(Figure 8)*

This happens if the clearance between the ratchet pawl (3) and the sprocket wheel is incorrect. See 7.4.4 for adjustment.

7.3.3 The Breaker Cannot be Opened Electrically

This may be due to the auxiliary circuit not being closed.

Verify the circuits and their connection to the switchgear terminal blocks.

7.4 CHECKS AND ADJUSTMENT

7.4.1 Adjustment of the Closing Spring Mechanical Lock *(Figure 7)*

Since this adjustment is to be made with the breaker closed, the eccentric (6, Fig. 7) should first be locked by tightening screw (1) in such a way as to position the lobe opposite the pin (7); then, with the breaker closed and springs discharged, perform the following operations:

(a) Loosen screw (1) slightly.

(b) Turn knob (2) counter-clockwise until the clearance between the lever (3) and the pin (4) of trip bar (5) is between 0 and .04 inch (0 and .1 mm).

(c) Rotate the eccentric (6) until it is touching pin (7) of knob (2); lock it in this position by tightening the screw (1).

7.4.2 Checking the Trip Bar (8) for Opening the Breaker *(Figure 7)*

When the breaker is closed, the clearance between the pin (9) of the trip lever (10) and the trip rod (8) actuated by the knob (2) is to be 3 to 4mm (.12 to .16 in.). Should this clearance be less, the pin (9) would hit the trip bar (8) thus tripping the breaker.

Therefore, it is necessary to check that:

(a) The trip bar (8) is not warped and is not held upward by foreign matter.

(b) That the pins (11) are provided with washers and split rings.

(c) That the lever (12) is not warped and moves freely.

(d) That the spring (13) is fastened securely.

7.4.3 Checking the Closing Release (7) for Closing the Breaker *(Figure 8)*

With breaker open and springs discharged:

(a) Check for free movement of closing release bar (7) and make sure that when it is in the stop position, the right end of lever (6) is stopped by the slot (9) in the dividing plate.

(b) Roller (5) should engage lever (6) with a minimum overlap of 1.5mm (.06 inch).

7.4.4 Adjustment of the Clearance between the Ratchet Pawl (3) and the Sprocket Wheel (4) to prevent undue stresses to the Chain or to the Spring Charging Motor *(Figure 8)*

Starting from spring "Discharged" (1) position, rotate the shaft (2) half a turn clockwise, which corresponds to the full closing spring charging.

The ratchet pawl (3) must clear the sprocket wheel (4) at the instant when the bearing (5) presses against the upper part of lever (6) of closing release bar (7), thus assuring the spring "Charged" position.

If the ratchet pawl (3) clears the sprocket wheel (4) *before* the bearing (5) presses on the lever (6), the closing springs (1) are not completely charged and the breaker cannot be closed.

If, on the other hand, the ratchet pawl (3) clears the sprocket wheel (4) *after* the bearing (5) has pressed on the lever (6), the pitch chain (16) would be subjected to undue stresses and the motor would be excessively overloaded.

Therefore, with the springs in "Charged" position, the clearance between the ratchet pawl (3) and the sprocket wheel (4) must be 4 ±.5mm (.16 ±.02 inch). This is set by adjusting the eccentric (8) fixed to the base plate to get the clearance required.

The manual charge crank will override if an operator continues to charge after the mechanism is fully charged. This prevents possible damage to the mechanism.

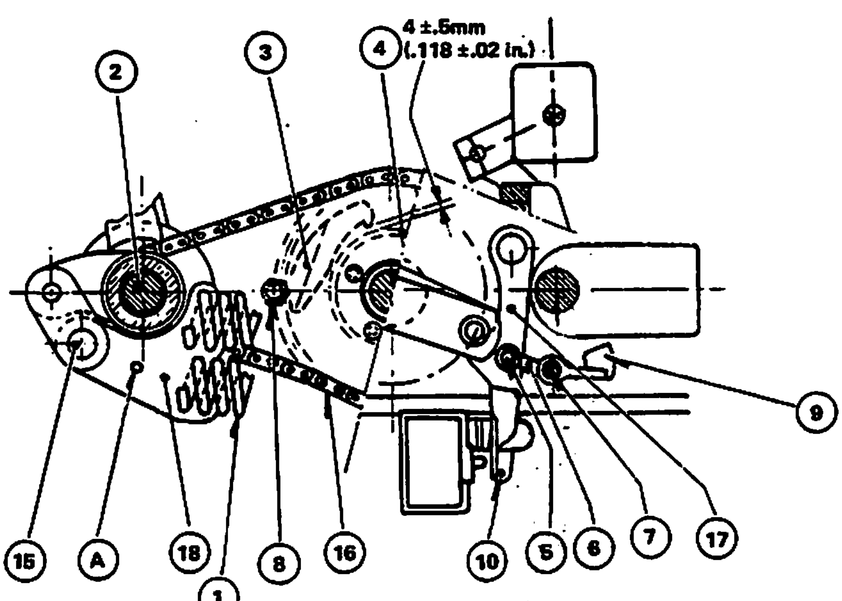


Figure 8

PART IV — Appendix

APPENDIX 7.5

Fitting, Replacement and Adjustment of the Trip Latch (Fig. 10).

(a) Open the breaker and discharge the springs.

(b) De-energize the auxiliary circuits.

(c) Charge the closing springs until the Trip Linkage system latches in the position shown, Fig. 10.

(d) Remove the split washer (2) and slip out the pin (3).

(e) Lift the lever (4) by operating on latch (5).

(f) Remove the clips and washers from pin (6).

(g) Disengage the trace reset springs (9).

(h) Remove the trace.

Adjustment of linkage length is made by screwing, in or out, of the right part into the left part of the assembly (item 7 and 8).

(i) Adjust the new assembly length (L) to equal the length of the one removed.

(j) To reassemble, reverse the above steps.

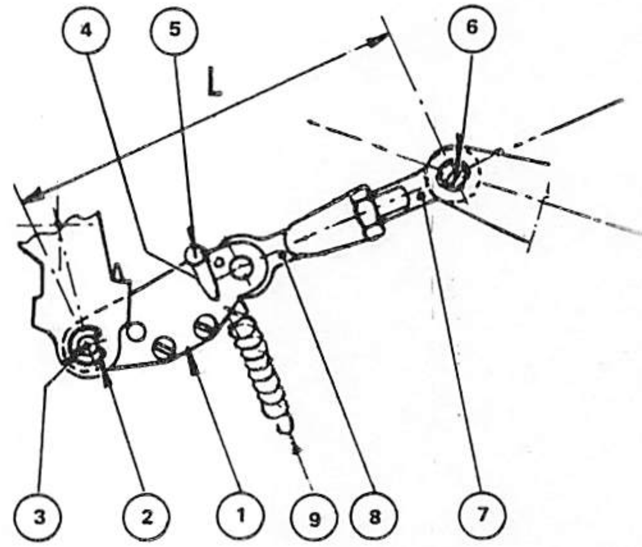


Figure 10

APPENDIX 7.6

(Type "AEM" Mechanism Only)

Replacement of Closing Springs (Fig. 8).

The closing springs can be fitted with the help of a hook (Fig. 11) which will be supplied on request, as follows:

(a) Insert a 5mm (.20 inch) dia. pin into hole (A) of closing spring support (18).

(b) Fit the hook to the pin and insert the threaded portion of the hook into the hole drilled in the left part of the operating mechanism housing.

(c) By means of the nut supplied with the hook, charge the springs until pin (15) can be fitted.

(d) Remove the hook and check the spring charging operation.

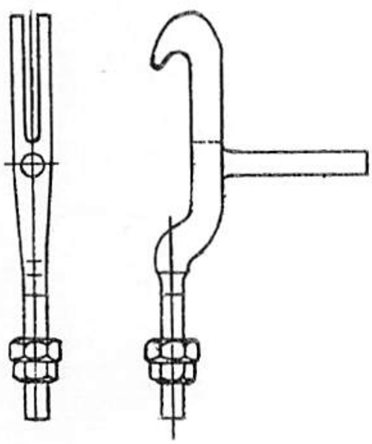


Figure 11

APPENDIX 7.7

Hydraulic Shock Absorber

Check Shock Absorber for any signs of leakage and for moving contact stopping without rebound.

An accurate check could only be made using a travel analyzer. Rebound is adjusted by shifting mounting brackets as shown.

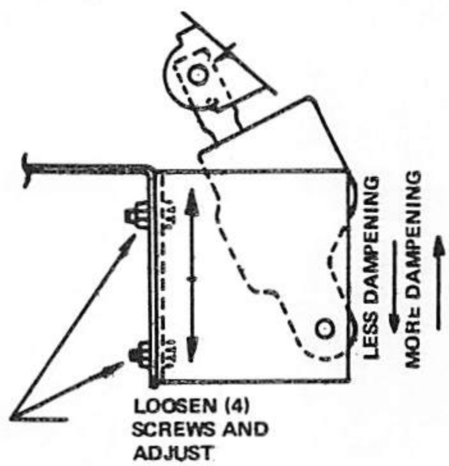


Figure 12a

5kV Except 5kV 350, 3000A

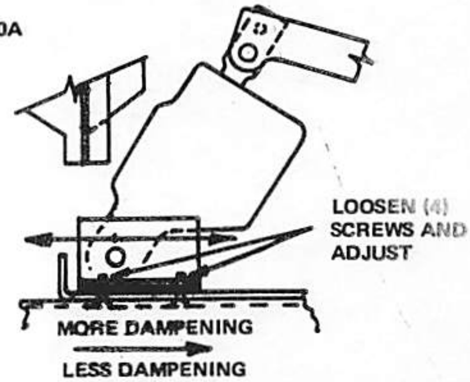


Figure 12b

5kV 350, 3000A and 15kV

APPENDIX 7.8

Fitting the Operating Mechanism to the Main Breaker.

The DST-2 is shipped as one unit with the operating mechanism mounted on the main breaker. If, however, it becomes necessary to remove the mechanism it should be refitted horizontally as shown in (Fig. 9a), using the holes in the frame as indicated in (Fig. 9b).

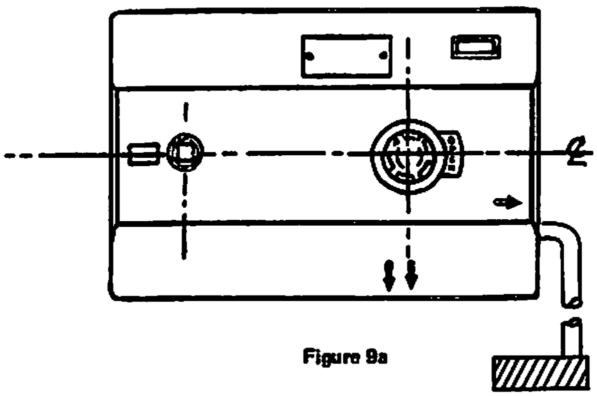


Figure 9a

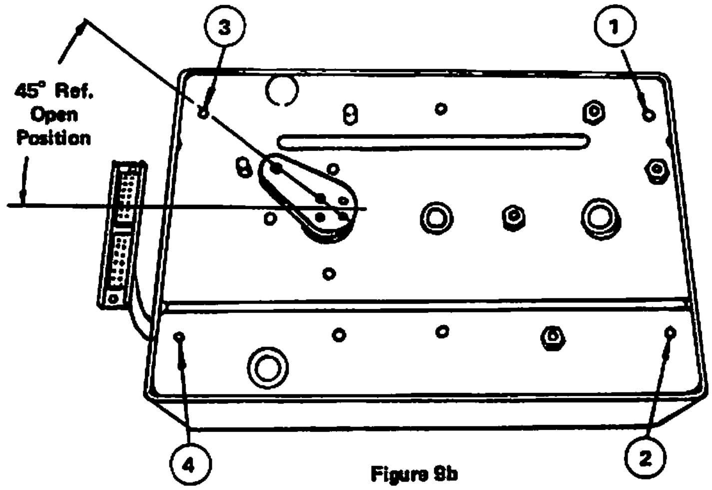


Figure 9b

NOTE: Mechanism should be assembled in the "Open" position and closing springs "Discharged". Moving contacts should be in the "Fully Open" position.

APPENDIX 8

RECOMMENDED MAINTENANCE SCHEDULE FOR THE DST-2 TYPE BREAKER

	MAINTENANCE TO BE CARRIED OUT	NUMBER OF OPERATIONS 5kV 250 & 15kV 500 = 10,000 max. 5kV 350 & 15kV 750 = 5,000 max. Every 2000	 Every 4000
		Or Once Annually, if Less	
INSPECTION	Arc chutes (1)	X	
	Main contacts		X
	Arcing contacts (2)	X	
	Main contact lubrication	X	
	Tightening of nuts, screws, etc.	X	
	Tightening of connections, shunt trip	X	
	Operating mechanism chain.		X
	Auxiliary contacts on the operating mechanism	X	
	Closing release latch		X

(1) The arc chutes can withstand without being serviced:

Mechanical Operations		Interruptions with rated current rated voltage cos ϕ=0.8		Interruptions with the full short-circuit current at rated voltage cos ϕ=0.15	
number	with inspection every	number	with inspection every	number replacement	with inspection after
10,000	2,000	5,000	2,000	as required	1 duty cycle

(2) The lifetime of arcing contacts depend on the nature of operations. Their condition is to be inspected: replacement is required when their wear is noticeable. Numbers of operations that the arcing contacts can withstand without being replaced are indicated below.

Interruptions with rated current at rated voltage cos ϕ=0.8	Interruptions with the full short-circuit current at rated voltage cos ϕ=0.15
5,000	1 duty cycle

APPENDIX 9

OPERATING TIME & CONTACT VELOCITIES OF DST-2 – 5 & 15kV

Circuit Breaker	Opening Velocity in Ft/Sec	Closing Velocity in Ft/Sec	Opening Time in Milliseconds	Closing Time in Milliseconds
5kV 75 -1200A 5kV 150-1200A 5kV 250-1200A 5kV 350-1200A	12.4–14.1	17.0–18.7	40-50	60-70
5kV 250-2000A 5KV 350-2000A & 3000A	12.4–14.1	15.4–17.0	40-50	60-70
15kV 150-1200A 15kV 250-1200A 15kV 500-1200A 15kV 500 & 750-1200A	14.4–15.7	18.7–20.3	40-50	70-80
15kV 500-2000A 15kV 750-2000A & 3000A	14.4–15.7	16.4–18.0	40-50	70-80

Note: Closing velocity measured in area 1½ inch before "arc contact touch" to "arc contact touch".
Opening velocity measured in area from "arc contact touch" to 1½ inch from "arc contact touch".

APPENDIX 10

DST-2 AIR CIRCUIT BREAKER CONTROL POWER REQUIREMENTS

AVAILABLE TRIPPING VOLTAGE

Voltage, Nominal	24 VDC	48 VDC	125 VDC	250 VDC	115 VAC 230 VAC CAPACITOR TRIP	
Voltage Range	14 – 30	28 – 60	70 – 140	140 – 280	95 – 125	170 – 250
Current Required (Intermittent) At Nominal Voltage	12.5	6.25	2.4	1.2	0.1 max.	0.1 max.
Recommended Fuse	None	None	None	None	None	None

AVAILABLE SPRING CLOSING MOTOR VOLTAGES

Voltage, Nominal	48 VDC	125 VDC	250 VDC	115 VAC	230 VAC
Voltage Range	36 – 60	90 – 130	180 – 260	95 – 125	190 – 250
Current Required	14	5.3	2.65	5.2	2.6
* Recommended Fuse (FPE ECN 250V Dual Element)	8	3.2	1.6	3.2	1.6

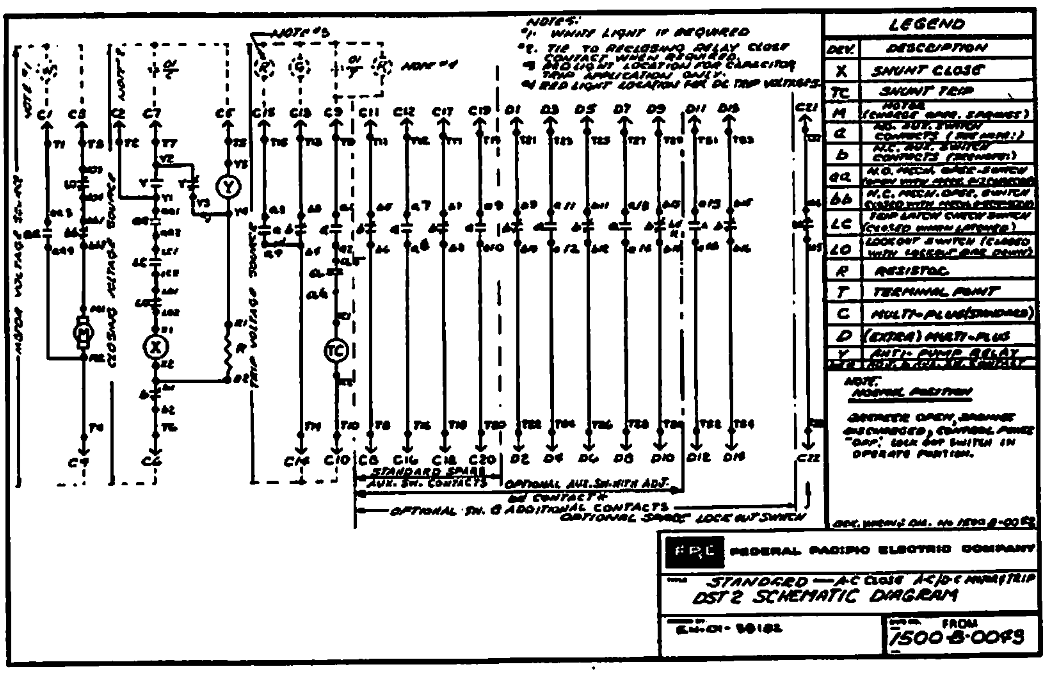
AVAILABLE CLOSING RELEASE COIL VOLTAGES

Voltage, Nominal	24 VDC Special	48 VDC	125 VDC	250 VDC	115 VAC	230 VAC
Voltage Range	18 – 30	36 – 60	90 – 130	180 – 260	95 – 125	190 – 250
Current Required At Nominal Voltage	12.5	6.25	2.4	1.2	4.4	2.2
Recommended Fuse (FPE ECO ® 250V One-time Cartridge)	10	10	10	10	10	10

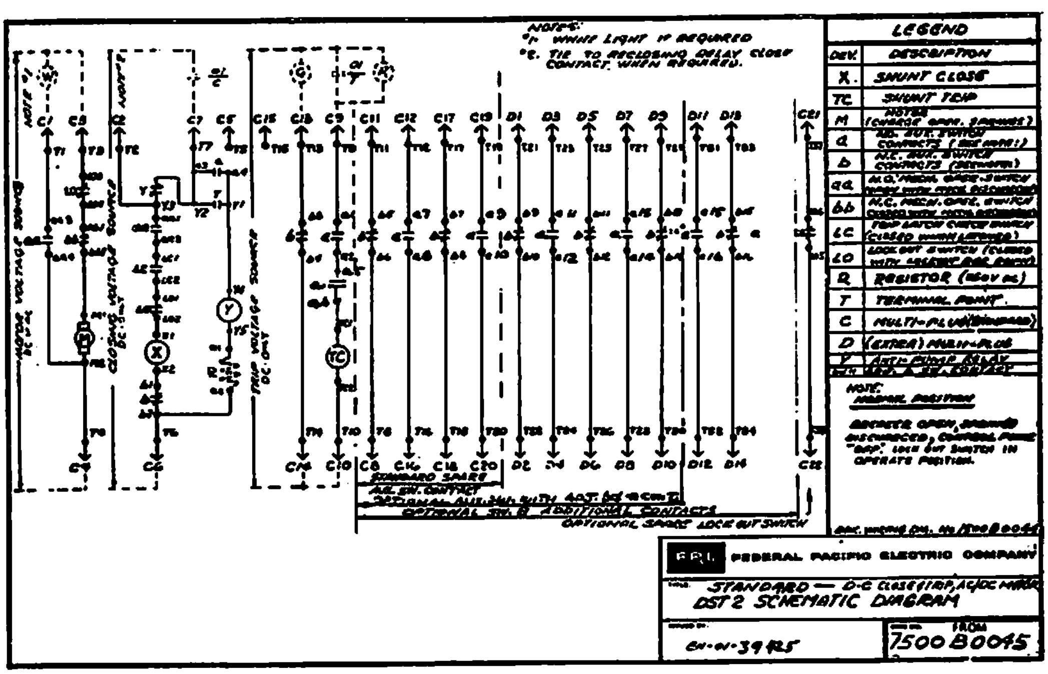
* Use fuse recommended for motor circuit when close and motor circuit have common power supply.

APPENDIX 11

WIRING DIAGRAM



AC Close

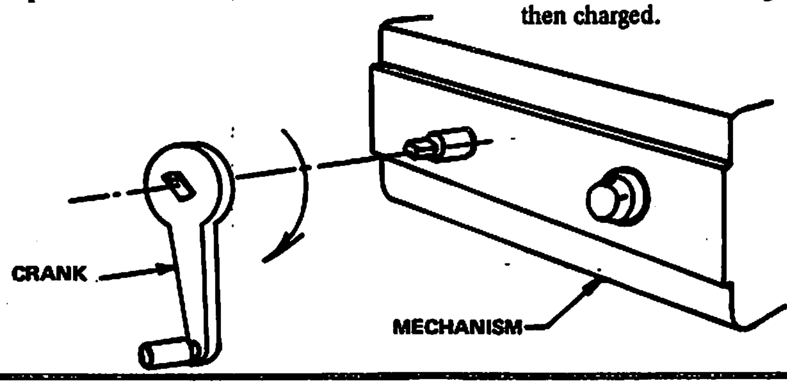


DC Close

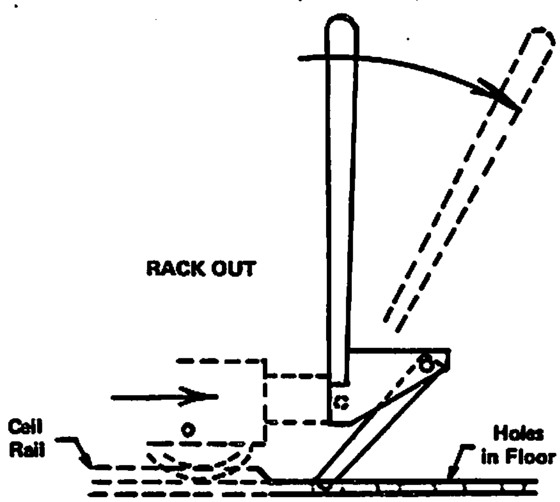
Standard and Optional Accessories

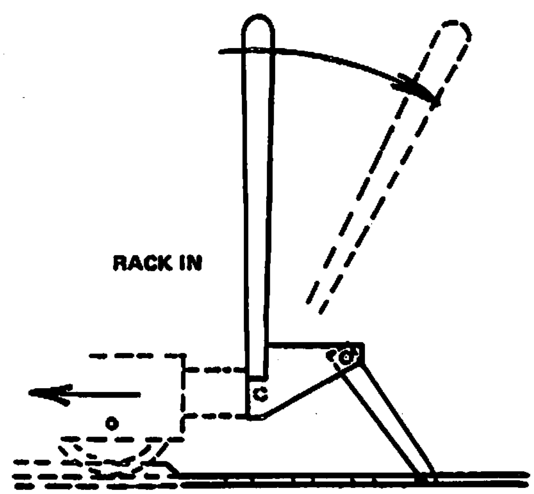
SPRING CHARGING CRANK
DWG. NO. 1551 A 5539 (Standard)

1. Attach crank to square shaft at front left of mechanism.
2. Rotate until ratcheting ceases. The closing springs are then charged.



RACKING HANDLE,
DWG. NO. 2251 B 5412 (Standard)

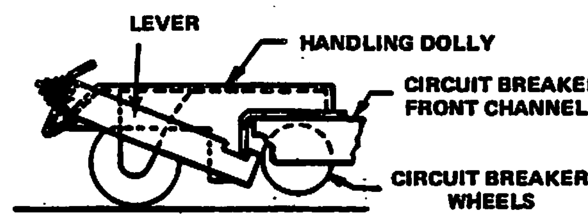




1. With circuit breaker on rails of cell, attach racking handle in accordance with above diagram.
2. If circuit breaker is in either test or operating position, depress pedal (14, Fig. 1) and rack. Racking from other positions does not require depressing of the pedal.

HANDLING DOLLY
DWG. NO. 2254 C 4327 (Optional)

1. Position dolly against left side of racking handle engagement block and with lifting angle under frame.
2. Rotate lever by pressing on right side until circuit breaker front wheels are off the ground.
3. Circuit breaker could now be pushed in any direction.
4. Disengage by pressing on left side and then allowing lever to rotate upward.



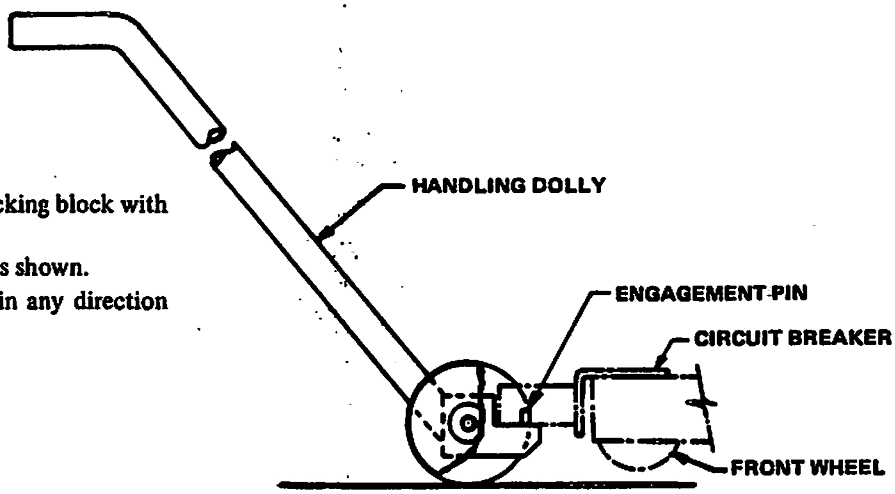
TRANSFER TRUCK

For outdoor non-walk-in 5 and 15kV switchgear.

	5kV	2251 D 4689
6" High Base	15kV	2251 D 4690
13½" High Base	5kV	2251 D 4691
	15kV	2251 D 4692

HANDLING DOLLY
DWG. NO. 2251 C 4842 (Standard)

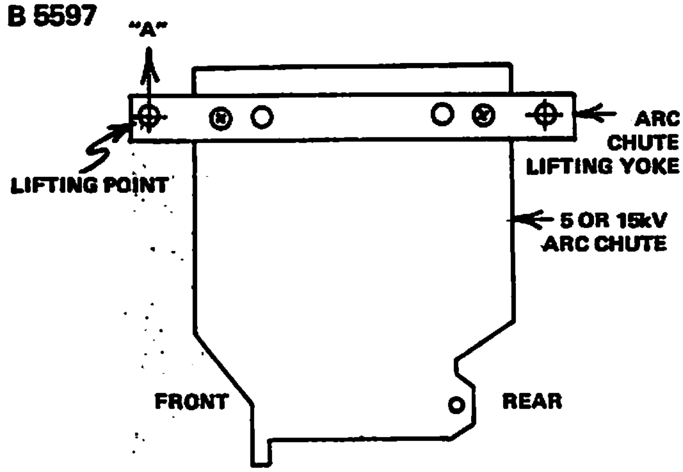
1. Position wheel below circuit breaker racking block with dolly handle up.
2. Lower handle to approximate position as shown.
3. Circuit breaker could now be pushed in any direction by turning handle.



5kV ARC CHUTE LIFTING YOKE, DWG. NO. 1552 B 5597
15kV ARC CHUTE LIFTING YOKE, DWG. NO. 1551 B 5597

(Standard)

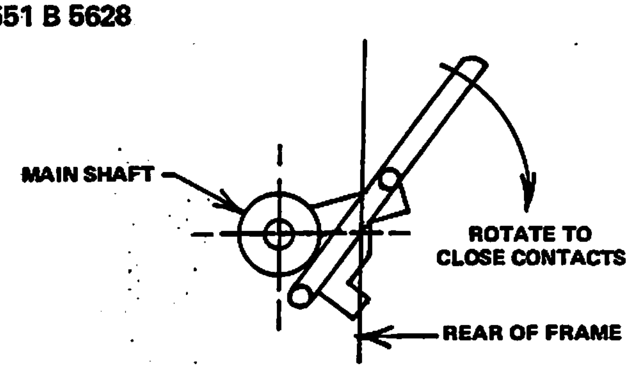
1. Attach arc chute lifting yoke and tighten clamping screws securely.
2. Lift by means of lifting hook or sling at point "A"; arc chute will swing at proper angle for removing or assembling on to circuit breaker.



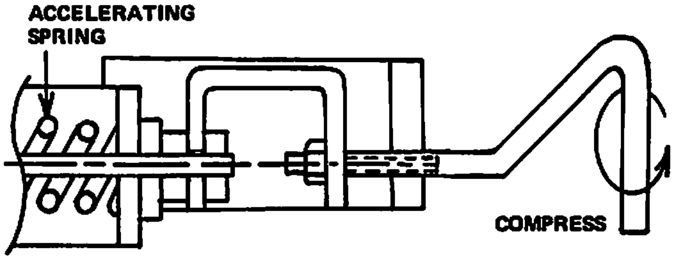
5kV MAINTENANCE CLOSE HANDLE DWG. NO. 1551 B 5628

(Standard)

1. Attach handle to main shaft as shown.
2. Rotate downwards until contacts touch and inspect contact sequence.

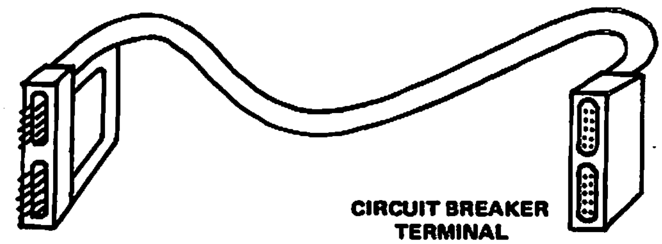


15kV MAINTENANCE CLOSE,
DWG. NO. 1551 C 5820 (Standard)



1. Attach handle to extension of accelerating spring as shown.
2. Compress accelerating spring by turning handle CCW.
3. Rotate contact blades by hand and inspect contact sequence.

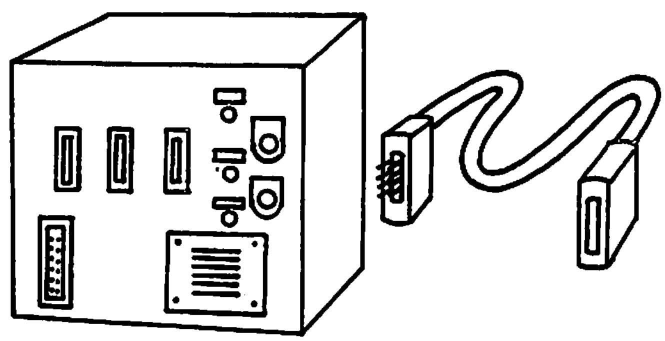
TEST JUMPER, DWG. NO. 2251 C 4509 (Optional)



1. With circuit breaker near the cell, insert one end of the jumper to the circuit breaker secondary disconnect terminal.
2. Insert the other end to the cell secondary disconnect terminal. The circuit breaker could now be tested electrically from switch on instrument door.

TEST CABINET ASS'Y DWG. NO. 2251 D 4340 (Optional)

1. With the circuit breaker removed from the cell and moved near the test cabinet, insert one end of the test jumper to the circuit breaker.
2. Connect the other end to the Test Cabinet secondary disconnect terminal. The circuit breaker can now be tested electrically from the test cabinet.



APPENDIX 13

TABLE OF SPARE PARTS FOR BREAKER SERIES DST-2

Typical part numbers shown. Breaker Serial Numbers must be given when ordering replacement parts.

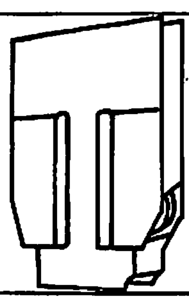
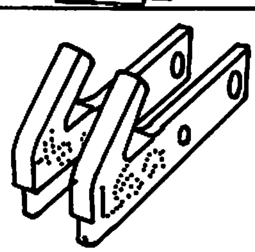
No.	Sketch	Description	Quantity for 1 Breaker	Part No.	Type of Breaker
1		Arc Chute	3	1551 D 5464	5kV 250 MVA
				1551 D 6006	5kV 350 MVA
				1552 D 5484	15kV 500 MVA
				1553 D 5484	15kV 750 MVA
2		Fixed Arcing Contact	3 Pairs	1565 D 5641	5kV 350 MVA 15kV 750 MVA
				1551 D 5641	5kV 250 MVA 15kV 500

TABLE OF SPARE PARTS FOR BREAKER SERIES DST-2

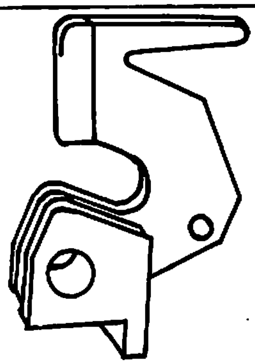
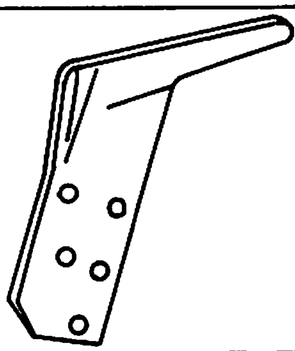
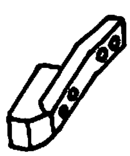
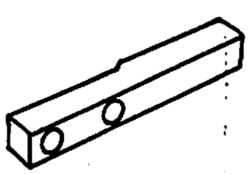
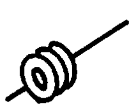
No.	Sketch	Description	Quantity for 1 Breaker	Part No.	Type of Breaker
3		Moving Arcing Contact	3	1552 D 5641	5kV 250 MVA & 350 MVA
				1569 D 5641	15kV 750 MVA
4		Moving Arcing Contact	3	1553 D 5641	15kV 500 MVA
5		Main Fixed Contact	24 48	1571 D 5641 1571 D 5641	15kV 500 MVA 1200A 15kV 750 MVA 1200A
			48	1555 D 5641	5kV 250 and 350 MVA 1200A
			48	1554 D 5641	15kV 500 & 750 MVA 2000A and 3000A
			48	1570 D 5641	5kV 250 MVA, 2000A 5kV 350 MVA 2000A & 3000A
6		Leading Finger for Moving Contact	6	1568 D 5641	5kV 250 MVA 2000A 5kV 350 MVA 1200 & 2000A 15kV 750 MVA 2000A
				1556 D 5641	5kv 250 MVA 1200A 5kV 350 MVA 3000A 15kV 750 MVA 1200 & 3000A
7		Fixed Arcing Contact Spring	6	1557 D 5641	15kV 500 MVA
				1558 D 5641	5kV 250 MVA, 350 MVA, and 15kV 750 MVA

TABLE OF SPARE PARTS FOR BREAKER SERIES DST-2

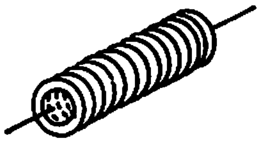
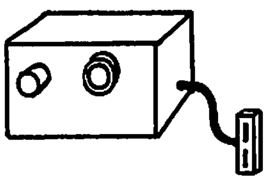
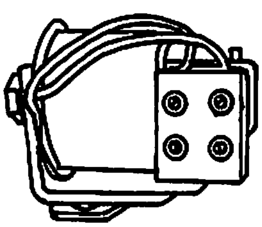
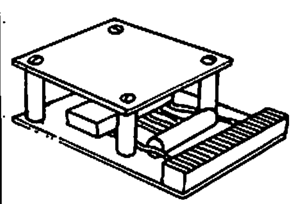
No.	Sketch	Description	Quantity for 1 Breaker	Part No.	Applied Voltage
8		Rotating Moving Arcing Contact Spring	3	1559 D 5641	5kV 250 MVA, 350 MVA, and 15kV 750 MVA
9		Main Fixed Contact Spring	24	1560 D 5641	All 5 and 15kV
10		Type AEM Mechanism	1	1551 B 6044	5kV 250, 1200 & 2000A 15kV 500, 1200 & 2000A
				1552 B 6044	5kV 350, 1200, 2000 & 3000A 15kV, 750-3000A
				1553 B 6044	15kV 750-1200 & 2000A
11		Shunt Close Assembly	1	1556 A 5575	24VDC
				1551 A 5575	48VDC & 115VAC
				1552 A 5575	125VDC
				1553 A 5575	250VDC
				1555 A 5575	230VAC
12		Y Relay Assembly	1	1551 B 5758	48VDC
				1552 B 5758	125VDC
				1553 B 5758	250VDC
				1554 B 5758	115VAC
				1555 B 5758	230VAC
				1556 B 5758	24VDC

TABLE OF SPARE PARTS FOR BREAKER SERIES DST-2

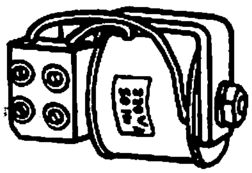
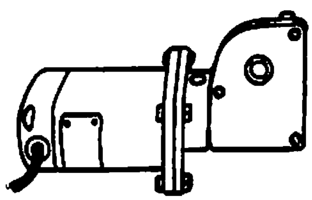
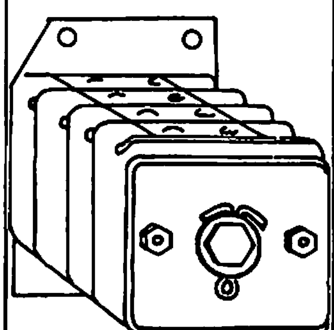
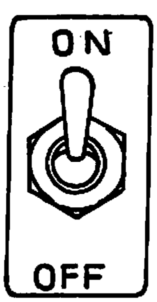
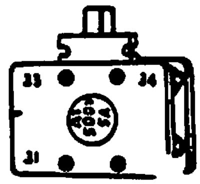
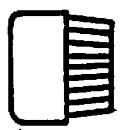
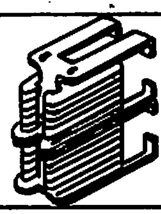
No.	Sketch	Description	Quantity for 1 Breaker	Part No.	Applied Voltage
				1551 C 5584	24VDC
				1552 C 5584	48VDC
13		Shunt Trip Assembly	1	1553 C 5584	125VDC 115/230VAC CAP. TRIP.
				1554 C 5584	250VDC
				1551 B 5585	48VDC
				1553 B 5585	250VDC
14		Spring Charging Motor	1	1554 B 5585	115 VAC & 125VDC
				1555 B 5585	230 VAC
		Auxiliary Switch Basic breaker is equipped with 5 unit aux. switch which provides "2a"and"2b" spare contacts. It is not necessary to specify this switch on breaker orders.	1	1551 D 5557	All
15		7 Unit aux. switch with 5a & 5b spare contacts. Convertible contact b13-b14 is adjustable with infinite resolution.	1	1552 D 5557	All
		8 unit aux. switch with 6a & 6b spare contacts.	1	1553 D 5557	All
16		*Lockout Switch* Basic breaker is equipped with 2 pole lockout switch used for internal control. It is not necessary to specify this switch on breaker order.	1	1501 A 5592	AC Charging Motor Applications
		Lockout switch with one additional spare contact.	1	1502 A 5592	DC Charging Motor Applications

TABLE OF SPARE PARTS FOR BREAKER SERIES DST-2

No.	Sketch	Description	Quantity for 1 Breaker	Part No.	Applied Voltage
17		Latch Switch	3	1564 D 5641	All
18		Secondary Disconnect Contact Assembly with 24 contacts	1	1551 B 5369	24 Pins
		16 Contact Block if req'd.		1502 A 5418	16 Pins
19		Primary Disconnect Contact Assembly	6	1553 A 5533	1200A
				1551 B 5675	2000A
20		Primary Disconnect Contact Assembly	6	1572 D 5641	5kV 350 3000A & 15kV 500 or 750 3000A

FPE

INSTRUCTIONS FOR
INSTALLATION

FEDERAL PACIFIC
Type DST 5 & 15 KV Magnetic Air Circuit Breakers

IN. DST

November 1959

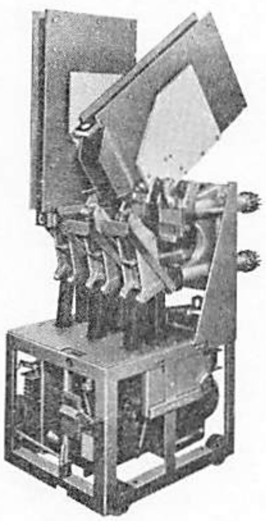
Federal Pacific Type DST-5 and DST-15 Magnetic Air Circuit Breakers

INSTALLATION INSTRUCTION MANUAL

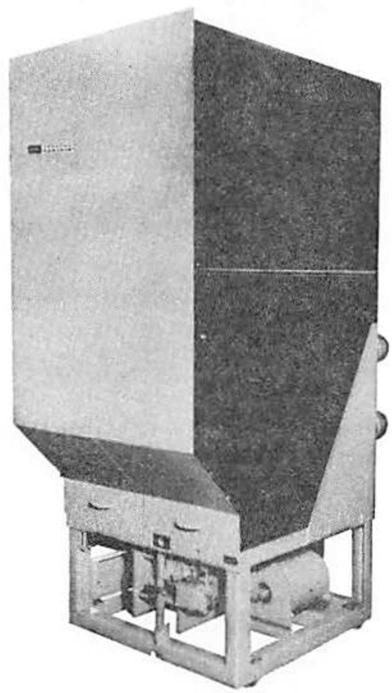
TABLE OF CONTENTS

FPE EQUIPMENT DESCRIPTIVE SHEET **CLASS 6045**

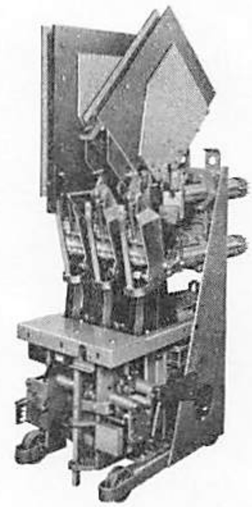
DST MAGNETIC AIR CIRCUIT BREAKERS



DST 5-250



DST 15-1000



DST 5-75

Type DST Magnetic Air Circuit Breakers can be quickly withdrawn from their cells with ease due to their horizontal drawout construction. Completely foolproof interlocking to meet all operator requirements is provided for by a rugged, positive acting racking in mechanism.

Primary disconnects provide positive alignment and are simple to maintain and inspect. Contact fingers are of high-conductivity extruded copper, heavily silver plated. Each finger is independently spring loaded to assure positive contact.

Breaker closing mechanism is completely self-contained—attached to the frame by only four bolts. No bearings or shafts are in contact with the breaker frame and the mechanism can be removed for inspection and maintenance as a unit simply and quickly. The closing solenoid has an exclusive double acting plunger disc which provides maximum closing torque and insures closing and latching of contacts at maximum current ratings of the breaker.

Built-in puffer assures effective arc interruption in less than 5 cycles at all current ranges, including magnetizing and line dropping currents. One large-volume air-puffer serves all three breaker poles. The puffer piston is driven by a solid connection to breakers main drive rod. This gives positive operation at the precise moment the air stream is required, for fast interruption of low currents.

Safety design provides four-way protection through mechanical breaker interlock. Breaker can not be inserted or removed in the closed position—raising vertical interlock bar to insert racking-in crank trips the breaker. If the breaker is not racked-in all the way, the cell interlock bar prevents vertical interlock bar from dropping and the breaker remains trip-free. If breaker is not racked-out all the way to "Test" position, breaker remains trip-free, and if any operation is attempted with trip coil armature down, the breaker is trip free.

Racking-in mechanism's extreme simplicity provides positive locking in any position once racking has started.

Polestiglas insulation provides flame retardant and non-tracking arc chutes and interphase barriers. Polestiglas insulation also has the additional ideal insulating features of low power factor, high impact strength, high tensile strength, high flexural strength and excellent dielectric characteristics.

STORED ENERGY CLOSING MECHANISM

Federal Pacific DST Magnetic Air Circuit Breakers are normally supplied with a d.c. closing solenoid. These breakers may be equipped, when required, with either hand charged or electric motor charged **stored energy** closing mechanism. Both of these stored energy mechanisms are unique in that they occupy only the space formally used by the closing solenoid. The mechanism delivers more than sufficient closing energy required for either the 5 or 15 KV breaker. Excess energy is absorbed by buffers at the end of the spring stroke and considerably reduces the breaker impact as compared with the solenoid operated breaker.
Both types of stored energy breakers are provided with means for maintenance closing for inspection of breaker.

DESCRIPTION

The DST magnetic air circuit breaker is electrically operated, horizontal drawout, three pole, for indoor and outdoor metal-clad switchgear.

The component parts are mounted on a welded steel frame equipped with wheels so that it can be easily moved into its cell. It has insulated interphase barriers, and a steel grounded front barrier to assure safety to operating personnel.

Primary disconnecting contacts carry the load current, and secondary disconnect contacts carry the control circuits for operating the circuit breaker.

The truck-mounted breaker is so interlocked with the racking-in mechanism that it is not possible to rack in the circuit breaker to its operating position when the circuit breaker is closed. It is also not possible to rack-out the circuit breaker from its operating position when the circuit breaker is closed. This protection is accomplished by a trip-lever that must be lifted before the racking-in crank can be inserted in the breaker frame.

These magnetic air circuit breakers are precision jig built devices and are factory adjusted and tested in compliance with NEMA standard factory operational tests. Each breaker is assigned a serial number and a careful record of each test is logged. This serial number should be referred to if it becomes necessary to contact the factory concerning a breaker.

As each breaker is carefully factory adjusted before it is shipped, no field adjustment should be necessary. The following information has been prepared for use only by Federal Pacific Electric field service personnel. Should it become necessary, consult the nearest sales office for field service assistance.

SHIPMENT

All circuit breakers are assembled in the factory before shipment, and tested for operational performance. Shipment is made in a total of five boxes and crates. The basic circuit breaker on its truck is in one crate. The three arc-chutes are packed in three separate boxes. The interphase barriers are packed in one crate. For 15KV circuit breakers, interphase barriers are inside the crate identified as right hand and left hand.

The serial number of each circuit breaker is on its nameplate and also marked on the circuit breaker crate. The two crates and the three boxes are marked with the factory FED number.

A copy of the packing list, enclosed in a water-proof envelope, is nailed on the outside of the circuit breaker crate. One envelope only is furnished with orders for more than one circuit breaker shipped to a single destination.

Each circuit breaker, in its crate, is enclosed in a *poly-vinyl dust and moisture-proof envelope*, which is zippered on three (3) sides. Within this envelope is a proper amount of *silica-gel* to absorb moisture.

It is recommended that this *envelope not be opened* prior to putting circuit breaker into service.

If breakers are to be stored for three (3) months or longer, silica-gel should be removed and placed in a dry oven to remove moisture, and then replaced in breaker envelope.

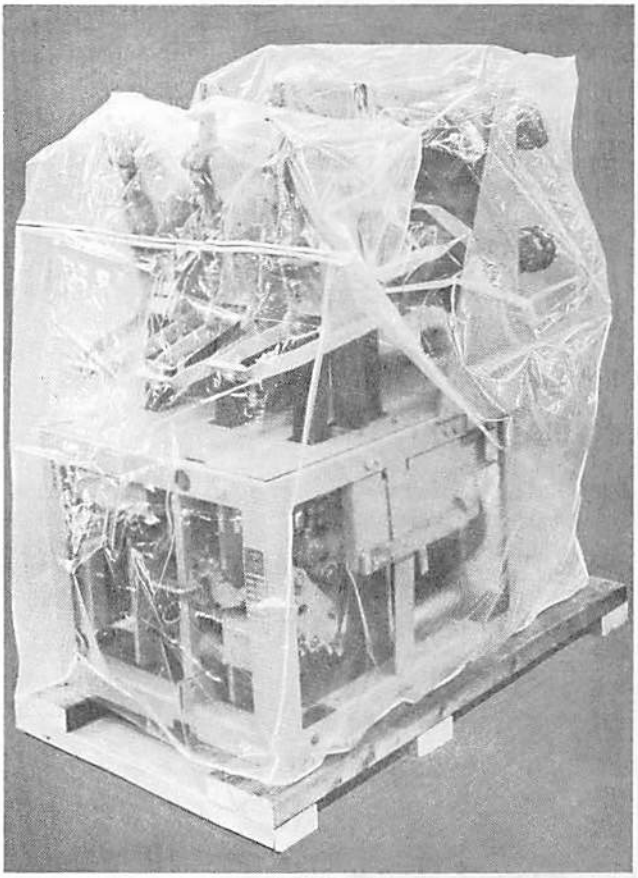


FIGURE 1

INSPECTION UPON RECEIPT OF SHIPMENT

When a shipment of circuit breakers is received, each circuit breaker should be examined before it is removed from the railroad car or truck. If any damage or indication of rough handling is evident, a description of the condition should be written on the freight bill, a claim should be filed against the carrier immediately, and notice of the extent of the damage sent immediately to the company at the address of the breaker from which shipment was made, giving serial number of the breaker, the carrier's name, and car number if shipped by rail. This information enables the company to supply needed information to assist the purchaser in support of the claim.

STORAGE BEFORE INSTALLATION

Circuit breakers arriving at the job in advance of installation should be stored indoors in a dry place. In cases where any time is to elapse before the circuit breaker is to be installed, the insulating parts should be tested for proper insulation level. If standard insulation level is not found, the insulating parts should be dried and retested. If stored near new construction work, care should be taken to protect from dust or other materials by covering with a tarpaulin.

BASIC ACCESSORIES

There is supplied with each metal-clad installation one of the following:

1. Racking-in crank
2. Manual or maintenance closing lever
3. Arc-chute lifting yoke
4. Test jumper (optional)
5. Breaker handling dolly (not illustrated)
6. Breaker transport truck (not illustrated) (outdoor installations only)

OTHER AVAILABLE BREAKER ACCESSORIES

CLOSING LOCKOUT SWITCH

5 KV toggle switch	1551-0534
5 KV momentary switch	1551-0533
15 KV toggle switch	1551-0529
15 KV momentary switch	1551-0528

CINCINNATI RECORDER ATTACHMENT

5 KV	1551-1858
15 KV	1551-0520

INTERLOCK ARRANGEMENT

5 KV (Standard Kirk Type F-3/8)	1501-0240
15 KV " " " "	1502-0240

LATCH CHECK SWITCH

5 & 15 KV	1551-1726

MECHANISM OPERATED CELL SWITCH (OPERATOR)

5 KV	1551-0636
15 KV	1551-0635

PADLOCK ARRANGEMENT

5 KV	1551-0523
15 KV	1551-0524

REACTOR TRIP RELAY ASSEMBLY

5 KV	1551-0791
15 KV	1551-0791

GROUND AND TEST DEVICES

5 KV

Current Rating	Symbol
1200 - Manual	1551-0314
2000 - Manual	1552-0314

15 KV

1200 - Manual	1551-0455
2000 - Manual	1552-0455

Also available electrical (solenoid operated) for Specific Applications.

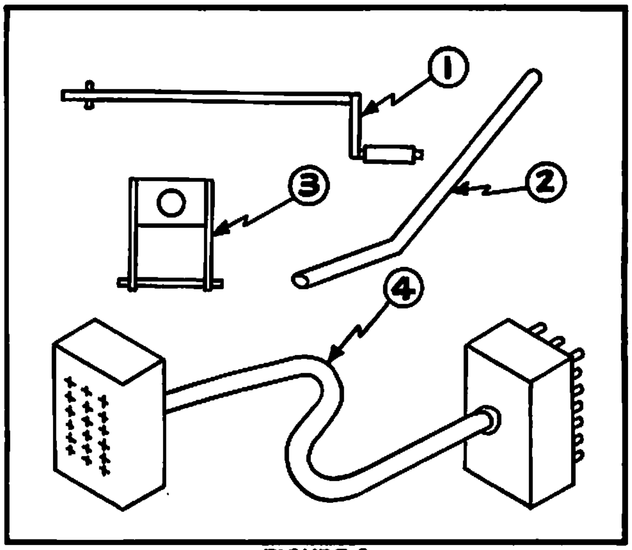


FIGURE 2

1. Racking-in crank

   Fits in socket at upper portion of mechanism to rack the breaker from "disconnect" to "test" to "operate" position in the cell. Shear pin located inside sleeve at handle protects racking mechanism from overstress.

2. Maintenance closing handle

   Fits in socket at lower front portion of mechanism to close breaker for maintenance and inspection. *Must not be used to close breaker manually when breaker is in the cell.*

3. Arc chute lifting yoke

   Used to lift arc chutes into place on circuit breaker if hoist is available.

4. Test jumper

   Connects secondary circuits of breaker to test cabinet or to plug-in cell for testing when observation of mechanism or contacts is desired.

RATINGS OF DST BREAKERS

Type	Current Rating	Symbol
DST 5-75	1200	1553-1653
DST 5-150	1200	1555-1653
DST 5-150	2000	1554-1653
DST 5-250	1200	1551-1653
DST 5-250	2000	1552-1653
Dummy	1200	1551-0838
Dummy	2000	1552-0838
DST 15-150	1200	1552-1655
DST 15-250	1200	1551-1655
DST 15-250	2000	1551-0606
DST 15-500	1200	1551-1655
DST 15-500	2000	1551-0606
Dummy	1200	1551-1680
Dummy	2000	1552-1680

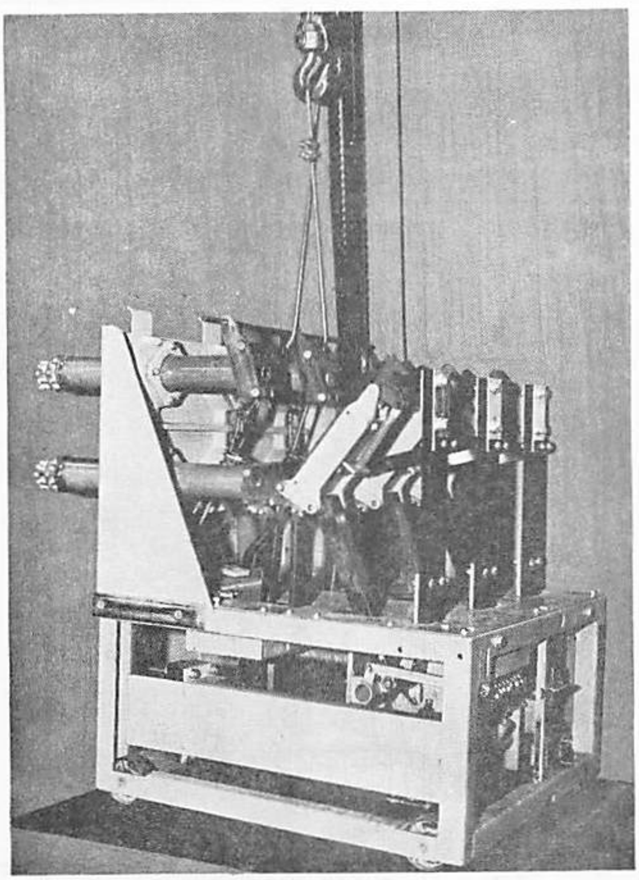


FIGURE 3

UNCRATING

If the breaker has to be moved to its proper location, lift the breaker in its crate if possible. If not, then lift the breaker without its arc-chutes and barrier. Always remove these components before lifting a breaker. Fig. 3 shows proper method of attaching lifting cable.

Uncrate the breaker. Use nail-puller for this purpose. Note that the breaker was shipped with contacts open, and blocked open with a shipping strut.

SETTING UP THE MAIN CIRCUIT BREAKER ASSEMBLY

1. After the breaker is uncrated, inspect for damage.
2. Clean off any accumulated dust with a dry cloth.
3. The contacts were not oiled or greased at the factory, nevertheless see that they are free from any oil or grease.
4. Check for any obvious loose hardware.
5. Do not install arc-chutes and barriers until ready to push the breaker into its cell.
6. First, operate the breaker by means of its maintenance operating handle. This is to be inserted into its socket at lower center of mechanism. See figure 8. Push the handle downward to close the breaker until an audible click is heard, indicating that the breaker has latched into the closed position. Check for any binding or friction.
7. Remove the manual closing handle.
8. Trip the breaker by raising the lift-to-trip lever.
9. Repeat 6 and 8 several times to insure proper operation.
10. Raise the lift-to-trip lever and insert the racking-in handle in socket that is uncovered by the projection on the trip bar. Note that in order to insert handle, the circuit breaker must be tripped open.
11. Turn handle to rotate racking-in lever against roller-lever against the step in the extended position (protruding outside the frame).
12. With handle still in the socket, place the manual closing lever in manual closing socket and attempt to close the breaker. It should trip-free. Note how trip-bar operates the cam to depress the trip armature.
13. If circuit breaker does not operate properly, check the contact adjustments as follows:

CHECKING FOR PROPER CONTACT ADJUSTMENTS

Main Contact Penetration

1. Close breaker to fully closed position (Figure 4A).
2. Scribe a line on copper contact bar immediately opposite edge of casting at (A) and (B).
3. Open breaker fully and again scribe lines at (A) and (B).

Lines at (A) and (B) should be 1/8" ± 1/32" apart.

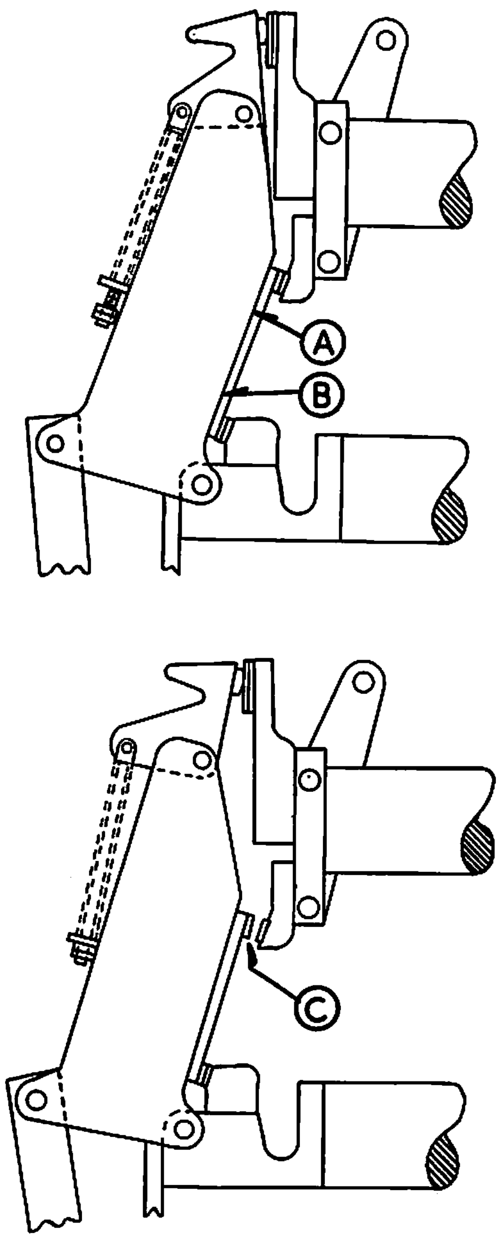


FIGURE 4

Arcing Contact Position

1. Close breaker manually until arcing contacts touch. (Figure 4B).
2. Gap at main contacts (C) should be approximately 3/8" ± 1/8-0. A 3/8" bolt is handy to check this adjustment.
3. Arcing contacts on 3 poles should touch simultaneously within 1/16".

1 - Arc chute installation (Figure 5).

1. Remove from crate.
2. Clean and blow out with dry air if necessary.
3. Inspect for damage
    a. Broken porcelain plates - small chips not objectionable
    b. Broken splitter plates - small chips not objectionable
4. Remove two loose screws (A) from side of contact and two cap screws (B) on back side of contact.
5. If hoist is available, remove through-bolt at (C) and install arc-chute lifting yoke.
6. Lift an angle shown and guide beveled end of pin (D) into hole in bracket (E).
7. Fasten bracket (F) to contact with screws (A).
8. Tilt arc chute back against rest on frame.
9. Remove lifting yoke and replace bolt at (C).

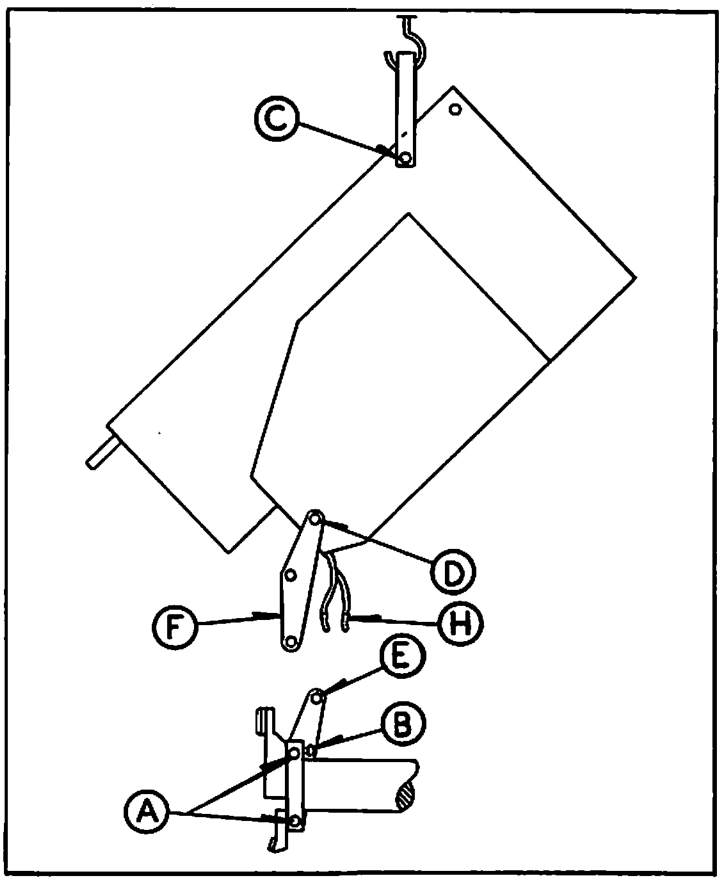


FIGURE 5

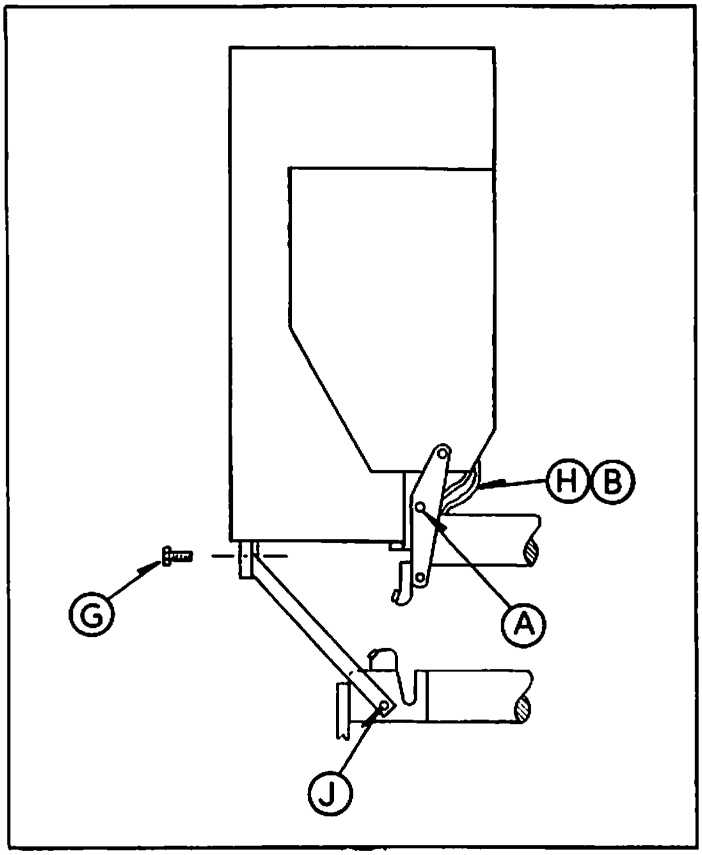


FIGURE 6

2 - Arc chute installation (Figure 6).

10. Remove bolt (G) from front upright.
11. Making sure that coil leads at (H) are free, gently lower arc chute until holes line up for bolt (G).
12. Install bolt (G) and tighten. This makes up mechanical and electrical connection at this point.
13. Tighten screws (J) on each side of bracket.
14. Fasten both coil leads at (H) with screws (B) removed in step 4. Note: These leads are in parallel. Other end of coil is connected internally to arc runner.
15. Check operation of breaker manually for any rubbing etc.

INSTALLATION OF INTERPHASE BARRIER

1. Remove from crate.
2. Wipe off dust with dry cloth.
3. Inspect for damage.
4. Remove two 1/2 inch bolts in front brace of breaker frame.
5. Slide the barrier assembly into place on the breaker. Make sure the outside sheets slip inside the frame gusset. See Figure 9.

Note: On 15KV breakers, slide right half of barrier assembly into place first, then left half. Install 1/4 inch bolt at top.

6. Tighten two lower bolts.
7. Check closing and tripping manually.

Electrical operation check
(May be done before installing arc chutes and barriers if power is available)

1. Check the closing and tripping voltages on the nameplate of the breaker. Breakers used with capacitor trip devices will indicate 125 volts d.c. for tripping. Breakers used with closing rectifiers will indicate 125 volts d. c. for closing.

2. Connect breaker to suitable supply.
   a. Connect test jumper (if available) to cell or test cabinet.
   b. If suitable supply not available, the breaker must be electrically operated several times after it has been installed in the cell in the test position. Before doing this, follow procedure in the following section entitled "Installing circuit breaker in cell". Be sure arc chutes and interphase barriers are installed before entering breaker in cell.

3. Close and trip the breaker electrically several times to insure proper operation.

SAFETY PRECAUTIONS

1. Before placing the circuit breaker in its cell, make sure that the circuit breaker frame will be adequately grounded to the ground-bus in the cell.

2. Be certain arc chutes and interphase barriers are installed before entering breaker in cell.

3. Check all main connections and contacts from bus to breaker and from breaker to line. Examine cell secondary contact connections. Make sure that phasing is correct, particularly if line feeds power into the breaker. This is extremely important if the breaker controls the output of a generator or synchronous motor.

4. It would be advisable to clean the circuit breaker with dry compressed air hose.

5. The upper part of the breaker, above the mechanism section, is normally enclosed by the interphase and front barriers, and the operator is protected from contact with live parts. Do not move the circuit breaker into the cell unless the barriers and arc chutes are in place. If, however, it is necessary to examine the action of the contacts, etc., with the breaker in the cell, the front barrier may be removed, but only in the "disconnect" or in the "test position". Never push the breaker in the "operating position" until all barriers are in place. In that position the breaker is live, whether closed or open.

6. Do not attempt to close the circuit breaker by hand against an energized circuit. The maintenance operating handle should only be used in testing the mechanical operation of the circuit breaker when not in the cell.

7. In order that sufficient closing force and acceleration are attained, the circuit breakers should be closed electrically from an adequate power source. See NEMA Standard SG-6-213.

8. Remove the circuit breaker from the cell when it is to be examined for maintenance or repair.

9. When testing the circuit breaker, make sure the circuit breaker control switch has a "do not operate" tag on it.

INSTALLING CIRCUIT BREAKER IN CELL

Before placing the circuit breaker in the cell, proceed as follows:

a. Before shipment, the circuit breaker closing relays in the top of the cells are "blocked". Remove these blocks, thus allowing the relays to operate.

b. See that the secondary sliding panel, with its plug-in block, is held at the front of the mechanism housing by its lock-pin.

c. Insert racking-in handle. Rotate handle counter-clockwise until lever-and-roller assembly is against its stop. This assembly is in the rear of the breaker on top of the mechanism housing. Racking-in lever should protrude outside the frame before placing breaker in frame.

Place breaker in its cell, and push until lever-and-roller assembly hits against horizontal racking-in hook which is mounting on rear of cell.

1. Rotate racking-in handle clockwise six (6) turns. Circuit breaker will at first back out a little and then go forward to Test position as shown by the indicators on the right-hand side-sheet.

2. Remove racking-in handle.

   To operate breaker in Test position, release secondary contact lock-pin and push sliding panel forward until its contacts engage similar contacts in the cell plug in block. The breaker can now be closed and tripped electrically several times to test the control circuits.

3. Insert the racking-in handle.

   The breaker is now open. Rotate racking-in handle eleven (11) more times clockwise. The shutter will be driven open as shown by its indicator. The secondary contact sliding panel will be automatically pushed toward the operator and locked in its operate position. The breaker is now in the operating position.

4. Remove the racking-in handle.

   The circuit breaker is ready for service, and should be closed and tripped electrically several times to assure that all control circuit connections and contacts are satisfactory. This should be done on a dead bus if possible. If the test must be made on a live bus, first read carefully the preceding section entitled "Safety Precautions".

   Close and fasten the cell door if breaker is to be tested on live bus.

5. When it is desired to rack the breaker into the Test position, first trip the breaker electrically by operating control switch, then insert racking-in handle.

   Rotate the racking-in handle counter clock-wise eleven (11) times. Shutter will close, and secondary contacts will be disconnected.

6. Remove the racking-in handle.

   To operate in Test position, release secondary contact lock-in pin and push sliding panel forward until its contacts engage contacts in the cell. The breaker can now be operated electrically in the Test position.

7. Insert the racking-in handle.

   The circuit breaker can be racked to the disconnect position by rotating the racking-in handle counter clock-wise six (6) times. The secondary contact sliding panel should be pulled forward to its operating position and locked there by its lockpin, otherwise there will be voltage on the control wiring of the circuit breaker.

Note:

As stated previously, under "Description", the circuit breaker has to be open before the operator can insert the racking-in handle into its socket. Therefore, it is impossible to rack a closed circuit breaker from Test to operating position, or from operating to test position.

GENERAL INFORMATION

5KV AND 15KV MAGNETIC AIR CIRCUIT BREAKERS

BREAKER - Dead Front - Figure 7

Note breaker has front steel plate that closes against angle irons in switchgear cell making a completely "dead front" arrangement!

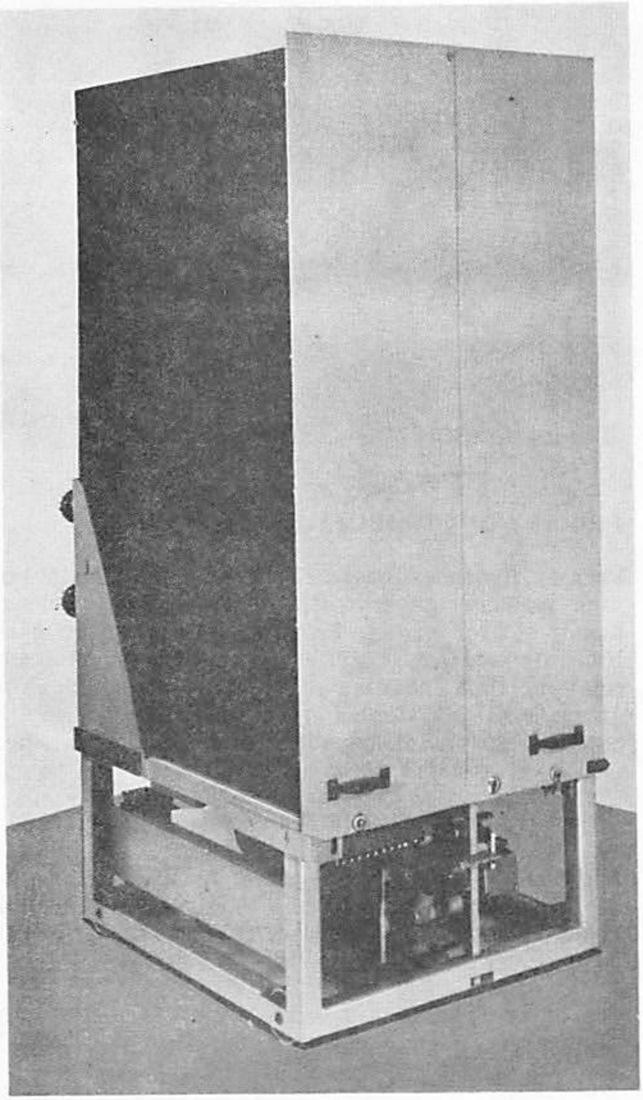


FIGURE 7

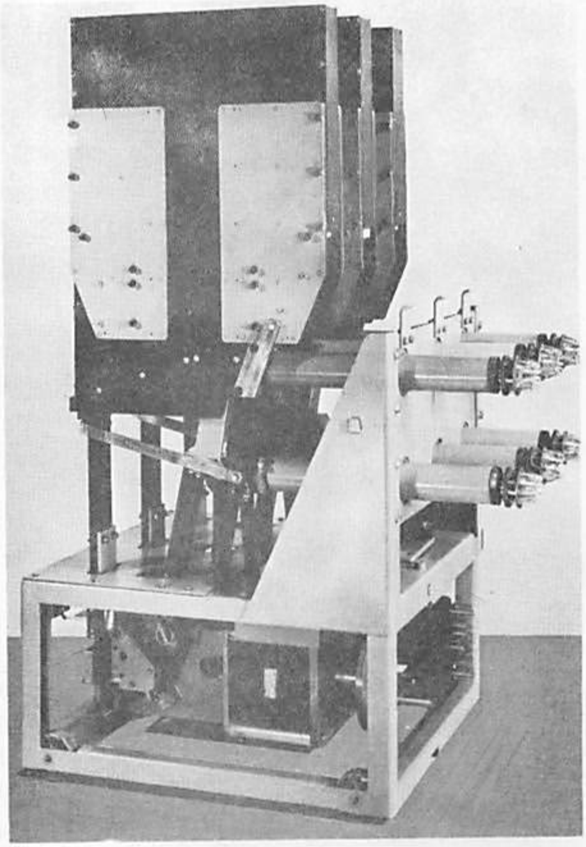


FIGURE 8

BREAKER FRAME - Figures 8 & 9

Breaker frame is a welded fabricated assembly of 1/8" and 1/4" thick steel very amply braced.

Four inch diameter wheels provide ease of withdrawal.

Breaker "position-indicator" mechanically locked with "breaker operating mechanism" provides positive visual indication of contact position.

Veeder counter is supplied to record number of operations.

GROUNDING - Figure 10 (I-11)

Breaker frame substantially grounded in both "operating" and "test" positions. 1/4" x 2" copper bar solidly bolted to breaker frame provides wiping action against stationary coil-spring loaded contact located in cell and formed of 1/8" x 2" copper.

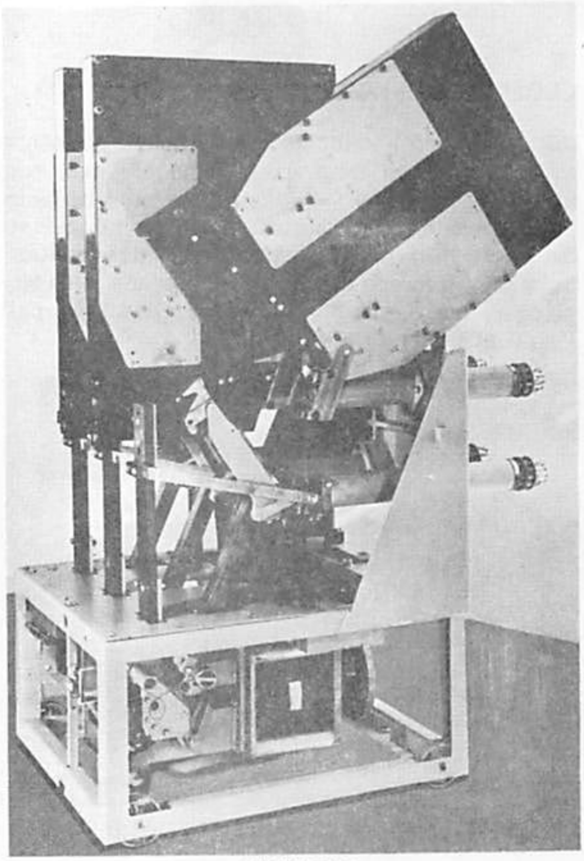


FIGURE 9

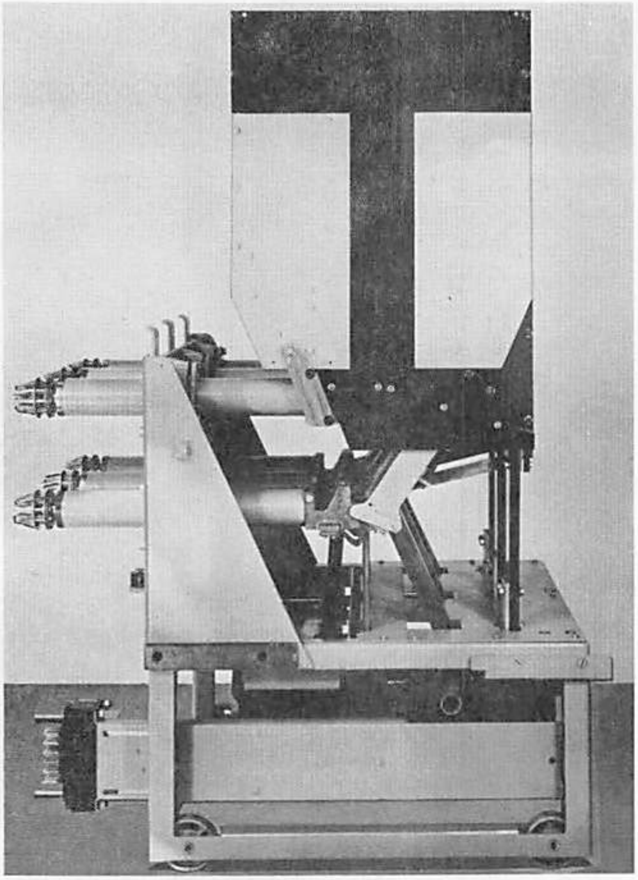


FIGURE 10

CLOSING SOLENOID - Figure 11

Note the closing solenoid plunger disc. At points near the close of the closing stroke (1) Breaker contacts are closing against considerable spring pressure and (2) The breaker may be required to close against fault currents within its full capability, which creates great mechanical forces tending to open the breaker. The plunger disc gives the solenoid additional pull and "zip" at the end of the stroke.

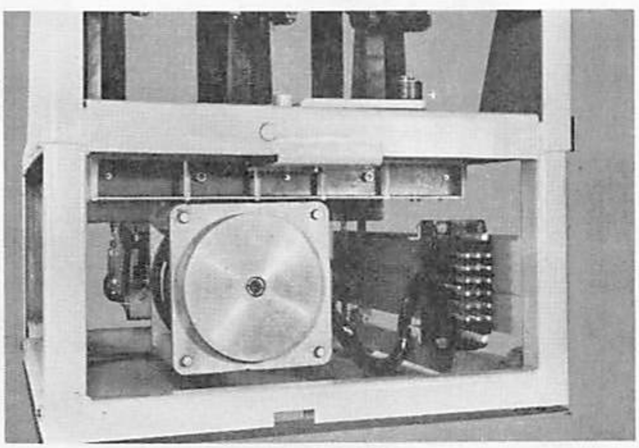


FIGURE 11

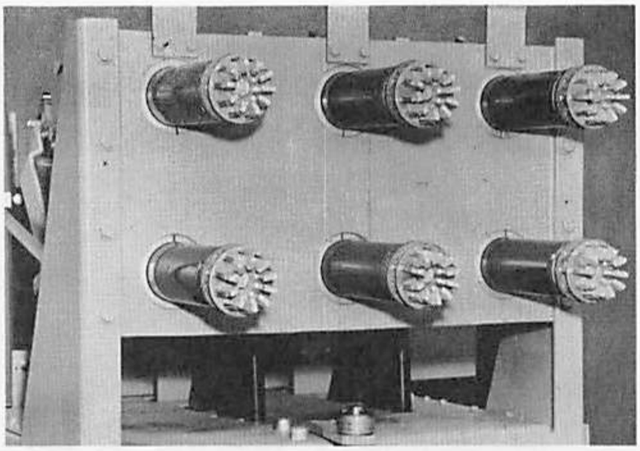


FIGURE 12

PRIMARY DISCONNECTS - Figure 12

Primary disconnects are self-aligning and consists of high pressure finger segments of extruded copper, heavily silver plated. Pressure is exerted on each finger by an individual leaf spring. A single brass retaining ring encircles the cluster of fingers. The disconnects are located on the breaker (not in the cell) for convenient inspection and maintenance when breaker is withdrawn from the housing.

SECONDARY DISCONNECTS - Figures 11 & 14

Secondary disconnect contact assembly may be (1) locked in place with pin to disconnect simultaneously with main contacts or (2) unlocked to remain connected with breaker in "test" position.

Secondary contacts may be readily engaged from front of breaker, before breaker is placed in "operating" position.

Horizontal travel of contacts considerably exceeds exact distance from "operating" to "test" position which eliminates any critical adjustment of contact movement.

"RACKING-IN" - Figures 11 & 12

The "racking-in" device is simple - positive - sturdy. Only two moving parts: (1) Horizontal shaft, manual crank on one end; worm gear on opposite end. (2) Horizontally rotating lever with cam roller and spur gear.

Requires only 17.5 turns for full travel of lever cam.

Breaker is in "test" position (clearly indicated in cell) before lever cam rotates to end of travel. This means breaker is firmly locked in cell in "test" position.

INTERLOCKING - Figures 13 & 14

Simple positive interlock bar that:

(1) Prevents insertion of "racking-in" crank, unless interlock bar is raised.
(2) Physically locks bottom of breaker to cell in "operating" position and prevents insertion from "test" position unless raised.
When interlock bar is raised it:
(a) trips breaker
(b) renders closing mechanism mechanically and electrically trip-free.

KIRK INTERLOCKS

Kirk interlock may be mounted in cell to prevent breaker insertion unless other equipment is in desired position.

Any electrical Kirk interlock scheme may, of course, be provided.

PUFFER - Figures 11 & 15

A single, large-sized puffer serves all three phases. This design gives the breaker the desirable characteristic of fast interruption on low currents. Air currents are conducted to each pole by three polyvinyl tubes.

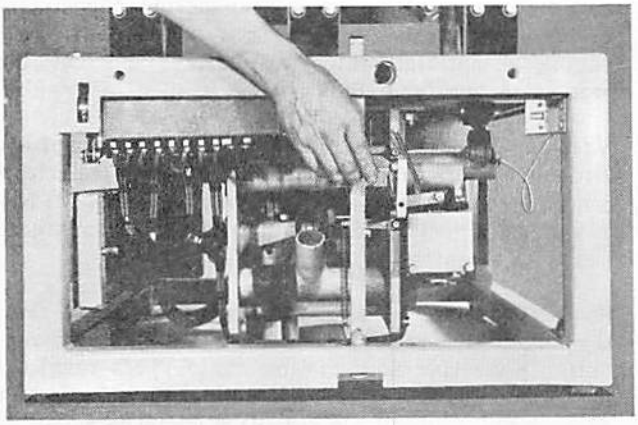


FIGURE 13

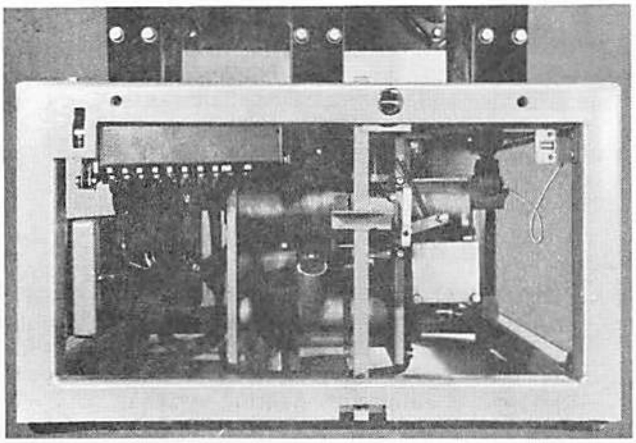


FIGURE 14

INTERRUPTION PRINCIPLE - Figures 16 & 17

Interruption is accomplished by the principle of elongation and cooling of the arc. The arc is magnetically forced into a series of closely spaced insulating barriers. The barriers both elongate the arc and at the same time absorb heat from the arc, thereby increasing the electrical resistance of the arc path. At an early current zero, the arc is interrupted. The arc path is so long and arc gases have been so cooled that re-ignition of the arc cannot take place and circuit interruption is accomplished.

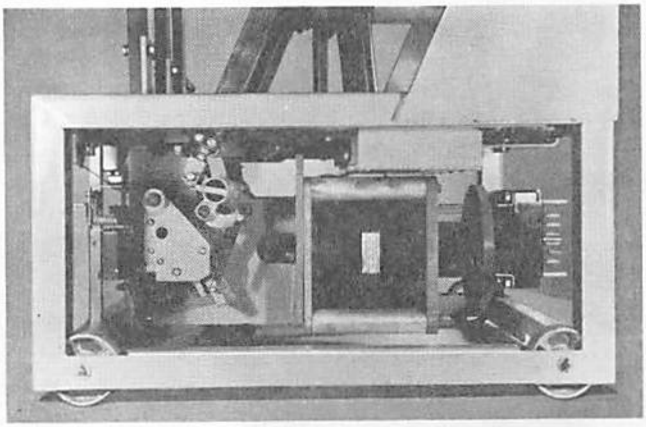


FIGURE 15

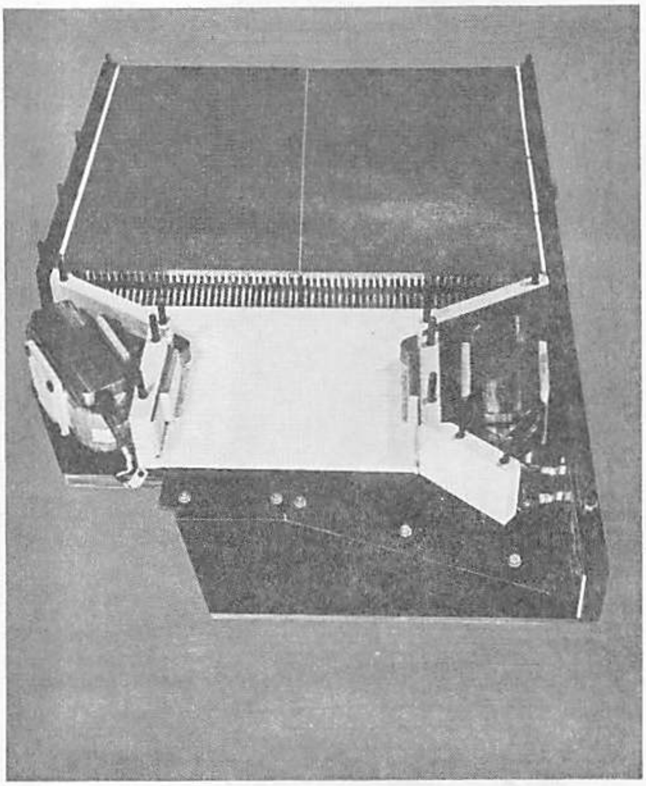


FIGURE 16

ARC CHUTE - Figure 9

By removing one bolt, the arc chute may be easily pushed back on a hinge, so contacts can be inspected. This is a very desirable maintenance feature.

CONTACTS - Figure 18

Main contacts of heavy copper and inlaid silver carry the normal operating current when breaker is in operation. Arcing takes place between contacts of special alloys which are extremely resistant to arc damage.

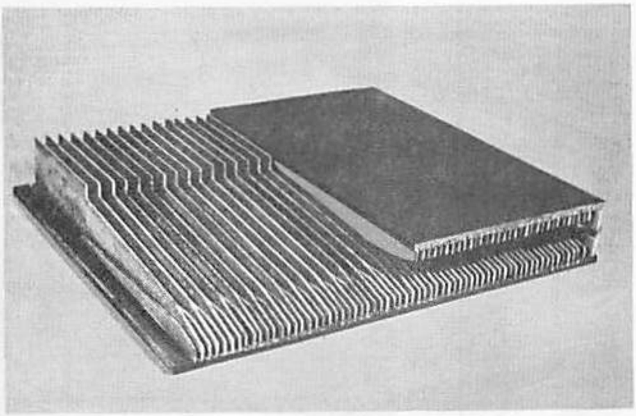


FIGURE 17

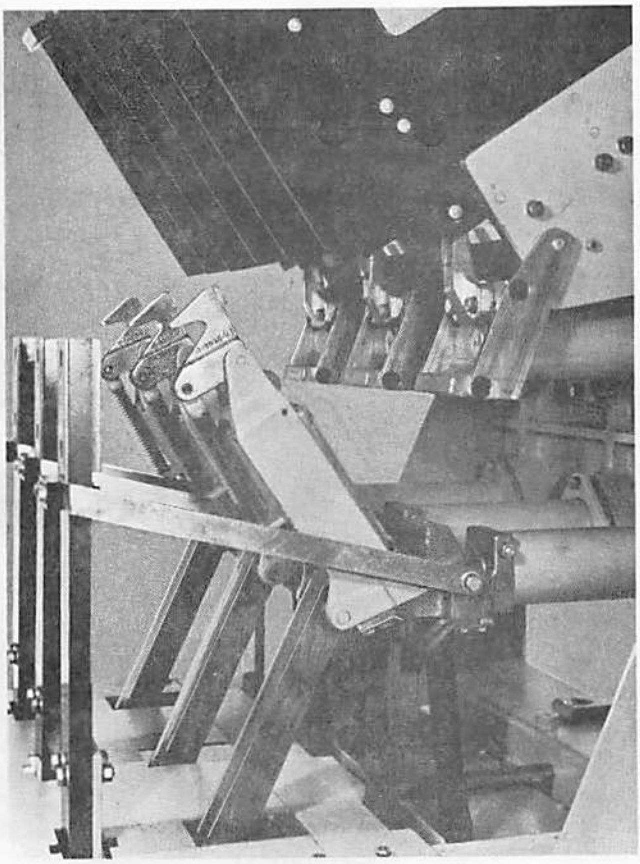


FIGURE 18

BAFFLE MATERIAL OF 15KV MAGNETIC CIRCUIT BREAKER - Figures 16 & 17

During fault interruptions, the arc which has a temperature of several thousand degrees F comes into intimate contact with the splitter plates or baffles. The material of the baffles must be able to withstand this drastic heat-shock without cracking or otherwise disintegrating.

The arc core is surrounded by hot gases which need to be cooled at a high rate. Fast propagation of the arc helps to expose large areas of the cool baffle plates to these hot gases. Porosity of the baffle material is of particular benefit for this action because it multiplies the surface area in contact with the gases.

The three principle attributes which we are looking for are:

1. High heat-shock properties.
2. Porosity without mechanical weakening.
3. Stability under high humidity.

These three qualities are not independent of each other and the problem for the engineer consists in combining them into the best possible compromise. Federal Pacific engineers have succeeded in producing a material which we believe has the best properties available today.

Heat shock resistance is generally a property of high zirconium-content materials and our baffle material is a *high zirconium-content refractory* for which we have developed special treatments to assure the highest heat-shock resistant properties.

Some materials when subjected to high local temperatures, expand and contract at different rates during a heating and cooling cycle. This results in permanent distortion with high "locked-in" stresses. At each short circuit the condition becomes worse and eventually leads to cracking of the plates. Our material is stable in that respect and no internal stresses develop.

Porosity has been increased progressively during the development of the DST breaker and our present material due to its porosity has large effective area.

Moisture absorption consists essentially of two types:

A. Mechanical absorption of moisture.
B. Chemical binding of moisture.

A. Mechanical absorption of moisture is determined by dipping the material in water and then measuring the amount of water absorbed. If the absorption is of mechanical nature only, then the water can be driven out quickly by heating to about 220°F. It is most desirable to be able to drive out *all* of the water in this manner and not have any chemical binding. Any porous material has the ability to absorb varying quantities of water by this dipping process but so long as the water can readily evaporate there is no detrimental side reaction to this type of water absorption.

B. When water is chemically bound, it can usually not be driven off by a 220°F heating cycle but must undergo a much longer heating at higher temperature, say 400°F. This type of water absorption is very undesirable and usually leads to excessive warpage of the plates while in service.

The Federal Pacific baffle material has shown no tendency to warp because it does not chemically bind moisture.

BAFFLE ASSEMBLY - Figure 17

Baffles on alternate sides of the assembly are staggered in such a manner as to elongate the arc more and more as it ascends in the arc chute.

VEEDER COUNTER AND POSITION INDICATOR - Figure 14

Breaker "position-indicator" mechanically locked with "15KV operating mechanism" provides positive visual indication of contact position.

Veeder counter is supplied to record the number of operations.

INSTRUCTIONS AND ADJUSTMENTS TYPE DST-5-250 AND DST-15-500 MAGNETIC AIR CIRCUIT BREAKERS

Basic Adjustments

1. Blade travel and contact engagement
2. Arc-chute installation and adjustment
3. Mechanism description
4. Mechanism adjustments (general)

Mechanism Adjustments

1. Adjustment roller to closing-lever
2. Adjustment prop to roller
3. Adjustment solenoid travel
4. Adjustment overtravel stop
5. Solenoid back-travel check

Latch Adjustment

Mechanism Check-points

Solenoid cut-off switch adjustment

Puffer

Shock absorber

Auxiliary switch contact

Contact adjustments

1. Main
2. Arcing
3. Cluster

Interlock and racking-in mechanism adjustment

1 - Blade Travel and Contact Engagement

The total travel of the breaker mechanism from the open to the closed position is set in the factory and may not be altered. Therefore, any adjustment of the contacts made in the closed position will alter, to a slight degree, the position of the blade when the breaker is open. With the breaker in the closed position as shown in the general assembly drawings, the deflection of the main bridging contacts should be 1/8 to 1/32. This is usually measured by scribing a mark on the copper bar when the breaker is closed. Then scribing another mark when the breaker is open. (These marks coincide with the edge of the blade castings on both positions). The distance between the two marks should measure 1/8 to 1/32. To alter this adjustment, it is necessary to alter the effective length of the operating rod by means of its threaded adjustment:

1. Remove the pin connecting the operating rod to the moving blade casting.
2. Loosen lock-nut at opposite end of rod (mechanism cover may be removed to do this).
3. Make one-half turn adjustment of rod as necessary to secure contact deflection desired.

   Note: One-half turn alters contact deflection approximately 1/32".
4. Reassemble and tighten.

2 - Arc-chute Installation and Adjustment

The arc-chute can be installed relatively easily if the hinge pin and one vertical support-plate are on the arc-chute assembly before it is lifted into position. Then either manually or by help of an overhead crane, the arc-chute, held in a generally tilted-back position, may be guided so that the pin will engage the hole in the support plate that is left fixed to the upper bushing. With this condition achieved, it is relatively easy to engage the flathead screws to hold the other upper plate to the bushing.

Note for 5KV breaker: **Caution!** Install copper spacer when mounting arc-chute.

The arc-chute may now be tilted forward and the front support bolt or bolts tightened. It is then possible to make the terminal connections between the coil and the upper bushing. If the arc-chute is not vertical when mounted, it is usually possible to tip it the necessary amount after front support bolts are loosened ..... (15KV only).

3 - Mechanism Description

The closing mechanism is a solenoid operated mechanical trip-free mechanism which closes and latches the breaker against the operating forces exerted by the contacts, operating spring, and electro-magnetic forces due to short circuits. At any position during the closing operation the breaker may be tripped open, free of the closing energy. The solenoid pushes on the closing lever which is shaped somewhat like a crescent. This force is then transmitted to the main operating shaft of the breaker through a roller which is held in a fixed relation to these two parts. If the position of the roller is altered, it breaks the connection between these parts, and the main shaft is then free to move to the open position.

The roller is held in its fixed relationship to the moving parts by the latch assembly.

Depressing the magnet armature releases the latch, allowing the two internal toggles to collapse and thus release the roller from its relatively fixed position.

During a normal closing operation this latch linkage remains firm, allowing the solenoid and closing lever to rotate the main shaft all the way to its closed position. At this point a prop snaps into place engaging the latch roller and holding the main shaft in the closed position. Simultaneously, the solenoid cut-off switch operates to de-energize the solenoid, and, after the necessary decay of current, the solenoid and closing lever return to their initial position leaving the operating shaft in the closed position as held by the roller and the prop.

4 - Mechanism Adjustments

The most important adjustment of the mechanism is that of the roller. The tangent point between the roller and the flat surface it rests against should be approximately 1/8" from the lower corner of the flat surface. There are two such flat surfaces involved; one on the nose of the closing lever - the other on the end of the prop.

The first step in this procedure is to adjust the position of the roller with respect to the closing lever. This is done by altering the position of the main latch assembly by the insertion or removal of spacing washers that bolt this assembly to the mechanism frame. With the roller thus adjusted to the closing lever, the breaker may be closed, and the position of the prop may then be adjusted to the roller by means of the adjusting castle-nut on the prop return spring rod.

With this accomplished, the face of the prop and the face of the closing lever will coincide when the breaker is in the closed position or when the closing lever is brought up lightly against the roller (by means of the maintenance manual closing lever).

Mechanism Adjustments

1. Adjust roller to closing- lever face.
   (a) Tangent point of roller 1/8" from bottom corner.
   (b) Adjust by varying spacers in latch.
2. Adjust prop to roller.
   (a) Tangent point 1/8". Same as closing-lever.
   (b) Adjust by castle-nut on prop spring guide.
3. Adjust solenoid travel.
   (a) Close breaker manually.
   (b) Push solenoid plunger until it hits lightly against closing lever and trip-free roller.
   (c) Gap between brass washers and solenoid back plate 3/32"-1/8". (over-travel)
   (d) Adjust by changing shims inside plunger.
4. Over-travel stop adjustment. Adjust so that:
   (a) Mechanism cannot go over dead center.
   (b) Puffer piston does not hit rear spacer tubes.
   (c) Auxiliary switch linkage does not go over dead center.
   (d) Gap between stop and main shaft should be at least 1/8" minimum when breaker is closed. **Caution!** A check should be then made (manually) to insure that this adjustment does not allow the mechanism to lock on dead center.
5. Solenoid back-travel check.
   (a) Space between closing lever and roller, when circuit breaker is open, should be 1/16" to 1/8".
   (b) 5KV only - Projection of solenoid plunger beyond breaker frame 1-1/4" maximum,

Latch Adjustment

1. Latch armature engagement with segment.
   (a) 1/16" to 5/64".

2. Gap between armature and segment when latch is unloaded 1/16" to 3/32".

3. Adjust magnet frame to allow 1/32" to 1/16" over-travel of armature after latch trips.
   (a) Gap between armature rivets and magnet pole face approximately 3/8" when latch is set.

4. Force to trip breaker approximately 4 lbs.

5. Latch should break freely when armature is depressed when latch reset spring is overcome by hand.

6. Latch engaging surfaces on armature and segment should be free of paint or foreign matter.

7. Magnet pole face should be lined up with armature face.

Mechanism Check Points

1. Latch must reset under all conditions (mechanical and electrical).

2. With latch armature depressed, breaker should trip free before contacts have traveled half-way closed.

3. Latch must have at least 1/32" clearance.

4. At least 1/8" clearance between closing lever and trip free roller.

5. Cut-off switch operates simultaneously when prop engages roller.

6. Over-travel stop is not hit before the closing armature has touched the solenoid backplate and will not let breaker lock on dead center.

Solenoid Cut-Off Switch Adjustment

1. The solenoid cut-off switch is adjusted so that it closes its contact as prop snaps into position.

2. When the mechanism settles back onto the prop, the cut-off switch contacts must remain closed.

Puffer

1. Should be free of any binding.

2. Should be air-tight enough to restrict opening of breaker when nozzles are closed.

3. Should not be lubricated.

4. Piston should not hit tubular spaces in back.

Shock Absorber

1. Should be lubricated inside with Lubriplate or equivalent.

2. Orifice size selected will permit 10% bounce or normal opening. Trip-free opening will have more bounce (approximately 25%).

3. Piston-ring gaps should be 180° opposite from each other.

Auxiliary Switch

1. Linkage should not go over dead center on closing.

2. "A" switches make just before arc contacts touch.

3. Trip coil "A" switch makes 1" or sooner before arc trips make.

4. "B" contacts make after 60% of the breaker opening stroke.

Contacts

1. Main Contacts

   (a) 1/8" ±1/32" deflection at top of bars on all 3 poles.

   (b) Make certain the two bolts at each end of the insulating support are tight.

   Note: The vertical insulating piece that supports the lower bushing from the breaker frame must be tight before these adjustments are made. Any loosening of the bolts holding this support will allow an upward movement of the lower bushing when the breaker is being closed, thus reducing contact deflection.

   (c) Clean and bright.

   (d) 50% of line to line when checked with carbon paper and thin tissue on manual closing.

   (e) 3/8" gap ± 1/16" when arcing contacts touch.

2. Adjustment of Arcing Contact

   (a) To adjust arcing contact, close breaker manually until the main upper contacts are separated by 3/8". At or near this point, the arcing contacts just touch. To adjust this, merely adjust the nut at the end of arcing contact spring rod.

   (b) With the individual phase thus adjusted, fine adjustment may then be made to effect simultaneously making of the three arcing contacts 1/16" of each other.

3. Cluster Contacts

   (a) Inside diameter of fingers. (Without tension).

   1200 amp. 1-1/8" - 1-1/4"
   2000 amp. 1-5/8" - 1-3/4"

   (b) Should be free to align to stud that is 3/16" off center in any direction without reducing contact pressure.

Interlocking must be adjusted to insure tripping of the breaker before the racking-in handle can be inserted. Fig. 19-A. This is done by adjustment of the eccentric cam on the interlock. Fig. 19-B.

1. Main contacts should be open 3/8" when arcing contacts touch. Fig. 20-A.
2. Arcing contact adjusting nut. Fig. 20-B.
3. Main contact bridging member. Fig. 20-C.
4. Pull pin to adjust push-rod. Fig. 20-D.
5. Shunt carries full current only during a portion of the interrupting time. Fig. 20-E.
6. Periodically test tightness of bolts. Fig. 20-F; Fig. 21-B.
7. Adjust main contact deflection by rotating push-rod on threaded clevis, 1/2 turn 1/32" on main upper contact. Fig. 21-A.
8. Main pivot axis. Fig. 21-C.
9. Interlock, Fig. 19-B, should trip the breaker before crank can be inserted into hole. Fig. 19-A.

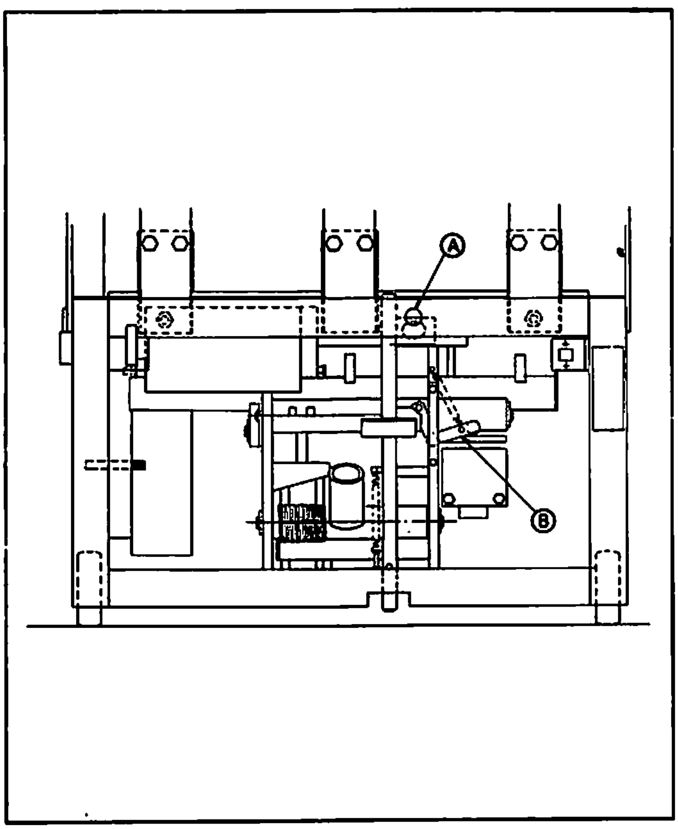


FIGURE 19

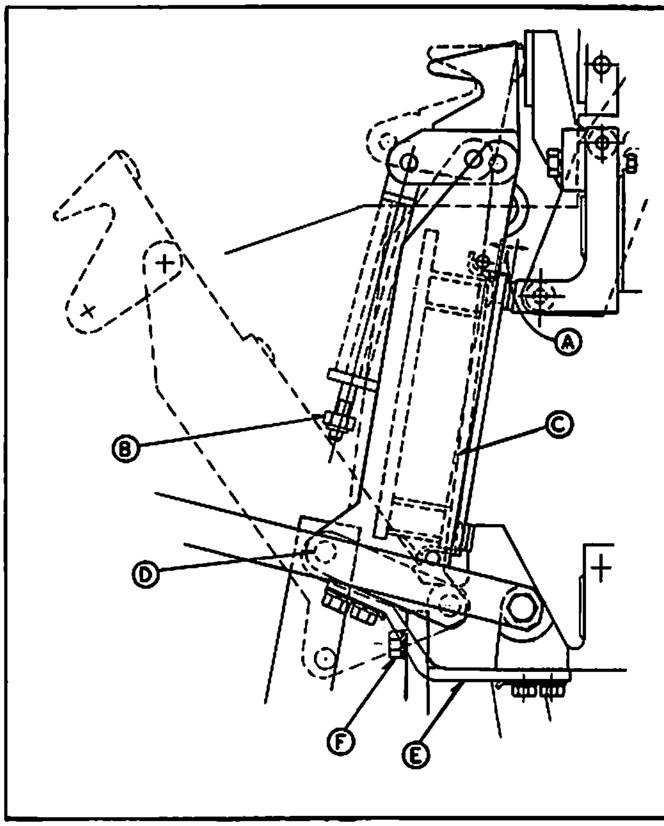


FIGURE 20

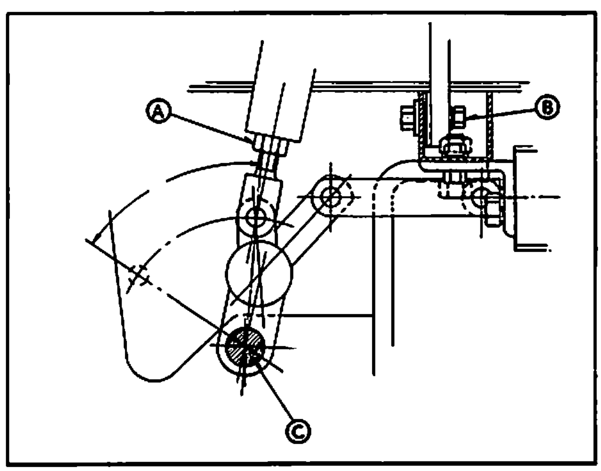


FIGURE 21

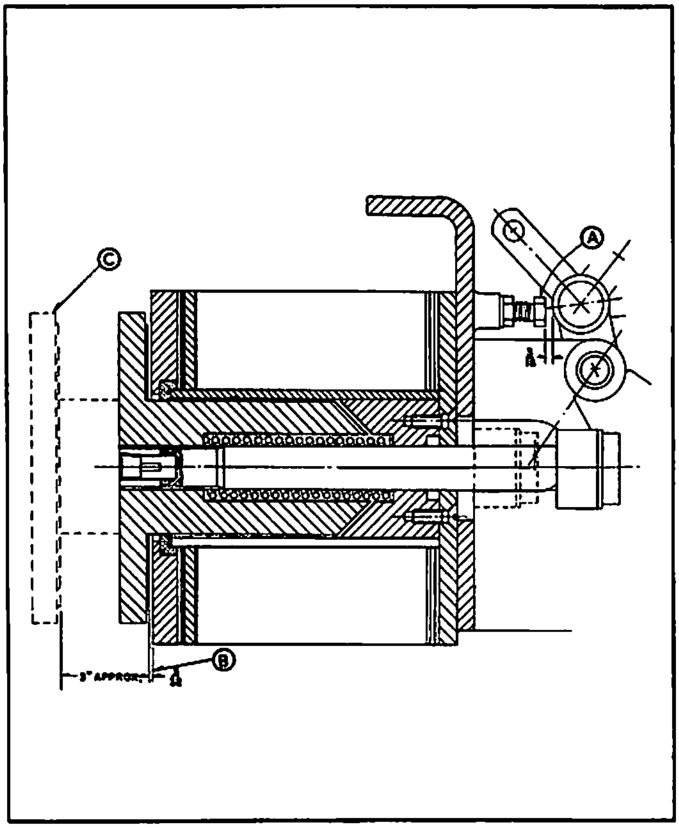


FIGURE 22

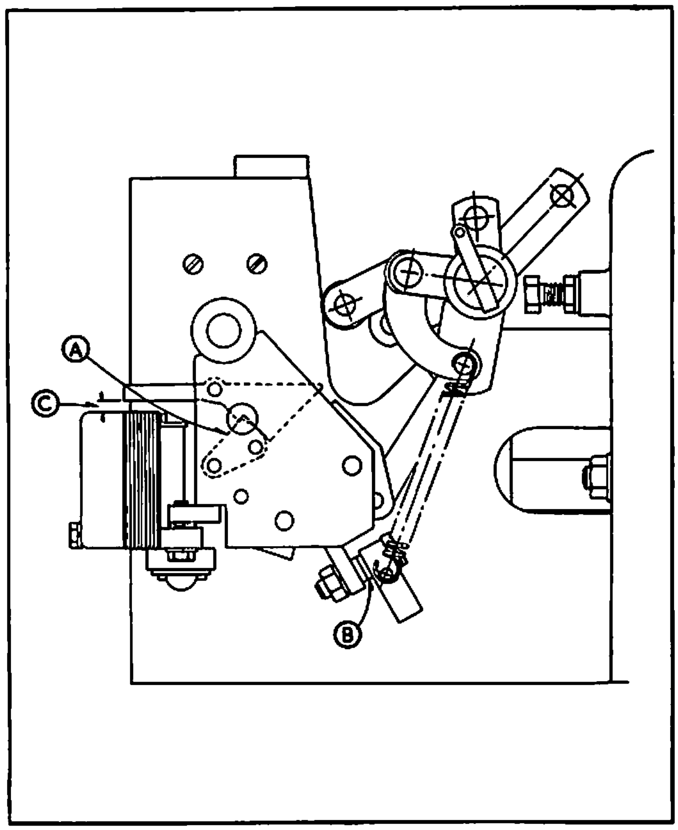


FIGURE 24

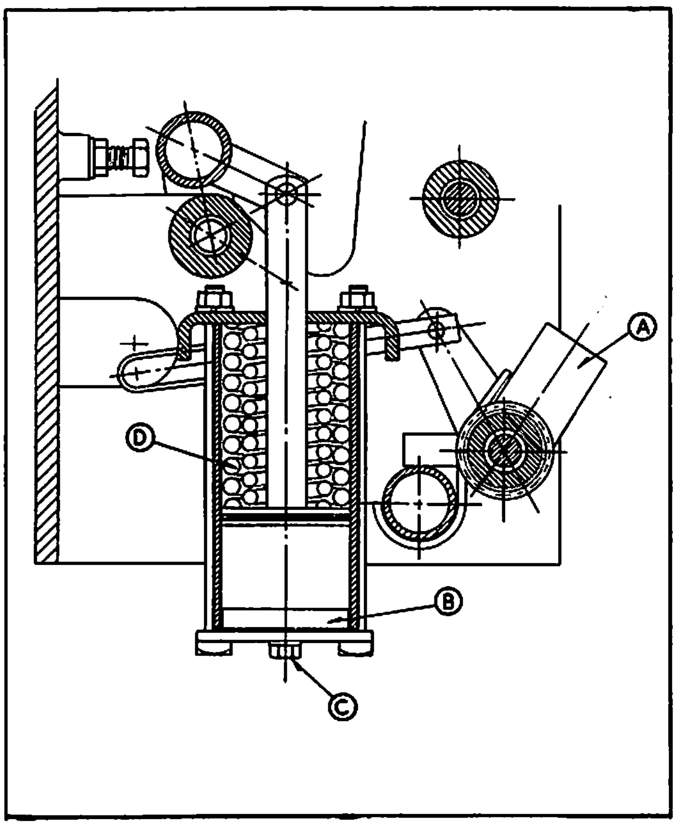


FIGURE 23

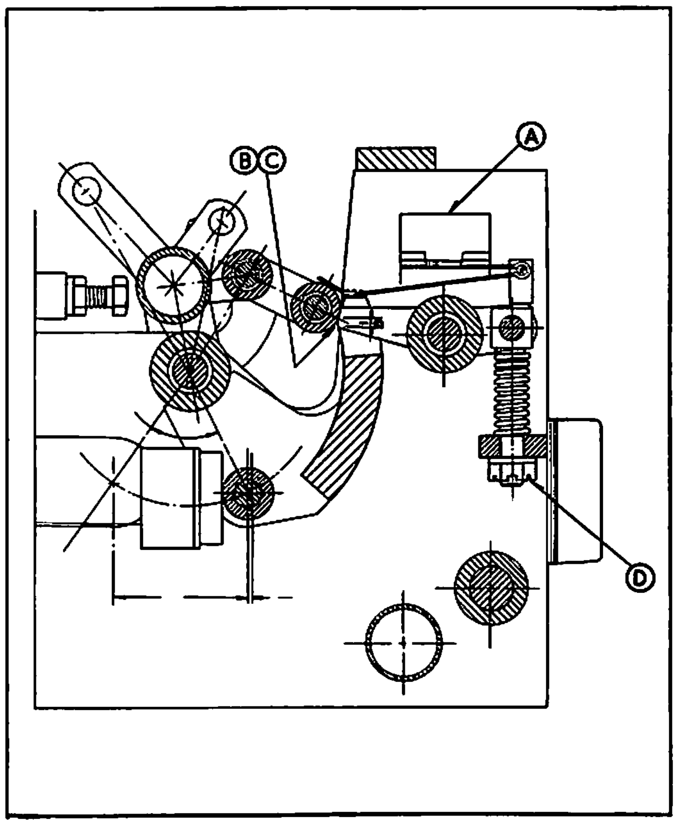


FIGURE 25

Fig. 22 15KV DST Mechanism Adjustments

1. Over-travel stop, Fig. 22-A, keeps main shaft from going dead center, but should not contact main shaft during electrical operation.
2. Adjustment, Fig. 22-B, should be 3/32" approximately. This gives enough travel to insure prop snapping into place.
3. Fig. 22-C is de-energized position of solenoid-plunger when breaker is in either open or closed position.
4. Manual closing lever. Fig. 23-A.
5. Neoprene pad to reduce shock. Fig. 23-B.
6. Exhaust orifice of shock absorber. Fig. 23-C.
7. Fig. 24-A - Latch rotates and permits toggle to collapse when armature is depressed.
8. Main opening springs. Fig. 23-D.
9. Varying number of spacers will adjust position of latch-roller to closing lever. Fig. 24-B.
10. Solenoid cut-off switch should operate only after prop snaps into position shown (breaker is closed). Fig. 25-A.
11. Tangent point of roller on surface to be 1/8" approximately from lower corner of surface. Fig. 25-B.
12. Adjust roller to closing-lever by moving latch-assembly. Fig. 25-C.
13. Nut to adjust prop to roller. Fig. 25-D.
14. 3/8" or enough gap to insure tripping. Fig. 24-C.

METHOD OF OPERATION

SEE SCHEMATIC DIAGRAM - Figure 26

Closing:

Assuming breaker is in the open position with voltage on the control bus, close control switch contact cs/c. Control relay 52/x is energized through a normally closed 52/y contact. Two (2) circuits are made simultaneously when control relay 52/x contacts close.

a. Seal-in circuit: Control relay 52/x is sealed in through its own contact which parallels cs/c contact.

b. Closing coil circuit: Control relay 52/x energizes the breaker closing coil 52/cc which closes the breaker.

Cut-off switch 52/aa closes just prior to the breaker main contacts, energizing the anti-pump relay, 52/y, through the 52/x seal-in contact. 52/y seals itself in and will remain energized until contact cs/c opens.

The normally closed 52/y contact in the control relay (52/x) circuit opens, thereby de-energizing 52/x which in turn breaks its seal-in contact and de-energizes the breaker closing coil.

Should the operator close the control switch when the breaker is already closed, the closing circuit will not again be energized - the 52/y coil will be energized through the cs/c and 52/aa contacts thus keeping the control relay (52/x) circuit open.

Anti-pump Feature:

If the operator closes the control switch, and holds the switch in that position when there is a short circuit on the load side of the circuit breaker, the overcurrent relays will function and energize the shunt trip coil, which will trip the breaker open.

Reclosure (pumping) of the circuit breaker is prevented because at that instant the 52/y coil is energized and its 52/y contact in the circuit of the 52/x coil is open. Therefore, the control relay 52/x cannot be energized and thus attempt to close the breaker again.

Suppressor Rectifier:

This rectifier is shown across the solenoid closing coil 52/cc. Its function is to limit the inductive kick when the circuit is opened and thus reduces the arc across the 52/x contacts in series with the 52/cc coil.

It is used only when the control circuit is direct current.

Opening:

Assuming breaker is in the closed position, energizing the trip coil from control switch or relays opens the circuit breaker by mechanical action of its operating mechanism.

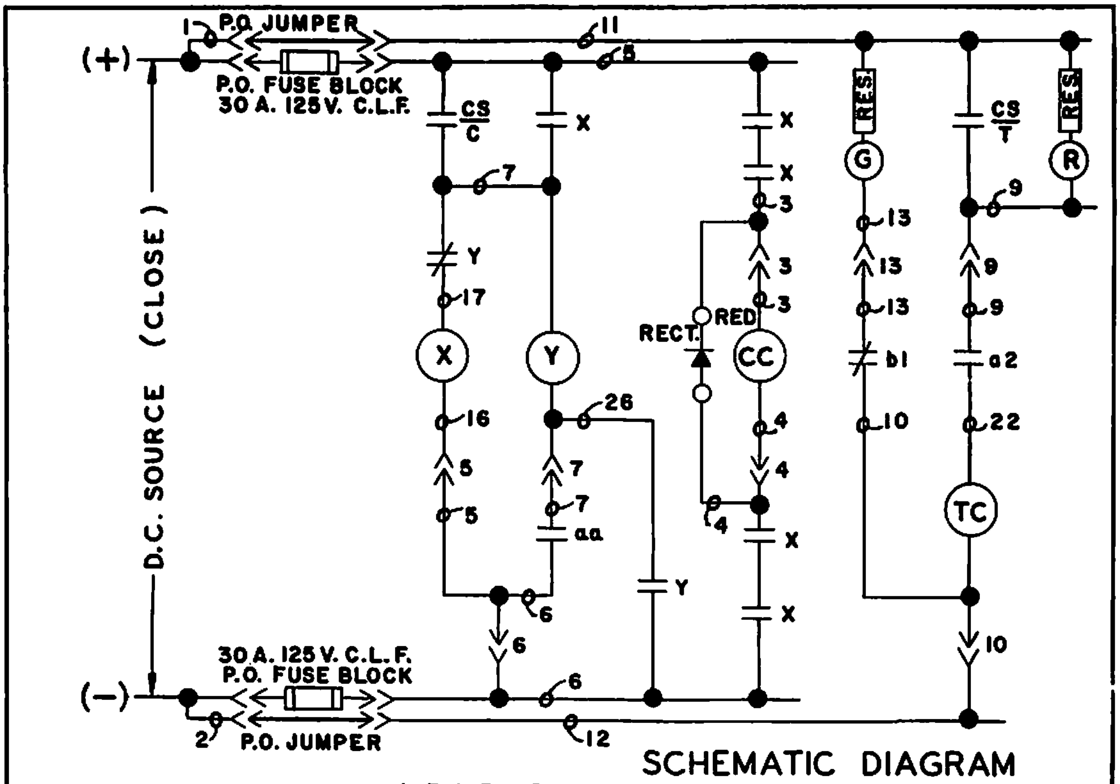
Special Note:

This instruction covers the circuit breaker as manufactured in standard form. It is necessary to refer to the actual diagrams supplied with the circuit breaker, because the diagram shown is typical, and there are many variations for meeting job requirements.

SOURCES OF CONTROL

Federal Pacific Type DST Air Circuit Breakers are operated by d-c solenoids and shunt trip coils. The following methods of operating are available.

Station Battery Closing and Tripping. The recommended method of operation of the DST air circuit breaker is by means of 125 volt d-c station battery-the most reliable source of power because it is essentially



LEGEND

CS/C CONTROL SWITCH CLOSE CONTACT.	CONTACT OPEN WHEN DEVICE IS DE-ENERGIZED.
CS/T CONTROL SWITCH TRIP CONTACT.	CONTACT CLOSED WHEN DEVICE IS DE-ENERGIZED.
(R) RED INDICATING LIGHT (CLOSED)	DRAWOUT DISCONNECT
(G) GREEN INDICATING LIGHT (OPEN)	X AUXILIARY RELAY
	Y AUXILIARY RELAY
	CC CLOSING COIL
( ) OPERATING COIL OF DEVICE	TC TRIP COIL
	P.O. PULL OUT
RECT. SUPPRESSOR RECTIFIER FOR D.C. CONTROL ONLY.	C.L.F. CURRENT LIMITING FUSE

FIGURE 26

independent of the a-c system conditions, and is available at all times.

Rectified AC Closing. This type of operation finds its greatest application in outdoor installations or small isolated indoor installations where the housing and maintenance of a 125 volt station battery creates a major problem. A single phase operating transformer is used to supply 240 volt a-c to a rectifier, which furnishes 125 volt d-c to operate the breaker.

Tripping Battery. If a breaker is a-c closed, it is recommended that a d-c tripping battery be supplied. A constant, reliable source of tripping power is essential for a well-designed, dependable substation.

Capacitor Trip. In applications where it is impractical to supply a source of d-c control, a 240 volt a-c capacitor trip may be used. This requires that a potential transformer be connected to the incoming line ahead of the circuit breakers so that the capacitor trip device is energized before the breaker is closed. A 125 volt d-c shunt trip coil is used.

RATED CONTROL VOLTAGES AND THEIR RANGE

Rated control voltages and their ranges for control and power supply of operating mechanisms of breakers, when measured at the terminals of the mechanisms are;

CLOSING COILS

Source Voltage	Coil Voltage	Symbol	Amps.	Voltage Range
125 DC	125 DC	1551-1672	100	90-130
250 DC	250 DC	1552-1672	50	180-260
230 AC (Note #1)	125 DC	1551-1672	100	190-250
230 AC (Note #2)	125 DC	1553-1672	84	190-250

TRIP COILS

24 DC	24 DC	1551-0409	25.6	14-30
48 DC	48 DC	1554-0409	12.3	28-60
125 DC	125 DC	1551-1003	5	70-140
250 DC	250 DC		2.5	180-260
Capacitor Reactor	125 DC	1551-1003	–	190-250

WIRING DIAGRAMS

Scheme	Symbol: Without Latch Check	Symbol: With Latch Check and Lockout
DC close and trip	1501-0395	1501-1955
AC close DC trip	1501-0394	1501-1956
AC close capacitor trip	1501-0396	1501-1957

Nameplate Marking

DST 5-75, 150, 250	DST 15-150, 250, 500
Rated KV 4.16	13.8
Max. Des. KV 4.76	15.0
BIL KV 60	95
Rated freq. 60	60

Closing and trip volts are coil voltages not source voltages.

NOTE #1 - For use with DST 5-250, 15-500, 1200A and all 2000A breakers.

NOTE #2 - For use with DST 5-75, 5-150, 15-150 and 15-250, 1200A breakers only.

FIGURE 27

Coil Data

Closing coil
Closing time approximately 5 cycles after coil is energized.

Shunt trip coil
This coil is also used when capacitor trip device is specified.

Tripping time approximately 3.5 cycles from the time the coil is energized until the arc is broken.

Test Data

50 Micro-ohm resistance top to bottom of main contact.

Insulation test
10,000 megohms to ground

Dielectric test - DST-5 air circuit breaker 19 KV, 60 cycle, one minute dielectric withstand. (Test should be made with arc-chutes and interphase barriers in position, and from phase-to-phase and phase-to-ground).

Dielectric test - DST-15 air circuit breaker 36 KV, 60 cycle, one minute dielectric withstand. (Test should be made with arc-chutes and interphase barriers in position, and from phase-to-phase and phase-to-ground).

Secondary control wiring

1500 volt, 60 cycle one minute dielectric withstand.

Milli-Volt Drop Tests
Subject to Modification

	Upper Flange to Lower Flange	Stud to Stud Without Clusters	Stud to Stud With Clusters
5KV			
1200		40	
2000		25	
15KV			
1200		50	
2000		35	

AIR CIRCUIT BREAKER MAINTENANCE

Federal Pacific Electric Company high voltage air circuit breakers are designed, tested and manufactured in accordance with NEMA Standards for power circuit breakers, Pub. No. SG4-1954 and as amended.

A periodic maintenance schedule should be established in accordance with NEMA Standards to insure years of trouble-free operation. The easily accessible arc-chutes, arc-contacts, many contacts etc. allow a complete inspection in a minimum of time.

Particular attention should be paid to NEMA SG4-5.07, paragraphs A & K, and a maintenance schedule put in effect based on the frequency of operation or six month intervals, whichever comes first.

Breakers installed under ideal operating conditions naturally should require less maintenance than those operating under more adverse conditions.

A convenient air circuit breaker log sheet is provided for each breaker.

NEMA - Standard for Power Circuit Breakers

SG4-5.07 repetitive duty and normal maintenance

Power operated breakers, when operating under usual service conditions, shall be capable of operating the required number of times given in the table on Page 34. The operating conditions and the permissible effect upon the breakers are given in the following paragraphs. For each column, all paragraphs listed must be given consideration.

Note: Conditions of switching of arc-furnaces or capacitors may require special consideration.

All parts of a breaker that function during a normal operation shall be included. Other parts such as overload coils, that function only during infrequent abnormal circuit conditions shall be excluded.

Servicing

Servicing shall consist of adjusting, cleaning, lubricating, tightening, etc., as recommended by the manufacturer. The operations listed are on the basis of servicing at intervals of six months or less.

Note: Federal Pacific Electric Air Circuit Breakers are designed as follows in accordance with NEMA SG4-2.13.

DST 5-75	1200 amp	Line	1
DST 5-150	1200 amp	Line	4
DST 5-150	2000 amp	Line	5
DST 5-250	1200 amp	Line	6
DST 5-250	2000 amp	Line	7
DST 15-150	1200 amp	Line	13
DST 15-250	1200 amp	Line	14
DST 15-250	1200 amp	Line	16
DST 15-500	2000 amp	Line	17

Visual Inspection

Arc-Chutes: Tip the arc-chute back on the hinge pin and check the condition of the blow-out coils, interrupting chamber and arc-runners. (Small pieces or flakes of the ceramic arc plates may chip off, if large pieces are broken a more thorough examination should be made to determine the extent of the damage.)

The interrupter chamber will become discolored with fault current interruption, (yellow, blue-green, or brown color but is operable unless mechanical damage is done to the arc-chamber or arc plates.

Arc-Contacts: The arc-contacts should be reasonably clean and free of pits, voids, and irregularities. A fine file may be used to dress the arc contacts. Minor pitting, etc., is to be expected under service conditions and will not necessitate replacement. Severe fault conditions will understandably cause more damage and may require replacement.

Arc-Contact Alignment: The arc-contacts should make before the main contacts and break after the main contacts. The stationary arcing contact is not adjustable, but the moving arc-contacts are individually adjustable, and should make within 1/16" of each other. (Close the breaker slowly with maintenance closing bar and observe three pole operation from the side of the breaker.)

Main Contacts: The main contacts should be reasonably clean and free of irregularities. Each contact is spring loaded, and in the open position the contact surfaces may not seat parallel. No current is interrupted by the main contacts and little or no pitting should be expected.

Main Contact Alignment: The lower set of main contacts should make before the upper set. Neither the upper or lower main contacts are adjustable, but are rather spring loaded. The lower and upper contacts should deflect 1/8". The upper main contacts should be 5/16" apart when the arcing contacts touch. (Close the breaker slowly with the maintenance closing bar and observe three pole operation from the side of the breaker.) A positive check on contact alignment is as follows: Insert a piece of white paper against the fixed main contacts with a piece of carbon paper between the white paper and moving contacts. Close the breaker slowly with the maintenance closing bar until it is latched closed. Trip the breaker manually and observe the contact line imprints on the white paper. A line contact of 50 ° per cent per contact is acceptable.

Auxiliary Switch: The "b" contacts should make in the open position and the "a" contacts in the closed position. The fingers of the auxiliary switches contacts can be dressed with crocus cloth if pitted. Severe pitting should be investigated circuit-wise and the auxiliary switch replaced.

Secondary Disconnects: The male prongs of the secondary disconnect should be clean and free of pitting. The molded housing should be reasonably clean and free of grease. (A small amount of petrolatum may be used on the two large guide pins and the small interlock pin.) Crocus cloth may be used to dress the male connectors.

Primary Disconnects: The primary disconnects should be clean and free of pitting. All the springs should be tight and the entire assembly should rotate freely on the stud. Loose springs will cause pitting of the contact areas and heating of the cell bushings as well as the breaker. Primary disconnects should be replaced as an assembly.

Lubrication

Trip Mechanism: A good grade of silicon grease or other lubricant that does not become stiff in cold weather should be used to lubricate the trip mechanism. The trip trigger should be kept free of corrosion at all times. All of the pins, bearing, etc., are a combination of non-ferrous metals and no corrosion or settling should result if lightly lubricated.

Closing Mechanism: A good grade of silicon grease or other lubricant that does not become stiff in cold weather should be used to lubricate the closing mechanism. All of the pins, bearings, etc., are a combination of non-ferrous metals and no corrosion seizing should result if lightly lubricated.

Racking-in Mechanism: Any good grade of heavy grease may be used to lubricate the bearings, wormgear, etc.

Primary Disconnects: The leading edges should be lightly greased with petrolatum to provide less friction when racking-in. Caution: excessive petrolatum will melt off at high temperatures and establish a potential track path in the cell bushing.

Operational Inspection

Manual Close: Close the breaker slowly with the maintenance closing bar (arc chutes should be down and breaker completely operable except interphase barrier should be off). The breaker should close smoothly and easily.

A small amount of tremor should be experienced after the breaker latches in. **CAUTION:** Do not close breaker in operate position with maintenance closing bar or without interphase barrier.

Manual Trip: Trip the breaker by lifting the interlock trip bar. The breaker should trip easily with a minimum of lifting effort.

Electrical Close: Close the breaker by means of the test cabinet or in the test position in the cell.

Low Voltage Trip: Trip the breaker electrically with the trip voltage adjusted to the minimum voltage indicated.

Rated	Minimum
24V DC	14V DC
48V DC	28V DC
125V DC	70V DC
250V DC	180V DC
230V AC (CAP.)	190V AC

Note: The trip voltage should be measured across the trip coil, *not* at the source. The armature may be blocked up to prevent tripping to get a steady voltage reading.

Puffer and Arc Chutes: Place a piece of thin paper over each arc chute and trip the breaker. The air blast from the puffer will raise the papers if the puffer is functioning properly and the arc-chute is free of obstructions.

When corresponding with the Factory, the following information should be given:

VOLTAGE CLASS ______

CONTINUOUS CURRENT ______

INTERRUPTING RATING ______

CLOSING VOLTAGE ______

CLOSING VOLTAGE RANGE ______

TRIP VOLTAGE ______

TRIP VOLTAGE RANGE ______

DATE INSTALLED ______

OPERATION COUNTER WHEN RECEIVED ______

OPERATION COUNTER WHEN INSTALLED ______

SERIAL NUMBER ______

REPLACEMENT OF COILS

Shunt-trip coil

Remove circuit breaker from cell.
Disconnect shunt-trip leads from terminal block.
Two hex head bolts support the shunt-trip device.

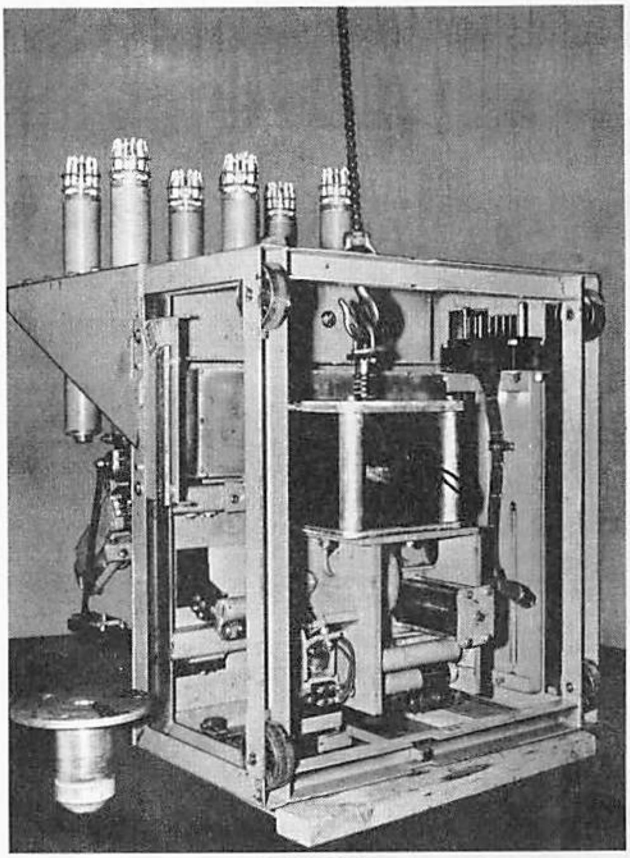


FIGURE 28

Remove these bolts and lift out the entire shunt trip device.
The shunt-trip coil can be replaced in a few minutes.

REPLACING SOLENOID COIL DST 15-500

Remove circuit breaker from cell and tip forward as shown in Figure 28. Disconnect the two coil-leads for the terminal block. Polarity is unimportant.

Remove circular plunger plate, etc., by removing the two 1-1/4" socket-head cap-screws that fasten it to the plunger shaft. Be careful to save the brass shims under the plunger-plate, also the two screws.

Remove end-plate, thus exposing coil.

Lift out coil (approximately 80 lbs.) noting that leads emerge from coil on right hand side of solenoid frame (as seen from rear of breaker).

Insert new coil, have leads emerge in proper direction.

Reassemble carefully in reverse order.

REPLACING SOLENOID MECHANISM AND COIL DST 5-250

Remove circuit breaker from cell and tip forward as shown in Figure 28. Disconnect the two coil-leads from the terminal block. Polarity is unimportant.

Remove circular plunger-plate, etc., by removing the two 1-1/4" socket-head cap-screws that fasten it to the plunger shaft. Be careful to save the brass shims under the plunger plate, also the two screws. Attach crane or hoist to the plunger shaft as shown in figure.

Loosen puffer device.

Remove the nuts from the three holding bolts on the bottom of the solenoid frame.

Lift complete solenoid out and set it down on floor or bench.

Remove end-plate, thus exposing coil.

Lift out coil (approximately 80 lbs.) noting that leads emerge from coil on right hand side of solenoid frame (as seen from rear of breaker).

Insert new coil, have leads emerge in proper direction.

Reassemble carefully in reverse order.

Lower complete solenoid into breaker frame. Adjust so that coil leads are on the right hand side. The 3 bolts on bottom plate will lineup with holes in breaker mechanism.

RECOMMENDED STOCK OF RENEWAL PARTS

One set of parts for every ten (10) circuit breakers.

1 Set of arcing contacts
1 Set main disconnecting contacts assembly
1 Shunt trip coil
1 Set lift or pull rods
1 Lot of fingers and segments for auxiliary switches
1 Secondary disconnecting block complete

Note: When ordering any of the items listed below the Serial Number of the breaker must be given.

FED-
Serial No.__________

RECOMMENDED SPARE PARTS

*DST-5, 250-1200 Amp Air Circuit Breaker

General Assembly Drawing 1551-1653

Quantity - Total for one Circuit Breaker

3	Arcing contact, stationary	Dwg. 1551-1182
3	Arcing contact, movable	Dwg. 1551-1080
3	Main contact, upper stationary	Dwg. 1551-1073
3	Main contact, lower stationary	Dwg. 1551-1075
3	Main contact, movable	Dwg. 1551-1081
3	Arc chutes	Dwg. 1551-1590
6	Clusters (10 fingers each)	Dwg. 1551-0284
3	Pull-rod assembly	Dwg. 1551-1270
1	Solenoid coil, 250 volts DC	Dwg. 1552-1672
1	Solenoid coil, 125 volts DC (230 V AC source)	Dwg. 1553-1672
1	Solenoid coil, 125 volts DC	Dwg. 1551-1672
1	Shunt trip coil, 24 volts DC	Dwg. 1551-0409
1	Shunt trip coil, 48 volts DC	Dwg. 1551-1002
1	Shunt trip coil, 125 volts DC	Dwg. 1551-1003
1	Eight circuit auxiliary switch	Dwg. 1551-1665
4	One stage only of auxiliary switch	Dwg. 1551-1216

Control Panel for Outdoor-Indoor Metal-Clad Switchgear - Dwg. 2253-0387 or 3351-0454

Quantity - Total for One Circuit Breaker

1	Rectifier, 100 Amp	Dwg. 2701-0244
1	Suppressor Rectifier Reference Dwg. 3300-0006	Dwg. 087-004
1	Capacitor Trip Device	Dwg. 2753-0137
1	X Relay Contactor Bull. 501-U-151-CA-186-M, 115 V DC	Dwg. 039-017
1	X Relay Contactor Bull. 501-U-151-06-M, 230 V, 60 Cycle	Dwg. 039-016
1	X Relay Contactor Bull. 501-U-151-CA-187-M, 250 V DC	Dwg. 039-018
1	Y Relay, 2 N.O. & 2 N.C. Contacts, 115 V DC Continuous Duty, Coil Resistance 3650 Ohms	Dwg. 095-002
1	Y Relay, 2 N.O. & 2 N.C. Contacts, 230 V, 60 Cycle Coil Resistance 180 Ohms	Dwg. 095-004
1	Y Relay, 2 N.O. & 2 N.C. Contacts, 250 V DC Continuous Duty, Coil Resistance 13,000 Ohms	Dwg. 095-005
1	Fixed Resistor, 25 Watt, 1250 Ohms	Dwg. 099-013
1	18 Point Contact Secondary Block	Dwg. 2752-0107
1	18 Point Contact Secondary Block (Cell)	Dwg. 2751-0107

*See Renewal Parts Catalogs for other Rated Breakers

SUGGESTED AIR CIRCUIT BREAKER LOG SHEET

Inspection	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Date										
Inspector										
OPERATION COUNTER										
OPERATIONS SINCE SERVICING										
VISUAL INSPECTION										
ARC CHUTES										
ARCING CONTACTS										
ARCING CONTACT ALIGNMENT										
MAIN CONTACTS										
MAIN CONTACT ALIGNMENT										
AUXILIARY SWITCH										
SECONDARY DISCONNECTS										
PRIMARY DISCONNECTS										
LUBRICATION										
TRIP MECHANISM										
CLOSING MECHANISM										
RACKING IN MECHANISM										
PRIMARY DISCONNECTS										
OPERATIONAL INSPECTION										
MANUAL CLOSE										
MANUAL TRIP										
ELECTRICAL CLOSE										
ELECTRICAL TRIP										
LOW VOLTAGE TRIP										
PUFFER AND ARC CHUTES										

Code:

G-Good, F-Fair, X-should be replaced next inspection.

NOTES: ______________________________

COMPLETE INSPECTION AND OPERATING TEST PROCEDURE FOR

4.16 KV-75/150/250 MVA, 1200 amp.
13.8 KV-150/250/500 MVA, 1200 amp.
4.16 KV-150/250/ 2000 amp.
13.8 KV-250/500/ 2000 amp.

Breaker Type DST__________, __________KV
__________MVA __________AMP. DATE__________

Serial No.__________
Shop Ord. No. Fed.__________
Mfg. Ord. No.__________

Operating voltage range: Close__________
V__________, TRIP__________V__________

Operating time at normal voltage: Close____sec.
Trip________sec. Reclose________sec.
Breaker nameplate agrees with bill of material
(v)__________

1. Check all hardware to be tight and in place (v)__________

2. Control wiring continuity check__________
Wiring Diagram No.________Rev. No.________

3. Resistance of coils: Closing Coil________ohms,
Trip Coil________ohms.__________

Resistance to be ±10% of the following values:

Closing Coils	Trip Coils
1551-1672 - 0.90 ohms	1551-0409 - 2.5 ohms
1552-1672 - 4.00 ohms	1551-1002 - 5.5 ohms
1553-1672 - 1.50 ohms	1551-1003 - 25 ohms

4. Mechanism adjustments before electrical operations:

(a) Close and open breaker slowly with manual closing lever holding prop away from roller. Check for smooth operation, binding, overtoggle, etc. (   ).

(b) Depress trip armature and manually close breaker.

allowable movement of main contacts 1" max. (   ).

(c) Closing lever clearance to roller (1/16-1/8)
__________Ga #2-4
Asm. to adjust shock absorber.

(d) Trip armature clearance to latch (.031 - .094)
__________Ga #3-5

(e) Trip armature engagement with latch (75% min.)
__________%
If less, check armature spring tension.

(f) Trip latch free of armature throughout latch stroke after tripping__________
If not free for complete stroke, call Inspection Leader.

(g) Trip armature clearance to pole face (3/8-7/16)__________Ga #2-3
Adjust by the number of shims under coil frame.

(h) Closing lever wipe on roller (3/32-1/8)
__________in.
Adjust by adding or removing shims under latch frame asm.

(i) Prop wipe on roller (3/32-1/8)
__________in.
Adjust by turning adjusting nut on spring retaining screw.

(j) Stop clearance to main shaft (1/8-3/16)
__________Ga #1-2

(k) Closing armature overtravel clearance to plate (3/32-1/8)
__________Ga #2-3
Asm. to adjust by the number of shims between plunger and armature

5. *Contact* adjustments before electrical operations:

Main Contacts

(a) Contacting surface area should be 50% min. of bar with__________
Make impression using carbon and tissue.
Dress contacts, if necessary

(b) Contact penetration (top and bottom all bars)
5KV, 15KV (1/8±1/32)

Adjust by turning clevis on bottom of push rods.
Ø A left - right, Ø B left - right,
Ø C left - right
Top______-______, ______-______
______, ______.

(c) Contact gap between stationary and moving contacts______________in.

5KV (2-7/8 + 1/4-0) Ga #3-4

15KV (5-1/8 + 3/8-0) Ga #1-2

ØA ______________

ØB ______________

ØC ______________

Adjust shock absorber

(d) Primary gap at arcing contacts make 5KV, 15KV (3/8 + 1/8-0) Ga #1-3

ØA ______________

ØB ______________

ØC ______________

Adjust using washers under spring guide nut.

Arcing Contacts

(a) Contacts on the same phase make simultaneously. ______________

(b) Contacts make within 1/16 of each other on different phases. ______________

Adjust using washers under spring guide nut.

6. Auxiliary Switches
Auxiliary Contacts

(a) Trip Coil - "A-A" contacts make (3/4-1) before arcing contacts touch ( ).

(b) Normally open "A" contacts make (0-1/4") before arcing contacts touch ( ).

(c) Normally closed "B" contacts make after arcing contacts are 60% open ( ).

Aux. contacts are adjusted by the spline shaft relation to cam or operating arm.

(d) Closing coil cut-off switch should make just after prop engages roller ( ).
Adjust by moving position of switch location on mech. frame.

(e) Latch check switch should make after trip armature has reset at least 50% ( ).
Adjust by turning operating screw in arm.

7. Hard Trip and Lockout Switch

Trip cam clearance to trip armature with breaker closed (1/32-Min.)______________Ga #5

Trip armature overtravel with hand trip lifted (1/32-Min.)______________Ga #5

Lockout switch opens simultaneously or just before breaker trips ( ).

Lockout switch has overtravel with hand trip lifted ( ).

8. Lubrication

Check all latch, cams, rollers, bearings, etc. for lubrication.

Check all contacts for grease.

9. Operating Control Voltage

Breaker opens at 20% below minimum voltage ______________C.C.V., or______________sec.
(At 10% below min. for 24V and 48V), (after 10 sec. delay on capacitor trip)

Breaker closes at 10% below minimum voltage ______________C.C.V.

10. No Load Operations

During operations observe veeder counter, semaphore, puffer operation and general performance of breakers.

Close and Trip — 10 times at maximum voltage________

Close and Trip — 15 times at minimum voltage________

Trip and Trip Free — 10 times at normal voltage________

Reclose — 10 times at normal voltage________

Reclose — 15 times at minimum voltage________

(Reclose breakers with latch check switch only)

11. Electrical Timing

Maximum trip time at normal voltage (0.05 sec.)
______________sec.______________cycles

Maximum closing time at normal voltage (0.25 sec.)
______________sec.______________cycles

Maximum trip free time at normal voltage (0.06 sec.)
______________sec.______________cycles

Maximum reclosing time at normal voltage (0.33 sec.)
______________sec.______________cycles

(Reclose breakers with latch check switch only)

12. Analyzer Curves

(a) Close and trip at minimum voltage

(b) Close and trip at normal voltage

(c) Reclose at minimum voltage

(d) Reclose at normal voltage

(c) Trip free at normal voltage
(Rebound on opening to be 10% maximum, check Orifice size.)

13. **Mechanical Check After Electrical Operations**

(a) Closing lever clearance to roller (1/16 - 1/8)
________________ Ga #2-4

(b) Trip armature clearance to latch (.063 - .094)
________________ Ga #3-4

(c) Trip armature engagement with latch (75% min.)
________________ %

(d) Trip armature clearance to poleface (3/8 - 7/16)
________________ Ga #2-3

(e) Closing lever wipe on roller (3/32 - 1/8)
________________ In.

(f) Prop wipe on roller (3/32 - 1/8)
________________ In.

(g) Stop clearance to main shaft (1/8 - 3/16)
________________ Ga #1-2

(h) Closing armature overtravel clearance to plate (3/32 - 1/8)
________________ Ga #2-3

If any changes in above, re-adjust and recheck minimum operating voltage

14. **Contact Check After Electric Operations**

Main Contacts

(a) Contact penetration
5KV, 15KV (1/8 ± 1/32)
ØA left - right, ØB left - right,
ØC left - right

Top ______ - ______ , ______ - ______
______ , ______ - ______ .

(b) Contact gap (5KV 2 7/8 + 1/4-0) Ga #3-4, (15KV 5-1/8 + 3/8-0), Ga #1-2,
ØA ________________
ØB ________________
ØC ________________

(c) Primary gap at arcing contacts make (3/8 + 1/8-0 5-15KV)
ØA ________________
ØB ________________
ØC ________________

Arcing Contacts

(a) Contacts on same phase make simultaneously.

(b) Contacts make within 1/16 of each other on different phases.

If any changes in above, re-adjust and recheck after trip and close 5 times at normal voltage.

15. **Contact Resistance**

Resistance of new clean contacts

With baskets (   )
(1200A - 60 microhms or less)
(2000A - 40 microhms or less)

Without baskets (   )
(1200A - 30 microhms or less)
(2000A - 20 microhms or less)

ØA ________________ microhms
ØB ________________ microhms
ØC ________________ microhms

16. **High Potential Test**

Primary Hi Pot for one minute

36 KV for 15 KV breakers, 19 KV for 5 KV breakers

Secondary Hi Pot for one minute

1500 volt for all breakers ________________

17. Test approval mark added to nameplate
____

18. Analyzer curves and contact impression record is attached to this report ________________

19. **Signatures:**

Test Inspector ________________
Date ________________

Factory Foreman ________________
Date ________________

Customer's Inspector ________________
Date ________________

Note: For making adjustments use gauges 1501-1742.

Revision No. ________________ Date ________________

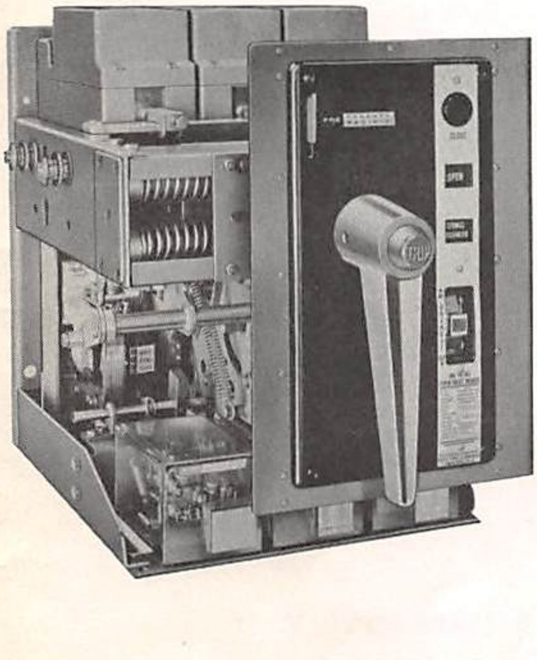
Engineer ________________

IN-810.9

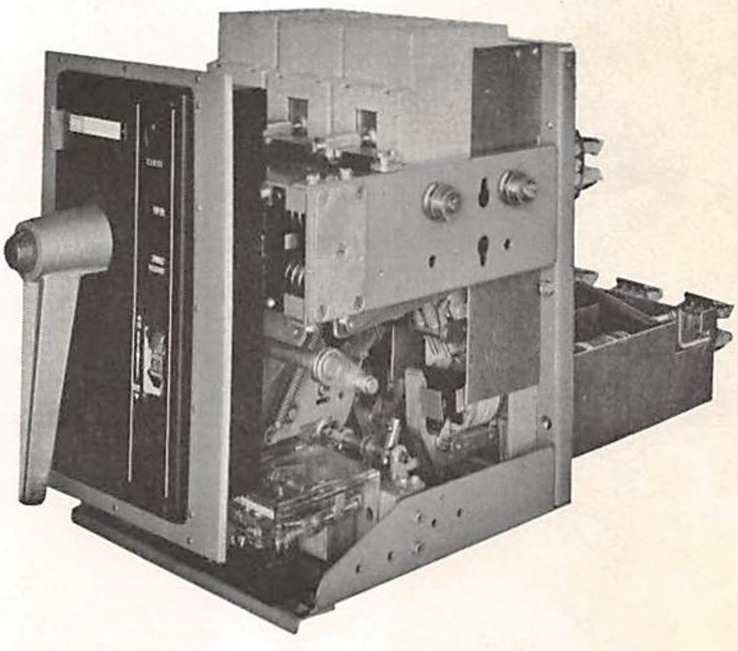
INSTRUCTION MANUAL
for
TYPE FP LOW VOLTAGE POWER CIRCUIT BREAKERS
and
FM FUSEMATIC® BREAKERS

FP25-600 FM25-600
FP50-1600 FM50-1600

JUNE, 1971



FP-25-600
CIRCUIT BREAKER



FM-25-600
FUSEMATIC®

FPE

FEDERAL PACIFIC ELECTRIC COMPANY
POWER EQUIPMENT SYSTEMS DIVISION
150 AVENUE L, NEWARK, NEW JERSEY 07101

INSTRUCTION MANUAL

for

TYPE FP LOW VOLTAGE POWER CIRCUIT BREAKERS

and

FM FUSEMATIC® BREAKERS

Manually and Electrically Operated

BREAKER	FUSEMATIC®
Type FP-25-600	FM-25-600
Type FP-50-1600	FM-50-1600

INDEX

FEDERAL PACIFIC ELECTRIC COMPANY
POWER EQUIPMENT SYSTEMS DIVISION
150 AVENUE L, NEWARK, NEW JERSEY 07101

PART 1
GENERAL DESCRIPTION

This Instruction Manual covers the FP25-600, FP50-1600, FM25-600 and FM50-1600 Fusematic breakers only. For instructions on the FP 75 series breakers refer in Instruction Booklet #IN810.10.

The FP line of Low Voltage Power Circuit Breakers and Fusematic Breakers, which ranges from 15A through 1600A continuous current at 600 Volt ratings, are designed for simplicity of operation, reliability and easy maintenance. The FP Breaker and FM Fusematic are equipped with a stored energy mechanism mechanically trip free in any position of the closing cycle, three unit pole assemblies, fully field adjustable timing devices, multi-range series trip coils, and telescoping roll-out rails. The three position drawout mechanism is operable with the door closed.

STANDARD ACCESSORIES

Maintenance closing handle 1151-9252
Cell racking in handle 1101-9251

PART 2
SHIPMENT, RECEIVING, HANDLING AND STORAGE

Each FP Breaker and FM Fusematic is thoroughly inspected and tested before leaving the factory. Breakers are shipped in individual crates or in the cell compartment. If breakers are crated, no hooks should be used in handling. Examine all equipment carefully for indication of damage sustained in transit. If damage in transit is indicated, call for an immediate inspection by the delivering carrier. Upon assessment of the damage a claim should be filed with the carrier or, depending on the nature of the damage, an intent to file for concealed damage should be registered. For assistance in filing the claim, advise the area sales office of Federal Pacific Electric Company, giving a full description of the damage, serial number of the breaker, delivering carrier's name, and, if shipped by rail, the car number, waybill reference, and any other information that might be of help to the Company in aiding in the filing of the damage claim.

When unpacking, make sure that all items are removed from the box including packing list, instruction book, maintenance parts and hardware. Report any shortage immediately. See that identification tags are left on the breaker. Lifting eyelets are furnished for handling. Do not lift or handle breaker by the front box or the operating handle.

Clean breaker thoroughly. To remove dust an industrial vacuum cleaner is recommended. If the breaker can be installed in its permanent location, it is advisable to do so, even if it is not expected to be energized for some time. When breakers must be stored in buildings under construction, be sure they are kept in a space free of dust, moisture, dirt and in an upright position. It is recommended that the breaker not be operated prior to final inspection.

PART 3
INSPECTION AND INSTALLATION

SECTION I Inspection - Manually Operated Breakers

The FP and FM breakers consist of a coordinated set of assemblies mounted on a steel frame, all carefully adjusted and locked in place for long and trouble-free operation.

To assist in properly checking and inspecting breakers prior to placing into service, the following steps should be followed in the order listed:

1. **Remove arc chutes and interphase barriers.**
2. **Charge stored energy mechanism by rotating operating handle to a positive stop. Return handle to normal vertical position by counter-clockwise rotation.**

NOTE: Charging Operation:

FP & FM25-600 — Rotate handle 90° counterclockwise to engage mechanism and then 180° clockwise to positive stop. (Figure 1).

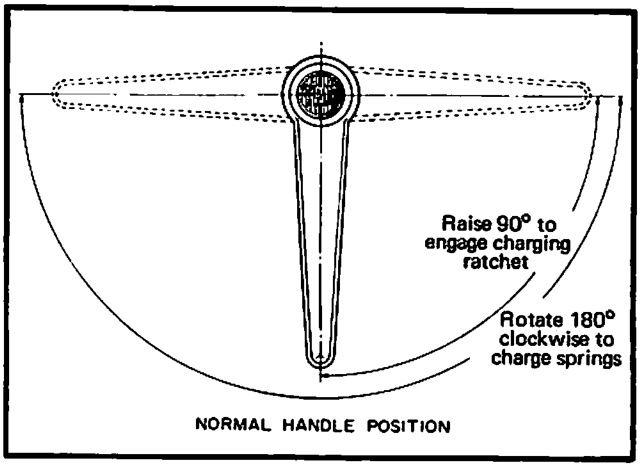


Figure 1

FP & FM50-1600 — Unfold collapsible handle from vertical down position to vertical up position. Rotate 180° clockwise to positive stop. Release handle slowly. (Figure 2).

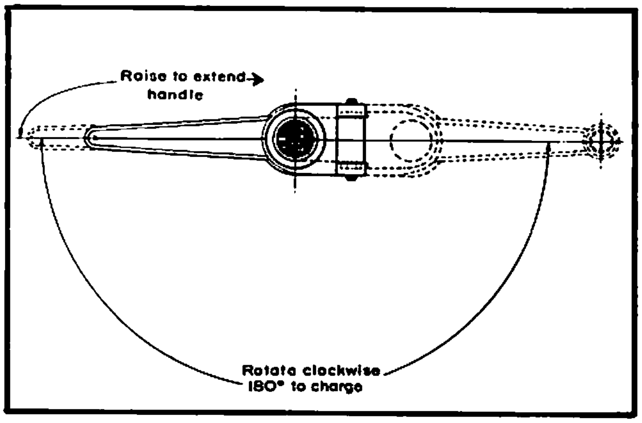


Figure 2

3. Block the undervoltage trip device , when supplied, to prevent tripping.
4. Remove right and left hand accelerating springs (Figure 4).

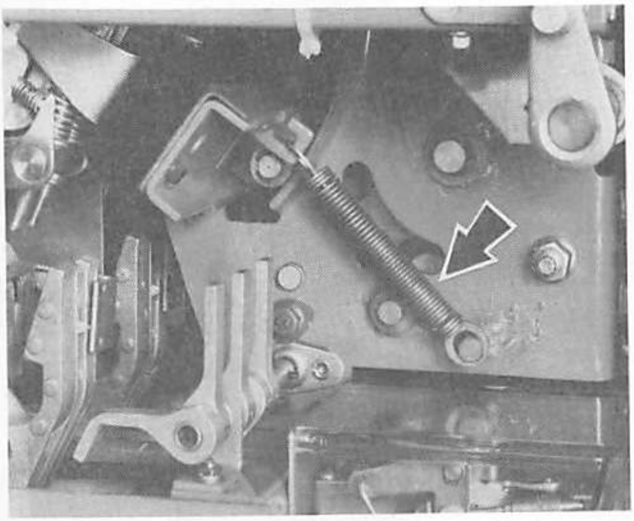


Figure 4

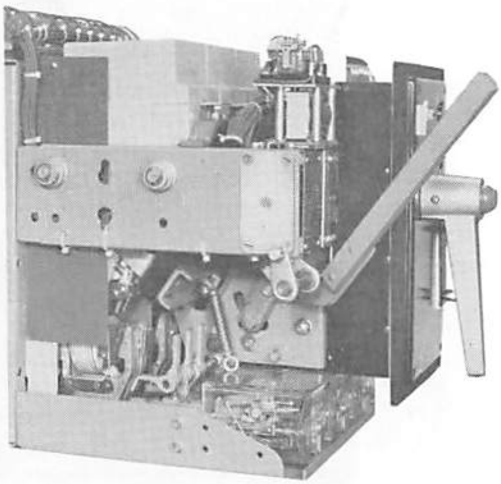


Figure 5

5. Insert maintenance closing handle #1151-9252 as in Figure 5 and slowly operate until arcing contacts touch. All arcing contacts should make simultaneously with a permissible variation of 1/32 max. Moveable arcing contact fingers should align with stationary arcing contacts.

   Refer to Part 4 for adjusting instructions if misalignment or misadjustments are observed. Moveable arcing contacts are designed with side clearances for better guidance inside the arc chutes. A side to side movement of 1/8 is allowable. Close breaker and check overtravel on main contacts: 1/8"± 1/32".

6. With maintenance closing handle in position and trip bar in tripped position, proceed to close breaker. Operating mechanism will now be trip free and contacts should not make.
7. Remove maintenance closing handle and trip breaker by moving trip bar.
8. Replace one pull-off spring right side only.
9. Inspect each arc chute to be sure no plates are damaged. Replace chutes and interphase barriers on breakers. Move contacts in by hand to insure contacts move in and out freely.
10. To avoid possible injury *NEVER* handle or touch any moveable part of the breaker when the stored energy mechanism is charged. Press close button on front cover. Breaker will close. Depress red trip button (located in charging handle). Breaker will open.
11. Recharge stored energy mechanism and close breaker. Slowly move series trip coil magnet (armature) to fully closed position. Breaker should trip before armature touches pole face assembly. Repeat this procedure on all poles.
12. On a draw-out breaker, charge stored energy mechanism, close breaker and move draw-out interlock plate to the left. Breaker will trip. D/O interlock plate must be fully reset to the right before operating breaker to prevent trip-free operations. (Figure 6).

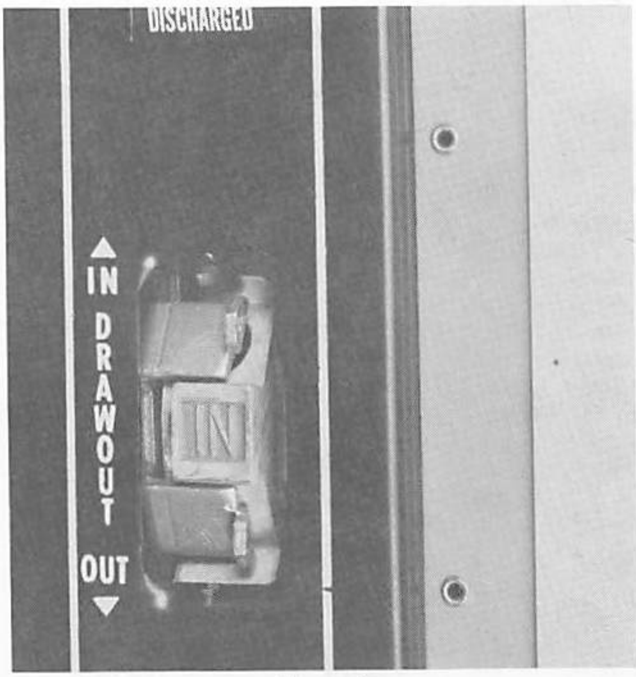


Figure 6

13. Charge stored energy mechanism and close breaker. Pull padlock lever out. Breaker should trip before padlock slot is fully exposed.
14. Check retaining rings and hardware for tightness.
15. Basket and finger assembly should be secured with Nylok retaining screws. Contact fingers must be free of dirt and foreign particles. The secondary contacts should operate freely.

SECTION II Inspection - Electrically Operated Breakers

The ratchet-driven stored energy mechanism is charged by a fractional horsepower AC/DC universal motor. Identification, voltage ranges and current requirements are specified below. The stored energy mechanism charges in approximately one second.

CHARGING MOTORS FOR FP BREAKERS STORED ENERGY MECHANISM

Voltage Rating	FPE Part #	Motor	FLA.	LRA.	Fuse*
48V A.C./48V D.C.	162-007	15058	20	50	12.0
115V A.C./125V D.C.	162-004	14976	6.5	25	5.0
230V A.C./250V D.C.	162-006	14978	6.1	12	3.5

Maximum 240V, use control power transformer for higher voltage
*Class 1330 Econ Dual element fuses

From wiring diagram supplied with equipment, or standard diagram Part 7 of this book, locate motor terminals on secondary contacts and connect required power source.

Motor will charge when power is applied and shutoff automatically when charging cycle is completed.

Breaker cannot be closed with the maintenance closing handle unless stored energy mechanism is charged. On all electrically operated FP breakers the stored energy mechanism will recharge immediately following a closing operation ready for instant reclosure if needed.

Follow inspection procedure as outlined in "Inspection — Manually Operated Breakers."

In addition the following steps are recommended:

16. From wiring diagram locate terminals on secondary contacts and connect proper control power supply and controls for shunt close and shunt trip attachments. Close and open breaker five times electrically and check for proper operation.
17. Disconnect control power supply. Close and trip trip-breaker manually. Do not leave breaker in the charged and/or closed position while in storage.
18. Move shunt close solenoid armature manually to release closing springs without control power.

SECTION III - Installation

Before installing breaker in cell, check following points inside cell:

1. Secondary contact support when supplied — make sure all connections are tight and adjusted to proper dimensions.
2. Ground connections should be tight.
3. Extension rails should be free to move in and out; check rail stops for tightness.
4. Rail rollers should be free and well lubricated.
5. Main contact stabs should be tight and free of dust and dirt. Lubricate with contact grease.
6. Check condition of insulating transite plate in roof of case. Screws should be tight.
7. Remove control power fuses.
8. Place breaker on fully extended moveable rails. Make sure all four rollers engage on inside grooves (Outside grooves fit into stationary rails inside cell). (Figure 7).

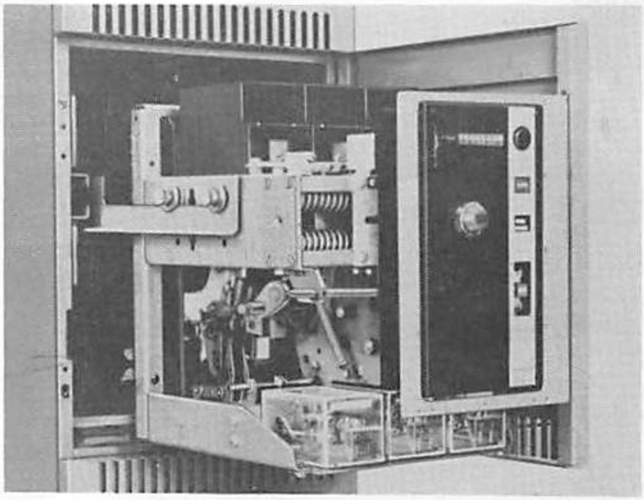


Figure 7

9. Draw-out mechanism on breaker should be in OUT position.
10. Push breaker inside the cell until racking-in cranks engage a positive stop. This is the OUT position.
11. Close and fasten the door. The metal mask provided on outside of front box will move freely back as it comes in contact with the door. The door should close all the way with the breaker in the OUT position.
12. Push drawout interlock to left, insert drawout lever 1101-9251, (Figure 8) into the bottom hole of the drawout mechanism and, with an up-stroke, rack breaker into the TEST position. Remove drawout lever, drawout interlock plate should snap into position completely covering the holes.
13. Install control power fuses, energizing the circuit. The motor will charge the stored energy mechanism. The closing and tripping control circuits become energized in the TEST position.
14. Open door and make sure that grounding contact in cell is in contact with the breaker. Close door and check breaker electrically for proper closing and opening operation.

If breaker operates properly, rack breaker back to OUT position and leave there until ready to be put into service.

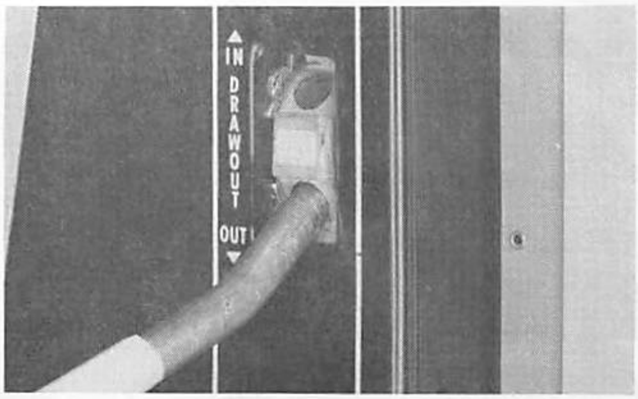


Figure 8

15. To put circuit breaker into service push drawout interlock to left, insert drawout lever in the bottom hole of the drawout mechanism (Figure 8) and with an upward stroke rack breaker into operating position. Remove drawout lever, interlock plate should snap in position and red IN appears. (Figure 9 and 9A).

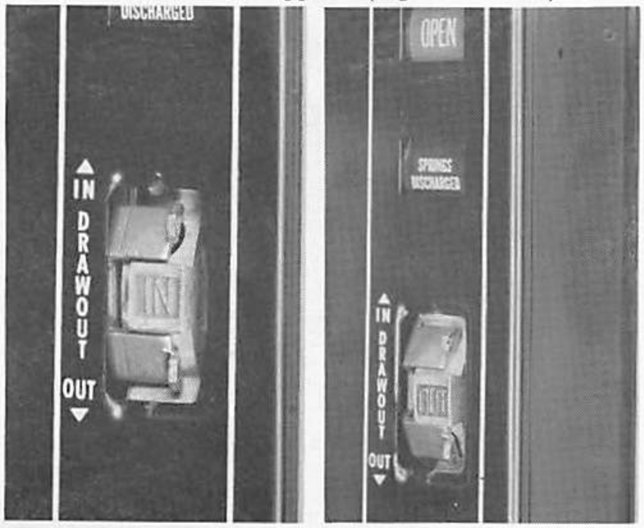


Figure 9 & Figure 9A

PART 4 MAINTENANCE

The breakers with all component parts have been extensively tested for performance as per NEMA Standards SG 3 and ANSI C37-13 and proved to be satisfactory with a wide margin of safety.

A periodic maintenance schedule should be established. An annual inspection should be made for clean, low-use applications. More frequent inspections should be made for dirty, corrosive or high-use applications.

The following instructions and adjustments should be followed carefully:

CONTACT ADJUSTMENT — Figure 10 and 11

MAIN AND ARCING CONTACTS ADJUSTMENT FOR FP600A AND FP1600A BREAKERS

"A" - Main Contact Pressure		
	600A ——	42-50 lbs., measured at point of contact
	1600A ——	25-35 lbs., measured at point of contact
"B" - Over Travel Mains		⅛ ±1/32 (Fig. 10)
"C" - Arcing Contact Press		22-25 lbs., measured at a point 1¼ below tip of contact
"D" - Gap (distance) between mains when arcing contacts touch		⅛ ±1/32 (Fig. 11)

CHECK POINTS — Figure 10, 11 and 12

1. Stationary arcing contacts — make sure that retaining screws and contacts are tight.
2. Main contacts should be clean and free.
3. Make sure all retaining rings are in place.
4. Surfaces marked "F" should be lubricated by a thin film of "Conducto-Lube #240-200" before assembly. (Figure 12).

Contacts must be inspected after every known short circuit interruption and should also be inspected at regular inspection periods. If contacts are found to be worn or excessively pitted they should be dressed or replaced.

CAUTION: When reinstalling the arc chutes, adjust the retaining screws on the arc chute retaining bar so that the contact insulating block clears the arc chute base when the breaker is closed.

CONTACT ASSEMBLY

To repair or replace moveable arcing contacts, proceed as follows (Figure 11):

1. Charge stored energy mechanism.
2. Remove arc chutes and interphase barrier.
3. Remove insulating block and push fork assembly.
4. Tighten moveable arcing contact's adjusting screw until springs are solid and remove retaining pins.
5. Remove arcing contact pivot pin and replace moveable arcing contacts. Both contacts should be replaced at one time.
6. Make sure nylon bushings on arcing contact pivot pin are in place and in a good condition, when replacing moveable arcing contact.

Reassemble following the reverse sequence of operations and adjust per Figs. 10 and 11. In most cases it is not necessary to replace contacts, but occasional redressing and readjustments are recommended.

To replace stationary arcing contacts (Figure 10), remove unit pole assembly, replace main stud and arcing contact assembly, part 1151-9939, for 600A breaker and 1151-9937 for 1600A breaker.

Adjust contacts as per Figures 10, 11 & 12.

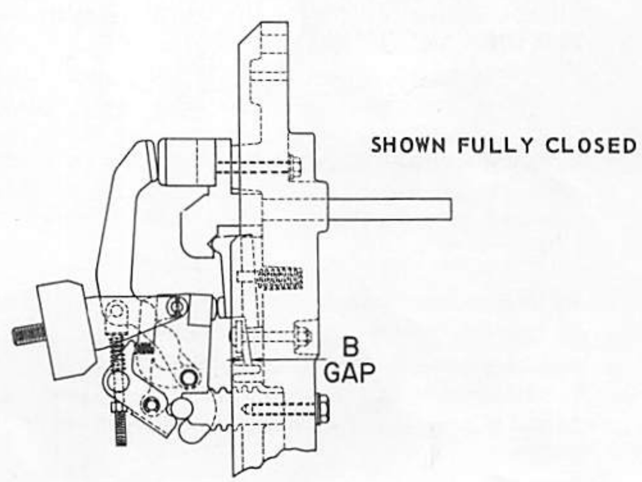


Figure 10

SHOWN AS ARC CONTACTS MAKE

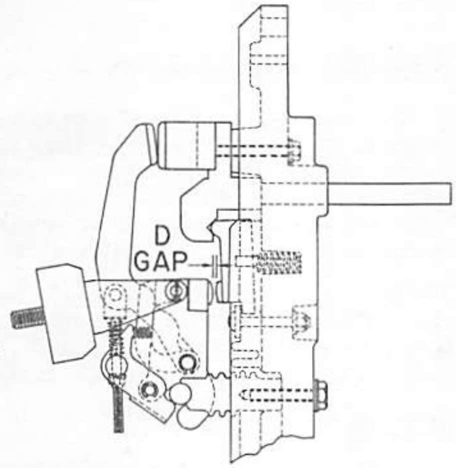
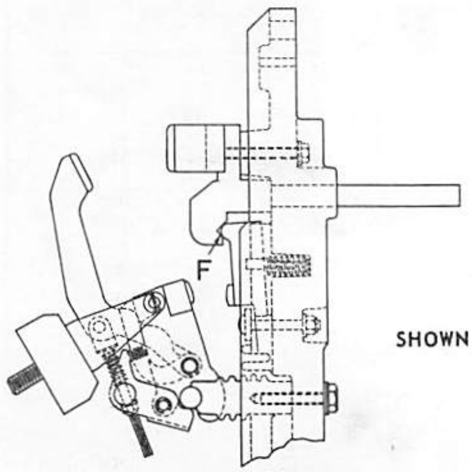


Figure 11



SHOWN FULLY OPEN

Figure 12

STORED ENERGY MECHANISM

Check latch engagement and adjust if necessary to provide a min. of .062" latch surface contact. Make sure springs are in place and in good condition. On electrically operated breakers, remove motor to make sure roller is free and well lubricated. Reinstall motor. Make sure that all retaining rings are in place. Check mechanism to insure that all moving parts are free and well lubricated.

OPERATING MECHANISM

Make sure that all retaining rings and springs are in place and that the mechanism is free. Replace nylon bumper rollers if excessive wear is evident. Make sure that the operating mechanism resets when stored energy mechanism is charged slowly and that the trip shaft is free. It should take no more than 22 ounce inches of torque to trip the breaker.

GENERAL

Make sure that all current carrying parts are secured and associated hardware is tight. Basket and finger assembly should be secured but free enough to compensate for misalignment in cell. The free up and down movement should be approximately $\frac{3}{16}$.

PART 5

ACCESSORIES

SHUNT TRIP

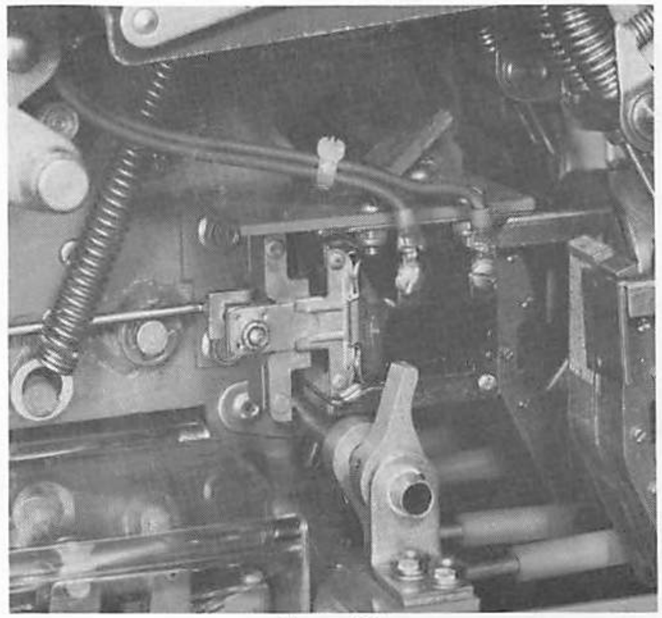
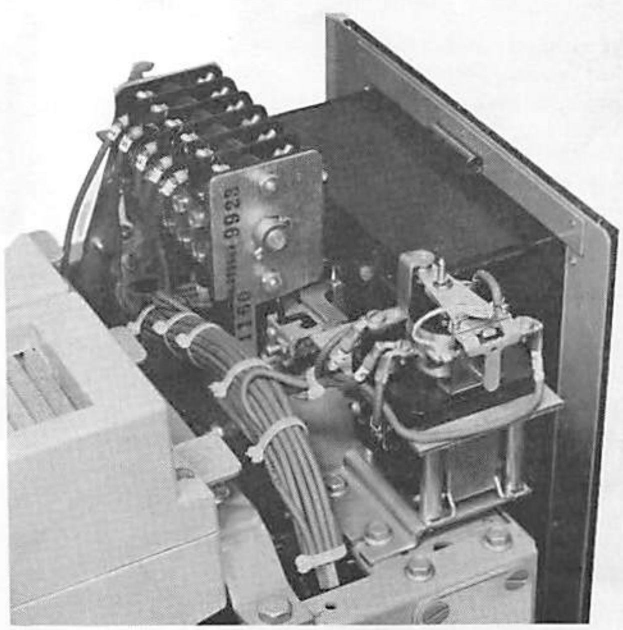


Figure 13

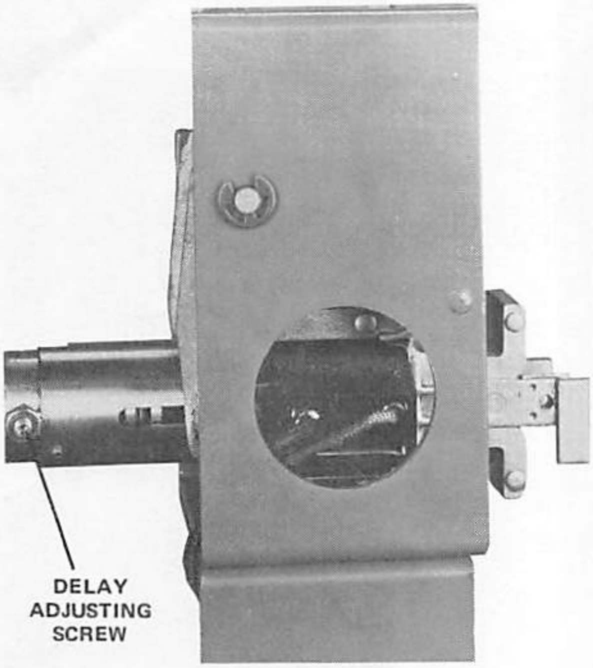
The shunt trip attachment is mounted directly above the trip shaft. It is a non-adjustable electro-magnet intended for intermittent duty only, and its circuit should be interrupted only by an auxiliary contact.

SHUNT CLOSE



The shunt close attachment is mounted on top of the stored energy mechanism and is used to electrically discharge the stored energy mechanism and thus to close the breaker. It is a non-adjustable intermittent duty device and its circuit should be interrupted by an auxiliary contact.

UNDERVOLTAGE ATTACHMENT (Figure 15)



The undervoltage attachment is a continuous duty device, which can be provided with or without a time delay, and which mechanically trips the breaker if the voltage drops to 30% to 60% of normal voltage. It is mechanically re-set and has no auxiliary contact in its circuit. The under-voltage time delay mechanism is of the pneumatic delay type. The time delay is controlled by the 10-32 adjusting screw.

To inspect the undervoltage attachment, hold the move-able armature by hand, close breaker and slowly release armature. Before the armature is fully opened, the spring loaded plunger will be released, strike the trip lever and trip the breaker. Check for missing retaining rings and loose or missing screws and bolts. Check condition of coil. If undervoltage attachment is noisy while being energized, clean faces of armature and core.

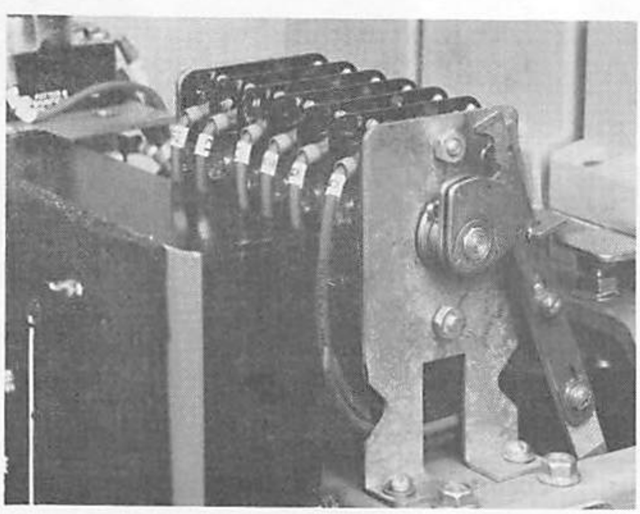


Figure 16

AUXILIARY SWITCH (Figure 16)

A max. 6 stage, 12 contact switch is available. It is mounted on top of the stored energy mechanism on the right hand side of the breaker and is operated by the main moveable contacts. All contacts are operated by phenolic cams and are factory adjusted to provide "a" (normally open) and "b" (normally closed) contacts.

The position and the condition of all contacts can be seen and inspected through the transparent dust covers. The contacts may be changed from a to b or b to a by removing the cover and inverting the contact bridge.

INTERRUPTING CAPACITY

TYPE R-4 AUXILIARY SWITCH INTERRUPTING RATING IN AMPS

Volts	D.C. Non-Inductive	D.C. Inductive	A.C. Non-Inductive	A.C. Inductive
		SINGLE CONTACT		
24	20	15	—	—
48	10	7.5	—	—
115	—	—	50	30
125	2.5	2.0	—	—
230	—	—	25	15
250	0.5	.45	—	—
		DOUBLE CONTACT		
24	50	40	—	—
48	25	20	—	—
115	—	—	80	60
125	12	7	—	—
230	—	—	50	30
250	2.25	2	—	—

BELL ALARM SWITCH (Figure 17)

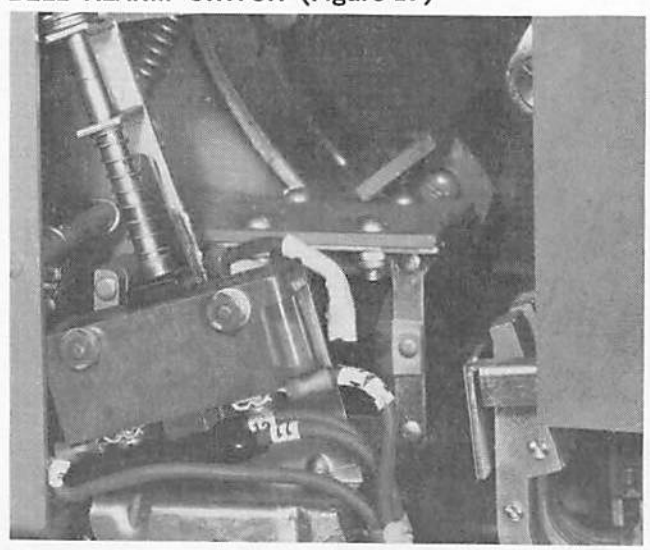


Figure 17

A bell alarm switch attachment is mounted on the right hand side of the breaker and will function only when breaker is tripped by the overcurrent trip units. It can be manually and/or electrically reset. Closing of breaker also resets the alarm switch.

To check the alarm switch attachment, trip breaker with trip button, then with shunt trip. In both cases the switch should not be actuated. Trip breaker by moving the series trip coil magnet and the switch should operate.

PART 6
OVERCURRENT TRIP DEVICES

GENERAL DESCRIPTION

The direct acting series coils and magnet assemblies provide the energy to operate the over-current time delay device and to trip the circuit breaker, interrupting sustained overcurrents and faults. There are seven (7) different coils covering the range from 15 to 2,000 amperes. Each magnet is field adjustable and calibrated for the values listed in Table A. Any one of the seven series coils may be used in any one of the three ratings of FP50 circuit breakers and FM Fusematic provided the maximum coil rating does not exceed the maximum continuous current rating of the circuit breaker frame size.

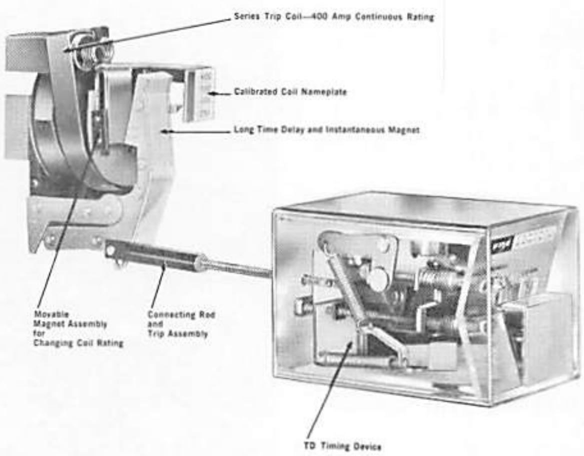


Figure 18

Dual Magnetic Overcurrent Trip Device (TD-1) (Figure 18)

The dual magnetic overcurrent trip device, in combination with the series coil and magnet, provides inverse long delayed tripping for all overcurrents below the instantaneous pickup setting, and adjustable instantaneous tripping. All devices are factory calibrated and can be field adjusted.

Selective Overcurrent Trip Device (TD-2) (Fig. 18)

The selective overcurrent trip device, in combination with the series coil and dual armature magnet, provides inverse long delayed tripping for all overcurrents below the short delay pickup setting, and short delayed tripping for all overcurrents and faults above the short delay pickup setting. All devices are factory calibrated and can be field adjusted.

Single Phasing Protection (Fig. 19)

When fuses are used to protect circuits feeding three phase motors or similar reactive apparatus there is always the possibility, upon the blowing of one fuse only, that the apparatus, single phased, will burn out. To eliminate this danger, Fusematic Air Circuit Breakers incorporate three single phase trip coils, one in parallel with each of the three main fuses. Each trip coil is approximately a one thousand-turn coil wound to operate down to $\frac{1}{10}$ of line voltage.

Each of the single phase trip coils can be looked upon as a shunt trip continuously energized by the voltage drop across its fuse. Under normal conditions the "fuse drop" voltage is zero, but it immediately rises to a value of "full phase voltage — back E.M.R. (reactive load)" when the load fuse blows. This energizes the single phase trip coil, causing the common trip bar to unlatch and trip the Fusematic Air Circuit Breaker. The coil is specifically rated at $\frac{1}{10}$ line voltage to assure instantaneous operation even when the Fusematic Air Circuit Braeker is used as a motor starter. In this case, although the back E.M.F. induced in the motor winding is equal to phase voltage, because of phase angle displacement the resultant voltage drop across the fuse is sufficient to trip Fusematic Air Circuit Breakers.

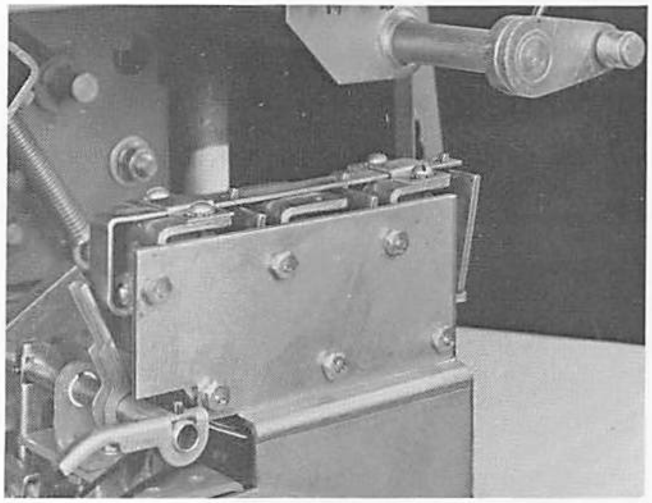


Figure 19

METHOD OF OPERATION

A. Series Coil and Magnet

The current through the series coil provides the magnetomotive force to energize the magnet assembly. The clapper type armature exerts the force on the push rod which operates the trip unit and trips the circuit breaker. The current rating of the coil and magnet may be changed by moving the pole face assembly up or down. The calibrated indicator plate lines up with the pointer on the armature to indicate the proper position of the poleface for each rating.

B. Dual Magnetic Overcurrent Trip Device (TD-1) (Long Time Delay and Instantaneous Trip)

The long delay overcurrent trip device consists of a dash pot which operates by the positive displacement of a liquid through a fixed orifice and an adjustable tension coupling spring which permits the push rod to move rapidly when the force from the magnet exceeds a predetermined value. The lever ratio between the push rod and the dash pot is adjustable permitting the time delay to be varied. There are three calibrated positions or adjustment bands. The three bands are identified as minimum, intermediate and maximum. In addition to the long delay band adjustment there is an adjustable tension spring which prevents motion of the push rod for currents below the maximum desired continuous current. This is the long delay pickup. It is adjustable from 80 percent to 160 percent with calibrated points at 80%, 100%, 120%, 140% and 160%.

The tension in the coupling spring determines the current at which the dash pot will be mechanically by-passed. This is the instantaneous pickup adjustment. The high range instantaneous element has calibrated settings at 7.5, 10 and 15 times the coil and magnet setting. The low range has calibrated settings at .8, 1.5 and 2.5 times. High range units cannot be field modified to low range units or vice versa.

C. Selective Service Trip Device (TD-2) (Long Delay and Short Delay)

The selective service trip device is similar to the dual magnetic trip device except that it has a rigid coupling link in place of an instantaneous pickup coupling spring and it has a mechanical escapement timing device which provides a short delay for high values of overcurrents and for faults. The long delay dash pot is identical to that used on the dual magnetic trip device. The short delay device is operated by a separate armature in the series coil and magnet assembly. It has an adjustable pickup spring with calibrated settings at 5, 7.5 and 10 times the coil and magnet setting. In addition, the short delay has a band adjustment with calibrated points for the minimum, intermediate and the maximum bands.

MAINTENANCE & ADJUSTMENTS

Remove breaker completely from cells before servicing.

A. Series Coil and Magnet Assembly

The series coil and magnet requires no maintenance other than cleaning periodically to remove dust and dirt which may accumulate on bearings and pivots of the magnet armatures. All pivots and bearings are made of nylon and no lubrication is required.

The current rating of the coil and magnet may be adjusted by loosening the two pole face retaining screws a few turns and sliding the pole face of the flux shunting device up or down to the desired position. The two retaining screws must be tightened securely after making the adjustment.

Certain care should be exercised when adjusting the pole face assembly to avoid bending or deforming it.

(1) Do not raise or lower the pole face assembly by exerting force on the indicator plate. This plate is calibrated at the factory and bending it will alter the calibration.

(2) Move the two pole faces so that they remain parallel, thus preventing binding on the magnet core.

The entire series coil and magnet assembly may be removed and replaced in the field by removing the 3/8" coil retaining screws and the 1/2" magnet retaining screws at the rear of the pole insulator. When replacing coils, always tighten the coil retaining screws securely. This is important to prevent overheating and possible failure. Care should be taken not to damage the coil insulation.

B. Dual Magnetic Overcurrent Trip Device (TD-1) (Long Delay and Instantaneous Trip)

The circuit breakers are shipped with the trip devices installed and properly adjusted. It is only necessary to keep the devices reasonably clean. They are lubricated for the life of the circuit breaker and *must not* be lubricated again.

It is possible to remove and replace a trip device in the field.

To Remove a Trip Device

The trip units which are contained in transparent plastic cases should be removed as units. Remove the two screws which hold the plastic case to the breaker frame. These screws are located in the back side of the trip unit (looking into the front of breaker) and can be removed by reaching in from behind. The connecting rod which connects to the magnet assembly must be slipped off the pin connection at the magnet. Then unscrew the plastic part of connecting rod and remove the two nuts holding the tripping pieces in place.

To Install a Trip Device

Insert the push rod in the proper hole in the front channel and screw the trip unit to the channel using the two 5/16" hex. head cap screws provided. IMPORTANT: Use the washer and lock washer provided. Run a 10-32 nut down the push rod. Follow it with a trip finger on top of the push rod with a spacer between the wings and another 10-32 nut. (Do not tighten it yet.) Install the nylon turnbuckle and adjust its length so that it is 1/32" longer than is just necessary to permit the trip device to reset the magnetic armature against its stop. Install the turn buckle on the armature pin and retain it with E-ring provided. Adjust the position of the trip finger so that the breaker does not trip when the magnet is closed with a 1/32" thick shim in the air gap, and does trip with a 1/64" thick shim in the air gap. Tighten the finger and check this adjustment again. The trip unit must reset the magnet armature all the way until the armature is against the stop.

C. Selective Service Trip Device (TD-2) (Long Delay and Short Delay)

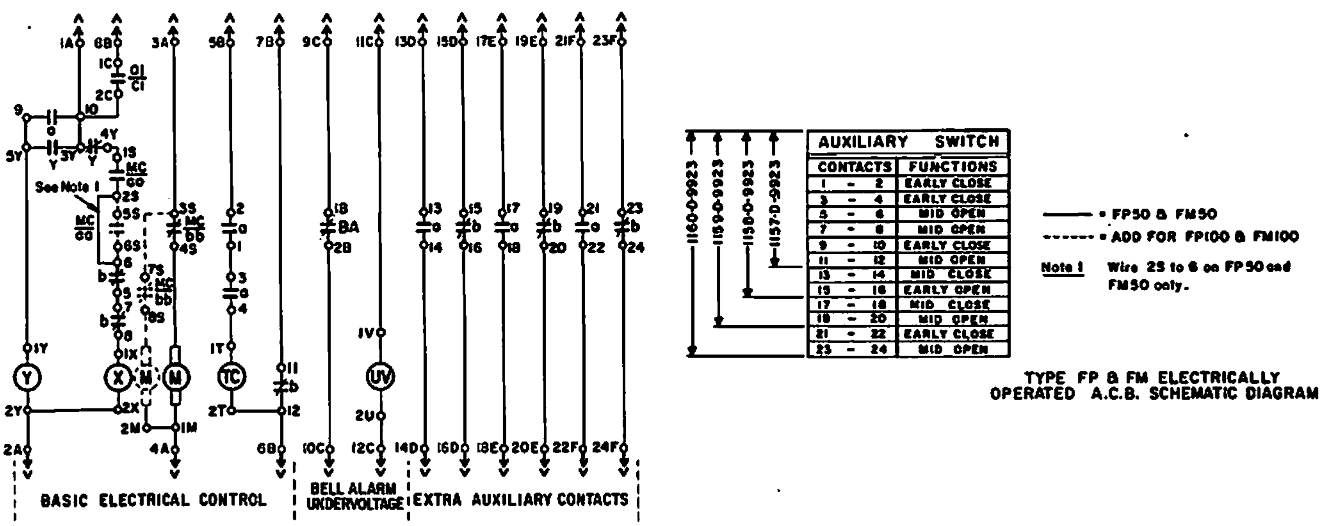
The maintenance and adjustment of the selective service trip device is the same as the dual magnetic trip device, except that the trip finger on the short delay push rod is installed under the push rod. Care should be taken to ensure that the long delay trip finger on top of its push rod does not interfere with the short delay trip finger which is installed under its push rod.

PART 7

DEFINITION OF SYMBOLS

TC — Trip coil
TC1 — A phase fuse trip coil
TC2 — B phase fuse trip coil
TC3 — C phase fuse trip coil
X — Closing release coil
Y — Anti pump relay
M — Spring charging motor
MC/aa — NO } Motor cut off switch (Shown with
MC/bb — NC { closing mechanism spring discharged)
a — Auxiliary switch contact (open when breaker is open)
b — Auxiliary switch contact (closed when breaker is open)

01 — Control switch 01 local, C1 close
BA — Bell alarm switch
PF — Power fuse
UV — Undervoltage device
A — Main power circuit - A phase
B — Main power circuit - B phase
C — Main power circuit - C phase



TYPE FP & FM ELECTRICALLY OPERATED A.C.B. SCHEMATIC DIAGRAM

FP BREAKER OPERATING SEQUENCE

1. Control switch 01-C closed.
2. "X" coil is energized thru "b" contact of the "Y" relay, "b" contact of the breaker auxiliary switch, and "aa" contact of the motor cut-off switch.
3. Stored energy closing spring released via "X" coil, closing breaker.
4. Closing breaker operates auxiliary switch opening "b" contacts and closing "a" contact thus energizing anti pump "Y" relay and de-energizing "X" coil.
5. "Y" relay remains energized via seal-in contact thus providing anti-pumping lockout of "X" coil if $\frac{01}{C1}$ is held closed.
6. "Y" relay is de-energized when $\frac{01}{C1}$ contact is opened.
7. Closing breaker, closes auxiliary switch "a" contacts permitting the breaker to be tripped electrically when control power is switched to auxiliary stabs 5B and 6B.
8. Motor cut-off switch contact "bb" closes when spring discharges and re-opens when spring is fully charged.
9. Auxiliary switch "b" contact closes when the breaker is tripped.
10. Motor cut-off switch contact "aa" closes when the closing mechanism spring is fully charged.
11. The breaker will close when control switch $\frac{01}{C1}$ is closed.

PART 8

MINIMUM RECOMMENDED SPARE PARTS FOR FP BREAKERS

Req.	FP 400/800	Req.	FP 2000	
6	1151-9986	6	1151-9986	Moving Arcing Contacts
3	1151-9939	3	1151-9937	Upper Stud Assembly
6	1151-9088	12	1151-9354	Main Stationary Contact Assembly
--	....	3	1152-9354	Leading Contacts
6	1151-9380	6	1151-9381	Cluster Assembly
3	1151-9566	3	1151-9566	Arc Chutes

One each of the following:

SHUNT CLOSE ATTACHMENTS (Common for All FP Breakers)

			Sealed	Inrush
48V A.C. 60 cycles	1156-9517	Amp A.C.	5.7A	7.5A
115V A.C. 60 cycles	1157-9517	Amp A.C.	3.15A	4.0A
230V A.C. 60 cycles	1158-9517	Amp A.C.	1.6A	1.95A
48V D.C.	1152-9517	Amp D.C.	4.8A	
125V D.C.	1153-9517	Amp D.C.	3.0A	
250V D.C.	1154-9517	Amp D.C.	2.3A	

SHUNT TRIP ATTACHMENTS (Common for All FP Breakers)

			Sealed	Inrush
48V A.C. 60 cycles	1156-9519	Amp A.C.	5.7A	7.5A
115V A.C. 60 cycles	1157-9519	Amp A.C.	3.15A	4.0A
230V A.C. 60 cycles	1158-9519	Amp A.C.	1.6A	1.95A
48V D.C.	1152-9519	Amp D.C.	4.8A	
125V D.C.	1153-9519	Amp D.C.	3.0A	
250V D.C. and Capacitor Trip Device*	1154-9519	Amp D.C.	2.3A	

*Capacitor Trip Device #2751-0137

UNDERVOLTAGE ATTACHMENT (Common for All FP Breakers)

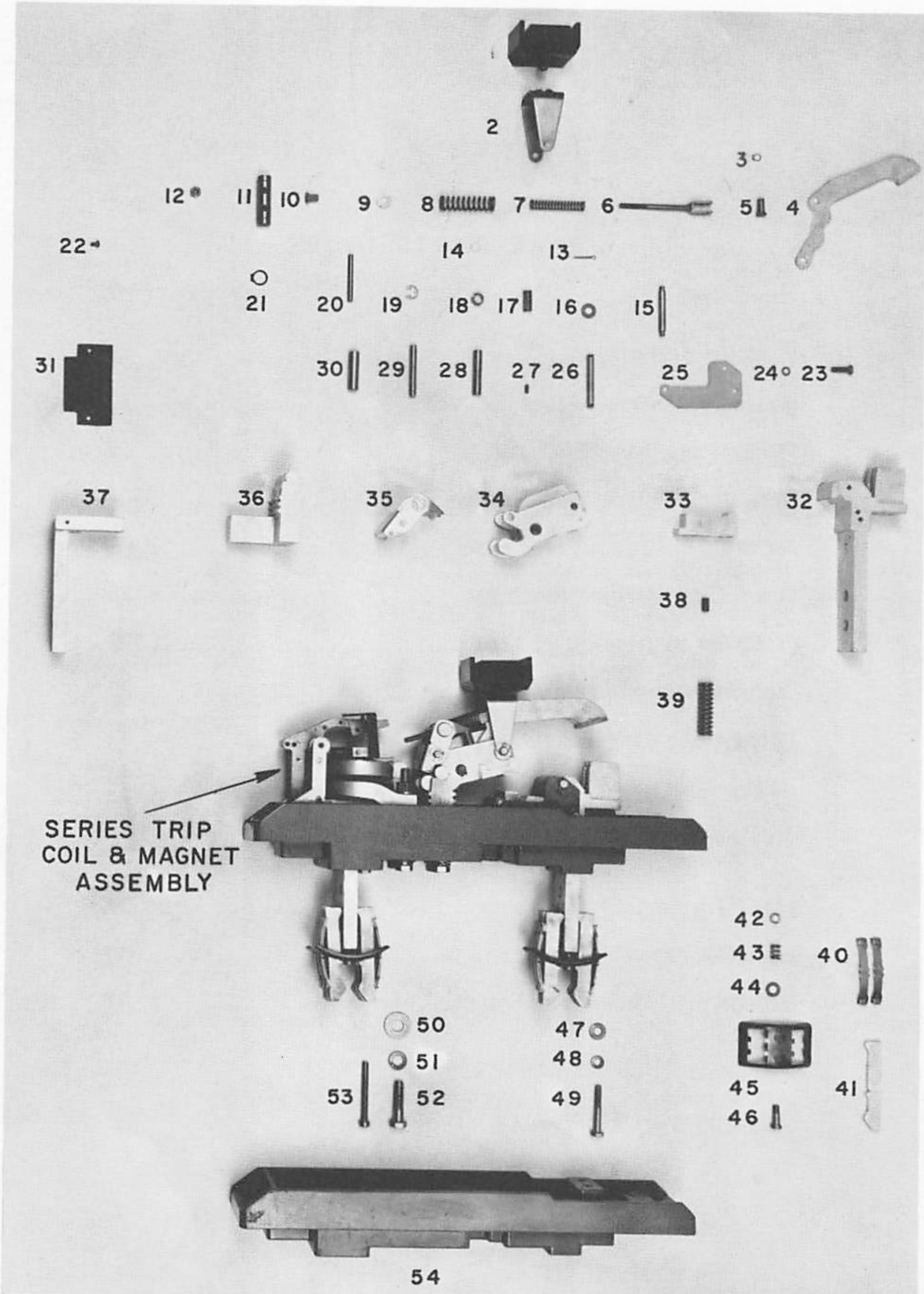
	Delayed	Instantaneous
115 Volts A.C.	1151-9458	1151-9456
230 Volts A.C.	1152-9458	1152-9456
460 Volts A.C.	1153-9458	1153-9456
575 Volts A.C.	1154-9458	1154-9456
125 Volts D.C.	1155-9458	1155-9456
250 Volts D.C.	1156-9458	1156-9456

***MOTORS TO CHARGE FP BREAKERS STORED ENERGY MECHANISM (Common for All FP Breakers)**

	Purchase Part #	Motor	FLA.	LRA.	Fuse**
48V A.C. / 48V D.C.	162-007	15058	20	50	12.0
115V A.C. / 125V D.C.	162-004	14976	6.5	25	5.0
230V A.C. / 250V D.C.	162-006	14978	6.1	12	3.5

*Maximum 240V, use control power transformer
**Class 1330 Econ Dual Element fuses

SPARE PARTS INDEX



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INSULATOR ASSEMBLY

INSULATOR

ITEM	PART NUMBER	DESCRIPTION	NUMBER REQUIRED PER INSULATOR ASSEMBLY 400 Amp	800 Amp	2000 Amp
54	1151-9137	Main Insulator	1	1	
54*	1151-9243	Main Insulator			1

STATIONARY CONTACT ASSEMBLY (Upper Stud Assembly)

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
32	1151-9339	Stationary Contact Assembly	1	1	
32*	1151-9937	Stationary Contact Assembly			1
25	1101-9146	Retaining Plate	2	2	2
23	19S-10-10	Retaining Plate Screw	4	4	4
24	1-W-10	Retaining Plate Lock Washer	4	4	4
15	1101-9233	Retaining Pin	1	1	
15*	1101-9430	Retaining Pin			1
33	1151-9088	Main Contact Finger	2	2	
33*	1151-9354	Main Contact Finger			4
33*	1152-9354	Main Leading Contact Finger			1
38	99-048-250-0500	Contact Compression Spring Guide	2	2	5
39	1122-9606	Contact Compression Spring	2	2	
39*	1103-9606	Contact Compression Spring			5
47	W-250	Mounting Washer	2	2	
48	1W-250	Mounting Lock Washer	2	2	2
49	19S-250-28	Mounting Bolt	2	2	
49*	10S-250-34	Mounting Screw			2
Not Shown	N-250	Mounting Nut			2

MOVEABLE MAIN CONTACT ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
1	1151-9244	Cross Bar Insulator	1	1	1
2	1151-9648	Driving Clevice	1	1	1
26	1101-9350	Driving Clevice Pin (Left & Center Pole)	1	1	
26*	1102-9350	Driving Clevice Pin (Right Pole)	1	1	
26*	1101-9674	Driving Clevice Pin (Left & Center Pole)			2
26*	1101-9687	Driving Clevice Pin (Right Pole)			1
26*	1101-9674	Driving Clevice Pin (Right Pole)			1
16	W-250	Driving Clevice Washer	2	2	6
13	1503-2639	Driving Clevice Cotter Pin	2	2	2
34	1151-9676	Moveable Main Contact	1	1	
34*	1151-9675	Moveable Main Contact			1
28	1101-9581	Moveable Arcing Contact Pivot Pin	1	1	1
18	5L4-F	Moveable Arcing Contact Pivot Pin Insulator	2	2	2
14	5100-31	Moveable Arcing Contact Pivot Pin Retaining Ring	2	2	2
35	1101-9148	Hinge Bracket	1	1	1
29	1101-9969	Hinge Bracket Pivot Pin	1	1	
29*	1101-9689	Hinge Bracket Pivot Pin			1
19	5133-25	Hinge Bracket Pivot Pin Retaining Ring	2	2	2
20	1101-9351	Hinge Pressure Roller Pin	1	1	
20*	1101-9670	Hinge Pressure Roller Pin			1
30	1101-9231	Hinge Pressure Roller	1	1	1
30*	1101-9669	Hinge Pressure Roller			2
Not Shown	5100-18	Hinge Pressure Roller Pin Retaining Ring			2
17	1102-9606	Hinge Pressure Compression Spring	2	2	2
27	1101-5582	Hinge·Pressure Compression Spring Guide	2	2	2

MOVEABLE ARCING CONTACT ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
4	1151-9986	Moveable Arcing Contact	2	2	2
5	1101-9232	Moveable Arcing Contact Adjusting Stud Pin	2	2	2
3	5100-25	Moveable Arcing Contact Adjusting Stud Pin Retaining Ring	2	2	2
6	1151-9353	Moveable Arcing Contact Adjusting Stud	2	2	2
7	1101-9606	Moveable Arcing Contact Inner Compression Spring	2	2	2
8	1119-9606	Moveable Arcing Contact Outer Compression Spring	2	2	2
9	W-250	Moveable Arcing Contact Compression Spring Washer	2	2	2
10	1101-9409	Moveable Arcing Contact Adjusting Stud Insulator	2	2	2
11	1101-9230	Moveable Arcing Contact Adjusting Stud Guide	1	1	1
21	5100-50	Guide Retaining Ring	2	2	2
12	22-TM-02	Moveable Arcing Contact Adjusting Nut	2	2	2

MOVEABLE MAIN CONTACT PIVOT

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
36*	1151-9325	Moveable Main Contact Pivot	1		
36	1151-9319	Moveable Main Contact Pivot		1	
36*	1151-9424	Moveable Main Contact Pivot			1
52	1-S-375-24	Mounting Screw	1	2	2
51	1W-375	Mounting Lock Washer	1	2	2
50	W-375	Mounting Washer	1	2	2

LOWER TERMINAL ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
37	1151-9646	Lower Terminal	1	1	
37*	1151-9425	Lower Terminal			1
31	1101-9418	Terminal Insulation	1	1	
31*	1101-9383	Terminal Insulation			1
22	PK #6 - Typ Ux5/16	(Screw) Terminal Insulation Screw	2	2	2
53	19S-250-32	Terminal Mounting Screw	2	2	
Not Shown	1-W-250	Terminal Mounting Lock Washer	2	2	
Not Shown	W-250	Terminal Mounting Washer	2	2	

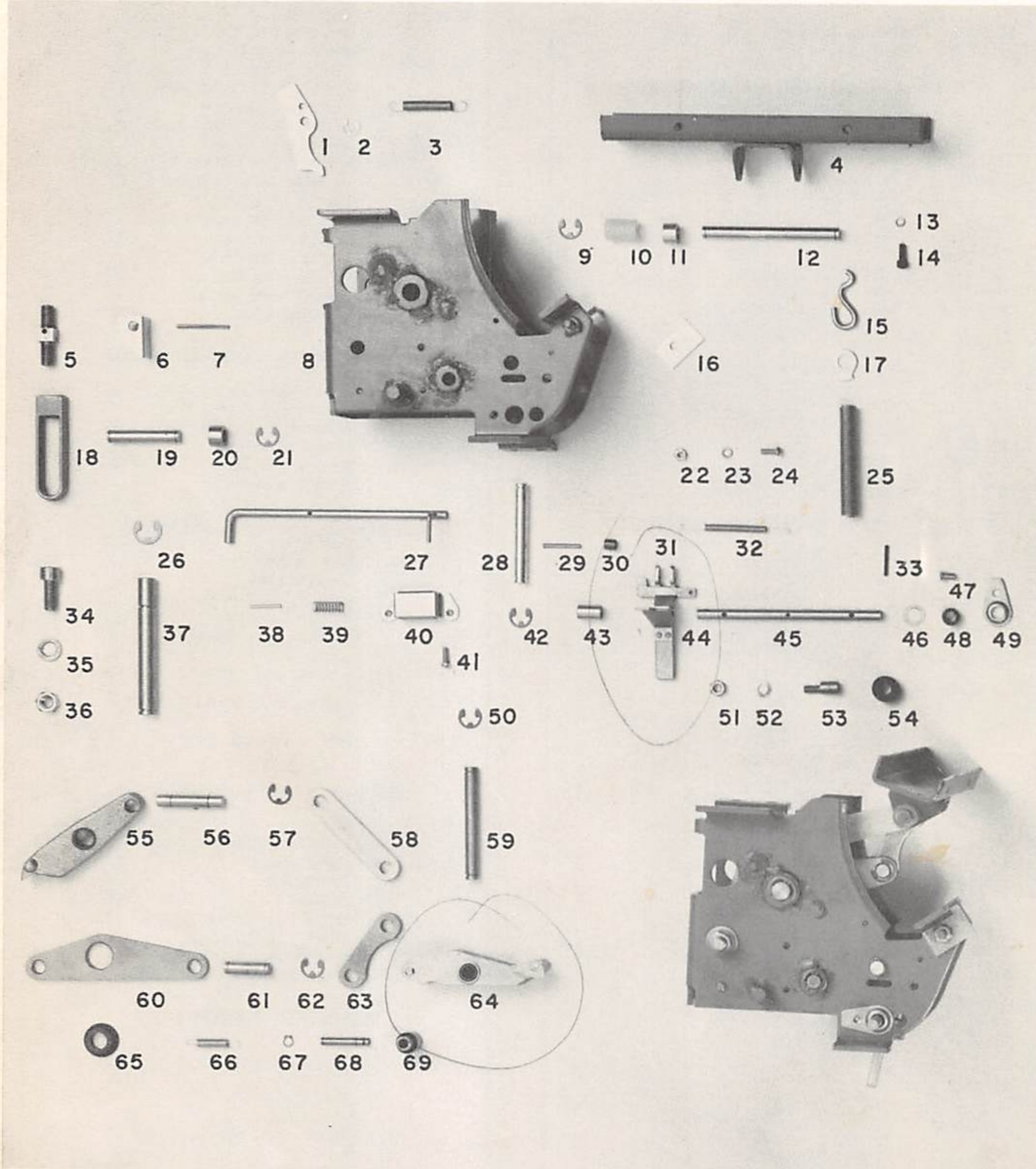
TERMINAL STAB ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
45	1101-0895	Contact Finger Retaining Bracket	2	2	
45*	1101-9679	Contact Finger Retaining Bracket			2
41	1101-0446	Contact Finger	12	12	40
40	1101-0117	Contact Finger Spring	24	24	40
46	1101-1280	Shouldered Mounting Screw	4	4	
46*	1101-0193	Shouldered Mounting Screw			4
44	1101-0173	Mounting Washer	4	4	4
43	1101-0192	Mounting Spring	4	4	4
42	2705-0339	Mounting Spacer	4	4	

MOUNTING HARDWARE

ITEM	PART NUMBER	DESCRIPTION	400 Amp	800 Amp	2000 Amp
Not Shown	1S 375-20	Mounting Bolt	6	6	12
Not Shown	W-375	Mounting Washer	6	6	12
Not Shown	1W-375	Mounting Lock Washer	6	6	12
Not Shown	N-375	Mounting Nut	6	6	12

*SIMILAR TO PART SHOWN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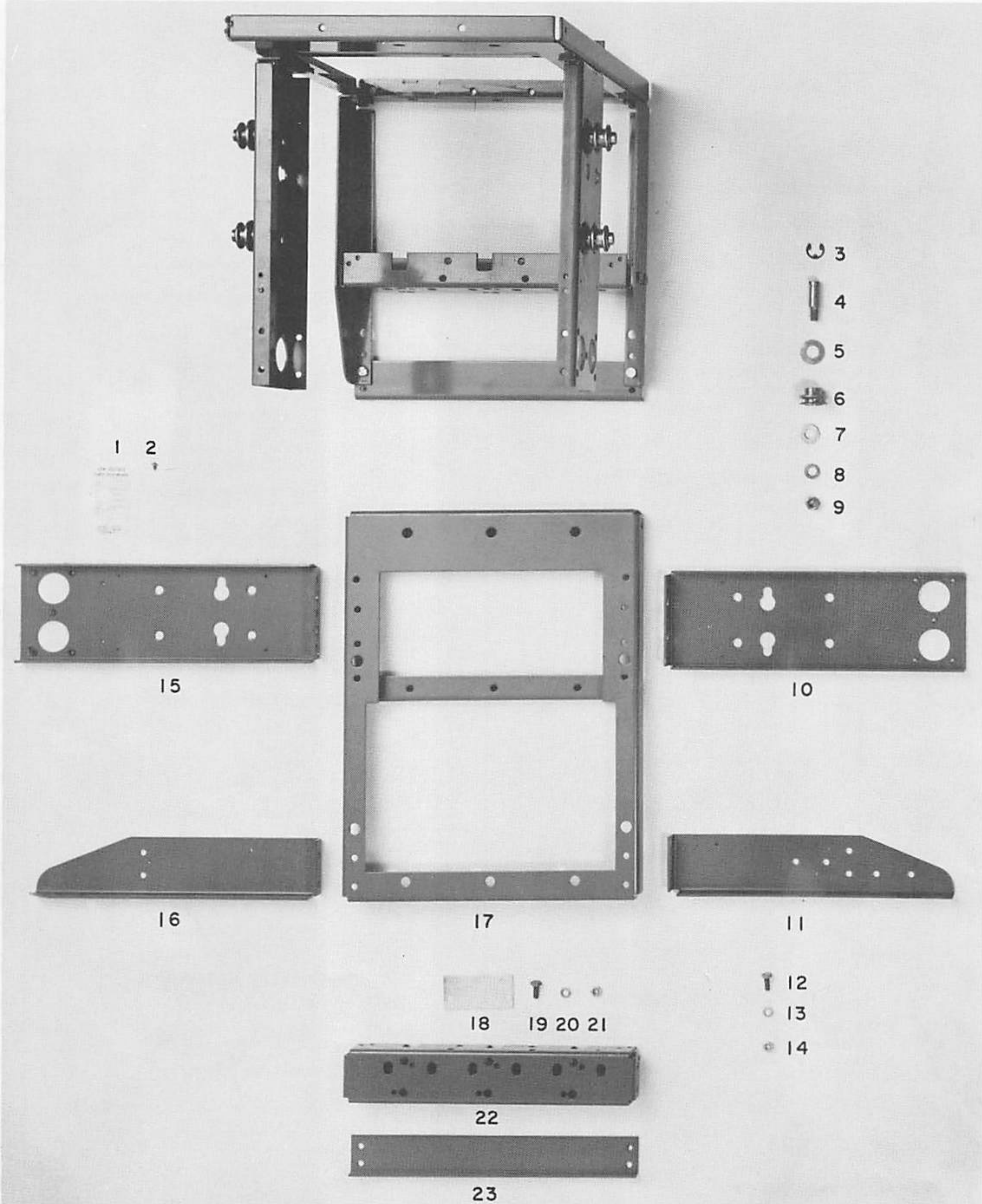
HOUSING MECHANISM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	NUMBER REQUIRED PER CIRCUIT BREAKER 400 Amp	800 Amp	2000 Amp
8	1151-C-9305	Housing Frame	1	1	1
		TRIP LEVER ASSEMBLY			
64	1151-A-9758	Trip Lever	1	1	1
59	1101-A-9218	Trip Lever Shaft	1	1	1
50	5133-37	Trip Lever Shaft Retaining Ring	1	1	1
Not Shown	1104-9796	Trip Lever Shim Washer	As Required		
69	1151-A-9853	Trip Lever Roller	1	1	1
68	1101-A-9927	Trip Lever Roller Shaft	1	1	1
67	5133-25	Trip Lever Roller Shaft Retaining Ring	2	2	2
66	1101-A-9052	Trip Lever Reset Spring	1	1	1
		MAIN SHAFT ASSEMBLY			
60	1101-A-9147	Lever Arm	2	2	2
65	1101-A-9213	Lever Arm Bearing	2	2	2
55	1151-A-9539	Main Latch Link	1	1	1
37	1101-A-9216	Main Latch Shaft	1	1	1
26	5133-50	Main Latch Shaft Retaining Ring	2	2	2
34	1101-A-9116	Lever Arm Stop	2	2	2
35	1W-375	Lever Arm Stop Lock Washer	2	2	2
36	N-375	Lever Arm Stop Nut	2	2	2
		OPERATING LINKAGE			
58	1101-9145	Compression Link	2	2	2
63	1101-A-9152	Lift Link	2	2	2
18	1101-A-9172	Drive Yoke	1	1	1
5	1101-A-9191	Drive Yoke Turnbuckle	1	1	1
6	1101-A-9108	Drive Yoke Turnbuckle Lock	1	1	1
7	52-028-125	Drive Yoke Turnbuckle Lock Pin	1	1	1
28	1101-9215	Trip Lever Stop Pin	1	1	1
42	5133-37	Trip Lever Stop Pin Retaining Ring	2	2	2
61	1101-A-9192	Lift Link Pin	1	1	1
62	5133-37	Lift Link Pin Retaining Ring	2	2	2
19	1101-A-9194	Drive Pin	1	1	1
20	1101-A-9196	Drive Pin Roller	2	2	2
21	5133-37	Drive Pin Roller Retaining Ring	2	2	2
56	1101-A-9195	Compression Link Pin	1	1	1
57	5133-37	Compression Link Pin Retaining Ring	2	2	2
		TRIP ROD ASSEMBLY			
40	1101-A-9593	Trip Rod Guide	1	1	1
27	1151-A-9942	Trip Rod	1	1	1
39	1105-B-9606	Trip Rod Spring	1	1	1
38	52-022-049-0875	Trip Rod Guide Pin	1	1	1
41	WS8-6	Trip Rod Assembly Mounting Screw	2	2	2

ITEM	PART NUMBER	DESCRIPTION	NUMBER REQUIRED PER CIRCUIT BREAKER 400 Amp	800 Amp	2000 Amp
		TRIP FINGER ASSEMBLY			
44	1151-A-9936	~~Trip~~ Finger	1	1	1
30	1151-A-9262	Latch Bearing Assembly	1	1	1
29	1101-A-9804	Latch Bearing Pin	1	1	1
31	5100-12	Latch Bearing Pin Retaining Ring	2	2	2
45	1101-A-9925	Trip Shaft	1	1	1
43	1101-A-5531	Trip Shaft Spacer	2	2	2
48	D.C.-B55	Trip Shaft Bearing	2	2	2
49	1101-A-9883	Trip Shaft Bearing Holder	4	4	4
47	E598-3/8Lg.	Trip Shaft Bearing Holder Rivet	2	2	2
33	55-022-094-0562	Trip Finger Roll Pin	1	1	1
32	1101-A-5544	Trip Finger Spring	1	1	1
24	S8-10	Trip Finger Spring Screw	1	1	1
23	1W-8	Trip Finger Spring Lockwasher	1	1	1
22	N-8	Trip Finger Spring Nut	1	1	1
		TRIP FINGER STOP			
53	1101-A-09934	Trip Finger Stop Pin	1	1	1
54	1101-A-9543	Stop Pin Tubing	1	1	1
52	1W-250	Mounting Lockwasher	1	1	1
51	N-250	Mounting Nut	1	1	1
		TRIP GUIDE ASSEMBLY			
1	1101-A-9111	Trip Guide Latch	1	1	1
2	5133-25	Trip Guide Latch Retaining Ring	1	1	1
3	1117-B-9606	Trip Guide Latch Spring	1	1	1
		CROSS BAR ASSEMBLY			
4	1151-9407	Cross Bar	1	1	
4*	1151-9408	Cross Bar			1
12	1101-9219	Cross Bar Pin	1	1	1
11	1101-9214	Cross Bar Spacer	2	2	2
10	1101-9190	Cross Bar Roller	2	2	2
9	5100-37	Cross Bar Roller Retaining Ring	2	2	2
15	1101-A-5543	Pull-Off Spring Hook	2	2	2
17	1101-A-9946	Pull-Off Spring End	4	4	4
25	1101-A-5540	Pull-Off Spring	2	2	2
16	1101-A-9142	Cross Bar Guide	1	1	1
14	1102-9116	Insulation Block Mounting Screw	4	4	4
14*	1104-9116	Insulation Block Mounting Screw	2	2	2
13	1W-10	Insulation Block Mounting Lockwasher	6	6	6
		MOUNTING HARDWARE			
Not Shown	1S-250-10	Mounting Screw	4	4	4
Not Shown	W-250	Mounting Washer	4	4	4
Not Shown	1W-250	Mounting Lock Washer	8	8	8
Not Shown	N-250	Mounting Nut	8	8	8

*SIMILAR TO PART SHOWN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FP-50 FRAME ASSEMBLY

MAIN ASSEMBLY PARTS

ITEM	PART NUMBER	DESCRIPTION	400 & 800 FIXED MOUNTED	2000 FIXED MOUNTED	400 & 800 DRAW-OUT	2000 DRAW-OUT
17	1151-9392	Back Plate Assembly	1		1	
17*	1151-9395	Back Plate Assembly		1		1
16	1101-9162	Lower Left Side	1	1	1	1
11	1101-9163	Lower Right Side	1	1	1	1
10	1101-9266	Upper Right Side	1	1	1	1
15	1101-9266	Upper Left Side	1	1	1	1
23	1102-9272	Forward Cross Member	1		1	
23*	1101-9272	Forward Cross Member		1		1
22	1101-9160	Main Cross Member	1		1	
22*	1101-9273	Main Cross Member		1		1

GROUNDING STRIP ASSEMBLY

18	1101-9917	Grounding Strip	1	1	1	1
19	1S-250-10	Grounding Strip Mounting Screw	2	2	2	2
20	1W-250	Grounding Strip Lock Washer	2	2	2	2
21	N-250	Grounding Strip Nut	2	2	2	2

DRAW-OUT ROLLER ASSEMBLY

6	1101-9686	Draw-Out Roller			4	4
4	1101-9685	Draw-Out Roller Shaft			4	4
5	W-500	Draw-Out Roller Washer			4	4
3	5133-50	Draw-Out Roller Retaining Ring			4	4
7	W-375	Mounting Washer			4	4
8	1W-375	Mounting Lock Washer			4	4
9	N-375	Mounting Nut			4	4

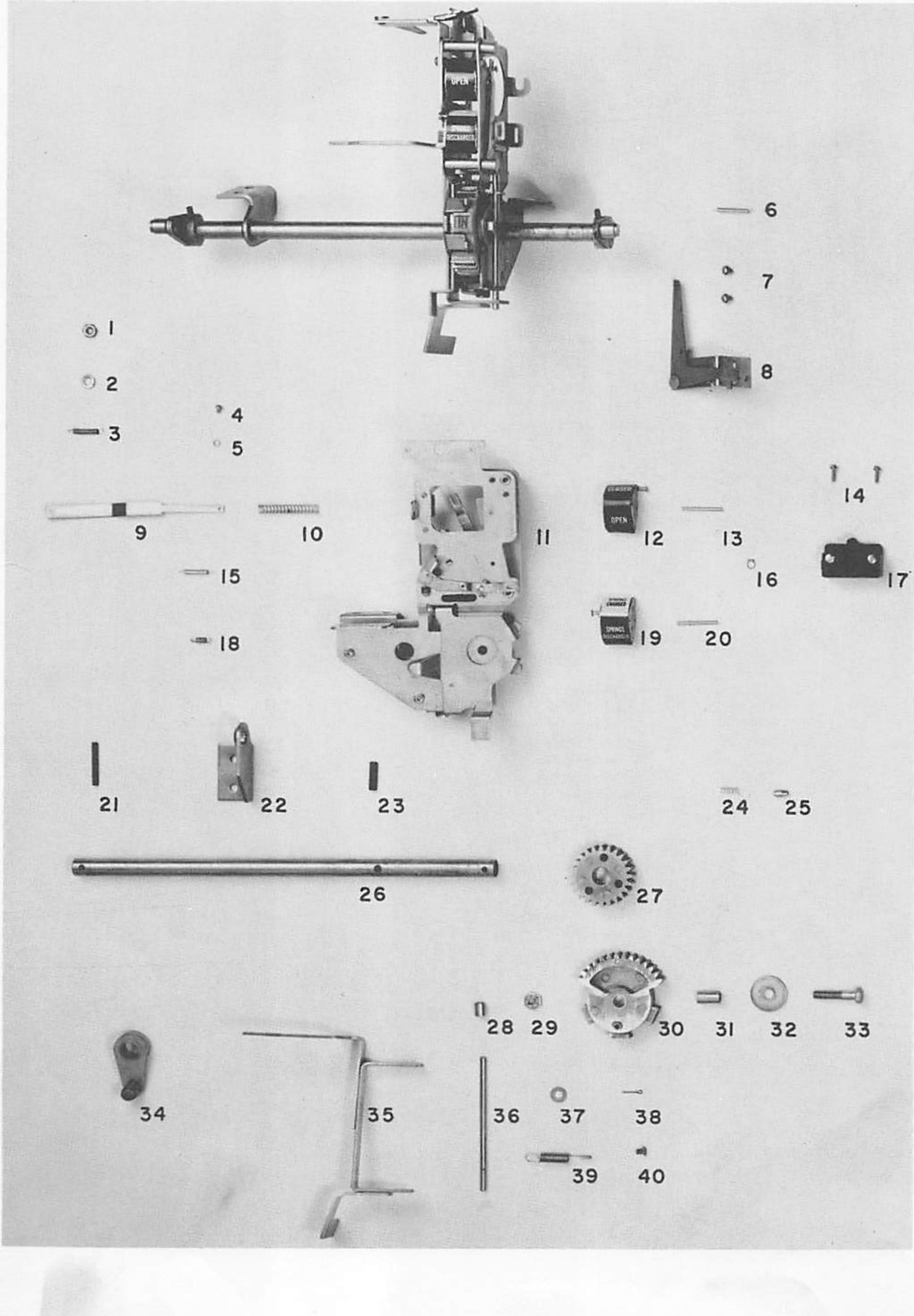
FRAME FASTENERS

12	1S-250-10	Frame Screw	16	16	16	16
13	1W-250	Frame Lock Washer	16	16	16	16
14	N-250	Frame Nut	16	16	16	16

NAME PLATE

1	1101-9295	Name Plate	1	1	1	1
2	1101-9277	Name Plate Screw	2	2	2	2

*SIMILAR TO PART SHOWN



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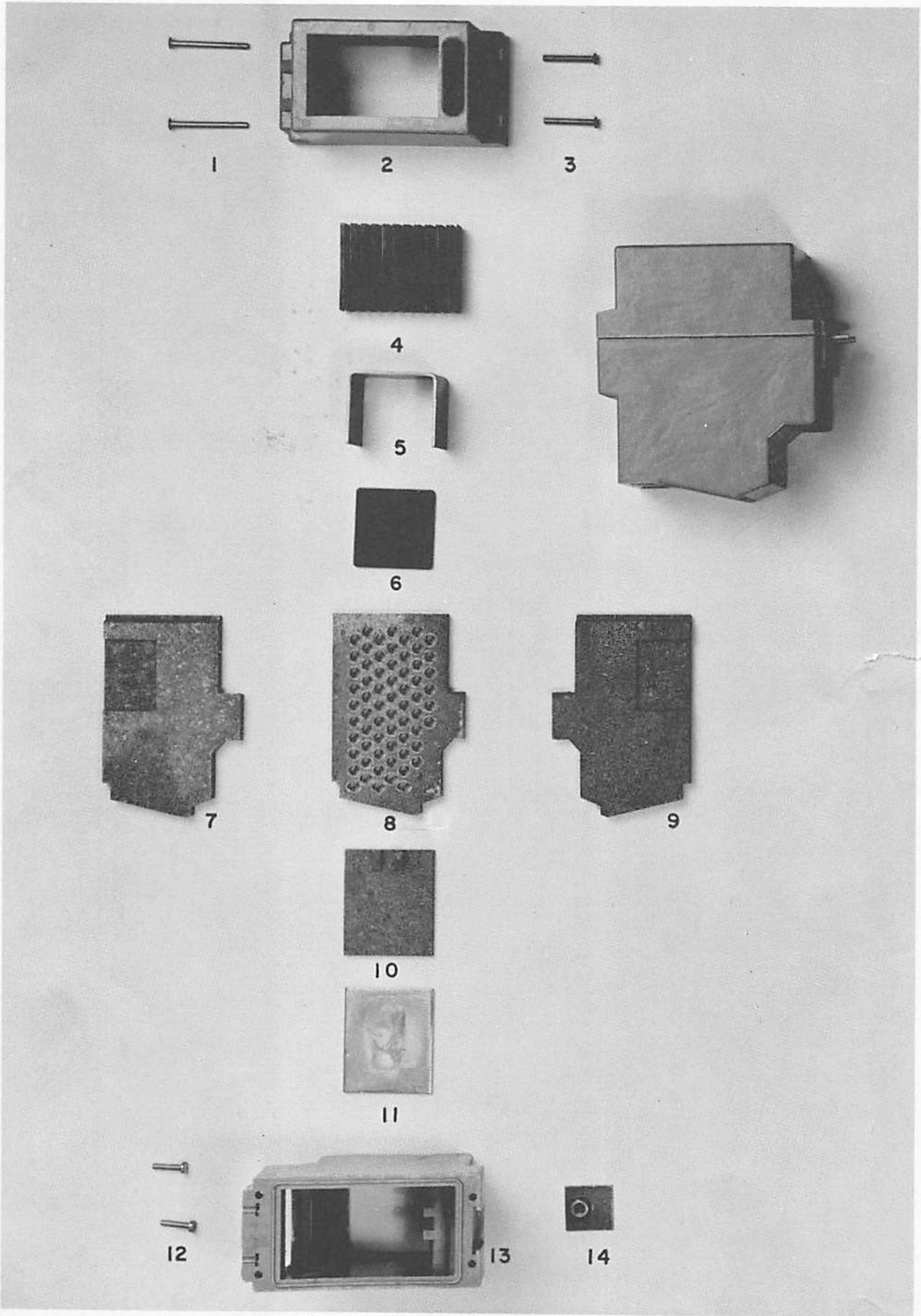
DRAW-OUT AND INDICATOR MECHANISM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	MANUALLY OPERATED FIXED 400 & 800	MANUALLY OPERATED FIXED 2000	MANUALLY OPERATED DRAW-OUT 400 & 800	MANUALLY OPERATED DRAW-OUT 2000	ELECTRICALLY OPERATED FIXED 400 & 800	ELECTRICALLY OPERATED FIXED 2000	ELECTRICALLY OPERATED DRAW-OUT 400 & 800	ELECTRICALLY OPERATED DRAW-OUT 2000
		FRAME ASSEMBLY								
11	1151-9710	Frame Assembly							1	1
11*	1152-9710	Frame Assembly			1	1				
11*	1153-9710	Frame Assembly					1	1		
11*	1154-9710	Frame Assembly	1	1						
		INDICATOR LINKS								
9	1101-9944	O.C. Indicator Conn. Link	1	1	1	1	1	1	1	1
10	1116-9606	O.C. Indicator Conn. Spring	1	1	1	1	1	1	1	1
4	SF6-40x5/32 Lg.	O.C. Indicator Conn. Screw	1	1	1	1	1	1	1	1
5	1W-6	O.C. Indicator Conn. Washer	1	1	1	1	1	1	1	1
3	1101-9732	O.C. Indicator Conn. Return Spring	1	1	1	1	1	1	1	1
12	1151-9735	O.C. Indicator	1	1	1	1	1	1	1	1
13	1101-9738	O.C. Indicator Pin	1	1	1	1	1	1	1	1
16	5133-15	Indicator Pin Retaining Ring	2	2	2	2	2	2	2	2
18	102-023	C.D. Link Spring	1	1	1	1	1	1	1	1
15	1101-9718	C.D. Link Return Spring	1	1	1	1	1	1	1	1
19	1151-9739	C.D. Indicator	1	1	1	1	1	1	1	1
20	1101-9738	C.D. Indicator Pin	1	1	1	1	1	1	1	1
16	5133-15	Indicator Pin Retaining Ring	2	2	2	2	2	2	2	2
		LOCAL CLOSE LINKAGE								
8	1151-9720	Local Close Linkage	1	1	1	1				
8*	1152-9720	Local Close Linkage					1	1	1	1
6	1101-9732	Local Close Return Spring	1	1	1	1	1	1	1	1
7	WS10-4	Close Linkage Mounting Screw	2	2	2	2	2	2	2	2
17	120-001	Local Close Switch					1	1	1	1
14	WS6-7	Local Close Switch Mounting Screw					2	2	2	2
		DRAW-OUT OPERATING MECHANISM								
30	1151-9800	Front Gear Assembly			1	1			1	1
33	19S-312-24	Front Gear Screw	1	1	1	1	1	1	1	1
32	1101-9743	Front Gear Washer	1	1	1	1	1	1	1	1
31	1101-A-9744	Fron Gear Spacer	1	1	1	1	1	1	1	1
29	N-312	Front Gear Lock Nut	1	1	1	1	1	1	1	1
27	1101-9652	Rear Gear			1	1			1	1
24	1108-B-9606	Rear Gear Index Pin Spring			3	3			3	3
25	1101-A-9734	Rear Gear Index Pin			3	3			3	3
23	52-048-219-1750	Rear Gear Roll Pin			1	1			1	1
26	1101-A-9663	Operating Shaft			1				1	
26*	1102-A-9663	Operating Shaft				1				1
22	1101-A-9742	Left Shaft Guide			1	1			1	1
22*	1102-A-9742	Right Shaft Guide				1				1
34	1151-9671	Drive Link Assembly			2	2			2	2
21	52-032-156-1250	Drive Link Pin			2	2			2	2
		TRIP LINKAGE								
35	1151-B-9528	Trip Link Assembly	1	1	1	1	1	1	1	1
28	1101-A-5512	Trip Link Spacer	1	1	1	1	1	1	1	1
36	1101-A-9529	Trip Link Pivot Shaft	1	1	1	1	1	1	1	1
37	1101-A-5514	Trip Link Washer	1	1	1	1	1	1	1	1
38	52-012-062-0500	Trip Link Pin	1	1	1	1	1	1	1	1
39	1120-B-9606	Trip Link Return Spring	1	1	1	1	1	1	1	1
40	1101-A-5581	Trip Link Return Spring Pin	1	1	1	1	1	1	1	1
2	1W-250	Mounting Lock Washer	6	6	8	10	6	6	8	10
1	N-250	Mounting Nut	6	6	8	10	6	6	8	10

*SIMILAR TO PART SHOWN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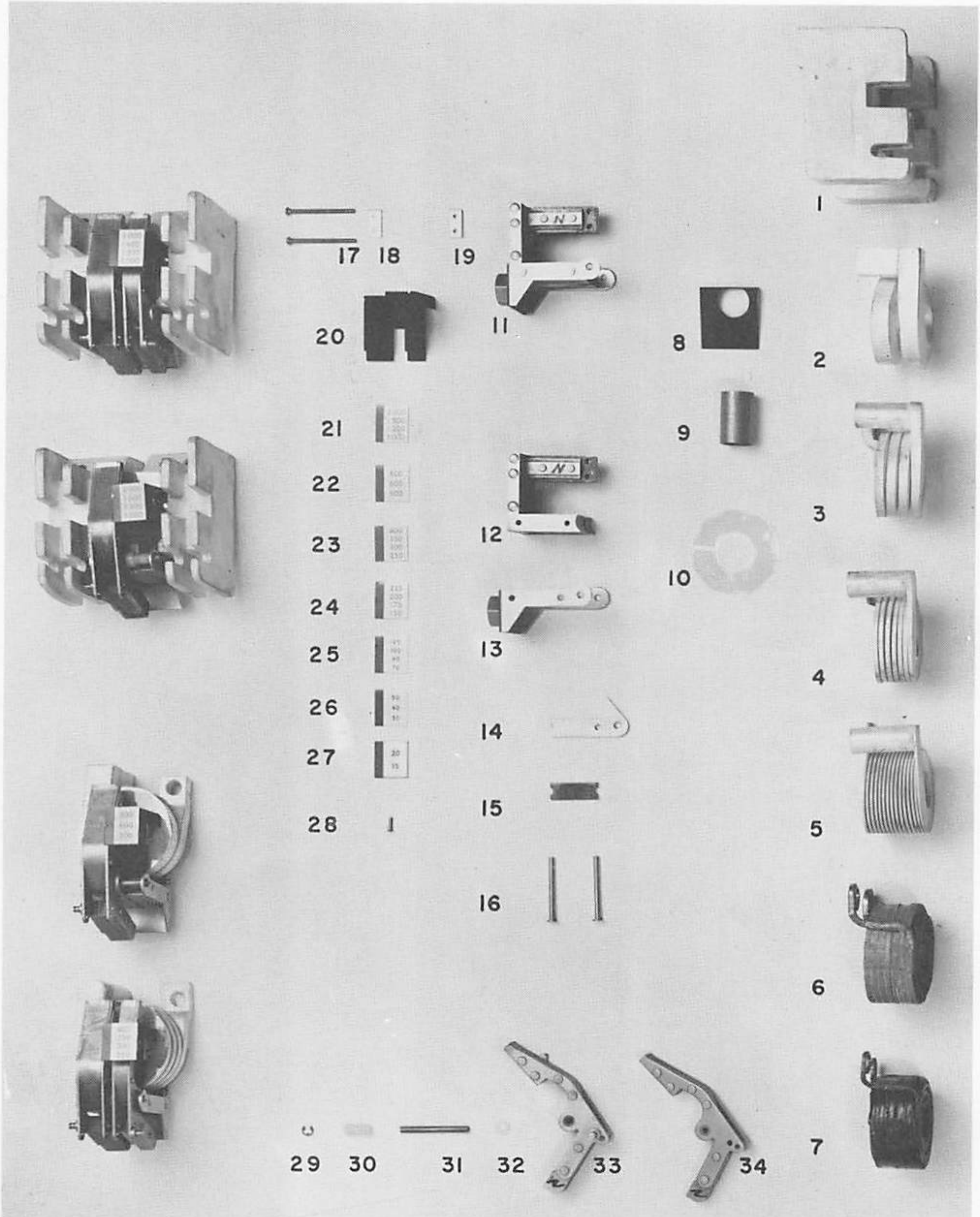
ARC CHUTE

ITEM	PART NUMBER	DESCRIPTION	NUMBER REQUIRED PER POLE ALL FP-50
2	1101-9554	Upper Cover	1
4	1101-9410	De-Ionization Screen	1
5	1101-9411	Blow-Out Magnet	1
6	1101-9414	Blow-Out Magnet Insulation Plate	1
7	1101-9558	Left Side Plate	1
8	1101-9558	Center Plate	3
9	1101-9557	Right Side Plate	1
10	1101-9413	Pressure Plate Insulation	1
11	1101-9412	Pressure Plate	1
13	1101-9553	Lower Cover	1
12	1101-9811	Guide Pin	2
14	1101-9824	Thrust Plate	1
1	RT6-148	Front Rivet	2
3	RT6-100	Rear Rivet	2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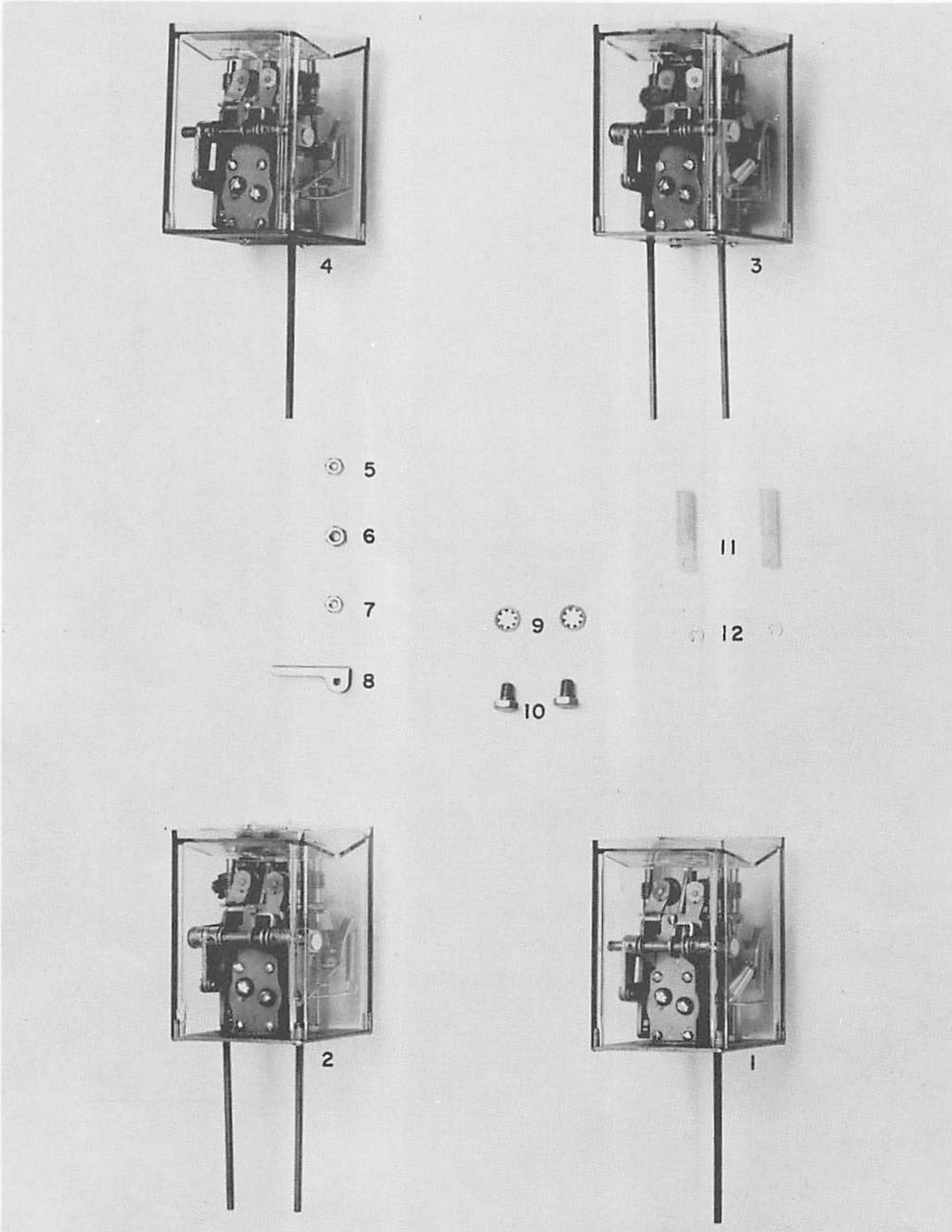
SERIES COIL & MAGNET ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	DUAL MAGNETIC 20	50	125	225	400	800	2000	SELECTIVE SERVICE 20	50	125	225	400	800	2000
		SERIES COIL														
7	1101-9771	15-20 Amp Coil	1							1						
6	1101-9772	30-50 Amp Coil		1							1					
5	1151-9994	70-125 Amp Coil			1							1				
4	1151-9755	150-225 Amp Coil				1							1			
3	1151-9756	250-400 Amp Coil					1							1		
2	1151-9776	500-800 Amp Coil						1							1	
1	1101-9440	1000-2000 Amp Coil							1							1
8	1101-9967	Rear Insulation	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1101-9966	Insulation Tube	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1101-9986	Insulation Disc	1	1	16	8	5	3	1	1	1	16	8	5	3	1
		MAGNET CORE ASSEMBLY														
11	1151-9769	Stationary Magnet Assembly							1							1
12	1151-9763	Magnet Core Assembly	1	1	1	1	1	1		1	1	1	1	1	1	
13	1151-9106	Magnet Core Bracket	1	1	1	1	1	1		1	1	1	1	1	1	
14	1101-9948	Center Spacer	1	1	1	1	1	1		1	1	1	1	1	1	
15	1101-9099	Outside Spacer	2	2	2	2	2	2		2	2	2	2	2	2	
16	12R5-118	Rivet	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		POLE FACE ASSEMBLY														
20	1151-9750	Pole Face	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	S6-30	Pole Face Screw	2	2	2	2	2	2	2	2	2	2	2	2	2	2
18	1101-9707	Pole Face Plate	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1101-9747	Pole Face Tapped Plate	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	1101-9855	Pole Face Indicator Plate	1							1						
26	1101-9856	Pole Face Indicator Plate		1							1					
25	1101-9857	Pole Face Indicator Plate			1							1				
24	1101-9858	Pole Face Indicator Plate				1							1			
23	1101-9859	Pole Face Indicator Plate					1							1		
22	1101-9860	Pole Face Indicator Plate						1							1	
21	1101-9861	Pole Face Indicator Plate							1							1
28	RT2-8A	Pole Face Indicator Plate Rivet	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		ARMATURE ASSEMBLY														
33	1151-9753	Left Hand Armature	1	1	1	1	1	1	1	1	1	1	1	1	1	1
34	1151-9754	Right Hand Armature								1	1	1	1	1	1	1
31	1101-9109	Armature Shaft	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	5133-18	Armature Shaft Retaining Ring	2	2	2	2	2	2	2	2	2	2	2	2	2	2
32	1101-9784	Spacer Washer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	1101-9379	Spacer Tube							1							
		MOUNTING HARDWARE														
N	19S-375-40	3/8-16 Bolt 2-1/2" Lg.	2	2	1	1				2	2	1	1			
o	19S-375-48	3/8-16 Bolt 3" Lg.			1	1	1	2	4			1	1	1	2	4
t	19S-375-44	3/8-16 Bolt 2-3/4" Lg.					1							1		
S	19S-500-20	1/2-13 Bolt 1-1/8" Lg.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
h	1W-375	3/8" Lock Washer	4	4	3	2	2	2	2	4	4	3	2	2	2	2
o	W-375	3/8" Washer	4	4	3	2	2	2	2	4	4	3	2	2	2	2
w	1W-500	1/2" Lock Washer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
n	W-500	1/2" Washer	1	1	1	1	1	1	1	1	1	1	1	1	1	1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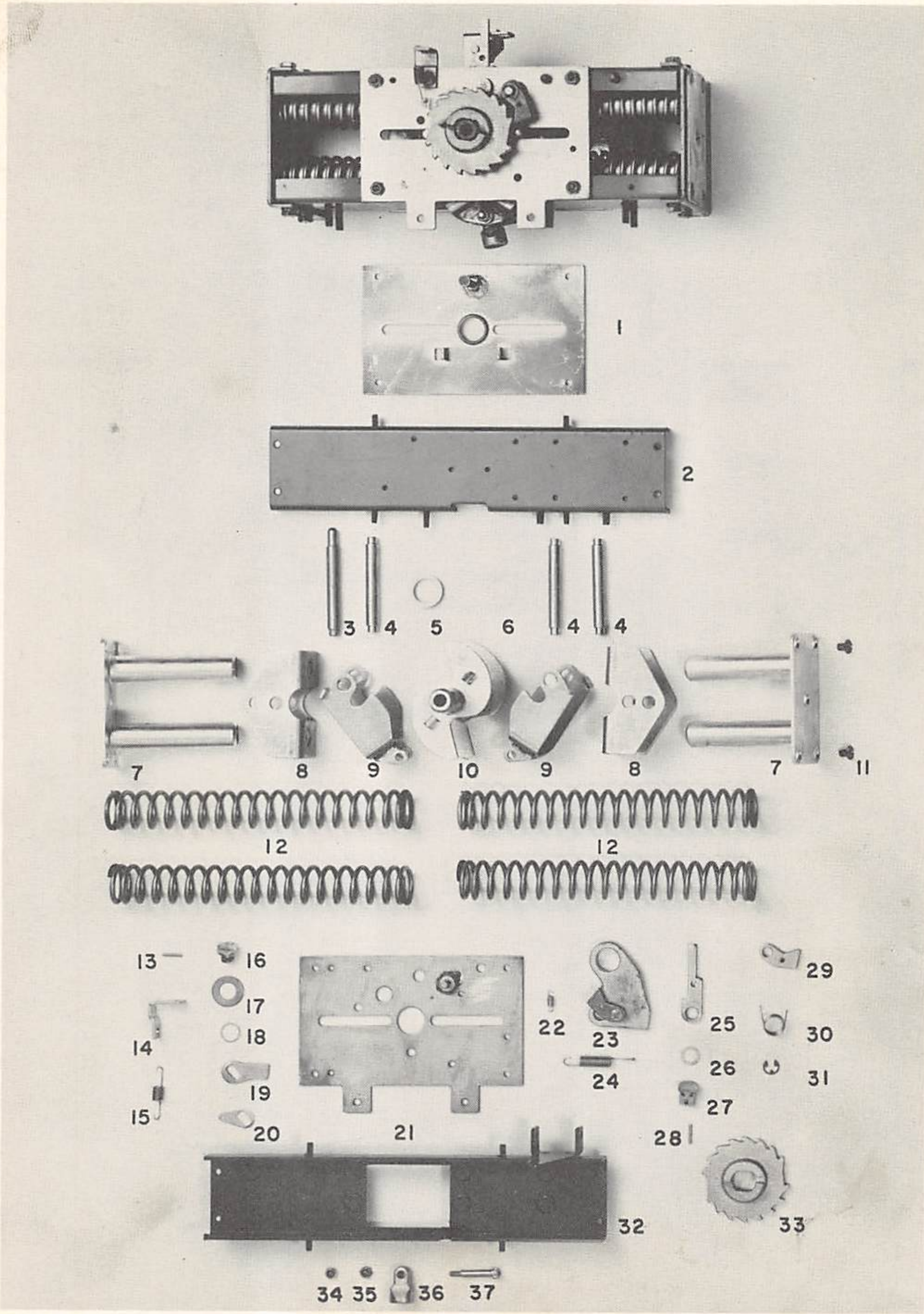
FP-50 SERIES TRIP UNIT

ITEM	PART NUMBER	DESCRIPTION	NUMBER REQUIRED PER POLE
1	1151-9082	Dual Magnetic Series Trip Unit Type TD1 Long Delay & Instantaneous Trip	1
2	1151-9081	Selecting Series Trip Unit Type TD2 Long Delay & Short Delay Trip	1
3	1151-9879	Special Service Trip Unit Type TD3 Long Delay, Short Delay & Instantaneous Trip	1
4	1151-9083	Special Application Trip Unit Type TD4 Long Delay Trip	1

MOUNTING HARDWARE

			TD 1 & 4	TD 2 & 3
10	1S-312-7	Mounting Screw	2	2
9	1W-312	Mounting Lock Washer	2	2
8	1101-9128	Trip Arm	1	2
7	N-10	Trip Arm Jam Nut	1	2
6	N-250	Spacer Nut	1	2
5	N-10	Trip Arm Nut	1	2
11	1101-9026	Nylon Turnbuckle	1	2
12	5133-18	Turnbuckle Retaining Ring	1	2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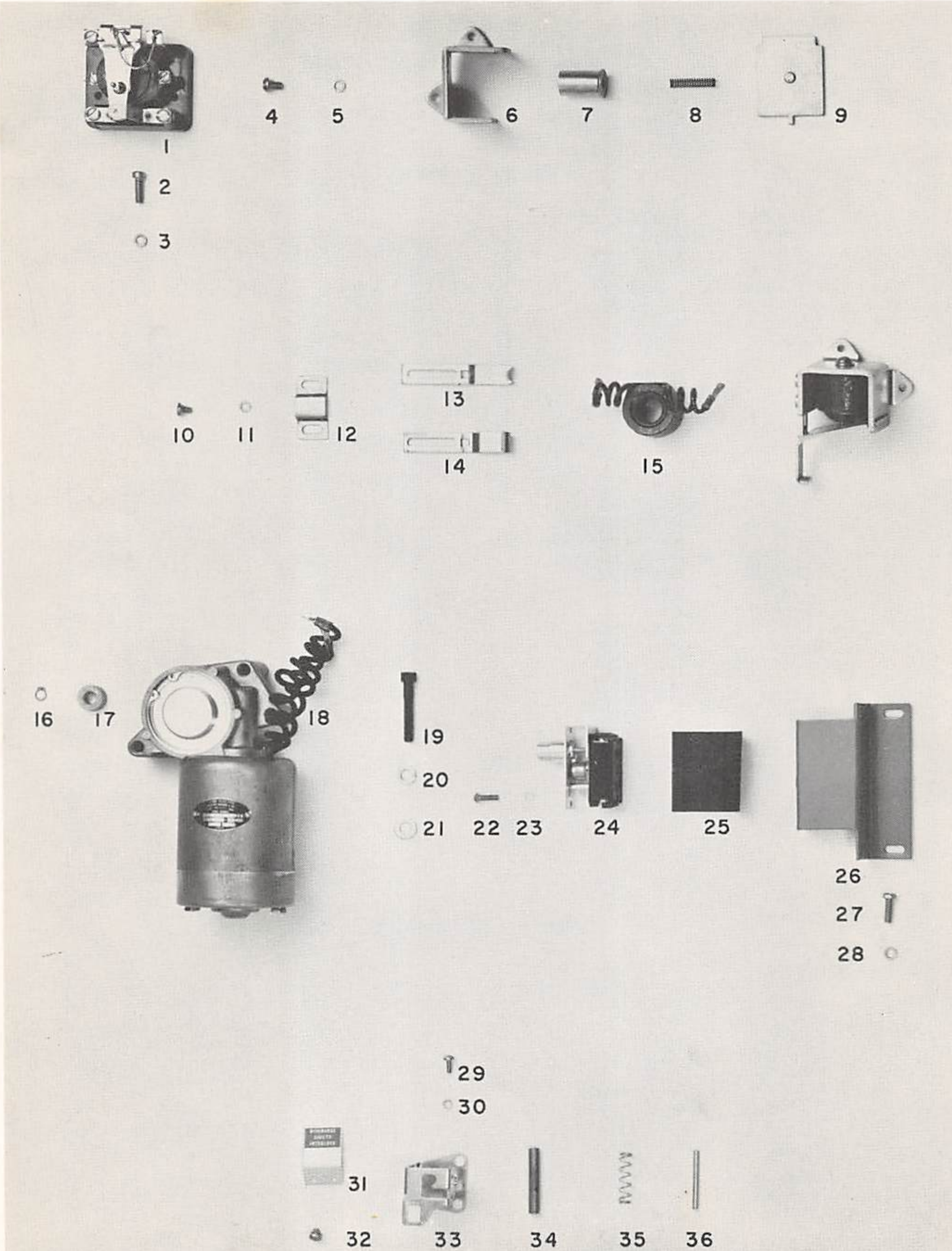
STORED ENERGY MECHANISM

ITEM	PART NUMBER	DESCRIPTION	MANUALLY OPERATED 400	800	2000	ELECTRICALLY OPERATED 400	800	2000
		FRAME ASSEMBLY						
1	1151-B-9538	Rear Plate	1	1	1	1	1	1
1*	1101-9156	Rear Plate						
2	1151-B-9396	Upper Channel	1	1		1	1	
2*	1151-B-9365	Upper Channel			1			1
32	1151-B-9362	Lower Channel	1	1		1	1	
32*	1151-B-9364	Lower Channel			1			1
21	1151-B-9230	Front Plate	1	1	1	1	1	1
34	22TM-02	Assembly Nut	9	9	9	9	9	9
		FRONT PLATE ASSEMBLY						
33	1101-A-9164	Ratchet Gear	1	1	1	1	1	1
29	1101-A-9166	Ratchet Pawl	1	1	1	1	1	1
30	1101-A-9155	Ratchet Pawl Spring	1	1	1	1	1	1
31	5100-25	Ratchet Pawl Retaining Ring	1	1	1	1	1	1
19	1101-A-9450	Cam Stop Latch Plate	1	1	1	1	1	1
20	1101-A-9522	Latch Reset Plate	1	1	1	1	1	1
18	1105-A-9796	Shim Washer			As Required			
17	2701-A-0412	Washer	1	1	1	1	1	1
18	1103-A-9796	Rear Shim Washer	1	1	1	1	1	1
16	1101-A-9521	Cam Stop Pin	1	1	1	1	1	1
13	79-022-094-0375	Cam Stop Roll Pin	1	1	1	1	1	1
27	1101-9222	Close Latch Pin	1	1	1	1	1	1
26	1104-9764	Close Latch Shim			As Required			
25	1101-9151	Close Latch Lever	1	1	1	1	1	1
28	79-022-094-0625	Close Latch Level Roll Pin	1	1	1	1	1	1
14	1101-9248	Cam Stop Reset Spring Support	1	1	1	1	1	1
15	1101-9788	Cam Stop Reset Spring	1	1	1	1	1	1
23	1151-A-9490	Charging Lever Assembly				1	1	1
22	Z-7756-W	Charging Lever Pawl Spring				1	1	1
24	1101-A-9417	Charging Lever Return Spring				1	1	1
		INTERNAL MECHANISM						
10	1151-9374	Cam Assembly	1	1	1	1	1	1
9	1151-9373	Thrust Bracket Assembly	2	2	2	2	2	2
8	1101-A-9241	Spring Holder	2	2	2	2	2	2
3	1101-4684	Guide Pin	2	2	2	2	2	2
4	1101-9229	Guide Pin	2	2	2	2	2	2
5	1101-A-9796	Cam Spacer	1	1	1	1	1	1
6	1102-A-9796	Cam Shim			As Required			
7	1151-9806	Main Spring Guide	2	2		2	2	
7*	1152-9806	Main Spring Guide			2			2
11	1101-9267	Main Spring Guide Screw	10	10	10	10	10	10
12	1112-9606	Main Spring	4	4		4	4	
12*	1111-9606	Main Spring			4			4
36	1101-A-9165	Turnbuckle Head	1	1	1	1	1	1
37	1101-A-9748	Turnbuckle Screw	1	1	1	1	1	1
35	22M-04	Turnbuckle Screw Nut	1	1	1	1	1	1

*SIMILAR TO PART SHOWN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Y-RELAY; CHARGING MOTOR – SHUNT CLOSE; SHUNT TRIP; SAFETY LOCK

Y (ANTI PUMP) RELAY

ITEM	PART NUMBER	DESCRIPTION	ALL BREAKERS
1	1151-5569	Y Relay 48V AC	1
1*	1152-5569	Y Relay 115V AC	1
1*	1153-5569	Y Relay 230V AC	1
1*	1154-5569	Y Relay 125V DC	1
1*	1155-5569	Y Relay 250V DC	1
2	S-10-10	Y Relay Mounting Screw	2
3	1W-10	Y Relay Mounting Lock Washer	2
Not Shown	N-10	Y Relay Mounting Nut	2

SHUNT TRIP & SHUNT CLOSE

ITEM	PART NUMBER	DESCRIPTION	SHUNT TRIP	SHUNT CLOSE
6	1101-9513	Magnet Frame	1	1
7	1101-9512	Magnet Core	1	1
8	1101-9524	Magnet Spring	1	1
9	1101-9516	Magnet Armature	1	1
15	1151-9818	Coil 24V DC	1	1
15*	1152-9818	Coil 48V DC	1	1
15*	1153-9818	Coil 125V DC	1	1
15*	1154-9818	Coil 250V DC	1	1
15*	1155-9818	Coil 230V AC	1	1
15*	1156-9818	Coil 48V AC	1	1
15*	1157-9818	Coil 115V AC	1	1
15*	1158-9818	Coil 230V AC	1	1
13	1101-9931	Shunt Close Arm		1
14	1101-9690	Shunt Trip Arm	1	
12	1101-A-5583	Guide Plate	1	1
10	S10-4	Guide Plate Screw	2	2
11	2W-10	Guide Plate Lock Washer	2	2
4	S8-8	Mounting Screw	2	2
5	1W8	Mounting Lock Washer	2	2

SPRING CHARGING MOTOR

ITEM	PART NUMBER	DESCRIPTION	400	800	2000
18	15058	Spring Charging Motor 48V AC-DC	1	1	1
18*	14975	Spring Charging Motor 115V AC - 125V DC	1	1	
18*	14977	Spring Charging Motor 230V AC - 250V DC	1	1	
18*	14976	Spring Charging Motor 115V AC - 125V DC			1
18*	14978	Spring Charging Motor 230V AC - 250V DC			1
17	1101-9220	Motor Roller	1	1	1
16	5100-31	Motor Roller Retaining Ring	1	1	1
19	1/4-20 x 1-1/2 Lg.	Motor Mounting Screw	3	3	3
20	1W-250	Motor Mounting Lock Washer	3	3	3
21	W-250	Motor Mounting Washer	3	3	3

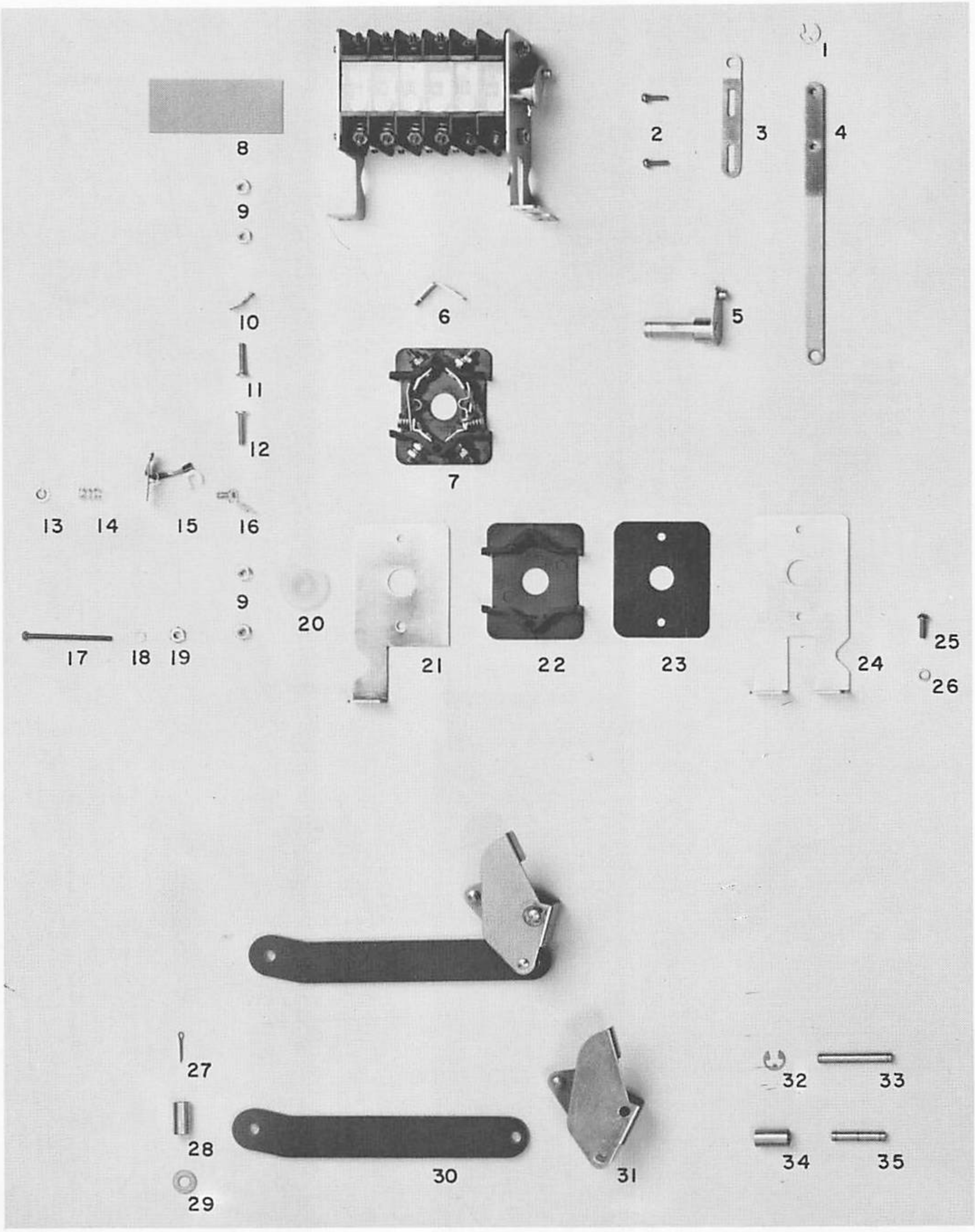
MOTOR CUT-OFF SWITCH

ITEM	PART NUMBER	DESCRIPTION	400	800	2000
24	1101-A-5543	Motor Cut-Off Switch	1	1	1
25	1101-A-5605	Switch Insulation	1	1	1
22	SF6-32-4	Switch Mounting Screw	2	2	2
23	2W-6	Switch Mounting Lock Washer	2	2	2
26	1101-B-5604	Mounting Bracket	1	1	1
27	1S8-5	Mounting Screw	2	2	2
28	2W-8	Mounting Lock Washer	2	2	2

STORED ENERGY SAFETY LOCK

ITEM	PART NUMBER	DESCRIPTION	400	800	2000
33	1151-9863	Lock Frame	1	1	1
34	1101-9864	Lock Pin	1	1	1
35	1113-9606	Lock Pin Spring	1	1	1
36	50-028-125-1250	Lock Pin Roll Pin	1	1	1
31	1101-9225	Name Plate	1	1	1
32	WS6-2	Name Plate Screw	2	2	2
29	S8-6	Mounting Screw	2	2	2
30	1W-8	Mounting Lock Washer	2	2	2

*SIMILAR TO PART SHOWN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AUXILIARY SWITCH & SECTOR ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	ELECTRICALLY OPERATED FP-50 BREAKERS 1157-9923 3 UNITS NO EXTRA CONTACTS	1158-9923 4 UNITS 2 EXTRA CONTACTS	1159-9923 5 UNITS 4 EXTRA CONTACTS	1160-9923 6 UNITS 6 EXTRA CONTACTS	MANUALLY OPERATED FP-50 BREAKERS 1161-9923 3 UNITS 6 EXTRA CONTACTS
		AUXILIARY SWITCH					
7	C-46422	Unit Assembly	3	4	5	6	3
24	1101-9914	Right End Mounting Bracket	1	1	1	1	1
23	A-356791	End Insulation	1	1	1	1	1
21	1102-9914	Left End Mounting Bracket	1	1	1	1	1
20	1101-9815	Switch Cam	6	8	10	12	6
6	C-45287	Terminal Jumper	2	2	2	2	
8*	1101-9961	Contact Insulation Panel					
8*	1102-9961	Contact Insulation Panel	2				2
8*	1103-9961	Contact Insulation Panel		2			
8	1104-9961	Contact Insulation Panel			2		
8*	1105-9961	Contact Insulation Panel				2	
17*	S8-38	Switch Assembly Screw	2				2
17*	S8-48	Switch Assembly Screw		2			
17*	S8-58	Switch Assembly Screw			2		
17	S8-68	Switch Assembly Screw				2	
5	1151-9911	Operating Shaft Assembly	1	1	1	1	1
4	1101-9890	Drive Link Long	1	1	1	1	1
1	5133-25	Drive Link Retaining Ring	2	2	2	2	2
3	1101-9501	Drive Link Short	1	1	1	1	1
2	WS6-4	Drive Link Lock Screw	2	2	2	2	2
25	S8-5	Mounting Screw	3	3	3	3	3
26	1W-8	Mounting Lock Washer	3	3	3	3	3
18	1W-8	Switch Assembly Lock Washer	2	2	2	2	2
19	N-8	Switch Assembly Nut	2	2	2	2	2

UNIT ASSEMBLY C-46422

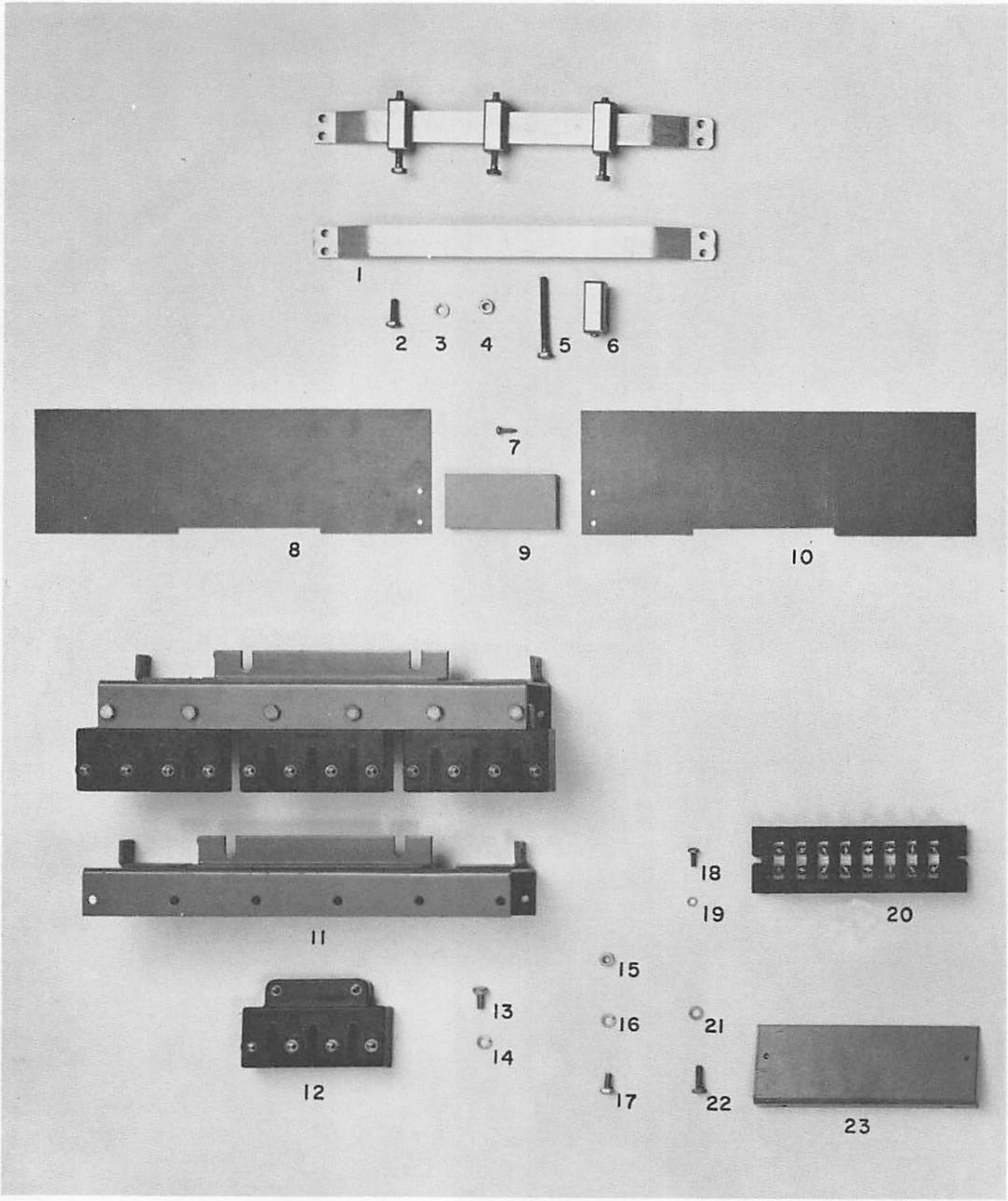
			NUMBER REQUIRED PER UNIT ASSEMBLY
22	D-45276	Unit Housing	1
15	C-45278	Moving Contact Assembly	2
16	C-45293	Moving Contact Support	2
14	C-45300	Moving Contact Spring	2
13	C-45299	Moving Contact Spring Retainer	2
12	C-45286-1	Lower Terminal Stud	2
11	C-45286-1	Upper Terminal Stud	2
9	A-125019-1	Terminal Nut	8
10	C-45298	Stationary Contact	2

COMMON LINKAGE ASSEMBLY

(Operates: C.O. Indicator Bell-Alarm, Under Voltage, Auxiliary Switch)

			400A	800A	2000A
31	1151-9508	Sector Assembly	1		
31	1151-9821	Sector Assembly		1	
33	1101-9509	Sector Pivot Pin	1		
33*	1101-9822	Sector Pivot Pin		1	
30	1101-9506	Sector Drive Link	1	1	
29	W-250	Spacer Washer	As Required		
28	1102-5586	Spacer			1
27	1503-2639	Cotter Pin	1	1	1
35	1101-9505	Drive Pin	1	1	
35*	1101-9823	Drive Pin			1
34	1101-5586	Drive Pin Spacer	1	1	
34*	1103-5586	Drive Pin Spacer			1
32	5133-25	Drive & Pivot Pin Retaining Ring	5	5	5

*SIMILAR TO PART SHOWN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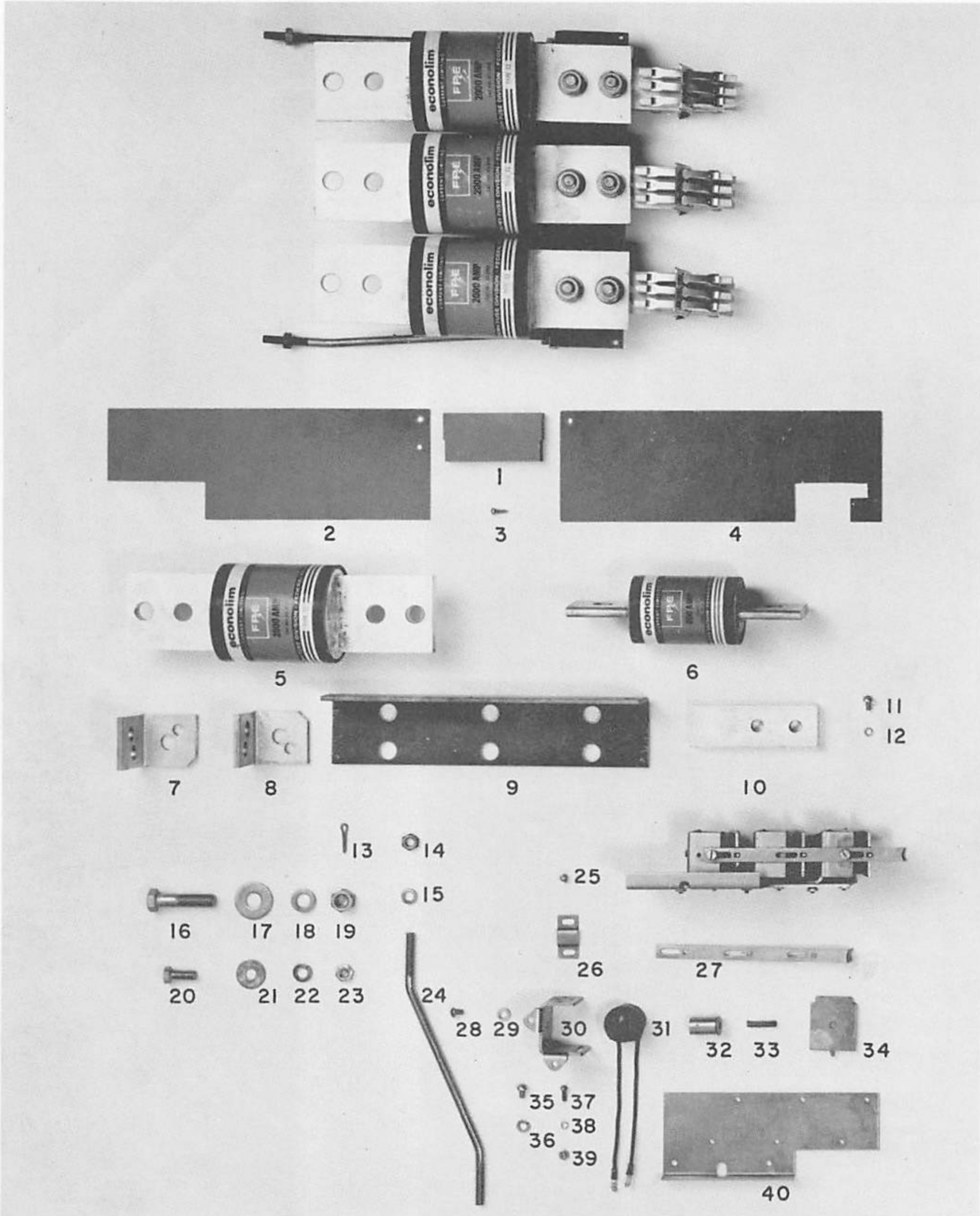
ARC-CHUTE RETAINING BAR — INTERPHASE BARRIER AUXILIARY CONTACT ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400A FRAME	800A FRAME	2000A FRAME
		ARC-CHUTE RETAINING BAR			
1	1101-9887	Arc-Chute Retaining Bar	1	1	
1*	1101-9888	Arc-Chute Retaining Bar			1
6	1101-9885	Retaining Screw Holder	3	3	3
5	1S-250-40	Retaining Screw	3	3	3
2	1S-250-12	Mounting Screw	4	4	4
3	1W-250	Mounting Lock Washer	4	4	4
4	N-250	Mounting Nut	4	4	4
		INTERPHASE BARRIER (2 Req. Per Breaker)			
9	1101-9289	Spacer Block	1	1	
9*	1102-9289	Spacer Block			1
8	1101-9288	Left Barrier	1	1	1
10	1101-9288	Right Barrier	1	1	1
7	SA8-8	Assembly Screw	4	4	4
		SECONDARY CONTACT ASSEMBLY DRAW-OUT BREAKERS (1 Req. Per Breaker)			
11	1151-9403	Secondary Contact Bracket	1	1	1
12	1151-0631	Secondary Contact Block		As Required (1 to 6)	
13	1S-250-7	Secondary Contact Mounting Screw		2 Per Block (Item 12)	
14	1W-250	Secondary Contact Mounting Lock Washer		2 Per Block	
Not	3S10-7	Wire Binding Screw		4 Per Block	
Shown	1W-10	Wire Binding Lock Washer		4 Per Block	
17	1S-250-12	Mounting Screw	4	4	4
16	1W-250	Mounting Lock Washer	4	4	4
15	N-250	Mounting Nut	4	4	4
		FIXED MOUNTED			
20	121-012	Terminal Block	1	1	1
23	1101-5518	Mounting Bracket	1	1	1
18	1S-8-14	Terminal Block Mounting Screw	2	2	2
19	1W-8	Terminal Block Mounting Lock Washer	2	2	2
22	1S-250-8	Mounting Screw	2	2	2
21	1W-250	Mounting Lock Washer	2	2	2

*SIMILAR TO PART SHOWN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FM-50 FUSEMATIC ATTACHMENTS

ITEM	PART NUMBER	DESCRIPTION	800A FRAME J	800A FRAME J	800A & 2000A FRAME L	800A & 2000A FRAME L	800A & 2000A FRAME L	800A & 2000A FRAME L	2000A FRAME L
		FUSE							
6*	P1690	Econolim Fuse "J" 201 to 400 Amp	3						
6	P1690	Econolim Fuse "J" 401 to 600 Amp		3					
5*	P1700	Econolim Fuse "L" Type II 601 to 800 Amp			3				
5*	P1700	Econolim Fuse "L" Type II 801 to 1200 Amp				3			
5*	P1700	Econolim Fuse "L" Type II 1201 to 1600 Amp					3		
5	P1700	Econolim Fuse "L" Type II 1601 to 2000 Amp						3	
5*	P1700	Econolim Fuse "L" Type II 2100 to 3000 Amp							3
		FUSE MOUNTING ACCESSORIES							
7	1101-8108	Right Hand "J" Fuse Adaptor	3	3					
8	1101-8107	Left Hand "J" Fuse Adaptor	3	3					
9	1101-8102	Fuse Support Insulator, 800 only	1	1	1	1	1	1	
9*	1101-8202	Fuse Support Insulator, 2000 only			1	1	1	1	1
10	1101-8101	Stab Adaptor, 800 only	3	3	3	3	3	3	
10*	1101-8201	Stab Adaptor, 2000 only			3	3	3	3	3
24	1101-8103	Supporting Rod	2	2	2	2	2	2	2
14	N-312	Supporting Rod Nut	8	8	8	8	8	8	8
15	1W-312	Supporting Rod Lock Washer	8	8	8	8	8	8	8
16	19S-500-32	"L" Fuse Mounting Bolt			12	12	12	12	12
16*	19S-500-24	"J" Fuse Mounting Bolt	12	12					
16*	19S-250-20	"J" Fuse Mounting Bolt 401 to 600 Amp only		6					
17	W500	Fuse Mounting Washer	12	18	12	12	12	12	12
18	1W500	Fuse Mounting Lock Washer	12	18	12	12	12	12	12
19	N500	Fuse Mounting Nut	12	18	12	12	12	12	12
20	19S-375-15	Fuse Mounting Bolt	6						
21	W375	Fuse Mounting Washer	6						
22	1W375	Fuse Mounting Lock Washer	6						
23	N375	Fuse Mounting Nut	6						

INTERPHASE BARRIER

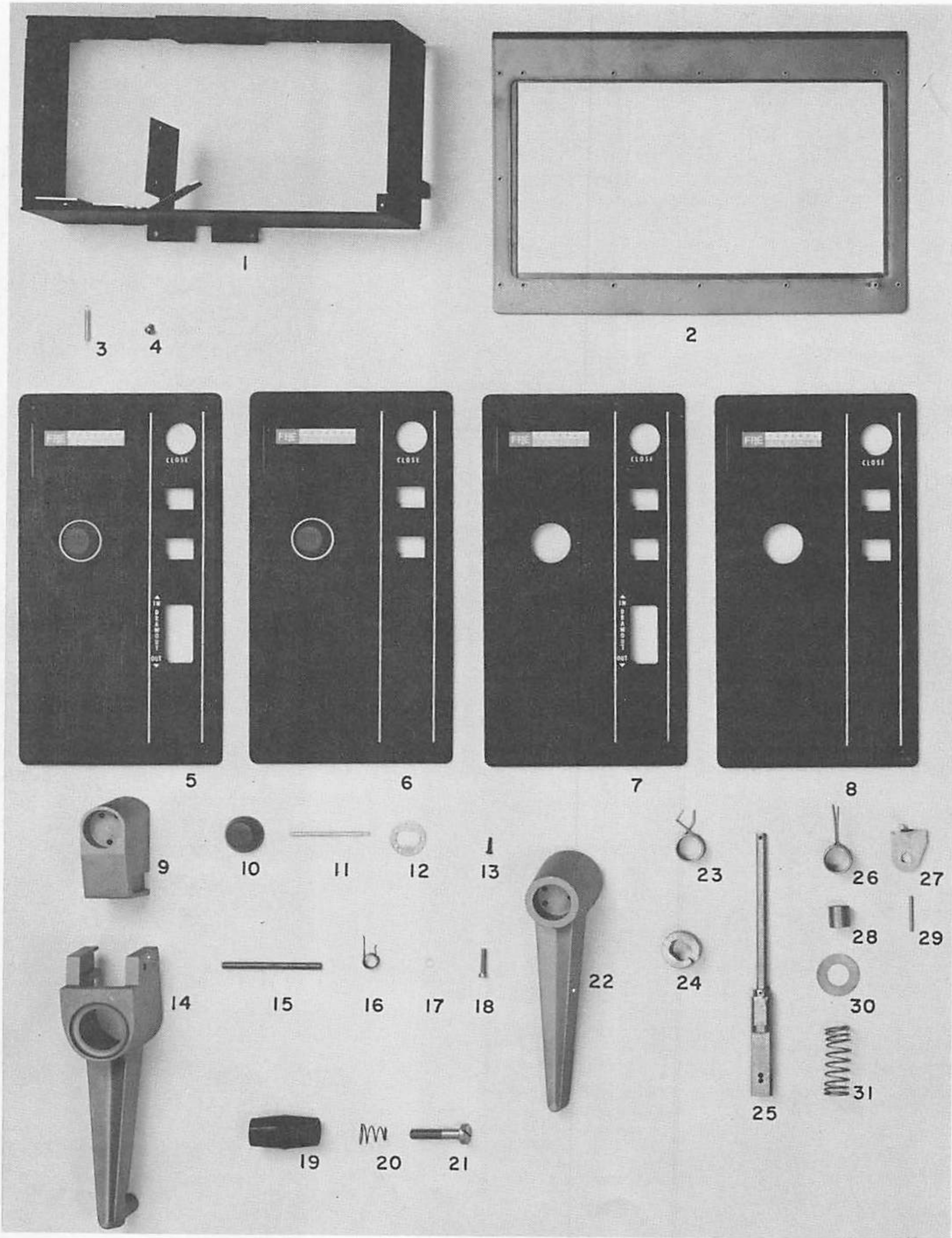
800A FM-50 FRAME 1601 - 2000 AMP FUSE

ITEM	PART NUMBER	DESCRIPTION	800A FRAME
LINE (UPPER STUD) FUSE MOUNTING			
2	1101-8109	Inside Barrier	4
1*	1101-8113	Spacer	2
Not Shown	Stimpson A 1730	Assembly Eyelet	8
LOAD SIDE (LOWER STUD) FUSE MOUNTING			
LEFT HAND BARRIER			
2	1101-8109	Inside Barrier	1
4	1101-8104	Outside Barrier	1
1	1101-8110	Spacer	1
3	SA8-8	Assembly Screw	4
RIGHT HAND BARRIER			
2	1101-8109	Inside Barrier	1
4	1101-8114	Outside Barrier	1
1*	1101-8113	Spacer	1
Not Shown	Stimpson A 1730	Assembly Eyelet	4

SINGLE PHASE PROTECTIVE DEVICE

ITEM	PART NUMBER	DESCRIPTION	800A & 2000A FRAME
40	1101-B-8105	Mounting Plate	1
27	1101-A-8106	Tripping Arm	1
30	1101-9513	Magnet Frame	3
31	1151-B-9818	Magnet Coil	3
32	1101-9512	Magnet Core	3
28	S12-5B	Magnet Core Screw	3
29	1W-12	Magnet Core Lock Washer	3
33	1101-A-9524	Magnet Core Spring	3
34	1101-A-9516	Armature Plate	3
26	1101-A-5583	Guiding Plate	2
25	S10-4	Guide Plate Mounting Screw	2
Not Shown	2W10	Guide Plate Mounting Lock Washer	2
37	S8-5	Magnet Assembly Mounting Screw	6
38	1W-8	Magnet Assembly Mounting Lock Washer	6
39	N-8	Magnet Assembly Mounting Nut	6
35	S 250-10	Assembly Mounting Screw	3
36	1W-250	Assembly Mounting Lock Washer	3
Not Shown	N-250	Assembly Mounting Nut	3
		WIRING ACCESSORIES	
11	S10	Wire Mounting Screw	3
12	2W10	Wire Mounting Lock Washer	3
Not Shown	S-250	Wire Mounting Screw	3
Not Shown	2W-250	Wire Mounting Lock Washer	3

*SIMILAR TO PART SHOWN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FRONT BOX ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	ELECT. DRAWOUT	ELECT. FIXED	MAN. DRAWOUT	MAN. FIXED	MAN. & ELECT. DRAWOUT	MAN. & ELECT. FIXED
1	1151-9695	Front Box Assembly	1	1	1	1	1	1
2	M51-9810	Front Box Screen	1	1	1	1	1	1
5	1151-C-9844	Front Box Cover Assembly	1					
6	1151-9998	Front Box Cover Assembly		1				
7	1151-9845	Front Box Cover Assembly			1		1	
8	1151-9999	Front Box Cover Assembly				1		1
3	1101-9718	Lock Lever Spring	1	1	1	1	1	1
13	17S6-4	Front Box Cover Mounting Screw	4	4	4	4	4	4
4	WS-10-6	Front Box Mounting Screw	3	3	3	3	3	3

2000 AMP MANUAL CHARGING HANDLE ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	ELECT. DRAWOUT	ELECT. FIXED	MAN. DRAWOUT	MAN. FIXED	MAN. & ELECT. DRAWOUT	MAN. & ELECT. FIXED
9	1101-9278	Charging Handle Hub			1	1	1	1
14	1101-9279	Charging Handle			1	1	1	1
15	1102-A-9215	Handle Pivot Pin			1	1	1	1
16	1101-9846	Handle Spring			1	1	1	1
17	5133-25	Handle Pivot Pin Retaining Ring			2	2	2	2
19	1101-9560	Handle Knob			1	1	1	1
20	1101-9846	Handle Knob Spring			1	1	1	1
21	1101-9561	Handle Knob Screw			1	1	1	1
10	1101-A-9562	Trip Button			1	1	1	1
11	1102-A-9563	Trip Button Pin			3	3	3	3
12	1101-9149	Trip Button Plate			1	1	1	1
18	6S10-32	Handle Mounting Screw			1	1	1	1
Not Shown	1W-10	Handle Mounting Lock Washer			1	1	1	1

FP 50-400 & -800 MANUAL CHARGING HANDLE

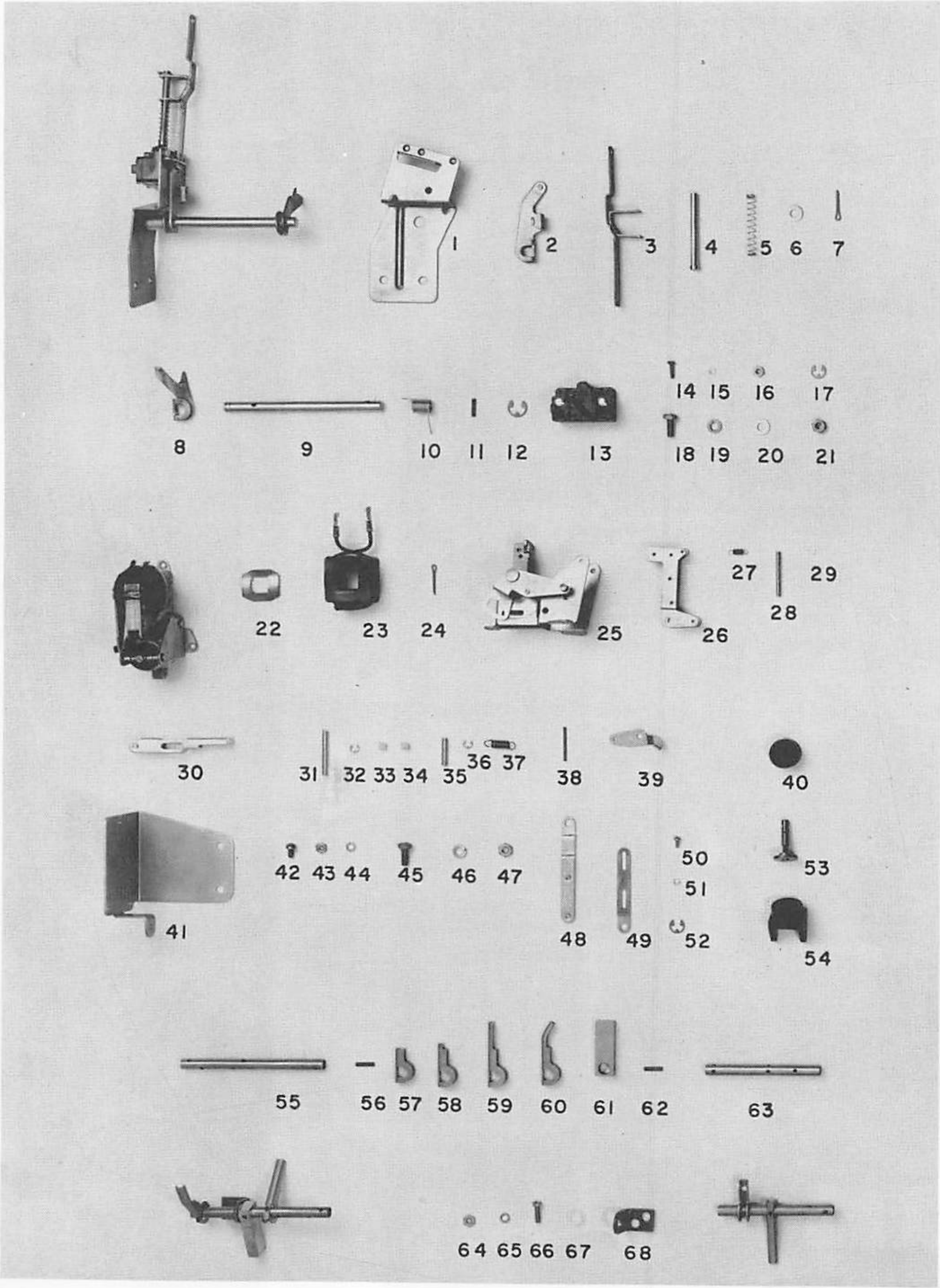
ITEM	PART NUMBER	DESCRIPTION	ELECT. DRAWOUT	ELECT. FIXED	MAN. DRAWOUT	MAN. FIXED	MAN. & ELECT. DRAWOUT	MAN. & ELECT. FIXED
22	1151-9807	Charging Handle			1	1	1	1
10	1101-A-9562	Trip Button			1	1	1	1
11*	1101-A-9563	Trip Button Pin			3	3	3	3
12	1101-9149	Trip Button Plate			1	1	1	1
18	6S10-32	Handle Mounting Screw			1	1	1	1
Not Shown	1W-10	Handle Mounting Lock Washer			1	1	1	1

CHARGING SHAFT ASSEMBLY

(All Manual and Manual & Electrical FP-50 Breakers)

ITEM	PART NUMBER	DESCRIPTION	ELECT. DRAWOUT	ELECT. FIXED	MAN. DRAWOUT	MAN. FIXED	MAN. & ELECT. DRAWOUT	MAN. & ELECT. FIXED
25	1151-9479	Charging Shaft Assembly			1		1	1
24	1101-9310	Manual Charging Dog			1		1	1
31	1115-9606	Dog Spring			1		1	1
30	2703-A-0412	Dog Washer			1		1	1
23	1101-9306	Handle Centering Spring						1
26	1101-9301	Handle Centering Spring			1		1	
28	1101-9549	Spring Guide			1		1	1
27	1101-9548	Centering Spring Lever			1		1	1
29	99-028-125-1000	Centering Spring Lever Retaining Pin			1		1	1

*SIMILAR TO PART SHOWN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BELL-ALARM, UNDERVOLTAGE TRIP SHAFT EXTENSIONS

BELL ALARM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	400	800	2000
1	1101-9896	Mounting Plate	1	1	1
2	1101-9899	Deflector Arm	1	1	1
3	1151-9902	Operating Link	1	1	1
17	1533-25	Operating Link Retaining Ring	1	1	1
4	1101-5587	Operating Pin	1	1	1
5	1123-9606	Operating Pin Spring	1	1	1
6	W-250	Operating Pin Washer	1	1	1
7	1503-A-2639	Operating Pin Cotter Pin	1	1	1
8	1101-9898	Deflection Shaft Drive Arm	1	1	1
9	1101-9897	Deflection Shaft	1	1	
9*	1102-9897	Deflection Shaft			1
10	1101-9900	Deflection Shaft Return Spring	1	1	1
11	59-028-125-0500	Deflection Arm & Drive Arm Pin	2	2	2
12	5133-37	Deflection Shaft Retaining Ring	2	2	2
13	120-001	Bell-Alarm Switch	1	1	1
14	10S6-8	Bell-Alarm Switch Mounting Screw	2	2	2
15	1W6	Bell-Alarm Switch Mounting Lock Washer	2	2	2
16	N-6	Bell-Alarm Switch Mounting Nut	2	2	2
18	19S-250-8	Bell-Alarm Mounting Screw	2	2	2
19	1W-250	Bell-Alarm Mounting Lock Washer	2	2	2
20	W-250	Bell-Alarm Mounting Washer	2	2	2
21	N-250	Bell-Alarm Mounting Nut	2	2	2

UNDERVOLTAGE TRIP DEVICE

ITEM	PART NUMBER	DESCRIPTION	INST. TRIP	DELAYED TRIP
25	1151-9493	Stationary Magnet & Bracket Assembly	1	1
23	1151-9817	Undervoltage Coil 115V AC	1	1
23*	1152-9817	Undervoltage Coil 230V AC	1	1
23*	1153-9817	Undervoltage Coil 460V AC	1	1
23*	1154-9817	Undervoltage Coil 575V AC	1	1
23*	1155-9817	Undervoltage Coil 125V DC	1	1
23*	1156-9817	Undervoltage Coil 250V DC	1	1
22	1101-9461	Coil Retaining Spring	1	1
24	1508-2639	Coil Retaining Cotter Pin	1	1
26	1151-9494	Armature Assembly	1	1
27	1101-9478	Pull Off Spring	2	2
28	1101-9479	Pull Off Spring Pin	1	1
29	1533-15	Pull Off Spring Pin Retaining Ring	2	2
30	1151-5511	Tripping Ram Assembly	1	1
31	1101-9469	Armature Pivot Pin	1	1
32	5133-18	Armature Pivot Pin Rétaining Ring	2	2
33	1101-9473	Armature Pivot Pin Spacer	1	1
34	1101-9472	Armature Pivot Pin Spacer	1	1
35	1101-9468	Drive Pin	1	1
36	1533-18	Drive Pin Retaining Ring	2	2
37	1101-9470	Main Spring	1	1
38	1101-9480	Latch Pin	1	1
39	1101-9471	Armature Latch Lever	1	1
40	1101-9485	Dash Pot Gasket		1
53	1151-9495	Piston Assembly		1
54	1101-9481	Dash Pot Housing		1
41	1101-9500	Mounting Bracket	1	1
42	S8-8	Undervoltage Unit Mounting Screw	4	4
44	1W-8	Undervoltage Unit Mounting Lock Washer	4	4
43	N8	Undervoltage Unit Mounting Nut	4	4
45	19S-250-8	Mounting Screw	2	2
46	1W-250	Mounting Lock Washer	2	2
47	N-250	Mounting Nut	2	2
48	1101-9502	Reset Link	1	1
49	1101-9501	Reset Link	1	1
50	S6-4	Reset Link Screw	2	2
51	1W-6	Reset Link Lock Washer	2	2
52	5133-25	Reset Link Retaining Ring	2	2

TRIP SHAFT EXTENSIONS

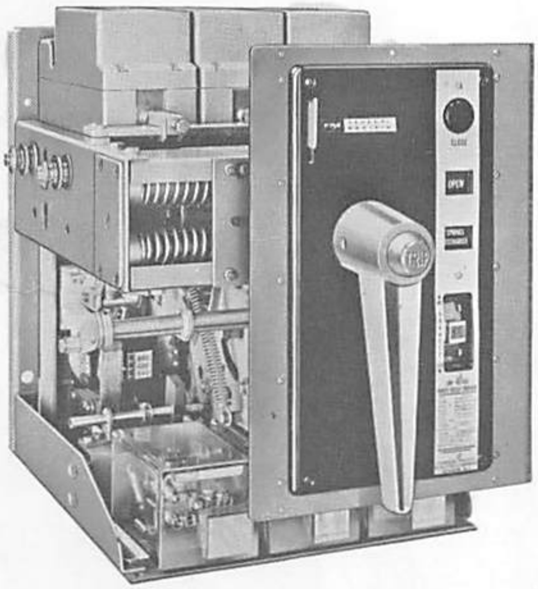
ITEM	PART NUMBER	DESCRIPTION	FP-50 400	FP-50 800	FP-50 2000
55	1101-9779	Left Hand Shaft Extension	1	1	
55*	1101-9781	Left Hand Shaft Extension			1
63	1101-9778	Right Hand Shaft Extension	1	1	
63*	1101-9782	Right Hand Shaft Extension			1
56	59-028-125-0500	Shaft Extension Coupling Pin	2	2	2
57	1101-9531	Trip Finger	1	1	1
58	1102-9531	Trip Finger	1	1	1
59	1103-9531	Trip Finger	2	2	2
60	1101-9385	Trip Finger	1	1	1
61	1101-9309	Counter Weight	1	1	1
62	59-028-125-0625	Trip Finger Roll Pin	6	6	6
68	1101-9402	Shaft Extension Support	2	2	2
67	6L1-FF	Shaft Extension Bearing Thomson Industries	2	2	2
66	S8-8	Shaft Extension Support Mounting Screw	4	4	4
65	1W-8	Shaft Extension Support Mounting Screw Lock Washer	4	4	4
64	N-8	Shaft Extension Support Mounting Nut	4	4	4

*SIMILAR TO PART SHOWN

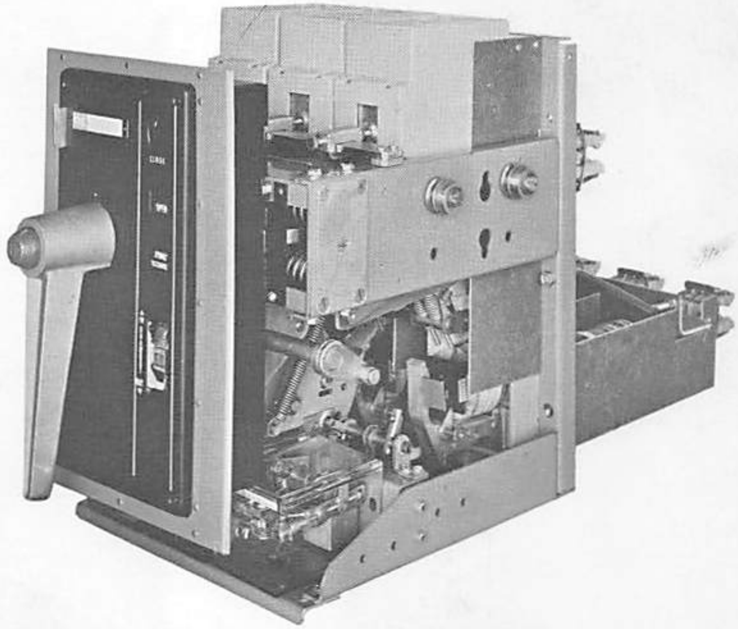
IN-810.4

INSTRUCTION & RENEWAL PARTS MANUAL
for
TYPE FP LOW VOLTAGE POWER CIRCUIT BREAKERS
and
FM FUSEMATIC BREAKER

FEBRUARY, 1963



FP-50-800
CIRCUIT BREAKER



FM-50-800
FUSEMATIC

INSTRUCTION & RENEWAL PARTS MANUAL

for

TYPE FP LOW VOLTAGE POWER CIRCUIT BREAKERS

and

FM FUSEMATIC BREAKERS

Manually and Electrically Operated

BREAKER	FUSEMATIC
Type FP-50-400	
Type FP-50-800	FM-50-800
Type FP-50-2000	FM-50-2000

INDEX

FEDERAL PACIFIC ELECTRIC COMPANY
50 PARIS STREET, NEWARK 1, NEW JERSEY

PART 1
GENERAL DESCRIPTION

This Instruction Manual covers the FP50-400, FP50-800, FP50-2000, FM50-800 and FM50-2000 Fusematic breakers only. For instructions on the FP100 series breakers refer in Instruction Booklet #IN810.6.

The FP line of Low Voltage Power Circuit Breakers and Fusematic Breakers, which ranges from 15A through 2000A continuous current at 600 Volt ratings, are designed for simplicity of operation, reliability and easy maintenance. The FP Breaker and FM Fusematic are equipped with a stored energy mechanism mechanically trip free in any position of the closing cycle, three unit pole assemblies, fully field adjustable timing devices, multi-range series trip coils, and telescoping roll-out rails. The three position drawout mechanism is operable with the door closed.

STANDARD ACCESSORIES

Maintenance closing handle 1151-9252
Cell racking in handle 1101-9251

PART 2
SHIPMENT, RECEIVING, HANDLING AND STORAGE

Each FP Breaker and FM Fusematic is thoroughly inspected and tested before leaving the factory. Breakers are shipped in individual crates or in the cell compartment. If breakers are crated, no hooks should be used in handling. Examine all equipment carefully for indication of damage sustained in transit. If damage in transit is indicated, call for an immediate inspection by the delivering carrier. Upon assessment of the damage a claim should be filed with the carrier or, depending on the nature of the damage, an intent to file for concealed damage should be registered. For assistance in filing the claim, advise the area sales office of Federal Pacific Electric Company, giving a full description of the damage, serial number of the breaker, delivering carrier's name, and, if shipped by rail, the car number, waybill reference, and any other information that might be of help to the Company in aiding in the filing of the damage claim.

When unpacking, make sure that all items are removed from the box including packing list, instruction book, maintenance parts and hardware. Report any shortage immediately. See that identification tags are left on the breaker. Lifting eyelets are furnished for handling. Do not lift or handle breaker by the front box or the operating handle.

Clean breaker thoroughly. To remove dust an industrial vacuum cleaner is recommended. If the breaker can be installed in its permanent location, it is advisable to do so, even if it is not expected to be energized for some time. When breakers must be stored in buildings under construction, be sure they are kept in a space free of dust, moisture, dirt and in an upright position. It is recommended that the breaker not be operated prior to final inspection.

PART 3
INSPECTION AND INSTALLATION

SECTION I Inspection - Manually Operated Breakers

The FP and FM breakers consist of a coordinated set of assemblies mounted on a steel frame, all carefully adjusted and locked in place for long and trouble-free operation.

To assist in properly checking and inspecting breakers prior to placing into service, the following 15 points should be followed in the order listed:

1. Remove arc chutes and interphase barriers.
2. Charge stored energy mechanism by rotating operating handle to a positive stop. Handle should return to normal vertical position.

NOTE: Charging Operation:

FP & FM50-400 and 50-800 — Rotate handle 90° counterclockwise to engage mechanism and then 180° clockwise to positive stop. (Figure 1).

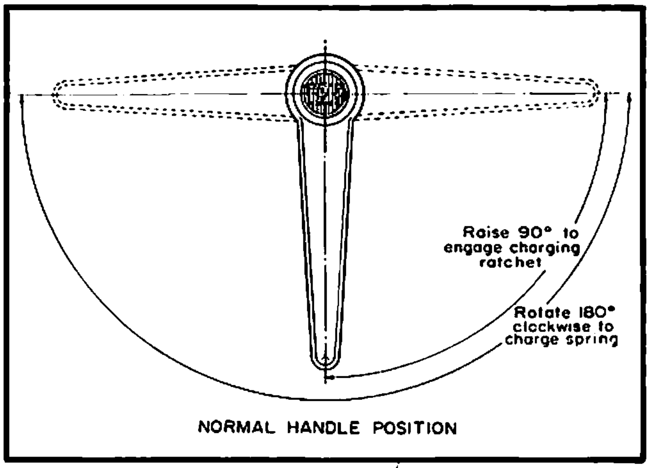


Figure 1

FP & FM50-2000 — Unfold collapsible handle from vertical down position to vertical up position. Rotate 180° clockwise to positive stop. Release handle slowly. (Figure 2).

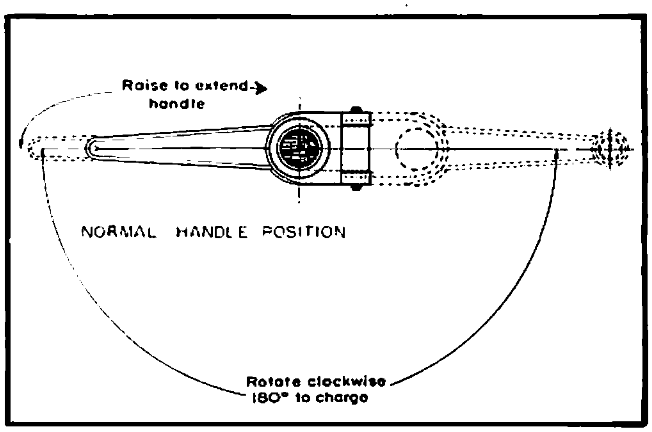


Figure 2

3. Lock safety discharge interlock to prevent accidental discharge of stored energy mechanism. (Figure 3).

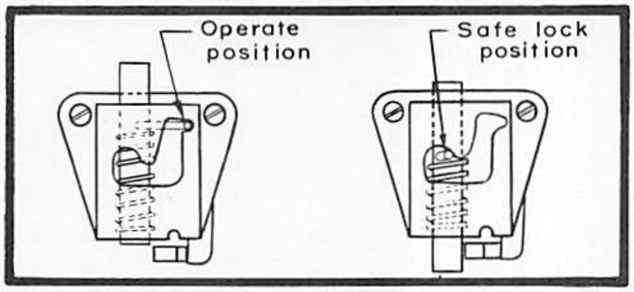


Figure 3

4. Remove right and left hand accelerating springs (Figure 4).

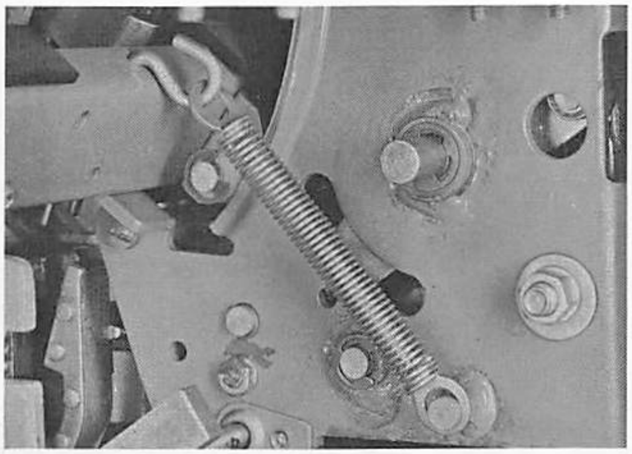


Figure 4

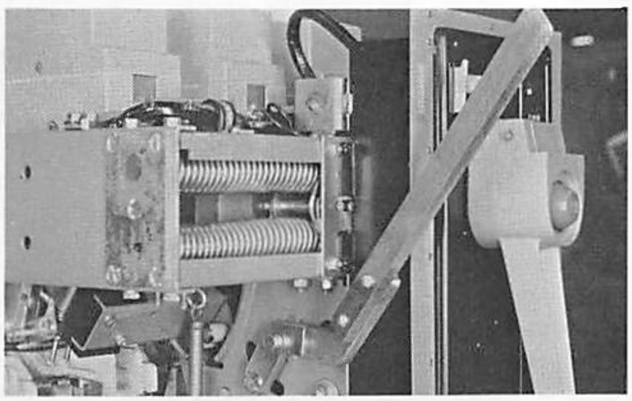


Figure 5

5. Insert maintenance closing handle #1151-9252 as in Figure 5 and slowly operate until arcing contacts touch. All arcing contacts should make simultaneously with a permissible variation of $\frac{1}{32}$ max. Moveable arcing contact fingers should align with stationary arcing contacts.

   If misalignment or misadjustments are observed, refer to Part 4 — MAINTENANCE FOR ADJUSTING INSTRUCTIONS. Moveable arcing contacts are designed with side clearances for better guidance inside the arc chutes. A side to side movement of $\frac{1}{8}$ is allowable. Close breaker and check overtravel on main contacts.

6. With maintenance closing handle in position and trip bar in tripped position, proceed to close breaker. Operating mechanism will now be trip free and contacts should not make.

7. Remove maintenance closing handle and trip breaker by moving trip bar.

8. Replace one pull-off spring right side only.

9. Inspect each arc chute to be sure no plates are damaged. Replace chutes and interphase barriers on breaker. Move contacts in by hand and tighten arc chutes only after contacts move in and out freely.

10. Release discharge safety interlock. (Figure 3). NOTE: To avoid possible injury *NEVER* handle or touch any moveable part of the breaker when the stored energy mechanism is charged, without first applying safety interlock. Press close button on front cover. Breaker will close. Depress red trip button (located in charging handle) slowly. Breaker will open before trip button reaches its extreme stop.

11. Recharge stored energy mechanism and close breaker. Slowly move series trip coil's magnet (armature) to fully closed position. Breaker should trip before armature touches pole face assembly. Repeat this procedure on all poles.

12. On a draw-out breaker, charge stored energy mechanism, close breaker and move draw-out interlock plate sideways. Breaker will trip. (Figure 6).

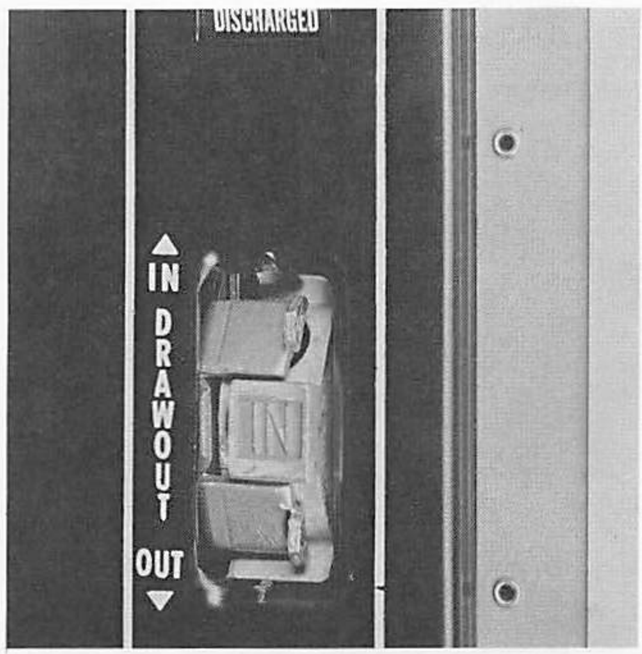


Figure 6

13. Charge stored energy mechanism and close breaker. Pull padlock lever out. Breaker should trip before padlock slot is fully exposed.

14. Check retaining rings and hardware for tightness.

15. Basket and finger assembly should be secured and retaining bolts tight. Contact finger must be free of dirt and foreign particles. Secondary female contacts mounted on breaker must operate freely.

SECTION II Inspection - Electrically Operated Breakers

Electrically the stored energy mechanism is charged by a fractional horsepower ratchet type AC/DC universal motor. Identification, voltage ranges and currents requirements are specified below. The stored energy mechanism is charged electrically in approximately one second.

CHARGING MOTORS FOR FP BREAKERS STORED ENERGY MECHANISM

Voltage Rating	FPE Part #	Motor	FLA.	LRA.	Fuse*
48V A.C./48V D.C.	162-007	15058	20	50	12.0
115V A.C./125V D.C.	162-004	14976	6.5	25	5.0
230V A.C./250V D.C.	162-006	14978	6.1	12	3.5

Maximum 240V, use control power transformer for higher voltage
*Class 1330 Econ Dual element fuses

From wiring diagram supplied with equipment, or standard diagram Part 7 of this book, locate motor terminals on secondary contacts and connect required power source.

Motor will charge when power is applied and shutoff automatically when charging cycle is completed.

Breaker cannot be closed with the maintenance closing handle unless stored energy mechanism is charged. On all electrically operated FP breakers the stored energy mechanism will recharge immediately following a closing operation ready for instant reclosure if needed.

Follow inspection procedure Steps 1 through 15 exactly as outlined in "Inspection - Manually Operated Breakers."

In addition the following steps are recommended:

16. From wiring diagram locate terminals on secondary contacts and connect proper control power supply and controls for shunt close and shunt trip attachments. Close and open breaker five times electrically and check for proper operation.
17. Disconnect control power supply. Close and trip trip-breaker manually. Do not leave breaker in the charged and/or closed position while in storage.

SECTION III - Installation

Before installing breaker in cell, check following points inside cell:

1. Secondary contact support — make sure all connections are tight and adjusted to proper dimensions.
2. Ground connections should be tight.
3. Extension rails should be free to move in and out; check rail stops for tightness.
4. Rail rollers should be free and well lubricated.
5. Main contact stabs should be tight and free of dust and dirt.
6. Check condition of insulating transite plate in roof of case. Screws should be tight.
7. Remove control power fuses.
8. Place breaker on fully extended moveable rails. Make sure all four rollers engage on inside grooves (Outside grooves fit into stationary rails inside cell). (Figure 7).

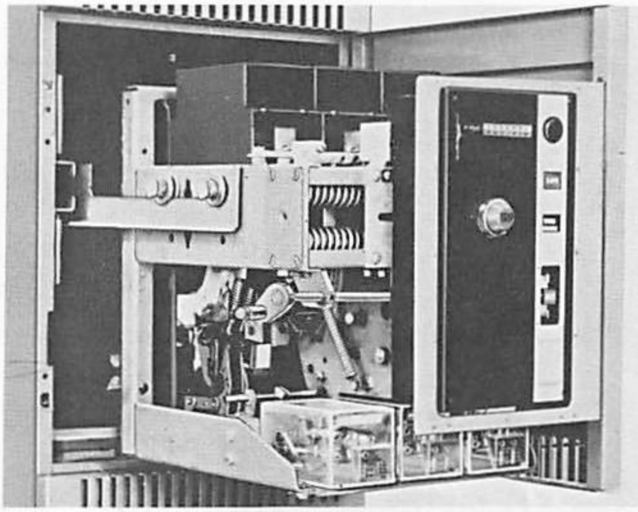


Figure 7

9. Draw-out mechanism on breaker should be in OUT position.
10. Push breaker inside the cell until racking-in cranks engage a positive stop. This is the OUT position.
11. Close door slowly and latch and make sure that the metal mask provided on outside of front box moves freely back as it comes in contact with the door. The door should close all the way with the breaker in the OUT position.
12. Push drawout interlock to left, insert drawout lever 1101-9251, (Figure 8) into the bottom hole of the drawout mechanism and, with an up-stroke, rack breaker into the TEST position. Remove drawout lever, drawout interlock plate should snap into position completely covering the holes.
13. Install control power fuses, circuit is now energized, the motor will charge the stored energy mechanism and closing and tripping control circuits become energized in the TEST position.
14. Open door and make sure that grounding contact in cell is now in contact with the breaker. Close door and check breaker electrically for proper closing and opening operation.

If breaker operates properly, rack breaker back to OUT position and leave there until ready to be put into service.

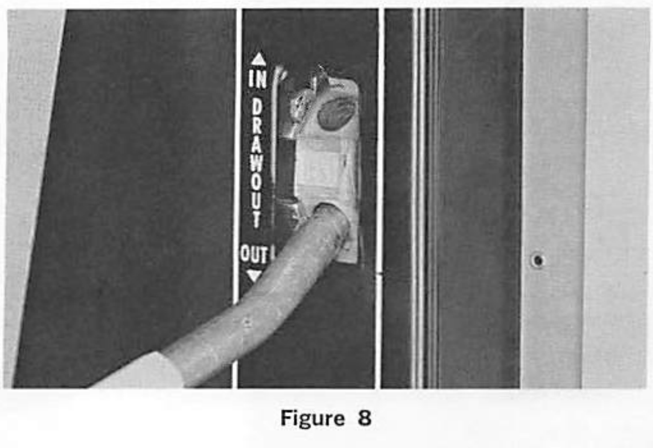


Figure 8

15. When putting into service push drawout interlock to left, insert drawout lever in the bottom hole of the drawout mechanism (Figure 8) and with an upward stroke rack breaker into operating position. Remove drawout lever, interlock plate should snap in position and red IN appears.

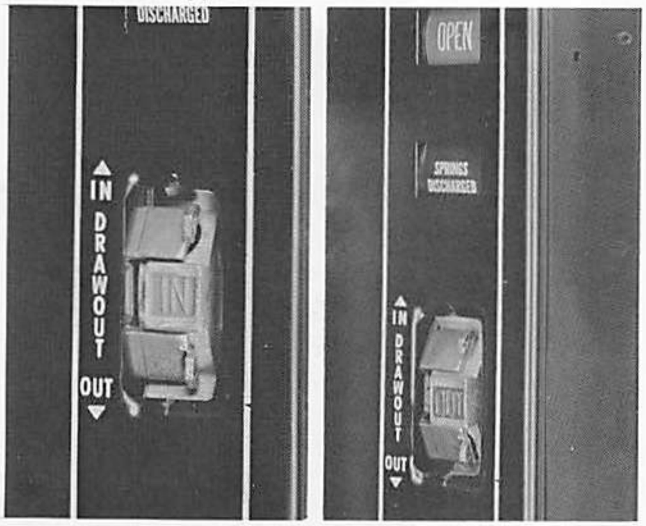


Figure 9 & Figure 9A

PART 4 MAINTENANCE

The breakers with all component parts have been extensively tested for performance as per NEMA Standards SG. 3-3-17 and SG. 3-3-18 and proved to be satisfactory with a wide margin of safety.

In accordance with NEMA Standards SG3 - Part 6, a periodic maintenance schedule should be established. For the convenience of the user a simple log sheet is provided with every breaker to ensure proper maintenance and years of trouble-free operation. It should be kept and followed conscientiously, especially in cases where breakers are required to operate under more adverse conditions.

The following instructions and adjustments should be followed carefully:

CONTACT ADJUSTMENT — Figure 10 and 11

MAIN AND ARCING CONTACTS ADJUSTMENT FOR FP400/800 AND FP 2000 BREAKERS

"A" -	Main Contact Press 400/800A	42-50 lbs., measured at point of contact
	— 2000A	25-35 lbs., measured at point of contact
"B" -	Over Travel Mains	$\frac{1}{8} \pm \frac{1}{32}$
"C" -	Arcing Contact Press	22-25 lbs., measured at a point $1\frac{1}{4}$ below tip of contact
"D" -	Gap (distance) between mains when arcing contacts touch	$\frac{1}{8} \pm \frac{1}{32}$

CHECK POINTS — Figure 10 and 11

1. Stationary arcing contacts — make sure that retaining screws and contacts are tight.
2. Main contacts should be clean and free.
3. Make sure all retaining rings are in place.
4. Make sure nylon spacer is in place.
5. Roller 1101-9231 must roll free on its pivot pin.
6. Surfaces marked "F" should be lubricated by a thin film of "Conducto-Lube #240-200" before assembly.

Contacts must be inspected after every known short circuit interruption and should also be inspected at regular inspection periods. If contacts are found to be worn or excessively pitted they should be dressed or replaced.

CAUTION: When reinstalling the arc chutes, adjust the retaining screw holder on the arc chute retaining bar so that the arcing contacts do not come in contact with the arc chute baffles.

CONTACT ASSEMBLY

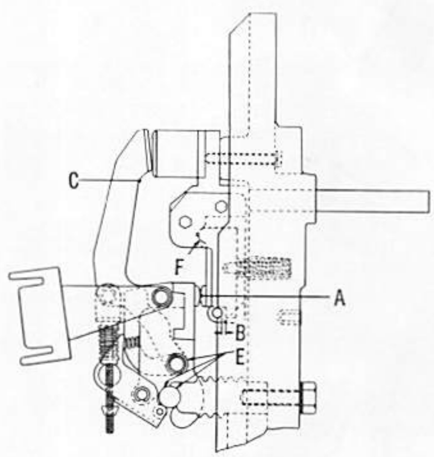
To repair or replace moveable arcing contacts, proceed as follows (Figure 11):

1. Charge stored energy mechanism and lock discharge safety interlock (Figure 3).
2. Remove arc chutes and interphase barrier.
3. Remove arc chute retaining bar.
4. Remove insulating block and push fork assembly.
5. Tighten moveable arcing contact's adjusting screw until springs are solid and remove retaining pins.
6. Remove arcing contact pivot pin and replace moveable arcing contacts. Both contacts should be replaced at one time.
7. Make sure nylon bushings are in place and in a good condition, while replacing moveable arcing contact.

Reassemble following the same sequence of operations and adjust per Figs. 10 & 11. In most cases it is not necessary to replace contacts, but occasional redressing and readjustments are recommended.

To replace stationary arcing contacts (Figure 11), remove unit pole assembly, replace main stud and arcing contact assembly, part 1151-9339, for 400/800A breaker and 1151-9432 for 2000A breaker.

Adjust contacts as per Figures 10, 11 & 12.



SHOWN FULLY CLOSED

Figure 10

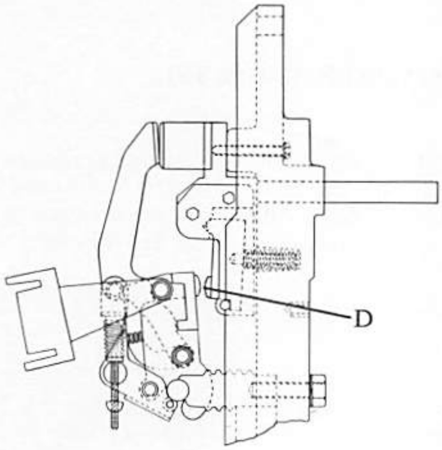


Figure 11

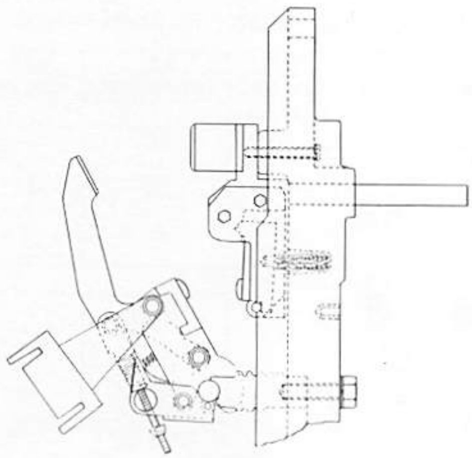


Figure 12

STORED ENERGY MECHANISM

Check latch engagement and adjust if necessary by moving safety discharge interlock (Figure 3) to proper position. Make sure springs are in place and in good condition. On electrically operated breakers, remove motor to make sure roller is free and well lubricated. Reinstall motor. Make sure that all retaining rings are in place. Check mechanism to insure that all moving parts are free and well lubricated.

OPERATING MECHANISM

Make sure that all retaining rings and springs are in place and that the mechanism is free. Replace nylon bumper rollers if excessive wear is evident. Make sure that the operating mechanism resets when stored energy mechanism is charged slowly and that the trip shaft is free. It should take no more than 20-22 ounce inches of torque to trip the breaker.

GENERAL

Make sure that all current carrying parts are secured and associated hardware is tight. Basket and finger assembly should be secured but free enough to compensate for misalignment in cell. The free up and down movement should be approximately $\frac{3}{16}$.

PART 5

ACCESSORIES

SHUNT TRIP

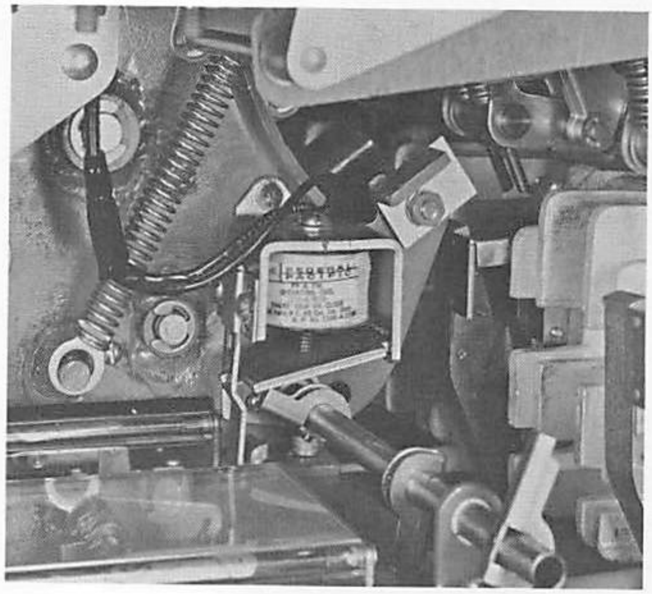


Figure 13

The shunt trip attachment is mounted directly above the trip shaft. It is a non-adjustable electro-magnet intended for intermittent duty only, and its circuit should be interrupted only by an auxiliary contact.

SHUNT CLOSE

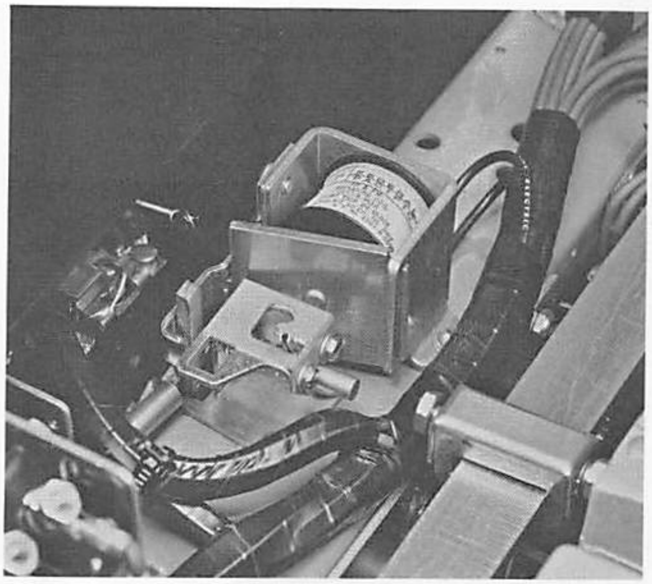


Figure 14

The shunt close attachment is mounted on top of the stored energy mechanism and is used to electrically discharge the stored energy mechanism and thus to close the breaker. It is a non-adjustable intermittent duty device and its circuit should be interrupted by an auxiliary contact.

UNDERVOLTAGE ATTACHMENT (Figure 15 & 15A)

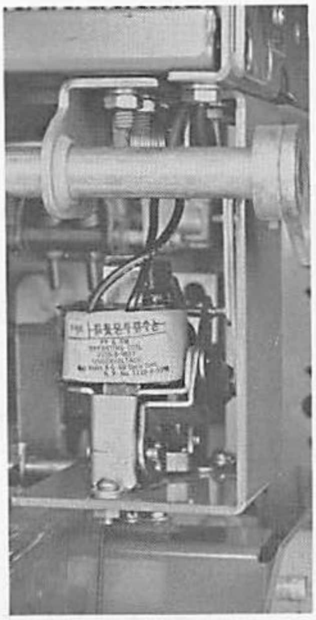


Figure 15

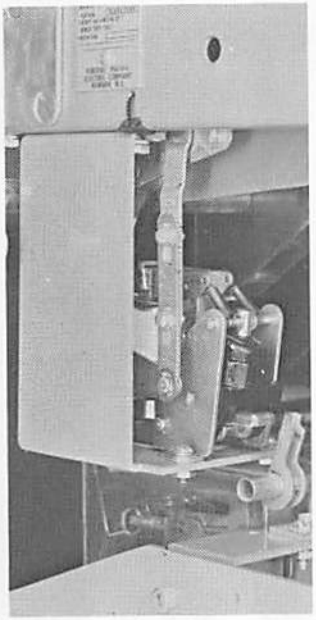


Figure 15A

The undervoltage attachment is a continuous duty device, which can be provided with or without a time delay, and which mechanically trips the breaker if the voltage drops to 30% to 60% of normal voltage. It is mechanically resettable with no auxiliary contact in its circuit.

The undervoltage time delay mechanism is of the surface tension delay type. The time delay is controlled by the viscosity of a fluid and is factory adjusted.

To inspect the undervoltage attachment, hold the moveable armature by hand, close breaker and slowly release armature. Before the armature is fully opened, the spring loaded plunger will be released and strike the trip lever and trip the breaker. Check for missing retaining rings and loose or missing screws and bolts. Check condition of coil. If undervoltage attachment is noisy while being energized, clean faces of both armatures.

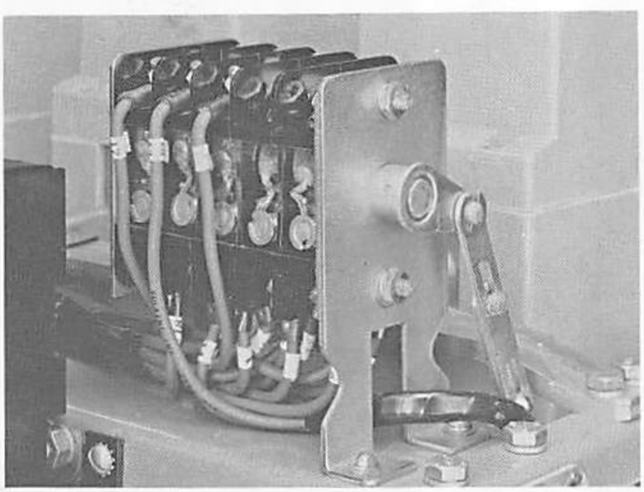


Figure 16

AUXILIARY SWITCH (Figure 16)

A 4 pole or a 10 pole auxiliary switch is normally provided.

It is mounted on top of the stored energy mechanism on the right hand side of the breaker and is operated by the main moveable contacts. All contacts are operated by nylon cams and are factory adjusted to any of the following combinations:

Normally Open	Normally Closed
Early Open	Early Closed
Late Open	Late Closed

The position and the conditoin of all contacts can be seen and inspected through a transparent dust cover.

LOAD AND INTERRUPTING CAPACITY

TYPE R-4 AUXILIARY SWITCH INTERRUPTING RATING IN AMPS

Volts	D.C. Non-Inductive	D.C. Inductive	A.C. Non-Inductive	A.C. Inductive
SINGLE BREAK				
24	20	15	—	—
48	10	7.5	—	—
115	—	—	50	30
125	2.5	2.0	—	—
230	—	—	25	15
250	0.5	.45	—	—
DOUBLE BREAK				
24	50	40	—	—
48	25	20	—	—
115	—	—	80	60
125	12	7	—	—
230	—	—	50	30
250	2.25	2	—	—

BELL ALARM SWITCH (Figure 17)

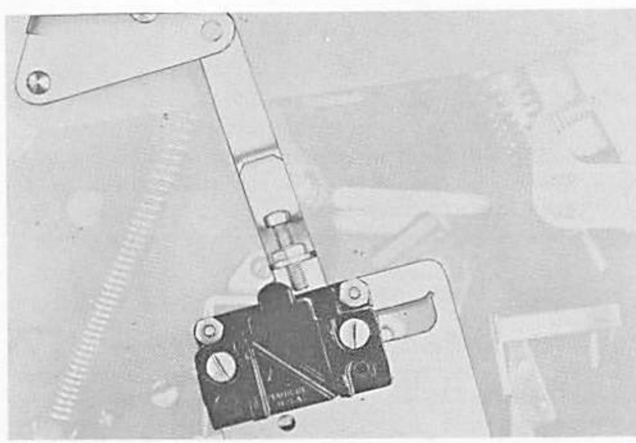


Figure 17

A bell alarm switch attachment is mounted on the right hand side of the breaker and will function only when breaker is tripped by the overcurrent trip units. It can be manually and/or electrically reset. Closing of breaker also resets the alarm switch.

To check the alarm switch attachment, trip breaker with trip button, then with shunt trip. In both cases the switch should not be actuated. Trip breaker by moving the series trip coil magnet and the switch should operate.

PART 6
OVERCURRENT TRIP DEVICES

GENERAL DESCRIPTION

The direct acting series coils and magnet assemblies provide the energy to operate the over-current time delay device and to trip the circuit breaker, interrupting sustained overcurrents and faults. There are seven (7) different coils covering the range from 15 to 1600 amperes.

Each magnet is set and calibrated in the factory at the desired continuous current rating. Any one of the seven series coils may be used in any of the FP circuit breakers and FM Fusematic circuit breakers provided the current rating does not exceed the maximum continuous current rating of the circuit breaker frame. [IE., 600A, 1600A.]

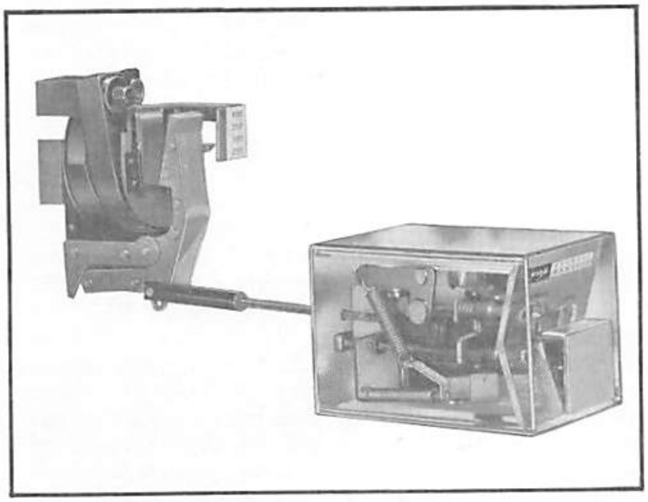


Figure 18

Dual Magnetic Overcurrent Trip Device (TD-1) (Figure 18)

The dual magnetic overcurrent trip device, in combination with the series coil and magnet, provides inverse long delayed tripping for all overcurrents below the instantaneous pickup setting, and adjustable instantaneous tripping. All devices are factory calibrated and can be field adjusted.

Selective Overcurrent Trip Device (TD-2) (Fig. 18)

The selective overcurrent trip device, in combination with the series coil and dual armature magnet, provides inverse long delayed tripping for all overcurrents below the short delay pickup setting, and short delayed tripping for all overcurrents and faults above the short delay pickup setting. All devices are factory calibrated and can be field adjusted.

Single Phasing Protection (Fig. 19) (Fusematic)

When fuses are used to protect circuits feeding three phase motors or similar reactive apparatus there is always the possibility, upon the blowing of one fuse only, that the apparatus, single phased, will burn out. To eliminate this danger, Fusematic Air Circuit Breakers incorporate three single phase trip coils, one in parallel with each of the three main fuses.

The voltage drop across a blown fuse energizes the single phase trip coil in parallel with it.

The trip coils will operate from 630 volts down to 24 volts. Each coil, when energized, releases a spring loaded plunger which trips and locks the circuit breaker in the "TRIP FREE," (Open) position. The plunger(s) which has been released indicates which fuse(s) have blown. They are reset manually, after replacing the blown fuses, by pulling the plunger(s) out as far as they will go and releasing them. The reset plunger will remain latched in the "OUT" position. The circuit breaker should be thoroughly inspected after every "Blown Fuse" operation and returned to service only after the conditions in part 3 Section I & II "Inspection and Installation" have been satisfied.

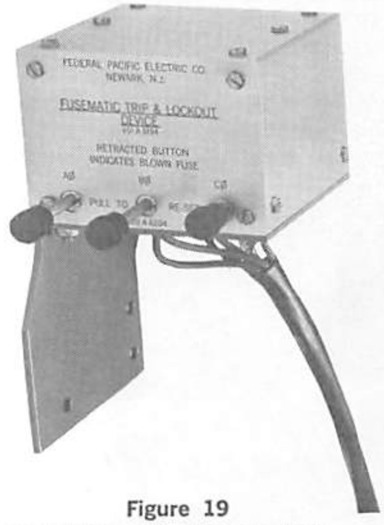


Figure 19

METHOD OF OPERATION

A. Series Coil and Magnet

The current through the series coil provides the magnetomotive force to energize the magnet assembly. The clapper type armature exerts a force on the push rod which operates the trip unit and trips the circuit breaker. The current rating of the coil and magnet may be changed by moving the pole face assembly up or down. The trip system must be recalibrated after adjusting the magnet pole face.

B. Dual Magnetic Overcurrent Trip Device (TD-1) (Long Time Delay and Instantaneous Trip)

The long delay overcurrent trip device consists of a dash pot which operates by the positive displacement of a liquid through a fixed orifice and an adjustable tension coupling spring which permits the push rod to move rapidly when the force from the magnet exceeds a predetermined value. The lever ratio between the push rod and the dash pot is adjustable permitting the time delay to be varied. There are three adjustment bands, identified as minimum, intermediate and maximum. In addition to the long delay band adjustment there is an adjustable tension spring which prevents motion of the push rod for currents below the maximum desired continuous current. This is the long delay pickup. It is adjustable from 80 percent to 160 percent with calibrated points at 80%, 100%, 120%, 140% and 160%.

The tension in the coupling spring determines the current at which the dash pot will be mechanically by-passed. This is the instantaneous pickup adjustment. The high range instantaneous element has calibrated settings at 7.5, 10 and 15 times the coil and magnet setting.

C. Selective Service Trip Device (TD-2) (Long Delay and Short Delay)

The selective service trip device is similar to the dual magnetic trip device except that it has a rigid coupling link in place of an instantaneous pickup coupling spring and it has a mechanical escapement timing device which provides a short delay for high values of overcurrents and for faults. The long delay dash pot is identical to that used on the dual magnetic trip device. The short delay device is operated by a separate armature in the series coil and magnet assembly. It has a pickup adjustment range of 5 to 10 times the coil and magnet setting. In addition, the short delay has an adjustable band with minimum, intermediate and maximum settings.

MAINTENANCE & ADJUSTMENTS

Remove breaker completely from cells before servicing.

A. Series Coil and Magnet Assembly

The series coil and magnet requires no maintenance other than cleaning periodically to remove dust and dirt which may accumulate on bearings and pivots of the magnet armatures. All pivots and bearings are made of nylon and no lubrication is required.

The entire series coil and magnet assembly may be removed and replaced in the field by removing the 3/8" coil retaining screws and the 1/2" magnet retaining screws at the rear of the pole insulator. When replacing coils, always tighten the coil retaining screws securely. This is important to prevent overheating and possible failure. Care should be taken not to damage the coil insulation.

B. Dual Magnetic Overcurrent Trip Device (TD-1) (Long Delay and Instantaneous Trip)

The circuit breakers are shipped with the trip devices installed and properly adjusted. It is only necessary to keep the devices reasonably clean. They are lubricated for the life of the circuit breaker and *must not* be lubricated again.

It is possible to remove and replace a trip device in the field.

To Remove a Trip Device

The trip units which are contained in transparent plastic cases should be removed as units. Remove the two screws which hold the trip unit to the breaker frame. These screws are located in the back of the trip unit and can be removed by reaching in from behind. The connecting rod which connects to the magnet assembly must be slipped off the pin connection at the magnet. The plastic connector and trip finger are then removed from the push-rod.

To Install a Trip Device

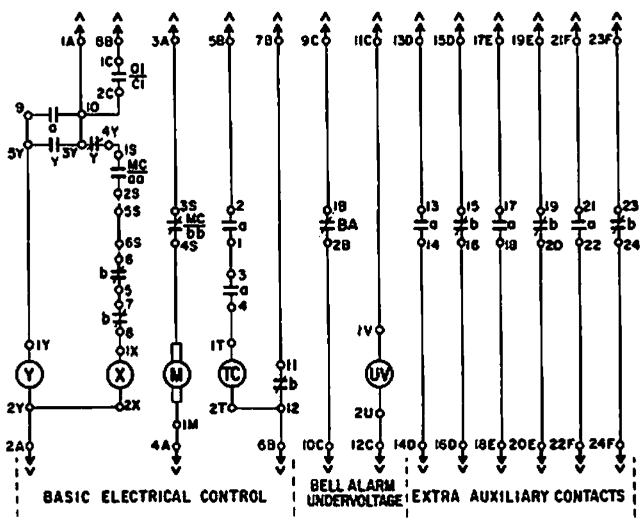
Insert the push rod in the proper hole in the front channel and screw the trip unit to the channel using the two 5/16" hex. nuts provided. Run a special "Dyna-lock" 10-32 nut down the push rod. Follow it with a trip finger on top of the push rod with a spacer between the wings and another 10-32 nut. (Do not tighten it yet.) Install the nylon turn-buckle and adjust its length so that it is 1/32" longer than is just necessary to permit the trip device to reset the magnetic armature against its stop. Install the turn buckle on the armature pin and retain it with E-ring provided. Adjust the position of the trip finger so that the breaker does not trip when the magnet is closed with a 1/32" thick shim in the air gap, and does trip with a 1/64" thick shim in the air gap. Tighten the finger and check this adjustment again. The trip unit must reset the magnet armature all the way until the armature is against the stop.

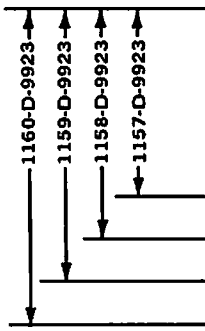
C. Selective Service Trip Device (TD-2) (Long Delay and Short Delay)

The maintenance and adjustment of the selective service trip device is the same as the dual magnetic trip device, except that the trip finger on the short delay push rod is installed under the push rod. Care should be taken to ensure that the long delay trip finger on top of its push rod does not interfere with the short delay trip finger which is installed under its push rod.

PART 7
WIRING DIAGRAMS
DEFINITION OF SYMBOLS

TC	—	Trip coil
TC1	—	A phase fuse trip coil
TC2	—	B phase fuse trip coil
TC3	—	C phase fuse trip coil
X	—	Closing release coil
Y	—	Anti pump relay
M	—	Spring charging motor
MC/aa	—	NO } Motor cut off switch (Shown with
MC/bb	—	NC } closing mechanism spring discharged)
a	—	Auxiliary switch contact (open when breaker is open)
b	—	Auxiliary switch contact (closed when breaker is open)
01	—	Control switch 01 local C1 close
BA	—	Bell alarm switch
PF	—	Power fuse
UV	—	Undervoltage device
A	—	Main power circuit - A phase
B	—	Main power circuit - B phase
C	—	Main power circuit - C phase





AUXILIARY SWITCH	
CONTACTS	FUNCTIONS
1 — 2	a CONTACT
3 — 4	a CONTACT
5 — 6	b CONTACT
7 — 8	b CONTACT
9 — 10	a CONTACT
11 — 12	b CONTACT
13 — 14	a CONTACT
15 — 16	b CONTACT
17 — 18	a CONTACT
19 — 20	b CONTACT
21 — 22	a CONTACT
23 — 24	b CONTACT

TYPE FP & FM ELECTRICALLY OPERATED A.C.B. SCHEMATIC DIAGRAM

FP25 FP50
FM25 FM50

FP BREAKER OPERATING SEQUENCE

1. Control switch O1-C closed (local close) or remote close via Terminal 1A.
2. "X" coil is energized thru "b" contact of the "Y" relay, "b" contact of the breaker auxiliary switch, and "aa" contact of the motor cut-off switch.
3. Stored energy closing spring released via "X" coil, closing breaker.
4. Closing breaker operates auxiliary switch opening "b" contacts and closing "a" contact thus energizing anti pump "Y" relay and de-energizing "X" coil.
5. "Y" relay remains energized via seal-in contact thus providing anti-pumping lockout of "X" coil if $\frac{O1}{C1}$ is held closed.
6. "Y" relay is de-energized when $\frac{O1}{C1}$ contact is opened.
7. Closing breaker, closes auxiliary switch "a" contacts permitting the breaker to be tripped electrically when control power is switched to auxiliary stabs 5B and 6B.
8. Motor cut-off switch contact "bb" closes when spring discharges and re-opens when spring is fully charged.
9. Auxiliary switch "b" contact closes when the breaker is tripped.
10. Motor cut-off switch contact "aa" closes when the closing mechanism spring is fully charged.
11. The breaker will close when control switch $\frac{O1}{C1}$ is closed.

PART 8

RECOMMENDED SPARE PARTS

No. Reg.	FP-25-600	No. Reg.	FP-50-1600	Description
6	1151-9986	6	1151-9986	Moving arcing contacts
3	1151-9939	3	1151-9937	Upper stud assembly
6	1151-9088	12	1151-9354	Main Stationary contact assembly
..	....	3	1152-9354	Leading contacts
6	1152-9380	6	1151-0632	Cluster assembly
3	1151-9566	3	1151-9566	Arc Chutes

SHUNT CLOSE

Voltage	Assembly No.	Mounting Ref. Drawing
48V AC 48V DC	1151-6038	
115V AC 125V DC	1152-6038	1100-6034
230V AC 230V DC	1153-6038	

SHUNT TRIP

Voltage	Assembly No.	Mounting Ref. Drawing
48V AC 48V DC	1151-6039	
115V AC 125V DC	1152-6039	1100-6035
230V AC. 250V DC	1153-6039	

MOTORS TO CHARGE STORED ENERGY MECHANISM

Voltage	Assembly No.	Mounting Ref. Drawing
48V AC 48V DC	1102-6013	
115V AC 125V DC	1103-6013	1100-6014
230V AC 250V DC	1104-6013	

UNDER VOLTAGE TRIP DEVICE

Voltage	Assembly No.	Mounting Ref. Drawing
115V AC	1151C6138	
230V AC	1152C6138	1100C6032
480V AC	1153C6138	

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IN-810.6

I N S T R U C T I O N   M A N U A L

TYPE FP LOW VOLTAGE

POWER CIRCUIT BREAKER

&

TYPE FM FUSEMATIC BREAKER

August 1963

PART I

GENERAL DESCRIPTION

This instruction manual covers the FP75-3000 circuit breaker and FM100-3000 fusematic breaker. For instructions on the FP50 series breaker, refer to instruction manual IN-810.4.

The FP75 line of low voltage power circuit breakers and fusematic breakers ranging from 2000A through 3000A continuous current at 600 volt ratings, is designed for simplicity of operation, reliability, and easy maintenance.

The FP breaker is equipped with a stored energy mechanism which is mechanically trip-free in any position of the closing cycle, three unit pole assemblies, fully field-adjustable timing devices, series trip coils, and roll-out rails. The three position drawout mechanism is operable with the door closed.

The FM100-3000 fusematic system consists of two individual drawout devices. The breaker unit is identical to a standard FP75-3000, except for addition of a Single Phasing Protection trip device. The fuse unit consists of fuses mounted on a breaker drawout truck. Key interlocks are provided, which require the breaker to be in th TEST position before the fuse truck can be racked in or out. Secondary contacts are provided on both the breaker and fuse truck to allow connection of the Single Phasing Protection device.

STANDARD ACCESSORIES

Maintenance closing handle, 1151-9252 (two required)
Cell racking-in crank, 1151-5036
Emergency charging handle, 1151-5349

PART II

SHIPPING, RECEIVING, HANDLING, AND STORING

Each FP breaker and FM fusematic is thoroughly inspected and tested before leaving the factory. Breakers are shipped in individual crates. No hooks should be used in handling. Examine all equipment carefully for indication of damage sustained in transit. If damage in transit is indicated, call for an immediate inspection by the delivering carrier. Upon assessment of the damage, a claim should be filed with the carrier or, depending on the nature of the damage, an intent to file for concealed damage should be registered. For assistance in filing the claim, advise the area sales office of Federal Pacific Electric Company, giving a full description of the damage, serial number of the breaker, delivering carrier's name, and, if shipped by rail, the car number, waybill reference, and any other information that might be of help to the Company in aiding in the filing of the damage claim.

When unpacking, make sure that all items are removed from the box, including packing list, instruction book, maintenance parts, and hardware. Report any shortage immediately. See that identification tags are left on the breaker. Lifting eyelets are furnished for handling. Do not lift or handle breaker by the front box, by the operating handle, or by the secondary contacts.

Clean breaker thoroughly. To remove dust, an industrial vacuum cleaner is recommended. If the breaker can be installed in its permanent location, it is advisable to do so, even if it is not expected to be energized for some time. When breakers must be stored in buildings under construction, be sure they are kept in a space free of dust, moisture, dirt, and in an upright position. It is recommended that the breaker not be operated prior to final inspection.

P A R T I I I

INSPECTION AND INSTALLATION

Section 1. Inspection

The FP75 breaker consists of a coordinated set of assemblies, mounted on a steel frame, all carefully adjusted and locked in place for long and trouble-free operation.

To assist in properly checking and inspecting breakers prior to placing into service, the following points should be followed in the order listed:

1. Remove arc chutes.

2. Remove covers marked, "REMOVE THIS PLATE FOR EMERGENCY CHARGING." Using emergency charging handle, 1151-5349, charge each mechanism by rotating the handle clockwise 180^{o} to positive stop.

3. Lock safety discharge interlocks to prevent accidental discharge of stored energy mechanism (Figure 2). There is a safety interlock on each mechanism.

4. Remove right- and left-hand accelerating springs (Figure 3).

5. Insert maintenance closing handles, 1151-9252, as in Figure 4; and slowly operate simultaneously until arcing contacts touch. All arcing contacts should make simultaneously with a permissible variation of 1/32 maximum. Movable arcing contact fingers should align with stationary arcing contacts. If misalignment or misadjustments are observed, refer to part four of this manual, "MAINTENANCE," for adjusting instructions. Movable arcing contacts are designed with side clearances for better guidance inside the arc chutes. A side-to-side movement of 1/8 is allowable. Close breaker and check overtravel on main contacts. Remove maintenance closing handles and trip breaker.

6. Replace pull-off springs.

7. Inspect each arc chute to be sure no plates are damaged. Replace chutes on breaker. Move contacts in, by hand, and tighten arc chutes only after contacts move in and out freely.

8. Release discharge safety interlocks (Figure 2). NOTE: To avoid possible injury, NEVER handle or touch any movable part of the breaker when the stored energy mechanism is charged, without first applying safety interlocks. Operate closing release solenoid manually, with vigor, releasing both stored energy mechanisms simultaneously. Breaker will close. NOTE: The Close button on escutcheon will NOT close breaker unless control power is connected. Depress red trip lever on escutcheon to open the breaker.

9. Recharge stored energy mechanisms and close breaker. Slowly move series trip coil magnet (armature) to fully closed position. Breaker should trip before armature touches pole face assembly. Repeat this procedure on all poles.

10. Check retaining rings and hardware for tightness.

11. Basket and finger assembly should be secured and retaining bolts tightened. Contact finger must be free of dirt and foreign particles. Secondary female contacts mounted on breaker must operate freely.

12. Electrically, the stored energy mechanism is charged by a fractional horsepower ratchet-type A.C./D.C. universal motor. Identification, voltage ranges, and current requirements are specified below. The stored energy mechanism is charged, electrically, in approximately one second. Two motors of identical ratings are used.

CHARGING MOTORS FOR FP BREAKERS
STORED ENERGY MECHANISM

Voltage Rating	F.P.E. Part #	Motor	FLA.	LRA.
48V A.C./48V D.C.	162-007	15058	20.0	50
115V A.C./125V D.C.	162-004	14976	6.5	25
230V A.C./250V D.C.	162-006	14978	6.1	12

240V maximum--use control power transformer for higher voltage

From wiring diagram supplied with equipment, or from the standard diagram in Part VII of this manual, locate motor terminals on secondary contacts and connect required power source.

Motors will charge when power is applied and automatically shut off when charging cycle is completed.

Breaker cannot be closed with the maintenance closing handle unless the stored energy mechanism is charged. On all electrically operated FP breakers, the stored energy mechanism will recharge immediately following a closing operation--ready for instant reclosure, if needed.

13. From wiring diagram, locate terminals on secondary contacts and connect proper control power supply and controls for shunt close and shunt trip attachments. Close and open breaker five times, electrically, and check for proper operation.

14. Disconnect control power supply. Do not leave breaker in the charged and/or closed position while in storage.

15. When the FM100-3000 is furnished, check the separate fuse truck, using applicable procedures as listed above.

Section II. Installation

Before installing breaker in cell, check the following points inside cell:

1. Secondary contact support--make sure all connections are tightened and adjusted to proper dimensions.
2. Ground connections should be tight.
3. Removable extension rails should fit and lock properly in cell.
4. Breaker wheels should be free and well lubricated.
5. Main contact stabs should be tight and free of dust and dirt.

6. Check condition of insulating transite plate in roof of case. Screws should be tight.

7. Remove control power fuses.

8. Place breaker on installed extension rails. Make sure all four wheels are in rail grooves.

9. Drawout mechanism on breaker should be in OUT position.

10. While depressing trip lever, push breaker inside the cell until racking-in cranks engage a positive stop. This is the OUT position. Remove rail extensions and store in cell.

11. Close door slowly and latch; make sure that the metal mask which is provided on the outside of front box moves freely back as it comes in contact with the door. The door should close all the way with the breaker in the OUT position.

12. Depress trip lever and insert racking-in crank, 1151C5036 (Figure 5). Rotate crank clockwise until breaker reaches TEST position. At this point, interlock bar will drop into slot on cell floor when racking-in crank is removed. This locks breaker in TEST position and releases trip interlock.

13. Install control power fuses; circuit is now energized. The motors will charge the stored energy mechamisms, and closing and tripping control circuits become energized in the TEST position.

14. Open door and make sure that grounding contact in cell is now in contact with the breaker. Close door and check breaker electrically for proper closing and opening operation.

    If breaker operates properly, rack breaker back to OUT position and leave there until ready to put into service.

15. When putting into service, insert racking-in handle, rotate clockwise until breaker is in OPERATE position. When properly racked in, the interlock bar will be free to drop into another slot, locking the breaker in position. The trip interlock will be released and the interlock bar will drop when the racking-in crank is removed.

16. When the FM100-3000 is furnished, the points listed above, relative to cell, stationary contacts, contact stabs, and racking-in assembly, should also be checked on the fuse truck. Note that a trip interlock is not furnished on the fuse truck. Fuse truck has two positions only--"IN" and "OUT." Positive stops in the gear train determine proper location of the breaker in both the "IN" and "OUT" positions.

P A R T I V

MAINTENANCE

The breakers and all component parts have been tested extensively for performance, per NEMA Standards SG.3-3-17 and SG.3-3-18, and have proved to be satisfactory with a wide margin of safety.

In accordance with NEMA Standard SG.3, Part 6, a periodic maintenance schedule should be established. For the convenience of the user, a simple log sheet is provided with every breaker to ensure proper maintenance and years of trouble-free operation. It should be kept and followed conscientiously, especially in cases where breakers are required to operate under more adverse conditions.

The following instructions and adjustments should be followed carefully:

Main and Arcing Contacts Adjustment

"A" - Main contact press	25-35 pounds, measured at point of contact
"B" - Overtravel mains	1/8-1/32

"C" - Arcing contact press	22-25 pounds, measured at a point 1-1/4 below tip of contact
"D" - Gap (distance) between mains when arcing contacts touch	1/8-1/32

CHECK POINTS (Figures 6 and 7)

1. Stationary arcing contacts--make sure that retaining screws and contacts are tight.

2. Main contacts should be clean and free.

3. Make sure all retaining rings are in place.

4. Make sure nylon spacer is in place.

5. Roller, 1101-9231, must roll free on its pivot pin.

6. Surfaces marked "F" should be lubricated by a thin film of "Conducto-Lube," No. 240-200, before assembly.

Contacts must be inspected after every known short circuit interruption and also should be inspected at regular inspection periods. If contacts are found to be worn or excessively pitted, they should be dressed or replaced.

CAUTION: When reinstalling the arc chutes, adjust the retaining screw holder on the arc chute retaining bar so that the arcing contacts do not come in contact with the arc chute baffles.

CONTACT ASSEMBLY

To repair or replace movable arcing contacts, proceed as follows (Figure 6):

1. Charge stored energy mechanism and lock discharge safety interlock (Figure 2).

2. Remove arc chutes.

3. Remove arc chute retaining bar.

4. Remove insulating block and push fork assembly.

5. Tighten movable arcing contact's adjusting screw until springs are solid, and remove retaining pins.

6. Remove arcing contact pivot pin and replace movable arcing contacts. Both contacts should be replaced at one time.

7. Make sure nylon bushings are in place and in good condition while replacing movable arcing contact.

Reassemble, following the same sequence of operations, and adjust per Figures 6 and 7. In most cases, it is not necessary to replace contacts, but occasional redressing and readjusting are recommended.

To replace stationary arcing contacts (Figure 6), remove unit pole assembly, replace main stud and arcing contact assembly, 1151-5023.

Adjust contacts per Figures 6, 7, and 8.

STORED ENERGY MECHANISM

Check latch engagements and adjust, if necessary, by moving safety discharge interlock (Figure 2) to proper position. Make sure springs are in place and in good condition. Remove motors to make sure roller is free and well lubricated. Reinstall motors. Make sure that all retaining rings are in place. Check mechanism to ensure that all moving parts are free and well lubricated.

OPERATING MECHANISM

Make sure that all retaining rings and springs are in place and that the mechanism is free. Replace nylon bumper rollers, if excessive wear is evident. Make sure that the operating mechanism resets, when the stored energy mechanism is charged slowly, and that the trip shaft is free. It should take no more than 20-22 ounce inches of torque to trip the breaker.

GENERAL

Make sure that all current-carrying parts are secured and that associated hardware is tight. Basket and finger assembly should be secured, but free enough to compensate for misalignment in cell.

PART V

ACCESSORIES

SHUNT TRIP

The shunt trip attachment is mounted directly below the trip shaft. It is a nonadjustable solenoid intended for intermittent duty only, and its circuit should be interrupted only by an auxiliary contact.

SHUNT CLOSE

The shunt close attachment is mounted on top of the stored energy mechanism and is used to discharge the stored energy mechanism, electrically, and to close the breaker. It is a nonadjustable intermittent duty device, and its circuit should be interrupted by an auxiliary contact.

UNDERVOLTAGE ATTACHMENT

The undervoltage attachment is a continuous duty device which can be provided with or without a time delay, and which mechanically trips the breaker if the voltage drops to 30% or 60% of normal voltage. It is mechanically resettable, with no auxiliary contact in its circuit.

The undervoltage time delay mechanism is of the surface tension delay type. The time delay is controlled by the viscosity of a fluid, and is adjusted at the factory.

To inspect the undervoltage attachment, hold the movable armature by hand, close the breaker, and slowly release the armature. Before the armature is fully opened, the spring loaded plunger will be released and will strike the trip lever and trip the breaker. Check for missing retaining rings and loose or missing screws and bolts. Check condition of coil. If undervoltage attachment is noisy while being energized, clean faces of both armatures.

AUXILIARY SWITCH (Figure 11)

A six pole auxiliary switch normally is provided.

It is mounted on top of the stored energy mechanism, on the right-hand side of the breaker, and is operated by the main movable contacts. All contacts are operated by nylon cams and are adjusted, at the factory, to any of the following combinations:

Normally open	Normally closed
Early open	Early closed
Late open	Late closed

The position and condition of all contacts can be seen and inspected through a transparent dust cover.

Load and interrupting capacity

TYPE R-4 AUXILIARY SWITCH INTERRUPTING RATING IN AMPS

Volts	D.C. Noninductive	D.C. Inductive	A.C. Noninductive	A.C. Inductive
SINGLE BREAK				
24	20.0	15.0	--	--
48	10.0	7.5	--	--
115	--	--	50	30
125	2.5	2.0	--	--
230	--	--	25	15
250	0.5	0.45	--	--
DOUBLE BREAK				
24	50.0	40.0	--	--
48	25.0	20.0	--	--
115	--	--	80	60
125	12.0	7.0	--	--
230	--	--	50	30
250	2.25	2.0	--	--

BELL ALARM SWITCH (Figure 12)

A bell alarm switch attachment is mounted on the right-hand side of the breaker and will function only when the breaker is tripped by the overcurrent trip units. It can be manually and/or electrically reset. Closing of the breaker also resets the alarm switch.

To check the alarm switch attachment, trip breaker with trip button, then with shunt trip. In both cases, the switch should not be actuated. Trip breaker by moving the series trip coil magnet; the switch should operate.

PART VI

OVERCURRENT TRIP DEVICES

GENERAL DESCRIPTION

The direct acting series coils and magnet assemblies provide the energy to operate the overcurrent time delay device and to trip the circuit breaker, thus, interrupting sustained overcurrents and faults. Each magnet is adjusted at the factory and calibrated for either 2000 to 2500 amperes, or 3000 amperes.

DUAL MAGNETIC OVERCURRENT TRIP DEVICE (TD-1) (Figure 13)

The dual magnetic overcurrent trip device, in combination with the series coil and dual armature magnet, provides inverse, long delayed tripping for all overcurrents below the instantaneous pick-up setting and the adjustable instantaneous tripping. All devices are factory calibrated and can be adjusted in the field.

SELECTIVE OVERCURRENT TRIP DEVICE (TD-2) (Figure 13)

The selective overcurrent trip device, in combination with the series coil and dual armature magnet, provides inverse, long delayed tripping for all overcurrents below the short delay pick-up setting, and provides short delayed tripping for all overcurrents and faults above the short delay pick-up setting. All devices are factory calibrated and can be adjusted in the field.

SINGLE PHASING PROTECTION

When fuses are used to protect circuits feeding three phase motors or similar reactive apparatus, there is always the possibility, upon the blowing of one fuse only, that the apparatus, single phased, will burn out. To eliminate this danger, fusematic air circuit breakers incorporate three single phase trip coils, one in parallel with each of the three main fuses. Each trip coil is approximately a one thousand-turn coil, wound to operate down to 1/10 of line voltage.

Each of the single phase trip coils can be looked upon as a shunt trip, continuously energized by the voltage drop across its fuse. Under normal conditions, the "fuse drop" voltage is zero, but it immediately rises to a value of full phase voltage--when the load fuse blows. This energizes the single phase trip coil, causing the common trip bar to unlatch and trip the fusematic air circuit breaker. The coil is specifically rated at 1/10 line voltage to assure instantaneous operation, even when the fusematic air circuit breaker is used as a motor starter. In this case, although the back E.M.F. induced in the motor winding is equal to phase voltage, because of phase angle displacement, the resultant voltage drop across the fuse is sufficient to trip the fusematic air circuit breaker.

METHOD OF OPERATION

A. Series Magnet

The current through the circuit breaker pole provides the magnetomotive force to energize the magnet assembly. The clapper-type armature exerts the force on the push rod which operates the trip unit and trips the circuit breaker.

B. <u>Dual Magnetic Overcurrent Trip Device</u> (TD-1) (Long Time Delay and Instantaneous Trip)

The long delay overcurrent trip device consists of a dash pot which operates by the positive displacement of a liquid through a fixed orifice, and an adjustable tension coupling spring which permits the push rod to move rapidly when the force from the magnet exceeds a predetermined value. The lever ratio between the push rod and the dash pot is adjustable, permitting the time delay to be varied. There are three calibrated positions or adjustment bands. The three bands are identified as minimum, intermediate, and maximum. In addition to the long delay band adjustment, there is an adjustable tension spring which prevents motion of the push rod for currents below the maximum desired continuous current. This is the long delay pick-up. It is adjustable from 80% to 160%, with calibrated points at 80%, 100%, 120%, 140%, and 160%.

The tension in the coupling spring determines the current at which the dash pot will be mechanically by passed. This is the instantaneous pick-up adjustment. The instantaneous element has a maximum setting of twelve.

C. <u>Selective Service Trip Device</u> (TD-2) (Long Delay and Short Delay)

The selective service trip device is similar to the dual magnetic trip device, except that it has a rigid coupling link in place of an instantaneous pick-up coupling spring, and it has a mechanical escapement timing device which provides a short delay for high values of overcurrents and for faults. The long delay dash pot is identical to that used on the dual magnetic trip device. The short delay device is operated by a separate armature in the series magnet assembly. It has an adjustable pick-up spring with calibrated settings at 5, 7.5, and 10 times the coil and magnet setting. In addition, the short delay has a band adjustment with calibrated points for the minimum, intermediate, and maximum bands.

MAINTENANCE & ADJUSTMENTS

REMOVE BREAKER COMPLETELY FROM CELLS BEFORE SERVICING.

A. Series Coil and Magnet Assembly

The series magnet requires no maintenance other than cleaning, periodically, to remove dust and dirt which may accumulate on bearings and pivots of the magnet armatures. All pivots and bearings are made of nylon, and no lubrication is required.

B. Dual Magnetic Overcurrent Trip Device (TD-1) (Long Delay and Instantaneous Trip)

The circuit breakers are shipped with the trip devices installed and properly adjusted. It is only necessary to keep the devices reasonably clean. They are lubricated for the life of the circuit breaker and must not be lubricated again.

C. Selective Service Trip Device (TD-2) (Long Delay and Short Delay)

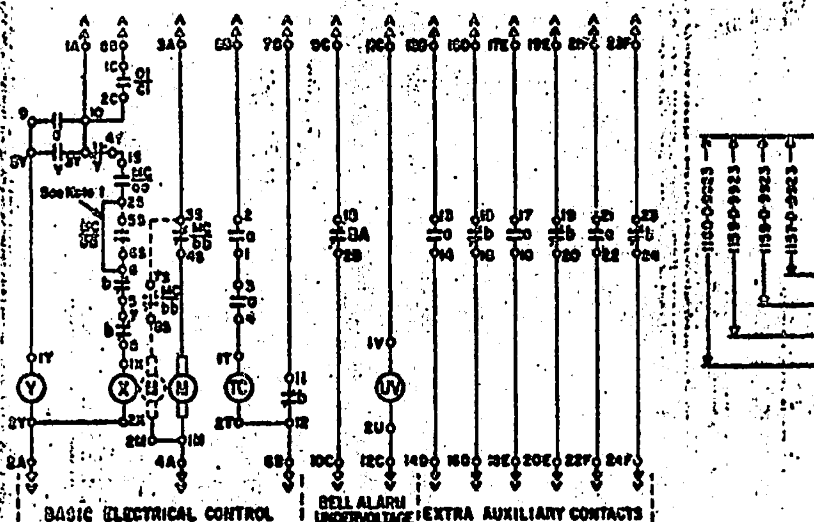
The maintenance and adjustment of the selective service trip device is the same as for the dual magnetic trip device.

D. Series trip units must be recalibrated, on the circuit breaker, if they are removed or replaced in the field. The factory should be contacted if the series trip units require servicing.

PART 7

DEFINITION OF SYMBOLS

TC	—	Trip coil
TC1	—	A phase fuse trip coil
TC2	—	B. phase fuse trip coil
TC3	—	C phase fuse trip coil
X	—	Closing release coil
Y	—	Anti pump relay
M	—	Spring charging motor
MC/aa	—	NO } Motor cut off switch (Shown with
MC/bb	—	NC } closing mechanism spring discharged)
a	—	Auxiliary switch contact (open when breaker is open)
b	—	Auxiliary switch contact (closed when breaker is open)
O1	—	Control switch O1 local, C1 close
BA	—	Bell alarm switch
PF	—	Power fuse
UV	—	Undervoltage device
A	—	Main power circuit - A phase
B	—	Main power circuit - B phase
C	—	Main power circuit - C phase



AUXILIARY SWITCH	
CONTACTS	FUNCTIONS
1 - 2	EARLY CLOSE
3 - 4	EARLY CLOSE
5 - 6	MID OPEN
7 - 8	MID OPEN
9 - 10	EARLY CLOSE
11 - 12	MID OPEN
13 - 14	MID CLOSE
15 - 16	EARLY OPEN
17 - 18	MID CLOSE
19 - 20	MID OPEN
21 - 22	EARLY CLOSE
23 - 24	MID OPEN

—— FP50 & FM50
------ ADD FOR FP100 & FM100

Note 1 Wire 2S to 6 on FP50 and FM50 only.

TYPE FP & FM ELECTRICALLY OPERATED A.C.B. SCHEMATIC DIAGRAM

FP BREAKER OPERATING SEQUENCE

1. Control switch O1-C closed.
2. "X" coil is energized thru "b" contact of the "Y" relay, "b" contact of the breaker auxiliary switch, and "aa" contact of the motor cut-off switch.
3. Stored energy closing spring released via "X" coil, closing breaker.
4. Closing breaker operates auxiliary switch opening "b" contacts and closing "a" contact thus energizing anti pump "Y" relay and de-energizing "X" coil.
5. "Y" relay remains energized via seal-in contact thus providing anti-pumping lockout of "X" coil if $\frac{O1}{C1}$ is held closed.
6. "Y" relay is de-energized when $\frac{O1}{C1}$ contact is opened.
7. Closing breaker, closes auxiliary switch "a" contacts permitting the breaker to be tripped electrically when control power is switched to auxiliary stabs 5B and 6B.
8. Motor cut-off switch contact "bb" closes when spring discharges and re-opens when spring is fully charged.
9. Auxiliary switch "b" contact closes when the breaker is tripped.
10. Motor cut-off switch contact "aa" closes when the closing mechanism spring is fully charged.
11. The breaker will close when control switch $\frac{O1}{C1}$ is closed.

PART VIII

MINIMUM RECOMMENDED SPARE PARTS

FP75-3000 & FM100-3000 BREAKERS

Description	Required	Part No.
Moving arcing contacts	12	1151A9986
Upper stud assembly	3	1151B5023
Main stationary contact assembly	24	1151A9354
Leading contacts	6	1152A9354
Cluster assembly	6*	1151B1024
Arc chutes	6	1151D9566

*12 required for FM100-3000 breaker

SHUNT CLOSE ATTACHMENTS (common for all FP breakers)

480 volts A.C., 60 cycles	1	1151B5359
115 volts A.C., 60 cycles	1	1152B5359
230 volts A.C., 60 cycles	1	1153B5359
48 volts D.C.	1	1151B5359
125 volts D.C.	1	1152B5359
250 volts D.C.	1	1153B5359

SHUNT TRIP ATTACHMENTS (common for all FP breakers)

48 volts A.C., 60 cycles	1	1151A5326
115 volts A.C., 60 cycles	1	1152A5326
230 volts A.C., 60 cycles	1	1153A5326
48 volts D.C.	1	1151A5326
125 volts D.C.	1	1152A5326
250 volts D.C.	1	1153A5326

RECOMMENDED SPARE PARTS (continued)

UNDERVOLTAGE ATTACHMENT (common for all FP breakers)

Description	Part Numbers delayed	Part Numbers instantaneous
115 volts A.C.	1151-9458	1151-9456
230 volts A.C.	1152-9458	1152-9456
460 volts A.C.	1153-9458	1153-9456
575 volts A.C.	1154-9458	1154-9456
125 volts D.C.	1155-9458	1155-9456
250 volts D.C.	1156-9458	1156-9456

MOTORS TO CHARGE FP BREAKER STORED ENERGY MECHANISM (common for all FP breakers)

Note: Two motors of specified voltage required for FP75-3000

Description	Part No.	Motor	FLA.	LRA.
48V A.C./48V D.C.	162-007	15058	20.0	50
115V A.C./125V D.C.	162-004	14976	6.5	25
230V A.C./250V D.C.	162-006	14978	6.1	12

Maximum 240V, use control power transformer for higher voltages.

	Part No.
Emergency manual charging handle	1151C5349
Maintenance closing handle	1151-9252
Drawout crank	1151C5036

Subject: FP-50 Breaker - Revision of Retrofit (using E. Pgh. Actuator)

The original procedure to retrofit an FP-50 was to use the Beaver Flux transfer trip. But experience has shown that the Flux transfer trip would cause the breaker to trip free. When the breaker is closing, mechanical shock would release the Flux transfer, causing the trip free condition. To eliminate this problem, an E. Pgh. actuator is used instead of the Flux trip. The bracket for the E. Pgh. actuator is shown in Figure #1. The bracket is mounted using the same three holes as the original trip unit used. The two additional holes to hold bracket in place are shown in Figure #1 drawing of mounting bracket.

To trip the breaker, remove the aluminum paddle on trip bar on the right side of the breaker. Remount the tripping paddle on the trip bar to the left, approximately 1 9/16" from center of original hole, and drill a hole in tripping bar to keep paddle from moving. The hole size is equal to a #29 drill bit. The paddle is just inside bracket that holds tripping bar to the frame of breaker. When mounting this tripping paddle to trip bar, it is best to charge the stored energy mechanism to insure that the trip paddle is mounted correctly. This is done because when the stored energy mechanism is being charged the trip bar moves forward a little. If this procedure is not followed, the breaker will trip free due to the movement of trip bar (Figure #2).

To reset the E. Pgh. actuator, use the indicating assembly located just behind the stored energy mechanism on the right-hand side of breaker (Figure #3). The reset arm on actuator may have to be bent to get the correct position to reset the actuator.

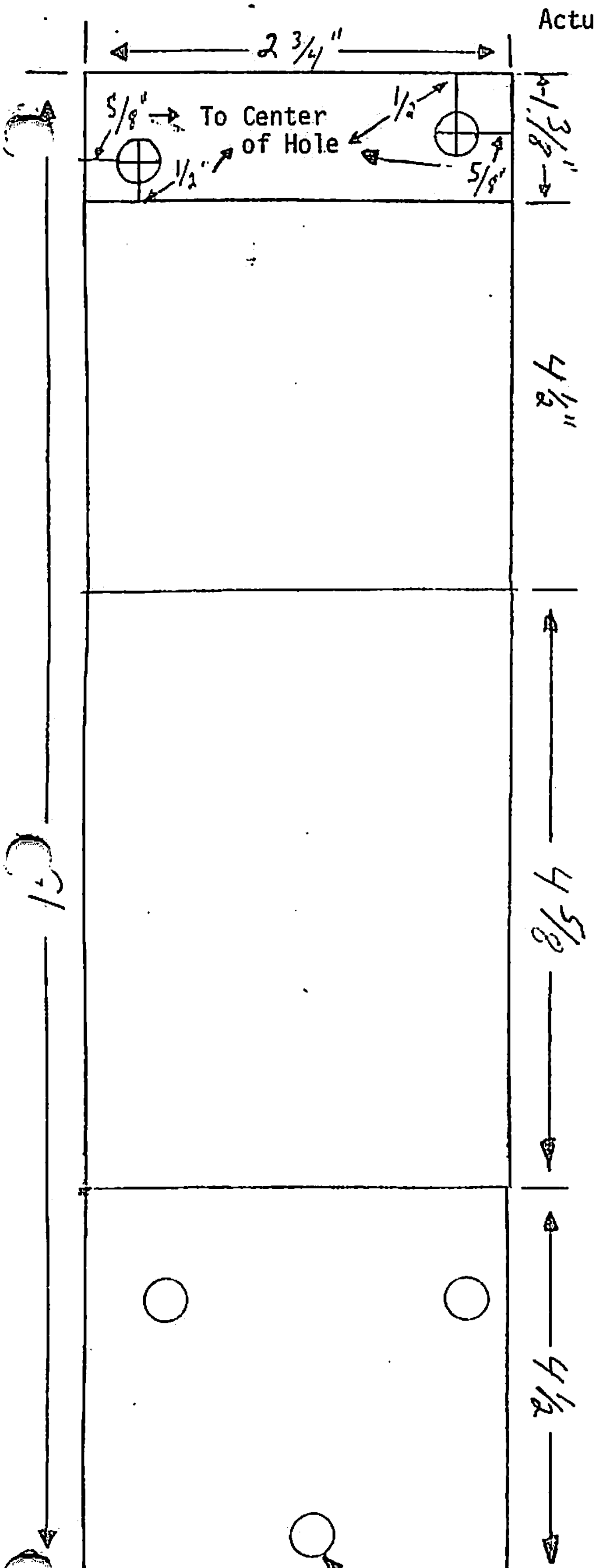
Before mounting amptector to frame of breaker, remove the A Phase tripping paddle and the counter-weight which is right next to A Phase tripping paddle. The counter-weight is placed in a downward position so it does not interfere with amptector as shown in Picture # . The next step is to hacksaw a little piece of metal off the racking bar which is also shown in Picture # to accept amptector. If this piece of metal is not cut off, amptector will not sit in a vertical position. This will not harm breaker at all. After above procedure is completed, take a piece of Micarta to mount amptector. Place it to the piece of metal, which is bolted underneath the stored energy mechanism on the left-hand side of mechanism. Drill two holes to hold the piece of Micarta to frame. Then take piece of Micarta off and countersink the two holes. The next step is to drill three more holes in the Micarta to match the three holes on the brackets of the Beaver amptector. Mount the Micarta piece to the frame first and then mount the Beaver amptector to the Micarta piece (Figure #4).

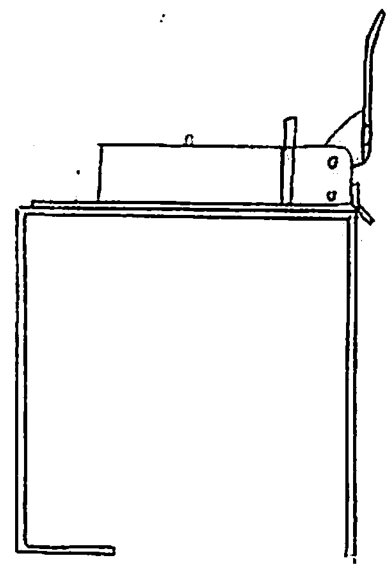
Pershing Road Breaker Lab - Chicago

FP-50 RETROFIT

Actuator Mounting

(FIGURE #1)





SIDE VIEW

NOTE: Use 1/6" metal.

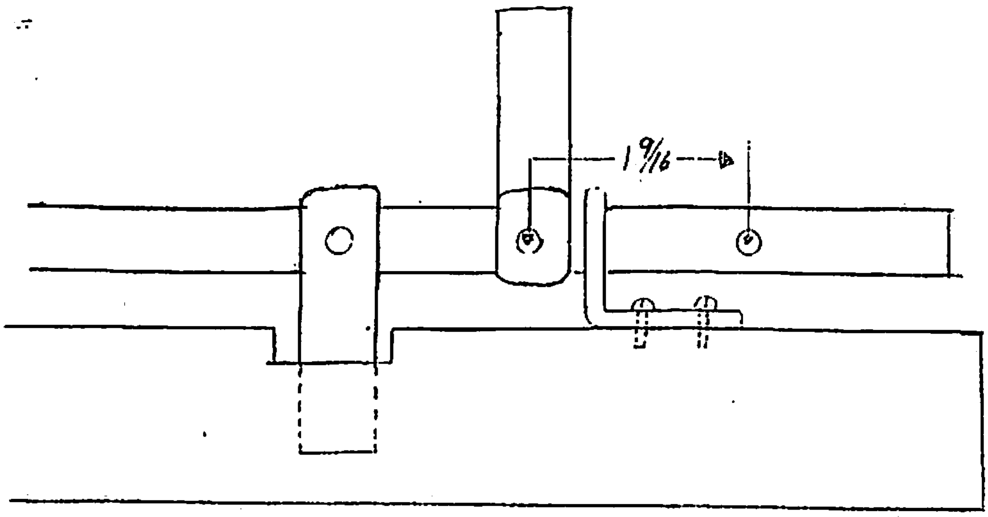
(FIGURE #1)

Use same holes that mount trip unit.

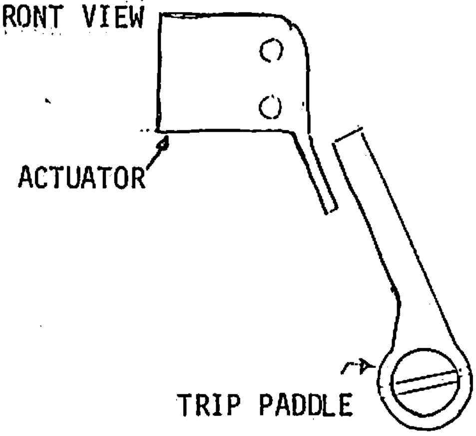
FP-50 RETROFIT

Trip Paddle Mounting

(FIGURE #2)



FRONT VIEW



SIDE VIEW

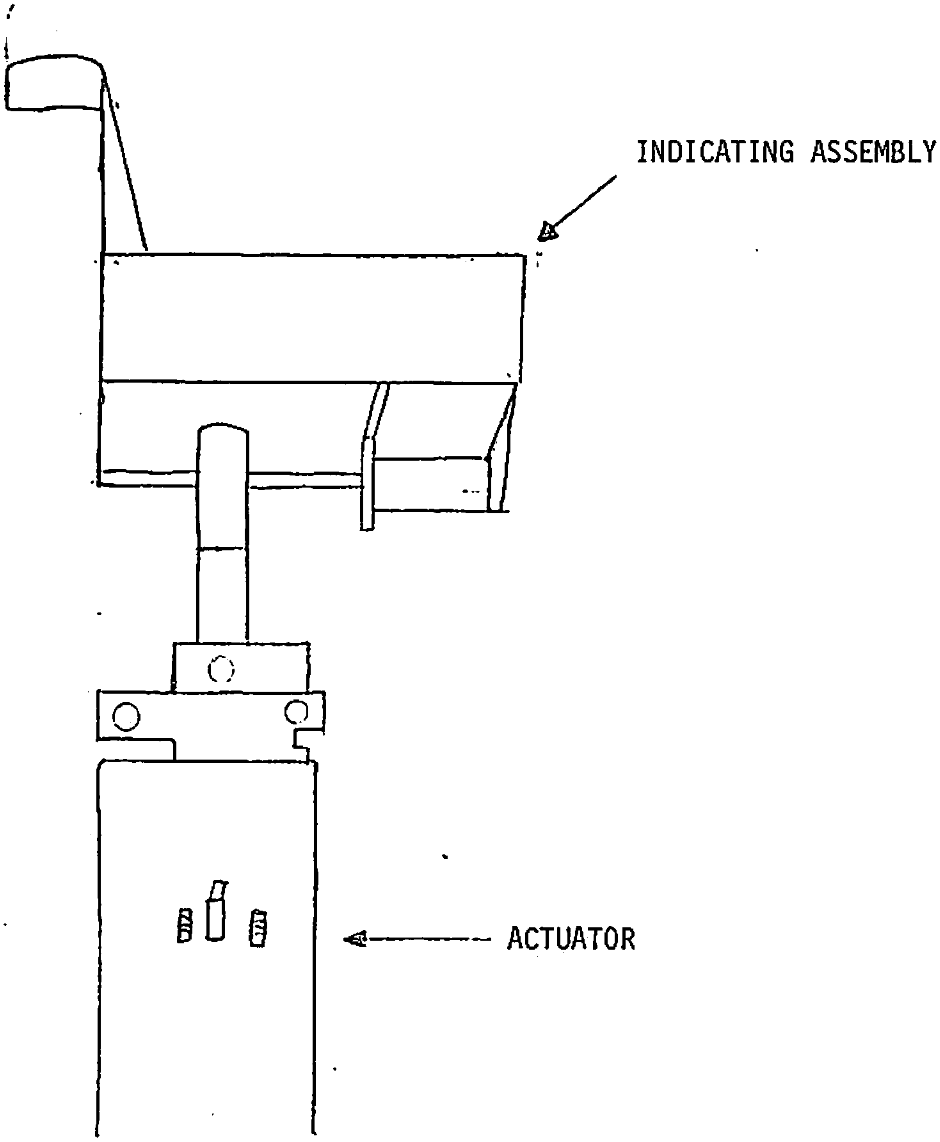
NOTE: Actuator tripping lever must be bent in a downward position. When stored energy mechanism is charged, trip bar and paddle move toward actuator.

(FIGURE #2)

FP-50 RETROFIT

Reset Arm

(FIGURE #3)

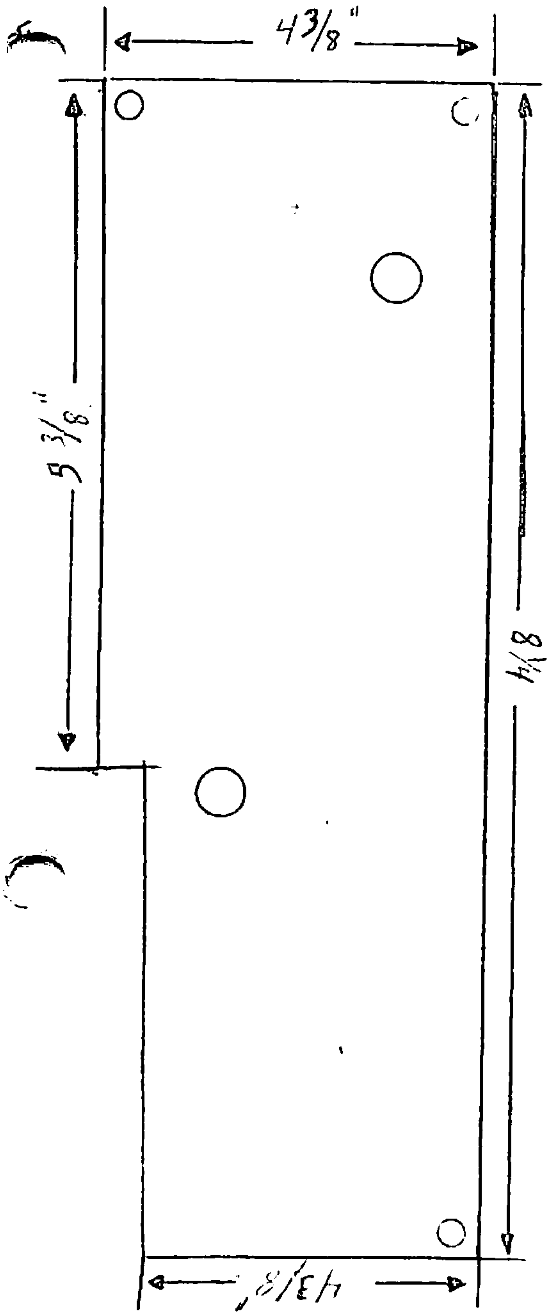


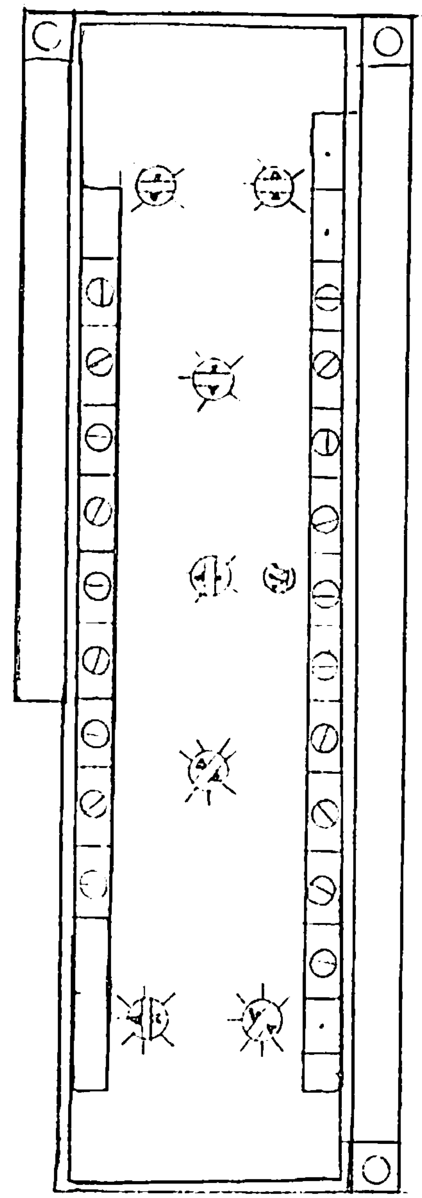
(FIGURE #3)

FP-50 RETROFIT

Amptector Mounting

(FIGURE #4)





NOTE: Use 1/16" Micarta.

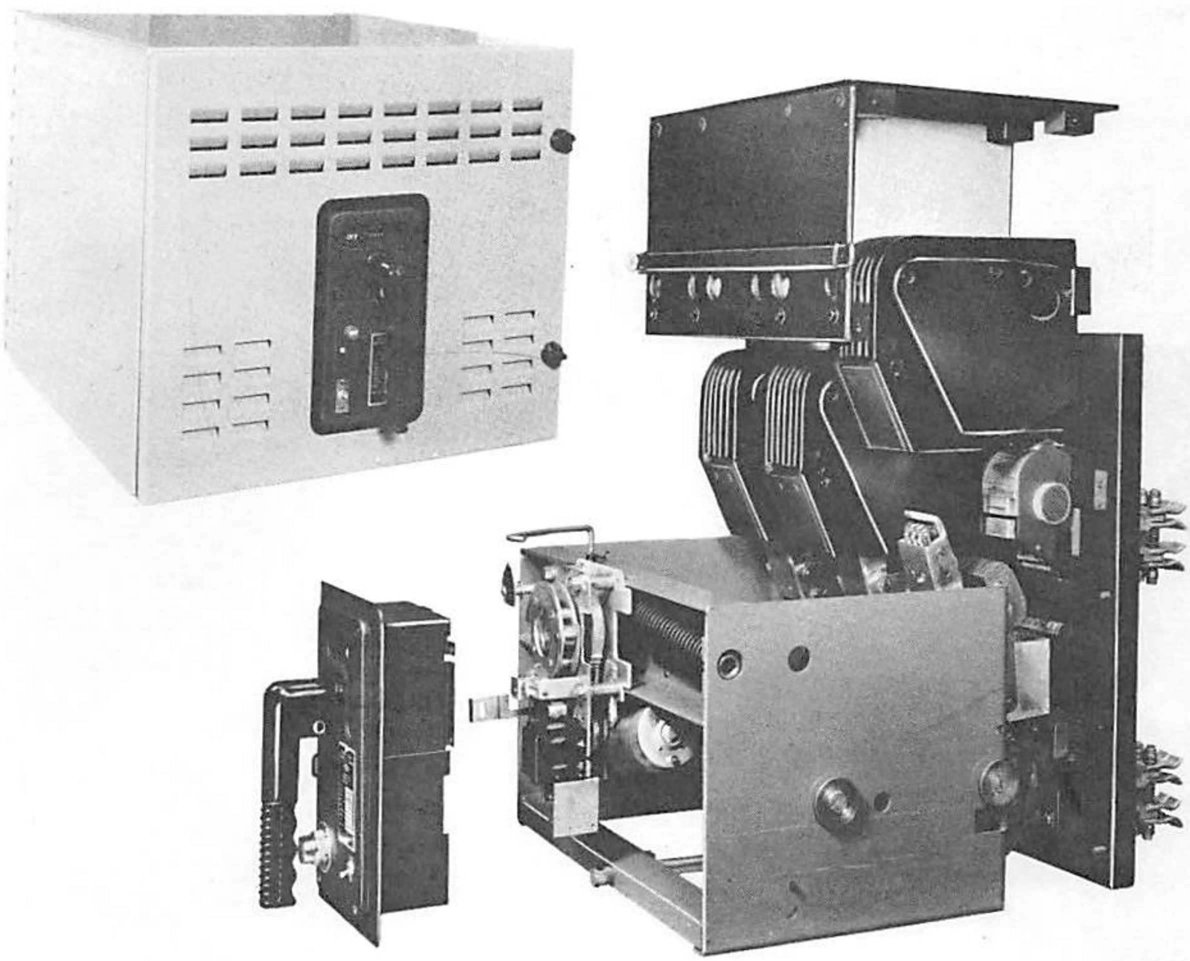
(FIGURE #4)

C-3-413
August, 1964

INSTRUCTIONS

FOR THE CARE AND MAINTENANCE OF

TYPE H
AIR CIRCUIT BREAKERS



FEDERAL PACIFIC ELECTRIC OF CANADA

GRANBY TORONTO VANCOUVER

MAINTENANCE INSTRUCTIONS

FOR

TYPE H AIR CIRCUIT BREAKERS

LIST OF CONTENTS

FPE

INTRODUCTION

FPE Type H low voltage power circuit breakers are designed to provide many years of reliable service even under severe conditions. The mechanism design employs high throw-off toggles to ensure tripping even after long periods of inactivity. Current carrying parts are designed for low current densities and the extremely efficient tripping relays do not require high current density coils thus realizing a low temperature rise even when the circuit breaker is loaded to its full rating.

Normal maintenance and replacement of arc control parts can be made without special tools or resetting factory adjustments and thus maintenance shut down periods can be very short.

SHIPMENT

Each circuit breaker is carefully inspected and tested before leaving the factory and then packed by workmen experienced in the proper handling and packing of electrical equipment. Every circuit breaker should be examined immediately on receipt for any damage sustained enroute. If damage is evident or if indication of rough handling is visible, a claim should be filed immediately with the transportation company. FPE should be notified immediately if replacement parts are required.

STORAGE

Air circuit breakers should be stored in their shipping crates in the upright position in a clean dry area. Should the breaker get wet it must be thoroughly dried out using forced warm air over an extended period until "infinite" readings are obtained using a 600 volt megger.

UNPACKING

Crates used for domestic shipment of air circuit breakers are of open lattice work construction so that the breaker may be readily uncrated without damage. The breaker is bolted into the crate using its normal mounting holes so it is preferable to first remove top, front and sides of the crate. The breaker may then be unbolted and removed from the remaining crate. Do not lift the breaker by the rear connecting terminals or the operating handle. Lift on the steel channel at the front and hold the base to keep the breaker steady. The steel side plates will support the breaker but care should be taken to set the breaker on a level surface to avoid damage to the relays or the interlock linkage on draw out type breakers. Check the breaker thoroughly to see that no parts of the breaker have been damaged or forced out of alignment during shipment.

LOCATION

Unless the circuit breaker enclosure is specifically designed for outdoor or unusual service conditions, circuit breakers should be installed in a clean dry place which is free from atmospheric contaminants and where good ventilation can be secured. Sufficient space should be provided to make connections and so that the breaker is readily accessible for operation and maintenance. Reference should be made to local code regulations.

MOUNTING

Circuit breakers should be enclosed in sheet steel cases in accordance with recommended dimensions and in general these cases provide the mounting for the breaker.

Fixed mounted breakers are mounted with 4-3/8" bolts through the base, (Frame size 2 & 3 use ½" bolts), while drawout type breakers will roll in or out on rails which are fixed to the enclosure. A worm and nut assembly is used to pull the breaker either on or off the disconnecting contacts.

The mounting support should be a rigid structure able to withstand the impact of breaker closing and tripping.

CONNECTIONS

Before making any electrical connections to the circuit breaker, every precaution must be taken to ensure that all cables which are to be connected to the circuit breaker are safely de-energized. Breaker terminals are silver plated for maximum joint efficiency and cable connectors should be clean and free from dents or burns and bolted securely to the breaker terminals. Poor joints lead to breaker overheating and subsequent contact deterioration and eventual breaker failure so that considerable care should be exercised in making these primary connections.

Cables or bus connections should be properly supported so that the circuit breaker terminals are not subjected to unnecessary weight or strain. Any strain which at first has no apparent affect, may cause poor contact alignment after prolonged periods of vibration or shock from normal breaker operations.

Meter shunts, resistors and similar devices which operate at relatively high temperatures should be mounted far enough away from the circuit breaker so that they do not contribute to breaker heating.

Control circuit wiring where applicable should be made in strict accordance with detailed wiring diagrams. Wiring connections are made to terminal blocks or to secondary drawout contacts and should be run in a supported and protected manner such that control wires cannot come into contact with primary connections.

INSPECTION

Read this instruction book completely before proceeding with inspection.

Before line side cables are energized, the breaker should be thoroughly checked and operated to ensure trouble free operation when it is placed in service. The following points should be specifically checked:

1. Make visible inspection after installation to ensure no parts have been damaged or forced out of alignment.
2. Check door interlock lever (see page 5) for freedom of movement and block in depressed position. This will allow normal breaker operation with the door open.
3. On drawout breakers check the drawout mechanism to see that the breaker rolls freely on the rails and that the worm engages the nut and pulls the breaker completely home on the contact. There should be approximately 1/8" clearance between the male stab and the contact finger spacer.
4. On drawout breakers check the drawout interlock. The interlock should be free with the breaker fully engaged or in the test position but should ride up on the wedge to trip the breaker as it moves from either position.
5. Check contacts to see that they are clean and free of foreign material.
6. Check any control wiring to ensure it has not been damaged during installation.
7. Check overload relays. Push on armature to ensure that the relay will trip the breaker. If moderate force is used the relay armature will move slowly because of the delay characteristics.

   A heavier force will extend the instantaneous springs and should trip the breaker immediately. Note that a small amount of oil seepage may occur during shipment if the breaker has not been in the upright position but the relay design employs sufficient cavities to trap ample amounts of oil for relay operation.
8. Close and trip the breaker several times to ensure correct operations. Note that interlocks should be voided or in normal released position so that the spring closing mechanism will pick up the contacts and thus avoid discharging the mechanism without its normal load. Discharging the spring closing mechanism without load imposes severe stresses on the linkage and should be avoided.

CLOSING THE BREAKER

As these breakers are complete stored energy as opposed to spring assisted closing, the energy for closing must be stored in the main spring before the breaker can be closed.

MANUAL CLOSING

The handle is rotated counter-clockwise to the upright position to engage the spring charging cam. Rotating the handle through 180° will then completely charge the springs. A rachet mechanism allows several short strokes instead of one 180° single stroke if preferred and also prevents any spring fly back during the charging stroke. The springs can be charged when the breaker is closed which will allow one immediate reclosure. Pressing a mechanical push button on the face plate releases the energy in the compression springs to close the breaker.

ELECTRICAL CLOSING

A universal ac/dc 120 volt ¼ H.P. motor is used to wind the spring closing mechanism and a shunt close releases the stored energy to close the breaker. Upon supplying control power with the breaker open, the motor will automatically charge the spring (time 2-4 seconds). Pressing a close button either on the face plate or at a remote location will then close the breaker. When the breaker is tripped the motor will immediately rewind the mechanism to charge the spring ready for the next close operation.

An emergency closing handle is supplied which can be used in the event of control power failure. The handle is inserted into the faceplate connection and is used in the same manner as for manual closing to store the energy in the spring. To close the breaker insert the opposite end of the handle in the small hole to the lower right as illustrated, figure 1, page 5 .

MAINTENANCE

The breakers have been manufactured and tested in accordance with NEMA standards SG-3 and to ensure the safety and the successful functioning of connected apparatus which depends upon the proper operation of the circuit breaker, the circuit breaker must have regular, systematic care and inspection.

The following points require special attention:

1. Be sure that the circuit breaker and its mechanism are disconnected from all electric power, both high voltage and control circuit: also be sure that the main closing spring is discharged before being inspected or repaired.

2. Inspect the operating mechanism periodically and keep it clean.
3. Examine the contacts frequently, see that they are aligned and that contact surfaces bear with firm uniform pressure. Replace badly pitted or burned contacts before they are burned away sufficiently to cause damage to other parts of the apparatus.
4. The contact members of all types of disconnecting or interrupting devices must be kept clean and bright to insure maximum operating efficiency. It has been found by experience that operating the circuit breaker several times at intervals of not over two weeks will remove the effects of oxidation and materially prolong the effective life of the circuit breaker. It is recommended that this practice be followed except that a circuit breaker which is operated every few days will not require much attention.
5. See that bolts, nuts, washer, clips and all terminal connections are in place and tight.
6. Clean the circuit breaker at regular intervals where abnormal conditions such as salt deposits, cement dust or acid fumes prevail to avoid flashovers as a result of the accumulation of foreign substances on the surface of the circuit breaker.
7. Always check for loose nuts and bolts after any maintenance work has been completed.

CIRCUIT BREAKER FACEPLATE

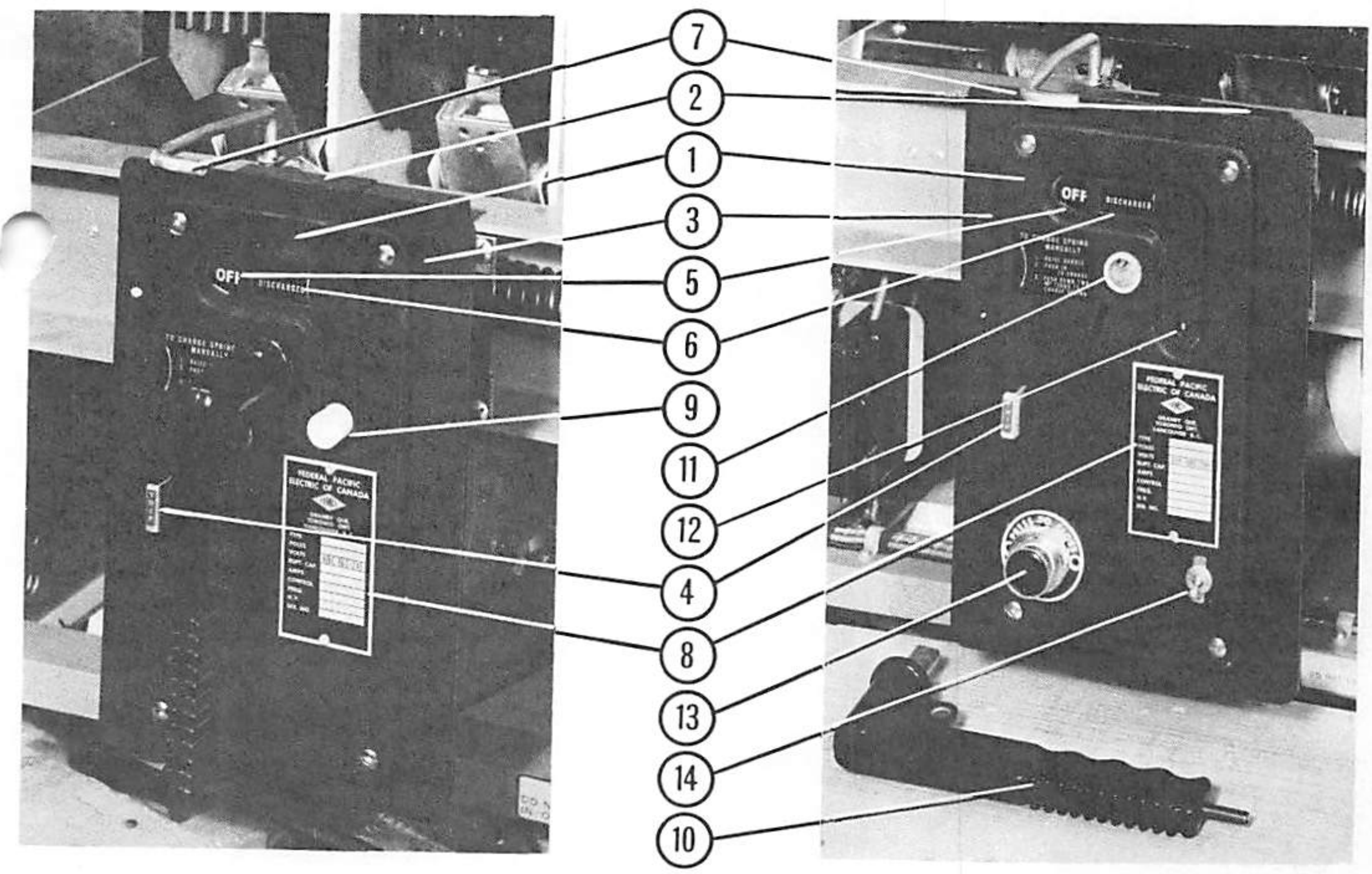


Figure 1a

Figure 1b

MANUAL

1. Front Plate
2. Frame
3. Floating Trim
4. Manual Trip
5. On-Off indicator
6. Spring charge indicator
7. Door Interlock lever
8. Rating plate
9. Close button

ELECTRICAL

10. Emergency close handle
11. Emergency spring charge
12. Emergency manual close
13. Local close button
14. Motor cut off switch

REMOVING THE FACEPLATE

The faceplate assembly consists of three parts: (1) the front plate, (2) the frame and (3) the floating trim and it is mounted to the cross channel of the mechanism bracket.

To disassemble, first remove the 4 oval head screws in each corner of the front plate. In removing the front plate turn it to the left so it will slip over the "trip" lever (4). The floating trim will then be free to be removed. Note that one side of the trim is bevelled to correspond with the hinging of the front cover and it must be replaced correctly to ensure smooth action as the door closes over the faceplate.

The manual handle is captive in the front plate and may be removed by drawing out the ¼" rolpin holding the clutch to the shaft (See fig. 2).

STORED ENERGY MECHANISM

Before close inspection of the stored energy mechanism extreme care should be taken to ensure the spring is discharged. Tripping the circuit breakers DOES NOT discharge the spring. On electrically operated breakers the motor cut off switch must be used to prevent the motor from recharging the spring automatically. If the face plate indicator shows "CHARGED" closing the breaker will discharge the spring.

With the front plate and frame removed the complete mechanism is exposed and inspection and lubrication of moving parts is readily accomplished. Use a very light good quality machine grease such as lubraplate on the rachet assembly. A light machine oil can be used on parts where grease cannot be applied.

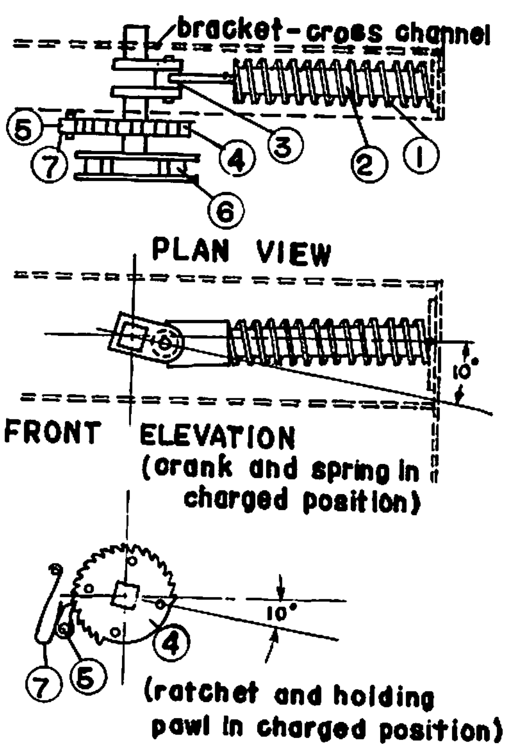
SPRING MECHANISM

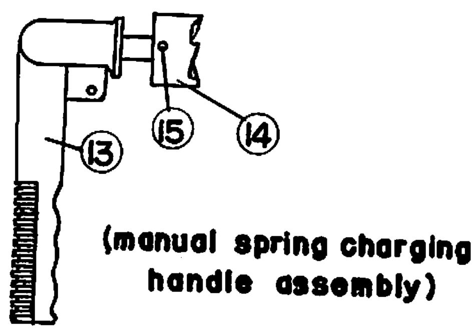
The spring mechanism is located in the steel cross channel and consists of seven parts (See fig. 2). The spring is charged by turning the crank approximately 180° in a clockwise direction. The rachet and holding panel prevents any flyback during the charging stroke. The spring in the charged position is 10° over toggle and is held by a needle bearing cam.

SPRING RELEASE MECHANISM

The spring release mechanism is located behind the frontplate and below the holding cam assembly and consists of 5 parts (see Fig. 3).

When the spring is fully charged the needle bearing of the holding cam assembly is stopped by the ground steel cam (8). When the manual close button is pressed or when the shunt close is actuated, the cam is rotated which releases the charged spring mechanism.

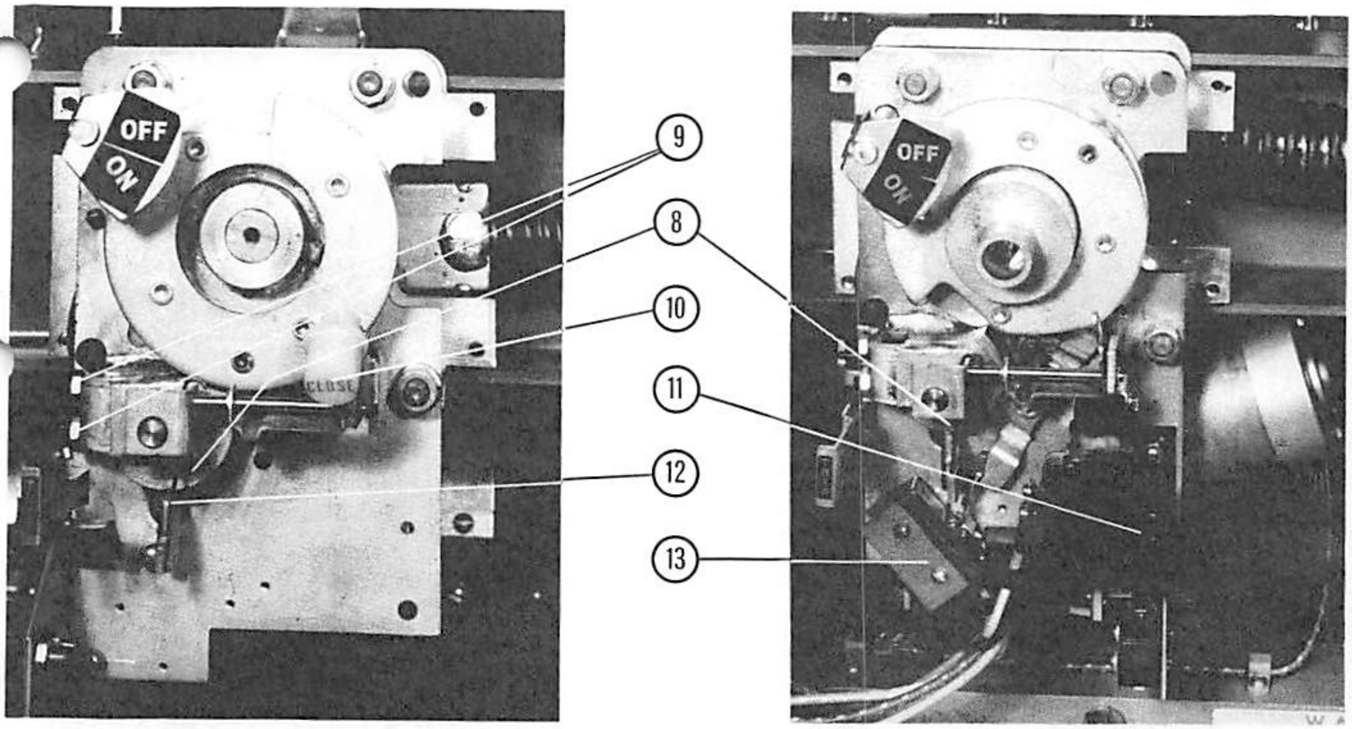




13. Handle
14. Clutch
15. Rolpin

Figure 2 – Spring Mechanism

1. Main spring
2. Spring guide
3. Crank
4. Rachet
5. Holding pawl
6. Holding cover
7. Holding pawl spring



SPRING RELEASE MECHANISM

Figure 3a
Manual Mechanism – Spring Charged

Figure 3b
Electrical Mechanism – Spring Discharged

8. Ground steel cam
9. Two set screws
10. Manual close button (when used)
11. Shunt close (when used)
12. Return spring
13. Micro Limit Switch

MOTOR MECHANISM

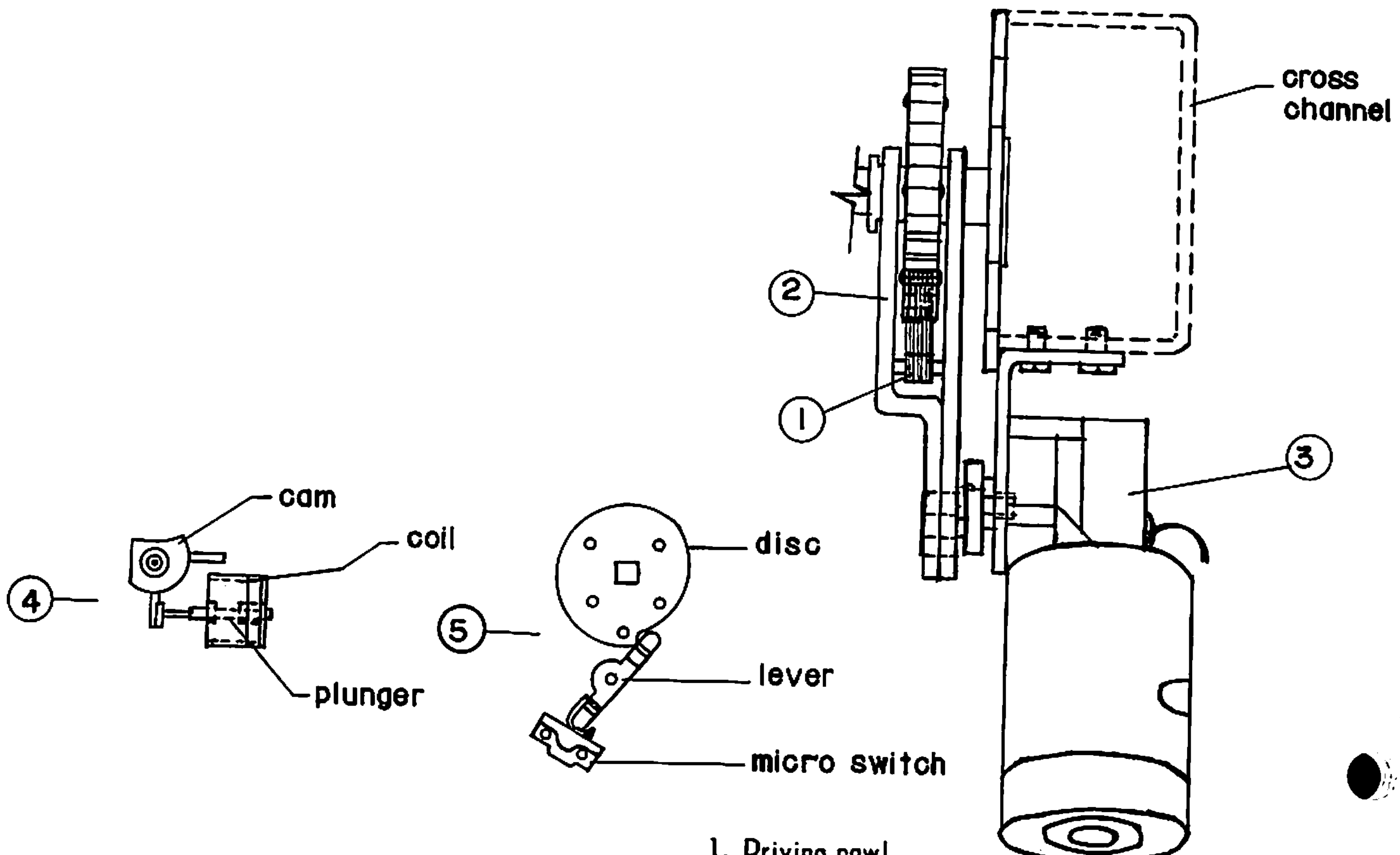
The motor mechanism consists of a ¼ h.p. universal motor with a worm gear reduction. An eccentric lever is mounted on the end of the worm gear redution and drives the oscillating lever. The driving pawl is mounted on the oscillating lever and with each stroke of the lever drives the ratchet around one tooth at a time until the spring is charged and the limit switch is actuated to cut off the motor.

To remove the motor mechanism, remove the two ¼ – 20 Allen Head screws inside the steel cross channel (see Fig. 4). Tilt the motor in to disengage it from the oscillating lever and remove the assembly from the breaker. The eccentric driving lever is threaded onto the end of the worm gear reduction of the motor. Tap lightly in a counter clockwise direction to remove the eccentric and then remove the motor mounting bolts.

A special grease is used in the worm gear reduction assembly and should not require replacement. If necessary use only Led-Plate compound 250.

The following table lists the standard ratings of motors. Note that for a.c. applications 115 volt motor is used throughout and a control transformer is supplied for voltages other than 115V.

RATED CONTROL VOLTAGE	CLOSING VOLTAGE RANGE	MAXIMUM MOTOR CURRENT AMPS	SHUNT CLOSE AMPS	TRIPPING VOLTAGE RANGE VOLTS	SHUNT TRIP AMPS
48V dc 125V dc 250V dc	– 90 – 130 180 – 260	– 11 6	– 0.89 1.10	28 – 60 70 – 140 140 – 280	2.4 0.89 1.10
115V ac 230V ac 460V ac 575V ac	95 – 125 190 – 250 380 – 500 475 – 630	Inrush 12 Full load 6	1.4	95 – 125 190 – 250 380 – 500 475 – 630	1.4



1. Driving pawl
2. Oscillating lever
3. Motor assembly
4. Shunt close
5. Motor limit switch

Electrically operated breakers use a motor to rotate the crank and fully charge the spring.

Figure 4– Motor Mechanism

BREAKER MECHANISM

The breaker mechanism is attached to the spring closing mechanism by means of a closing crank (1) connected to an eccentric link (2) which pivots on a uni-ball (3). See figure 5(a)

The breaker is closed by rotating the closing crank clockwise through approximately 180°. As the crank starts to move the linkage is prevented from collapsing by the latch bearing (4) resting against the ground steel cam (5). As the crank continues to rotate the pin (6) is pushed by the closing casting (7) up to the stops (8) located on the mechanism side plates. See Figure 5 (a).

The breaker is tripped by rotating the ground steel cam backwards which releases the latch bearing allowing the linkage to collapse.

When the breaker is open and the spring charged ready for closing, the latch bearing will have a clearance of 1/64" to 1/16" above the ground steel cam. Figure 5 (b).

If there is not sufficient clearance between the cam and the latch bearing the cam cannot return to its proper position and the breaker will not latch. After one attempt, the vibration may assist the cam to its proper location and the breaker will then close.

If the clearance is excessive, the latch bearing may bounce off the ground steel cam and the breaker will not close.

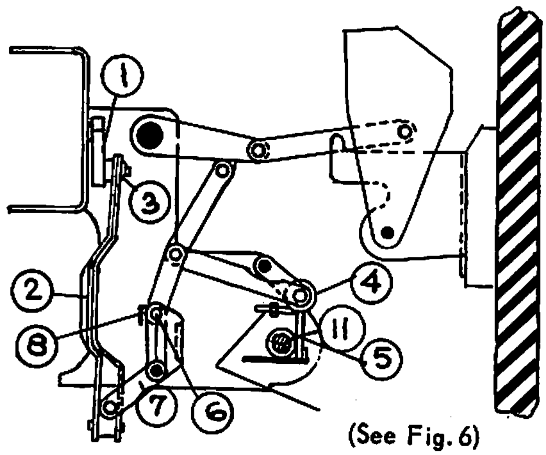


Figure 5(a)

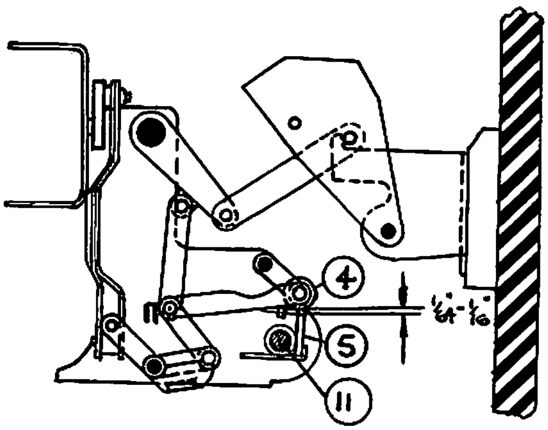


Figure 5b

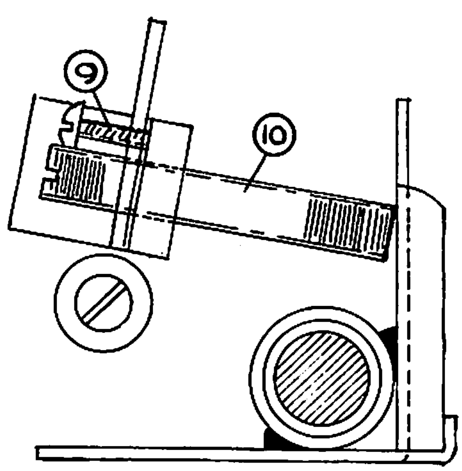


Figure 6

ADJUSTMENTS

During the course of manufacture each circuit breaker is operated up to 50 times. All adjustments are set and locked and should not require adjustment in the field. However should the breaker fail to operate correctly the following adjustments can be made.

1. Latch Adjustment

When the breaker fails to latch the spring mechanism discharges without carrying the contact assembly to the closed position. Without the inertia of the contact assembly to absorb the energy from the closing spring, severe stress is imposed on the closing mechanism and damage will result if this process is repeated.

To adjust the latch first loosen the lock screw (9). Turn the adjusting screw (10) counter-clockwise two or three turns to ensure proper latching. Close the breaker and then turn the adjusting screw clockwise slowly until the breaker trips. Then turn the adjusting screw back counter-clockwise one and one quarter turn and lock with lockscrew (9). If the breaker is subjected to severe vibration which results in nuisance tripping more latch travel is needed and one and a half turns can be used.

2. Holding Cam

If the holding cam does not reset properly it may be jarred when the closing spring is charged, the breaker will attempt to close as the closing spring is charged without pressing the close button or operating the shunt close device.

Referring to the spring mechanism shown in Figure 3, adjustments can be made as follows and should be tried one at a time.

1. The return spring (12) may require slightly more pressure. Bend the tail of the spring a little to increase the pressure.

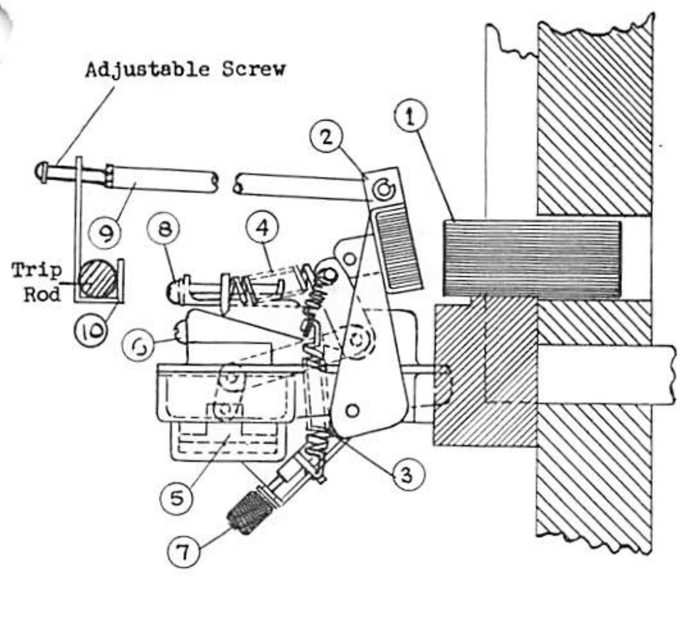
2. The motor limit switch is operated by the holding cam and it may prevent the cam from returning against the top stop screw. Bend the operating lever of the limit switch to overcome this.

3. To adjust the holding cam itself release the lock nut on the top screw and turn counter-clockwise one quarter of a turn and relock. This increases the loading on the cam and it is important that the adjustment be made carefully to ensure that the resultant load will not be too heavy for the shunt close device.

OVERLOAD RELAYS

All type H breakers are supplied with the new type PA direct acting overcurrent relay. These relays are dual magnetic type consisting of long delay element and an instantaneous element.

A series coil is used on breakers below 600 amperes while a single conductor provides sufficient magnetic flux for all ratings over 600 amperes. The very efficient magnetic design permits operation of the relay at very low ampere turn values and thus the coil normally associated with air circuit breaker relays is completely eliminated for all ratings of 600 amperes and over. In addition, coils used on the lower ratings employ much lower current densities than usual for this type of device and thus will operate at much lower temperatures.



1. Fixed Yoke
2. Moving Armature
3. Long delay springs
4. Instantaneous springs
5. Delay mechanism
6. Oil filler hole
7. Long delay adjustments
8. Instantaneous adjustments

Figure 7

LONG DELAY CALIBRATION

The relays are calibrated at the factory at 80%, 100% and 160% of trip coil rating and may be adjusted in the field to these calibrated marks.

INSTANTANEOUS CALIBRATION

The relays are calibrated at the factory at 10 times the trip coil rating or for the range to suit the continuous rating of the breaker and may be adjusted in the field to these calibrated marks.

STANDARD TRIP RATINGS

Breaker Type	Overcurrent Trip Ratings (100% Calibration)	Instantaneous Trip Range (Adjustable)
25H-1	50, 70, 90, 100, 125, 150 175, 200, 225, 250, 300, 350, 400, 500, 600, 800, 1000, 1200, 1600	8 – 15 times Overcurrent Trip ratings
50H-1	200, 225, 250, 300, 350, 400, 500, 600, 800, 1000, 1200, 1600	8 – 15 times
	2000, 2500, 3000	4 – 10 times
75H-1	1200, 1600, 2000, 2500 3000, 3500, 4000	4 – 10 times
100H-1	4000, 5000, 6000	4 – 10 times

OIL FILLER HOLE

The relays are shipped from the factory filled with oil and should not require servicing. If the relays are disassembled they should be thoroughly cleaned with carbon tetrachloride and reassembled with care to ensure they are completely free of dirt or lint. Refill the relay with 20 cc of the replacement silicon oil using a squirt type oil can.

CHECKING RELAY OPERATION

Push on both sides of moving armature with gentle pressure. The armature will move slowly as the delay piston retards the movement. At a point before the armature meets the yoke, the delay action ceases abruptly and the armature should travel freely to meet the yoke. In so doing the insulated pull rod connected to the armature should pull the the lever on the trip rod to trip the breaker. Adjust the screw at the trip shaft end of the pull rod if necessary to ensure the breaker trips.

This procedure may be repeated with more severe pressure which will extend the instantaneous springs and allow the armature to touch the yoke and trip the breaker.

Reference should be made to the time current characteristic curves for proper settings to suit load conditions.

SELECTIVE TRIPPING ATTACHMENT

When a short delay is required under short circuit conditions a delay device is introduced to prevent the instantaneous action of the relay. Three calibrated delays or 5, 15 or 25 cycles at 6 times the instantaneous pickup are provided.

A mechanical escapement device is mounted on the moving armature of the relay to prevent its movement under short circuit conditions. The timing adjustment is made by the amount of extension of the escapement spindle. Release the locknut on the side and adjust to one of the calibrated marks.

MAIN CONTACTS

Main contacts are a silver alloy and should be clean, bright and free from pitting. They may be gently sanded if necessary using a fine sandpaper to remove pit marks. Avoid having particles fall into the mechanism.

If main contacts are severely damaged careful inspection of all current carrying parts should be made. Supporting pins, linkage and especially springs should be examined for damage due to excess heat. Annealed or distorted parts should be replaced.

HOOD

The hood is provided to restrict ionized gases from direct access to the steel enclosure and in addition carries interphase barriers. The hood is held in place as illustrated for the various types of breakers. The hood is an asbestos type material and will break if subjected to undue shocks, therefore, care should be used in handling.

ARC CHUTES

Where the hood does not have a front panel the arc chutes may be removed without removing the hood for inspection of contacts. A long handled screw driver is necessary to reach the mounting screws at the back of the base. The arc chute may discolour from arc interruption but will not need replacement unless heavy deposits of arc contact material are present or unless parts are distorted or cracked.

ARCING CONTACTS

Arcing contacts are subjected to burning every time the circuit breaker interrupts the current and should be inspected at regular intervals if the circuit breaker is operated frequently. They should always be inspected after the breaker has interrupted a short circuit and should be replaced if they are showing serious pitting and burning.

To remove the moving arcing contact from the breaker, remove the circlip and ¼" dia. pin (3). Remove the braid connection by removing the ¼-20-round head machine screw. Examine the braid carefully for excessive broken strands or burned portions. Replace if necessary by disconnecting from the lower main contact bar. Replace in reverse order.

To remove the fixed arcing contact refer to Figure 8. Remove mounting bolts as indicated and replace.

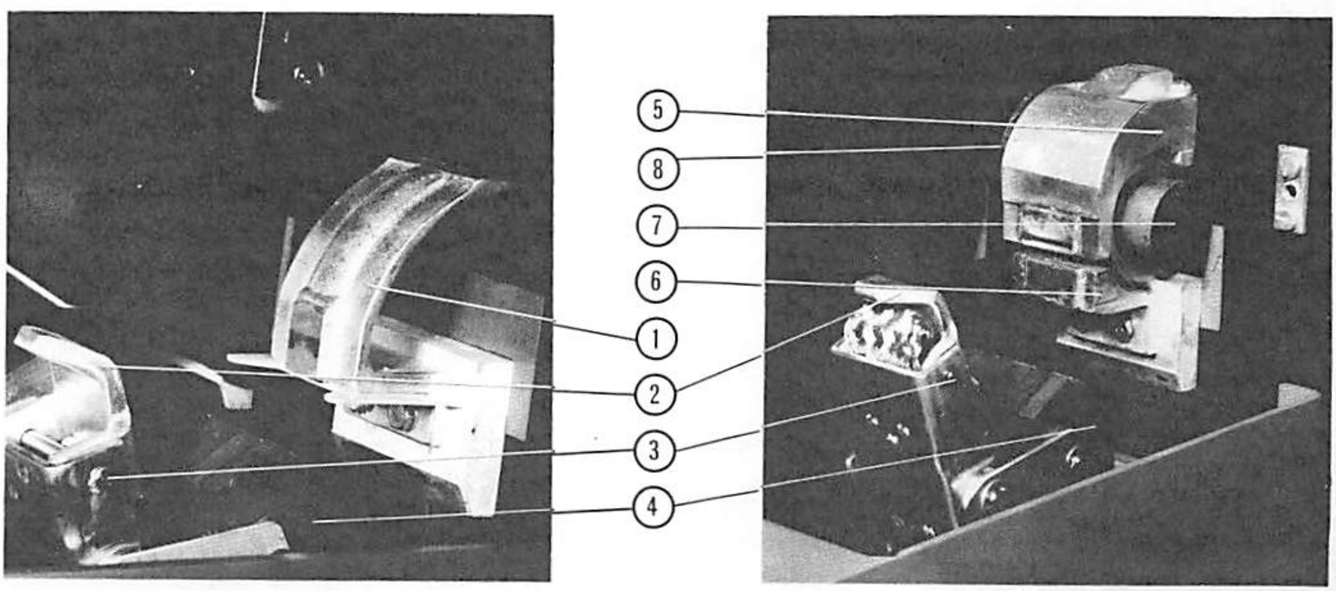


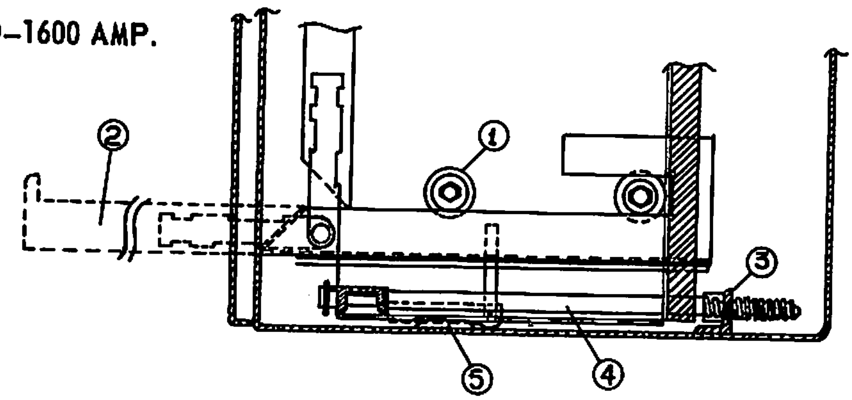
Figure 8a

(1) Fixed Arcing Contacts 25H–1
(2) Moving Arcing Contacts
(3) Pin
(4) Main contact

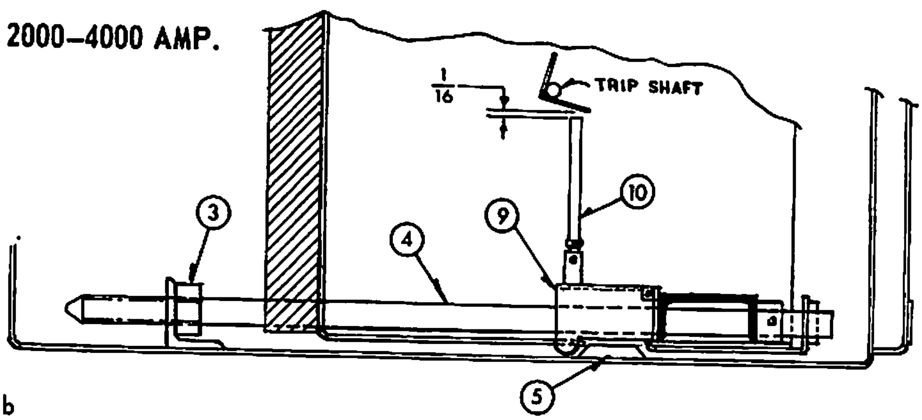
Figure 8b

(5) Fixed Arcing Contact 50H–1
(6) Lower fixed arcing contact 50H–1
(7) Blowout coil
(8) Contact sideplate.

50–1600 AMP.



2000–4000 AMP.



(1) Roller
(2) Folding Rail
(3) Crank Nut
(4) Crankshaft
(5) Interlock cam
(6) Shock Absorber
(7) Control tab
(8) Thrust bearing
(9) Interlock lever tab
(10) Interlock trip rod
(11) Truck Stops
(12) Rolpin

5000–6000 AMP.

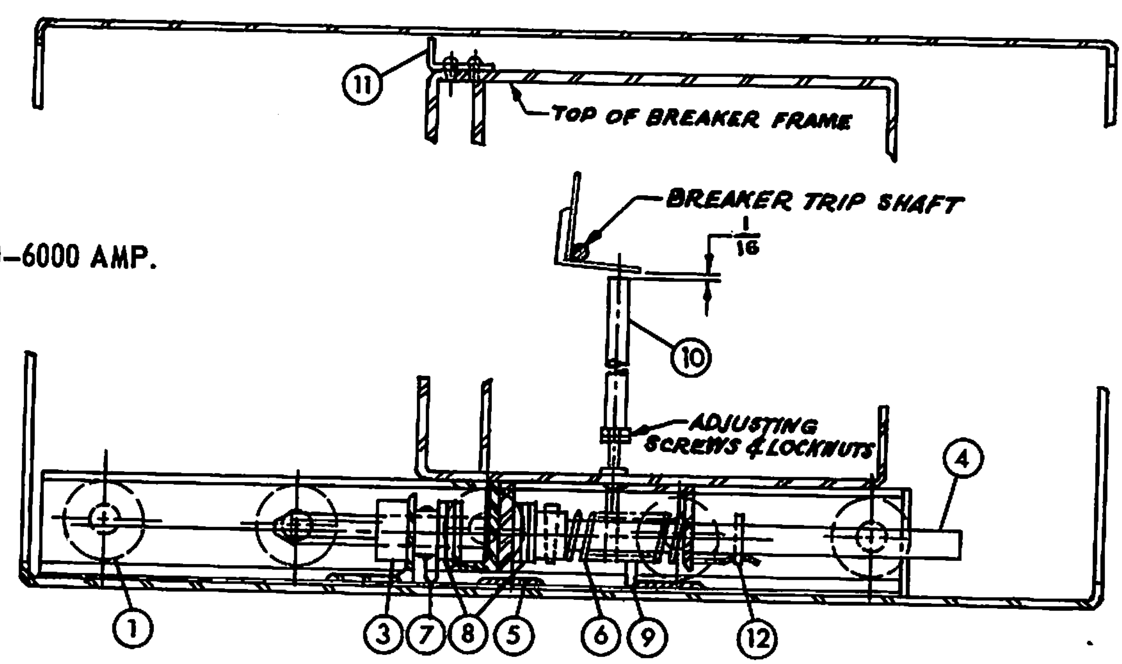


Figure 9 – Drawout Mechanism

DRAWOUT CIRCUIT BREAKERS

All drawout circuit breakers are mounted on a three position carriage so that the breaker may be moved to any of its positions, connected, tested and withdrawn without opening the door.

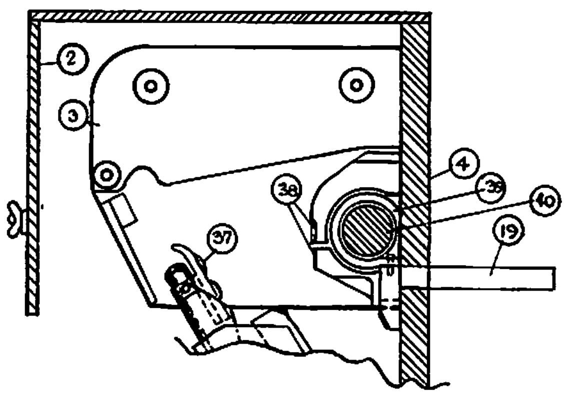
On the smaller frame breakers a folding rail assembly is used while the large frame breakers require a rigid self supporting truck. These are illustrated in Figure 9.

An interlock is provided which will ensure that the breaker is open when it is either engaging or disengaging the main contacts. The wedge is located in the bottom of the enclosure and the trip lever adjusted as shown in the diagrams above.

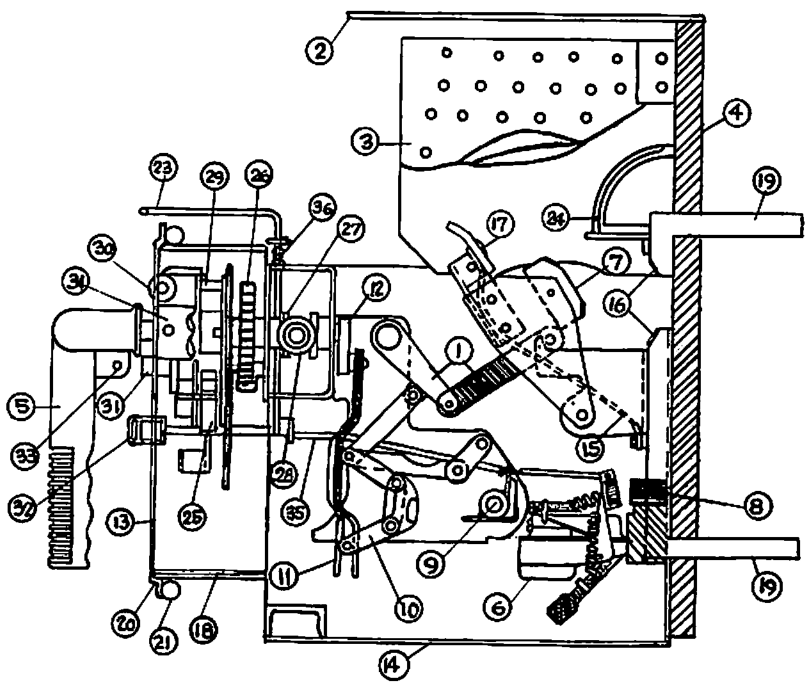
It is essential that the breaker trip after three turns of the crank when removing the breaker to ensure that the circuit is not broken on the drawout contacts.

If the breaker does not latch properly after it has been moved through this interlock position, check to see that the interlock has reset and the trip shaft has returned to its normal position and clearances are maintained as indicated.

1. Closing Link Assembly
2. Hood
3. Arc Chute
4. Base
5. Operating Handle
6. Dual Overload Relay
7. Main Moving Contact
8. Yoke
9. Trip Shaft
10. Closing Casting Link
11. Operating Eccentric Link
12. Crank Shaft
13. Faceplate
14. Spring Mechanism Frame
15. Braid
16. Main Fixed Contacts
17. Moving Arcing Contact
18. Faceplate Bracket
19. Terminals
20. Floating Trim
21. Floating Trim Springs
22. Trip Button
23. Interlock Lever
24. Fixed Arcing Contacts
25. Ground Steel Cam
26. Ratchet Wheel
27. Spring Crank
28. Main Spring
29. Holding Cam Assembly
30. Spring Charge Indicator
31. Manual Close Button
32. Provision for Padlocking Trip Button
33. Provision for Padlocking Operating Handle
34. Handle Clutch
35. Manual Trip Rod
36. Interlock Lever Spring
37. Moving Arcing Contacts
38. Fixed Arcing Contacts
39. Blowout Coil
40. Blowout Core



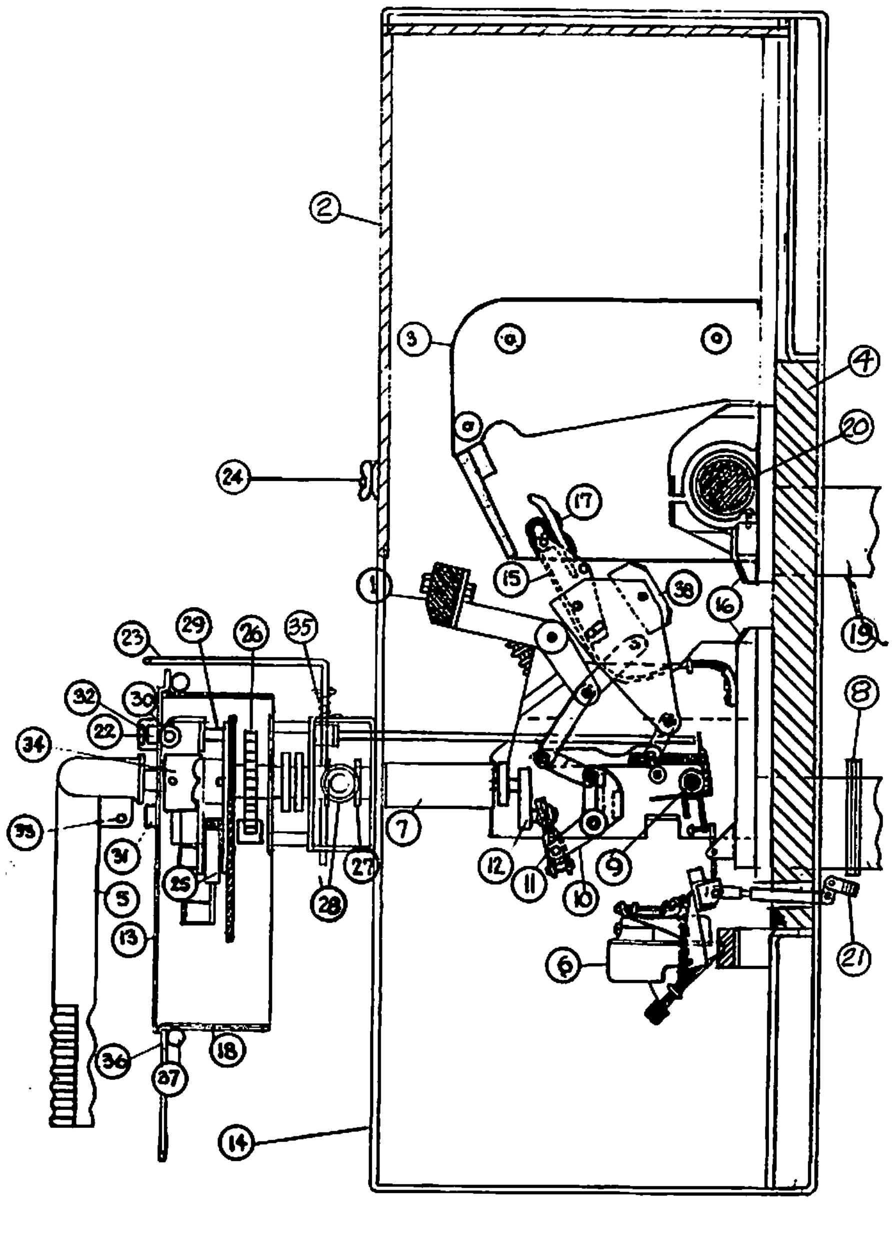
SECTION VIEW 25H-1



Section View 50H-1, 75H-1

Section View 100H-1

1. Tie Bar
2. Hood
3. Arc-chute
4. Base
5. Operating Handle
6. Overload Relay
7. Insulated Coupling
8. Yoke
9. Tripshaft
10. Operating Lever
11. Operating Link
12. Crankshaft
13. Faceplate
14. Spring Mechanism Frame
15. Braid
16. Main Contacts
17. Arcing Contacts
18. Faceplate Bracket
19. Terminals
20. Blowout Coil
21. Armature
22. Trip Button
23. Interlock Lever
24. Wing Nuts
25. Ground Steel Cam
26. Ratchet Wheel
27. Spring Crank
28. Main Spring
29. Holding Cam Assembly
30. Spring Charge Indicator
31. Manual Close Button
32. Provision for Padlocking Trip Button
33. Provision for Padlocking Operating Handle
34. Handle Clutch
35. Interlock Lever Spring
36. Floating Trim
37. Floating Trim Springs
38. Moving Main Contacts



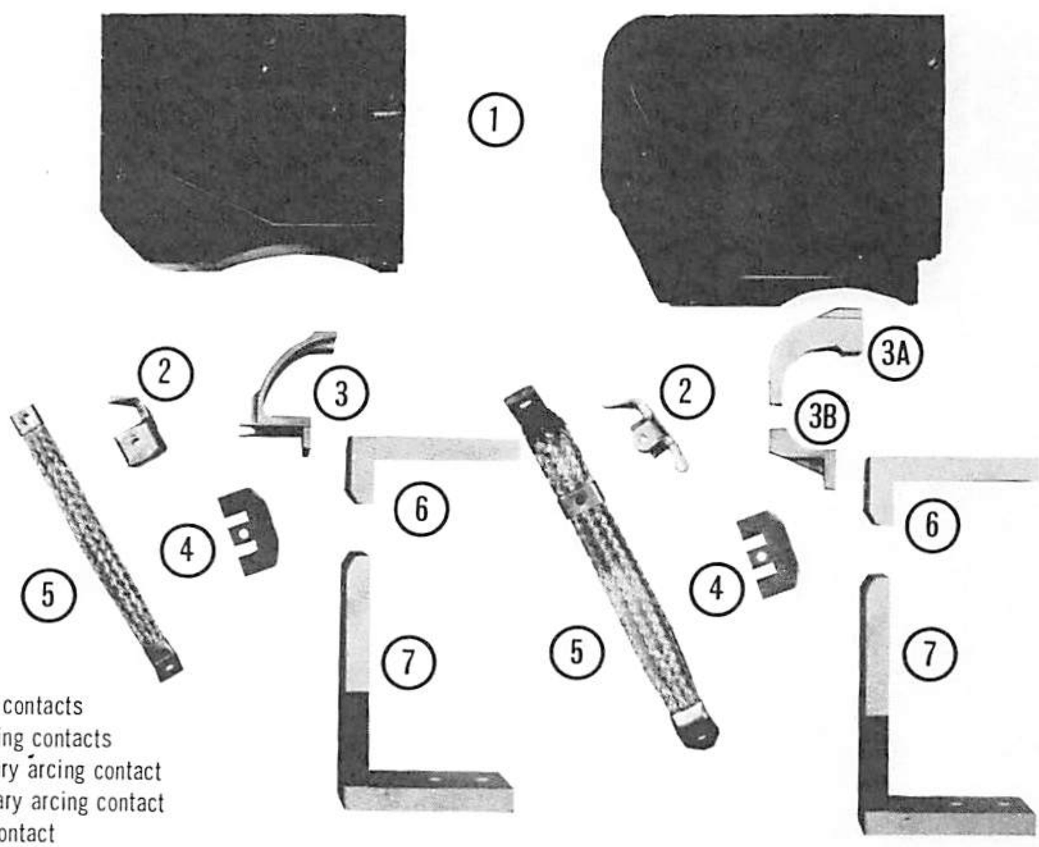
SPARE PARTS

It is recommended that sufficient spare parts be carried in stock to enable the operators of circuit breakers to promptly replace any worn, broken or damaged parts. It will be readily appreciated that a stock of parts reduces delays in service and saves time and expense. The following spare parts are recommended as minimum requirements for a breaker installation.

Quantity *(1)	DESCRIPTION	ITEM NO.	PART NUMBER FOR BREAKER TYPE				
			25H-1	50H-1 1600AMP	75H-1-3000A 50H-1-3000A	100H-1-4000A 75H-1-4000A	100H-1 6000A
3	Moving Arcing Contact	2	49B-98	49B-88	49B-89	49B-88	49B-89
3	Stationary Arcing Contact	3	49B-94	–	–	–	–
3	Upper Stationary Arc. "	3A	–	49B-9889	49B-9889	49B-9889	49B-9889
3	Lower " " "	3B	–	49B-9888	49B-9888	49B-9888	49B-9888
3	Arc Chute	1	41A-4	41A-9880B	41A-9880B	41A-8	41A-2-3
3	Main Braids	5	27A-81	27A-45A-1	27A-89	27A-45A-1	27A-58
1	Relay Oil (60cc)	–	195A-1	195A-1	195A-1	195A-1	195A-1

NOTE: When ordering spare parts specify complete nameplate data.

* (1) Quantities listed are total for a 3 pole breaker except 100H–1 which uses 6 of each arcing contact and braid for a three pole breaker.



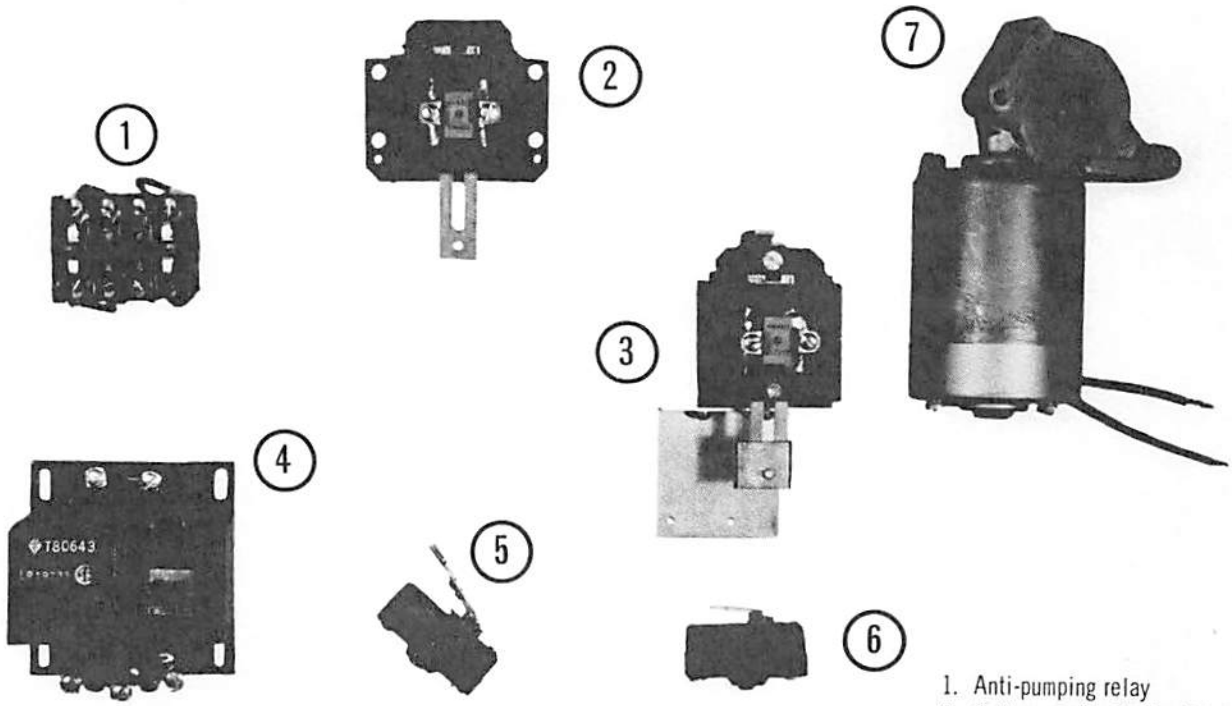
1. Arc chutes
2. Moving arcing contacts
3. Stationary arcing contacts
3a. Upper stationary arcing contact
3b. Lower stationary arcing contact
4. Main moving contact
5. Braids
6. Upper main contact
7. Lower main contact

25H-1 50H-1, 75H-1, 100H-1

FOR ELECTRICALLY OPERATED BREAKERS ADD

Qty.	DESCRIPTION	VOLTAGE RATING						
		48V D.C.	125V D.C.	250V D.C.	115V A.C.	230V A.C.	460V A.C.	575V A.C.
1	Motor	183A-1A-3	183A-1A-1	183A-1A-2	183A-1A-1	183A-1A-2	–	–
1	Closing Coil	46A-9922-10B	240A-4	240A-6	240A-3	240A-4	240A-5	240A-6
1	Shunt Trip Coil	46A-9922-10B	46A-9922-10C	46A-9922-10D	46A-9922-10A	46A-9922-10B	46A-9922-10D	46A-9922-10D
1	No Volt Coil	46A-7705-J	46A-7705-K	46A-7705-L	240A-2A	240A-2B	240A-2C	240A-2D
1	Limit Switch (SLS)	49E-8	49E-8	49E-8	249E-6	249E-6	–	–
1	Limit Switch (CC)	49E-8	49E-8	49E-8	249E-8	249E-8		
1	Auxiliary Relay	219A-4	219A-5	219A-6	219A-7	219A-8	–	–
1	Control Transformer	–	–	–	–	266C-4	266C-4	266C-4

NOTE: When ordering spare parts specify complete nameplate data.



1. Anti-pumping relay
2. Coil assembly for No Volt Trip
3. Shunt Close assembly
4. Control transformer
5. Spring Limit Switch (S.L.S.)
6. Closing Coil Limit Switch (C.C.)
7. Motor

FEDERAL PACIFIC
NX 116709
TYPE DST 5-250
Yr. mfg. 1967
Rated KV 4.16
MAX. DESIGN KV 4.76
Rated MVA 250
BIL KV 60
Rated frequency 60
CONT. current rate 1200
Closing ckt 48VDC
Trip Volt 48VDC
Wire diagram 0080031

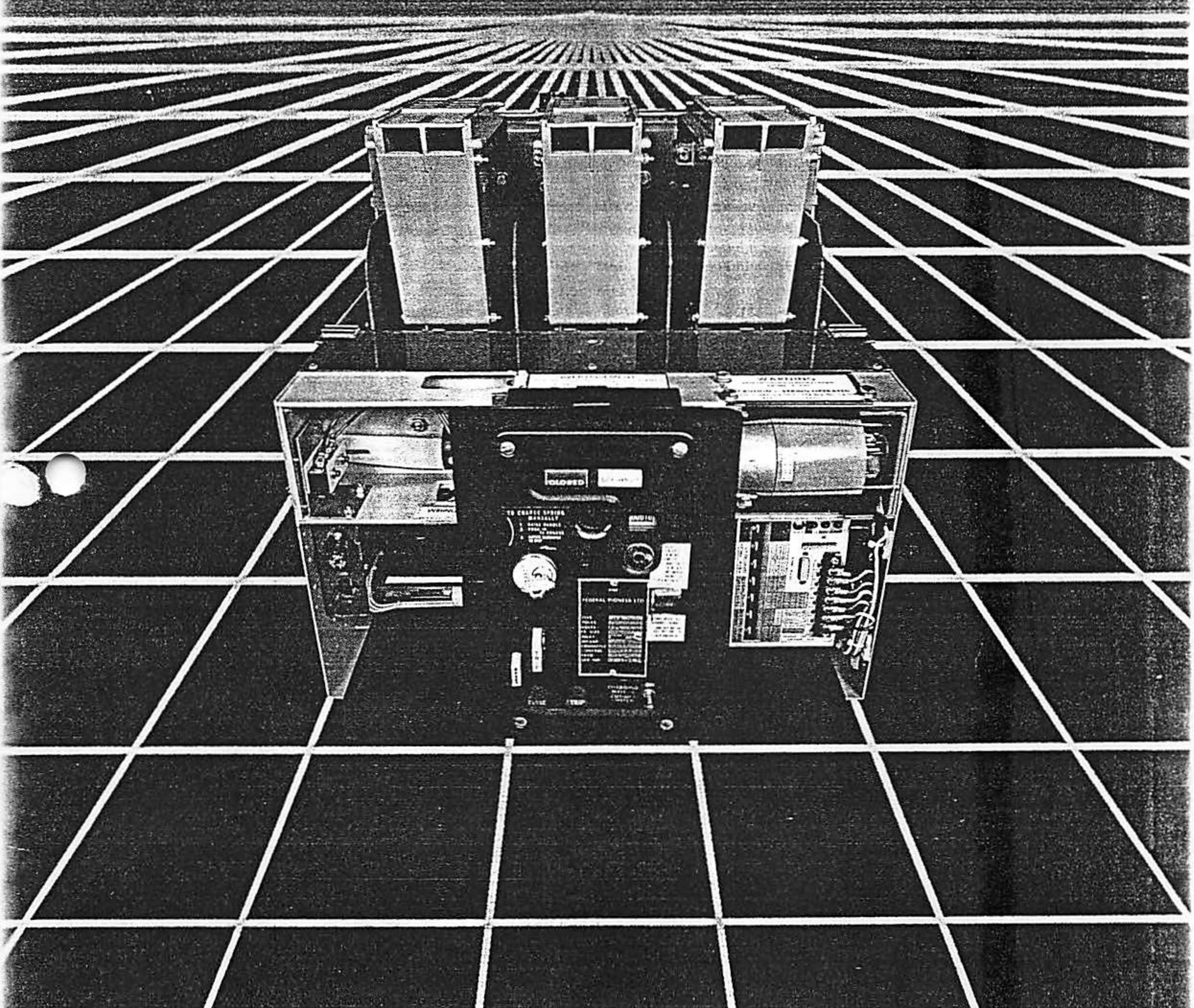
SUSAN SEND THIS
DOWN TO BRAD NANNA
& SEE IF WE CAN
VACUUM RETROFIT. ASK
for ESTIMATED price.

Jules

V. A. HINES
HOSPITAL

C-3-222
JUNE, 1983

TYPE H-3, HL-3 LOW VOLTAGE POWER AIR CIRCUIT BREAKERS



FPE FEDERAL PIONEER

FEDERAL PIONEER LIMITED

TYPE H-3, HL-3 LOW VOLTAGE POWER AIR CIRCUIT BREAKERS

APPLICATION

Type H-3 and HL-3 low voltage power air circuit breakers are used in metal-enclosed switchgear and unit substations for the protection and control of low voltage power circuits up to 250 volts dc and 600 volts ac. They are a means of safely switching loads and automatically clearing circuits when such abnormal conditions as sustained overloads, short circuits, ground faults, or under-voltage occur.

RATINGS

600, 800, 1600, 2000, 3000, 3200, 4000 and 6000 ampere continuous current rating are available. Interrupting capacities from 30,000 to 130,000 amperes for Type H-3, and up to 200,000 amperes for Type HL-3 fused air circuit breaker are available.

DRAWOUT OR FIXED MOUNTING

Type H-3 and HL-3 breakers are available mounted on a drawout cradle with disconnecting primary power and secondary control contacts. Type H-3 breakers can also be provided for fixed mounting.

ELECTRICAL OR MANUAL OPERATION

The breakers are provided with either a manually operated handle or an electric motor for charging the stored-energy closing mechanism.

USD SOLID STATE OVERCURRENT RELAY

Full overcurrent protection features include USD solid-state relays with Federal Pioneer's ZSIP® (ZONE SELECTIVE INSTANTANEOUS PROTECTION).

STANDARDS

Federal Pioneer Type H-3 and HL-3 circuit breakers and switchgear conform to the following standards:

ANSI	C37.13	— "Low-Voltage AC Power Circuit Breakers"
ANSI	C37.16	— "Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors"
ANSI	C37.17	— "Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers"
ANSI	C37.19	— "Low-Voltage AC Power Circuit Breakers and Switchgear Assemblies"
ANSI	C37.20	— "Switchgear Assemblies including metal-enclosed bus"
ANSI	C37.28	— "Low-Voltage AC Integrally Fused Power Circuit Breakers"
ANSI	C37.50	— "Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures".

British Standard 4752, "Part 1"

CSA	C22.1	— "Canadian Electrical Code, Part 1".
CSA	C22.2	— No. 31, "Switchgear Assemblies"
EEMAC	G8-2	— "Switchgear Assemblies"
IEC	157-1,	— 1A "Specification for Switchgear and Control Gear for voltages up to and including 1000V ac and 1200V dc. Part 1, Circuit Breakers."
NEMA	SG-3	— "Low-Voltage Power Circuit Breakers"
NEMA	SG-5	— "Switchgear Assemblies"

FEATURES	BENEFITS
Trip-free operation	SAFETY
Proven multi-segment design double break contacts	High contact pressure and low resistance
USD relay with instantaneous, short time, long time, ground fault and ZSIP®	Selective protection and adjustable time current characteristics
Stainless steel in critical areas of frame	Prevents magnetic heating
Precision assembly	Reliability and interchangeability
Compression spring, stored energy operating mechanism	Positive control of speed and force of closing, independent of the operator
Ratchet-wheel stored energy mechanism	Pause anywhere in charging cycle. No handle flyback
Easy interchangeability of type H-3 with Federal Pioneer Type H-2 breaker	No obsolescence
Fibre reinforced polyester arc chutes	No asbestos used
Silver plated main drawout contacts	Maximum efficiency and low temperature rise
Individually spring-loaded main draw-out contacts designed for "blow-on" effect.	Contact pressure increases with higher current flow.
DRAWOUT CONSTRUCTION	
Inherently dead front	SAFETY
Three position closed-door racking	SAFETY
Safety Interlock ensures breaker is open and spring discharged before breaker is connected or withdrawn	SAFETY
Rejection feature to prevent breaker being installed in vacant cell of different current rating.	SAFETY
MANUAL OR ELECTRICAL OPERATION	Choice of local or remote control.
TYPE HL-3 FUSED AIR CIRCUIT BREAKER	Up to 200,000 ampere rms symmetrical interrupting capacity.
Blown fuse, single phase protection	Protection of rotating machinery
Blown fuse indicator	Rapid identification of faulted phase
OPTIONAL FEATURES	
Padlockable shutters on drawout breakers	SAFETY
Overload lockout	SAFETY
Mechanical Interlocks	SAFETY
Door Interlocks	SAFETY
Key Interlocks	SAFETY
Cell Switches	SAFETY
Up to 48 auxiliary contacts	Flexibility in control schemes
Shunt trip and shunt close	Remote operation possible
Undervoltage trip	Protection from undervoltage damage to rotating machinery
Operations Counter	Monitoring of maintenance intervals
Breaker Lifting Devices	Easy handling

TABLE OF CONTENTS

DETAILED CONSTRUCTION

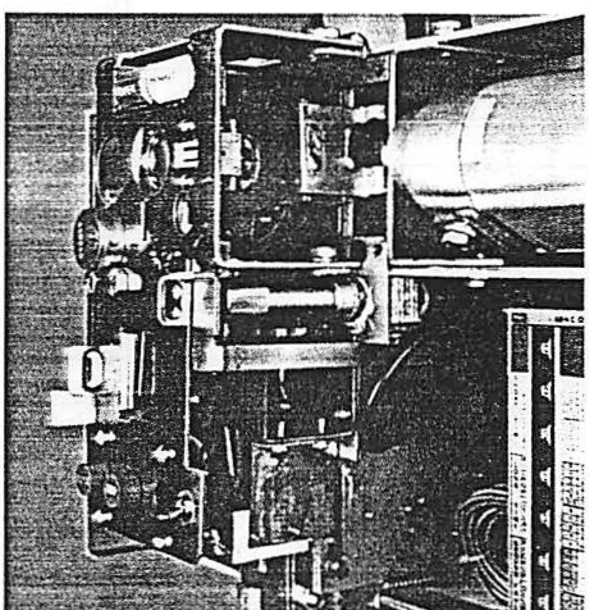
SUPPORTING FRAME

The type H-3 and HL-3 breakers are assembled on a moulded base of high strength polyester-glass compound using individual pole pieces carefully interlocked together and supported by a stainless steel frame. The use of stainless steel prevents magnetic heating. The mouldings are deeply ribbed to provide large creepage distances between adjacent current carrying parts. These ribs also serve as stiffeners to resist bending and distortion under conditions of maximum stress.

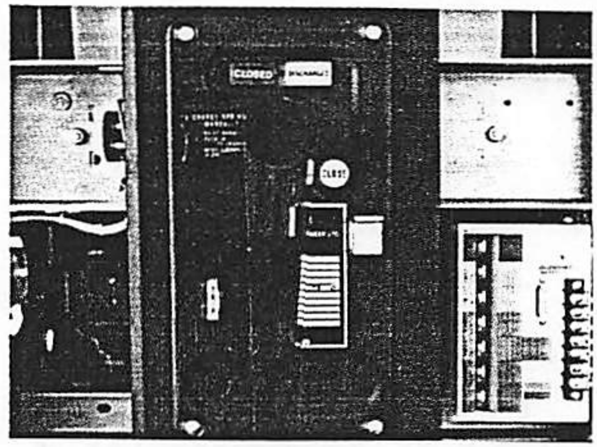
The circuit breaker frame is manufactured to close tolerances and jig-assembled to ensure accurate alignment of all parts. Close control is maintained over dimensional stability to ensure complete uniformity and interchangeability of finished breakers of each frame size.

OPERATING MECHANISM

Two types of operating mechanisms are available on the complete range of type H-3 and HL-3 circuit breakers; manual for local control and electrical for both local and remote operation. A high strength compression type closing spring is employed in all operating mechanisms to give positive control of closing speed and force, independent of the operator.



Electric motor charged operating mechanism (faceplate box removed)

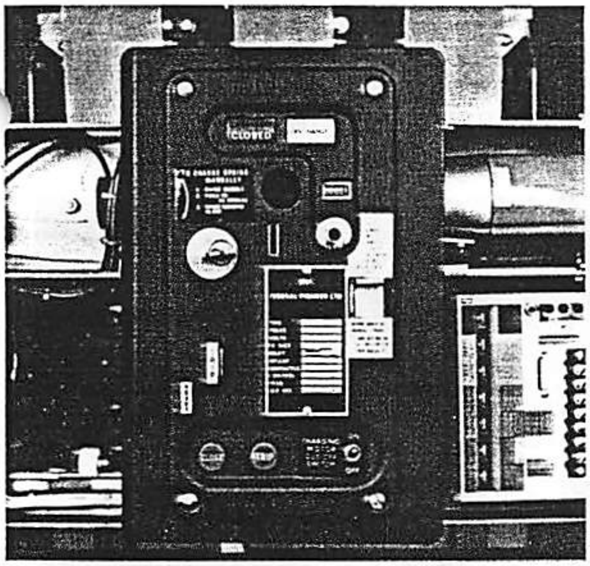


Manually operated H-3 breaker

Manual Operation

For manual operation the charging handle, located centrally on the breaker faceplate, is first rotated counter-clockwise and then pressed in to engage a clutch mechanism. Rotating the handle clockwise approximately 180° will fully charge the closing spring. A positive ratchet wheel mechanism allows a pause anywhere during the charging stroke without handle fly-back. The breaker can then be closed by pressing a direct acting manual close button on the breaker faceplate. The closing spring can also be charged manually when the breaker is open and left in the charged position, to be released from a remote position.

The manually operated mechanism includes provision for padlocking the handle. On frame sizes 1600 amperes and above, the handle has a pull-out extension for ease of operation.



Electrically operated H-3 breaker

Electrical Operation
For electrical operation a universal series-wound gear motor, suitable for operation on a.c. or d.c. current is provided. The motor is available in voltage ratings of 48, 120, 250V d.c. and 120, 240V a.c.

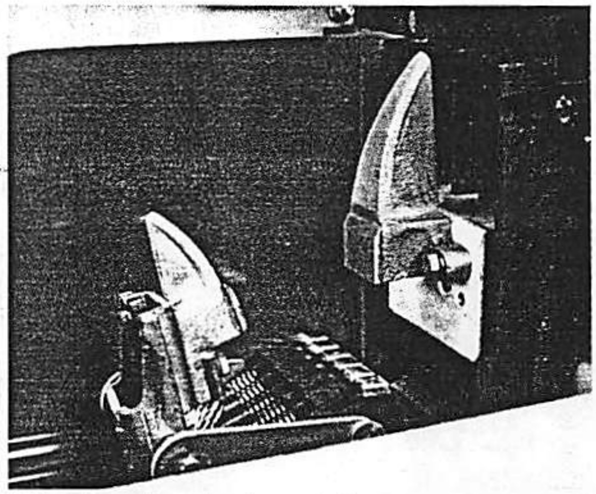
A toggle switch mounted on the faceplate permits the motor to be deenergized during maintenance or inspection. A spring limit switch stops the motor when the closing spring is fully charged. After the motor has charged the closing spring, the breaker can be closed remotely using a shunt close device.

The motor operates to charge the spring immediately after the breaker opens so it is ready to close as soon as the electrical close button is pressed. A latch check switch prevents any attempted electrical close until the trip shaft is completely reset in readiness to close. As an option, the motor may be connected to charge the spring, after the breaker closes to provide one immediate reclosure after opening. The electrically operated mechanism includes provision for a manual spring charging handle for emergency use. A shunt trip for remote tripping of the breaker is provided on all electrically operated breakers in addition to the dedicated tripping solenoid operated by the USD overcurrent relay.

An electrical trip button is provided on the faceplate and will operate in both "connected" and "test" positions. A manual trip button is also provided and operates in all breaker positions.

In addition to the electrical "close" and "trip" buttons one additional electrical button can be provided on the faceplate for special purpose controls such as electrical reset of lockout devices.

The faceplates of both operating mechanisms, include CLOSED-OPEN and CHARGED-DISCHARGED indicators and provision for key interlocks and/or operation counter.



H-3 breaker main and arcing contacts

MAIN CONTACTS
Type H-3 and HL-3 breakers have silver tungsten double-break bridge type main contacts, with wedge contact surfaces. The angular configuration minimizes the "blow-off" forces produced by short circuit currents.

Individual segments of the main moving contacts are fully insulated from each other and the carrying arm and are also self-aligning. Two compression springs per contact produce high contact pressures to ensure the breakdown of corrosive films and dirt. The design was optimized utilizing extensive computer studies, to control current flow through the segments while minimizing temperature rise.

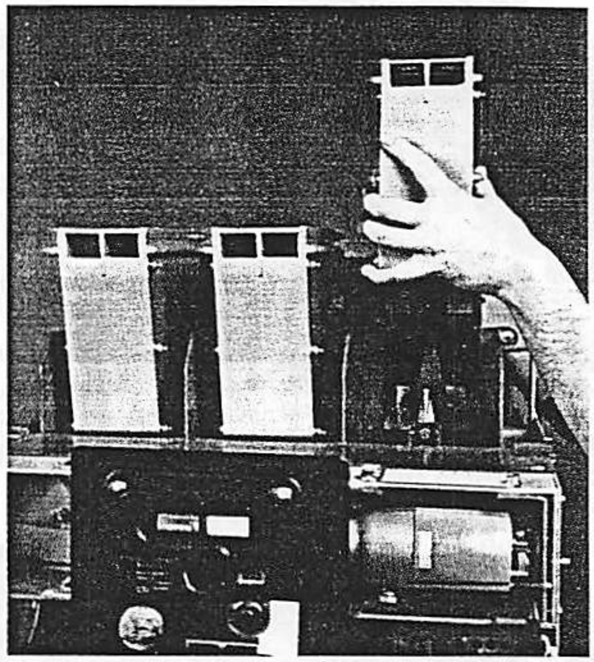
DETAILED
:ONSTRUCTION

ARC CONTROL

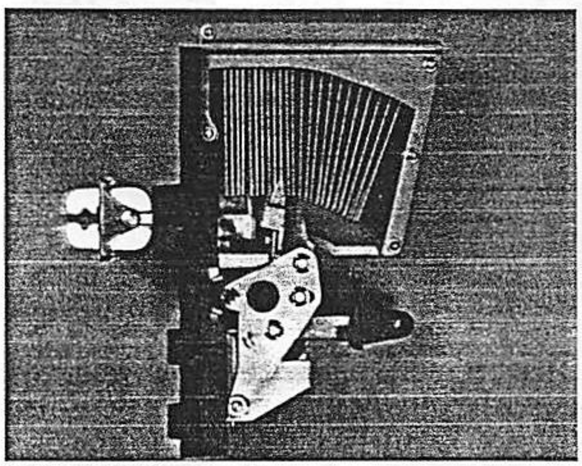
When the breaker opens under loads or short circuits, the main contacts part first and the double break contacts quickly establish a wide air gap. The current-flow is transferred to the arcing contacts, through a heavy copper braid. At no time are hinge pins relied on for carrying current in the Federal Pioneer H-3 and HL-3 breakers.

The arcing contacts part and an arc is established and the magnetic field produced forces the arc up into the arc chute. The arc chutes are made of fibre reinforced polyester and contain the steel arc chute plates and de-ionizing plates. The action of the arc-quenching and de-ionizing plates pulls the arc still further inside the arc chute, where it is cooled and broken into many small series arcs. The arc is thus extended, cooled and quickly extinguished, without arcing on the main contacts.

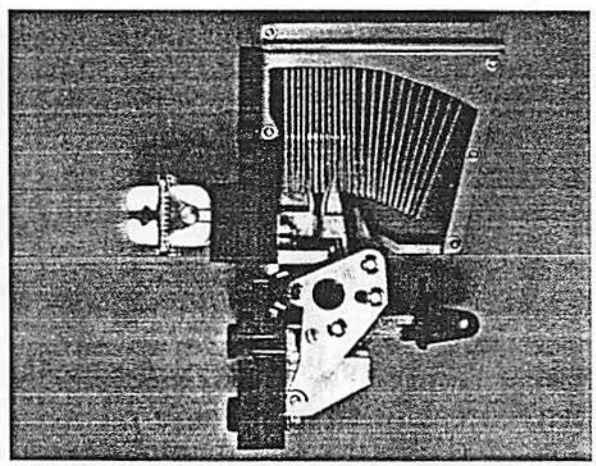
During interruption, the main contacts are further protected from the arcing by a shield located below the stationary arcing contact. An insulating barrier, fixed in the switchgear compartment above the arc chutes, completes the arc control system.



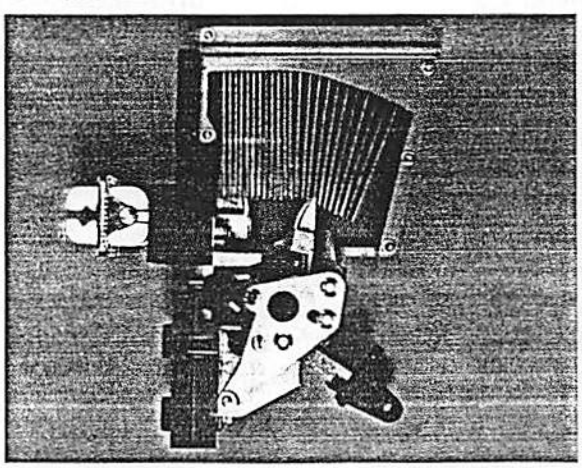
Arc chutes are easily removable for contact inspection



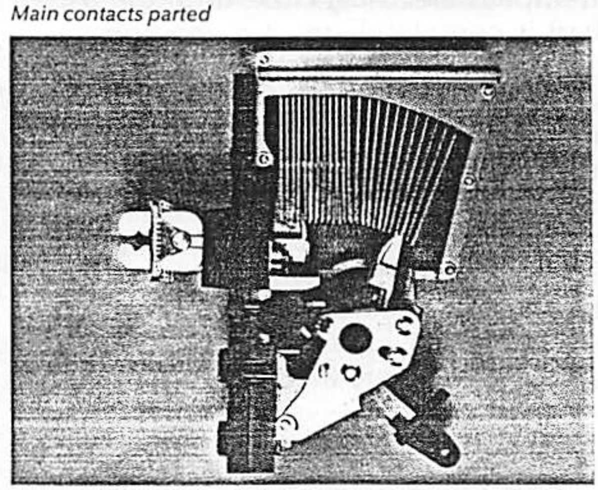
Contacts closed



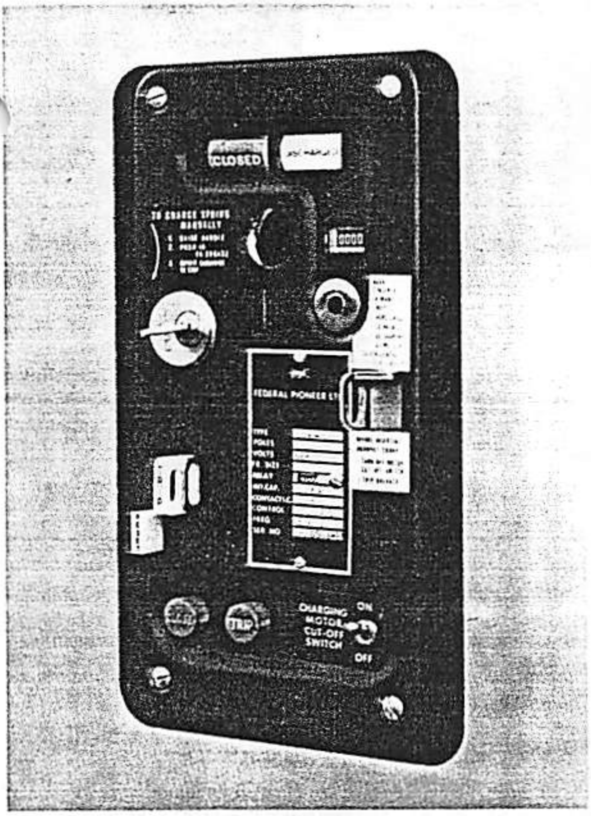
Main contacts parted



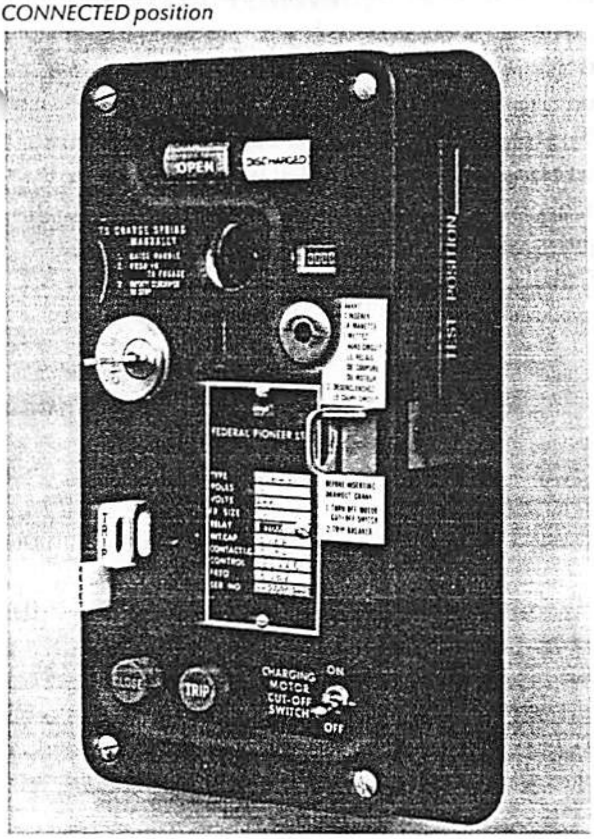
Arcing contacts parted



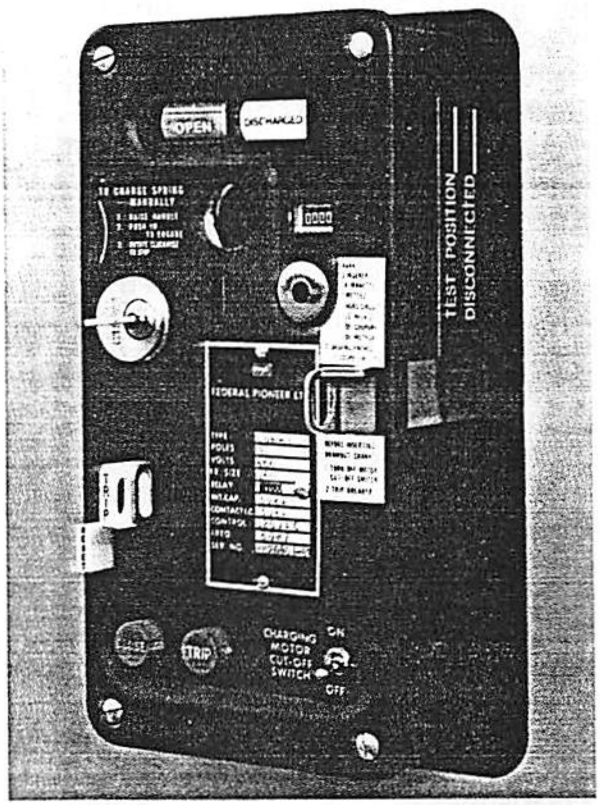
Arc extinguished



CONNECTED position



TEST position



DISCONNECTED position

DRAWOUT CONSTRUCTION

The drawout mechanism provides three positions for the breaker with the door closed.

CONNECTED — Primary and secondary contacts energized

TEST — Primary contacts isolated; secondary contacts energized

DISCONNECTED — Primary and secondary contacts isolated

A positive gear drive can be operated from the breaker faceplate even when the enclosure door is closed and operates a cam lever on each side of the draw-out cradle to move the breaker through its positions. Normally, the door can be opened with the breaker in any position. An optional door interlock can be provided to trip the breaker if the door is opened.

DETAILED CONSTRUCTION

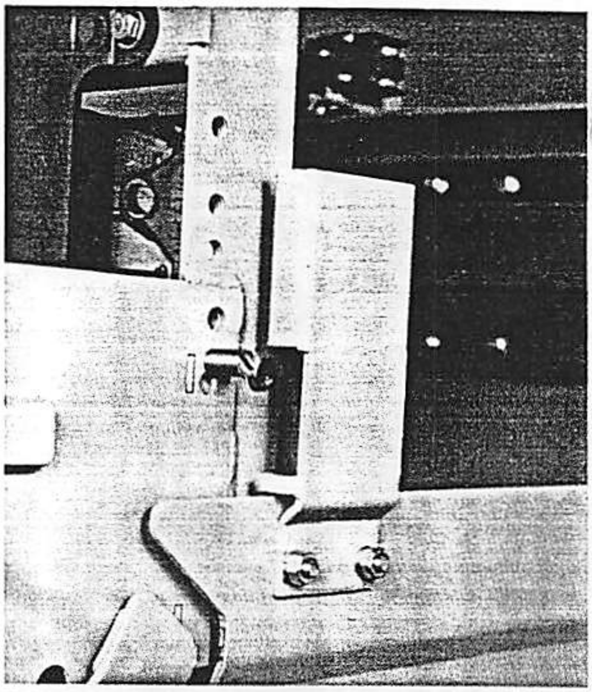
The breaker is guided accurately on grooved steel wheels fitted to the outside of the breaker frame. As the breaker is moved in from the "disconnected" position, the grounding contact is engaged first. This is a sturdy phosphor bronze to copper contact which ensures a positive ground connection to the breaker frame. The secondary or control contacts make next, as the breaker reaches the "test" position. Finally the main contacts are made as the breaker reaches the "connected" position. A positive stop on the mechansim ensures that the breaker is fully connected before it can be closed. Breaker position is also clearly shown by indicators on the side of the faceplate box.

Whenever the breaker is moved out the reverse sequence takes place. After the breaker reaches the "disconnected" position and the enclosure door is opened, rugged folding tracks can be pulled down to roll the breaker by hand fully clear of the enclosure, exposing all the plug-in contacts for examination. Safety shutters are available as an option to cover the main plug-in contacts of the enclosure.

Safety Interlock

The drawout mechanism is provided with a safety interlock as standard to ensure that the breaker is open and the closing spring is discharged before the breaker is either withdrawn from the cell or connected into the cell.

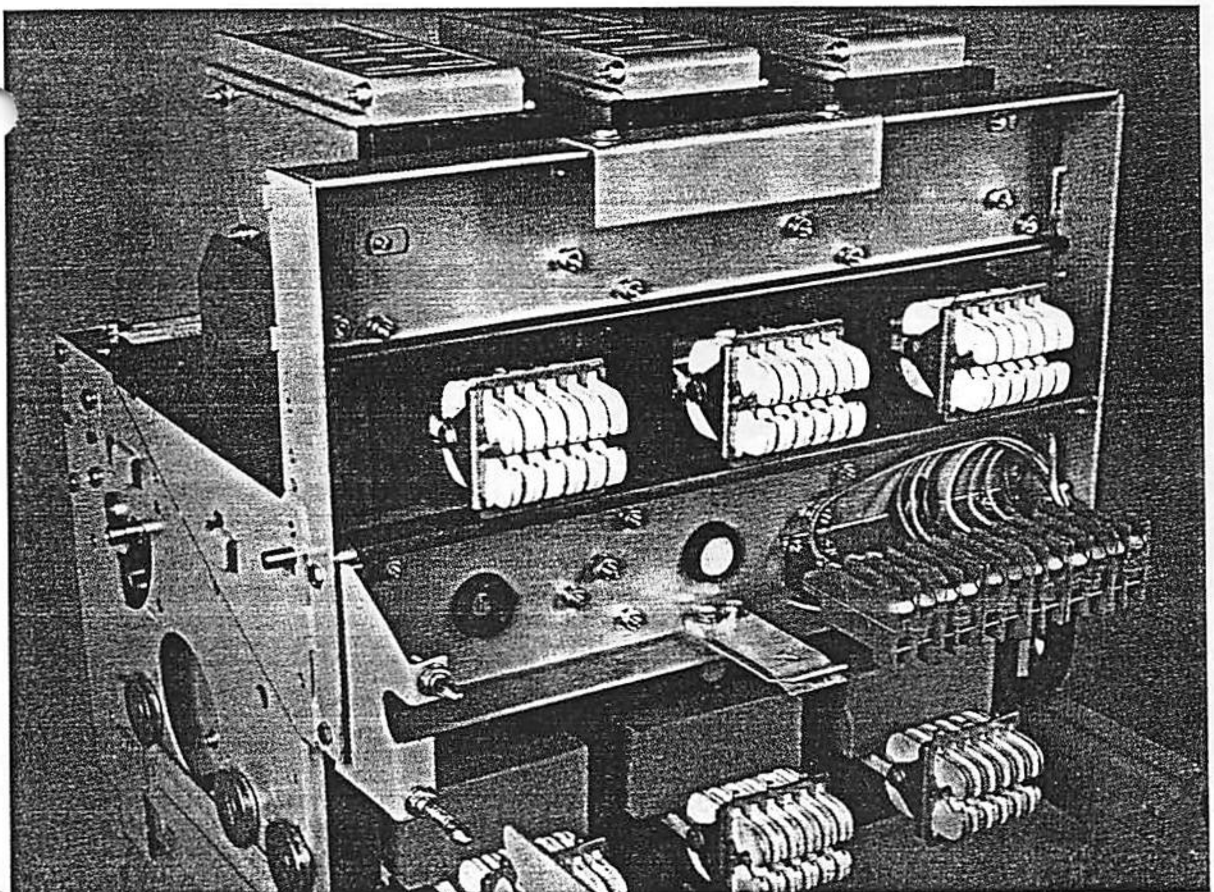
The drawout mechanism operating shaft is located behind a padlockable sliding gate interlock on the breaker faceplace. Lowering the gate to insert the drawout handle trips the air circuit breaker if it is closed, and then discharges the closing spring if it is charged. As long as the handle is inserted, the breaker cannot be closed.



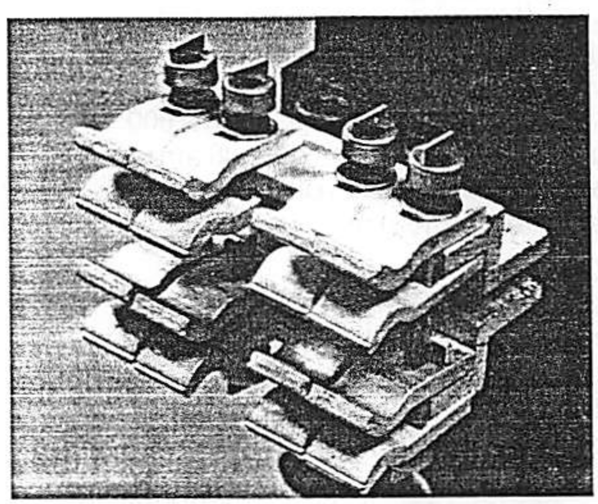
Rejection Feature

Rejection Safety Feature

A rejection feature is standard on all frame sizes and prevents entry of a breaker into an enclosure intended for a different frame size. Pins on both sides of the breaker frame must match slots cut in brackets mounted on both sides of the cradle. If the cradle is a different frame size than the breaker, the breaker pins will not match the slots cut in the cradle brackets.



Main Drawout Contacts - 1600A H-3



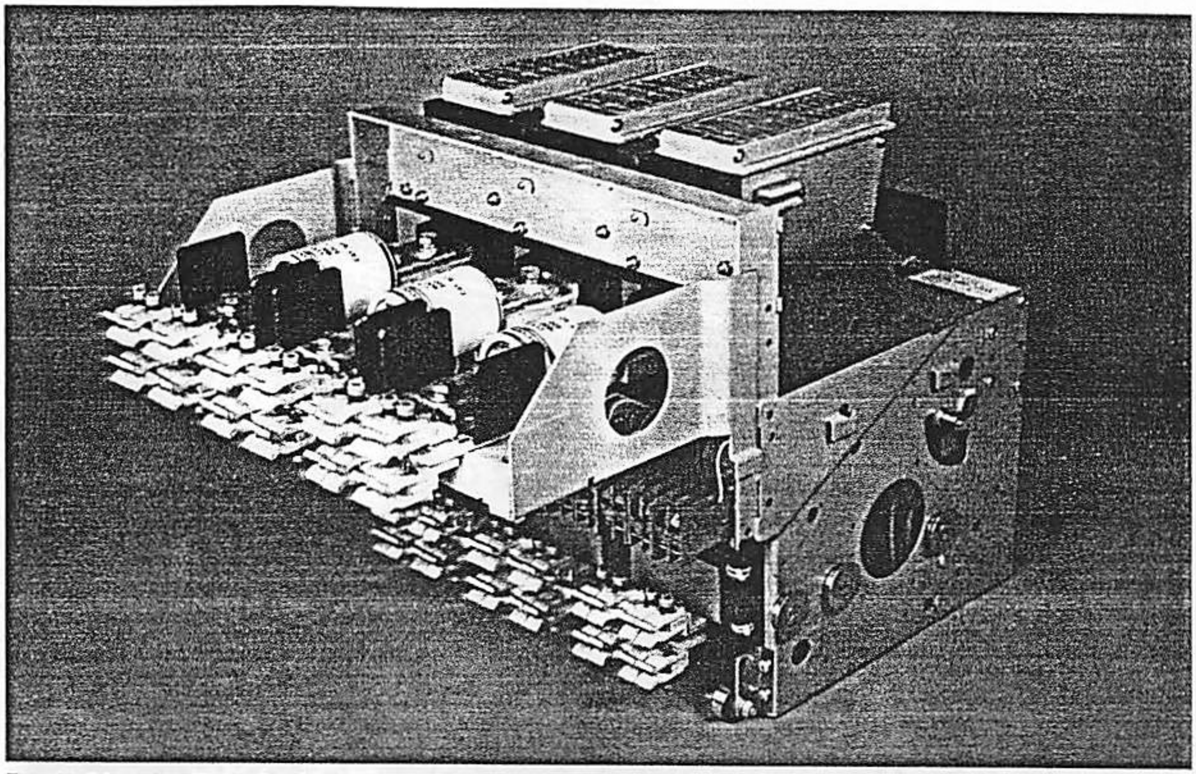
Main Drawout Contacts - 2000A H3

Main Drawout Contacts
Main drawout contacts utilize electromagnetic force to create a "blow-on" effect to increase contact pressure as current flow increases. This high pressure gripping action, along with a wiping-action as contacts are first engaged, maintains low contact resistance and operating temperatures.

These contacts are pre-loaded with individual springs for each pair of contacts to provide a reliable self-aligning connection. The 600 and 800 ampere breaker contacts utilize 4 pairs of segments, each 1/8" (3.18mm) thick. The 1600 ampere breaker contacts use 6 pairs of segments, each 1/4" (6.35 mm) thick. The 3000 and 3200 ampere breaker use two sets of 1600 ampere contacts.

The 2000 and 4000 ampere breakers utilize rows of contact segments designed to give "line-contact" for maximum conductivity in minimum space; individual springs are again used. Two rows of these contacts are used on the 2000 ampere breaker, and four such rows arranged in a compact box are used on the 4000 ampere breaker.

All main drawout contacts are silver plated for maximum efficiency and low temperature rise as a standard feature.



Type HL-3 Fused Air Circuit Breaker

TYPE HL-3 FUSED AIR CIRCUIT BREAKERS

The use of HRC fuses increases the interrupting capacity of the fused breaker to 200,000 amperes. The air circuit breaker alone retains the interrupting rating for its frame size, which ranges from 30,000 amperes symmetrical at 600 volts with a 600 ampere frame size, to 85,000 amperes symmetrical at 600 volts with a 4000 ampere frame size.

Overcurrent Protection
When a short circuit occurs the magnitude of the current and the co-ordination between the fuse and the breaker overcurrent relay will determine whether the breaker or the fuse will clear the fault. Co-ordination must be such that the breaker will not attempt to clear faults beyond its ratings. As breaker contacts must withstand the peak let-through of the fuse there is a maximum size fuse which can be supplied with each breaker frame size. Co-ordination between the breaker relay and the fuse is such that the breaker will operate to clear overloads and faults up to its interrupting rating and the fuse will clear faults above the breaker rating.

HRC Fuse Protection
Fault current damage is a result of the excessive heat energy released and the mechanical distortion produced by magnetic forces. Both these destructive elements are proportional to the square of the short circuit current. The heat energy is also directly proportional to the time that the short circuit current flows. Since HRC fuses have the precise qualities of limiting both the current and the time through which it acts, fault damage can be considerably reduced. HRC fuses operate silently and safely without expelling any ionized gas.

Selection of Ratings & Co-ordination
The frame size and trip ratings for fused breakers are selected in the same manner as for a conventional air circuit breaker. To achieve the best protection from the HRC fuse, the smallest rating which can co-ordinate with the relay should be chosen.

Where fused breakers are used in series, co-ordination between the fuses must also be considered. With reference to the I^2t curves for the fuses in question, one must ensure that the total clearing I^2t of the load side fuse does not exceed the melting I^2t of the supply side fuse.

Where the HRC fuse must protect equipment by virtue of its current limiting abilities, the maximum peak withstand current for the equipment to be protected must be determined. For the circuit breaker, the maximum peak withstand current is 2.3 times the symmetrical short-circuit rating. At the available short circuit current in RMS symmetrical amperes, the peak let-through current of the fuse selected should not exceed the maximum peak withstand current for the equipment to be protected.

For further information on breaker-fuse co-ordination contact Federal Pioneer.

Fuse Truck

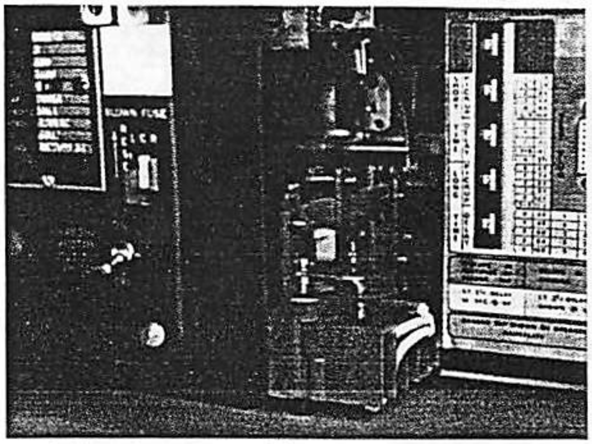
In ratings of 2000, 3000 and 4000 amperes, a separate fuse truck is available to be used in conjunction with an H-3 breaker. Key interlocking is provided to ensure that the circuit breaker is open before the fuse unit is withdrawn. The fuse unit is equipped with a rejection feature which prevents entry of the fuse unit into the breaker cell.

TYPE HL-3 FUSED AIR CIRCUIT BREAKER

The type HL-3 circuit breaker is available in 600 to 4000 amperes frame sizes. The HL-3 breaker is similar to a drawout Type H-3 with the addition of a provision for mounting NEMA HRC fuses. Optional accessories available for the H-3 breaker are also available for the fused breaker. These fuses are mounted on the line side on a frame extension at the rear of the breaker and are accessible for replacement when the breaker is fully withdrawn.

The following maximum fuse sizes may be used:

HL-3 FRAME RATING (AMPERES)	RELAY RATING (AMPERES)	MAXIMUM FUSE RATING (AMPERES)
600	600	800 NEMA L
800	800	1200 NEMA L
1600	1600	2000 NEMA L
2000	2000	3000 NEMA L
3000	3000	4000 NEMA L
4000	4000	6000 NEMA L



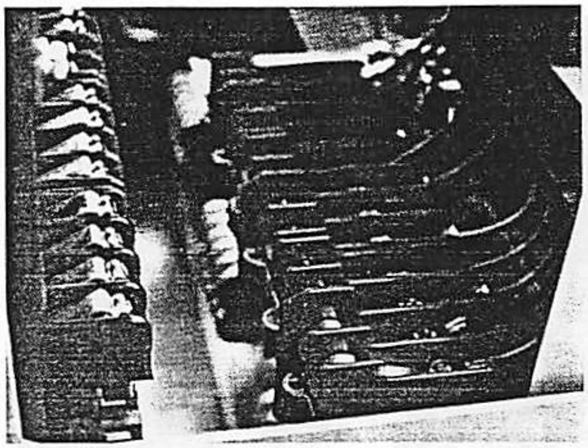
Single Phase Protection and Blown Fuse Indicator

Single Phase Protection

Protection against single phasing caused by breaker fuse interruption is a standard feature on Type HL-3 fused air circuit breakers. Three solenoid coils (one per phase) are connected in parallel with the HRC fuses. They are provided with plungers which act directly on the common trip shaft. The coils are rated 1/5th line voltage so that should a fuse blow on short circuit, the coil will provide sufficient power to trip the breaker, even though the line voltage may be reduced.

Blown Fuse Indicator

An indicator is provided which is actuated by the single phase protection coils. Should one fuse blow, the corresponding coil will trip the breaker and project an indicating bar through the faceplate. The three indicators are coloured red, yellow and blue and correspond to left, centre and right side fuses. When the fuse has been replaced the linkage can be reset by pushing in the indicator. The breaker can then be reclosed.



Secondary Control Contacts

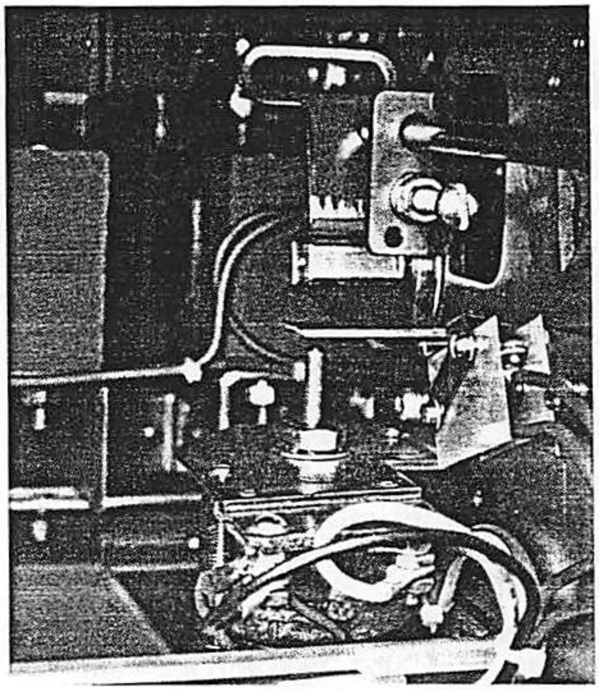
ACCESSORIES FOR H-3 AND HL-3 CIRCUIT BREAKERS

Secondary Control Contacts

Secondary control contacts are provided on drawout units to automatically connect or disconnect control circuits, as the circuit breaker moves through its positions in the cradle. The contacts are designed so that the control circuit can be energized or isolated in the test position. These connections can be altered in the field, when required, by means of jumpers between contacts of the stationary block.

Supplied in multiples of 8 contacts, a total of 48 can be provided, and each contact has a continuous current rating of 30 amperes. In applications where a control supply voltage in excess of 250 V is to be used, the higher voltage contacts are double spaced (i.e. the adjoining contact is unused).

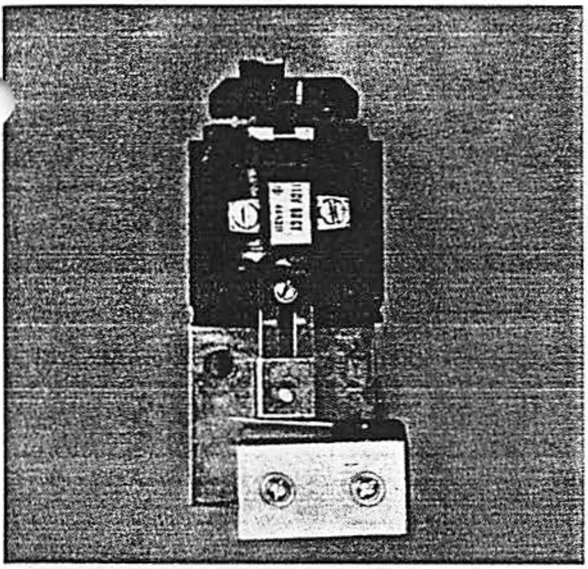
Contacts are formed copper, cadmium plated and mounted in a polycarbonate moulding. The moulding is designed with high barriers between contacts to provide large creepage distances. The movable secondary contact block fitted to the breaker assembly is spring mounted to ensure alignment with the stationary contacts.



Shunt Trip

Shunt Trip

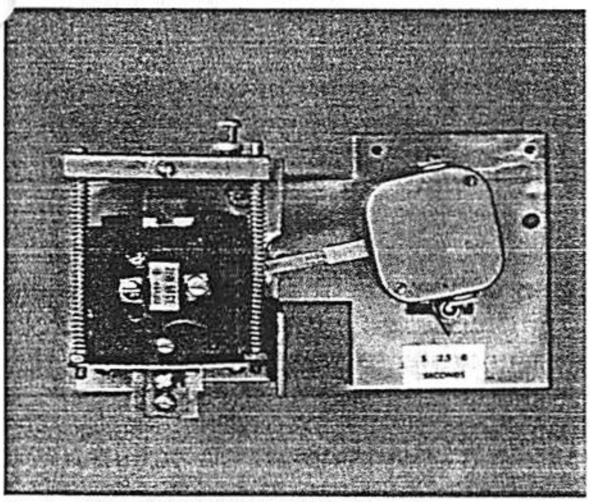
The shunt trip is a solenoid device separate from the dedicated solenoid used with the USD relay. When energized it acts directly on the breaker trip shaft to trip the breaker. Coils are interchangeable with all standard control ratings available. (See rating data). A shunt trip is supplied as standard on electrically operated breakers and is available as an option on manually operated breakers.



Shunt Close

Shunt Close

The shunt close device is used to release the energy stored in the closing spring to close the breaker from a remote position. It is standard on electrically operated breakers and is available as an option on manually operated breakers.



Undervoltage Trip with Time Delay Attachment

Undervoltage Trip

The undervoltage trip provides protection on loss of system voltage or low system voltage. It is an a.c. solenoid holding two compressed springs which will trip the breaker mechanically when the supply voltage falls too far below normal. (See rating data). Tripping action may be instantaneous or delayed up to 5 seconds when the adjustable time-delay attachment is specified.

The device is energized directly, or from a control transformer, and is connected across two phases.

If voltage is available on the line side terminals, the coil is energized and will compress the springs. The breaker may then be closed in the normal manner. In operation, the coil drops-out at 35% of rated voltage for 120V a.c. and 46% of rated voltage for 240V a.c. Both pull in at 80% rated voltage.

Overload Lockout Device

The overload lockout device prevents reclosing of the breaker either manually or electrically after the breaker has been tripped by the overload relay, until this device is manually reset.

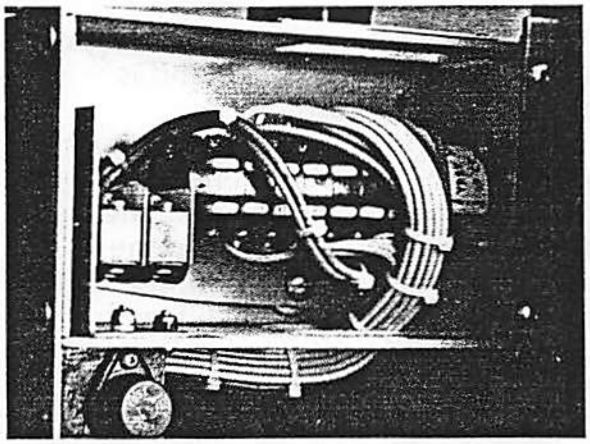
The direct acting shunt trip solenoid plunger mechanically holds the closing mechanism in the trip-free position, preventing closing of the main contacts. The latch check switch wired in series with the closing coil is open in this position, to block electrical operation of the closing coil.

The device is reset by pushing the manual overload lockout reset button on the breaker faceplate. This reset button is spring returned to its normal position.

Alarm Contacts

A Single Pole Double Throw contact is supplied and operated in conjunction with the overload lockout device. Contact is reset with the overload lockout device. Where overload lockout is not required a momentary overload alarm contact can be supplied to operate a remote flag relay.

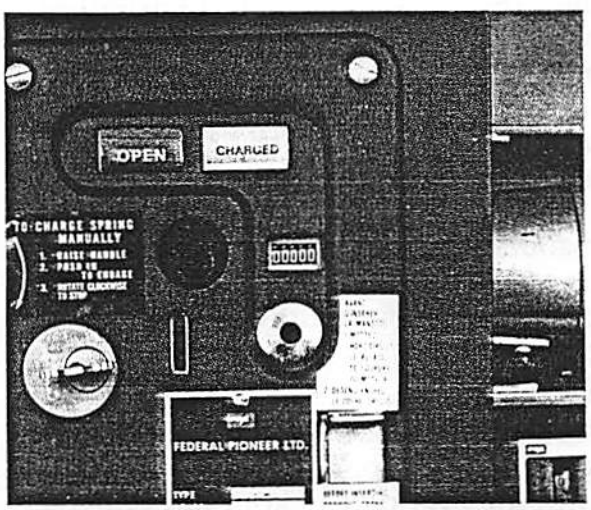
ACCESSORIES FOR H-3 AND HL-3 CIRCUIT BREAKERS



Auxiliary Switch

Auxiliary Switch

All H-3 and HL-3 units use a multi-section rotary switch coupled directly to the closing shaft, operated on a snap action principle which provides quick break switching. Switches with up to 20 poles are available.



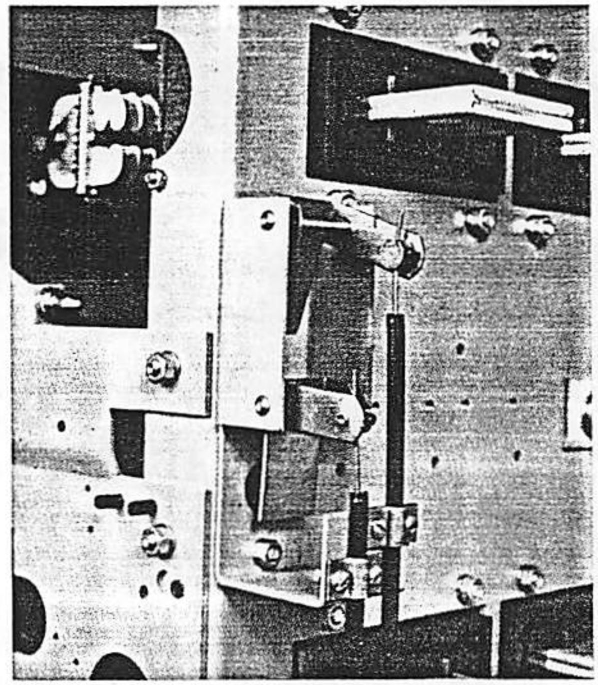
Operations Counter

Operations Counter

A five digit mechanical counter can be supplied, mounted in the faceplate of the breaker.

This device is mechanically driven by the "CHARGED-DISCHARGED" indicator, and operates once for each charging of the breaker closing spring.

Operations counters are recommended where breakers will be subjected to frequent operations as an indicator of the recommended maintenance intervals.

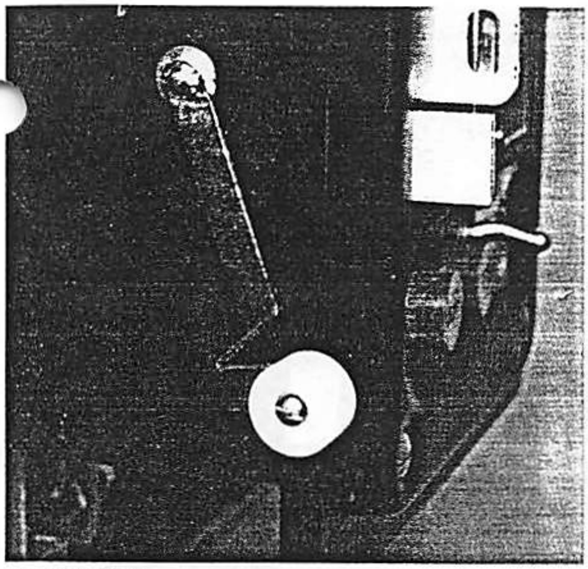


Mechanical Interlock

Mechanical Interlock

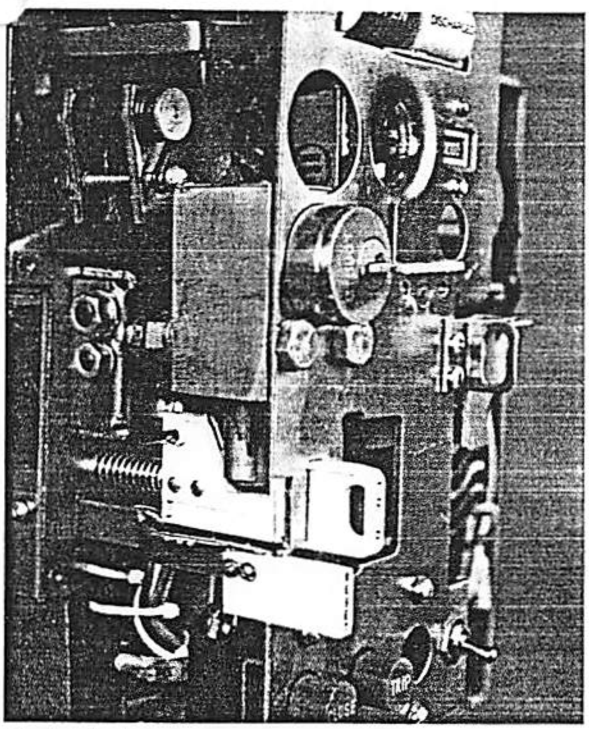
Mechanical interlocks are available on all H-3 and HL-3 breakers. They are used to mechanically interlock breakers in a two or three breaker transfer scheme. In the case of a two breaker transfer scheme, mechanical interlocks ensure only one breaker is closed while the other is held in a trip-free position. Mechanical interlocks connect the closing shaft of one breaker to the trip shaft of a second breaker by means of a flexible cable and vice versa. In a three breaker transfer scheme mechanical interlocks ensure only two breakers are closed while the third is held in a trip-free position.

Drawout breakers are interlocked by cable connections between the cradles. There are no permanent connections between the breaker and matching cradle when interlocking is supplied, so the breaker can be freely withdrawn from the cell. Mechanical interlocks are operable only when the breaker is in the connected position. When withdrawn to the "test" position, breakers can be test operated in the normal manner.



Door Interlock

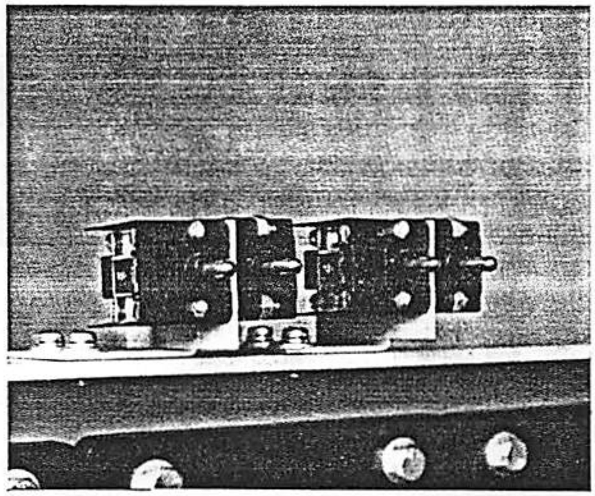
Door Interlock
All H-3 and HL-3 circuit breakers may be fitted with a device which acts to trip the unit when the cell door is opened. In operation, the door lever acts internally on the mechanical trip button causing it to move in towards the faceplate.



Key Interlock

Key Interlocks
Type VF key interlocks, single or double lock, with 3/8 inch (9.5mm) projection can be provided. Provision is made for key interlocks on all frame sizes.

With the key removed the closing mechanism is completely trip-free, preventing closing of the main contacts. On electrically operated units an auxiliary switch contact is provided to operate in conjunction with the interlock isolating the closing circuit.



Cell Switches

Cell Switches
Cell switches mounted in the cradle can be provided to serve as position indicators or as an electrical interlock bypass. The switches are operated when the breaker is removed from the "connected" position in the enclosure.

Each switch contains one normally closed and one normally open contact. A total of six switches can be supplied. These contacts are rated 10 amperes up to 300V a.c.

ACCESSORIES FOR H-3 AND HL-3 CIRCUIT BREAKERS

Shutters

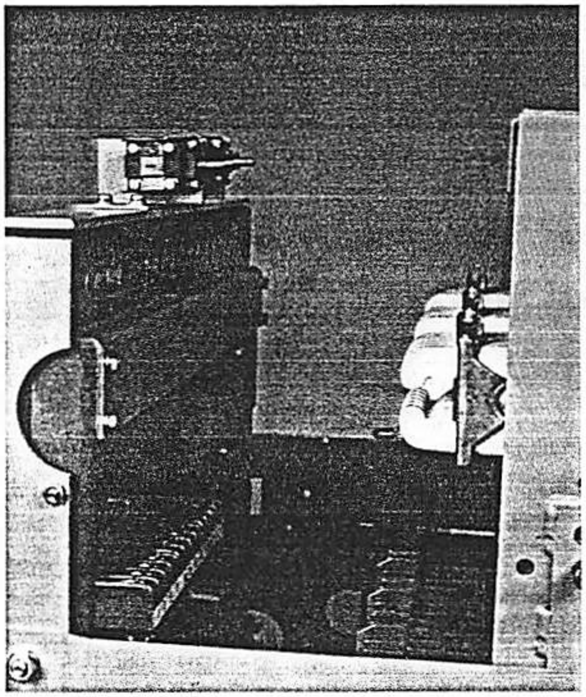
Shutters are available for all frame sizes up to and including 3200 amperes for both line and load side main plug-in contact stabs.

For the 600, 800, 1600, 3000 and 3200 ampere H-3 frame sizes, shutters are of the lifting type. They have a padlock bracket in the bottom of the enclosure for locking in the down position.

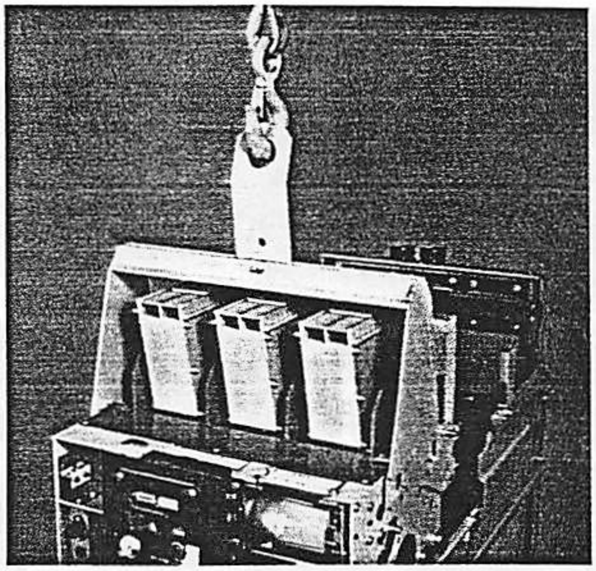
When the breaker moves from the "test" to the "connected" position, shutter bolts on the frame of the breaker lift the shutter to expose the main plug-in contacts.

For the 2000 ampere H-3 and for the 600, 800, 1600, 2000 and 3000 amperes HL-3, shutters are of the splitting type. When the breaker moves from the test to operating position, shutter bolts on the frame of the breaker open the shutter to expose the main plug-in contacts.

A separate blanking truck may be used in 4000 ampere drawout breaker cells.



Shutters lift automatically as breaker moves to "CONNECTED" position



Lifting Device facilitates safe handling of breaker

Lifting Device

A lifting device is available from Federal Pioneer for all frame size breakers. The lifting device is a one-piece yoke which fits into lugs on the breaker sideplates. This permits safe removal of the breaker from the enclosure drawout tracks. Lifting yokes are ordered as follows.

Part Number 26G-542 for 600, 800, 1600 and 2000 ampere H-3's.

Part Number 26G-151 for 3000, 3200 and 4000 ampere H-3's.

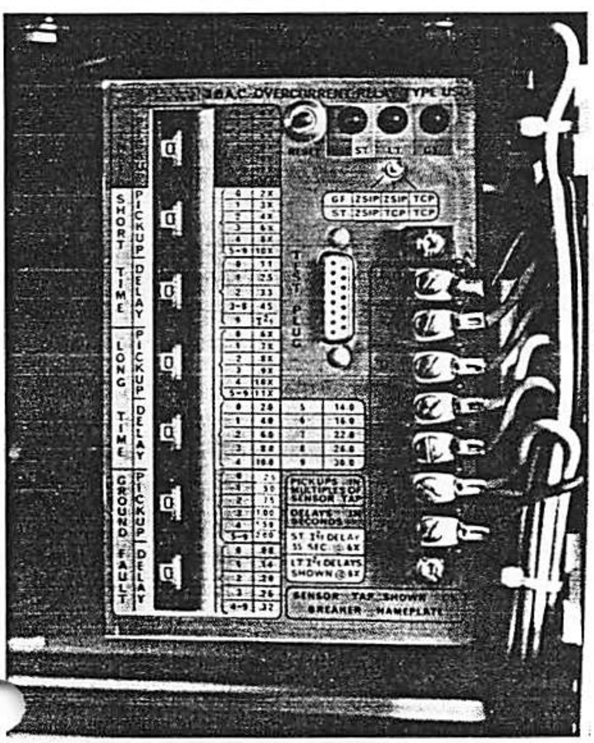
Part Number 26G-601 for 600, 800, 1600 and 2000 ampere HL-3's.

Part Number 26G-603 for 3000 and 4000 ampere HL-3's.

Part Number 26G-150 for 6000 ampere 100H-2.

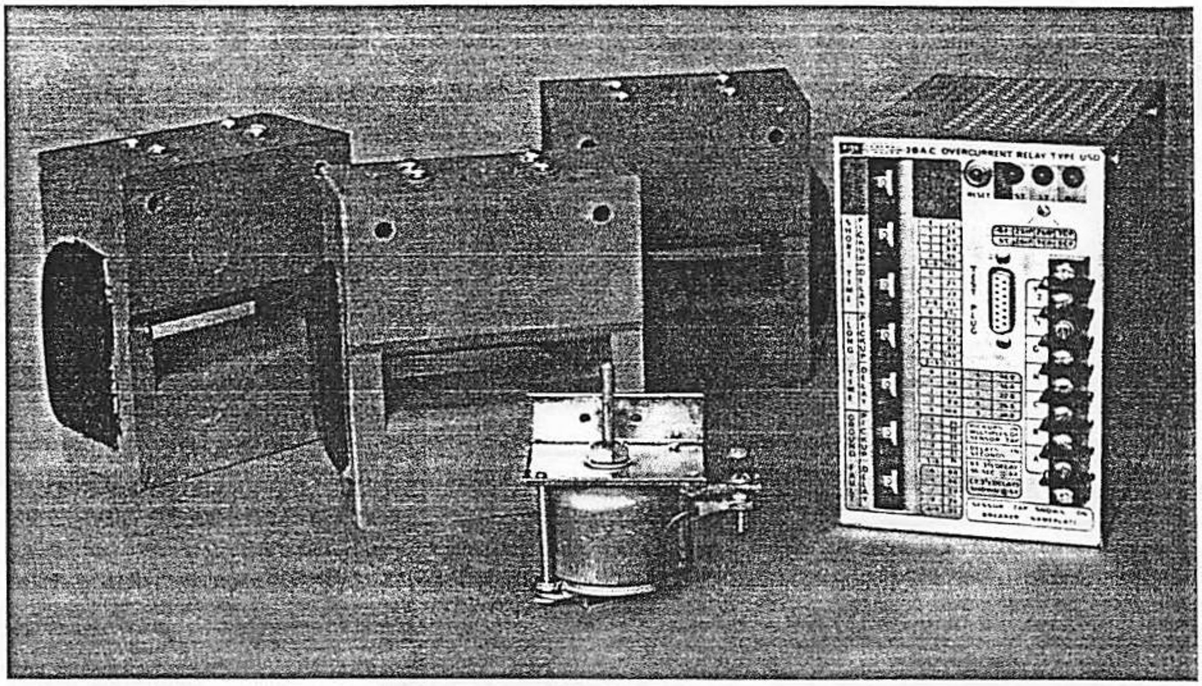
USD SOLID STATE OVERCURRENT RELAY

AVAILABLE FEATURES	BENEFIT
Long time, short time instantaneous and ground fault protective functions	Selective co-ordination for maximum service continuity
Pick up elements work independently	Relay reliability
ZSIP® on short time and ground fault	Selectivity with minimum system damage
Thumbwheel programming switches with positive detents and gold plated contacts. Factory calibrated discrete values for pick up and time delay.	Precision setting of protection function, without in service "drift".
Colour keyed faceplate	Ease of setting relay
Local and remote indication	Rapid fault location



USD Relay – A standard feature of H-3, HL-3 breakers

Type H-3 and HL-3 breakers are supplied with the Federal Pioneer Type USD Solid State Overcurrent Relay, as a standard feature. The USD relay protects low voltage power systems against damage caused by short circuits, overloads and ground faults. The relay may have up to four pick up elements: instantaneous, short-time, long time and ground fault, each working independently of the others for increased reliability. Local and remote indication are available. In addition ZSIP® (ZONE SELECTIVE INSTANTANEOUS PROTECTION) is available for the short-time and ground fault elements.



Carefully matched components of the USD trip system

USD SOLID STATE OVERCURRENT RELAY

The Type USD Relay is mounted low on the front of the breaker frame, away from the arc-chutes.

Tripping energy for the operation of the circuit breaker is obtained solely from the circuit being protected. Other power sources are only required for fault indication (if specified).

The USD relay complies with ANSI Standard C37.17 "Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers".

Three multiple-tap current sensors, mounted on the breaker provide power input to the USD relay from the protected circuit and current signals to the fault detection logic circuit. A fourth sensor, can also be ordered where four-wire ground fault protection is required. Sensors utilize high quality grain-oriented silicon steel alloy cores, and are encapsulated in POLESTIGLASS to provide moisture protection and mechanical strength. Sensor tap setting is shown on the breaker faceplate by an adjustable rotatable disc.

Solenoid Trip Device — A dedicated direct acting solenoid provides positive activation of the trip latch on the breaker, and positive resetting after operation, completes the trip system.

Pick up levels and time delay settings are factory programmed and calibrated in discrete settings for repetitive accuracy and precision. Gold plated contacts on the thumbwheel switches used for selecting settings, assure long lasting, positive electrical performance.

ZSIP®

Selectivity between main and feeder breakers is conventionally obtained by using time co-ordinated trip devices, with the device furthest downstream set for minimum time delay. The disadvantages of this method is that fault levels increase in zones closer to the main breaker and the time to clear these faults increases. The power system must withstand these high fault current levels until the time delay on the first device upstream of the fault expires.

With ZSIP® the trip device that senses a fault in its zone of protection trips instantaneously, minimizing system damage.

The USD relay also sends a restraint signal to all upstream devices and causes them to operate according to their time co-ordinated protection mode, increasing service continuity.

ZSIP® is available on the short time and ground fault elements of the USD relay.

LOCAL AND REMOTE INDICATION

Local indication is by long-life LED's on the relay faceplate while remote indication is facilitated through a set of dry contacts which can be connected to remote annunciating or alarm devices. 120 volt a.c. 2.5VA control power is required.

USD RELAY MODELS

CHARACTERISTICS		USD-3	USD-3IR	USD-6-*	USD6-IR-*
ELEMENTS	LONG TIME	•	•	•	•
	SHORT TIME WITHOUT ZSIP®	•	•		
	SHORT TIME WITH ZSIP®			•	•
	INSTANTANEOUS	•	•	•	•
	GROUND FAULT WITH ZSIP®			•	•
LOCAL AND REMOTE INDICATION			•		•

*Add the following suffixes:

6 for use with CUD 1.5 and CSD-6 sensors

8 for use with CSD-8 sensors

16 for use with CSD-16 sensors

20 for use with CSD-20 sensor

32 for use with CUD-30 and CUD-32 sensor

40 for use with CUD-40 andCUD-60 sensors

TECHNICAL DATA SUMMARY

TYPE H-3 BREAKER DATA

BREAKER TYPE		30H-3	42H-3	50H-3	65H-3	50H-3	75H-3	100H-3	100H-2
MINIMUM ENCLOSURE WIDTH (INCH)		25	25	25	25	32	32	32	32
VOLTAGE (VOLTS)	Voltage Ratings	600	600	600	600	600	600	600	600
	Rated Maximum Voltage	635	635	635	635	635	635	635	635
	1 minute withstand	2200	2200	2200	2200	2200	2200	2200	2200
CURRENT (AMPERES)	CONTINUOUS CURRENT	600/800	600/800	1600/2000	1600/2000	3000/3200	3000/3200	4000	6000
	INTERRUPTING CURRENT (RMS SYMMETRICAL) (1)								
	WITH INSTANTANEOUS TRIP								
	254 V	42,000	50,000	65,000	65,000	65,000	85,000	130,000	130,000
	508 V	30,000	42,000	50,000	65,000	50,000	85,000	85,000	85,000
	635 V	30,000	42,000	50,000	65,000	50,000	65,000	85,000	85,000
	WITH SHORT TIME DELAY (2)								
	254 V	30,000	42,000	50,000	65,000	50,000	65,000	85,000	85,000
	508 V	30,000	42,000	50,000	65,000	50,000	65,000	85,000	85,000
	635 V	30,000	42,000	50,000	65,000	50,000	65,000	85,000	85,000
	MAKING CURRENT (Peak amperes)	69,000	96,600	115,000	149,500	115,000	149,500	195,500	195,500
OPERATING TIMES (SECONDS)	-Closing (Contact Touch)	.025	.025	.025	.030	.030	.030	.030	.030
	-Closing (Breaker Latched)	.030	.030	.030	.035	.035	.035	.035	.035
	-Contact Parting	.004	.004	.004	.005	.005	.005	.005	.005
	-Arcing (Max.) (3)	.0085	.0085	.0085	.0085	.0085	.0085	.0085	.0085
	-Total Clearing incl. USD relay operation time	.034	.034	.034	.034	.034	.034	.034	.034
	-Reclosing Time (No Intentional Time Delay) (4)	.176	.176	.176	.176	.176	.176	.176	.176
	-Motor charging time	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
TEMPERATURE RISE ON TERMINALS (40°C AMBIENT)		— less than 55°C —							

(1) INTERRUPTING DUTY CYCLE consists of an opening operation, a 15 second interval, followed by a close-open operation, per ANSI Std. C37.50.
(2) SHORT-TIME DUTY CYCLE consists of 2 — 30 cycle intervals with a 15 second period of zero current between the two periods, per ANSI Std. C37.50.
(3) Maximum Arcing Time in critical current range (Range 175-400A) is .035 seconds.
(4) Operating factor for reclosing duty is 100%.

TYPE HL-3 BREAKER DATA*

BREAKER TYPE	FRAME SIZE AMPS	INTERRUPTING RATING BREAKER C/W FUSE KA SYM.	INTERRUPTING RATING BREAKER ONLY KA SYM.			MAXIMUM FUSE SIZE AMPS
			240V	480V	600V	
30HL-3	600	200	42	30	30	800 NEMA L
30HL-3	800	200	42	30	30	1200 NEMA L
50HL-3	1600	200	65	50	50	2000 NEMA L
50HL-3	2000	200	65	50	50	3000 NEMA L
75HL-3	3000	200	85	85	65	4000 NEMA L
100HL-3	4000	200	130	85	85	6000 NEMA L

*All data for HL-3 is same as corresponding size H-3 air circuit breaker, except for increased interrupting capacity.

SPRING CHARGING MOTOR DATA

NOMINAL VOLTAGE	48 VOLTS DC	125 VOLTS DC	250 VOLTS DC	120 VOLTS AC	240 VOLTS AC
CURRENT REQUIRED (INTERMITTENT)	7 amperes	4 amperes	2.5 amperes	4 amperes	2.5 amperes
MOTOR CHARGING TIME	4.0 sec.	4.0 sec.	4.0 sec.	4.0 sec.	4.0 sec.

AUXILIARY SWITCH CONTACT RATINGS
10 amperes up to 254V a.c.
1 ampere at 250V d.c.
2 amperes at 125V d.c.

SECONDARY CONTROL CONTACT RATING
30 amperes

CELL SWITCH CONTACT RATING
10 amperes up to 300V a.c.

TECHNICAL DATA SUMMARY

COIL RATING DATA

	RATED CONTROL VOLTAGE	MINIMUM OPERATING VOLTAGE	D.C. OHMS	AMPERES INRUSH	AMPERES SEALED
SHUNT	120 AC	75	30.0	2.45	0.34
TRIP	240 AC	150	312.0	1.5	0.15
TYPE A	48 DC	40	6.0	8.0	0.2
	125 DC	40	50.0	2.2	0.2
	250 DC	70	312.0	0.8	0.1
SHUNT	120 AC	60	13.0	1.4	
TRIP	240 AC	120	50.0	1.0	MOMENTARY
TYPE B	48 DC	40	13.0	2.0	RATED
	125 DC	40	86.0	2.5	ONLY
	250 DC	70	215.0	1.25	
SHUNT	120 AC	90	30.0	2.45	0.34
CLOSE	240 AC	180	312.0	1.5	0.15
	48 DC	40	6.0	8.0	0.2
	125 DC	60	50.0	2.2	0.2
	250 DC	150	312.0	0.8	0.1
UNDERVOLTAGE	120 AC	96	23.0	2.45	0.34
TRIP	240 AC	190	312.0	0.8	0.1
ANTI-SINGLE	240 AC	90	13.0	2.8	MOMENTARY
PHASE	480 AC	120	50.0	1.8	RATED
DEVICE	600 AC	120	50.0	2.3	ONLY

NOTES:
Type A shunt trip is continuously rated and is used only when a continuous rated coil for a separate trip source is required.

Type B shunt trip is momentary rated. It is used as the dedicated solenoid for the USD relay or earlier SD relay and/or when only a separate trip coil is required.

USD RELAY SETTINGS

ELEMENT	PICK UP LEVELS IN MULTIPLES OF SENSOR TAP	DELAY IN SECONDS
INSTANTANEOUS	4X, 5X, 6X, 8X, 10X, 12X, OFF (1)	NO INTENTIONAL TIME DELAY
SHORT TIME	2X, 3X, 4X, 6X, 8X, 10X	.11, .25, .33, .45, I^2t (2), .05 in ZSIP® mode regardless of short time delay setting.
LONG TIME	.6X, .7X, .8X, .9X, 1.0X, 1.1X	2.0, 4.0, 6.0, 8.0, 10.0, 14,0, 16.0, 22.0, 26.0, 30.0 (3)
GROUND FAULT Catalogue Numbers:		
USD-6 (IR) -6	.25, .50, .75, 1.0, 1.5, 2.0	.08, .14, .20, .26, .32,
USD-6 (IR) -8	.25, .50, .75, 1.0, 1.25, 1.5	.02 in ZSIP® mode
USD-6 (IR) -16	.20, .30, .40, .50, .60, .70	regardless of ground
USD-6 (IR) -20	.20, .25, .30, .40, .50, .60	fault time delay setting.
USD-6 (IR) -32	.20, .22, .24, .28, .32, .36	
USD-6 (IR) -40	.20, .22, .24, .26, .28, .30	

TEMPERATURE RANGE: The USD relay is ambient temperature compensated over the range -20°C to +55°C. Tolerances apply over this range. Operation outside this range is possible. Consult Federal Pioneer.

(1) DISCRIMINATOR: When the instantaneous pick-up switch is in the "OFF" position, the instantaneous element will not pick up unless the breaker closes on a fault that exceeds 13X the sensor tap setting, in which case a discriminator will initiate tripping. In addition a trip will be initiated if a fault of 13X the sensor tap setting, or greater occurs while the breaker is supplying a load of less than 0.04X the sensor tap setting. If the breaker closes and the current is greater than 0.04X, but less than 13X the sensor tap setting, the discriminator monitors the current for 40ms. and if the fault level of 13X is not exceeded during this time, the discriminator switches itself off.

(2) SHORT TIME Time Delay .55 sec. @ 6X

(3) LONG TIME Time Delays shown @ 6X

TOLERANCES: ± 8% on pick up values
± 10% on time delay values

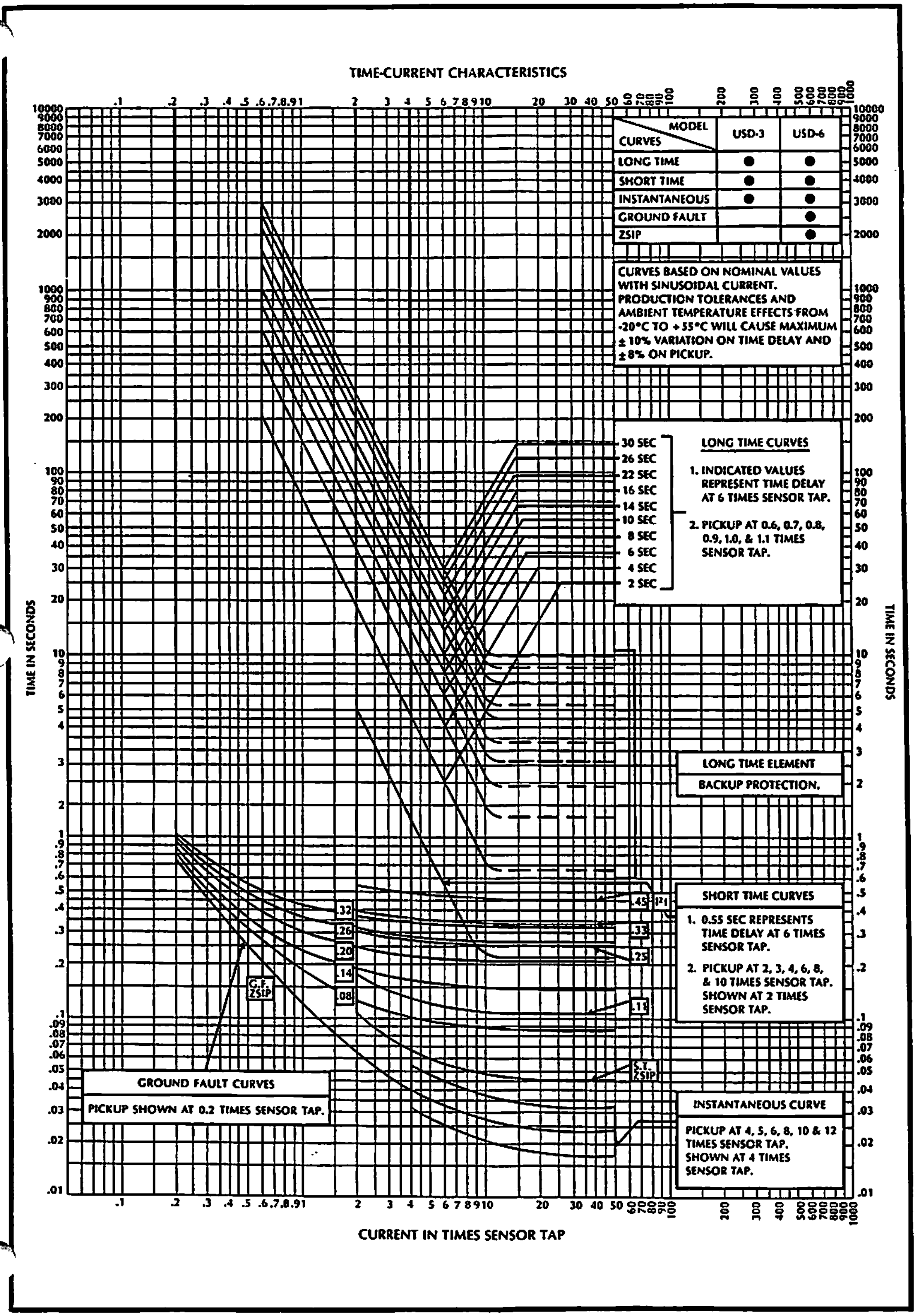
RELAY RESET TIME: 30ms

TECHNICAL DATA SUMMARY

CURRENT SENSOR SIZES AND AMPERE TAPS

SENSOR TYPE	TAPS AVAILABLE IN PRIMARY TAPS	BREAKER	FRAME
CUD-1.5	100, 150	600A	30H-3, 42H-3
		800A	30H-3, 42H-3
		1600A	50H-3, 65H-3
		2000A	50H-3, 65H-3
CSD-6	250, 400, 600	600A	30H-3, 42H-3
		800A	30H-3, 42H-3
		1600A	50H-3, 65H-3
		2000A	50H-3, 65H-3
CSD-8	400, 600, 800	800A	30H-3, 42H-3
		1600A	50H-3, 65H-3
		2000A	50H-3, 65H-3
CSD-16	1000, 1200, 1600	1600A	50H-3, 65H-3
		2000A	50H-3, 65H-3

SENSOR TYPE	TAPS AVAILABLE IN PRIMARY TAPS	BREAKER	FRAME
CSD-20	800, 1200, 2000	2000A	50H-3, 65H-3
CUD-30	1200, 2000, 3000	3000A	50H-3
		3000A	75H-3
		3200A	50H-3
		3200A	75H-3
		4000A	100H-3
		6000A	100H-2
CUD-32	1600, 2000, 3200	3200A	50H-3
		3200A	75H-3
		4000A	100H-3
		6000A	100H-2
CUD-40	1600, 3000, 4000	4000A	100H-3
		6000A	100H-2
CUD-60	5000, 6000	6000A	100H-2


TIME-CURRENT CHARACTERISTICS
MODEL
CURVES
USD-3
USD-6
LONG TIME
SHORT TIME
INSTANTANEOUS
GROUND FAULT
ZSIP
CURVES BASED ON NOMINAL VALUES WITH SINUSOIDAL CURRENT. PRODUCTION TOLERANCES AND AMBIENT TEMPERATURE EFFECTS FROM -20°C TO +55°C WILL CAUSE MAXIMUM ± 10% VARIATION ON TIME DELAY AND ± 8% ON PICKUP.
30 SEC
26 SEC
22 SEC
16 SEC
14 SEC
10 SEC
8 SEC
6 SEC
4 SEC
2 SEC
LONG TIME CURVES
1. INDICATED VALUES REPRESENT TIME DELAY AT 6 TIMES SENSOR TAP.
2. PICKUP AT 0.6, 0.7, 0.8, 0.9, 1.0, & 1.1 TIMES SENSOR TAP.
LONG TIME ELEMENT
BACKUP PROTECTION.
SHORT TIME CURVES
1. 0.55 SEC REPRESENTS TIME DELAY AT 6 TIMES SENSOR TAP.
2. PICKUP AT 2, 3, 4, 6, 8, & 10 TIMES SENSOR TAP. SHOWN AT 2 TIMES SENSOR TAP.
.32
.26
.20
.14
.08
.45
.33
.25
.11
S.T. ZSIP
G.F. ZSIP
GROUND FAULT CURVES
PICKUP SHOWN AT 0.2 TIMES SENSOR TAP.
INSTANTANEOUS CURVE
PICKUP AT 4, 5, 6, 8, 10 & 12 TIMES SENSOR TAP. SHOWN AT 4 TIMES SENSOR TAP.
TIME IN SECONDS
CURRENT IN TIMES SENSOR TAP

TYPICAL SPECIFICATION

Low voltage power air circuit breakers shall be 3 pole 600 volt class with continuous current ratings and trip ratings as detailed on the plans. Interrupting ratings will be in accordance with NEMA Standards for the frame and/or their application in a fully rated system. Breakers shall have double break main contacts, a 3 phase solid state overload relay and shall be trip free in operation. A compression spring stored energy closing mechanism (either manually or electrically charged) shall be used for all ratings, with breakers being closed by means of a push button and shall have the ability to close and latch at interrupting rating at 600 volts. An emergency manual spring charging handle shall be supplied for electrically operated breakers.

Breaker faceplate shall have "closed-open" indicator, spring "charged-discharged" indicator, provision to padlock manual charging handle, provision to lock breaker in "open" position, and provision to lock drawout mechanism. Drawout circuit breakers shall be suitable for 3 position (connected, test, disconnected) racking with enclosure door closed, and shall be equipped with an interlock to ensure breaker contacts are open and closing spring is discharged when racking tool is inserted. Faceplate mounted control buttons, indicators interlocks etc. shall be accessible without opening enclosure door. Electrically operated breakers must have provision for emergency manual closing by inserting a special tool through the faceplate. A control isolating switch shall be provided on the faceplate to isolate the supply to the spring charging motor.

Relay pickup and time delay settings shall be selected in discrete factory calibrated values by means of detent action thumbwheel actuated switches with gold-plated contacts. When a solidly-grounded system is used, the relay shall be equipped with Zone Selective Intantaneous Protection feature on short time and ground fault elements. A direct acting dedicated solenoid shall be used for initiating breaker triping.

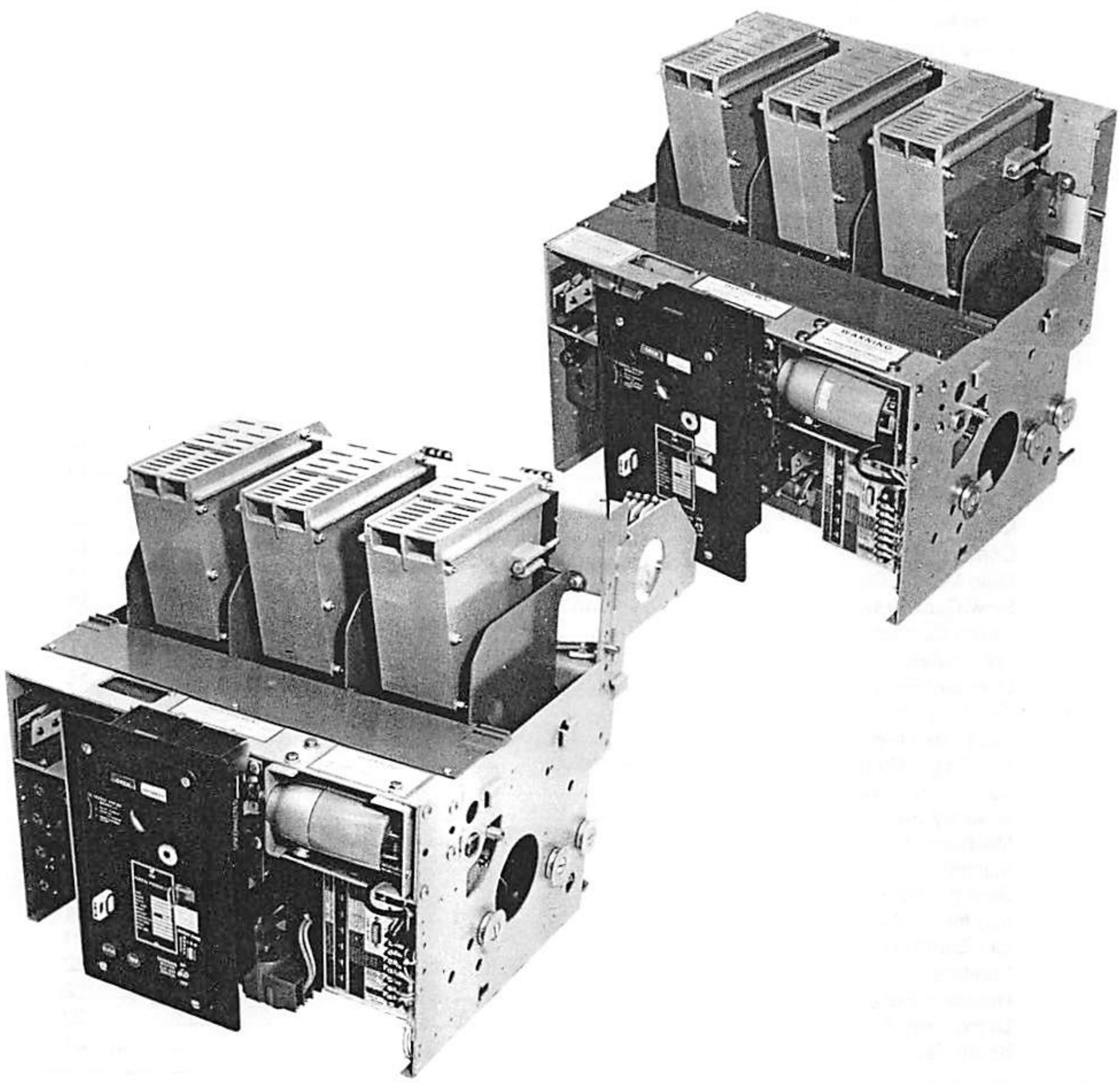
Breakers shall be Federal Pioneer Limited Type H-3 or HL-3.

FEDERAL PIONEER

C-3-222-1
FEBRUARY 1984

INSTRUCTIONS
FOR THE CARE AND MAINTENANCE OF

H-3 AND HL-3 CIRCUIT BREAKERS



This manual applies to H-3 and HL-3 breakers.

For H-2 and HL-2 breakers, consult the following instruction manuals:

For breakers with serial numbers BH consult Instruction Manual C-3-221-1 dated September 1979.

For breakers with serial numbers TH consult Instruction Manual C-3-221-1 dated March 1976.

For breakers with serial numbers T consult Instruction Manual C-3-414 dated August 1966.

CONTENTS

Before placing in service read this Instruction Manual completely and perform the pre-service inspection (see page 4).

GENERAL

Type H-3 and HL-3 power Air Circuit Breakers are suitable for controlling and protecting low voltage power circuits up to 250 volts dc and 600 volts ac. They are a means of safely switching loads and automatically clearing circuits when abnormal conditions occur such as undervoltage, sustained overloads, and short circuits.

The proper INSTALLATION, MAINTENANCE and OPERATION of these breakers is a prime safety consideration for the protection of personnel and equipment. Reference to this manual and adherence to its recommendations will enhance the performance of these breakers under all conditions.

This manual does not purport to cover all details or variations of equipment nor to provide for every possible contingency to be met in connection with receiving, storage, installation, maintenance or operation. Should further information be required or particular problems arise which are not covered sufficiently, please refer to Federal Pioneer Limited.

BASIC BREAKER TYPES

Type H-3 breakers are available mounted in a drawout cradle with disconnecting primary power and secondary control contacts. Alternatively a stationary fixed mounting in a suitable enclosure can be provided.

These breakers are provided with either a manually operated handle or an electric motor for compressing the closing spring.

HL-3 type breakers are available in the drawout version only, either manually or electrically operated. HL-3 type breakers are similar to the H-3 type but in addition have high rupturing capacity fuses mounted on the line side on a frame extension at the rear of the unit.

BREAKER DESCRIPTION

The three main functional components of a breaker are its mechanism, the conductive members and the interrupting devices.

The mechanism unit is designed to receive energy, store it, and deliver it to close the breaker contacts when required. Upon activation of the trip device, the mechanism must allow the contacts to open regardless of the state of the mechanism, that is the breaker mechanism is "TRIP FREE".

The conductive members are assembled on a moulded base of fiberglass reinforced polyester. Individual pole pieces carefully interlocked together and supported by a steel frame provide the mechanical support and insulating structure required. The conductive members comprise the main power contacts (drawout mounting) or lugs (fixed mounting), the main fixed contacts and the main moving bridge contacts.

The interrupting devices are the fixed and moving arcing contacts and the arc chutes.

In addition to these main functional components the breaker is available with overload protection and other accessories and interlocking devices.

RECEIVING, HANDLING AND STORAGE

Receiving

Immediately upon receipt of the breaker an examination should be made for damage sustained in transit. If damage has occurred or there is evidence of rough handling a claim should be filed immediately with the transportation company and Federal Pioneer Limited should be notified. Check all parts against the packing list to make sure all the correct items have been received.

Handling and Storage

Lift the breaker by the steel channels at the front and back. Do not lift by the connecting terminals, arc chutes, or operating handle. Check the unit thoroughly to see that no parts were damaged or forced out of alignment during shipment. If replacement parts are required, the manufacturer should be notified promptly. The breaker should be installed in a clean dry ventilated area, which is free from atmospheric contaminants.

Each circuit breaker should be stored in its shipping crate in an upright position in a clean dry area. Should the unit get wet, it must be thoroughly dried out using forced warm air over an extended period until "infinite" readings are obtained using a 600 volt megger.

BREAKER OPERATION

DRAWOUT MOUNTED BREAKERS

Switchgear assemblies for drawout mounted breakers are provided with supporting rails, main power contacts and secondary contacts to mate with those on the breakers when it is racked into position.

Drawout Racking Mechanism

An interlock is provided which will ensure that the unit is open and the main spring is discharged when it is either engaging or disengaging the main disconnecting contacts. A block is provided on the racking mechanism which operates in conjunction with the gate interlock lever over the racking opening. Before withdrawing electrically operated breakers turn off the motor isolating switch on the faceplate. To withdraw the unit, move the gate over the crank opening down so as to expose the socket end of the drawout racking shaft. This action will first open the unit if it is closed and then discharge the main spring if it is charged. The racking handle may now be inserted in the racking shaft socket and by counter-clockwise rotation the unit will move outward.

At the "test" position the main contacts are withdrawn but the auxiliary contacts remain engaged in the test position.

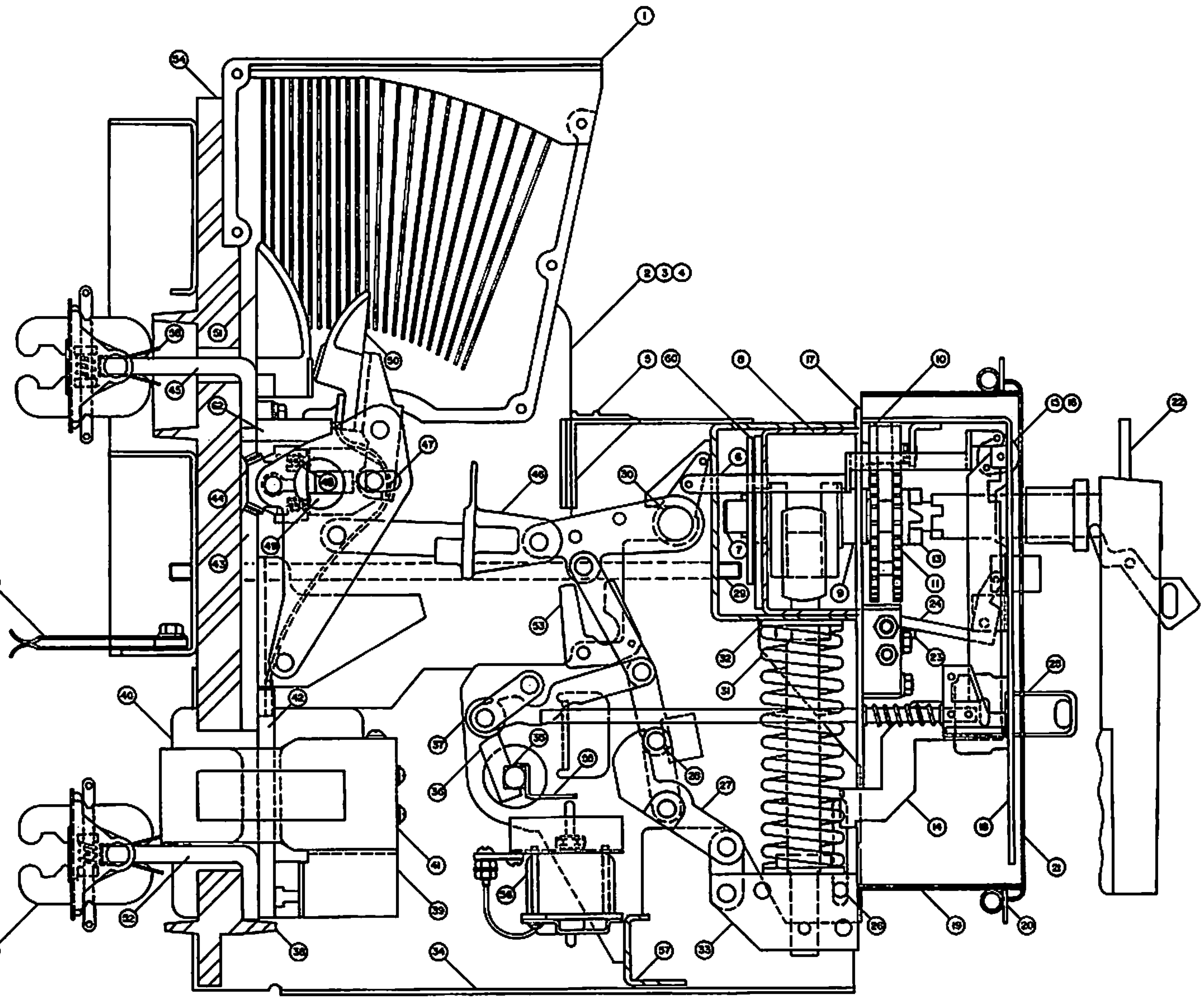
Further turns of the racking handle will move the unit to the "disconnected" position. It is then free to be pulled manually forward to the end of the tracks. Two lifting lugs are provided on each side of the unit so that it can be lifted clear of the tracks. Lifting yokes are available from the manufacturer. (Fig. 32).

Grounding continuity is established 1/8 inch (3.2 mm) before the secondary control contacts are energized. It is maintained throughout breaker positioning in the enclosure until the secondary control contacts have been de-energized by 1/8 inch (3.2 mm). Grounding continuity is established when the moving ground contact on the breaker mates with the stationary ground contact located on the frame of the breaker enclosure.

PART NUMBERS AIR CIRCUIT BREAKERS (DRAWOUT)

FIGURE 1 SECTION OF H-3 BREAKER	Type 30H-3 600 and 800 Amp	Type 50H-3 1600 Amp	Type 50H-3 2000 Amp	Type 50 and 75H-3 3000 and 3200 Amp	Type 100H-3 4000 Amp
1. Arc Chute Assembly	41A-504D	41A-504D	41A-504D	41A-504D	41A-504D
2. Interphase Barrier	13A-574C	13A-574C	13A-574C	13A-578C	13A-578C
3. R. H. End Barrier	13A-575C	13A-575C	13A-575C	13A-172A-1	13A-172A-1
4. L. H. End Barrier	13A-576C	13A-576C	13A-576C	13A-172A-1	13A-172A-1
5. Front Flash Shield	182A-542B	182A-542B	182A-542B	182A-40A-1 (-41A-1)	182A-40A-1 (-41A-1)
6. Closed-Open Link	170A-585	170A-585	170A-585	170A-585	170A-585
7. Crank Assembly	54C-507	54C-507	54C-507	54C-507	54C-507
8. Crank Box	24A-15A-2	24A-15A-2	24A-15A-2	24A-15A-2	24A-15A-2
9. Crank Box Bearings	29B-514	29B-514	29B-514	29B-514	29B-514
10. Holding Pawl	210A-505	210A-505	210A-505	210A-505	210A-505
11. Ratchet Wheel	35A-508	35A-508	35A-508	35A-508	35A-508
12. Oscillating Lever	168B-592	168B-592	168B-592	168B-592	168B-592
13. Clutch	45A-8	45A-8	45A-8	45A-8	45A-8
14. Charged-Discharged Link	168B-580	168B-580	168B-580	168B-580	168B-580
15. Closed-Open Button	182A-567B	182A-567B	182A-567B	182A-567B	182A-567B
16. Charged-Discharged Button	182A-568B	182A-568B	182A-568B	182A-568B	182A-568B
17. Front Plate	53M-65A-3	53M-65A-3	53M-65A-3	53M-65A-3	53M-65A-3
18. Indicator Plate	53M-64A-3	53M-64A-3	53M-64A-3	53M-64A-3	53M-64A-3
19. Faceplate Box Assembly	24A-8	24A-8	24A-8	24A-8	24A-8
20. Floating Trim	267A-1	267A-1	267A-1	267A-1	267A-1
21. Faceplate Assembly	84A-10C-2	84A-10C-2	84A-10C-2	84A-10C-2	84A-10C-2
22. Handle Assembly	115G-500	115G-500	115G-501	115G-501	115G-501
23. Close Lever	168B-39A-3	168B-39A-3	168B-39A-3	168B-39A-3	168B-39A-3
24. Close Latch	35A-509	35A-509	35A-509	35A-509	35A-509
25. Trip Rod Assembly	224B-124A-1	224B-124A-1	224B-124A-1	224B-124A-1	224B-124A-1
26. Spring Guide Pin	201B-88	201B-88	201B-88	201B-88	201B-88
27. Closing Casting	168A-3	168A-3	168A-3	168A-3	168A-3
28. Closing Pin	201B-72	201B-72	201B-72	201B-72	201B-72
29. Tie Rod Assembly	235D-17	235D-17	235D-17	235D-17	235D-17
30. Closing Shaft	170A-590	170A-590	170A-590	170A-593	170A-593
31. Main Spring	242A-510	242A-511	242A-511	242A-512	242A-512
32. Guide Bushings	29B-512	29B-512	29B-512	29B-512	29B-512
33. Clamp Assembly	42B-500	42B-500	42B-500	42B-500	42B-500
34. Breaker Frame	81A-566	81A-566	81A-566	81A-567	81A-567
35. Trip Shaft	235B-26	235B-26	235B-26	235B-26	235B-26
36. Trip Latch	168B-96	168B-96	168B-96	168B-96	168B-96
37. Latch Bearing	16A-9	16A-9	16A-9	16A-9	16A-9
38. Lower Moulding	182A-509D	182A-509D	182A-509D	14C-543	14C-543-1
39. Sensor Mounting Bracket	26G-606	26G-606	26G-606	26G-627	26G-627
40. Barrier	182A-24(-25)	182A-24(-25)	182A-24(-25)	182A-24(-25)	182A-24(-25)
41. Sensor	CSD-6(-8)	CSD-16	CSD-20	CUD-30(-32)	CUD-40
42. Jumper	147B-511	147D-503	147D-503	147D-510	147D-510
43. Centre Stationary Main Contact	49E-577	49E-550	49E-550	49E-550	49E-550
44. Main Moving Contact (Wafer Assy)	49E-575	49E-575	49E-575	49E-575	49E-575
45. Upper Stationary Main Contact	49E-554	49E-548	49E-549	49E-548	49E-549
46. Closing Link Assembly	170A-589	170A-589	170A-589	170A-589	170A-589
47. Braid	27A-500	27A-500	27A-500	27A-500	27A-500
48. Wafer Contact Spring	242A-521	242A-520	242A-520	242A-521	242A-521
49. Spring Holder	55B-502	55B-502	55B-502	55B-502	55B-502
50. Moving Arcing Contact	49E-552	49E-552	49E-552	49E-552	49E-552
51. Stationary Arcing Contact	49E-551	49E-551	49E-551	49E-551	49E-551
52. Load Terminal	271A-584	271A-507	271A-506	271A-507	271A-506
53. Anti-Bounce Plate	53L-545	53L-545	53L-545	53L-545	53L-545
54. Base Moulding	182A-548D	182A-548D	182A-548D	182A-548D	182A-548D
55. Trip Flipper	79A-517	79A-517	79A-517	79A-517	79A-517
56. Trip Coil Assembly	240A-514	240A-514	240A-514	240A-514	240A-514
57. Lower Channel	39A-530	39A-530	39A-530	39A-531	39A-531
58. Finger Spacer	26H-78	26H-503		26H-503	
59. Drawout Contact Assembly	49E-130	49E-519	49E-572(-573)	49E-519	49E-574
60. SLS Cam	35A-512	35A-512	35A-512	35A-512	35A-512
61. Ground Stab	49B-274A-1	49B-274A-1	49B-274A-1	49B-274A-1	49B-274A-1
62. Lower Flash Shield	13A-566B	13A-566B	13A-566B	13A-566B	13A-566B
(FIXED) 45. Upper Stationary Main Contact	49E-555	49E-549	49E-549	49E-549	49E-549
52. Load Terminal	271A-583	271A-506	271A-506	271A-506	271A-506

FIGURE 1



SECTION OF H-3 BREAKER

Except for the mounting the following instructions for fixed mounted breakers equally apply to drawout mounted breakers.

FIXED MOUNTED BREAKERS

H-3 and HL-3 circuit breakers should be mounted in sheet steel enclosures in accordance with recommended dimensions. The mounting support should be a rigid structure able to withstand the impact caused by the switching operations, without any distortion and undue vibration of the mechanism.

POWER TERMINAL CONNECTIONS

The H-3 and HL-3 terminals are silver plated for maximum joint efficiency and cable connectors must be clean and free from dents or burrs, and bolted securely to the terminals. Poor joints lead to over-heating and subsequent contact deterioration, and an eventual failure. Cables or bus connections should be properly supported so as not to transfer any unnecessary mechanical or short circuit stress to the terminals. Any strain which may have no apparent effect initially may after prolonged periods of vibration and shock from normal operation, cause poor contact alignment.

Meter shunts, resistors, and similar devices which operate at relatively high temperature should be mounted away from the circuit breaker so they do not contribute to the heating of the unit.

SECONDARY CONTROL CIRCUITS

Control circuit wiring, where applicable, should be made in strict accordance with detailed wiring diagrams. Wiring connections, which are made to terminal blocks should be run in a supported and protected manner, so control wiring cannot come into contact with the primary connections.

PRE-SERVICE INSPECTION

Read this instruction manual completely and inspect and check the unit in accordance with this manual.

The following items should be specifically checked.

1. Make a visual inspection after installation to ensure that no parts have been damaged or forced out of alignment.

2. Check the door interlock lever for freedom of movement, when supplied. (Fig. 27).

3. Check the main and drawout contacts to see that they are clean and free from foreign material.

4. Check all the control wiring to ensure that it has not been damaged or moved during the installation.

5. Check the single phase protection (when supplied) by manually raising each tripping plunger in turn on the three tripping coils, Fig. 24. If the unit is closed, it should trip and the correct indicator should show on the faceplate. (Fig. 2).

6. Close and open the unit several times to ensure correct operation. Interlocks should be defeated or be in normal release position. If an undervoltage trip unit is attached hold it down manually so the spring closing mechanism will pick up the contacts, and thus avoid discharging the mechanism without its normal contact spring load.

7. Manually activate the tripping devices to establish that they are operable. These devices include manual trip Fig. 2, spring discharge lever Fig. 9, shunt trip Fig. 11 and 12, and undervoltage trip Fig. 13.

8. Check all cable connections to ensure that they are tight.

9. The electrical operation of drawout breakers should be checked in the "test" position.

Manual Closing

The closing mechanism compresses a main spring which is held compressed until released. The handle is rotated counter-clockwise to the vertical position and pushed in to engage the clutch. Rotating the handle 180° clockwise fully charges the spring and as the internal crank passes through top-dead-centre, rotation is stopped, and held by the close release latch. Operation of this latch by means of the close push button Fig. 2 in the faceplate releases the spring energy to close the breaker. A multi-tooth ratchet wheel prevents recoil and permits the spring charging to be performed in several short strokes if desired. On frame sizes 1600 amperes and above, the handle is a pull-out extension type for ease of operation.

Electrical Closing

On all electrically operated units the motor charges the spring unit the close release latch engages. The close latch is operated by a solenoid energized from the push button in the faceplate, Fig. 2 or by a remote button. The closing stroke then follows in a similar manner to that of the manual type described above. A removable handle is provided to permit manual charging of the spring. A mechanical close button similar to that on the manually operated unit is not included. Emergency operation of the close release latch is accomplished by insertion of a pin through a small aperture in the faceplate, Fig. 2. A suitable pin is provided in the upper end of the manual charging handle.

BREAKER MAINTENANCE

The safe and successful operation of connected apparatus depends upon the proper operation of the circuit breaker. Therefore, it must have regular, systematic care and inspection. The following points require special attention.

1. Before inspecting or repairing the H-3 or HL-3 be sure it is disconnected from any electric power, either high voltage or control voltage. Also check that the main spring is discharged. If the breaker is electrically operated, turn the motor isolating switch on the faceplate to the "off" position before tripping the unit to prevent the motor from recharging the spring. (Fig. 2).

2. Inspect the operating mechanism periodically and keep it clean.

FIGURE 2(A)
FACEPLATE FOR ELECTRICALLY OPERATED

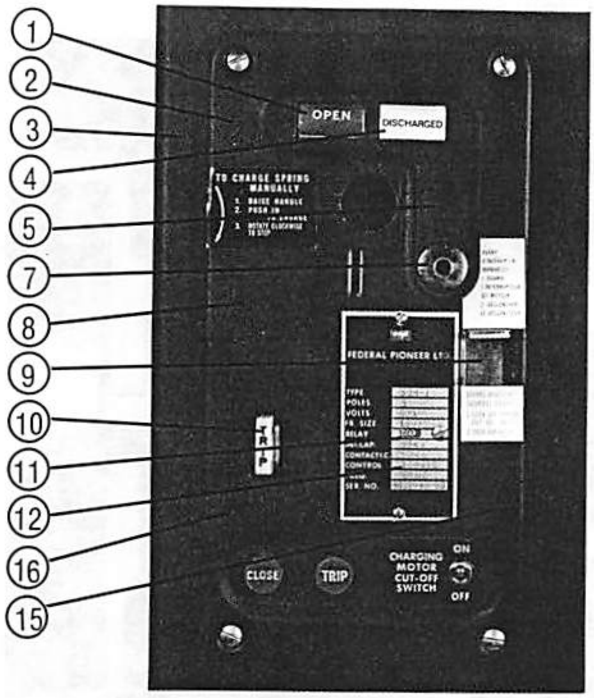
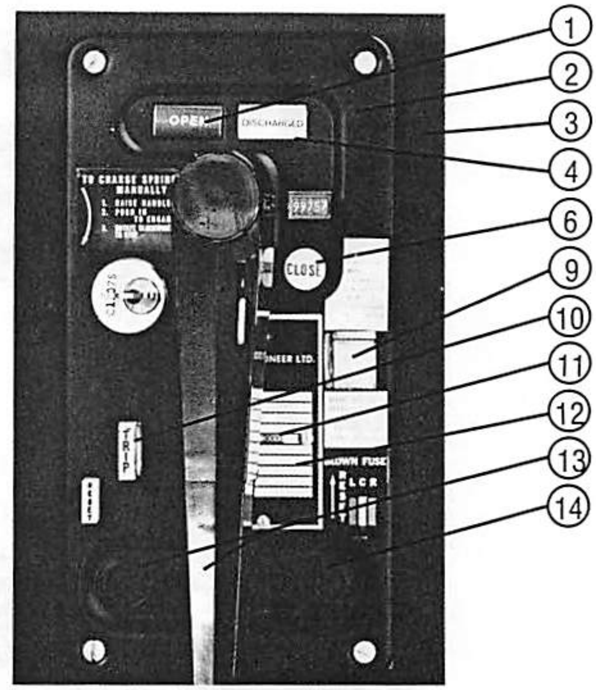


FIGURE 2(B)
FACEPLATE FOR MANUALLY OPERATED



LEGEND

1. Open-Closed Indicator
2. Front Plate
3. Floating Trim
4. Spring Charged-Discharged Indicator
5. Mechanical Operations Counter
6. Emergency Manual Close
7. Close Button
8. Key Interlock
9. Gate for Drawout Crank
10. Manual Trip
11. Sensor Tap Setting Indication
12. Rating Plate
13. Electrical Control Buttons
14. Motor Cut-Off Switch
15. Single Phase Indicator and Reset
16. Overload Lockout Reset

REMOVING THE FACEPLATE (Fig. 2)

First remove the four oval head screws located at the corners of the faceplate and remove the faceplate and trim. The four mounting screws located at the base of the enclosure may now be removed and the enclosure withdrawn. When replacing the faceplate and trim it is important that the bevelled edge of the trim be positioned on the side nearest the enclosure door hinge.

LUBRICATION

H-3 breakers have been tested for mechanical endurance to the prescribed number of operations by ANSI standards without lubrication during the tests. No seizing of the mechanism occurred and the breakers were still operational. In service it is possible to encounter dust, corrosive atmospheres and other adverse conditions which may impair proper operation. Therefore, we consider it prudent to lubricate and clean breakers periodically. ANSI standards recommend lubrication and servicing to be carried out at the following periods.

In frame sizes 600 and 800 amps this interval is 1750 operations, in sizes 1600 and 2000 amps the interval is 500 operations, and in sizes 3000 amps and above, 250 operations. The following points should receive attention:

MANUALLY OPERATED MECHANISM
(Ref. Fig. 3).
OIL-SAE 30

1. All linkage pivots within the mechanism compartment.
2. All closing shaft bearings.
3. Holding pawl pivot (located within the faceplate enclosure-upper left hand corner).
4. Close latch pivot (located below the main ratchet wheel).

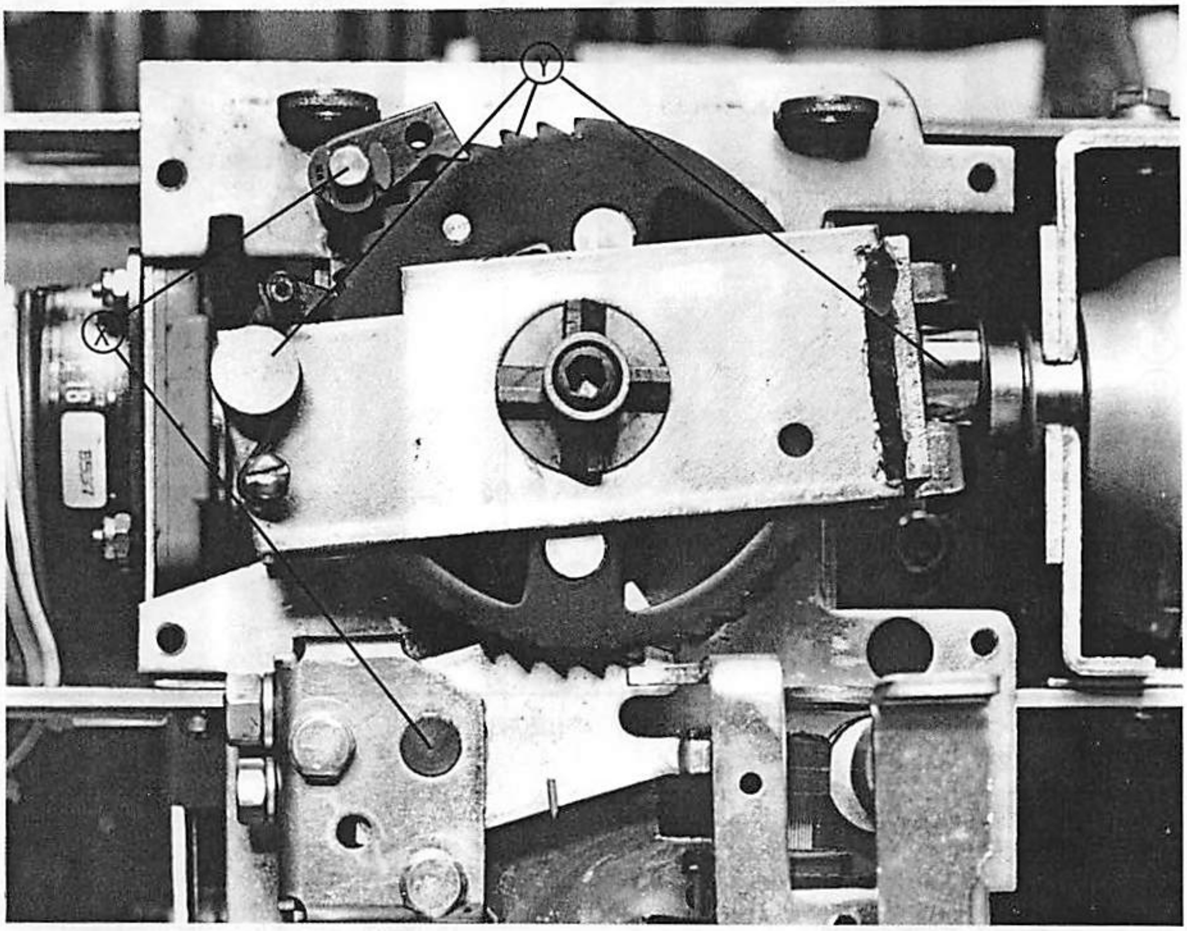
Grease-Lubriplate Lo-Temp.

1. Spring guide pin (located at the lower end of the closing spring).
2. Ratchet wheel teeth.

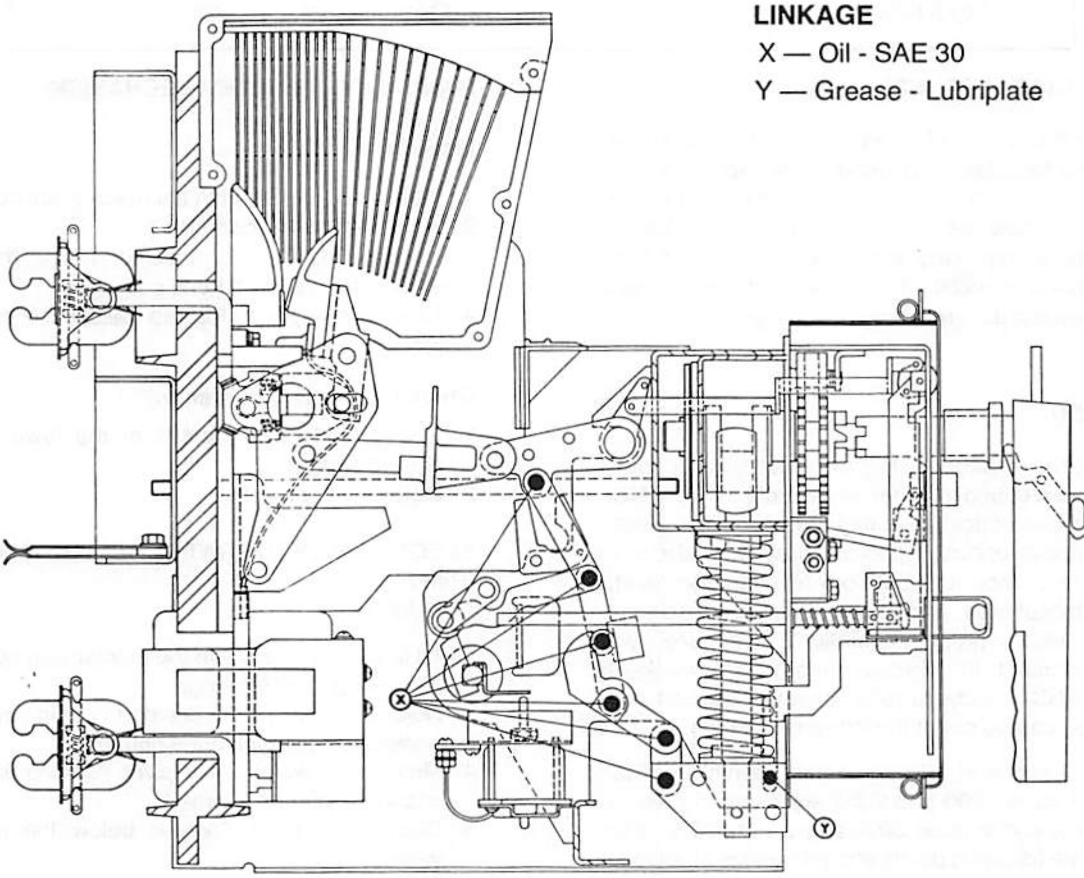
ELECTRICALLY OPERATED MECHANISM
(Ref. Fig. 3).
Oil-SAE 30

1. All linkage pivots within the mechanism compartment.
2. All closing shaft bearings.
3. Holding pawl pivot (located within the faceplate enclosure-upper left hand corner).
4. Motor limit switch lever pivot (located with the front channel - left hand corner).
5. Close latch pivot (located below the main ratchet wheel).

FIGURE 3
ELECTRICALLY OPERATED LUBRICATION

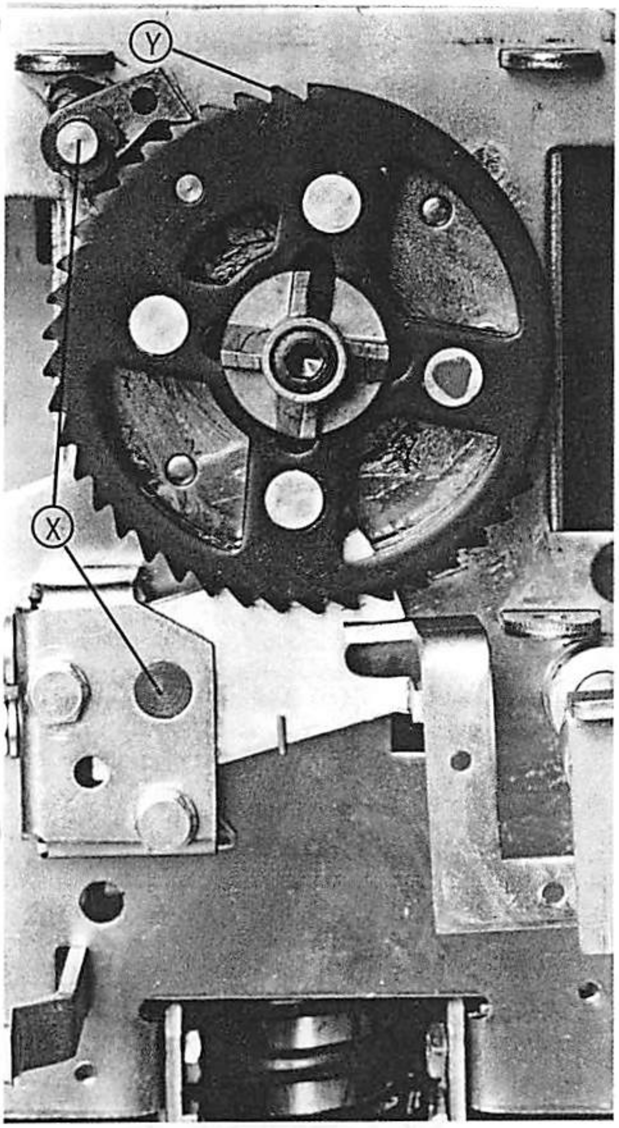


LINKAGE
X — Oil - SAE 30
Y — Grease - Lubriplate



SECTION OF H-3 BREAKER

FIGURE 3
MANUALLY OPERATED
LUBRICATION



LINKAGE

X — Oil - SAE 30

Y — Grease - Lubriplate

Grease-Lubriplate Lo-Temp.

1. Spring guide pin (located at the lower end of the closing spring).
2. Ratchet wheel teeth.
3. Front face of the ratchet wheel.
4. Oscillating lever - right hand end (at the motor drive cam).
5. Driving pawl pivot and springs (located on left hand end of the closing spring.)

CLOSE LATCH ADJUSTMENT (Figs. 6(A) and 6(B))

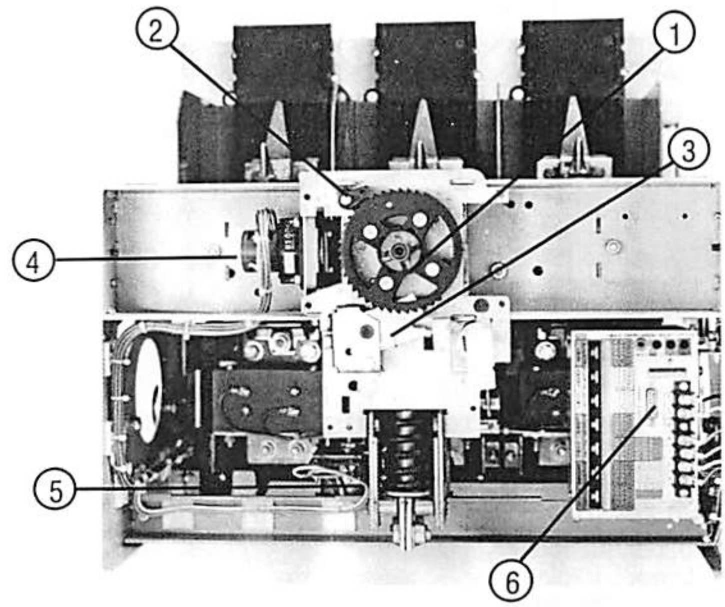
The function of the close latch is to arrest or hold the ratchet wheel at a point 13 degrees past top-dead-centre, with the spring fully charged in readiness to close. The closing stroke is initiated by release of the latch, either manually by means of the mechanical push button in the faceplate or electrically by means of the close solenoid. Insufficient engagement of the latch may allow the closing stroke to occur at completion of the charging of the spring.

Referring to figure 6(A), the adjustment procedure for the upper stopscrew is as follows.

The ratchet wheel assembly (Item 1) is made up of two plates riveted together. The two plates are held apart by spacers located between the plates on the four rivets. Rotate the ratchet wheel until one of the spacers on a rivet is directly above the nose of the close latch (Item 2). Loosen locknut (Item 3). Turning the stopscrew (Item 4) counter-clockwise adjusts the close latch up. Adjust the close latch height until there is approximately $^1/_{32}$ inch (0.8 mm) clearance between the spacer and the nose of the close latch. Tighten the locknut securely.

Referring to figure 6(B), the adjustment procedure for the lower stopscrew is as follows. Be sure that the main spring is discharged and that the main contacts are open. Loosen locknut (Item 5). Manually depress the close latch (Item 2) until it stops on the lower stopscrew (Item 6). Adjust the close latch height until there is approximately $^1/_{32}$ inch (0.8 mm) clearance between the bottom of the teeth on the ratchet wheel and nose of the close latch. Tighten the locknut securely.

FIGURE 4
MANUALLY OPERATED



1. Ratchet Wheel
2. Holding Pawl
3. Close Latch
4. Auxiliary Switch
5. Spring Guide Pin
6. Solid State Overcurrent Relay

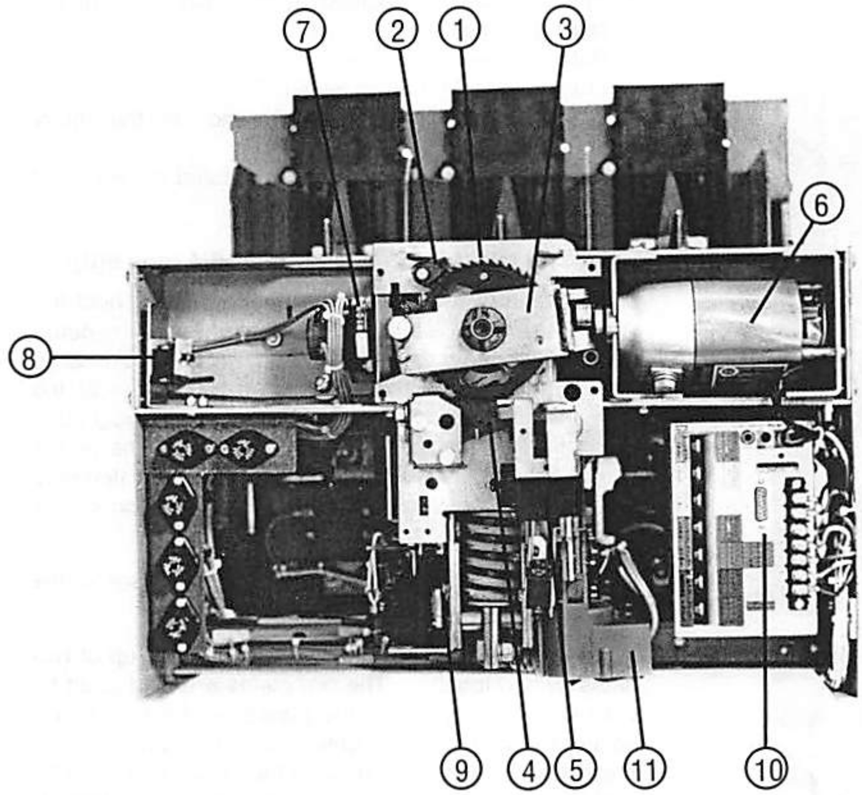


FIGURE 5
ELECTRICALLY OPERATED

1. Ratchet Wheel
2. Holding Pawl
3. Oscillating Lever
4. Close Latch
5. Shunt Close
6. Motor
7. Auxiliary Switch
8. Spring Limit Switch
9. Spring Guide Pin
10. Solid State Overcurrent Relay
11. Anti-Single Phase Device and Blown Fuse Indicator

FIGURE 6(A)

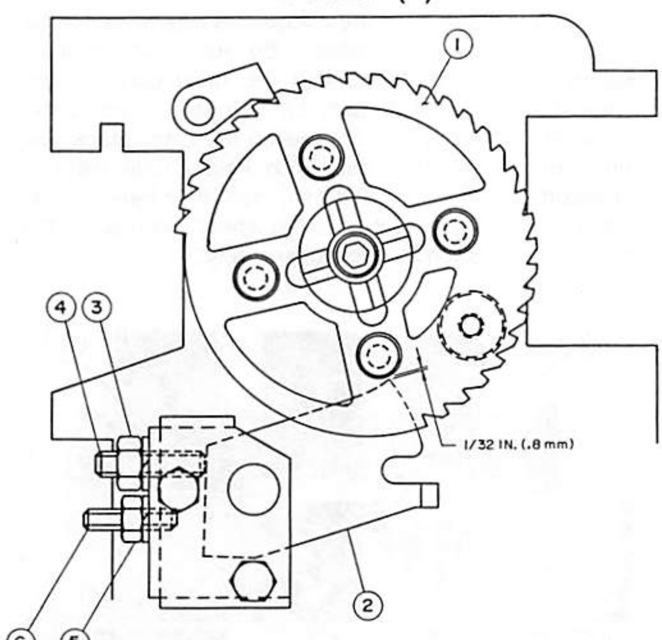
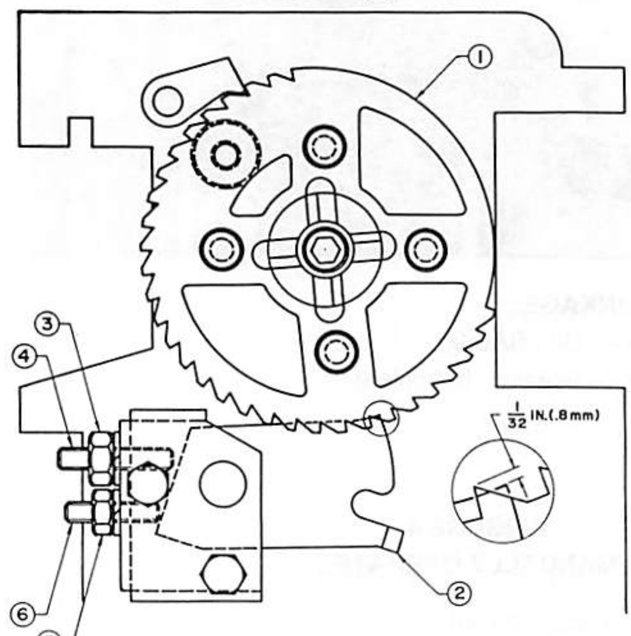


FIGURE 6(B)



CLOSE LATCH ADJUSTMENT

1. Ratchet Wheel
2. Close Latch
3. Upper Locknut
4. Upper Stopscrew
5. Lower Locknut
6. Lower Stopscrew

MECHANISM LATCHING AND TRIP SHAFT ADJUSTMENT

Misadjustment of latching results in failure to close, but it does not prevent the closing spring from being compressed and discharged for closure.

There are 3 possible causes of improper latching:

A) On units equipped with an overload lockout or single phase device, failure to manually reset the device after it has operated, will prevent latching and the discharge of the closing spring will not move the main contacts.

B) Misadjustment of the main linkage will prevent latching with the same result as above. This adjustment controls the engagement of the trip roller with the trip shaft, and also the position of the toggle pin when the main contacts are in the closed position.

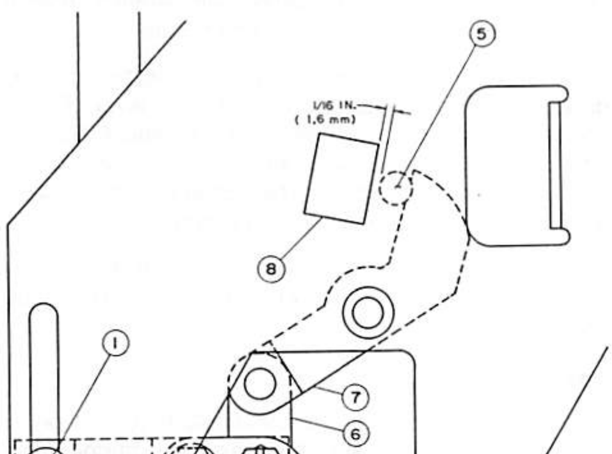
C) Insufficient overlap of the latch roller with the trip cam secured to the trip shaft. This condition will cause the moving contacts to pick up slightly and drop back to fully open position when the closing spring is discharged.

To correct A — Push manual reset lever. (Fig. 2).

To correct B — Linkage adjustment must be made.(Fig. 7).

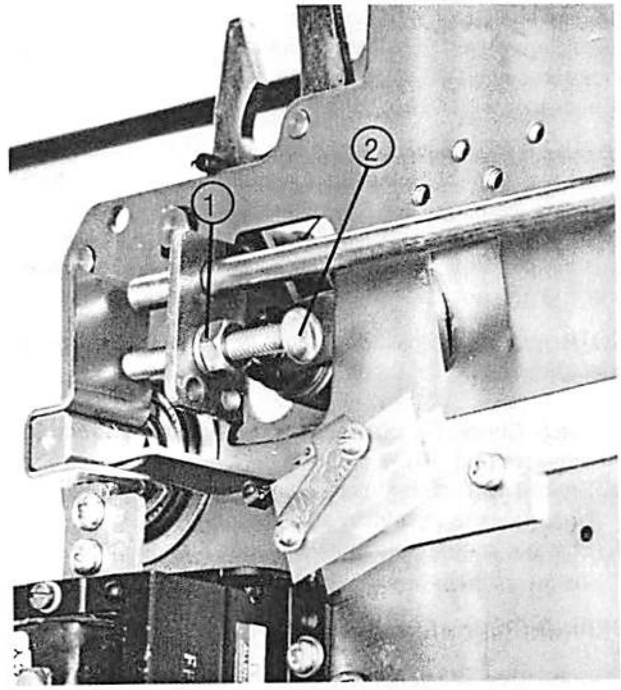
This adjustment is accomplished by means of an eccentric bolt accessible from the right hand side of the mechanism compartment. This eccentric moves the toggle pin (Item 5) relative to the stop in the sides of the mechanism compartment.

FIGURE 7
LINKAGE ECCENTRIC ADJUSTMENT



1. Spring Guide Pin
2. Main Spring Clamp
3. Locking Plate
4. Eccentric
5. Toggle Pin
6. Connecting Link
7. Closing Casting
8. Stop in Mechanism Sideplates
9. Mechanism Sideplate

FIGURE 8
TRIP SHAFT ADJUSTMENT



1. Locknut
2. Adjusting Screw

To proceed, isolate the breaker for servicing. Remove the arc chutes, front flash shield, interphase barriers, faceplate assembly, and faceplate box assembly. Be sure the main contacts are open and the main spring is discharged.

To ensure the main spring is completely discharged, a manual charging handle must be used to remove any spring force on the holding pawl, and driving pawl in the case of electrically operated breakers. Lift the holding and driving pawl away from the ratchet wheel. Releasing the manual charging handle now allows the main spring to completely discharge, with the crank assembly going to the bottom dead centre position, and the spring guide to its lowest point of travel.

Next remove the eccentric locking plate (Item 3). Rotate the eccentric bolt clockwise until the closing casting (Item 7) pushes the closing pin to within 1/16 inch (1.6 mm) away from the stops in the mechanism sideplates. This can be seen by viewing the mechanism sideplates from above. The locking plate should now be replaced, locating it to the nearest notch. Tighten the retainer nut firmly. In this operation, two wrenches should be used — one holding the head of the bolt at the left hand side — the other tightening the nut at the right hand side.

To check the adjustment, close the main contacts. The closing pin should be against the stops in the mechanism sideplate. If it is not, proceed as follows.

With the main spring discharged and the main contacts open, remove the eccentric locking plate. Rotate the eccentric bolt clockwise an amount required to locate it in the next notch of the locking plate. The locking plate should now be replaced and the retainer nut firmly tightened. Return to the checking procedure above.

To correct C-Latch roller engagement adjustment must be made.

This adjustment, located on the left hand side of the mechanism compartment, controls the engagement of the trip shaft to the latch roller. If this engagement is insufficient, the roller may release during the closing stroke, resulting in failure to close. The main contacts will appear to move but not complete the travel.

To adjust, the following procedure should be used. With reference to Fig. 8 loosen locknut (Item 1) and turn adjusting screw (Item 2) counter-clockwise two turns. Close the breaker and slowly turn the screw clockwise until the unit trips. Now turn the screw counter-clockwise one and one quarter turns and tighten the locknut.

NOTE: Whenever this adjustment is made the following should be checked if present on the breaker.

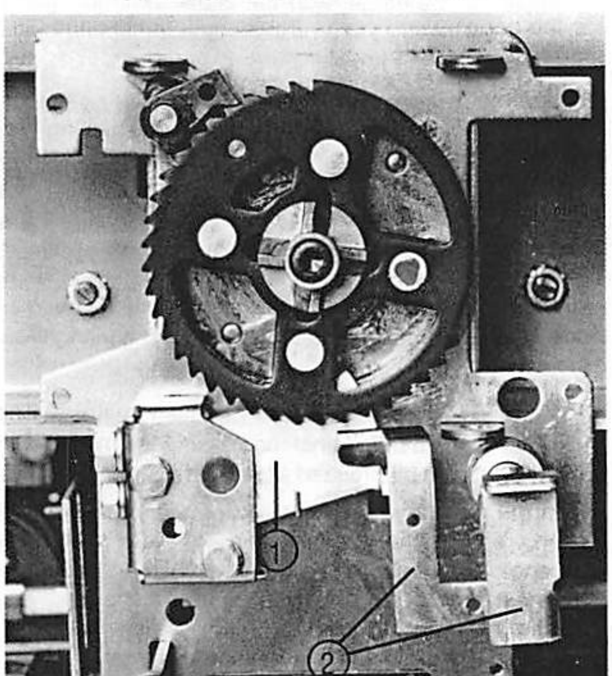
1. Latch Check Switch setting on electrically operated breakers (Fig. 16).
2. Shunt Trip Type B striker rod adjustment (Fig. 12).
3. Undervoltage trip striker adjustment (Fig. 13).
4. Drawout gate interlock lever eccentric adjustment on drawout breakers (Fig. 10).

SPRING DISCHARGE INTERLOCK

Drawout mounted breakers are fitted with a gate interlock to prevent the breaker being withdrawn while the unit is closed or the main spring is charged. Depressing the gate interlock down to expose the drawout crank opening first trips the breaker then discharges the main closing spring.

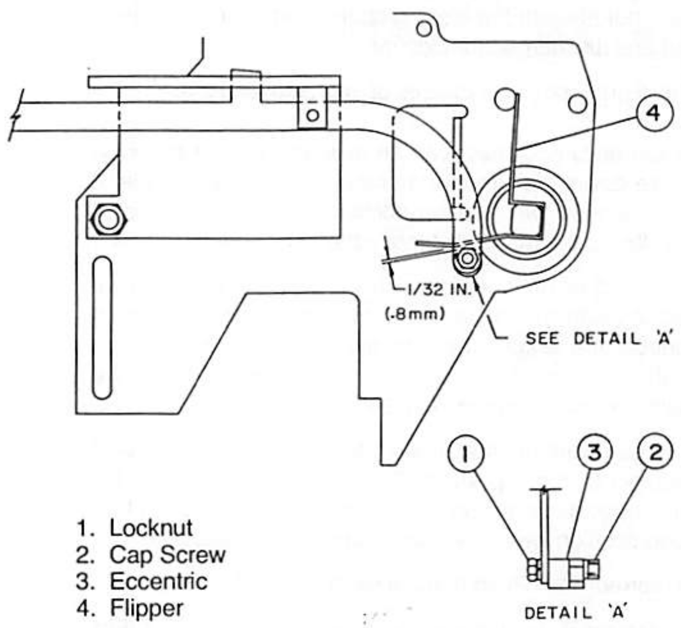
It should be noted that "empty" discharges of the closing spring stress the mechanism to a slightly greater extent than on normal closure. For this reason it is advisable to avoid additional intentional discharges to those which occur when the breaker is withdrawn and the spring is still charged.

FIGURE 9
SPRING DISCHARGE LEVER



1. Closing Latch
2. Spring Discharge Interlock Lever

FIGURE 10
ECCENTRIC ADJUSTMENT



1. Locknut
2. Cap Screw
3. Eccentric
4. Flipper

Adjustment of the drawout gate interlock lever is performed as follows. Be sure the trip shaft is rotated down so the left hand flipper is resting against the adjusting screw. Be sure the drawout lever is lifted to its upward position. With reference to Fig. 10 loosen locknut (Item 1) and allen head cap screw (Item 2). Using a wrench, rotate eccentric (Item 3) until the clearance between the eccentric and right hand flipper (Item 4) on the trip shaft is approximately 1/32 inch (0.8 mm). Holding the eccentric in position with wrench, tighten allen screw securely. Tighten locknut securely.

Discharging the main spring is accomplished by the drawout lever acting on the close button lever, Fig. 9. The lever arrangement requires no adjustment. Depressing the drawout lever activates the closing latch which discharges the main spring. This action results in failure to close, but discharge of the main spring.

Whenever trip shaft adjustment is performed (Fig. 8), the drawout gate interlock lever adjustment should be checked.

SHUNT TRIP

Two types of shunt trip units are available for use on all H-3 and HL-3 breakers each having specific performance features.

The two types are described as follows:—

TYPE A (Fig. 11)

This unit consists of a rectangular laminated solenoid frame, mounted on the left hand side of the mechanism and acting directly on the trip shaft. When used on typical 120 volt ac control, the coil has a continuous rating, with a holding current of only 340 milliamperes. This makes possible use of this trip unit without the conventional normally open auxiliary switch contact in series with the coil. When used in conjunction with a typical latching-type ground fault relay the breaker is locked out and will be totally trip-free until the relay has been reset. Any attempt to reclose the breaker before resetting the relay will preclude a restriking of the ground fault. No adjustment is required on this device and the only attention needed is that of ensuring that the plunger is free of any binding or friction. This unit is capable of tripping at 50% of the rated voltage.

Type B (Fig.12)

This is a cylindrical solenoid mounted within the mechanism compartment at the lower rear and acting directly on the trip shaft. Unlike the Type A unit, it is not continuously rated and for any application a normally open auxiliary switch contact must be used. In the 120 volt ac application the Type B unit is equivalent in performance to the Type A device (i.e. will operate at 50% of rated voltage) but in the 125 volt dc rating, tripping can be performed at levels as low as 25% of nominal rating. One adjustment is provided in the Type B trip unit to control the extent of free travel between the plunger and the trip shaft lever. By lifting the plunger until the striker rod is lightly touching the trip shaft lever a space of 1/16 inch (1.6 mm) should exist between the end of the plunger and the stop plate as shown in Figure 12.

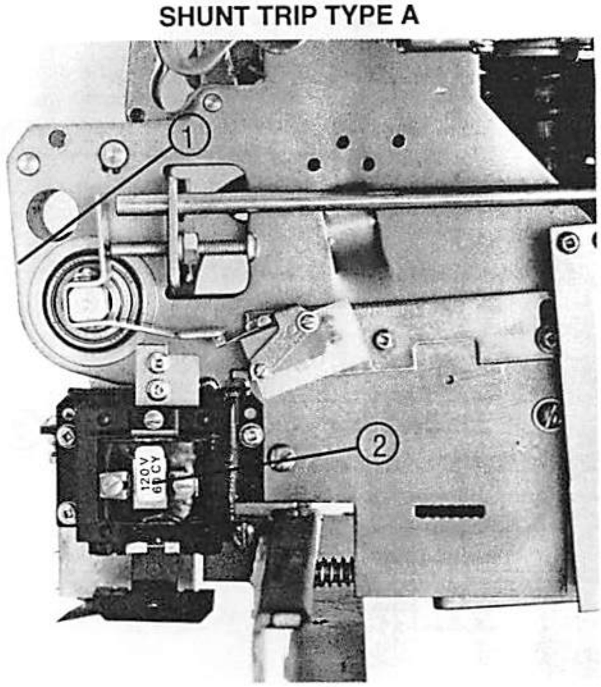
If adjustment is required, loosen the 8-32 socket head screw located at the bottom end of the plunger and turn the striker rod within the plunger as required. Retighten the set screw. If trip shaft adjustment (Fig. 8) is altered at any time, this striker rod adjustment should be checked.

The shunt trip is identified on the wiring diagram by the symbol "TC".

Both units can be installed on one breaker. With regard to use, the following rules are usually adhered to:

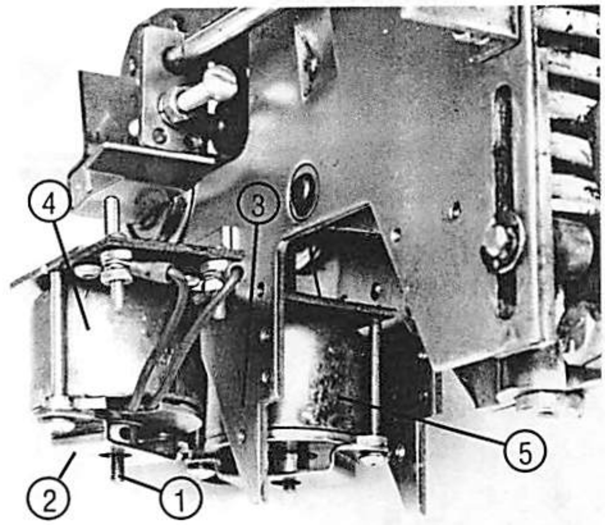
1. A Type B is used where only a separate trip coil is required.

FIGURE 11
SHUNT TRIP TYPE A



1. Mechanism Sideplate
2. Shunt Trip Type A

FIGURE 12
SHUNT TRIP TYPE B



1. Plunger
2. Stop Plate
3. Mechanism Sideplate
4. Shunt Trip (Separate Trip Source)
5. Shunt Trip (USD Relay Trip Source)

2. With USD relay, a Type B is used between the mechanism sideplates to operate with the relay, and possibly a Type B mounted outside the left hand mechanism sideplate to be used as a separate trip coil.
3. A Type A, mounted only outside the left hand mechanism sideplate, is used only when a continuous rated coil for a separate trip source is required.
4. Type A and Type B used in conjunction with the USD relay can both be used on the same unit.

UNDERVOLTAGE TRIP (Fig. 13)

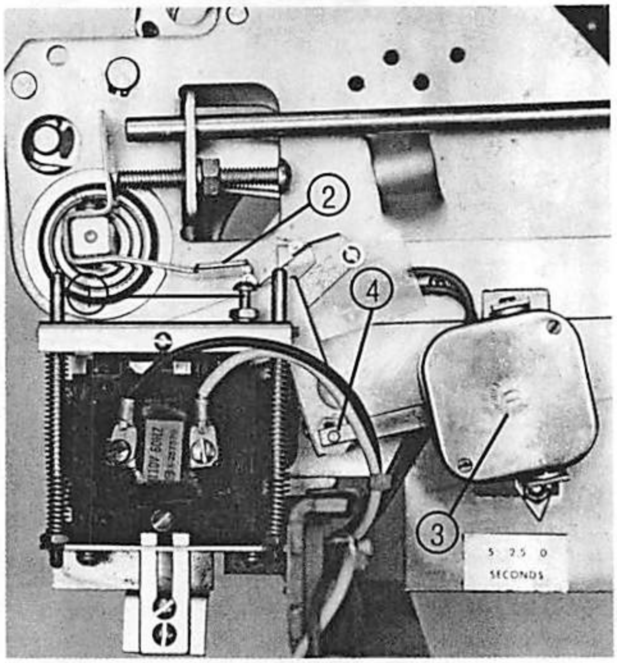
The Undervoltage Trip is a spring operated unit mounted on the left hand side of the main mechanism compartment and acting directly on the trip shaft. In operation two springs are held in compression by a rectangular solenoid.

Normally supplied in the 120 volt ac rating, the solenoid has a holding current of 340 milliamperes, with an inrush of 2.45 amperes. A mechanical escapement time delay attachment is available which provides a delay adjustable from 0 to 5 seconds.

An adjustable striker (Item 1) is provided to control the engagement of the solenoid plunger to the trip shaft. With the solenoid energized and the plunger seated, adjust the striker as required to provide a gap of 5/16 inch (8 mm) between the striker and the trip shaft lever. Tighten locknut firmly. If at any time the trip shaft adjustment (Fig. 8) has been altered the undervoltage striker adjustment should be checked.

A vernier time adjustment in the form of an eccentric is provided for fine adjustment, independent of the scale setting. If trimming is required, loosen the locknut located on the inside of the lever and turn the eccentric counter-clockwise to increase time, and clockwise to shorten time. The locknut must be firmly tightened each time the eccentric is moved.

FIGURE 13
UNDERVOLTAGE TRIP



1. Striker
2. Trip Shaft Lever
3. Timer
4. Vernier Time Adjustment

In operation, the undervoltage trip has a dropout of 35% of rated voltage for 120 V. a.c. and 46% of rated voltage for 240 V. a.c. Both have a pull-in of 85% rated voltage and are identified on the wiring diagram by the symbol "27".

SHUNT CLOSE (Fig. 14)

This accessory is supplied on electrically operated circuit breakers and consists of a rectangular laminated solenoid frame, similar to the Type A shunt trip device. It is mounted within the front mechanism compartment, and its function is that of actuating the close latch to initiate the closing stroke. It may be energized by the normally open push button in the faceplate or by a remote push button. In ac ratings the coil is inherently continuously rated and in the typical 120 volt application the holding current is 340 milliamps, with an inrush of 2.45 amperes. For dc operation a holding resistor in conjunction with a plunger operated limit switch again provides a continuous rating.

The shunt close unit is fitted with an independent normally closed limit switch, operated by the solenoid plunger. This switch is connected in series with the spring charging motor and serves to render the motor inoperative while the solenoid is energized. Used in conjunction with the conventional "charge after trip" motor operation, this performs the duties of an anti-pump relay. The breaker will not reclose because the spring is retained in a discharged condition. Only when the close signal is removed will the motor operate to charge the spring.

No adjustment is required on this unit and the only attention needed is that of ensuring that the plunger is free of any binding or friction. The device is capable of operating at 75% of rated voltage.

The shunt close is identified on the wiring diagram by the symbol "CC".

CLOSING SPRING CHARGING MOTOR

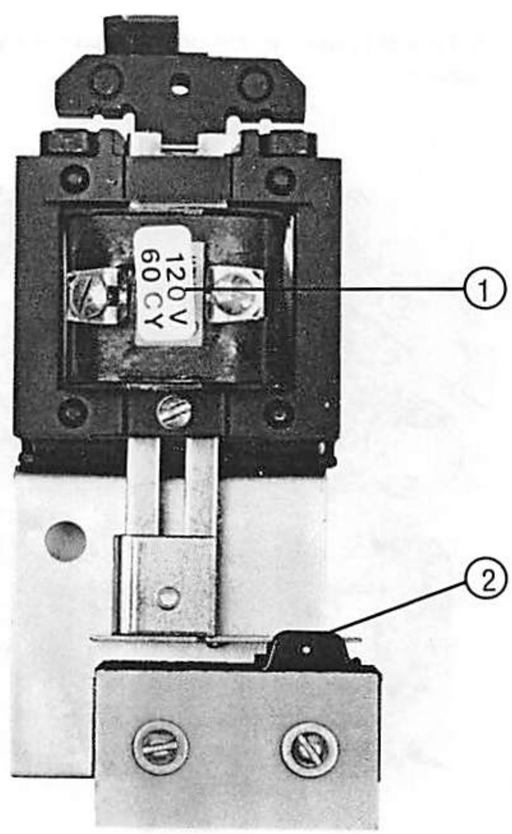
All electrically operated units employ a series-wound gear motor, suitable for operation on alternating or direct current. The reduction gear compartment is sealed and lubricated for life and the armature bearing similarly requires no maintenance lubrication. The basic motor is available in voltage ratings 48, 120, 250 dc and 120, 240 ac. In all alternating current applications above 240V a step down control transformer is used in conjunction with the 120 volt motor.

A toggle switch mounted in the faceplate permits the motor to be de-energized during maintenance or inspection. (Fig. 2).

Preferred control circuitry permits spring charging to take place after the breaker has tripped only. While a unit can be supplied to charge after close, this should be used only in applications requiring high speed reclosing. Unless otherwise specified all units are supplied to operate in the "charge after trip" sequence.

The charging motor is identified on the wiring diagram by the symbol "M".

FIGURE 14
SHUNT CLOSE



1. Shunt Close Coil
2. Independent Normally Closed Limit Switch

To remove the motor, first remove the bracket assembly from the frame channel, noting the number of shims at the top and bottom faces of the motor bracket. The drive cam and outboard bearing should then be removed. The drive cam is threaded to the motor output shaft and can be readily released by a light tap in the counter-clockwise direction. Remove the hex head bolt holding the front bracket to the motor. Next, remove the mounting screws at the end opposite to the drive and motor housing can be withdrawn from the rear bracket. When replacing the motor bracket assembly in the channel, replace the shims as originally installed. Do not tighten the hex head bolt holding the front bracket to the motor until the screws holding the motor brackets in the front channel have been tightened securely.

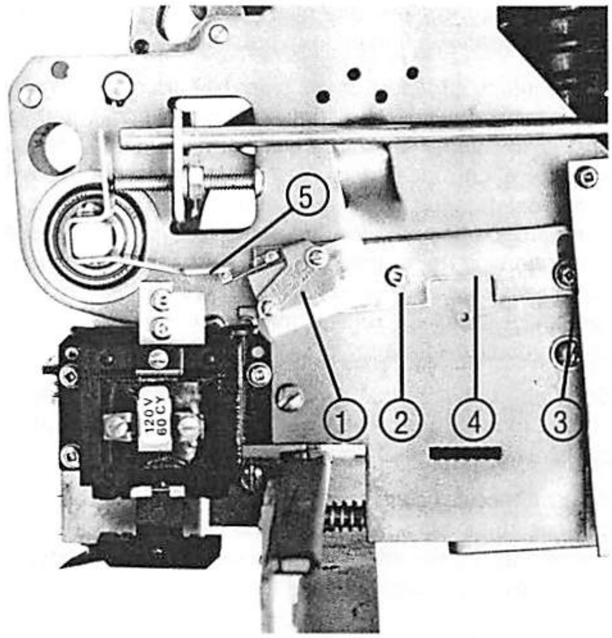
MOTOR CLOSING SPRING LIMIT SWITCH (Fig. 15)

All electrically operated H-3 and HL-3 units are equipped with a limit switch which stops the motor at the end of the charging stroke. The switch is mounted in the left hand end of the front channel. The switch is coupled with a lever actuator to a cam located on the rear of the crank assembly. As the crank passes through top-dead-centre and the ratchet wheel bearing approaches the close latch, the lever actuator moves to operate the switch and de-energize the motor. The lever actuator is reset when the main spring discharges. No adjustment is required for the motor closing spring limit switch.

LATCH CHECK SWITCH (Fig. 16)

The latch check switch is provided on electrically operated units to prevent any attempted electrical close until the trip shaft is completely reset and seated in readiness to close. The switch is connected in series with the shunt close solenoid and prevents operation of the solenoid until the trip shaft is fully seated. Failure of the trip shaft to be completely reset at the beginning of the close stroke will result in a trip free operation. This malfunction can occur in transfer switch installations where one circuit breaker is mechanically interlocked with its companion, and a signal to close enters before the trip shaft has fully returned to its stop. A key interlock or any form of mechanical lockout presents the same set of conditions.

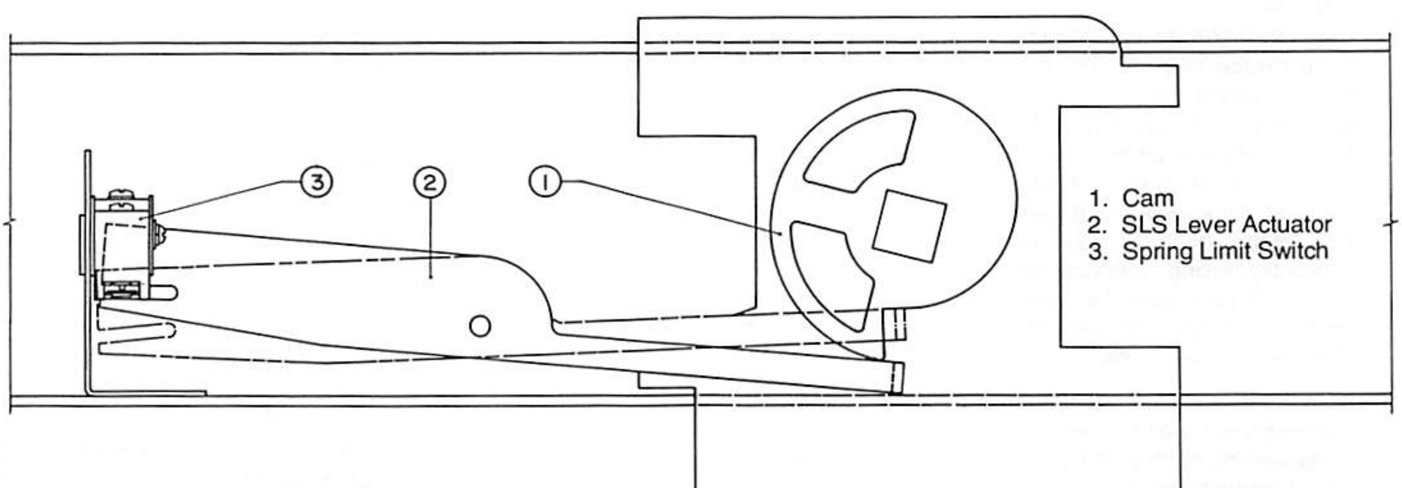
FIGURE 16
LATCH CHECK SWITCH



1. Latch Check Switch
2. Pivot Screw
3. Lock Screw
4. Mounting Plate
5. Trip Shaft Lever

With reference to Fig. 16, adjustment of the latch check switch is performed as follows: With the circuit breaker open, loosen pivot screw (Item 2) and lock screw (Item 3). By lowering mounting plate (Item 4) at the front end, engage the switch roller to trip shaft lever (Item 5) until the lever just begins to lift. From this reference point, raise the front end of the mounting plate 1/16 inch (1.6 mm) and tighten both pivot and lock screws firmly.

In normal operation the latch check switch should require no readjustment, but if at any time the trip shaft adjustment (Fig. 8) is altered, the latch check switch setting should be checked as above. This device is identified on the wiring diagram by the symbol "LCS".



1. Cam
2. SLS Lever Actuator
3. Spring Limit Switch

FIGURE 15
MOTOR CLOSING SPRING LIMIT SWITCH

CONTACT MAINTENANCE

Examine the main breaker contacts (and disconnecting contacts on drawout mounting breakers) frequently to see that they are properly aligned and that the contact surfaces bear with firm uniform pressure.

The contact surfaces of all types of disconnecting or interrupting devices must be kept clean and bright to ensure maximum operating efficiency. Contact surfaces which are corroded by contaminated atmospheres will cause overheating and subsequent failure of the device. The alloy contacts of the type H-3 and HL-3 will resist contamination to a great degree but in areas where sulphur is present or other chemicals which readily combine with silver, regular maintenance is required to ensure contact efficiency.

See that bolts, nuts, washers, clips and all terminal connections are in place and tight, especially after completion of any maintenance work.

When abnormal conditions exist, such as salt deposits, cement dust or acid fumes the breaker should be cleaned at regular intervals. This will prevent flashovers caused by the accumulation of foreign substances.

MAIN POWER CONTACTS

Main contacts are silver alloy and should be clean, bright and free from pitting. They may be gently sanded if necessary using a fine emery to remove pit marks. Avoid having particles fall into the mechanism, and wipe contacts clean with cloth after sanding.

If the main contacts are severely damaged make a careful inspection of all current carrying parts. Supporting pins, linkage, and especially springs should be examined for damage due to excess heat. Annealed or distorted parts should be replaced. Before attempting this, consult the manufacturer.

CONTACT DIFFERENTIAL (Fig. 17 and 18)

At intervals as recommended by ANSI standards (see paragraph on Lubrication), the differential between the main and arcing contacts should be checked. The differential should be maintained between the limits of 0.050 to 0.065 inches (1.3 to 1.6 mm). Using the slow close device (Fig. 18 (A)) close the contacts until the moving arcing contact touches the stationary arcing contact (Fig. 18 (B)). A gap of 0.050 to 0.065 inches (1.3 to 1.6 mm) between the main moving wafer contacts and the main upper fixed contact should exist. The gap is checked using a feeler gauge. If adjustment is necessary, shims (Fig. 17, Item 4) are placed between the stationary arcing contacts and the main upper fixed contact. This is done by removing the stationary arcing contacts. Shims are available from the manufacturer (Part Number 241A-500).

Note that it is not important nor necessary that the arcing contacts touch simultaneously. The differential should be measured on each pole by closing the contacts until the arcing contacts touch on the pole being measured.

Contact differential should always be checked before main moving contact deflection.

MAIN MOVING CONTACT DEFLECTION

At intervals as recommended by ANSI standards (see paragraph on Lubrication), the deflection of the main moving contacts should be checked. The deflection should be maintained between the limits of 3/64 to 4/64 inches (1.2 to 1.6 mm) for 600, 800, 1600, and 2000 ampere frame sizes, and 2/64 to 3/64 inches (0.8 to 1.2 mm) for 3000, 3200, and 4000 ampere frame sizes. A gauge is available for measuring purposes which carries a scale graduated in 1/64 inch (0.4 mm) divisions. For the 1600 amp and larger frames use Gauge Number 96A-500, and for the 600 and 800 amp frame use Gauge Number 96A-501.

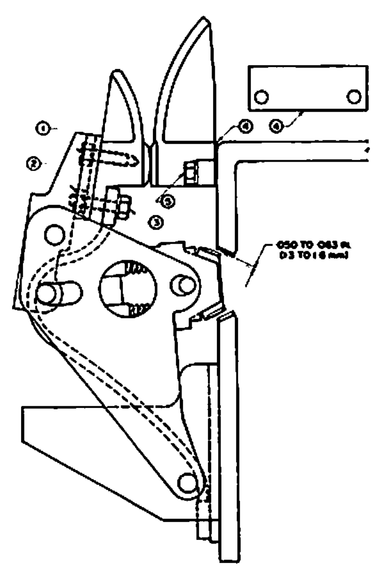
With the circuit breaker open establish the starting or "zero" point for each main moving contact assembly. Apply the gauge to the left hand side as shown in Figure 20 (A) and note the position of the pointer. To assist in positioning the gauge the pointer should be moved forward or "up scale" then released to allow the indicator pins to locate as shown.

With the circuit breaker closed again apply the gauge as shown in Figure 20(B), and note the position of the pointer. The number of divisions the pointer has moved from "zero" position indicates the amount of main contact deflection, each division representing 1/64 inch (0.4 mm) deflection.

When adjustment is required, proceed as shown in Figure 21. Using any suitable blocking device, position the moving contact members toward the closed position as shown and loosen capscrews (Item 1). Shims (Item 2) are added as required to restore deflection to within the limits stated above. After shims are added, it is important that the capscrews be firmly tightened before closing the unit in the normal manner.

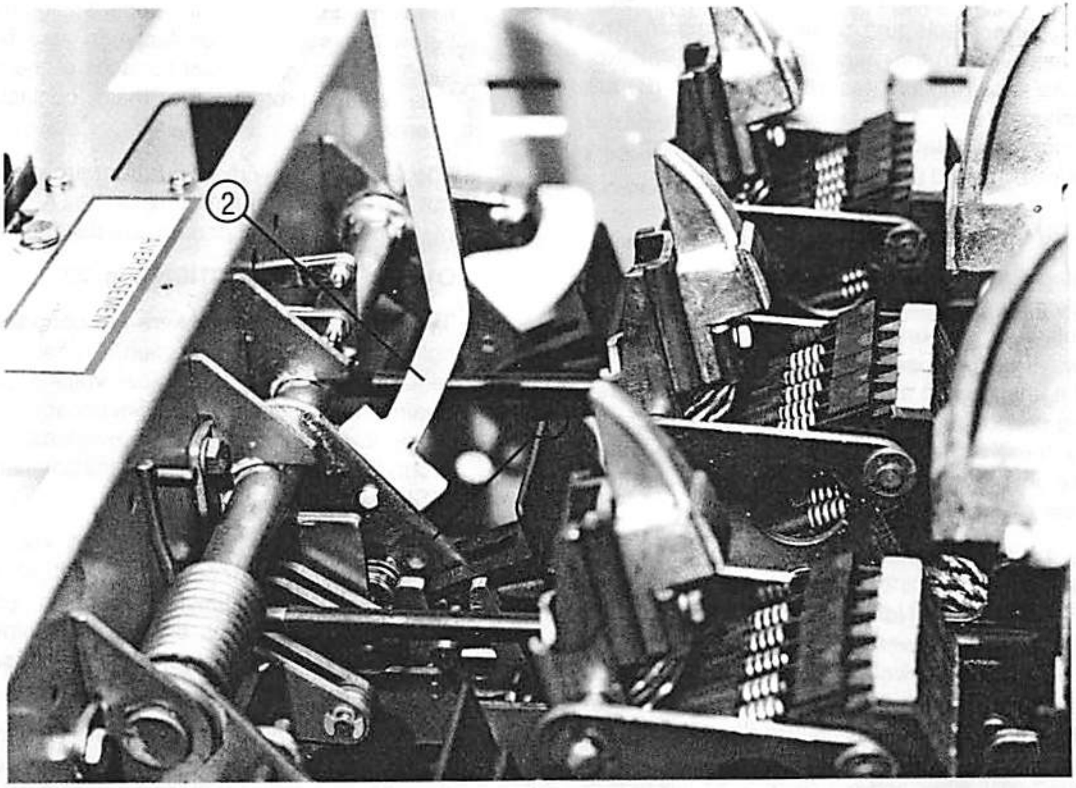
A supply of shims is included with the gauges.

FIGURE 17
CONTACT DIFFERENTIAL ADJUSTMENT



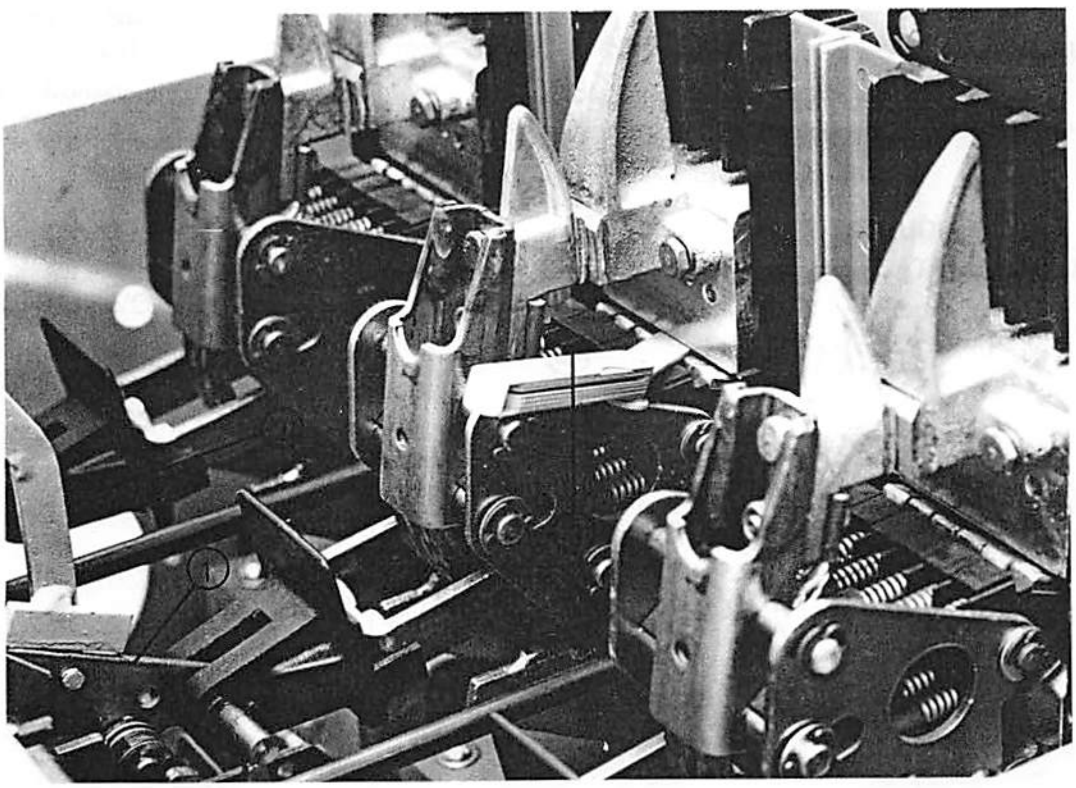
1. 1/4-20 x 3/4 Inch Long Hex Bolt and Lockwasher
2. 1/4-20 Hex Nut and Lockwasher
3. 1/4-20 x 1 Inch Long Hex Bolt and Lockwasher
4. Shim
5. 1/4-20 x 3/4 Inch Long Hex Bolt and Lockwasher

FIGURE 18(A)
SLOW CLOSE DEVICE



1. Closing Shaft Lever
2. Slow Close Device

FIGURE 18(B)
SLOW CLOSE DEVICE



1. Closing Shaft Lever
2. Slow Close Device
3. Feeler Gauge

SLOW CLOSE DEVICE

A slow close maintenance device is available which can be attached to the circuit breaker to permit slow operation of the contacts and closing mechanism. The device is available from the manufacturer, FPE Part No. 115G-514. As shown in Figures 18 (A) and 18 (B) the tool is attached to one of the lever arms of the closing shaft. The slow close device requires no attaching bolts and can be installed and removed with ease.

ARCING CONTACTS (Fig. 17)

Arcing contacts are subjected to pitting every time the circuit breaker interrupts current and should be inspected at regular intervals if the unit is operated frequently. They should always be inspected after the breaker has interrupted a short circuit and should be replaced if they are showing serious pitting and loss of contact material. To remove the fixed arcing contacts from the circuit breaker take out the two hex-head machine screws (Item 5) at the base of each fixed contact.

To remove the moving arcing contacts simply take out the two hex-head machine screws which hold each contact in the assembly. Note that the braid is attached to the contact by the lower hex-head screw (Item 3). Remove the nut and lockwasher (Item 2) at the rear of the assembly first before removing this lower screw. When replacing, tighten the lower screw (Item 3) firmly to attach the braid to the moving arcing contact before replacing the lockwasher and nut (Item 2) at the rear of the assembly.

When replacing arcing contacts, be sure to retrieve all hardware items and assemble as originally installed. Whenever replacing arcing contacts inspect the braids and replace them if they are discoloured or strands are broken.

ARC CHUTES

The arc chutes are made of fiberglass reinforced polyester material. They may be removed individually by removing the two 1/4-20 hex-head bolts on each side of the chute. The chutes mate with the upper base and can be lifted clear to expose the arcing contacts. A lower flash shield mounted to the upper stationary main contact below the stationary contact can also be removed to expose the silver contact surfaces of the main contacts. This shield protects the main contacts during arc interruption.

The arc chute may discolour from arc interruption but will not need replacement unless heavy deposits of arc material are present or parts are distorted or cracked.

OVERLOAD PROTECTION (Fig. 22)

Type H-3 and HL-3 breakers are normally supplied with solid state overload protection. The solid state overcurrent trip system protects low voltage power systems against damage caused by overloads and faults. The types of protection offered are overload, short circuit and ground fault. Zone selective instantaneous protection (ZSIP) is also available.

The trip unit operates to open a low voltage circuit breaker in accordance with a set of programmable time-current characteristics. Tripping energy for the operation of the circuit breaker is obtained solely from the circuit being protected. Other power sources are not required, except for fault indication.

The complete solid state overcurrent trip system consists of the primary current sensors, the overload relay, and the direct acting shunt trip solenoid. Each sensor is available with changeable tap settings to suit the rating of the breaker. Note — Sensor tap settings must not be changed while power is flowing through the breaker. When the sensor tap settings are altered, the sensor tap setting indication on the breaker faceplate (Fig. 2) should also be changed. Turning the screw to the right of the indication rotates a dial behind the rating plate until the correct tap setting indication is given.

The direct acting shunt trip solenoid is a Type B shunt trip, mounted between the mechanism side-

FIGURE 19
MOVING CONTACT DEFLECTION

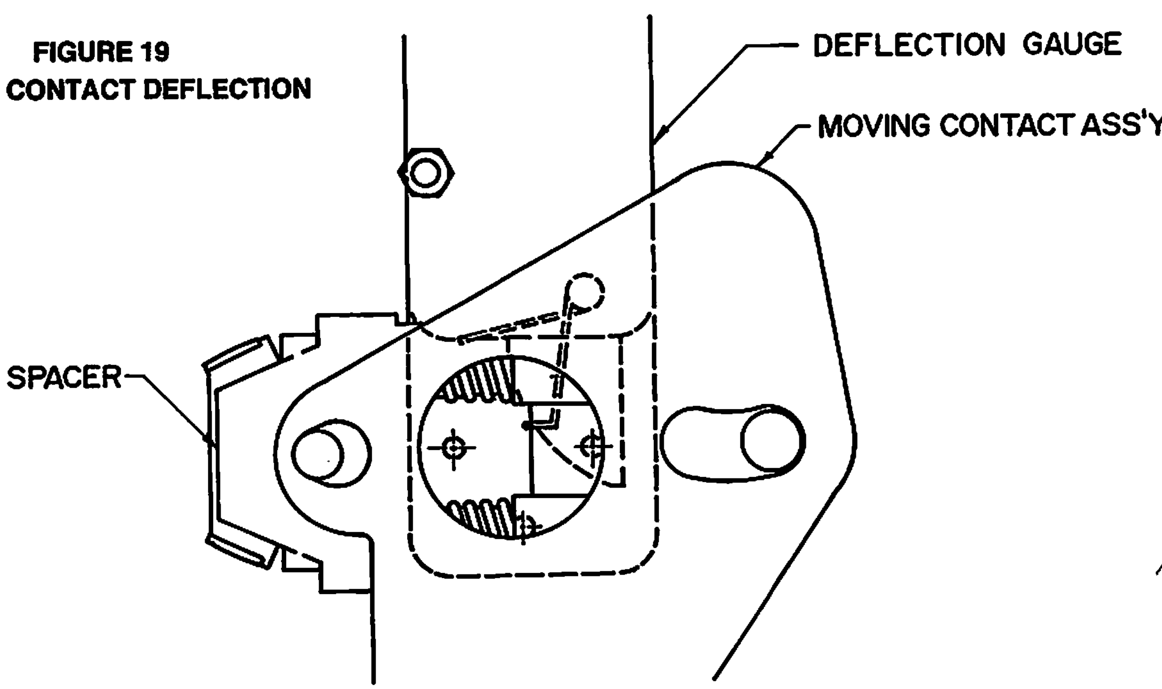


FIGURE 20(A)
MOVING CONTACT DEFLECTION

1. Moving Contact in Open Position
2. Deflection Gauge

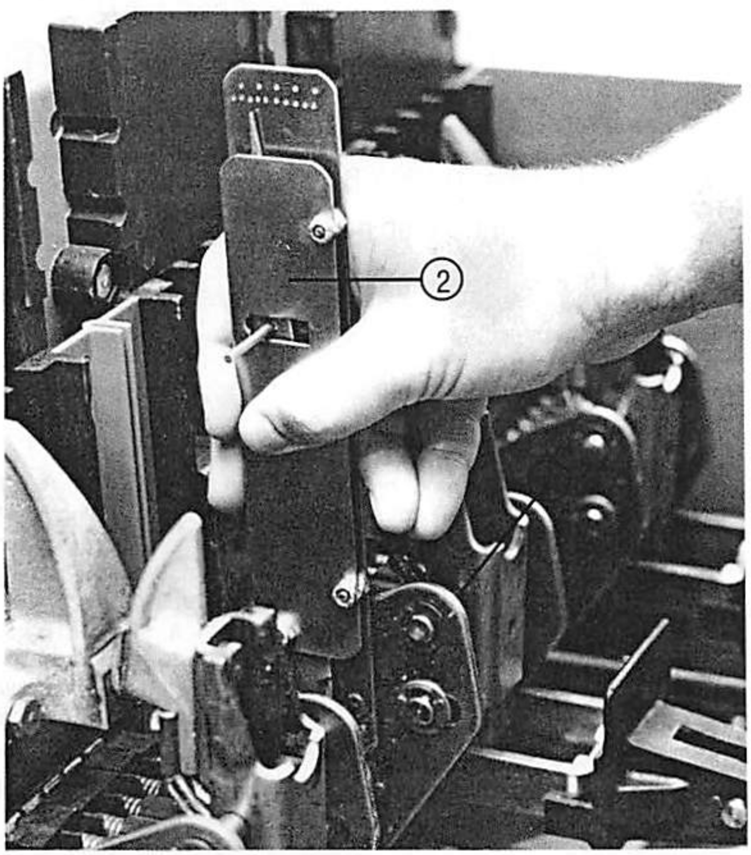
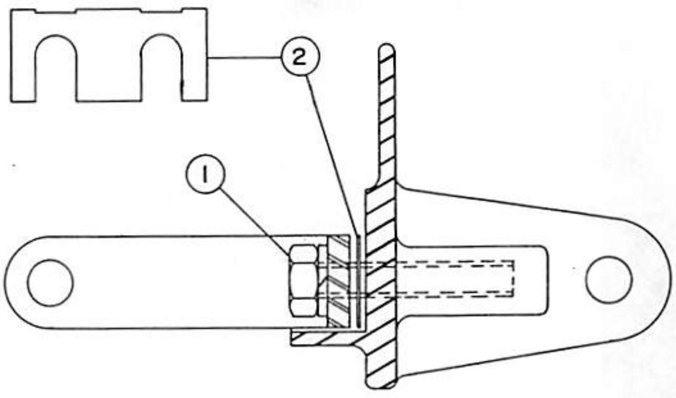


FIGURE 20(B)
MOVING CONTACT DEFLECTION

1. Moving Contact in Closed Position
2. Deflection Gauge

FIGURE 21
MOVING CONTACT ADJUSTMENT



1. 5/16-18 x 1 Inch Long Hex Bolt
2. Shim

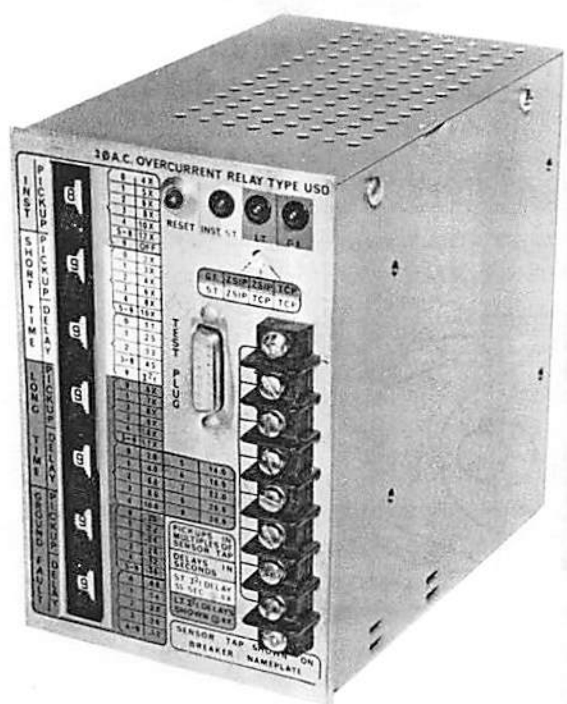
plates. One adjustment is provided to give a space of 1/16 inch (1.6 mm) between the end of the plunger and the stop plate on the trip shaft. If adjustment is required, refer to the section entitled Shunt Trip, Type B (Fig. 12).

Many H-3 and HL-3 type breakers have been supplied with the SD type solid state relay. This relay has been replaced in manufacturing by the USD type solid state relay. The USD relay is an improved design incorporating many features not available on the SD relay.

For complete details of the SD relay refer to instruction manual C-3-216-2.

For complete details of the USD relay refer to instruction manual C-3-217-2.

FIGURE 22
TYPE USD SOLID STATE RELAY



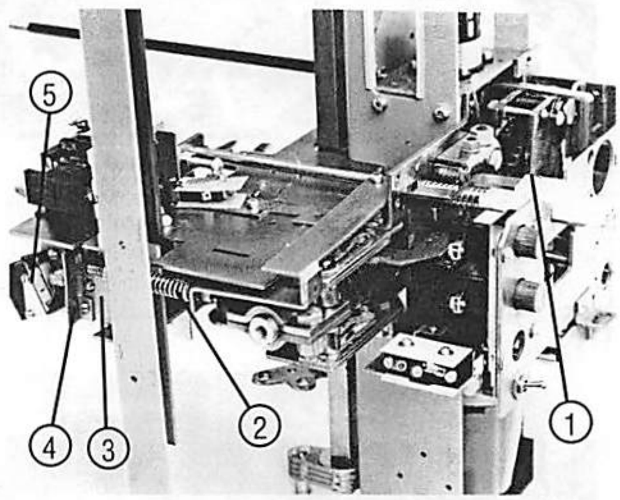
OVERLOAD LOCKOUT DEVICE (Fig. 23)

The overload lockout device prevents reclosing of the breaker either manually or electrically after the breaker has been tripped by the overload relay, unti this device is manually reset. Two micro switches with normally open contacts are also available to act as overload alarm contacts.

The direct acting shunt trip solenoid plunger mechanically holds the closing mechanism in the trip-free position thus preventing closing of the main contacts. The latch check switch wired in series with the closing coil is open in this position, preventing any attempted electrical operation of the closing coil.

The device is reset by pushing the manual overload lockout reset button on the breaker faceplate (Fig. 2). This reset button is spring loaded and returns to its normal position.

FIGURE 23
OVERLOAD LOCKOUT DEVICE



1. Overload Lockout Reset
2. Reset Spring
3. Shunt Trip (USD Relay Trip Source)
4. Overload Lockout Flipper
5. Overload Alarm Contacts

FUSE MOUNTING — HL-3 ONLY

All HL-3 circuit breakers in frame sizes up to and including 4000 amps have provision for mounting NEMA HRC fuses, mounted on the line side on a frame extension at the rear of the unit. As an option, in ratings of 3000 and 4000 amps, a separate fuse truck is available used in conjunction with a standard circuit breaker. Key interlocking is provided to ensure that the circuit breaker is open before the fuse unit is withdrawn. The fuse unit is equipped with a rejector feature which prevents entry of the fuse unit into the breaker cell.

In all applications the circuit breaker is equipped with anti-single phase protection.

HL-3 Frame Rating (Amperes)	Relay Rating (Amperes)	Maximum Fuse Rating (Amperes)
600	600	1600 NEMAL
800	800	1600 NEMAL
1600	1600	3000 NEMAL
2000	2000	3000 NEMAL
3000	3000	4000 NEMAL
4000	4000	5000 NEMAL

ANTI-SINGLE PHASE DEVICE AND BLOWN FUSE INDICATOR — HL-3 BREAKER ONLY (Fig. 24)

The anti-single phase device is supplied on all frame sizes. The unit consists of three trip solenoids each acting upon an independent slide, which in turn acts directly onto the trip mechanism. When activated by the solenoid, the slide moves forward and latches in this position, thus locking the breaker in a trip-free state. Each solenoid coil is connected in parallel across the corresponding power fuse and in normal operation the trip coil is, in effect, shorted out.

The slides are colour coded, red, yellow and blue and when tripped they protrude through an aperture in the faceplate (Ref. Fig. 2), thus providing a blown fuse indicator. Red indicates the left hand phase, yellow centre and blue right hand. To reset, the slide is lifted and pushed in at the faceplate opening. The breaker cannot be reclosed until the anti-single phase device and blown fuse indicator is reset.

Two coil voltage ratings are available, one for system voltages 240 or less, and one for systems 480 to 600 volts. The coils are identified by colour coded leads — the 240 volt carries blue leads, the 600 volt rating is fitted with red leads.

A simple mechanical check of the unit can be made by raising each plunger by hand to observe movement of the corresponding slide and rotation of the trip shaft. The plunger must be raised firmly against the internal stop to ensure that full travel is achieved. An electrical test may be performed by means of a single phase variable ac source, 250 va or larger. The test signal is applied directly to the trip coil terminals after first disconnecting one of the connecting leads. This is necessary to isolate the trip coil from the power fuse. The 240 volt coil should operate at approximately 50 volts and the 600 volt rating at approximately 100 volts. In this test it should be noted that these coils are short-time rated and in normal operation are de-energized the instant the breaker opens. A preset voltage and a momentary on-off switching action is recommended. Do not sustain the test power after the coil has operated.

SECONDARY CONTROL CONTACTS (Fig. 34)

Secondary control contacts are provided on drawout units to automatically connect or disconnect control circuits, as the circuit breaker moves through its positions in the cradle. The contacts are designed such that the control circuit can be energized or isolated in the test position. These connections can be altered in the field, when required, by means of jumpers between contacts of the stationary block.

Supplied in multiples of 8 contacts, a total of 48 can be provided, and each contact has a continuous current rating of 30 amperes. In applications where a control supply voltage in excess of 250 is to be used, the higher voltage contacts are double spaced (i.e. the adjoining contact is unused).

AUXILIARY SWITCH (Fig. 5)

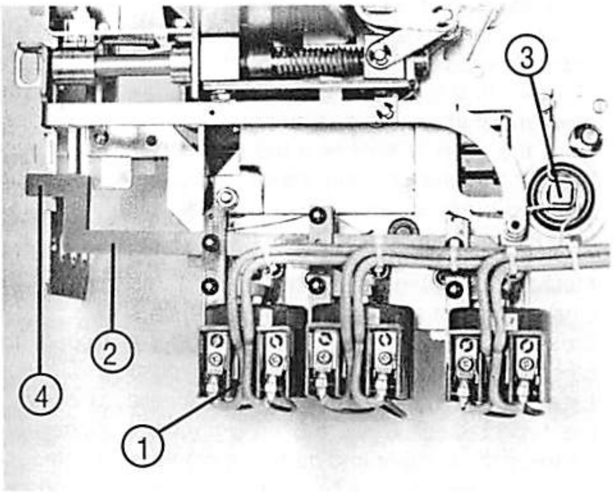
On all H-3 and HL-3 units a multi-section rotary switch is used. It is coupled directly to the closing shaft and operates on a snap-action principle which provides quick break switching. No adjustment is required and the switch is available in the following contact arrangements.

4-pole, providing 2 normally open and 2 normally closed.
8-pole, providing 4 normally open and 4 normally closed.
12-pole, providing 6 normally open and 6 normally closed.
16-pole, providing 8 normally open and 8 normally closed.
20-pole, providing 10 normally open and 10 normally closed.

The following contact ratings apply.

10 amperes up to 254 V.a.c.
1 ampere at 250 V.d.c.
2 amperes at 125 V.d.c.

FIGURE 24
ANTI-SINGLE PHASE DEVICE



1. Solenoid
2. Slide
3. Trip Shaft
4. Blown Fuse Indicator

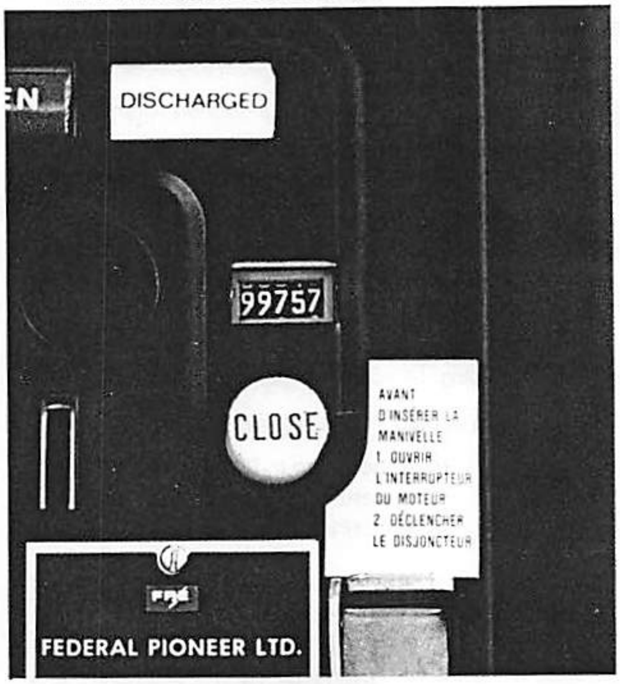
MECHANICAL OPERATIONS COUNTER (Fig. 25)

A five digit mechanical counter can be supplied. It is mounted in the faceplate of the breaker (Fig. 2).

This device is mechanically driven by the "charged-discharged" indicator. The counter operates once for each charging of the breaker main spring. No adjustment or maintenance is required for successful counter operation.

Operations counters are recommended where breakers will be subjected to frequent operations as an indicator of the recommended maintenance intervals.

FIGURE 25
MECHANICAL OPERATIONS COUNTER



MECHANICAL INTERLOCK (Fig. 26)

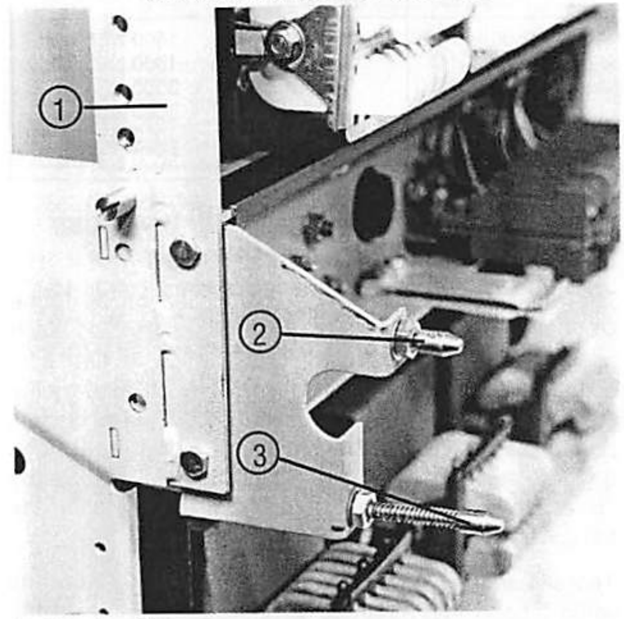
Mechanical interlocks are available on all H-3 and HL-3 breaker frame sizes. They are used to mechanically interlock breakers in a two or three breaker transfer scheme. In the case of a two breaker transfer scheme, mechanical interlocks ensure only one breaker is closed while the other is held in a trip free position. In a three breaker transfer scheme, mechanical interlocks ensure only two breakers are closed while the third is held in a trip free position.

Mechanical interlocks connect with flexible cable the closing shaft of one breaker to the trip shaft of a second breaker, and vice versa. If one breaker is closed, the other breaker is held in a trip free position. Drawout breakers are interlocked by cable connections between the two cradles. There are no permanent connections between the breaker and matching cradle when interlocking is supplied, so the breaker can be freely withdrawn from the cell. Mechanical interlocks are operable only when the breaker is in the connected position. When withdrawn to the test position, breakers are not interlocked and can be test operated in the normal manner.

Mechanical interlocks are preset at the factory and require no adjustment. The plungers at the rear of the breaker should be checked for freedom of movement at intervals as recommended by ANSI standards (see paragraph on Lubrication).

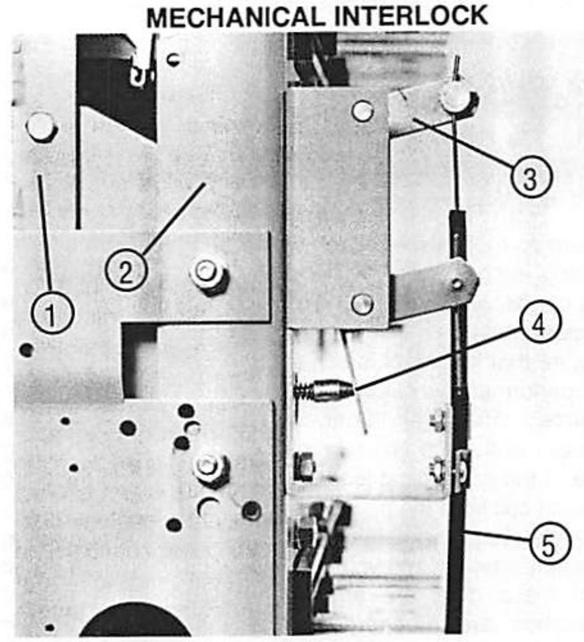
With the breaker removed from the cell, manually close the main contacts using the slow close device (Fig. 18). With reference to figure 26 (a), the top plunger at the rear of the breaker connected by cable to the closing shaft should move freely with movement of the closing shaft. Next, charge the main spring and close the breaker. Pushing in on the lower plunger at the rear of the breaker should open the main contacts. If the plungers do not move freely, the cable must be removed from the sheath and cleaned to restore free movement.

FIGURE 26(A)
MECHANICAL INTERLOCK



1. Breaker Frame
2. Upper Plunger (Connected to Closing Shaft)
3. Lower Plunger (Connected to Trip Shaft)

FIGURE 26(B)
MECHANICAL INTERLOCK

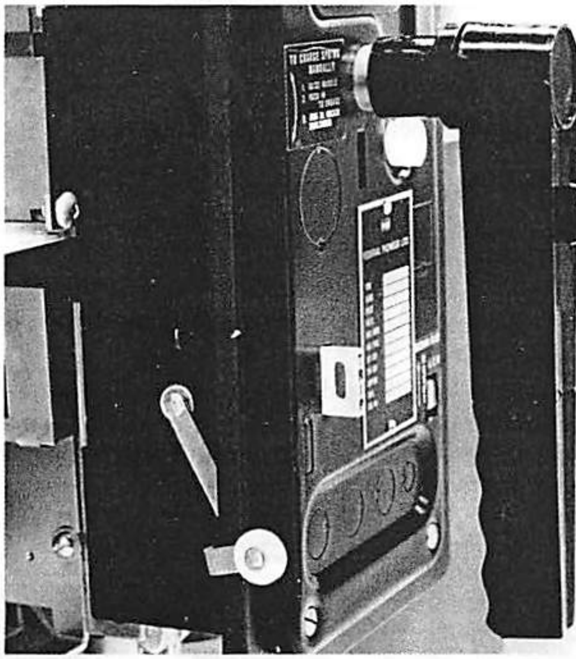


1. Breaker Frame
2. Cradle Frame
3. Upper Flipper
4. Lower Flipper
5. Cable Connections to Lower Cradle

DOOR INTERLOCK (Fig. 27)

All H-3 and HL-3 circuit breakers may be fitted with a device which acts to trip the unit when the cell door is opened. In operation, the door lever acts internally on the mechanical trip button causing it to move in towards the faceplate. This interlock may be defeated by arresting the movement of the trip button. A screwdriver blade or similar tool inserted through the slot in the trip button will allow the door to be opened without tripping the circuit breaker.

FIGURE 27
DOOR INTERLOCK

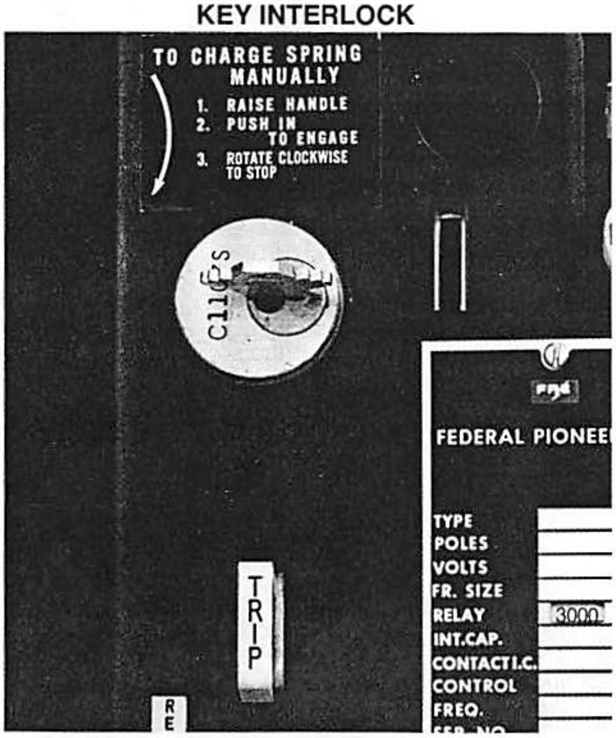


KEY INTERLOCKS (Fig. 28)

Type VF key interlocks single or double lock with 3/8 inch (9.5 mm) projection can be provided. They mount with 3/8-16 screws behind the breaker faceplate. Key interlocks can be installed in the factory. Provision is made for key interlocks on all frame sizes.

The lock plunger engages the tapered section of the manual trip button when the key is removed. With the key removed the closing mechanism is completely trip free thus preventing closing of the main contacts. For electrically operated units an auxiliary switch contact is provided to operate in conjunction with the interlock to isolate the closing circuit.

FIGURE 28
KEY INTERLOCK

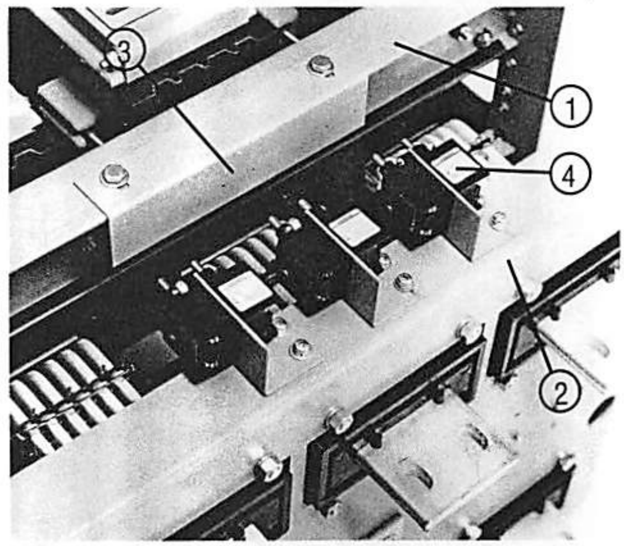


CELL SWITCHES (Fig. 29)

Cell switches mounted in the cradle can be provided when required to serve as position indicators or external electrical interlocks. The switches are operated when the breaker is moved from the test to operating position in the enclosure.

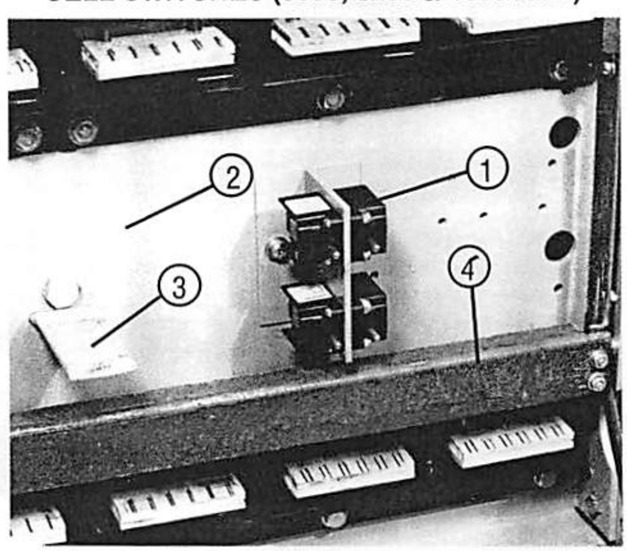
Each switch contains one normally closed and one normally open contact. A total of six switches can be supplied. These contacts are rated 10 amperes up to 300 V.a.c.

FIGURE 29(A)
CELL SWITCHES (600, 800, 1600 & 2000 AMP)



1. Breaker Frame
2. Cradle Frame
3. Operating Bracket
4. Cell Switches

FIGURE 29(B)
CELL SWITCHES (3000, 3200 & 4000 AMP)



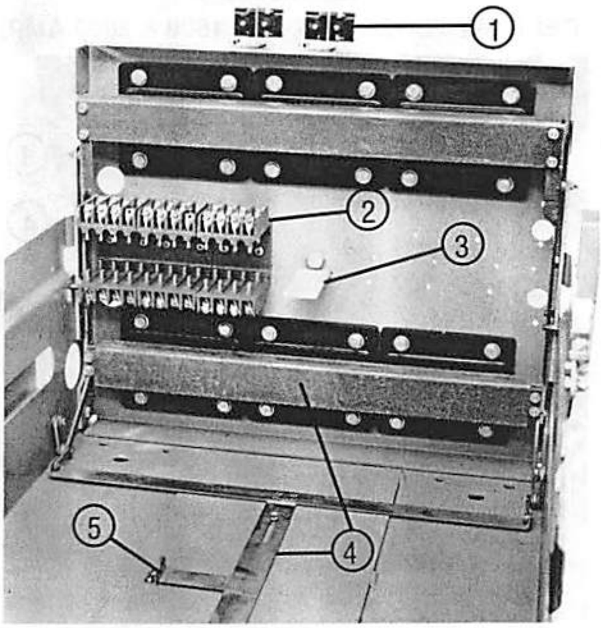
1. Cell Switches
2. Cradle Bus Pan
3. Ground Stab
4. Shutter (In Open Position)

SHUTTERS (Fig. 30)

Shutters are available for all frame sizes up to and including 3200 amperes for both line and load side main plug-in contact stabs.

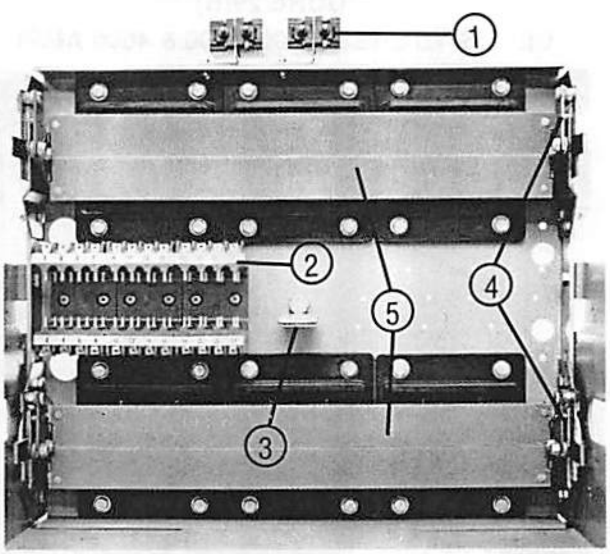
For the 600, 800, 1600, 3000, and 3200 ampere H-3 frame sizes, shutters are of the lifting type shown in figure 30 (A). They have a padlock bracket in the bottom of the enclosure for locking in the down position. When the breaker moves from the test to operating position, shutter bolts on the frame of the breaker lift the shutter to expose the main plug-in contacts.

FIGURE 30(A) SHUTTERS



1. Cell Switches
2. Secondary Control Contacts
3. Ground Stab
4. Shutter Mechanism
5. Padlock Bracket

FIGURE 30(B) SHUTTERS



1. Cell Switches
2. Secondary Control Contacts
3. Ground Stab
4. Shutter Mechanism
5. Shutter

For the 2000 ampere H-3 and for the 600, 800, 1600 and 2000 ampere HL-3 shutters are of the splitting type shown in figure 30 (B). When the breaker moves from the test to operating position, shutter bolts on the frame of the breaker open the shutter to expose the main plug-in contacts.

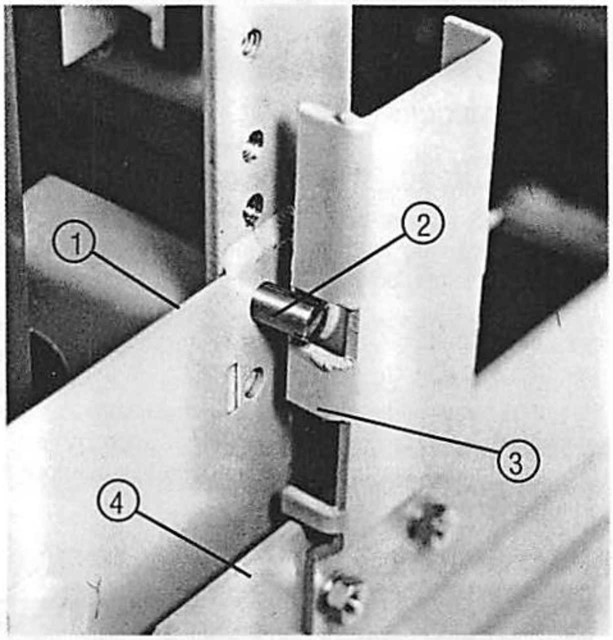
The shutters do not require field maintenance.

REJECTION FEATURES (Fig. 31)

Rejection features are provided on all frame sizes. The rejection feature prevents entry of a breaker into an enclosure of a different frame size. Pins on both sides of the breaker frame match slots cut in brackets mounted on both sides of the cradle.

If the cradle is a different frame size than the breaker, the breaker pins will not match the slots cut in the cradle brackets. Entry of the breaker into the wrong frame size enclosure is then prevented.

FIGURE 31 REJECTION FEATURES



1. Breaker Frame
2. Rejection Pin
3. Rejection Bracket
4. Cradle Sideplate

LIFTING DEVICE (Fig. 32)

A lifting device is available from the manufacturer for all frame size breakers. The lifting device is a one-piece yoke which fits into lugs on the breaker sideplates. This permits safe removal of the breaker from the enclosure drawout tracks. Lifting yokes are ordered as follows:

Part Number 26G-542 for	600, 800, 1600 and 2000 ampere H-3's.
Part Number 26G-151 for	3000, 3200 and 4000 ampere H-3's.
Part Number 26G-601 for	600, 800, 1600 and 2000 ampere HL-3's.
Part Number 26G-603 for	3000 and 4000 ampere HL-3's.

FIGURE 32
LIFTING DEVICE

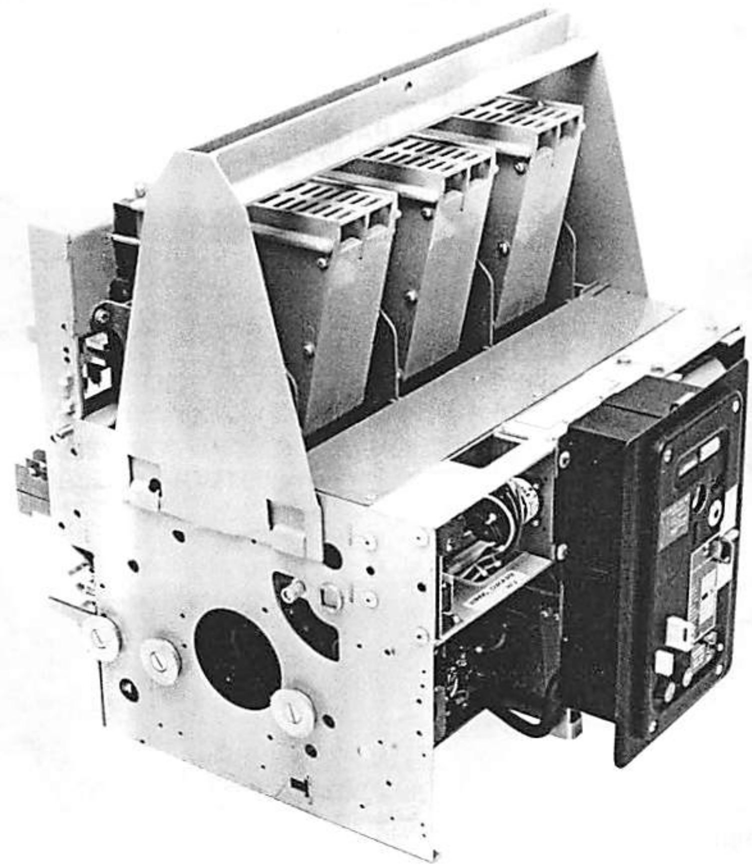


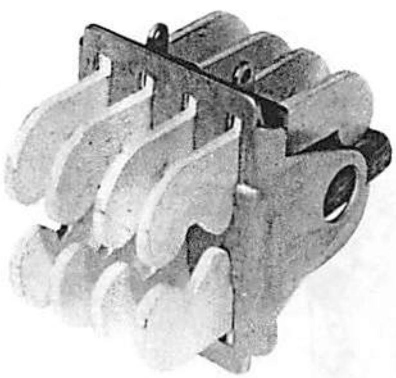
FIGURE 33
COIL DATA

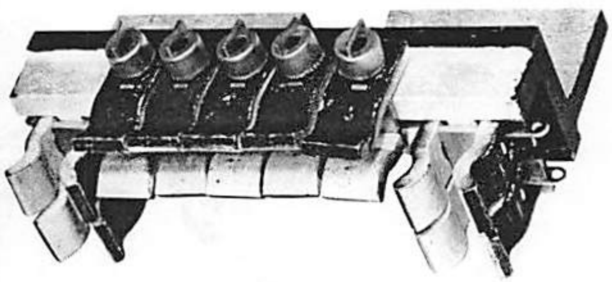
	Rated Control Voltage	Minimum Operating Voltage	D.C. OHMS	Amperes Inrush	Amperes Sealed
Shunt Trip Type A	120 AC	75	30.0	2.45	0.34
	240 AC	150	312.0	1.5	0.15
	48 DC	40	6.0	8.0	0.2
	125 DC	40	50.0	2.2	0.2
	250 DC	70	312.0	0.8	0.1
Shunt Trip Type B	120 AC	60	13.0	1.4	
	240 AC	120	50.0	1.0	
	48 DC	40	13.0	2.0	
	125 DC	40	86.0	2.5	
	250 DC	70	215.0	1.25	
Shunt Close	120 AC	90	30.0	2.45	0.34
	240 AC	180	312.0	1.5	0.15
	48 DC	40	6.0	8.0	0.2
	125 DC	60	50.0	2.2	0.2
	250 DC	150	312.0	0.8	0.1
Undervoltage Trip	120 AC	96	23.0	2.45	0.34
	240 AC	190	312.0	0.8	0.1
Anti-Single Phase Device	240 AC	90	13.0	2.8	
	480 AC	120	50.0	1.8	
	600 AC	120	50.0	2.3	
Charging Motor	120 AC	85		4	
	240 AC	190		2.5	
	48 DC	40		7	
	125 DC	85		4	
	250 DC	190		2.5	

SPARE PARTS (Fig. 34)

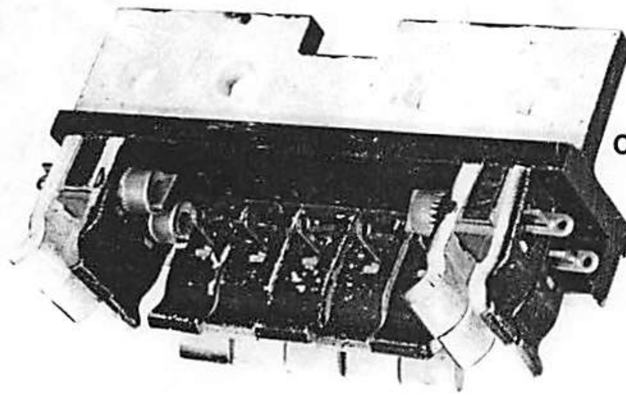
By the nature of its application and its switching capability spare parts for the circuit breaker should normally not be required. If the unit is going to be used for frequent load switching, then the parts shown on the recommended spare parts list should be carried in stock. When ordering spare parts, the complete nameplate data, especially the breaker serial number, should be provided to ensure that the correct parts are supplied.

FIGURE 34
SPARE PARTS



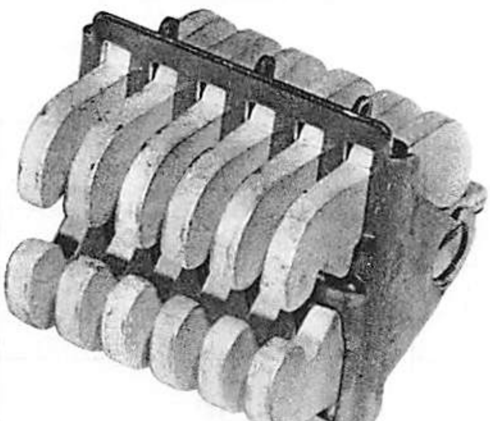


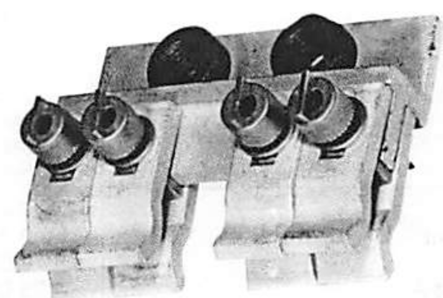
MAIN DRAWOUT CONTACT ASSEMBLY (600 & 800 Amp)



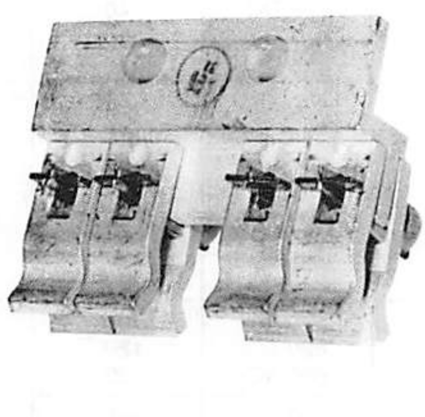
MAIN DRAWOUT CONTACT ASSEMBLY (4000 Amp)

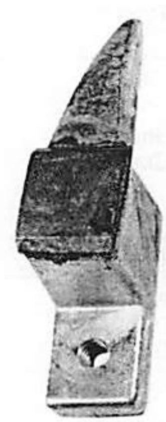
MAIN DRAWOUT CONTACT ASSEMBLY (1600, 3000 & 3200 Amp)





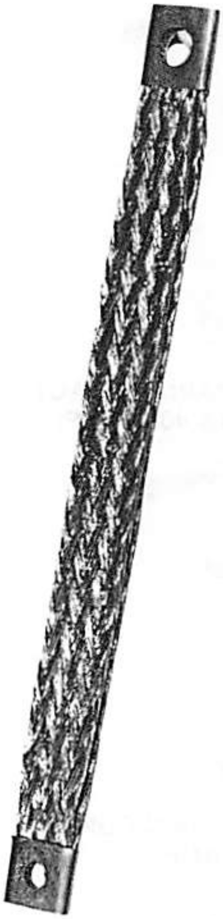
MAIN DRAWOUT CONTACT ASSEMBLY (2000 Amp)





STATIONARY ARCING CONTACT ASSEMBLY

MOVING ARCING CONTACT ASSEMBLY



MAIN
BRAIDS

MAIN MOVING CONTACT
(WAFER ASSEMBLY)

SPACER FOR WAFER
ASSEMBLY (OUTER)

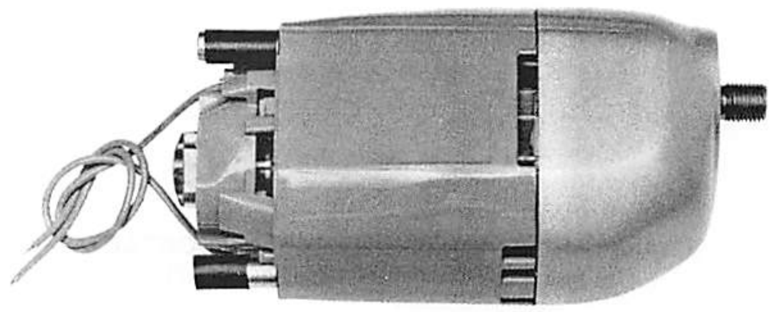
SPACER FOR WAFER
ASSEMBLY (INNER)

ARC CHUTE
ASSEMBLY

ARC CHUTE
LOWER FLASH SHIELD

MAIN MOVING
CONTACT SPRING

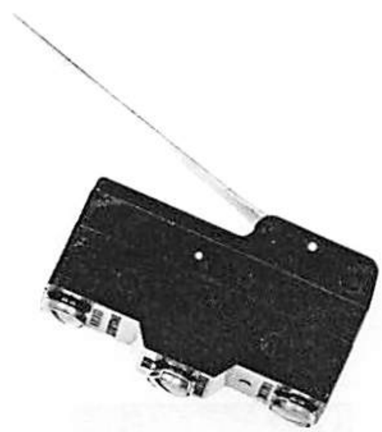
MAIN MOVING
CONTACT SPRING GUIDE



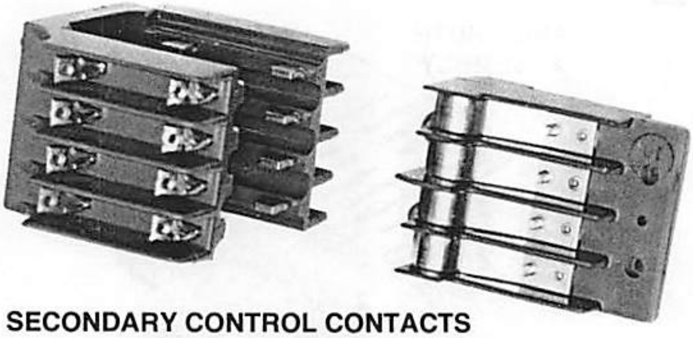
CHARGING MOTOR

SOLENOID COIL
SHUNT TRIP TYPE A
UNDERVOLTAGE TRIP
SHUNT CLOSE

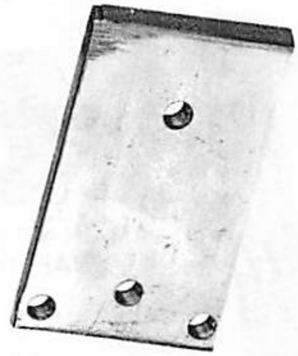
SOLENOID COIL
SHUNT TRIP TYPE B
ANTI-SINGLE PHASE DEVICE



LIMIT SWITCH



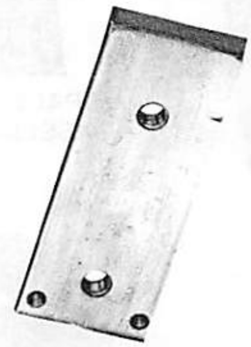
SECONDARY CONTROL CONTACTS



CENTRE STATIONARY MAIN CONTACT
(1600, 2000, 3000, 3200 & 4000 AMP)

UPPER STATIONARY MAIN CONTACT
(1600, 3000 & 3200 AMP DRAWOUT)

UPPER STATIONARY MAIN CONTACT
(1600, 3000 & 3200 AMP FIXED,
ALL 2000 & 4000 AMP)



CENTRE STATIONARY MAIN CONTACT
(600 & 800 AMP)

UPPER STATIONARY MAIN CONTACT
(600 & 800 AMP DRAWOUT)

UPPER STATIONARY MAIN CONTACT
(600 & 800 AMP FIXED)

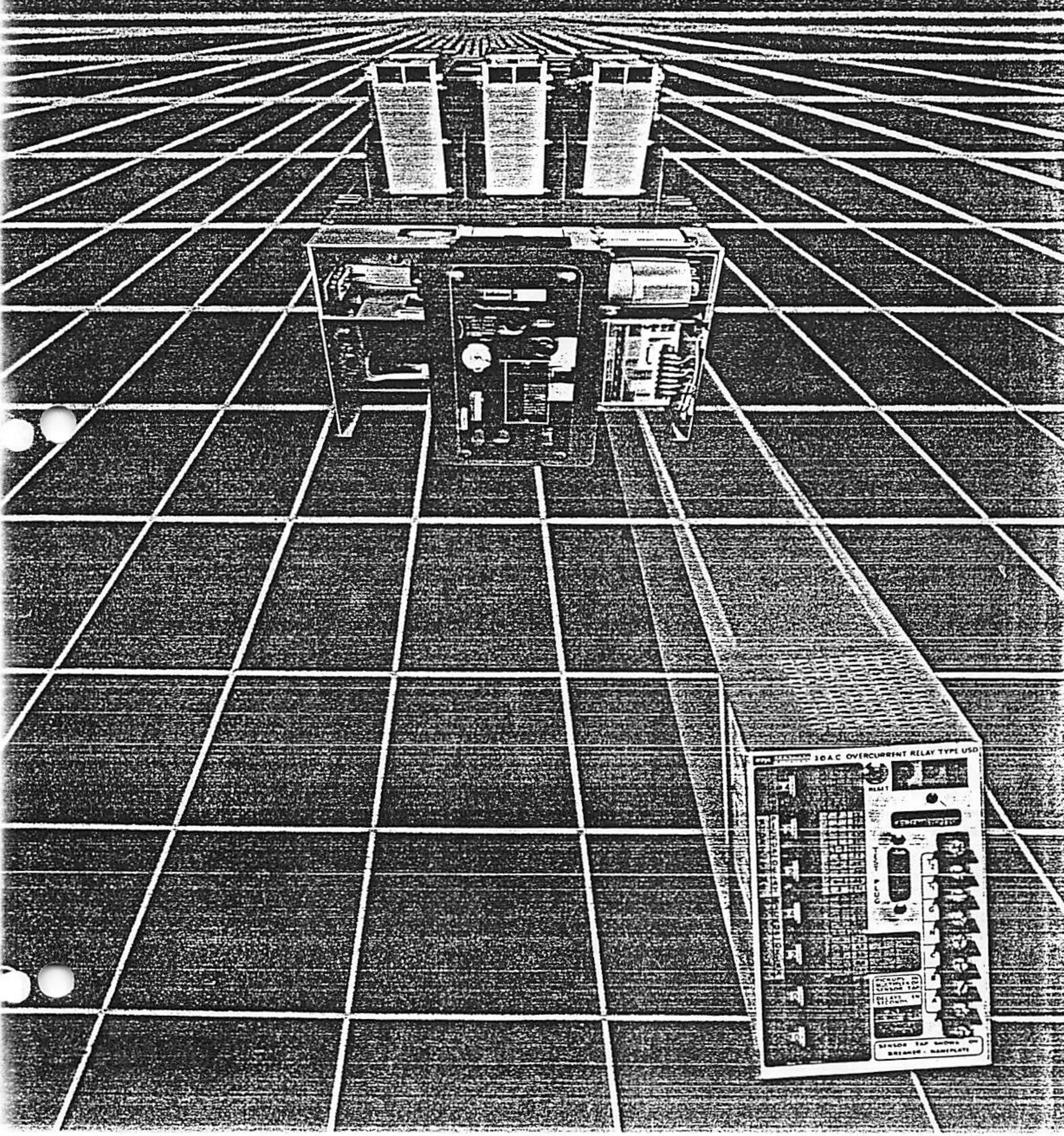
FPÉ FEDERAL PIONEER

Federal Pioneer Limited

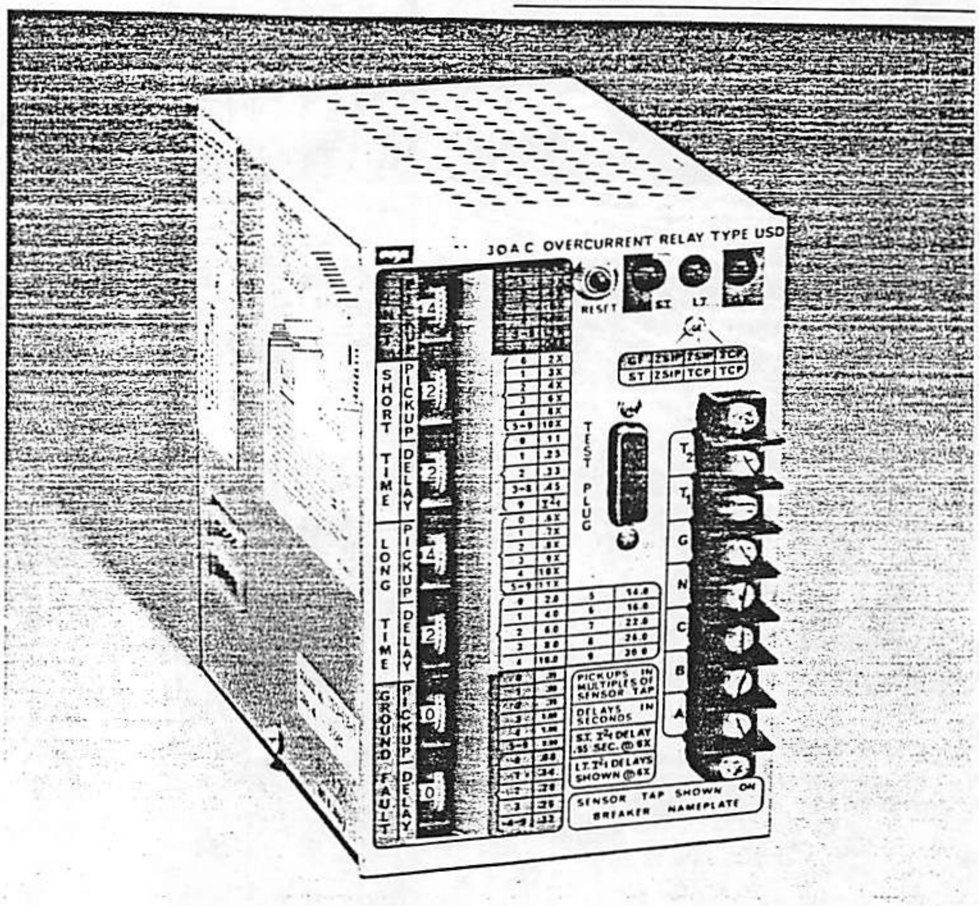
Switchgear Catalogue
C-3-218
May, 1985

New Issue

USD Solid State Relay



The USD relay provides full overcurrent protection for modern electrical installations.



Introduction

The USD solid state overcurrent relay is Federal Pioneer's latest generation of solid state protective relays. The USD is a self powered device which obtains its energy from the current through the breaker being controlled. No auxiliary power supply is required for tripping. The relay protects low voltage power systems against damage through the operation of its overload, short circuit and ground fault circuitry. Zone Selective Instantaneous Protection (ZSIP) is also available as a standard feature on USD relays equipped with ground fault elements. The Federal Pioneer type H-3 and HL-3 air circuit breakers are supplied with the USD relay as a standard feature.

Description

The USD overcurrent protection package is comprised of a 3 phase USD relay, current sensors and a high input energy direct acting solenoid type shunt trip. In the case of a 3 phase 3 wire system 3 sensors are mounted in the breaker. On a 3 phase 4 wire solidly grounded system a fourth sensor is required for ground fault protection.

Available Relay Models

There are two basic types of USD relays, the USD-3 and the USD-6. The features of these relays are listed below.

Relay	Features
USD-3	Long Time, Short Time and Instantaneous.
USD-3IR	As USD-3 + local indication and contacts for remote indication.
USD-6	Long Time, Short Time with ZSIP, Instantaneous and Ground Fault with ZSIP.
USD-6IR	As USD-6 + local indication and contacts for remote indication.

ZSIP®

Selectivity between main and feeder breakers is conventionally obtained by using time co-ordinated trip devices, with the device furthest downstream set for minimum time delay. The disadvantages of this method are that fault levels increase in zones closer to the main breaker and the time to clear these faults increases. The power system must withstand these high fault current levels until the time delay on the first device upstream of the fault expires.

With ZSIP® the trip device that senses a fault in its zone of protection trips instantaneously, minimizing system damage.

The USD relay also sends a restraint signal to all upstream devices and causes them to operate according to their time co-ordinated protection mode, increasing service continuity.

ZSIP® is available on the short time and ground fault elements of the USD relay.

Local and Remote Indication

Local indication is by long-life LED's on the relay faceplate while remote indication is facilitated through a set of dry contacts which can be connected to remote annunciating or alarm devices. 120 volt a.c. 2.5VA control power is required.

USD Relay Models

Characteristics	USD-3	USD-3IR	USD-6*	USD-6IR*
Long Time Elements	•	•	•	•
Short Time Elements without ZSIP®	•	•		
Short Time Elements with ZSIP®			•	•
Instantaneous Elements	•	•	•	•
Ground Fault Elements with ZSIP®			•	•
Local and Remote Indication		•		•

*Add the following suffixes:
- 6 for use with CUD 1.5 and CSD-6 sensors
- 8 for use with CSD-8 sensors
- 16 for use with CSD-16 sensors
- 20 for use with CSD-20 sensor
- 32 for use with CUD-30 and CUD-32 sensors
- 40 for use with CUD-40 and CUD-60 sensors

Figure 1 — **USD-6IR Faceplate Layout**

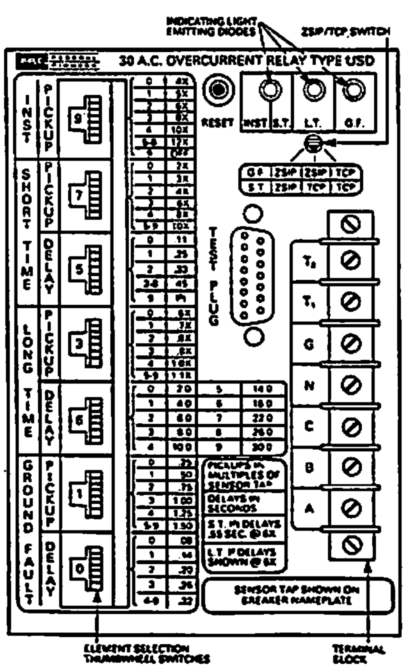
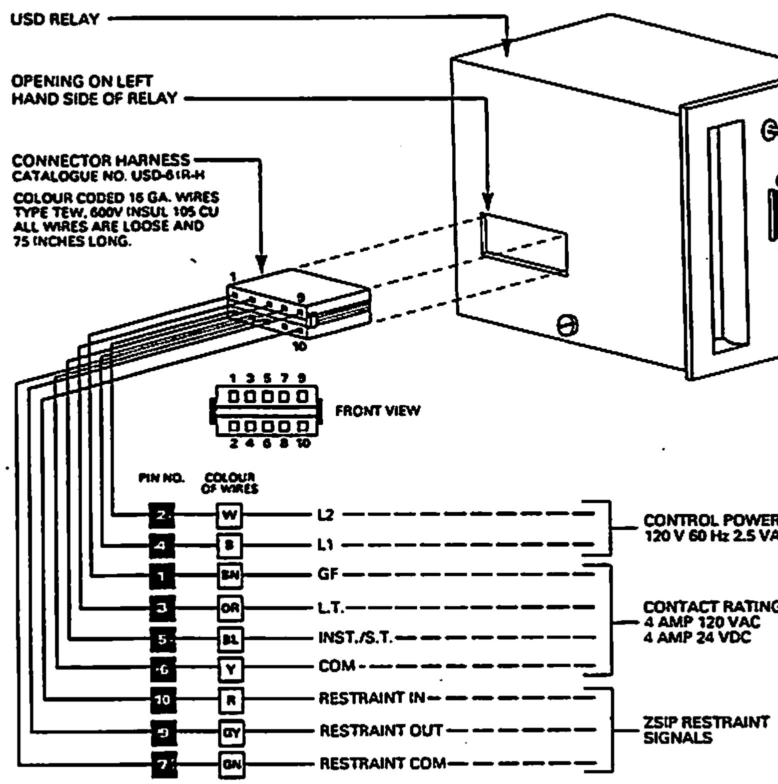


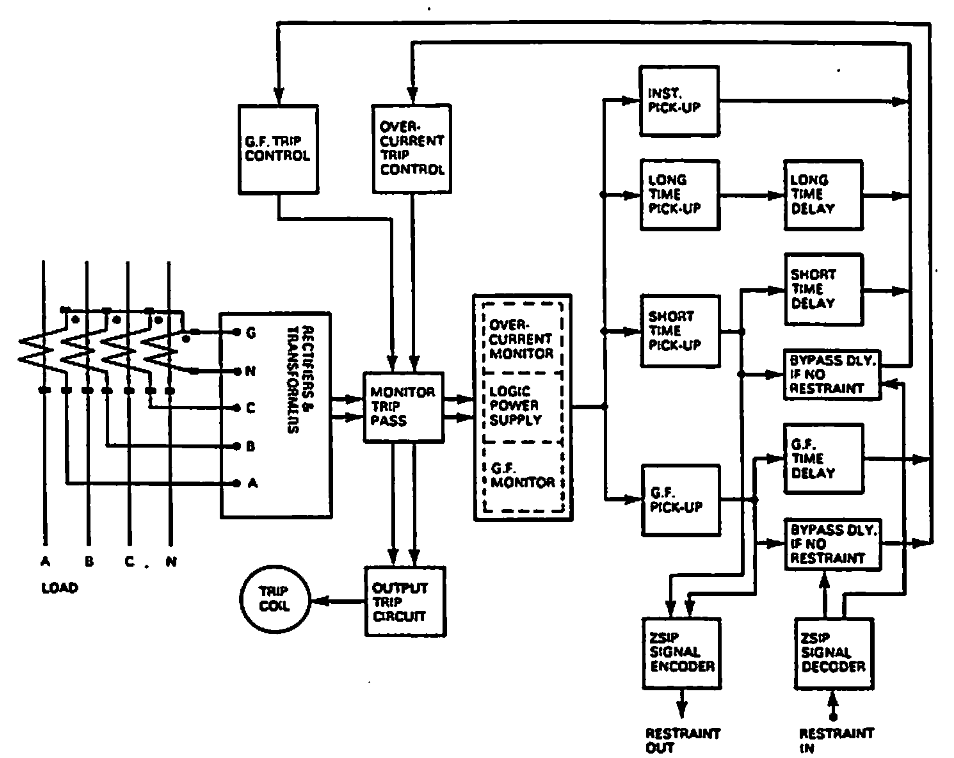
Figure 2 — **Remote Indication and ZSIP Connections for USD-6IR**



Relay Operation
The USD relay is comprised of current matching transformers, a power supply, logic circuitry, thumbwheel switches, and the output pulse generator. These components are housed in a single metal enclosure. Interconnection of the USD relay with the primary current sensors and the shunt trip solenoid is accomplished through a labelled terminal block mounted on the faceplate of the relay. Connections for the control power local indication, remote indication and the Zone Selective Instantaneous Protection (ZSIP) is accomplished by means of a colour coded wiring harness. The harness is attached to a 10 pin connector that plugs and locks into the left hand side of the relay enclosure. This connection is shown in Figure 2.

The relay has 4 elements which operate independently and perform the various protection functions. They are: Short Time, Long Time, Instantaneous and Ground Fault. The pickup settings and/or time bands are field selectable by means of thumbwheel switches located on the relay faceplate. The pickup and time delay settings are factory programmed and calibrated in discrete settings for repetitive accuracy and precision. Gold plated contacts are used on the thumbwheel switches for selecting settings, assuring long lasting positive electrical performance.

Figure 3 — **USD Relay Functional Block Diagram**



Selecting Settings
Thumbwheel switches for selection of current pickup levels and time delays are provided on the relay faceplate, grouped in a vertical column, and paired according to the characteristic controlled. Adjacent to each knurled thumbwheel switch is a setting table which correlates the setting number on the switch face (0-9) with the actual setting.

The use of thumbwheel switches provides positive factory calibrated settings, which are immune to "drifting" in service.

Long Time
The pickup setting is adjustable from 0.6 to 1.1 times the current sensor tap setting with calibration points at 0.6, 0.7, 0.8, 0.9, 1.0 and 1.1 times. Pickup tolerance is ±8%. Time delay is adjustable from 2 seconds to 30 seconds with 10 calibration points at 2, 4, 6, 8, 10, 14, 16, 22, 26 and 30 seconds. The time intervals shown are at 6 times the current sensor tap setting. The tolerance is ±10% of the time shown.

Short Time
The pickup setting is adjustable from 2 to 10 times the current sensor tap setting with calibration points at 2, 3, 4, 6, 8 and 10 times. Pickup tolerance is ±8%. The Short Time delay characteristics are adjustable from 0.11 to 0.45 seconds with calibration points at 0.11, 0.25, 0.33 and 0.45 seconds. The band width is ±10% of the times shown. In addition an I^2t function is available as a standard feature on all relay types. When short time ZSIP is selected and the fault is within the relay's zone the relay trips instantaneously (0.05 seconds).

Instantaneous
The pickup setting is adjustable from 4 to 12 times the current sensor tap setting with calibration points at 4, 5, 6, 8, 10 and 12 times. There is also an "off" position on the selector switch. With this setting the instantaneous element will not pickup unless the breaker closes on a fault that exceeds 13 times the sensor tap setting, in which case a discriminator will initiate the tripping. Pickup tolerance is ±8%.

Ground Fault
There are 6 models of USD-6 (IR) relay which have varying ground fault pick-up levels. This allows you to match the relay and sensors in order to comply with the 1200 amp max. rating specified by electrical codes. The various models are shown in Figure 4.

The ground fault element has a definite time delay characteristic for fault currents in excess of 10 times the sensor tap setting. For fault currents below this value it has an inverse time characteristic. The definite time delay characteristic at the 10 times current level is adjustable from 0.08 to 0.32 seconds with calibration points at 0.08, 0.14, 0.20, 0.26 and 0.32 seconds. When operated in the ZSIP mode tripping will be instantaneous (.02 sec.) unless the relay is operating in the back up TCP (Time Coordinated Protection) mode. The tolerance is ±10% of the times shown.

Figure 4

Catalogue Number	Pick-Up Levels
USD-6(IR)-6	.25, .50, .75, 1.0, 1.5, 2.0
USD-6(IR)-8	.25, .50, .75, 1.0, 1.25, 1.5
USD-6(IR)-16	.20, .30, .40, .50, .60, .70
USD-6(IR)-20	.20, .25, .30, .40, .50, .60
USD-6(IR)-32	.20, .22, .24, .28, .32, .36
USD-6(IR)-40	.20, .22, .24, .26, .28, .30

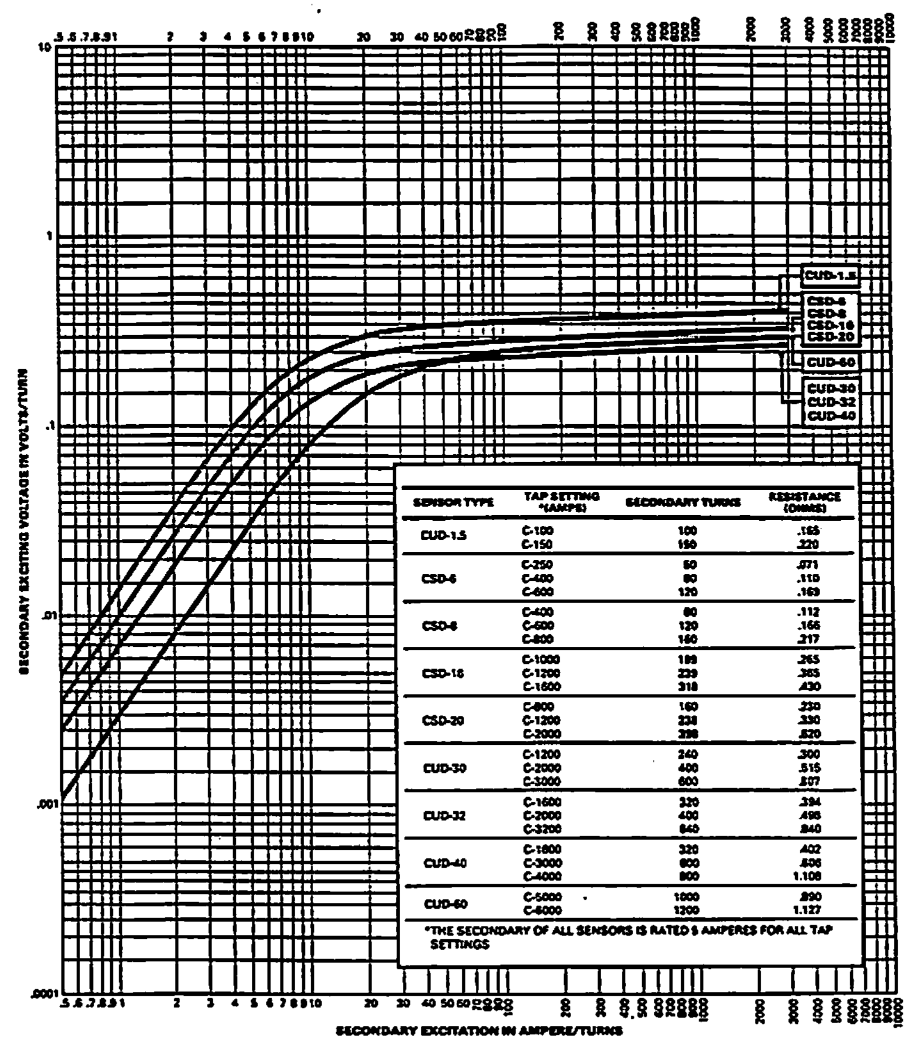
ZSIP Mode Selection
A faceplate mounted rotary switch allows selection of ground fault and short time operating modes.

Local and Remote Indication
When a fault of sufficient magnitude occurs on a circuit the USD relay will trip its associated circuit breaker. Identification of the fault is very important due to the different procedures which should be followed, (before the breaker can be reclosed), if the breaker trips on overload, short circuit or ground fault. Normally in the case of an overload tripping, the breaker can be reclosed safely, but with short circuit and ground fault tripping, investigation is required to locate and repair the fault before reclosing the circuit breaker.

Local indication is provided by long life LED's located on the relay faceplate. These LED's require 120V A.C. control power and they indicate which element of the relay has been operated. Indication LED's are considered superior to "pop-out" mechanical indicators as they provide high visibility indication and positive reset. The LED's will stay on until the relay is reset or control power is interrupted.

For remote indication, 3 sets of dry contacts which can be connected to a remote annunciator or alarm device are provided. There are also separate contacts for remote indication of overload, short circuit and ground fault. The contact is rated 4 amps, 120V AC and 4 amps, 24V DC and is terminated at the socket on the left hand side of the relay.

Figure 5 — **Characteristics of Current Sensors**



SENSOR TYPE	TAP SETTING *(AMPS)	SECONDARY TURNS	RESISTANCE (OHMS)
CUD-1.5	C-100	100	.165
	C-150	150	.220
CSD-6	C-250	50	.071
	C-400	80	.110
	C-600	120	.169
CSD-8	C-400	80	.112
	C-600	120	.166
	C-800	160	.217
CSD-16	C-1000	189	.265
	C-1200	239	.365
	C-1600	318	.430
CSD-20	C-800	160	.230
	C-1200	238	.330
	C-2000	398	.620
CUD-30	C-1200	240	.300
	C-2000	400	.515
	C-3000	600	.807
CUD-32	C-1600	320	.394
	C-2000	400	.496
	C-3200	640	.840
CUD-40	C-1600	320	.402
	C-3000	600	.806
	C-4000	800	1.108
CUD-60	C-5000	1000	.890
	C-6000	1200	1.127

*THE SECONDARY OF ALL SENSORS IS RATED 5 AMPERES FOR ALL TAP SETTINGS

Sensors
The Federal Pioneer sensors are special application 5 amp output secondary units which mount on the primary conductors of the air circuit breaker. These sensors then supply the fault detection logic circuitry of the USD relay with a current signal, through matching transformers provided in the relay. This signal is also supplied to a regulator in order to provide a power source to the USD relay's electronic circuitry.

The core of the current sensor is manufactured with a high quality grain oriented silicon steel alloy.

The core is tape wound and then encapsulated with polestiglass to provide moisture protection. The sensors have two or three tap settings (according to the rating). The same relay can be used for each selectable tap, thereby, the trip rating of the breaker can easily be changed by simply changing the sensor taps.

CUD current sensors have field adjustable tap settings which allow simple alteration of the breakers trip rating.

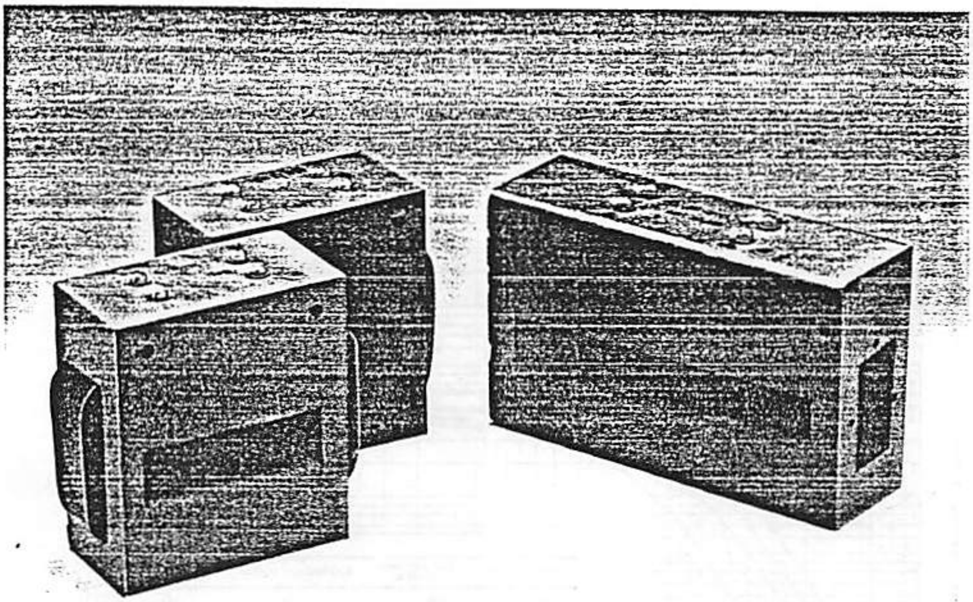


Figure 6 — **Current Sensor Size and Ampere Taps**

Sensor Type	Taps Available	Federal Pioneer Breaker Frame	
CUD-1.5	100,150	600A 800A 1600A 2000A	30H-3, 42H-3 30H-3, 42H-3 50H-3, 65H-3 50H-3, 65H-3
CSD-6	250, 400, 600	600A 800A 1600A 2000A	30H-3, 42H-3 30H-3, 42H-3 50H-3, 65H-3 50H-3, 65H-3
CSD-8	400, 600, 800	800A 1600A 2000A	30H-3, 42H-3 50H-3, 65H-3 50H-3, 65H-3
CSD-16	1000, 1200, 1600	1600A 2000A	50H-3, 65H-3 50H-3, 65H-3
CSD-20	800, 1200, 2000	2000A	50H-3, 65H-3
CUD-30	1200, 2000, 3000	3000A 3000A 3200A 3200A 4000A 6000A	50H-3 75H-3 50H-3 75H-3 100H-3 100H-2
CUD-32	1600, 2000, 3200	3200A 3200A 4000A 6000A	50H-3 75H-3 100H-3 100H-2
CUD-40	1600, 3000, 4000	4000A 6000A	100H-3 100H-2
CUD-60	5000, 6000	6000A	100H-2

Shunt Trip

The high input energy direct acting shunt trip is a cylindrical solenoid which is mounted in the circuit breaker in such a way that the plunger is held in the reset position by gravity. The USD relay, while operating in the trip level, provides a pulse with an initial voltage of 140V. When this trip pulse is supplied to the solenoid, the plunger travels free striking the trip lever of the air circuit breaker.

Relay Testing

The USD Relay has a test plug mounted on the faceplate which is used to connect a (type DDT-USD) Test Set or a metering device in order to run a complete operational test on the relay. This unit also checks the output tripping energy provided by the relay to the shunt trip. The Test Set is plugged into a convenient test plug provided on the faceplate of the relay. The pinout of this test plug is as follows:

Pin	Signal
1	Overcurrent Signal
2	Ground Fault Signal
3	Ground Fault Positive Input
4	Overcurrent Positive Input
5	Instantaneous Pickup/Inhibit
6	Short Time Pickup/Inhibit
7	Long Time Pickup/Inhibit
8	Ground Fault Pickup/Inhibit
9	Overcurrent Trip Inhibit
10	Logic Common
11	Ground Fault Trip Signal (Delay)
12	Overcurrent Trip Signal (Delay)

Special Applications

The USD relay can be modified to suit custom applications. For further details consult Federal Pioneer. The following special application models are available without custom engineering.

Marine Version

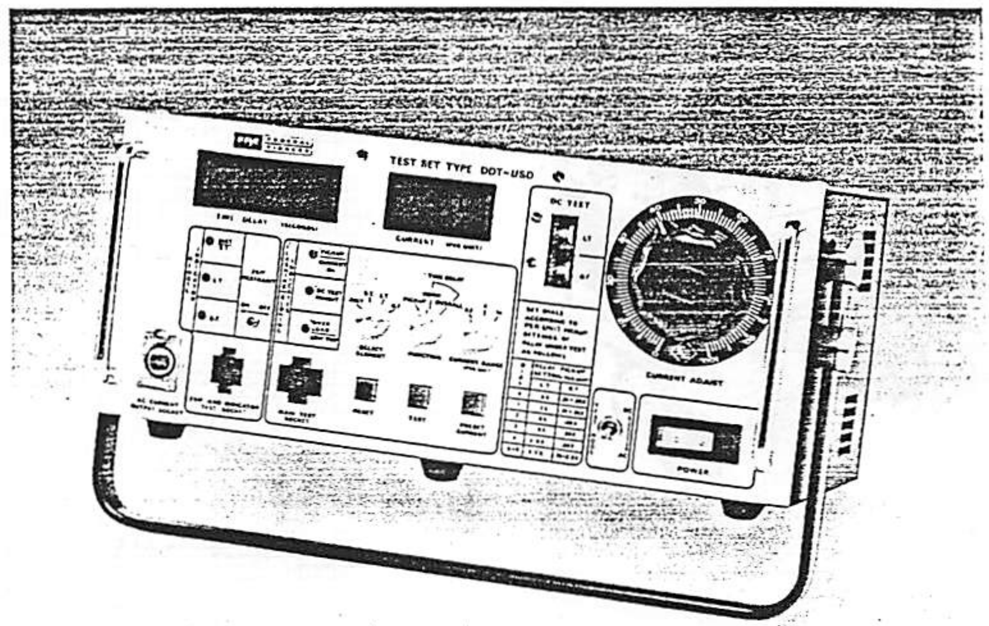
The USD relay is available for marine applications under the following catalog numbers, USDM-2I, USDM-3, USDM-3IR. These models are specially constructed to withstand the rigours of marine duty. In addition the short time and long time responses have been modified to suit marine applications. Ground fault pick-up is not available in the USDM series. Instantaneous pick-up in the USDM series is identical to that of the regular USD relay. The short time pick-up is modified to provide tripping at 2.0, 2.25, 2.5, 2.75, 3.0 and 4.0 times the sensor tap.

The USDM-2I relay does not have a long time pick-up while the USDM-3 and USDM-3IR have the same long time pick-up settings as the USD-3. Time delays in all cases are the same as the regular USD relay.

Long Time Version

The USD relay is available with only long time pick-up under the catalogue number USD-LT. The long time pick-up levels and time delays are the same as those on the regular USD relay. This relay will not provide any instantaneous or short time protection. It is also available with local and remote indication under the catalogue number USD-LT-IR.

The DDT-USD test set allows on-site testing of USD relay characteristics.

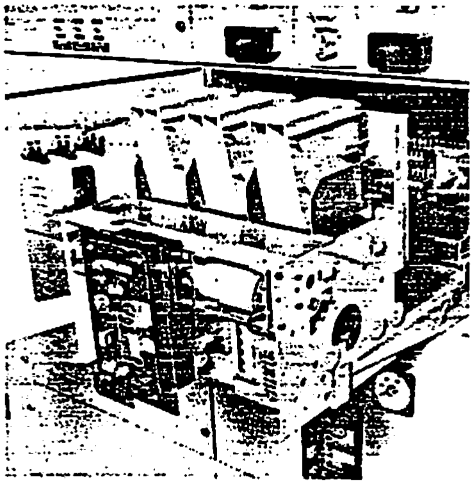


USD Test Set

The Federal Pioneer type DDT-USD Test Set is a portable instrument used for field testing of the USD or SD 3 phase overcurrent relay. The Test Set is completely self-contained, including a storage compartment for test leads and a carrying handle, and is capable of checking all facets of the relays' operations. The Test Set contains a current source and the logic circuitry which performs the test functions. The digital readout display selection switches and all controls are mounted on a fully labelled front panel.

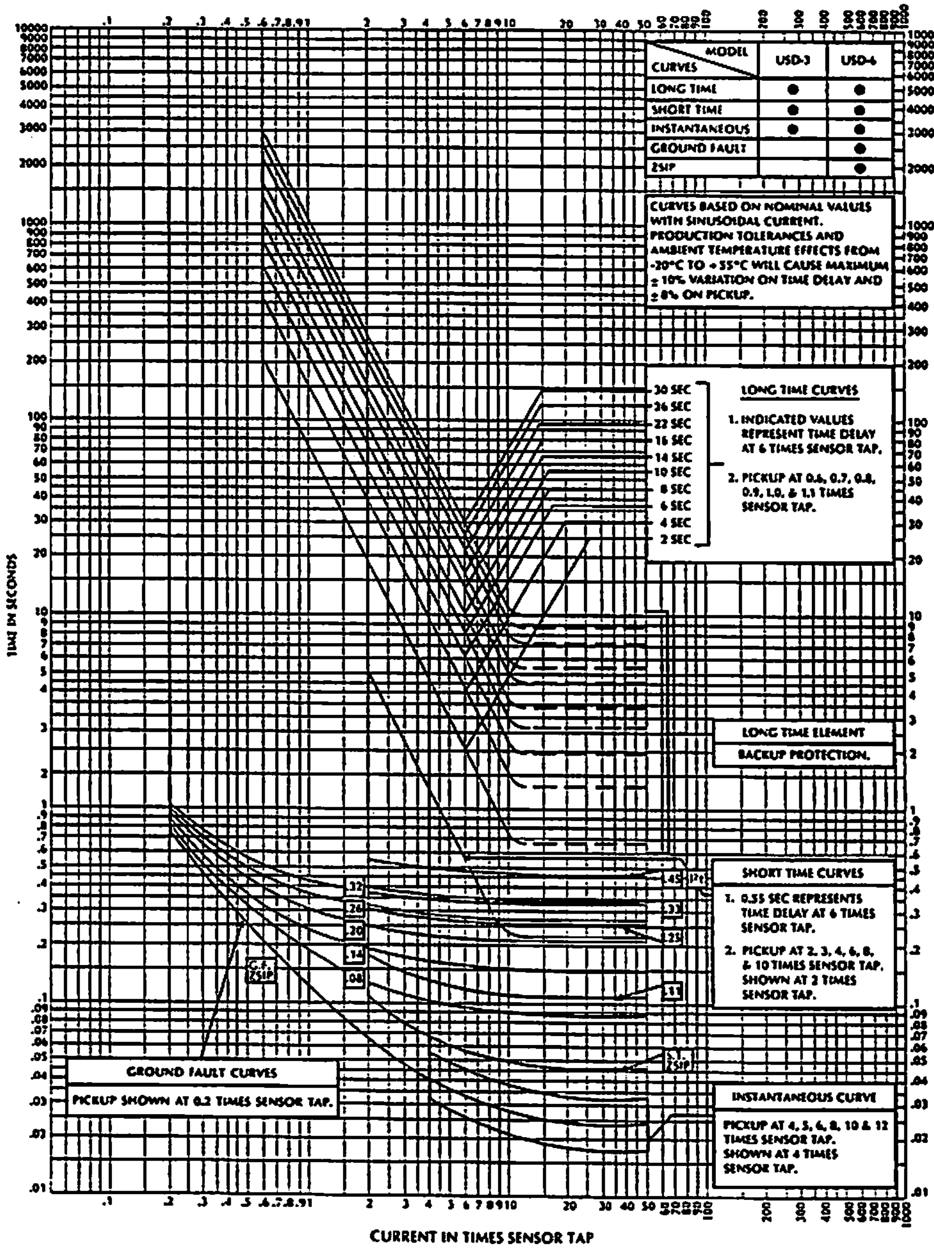
The Test set operates by delivering a momentary 70 amp (14 per unit) secondary injection current to the relay, thereby allowing the complete testing of the instantaneous element. To allow accurate calibration testing of the pickup settings on all elements, the current source of the Test Set is controlled to provide three output ranges with metering from 0.2 per unit to 14 per unit.

The relay accumulates energy on a trip capacitor after a fault condition has been determined and dumps it into the shunt trip device. To assure overall operation of the relay, it is necessary to check that this TRIP circuit does accumulate the required amount of energy when given the signal to do so by any of the four elements. The test set has a built-in feature to monitor the trip capacitor voltage and give indication of a LOW TRIP during the Overall Time Delay Test.



The USD relay is the brains of the H-3 breaker.

Figure 7 — **Time-Current Characteristics**



Federal Pioneer Limited

Parts Information
Type H-3/HL-3 Circuit Breakers

Product Data Sheet

Recommended Spare Parts
Type H-3 Circuit Breakers

DESCRIPTION	30H-3, 42H-3 (800A)		50H-3 (1600/2000A)	
	PART NUMBER	QUANTITY PER BRKR	PART NUMBER	QUANTITY PER BRKR
Arc Chute Assembly	41A-504D	3	41A-504D	3
Arc Chute Lower Flash Shield	13A-566B	3	13A-566B	3
Front Flash Shield	182A-542B	1	182A-542B	1
Moving Arcing Contact	49E-552	3	49E-552	3
Stationary Arcing Contact	49E-551	3	49E-551	3
Upper Stationary Main Contact (Fixed)	49E-555	3	49E-549	3
Upper Stationary Main Contact (Drawout)	49E-554	3	49E-548 (1600A)	3
			49E-549 (2000A)	3
Center Stationary Main Contact	49E-577	3	49E-550	3
Main Drawout Contact Assembly	49E-130	6	49E-519 (1600A)	6
			49E-572 and	3
			49E-573 (2000A)	9
Main Moving Contact (Wafer Assembly)	49E-575	12	49E-575	18
Spacer for Wafer Assembly (Outer)	241B-532	3	241B-532	3
Spacer for Wafer Assembly (Inner)	241B-533	12	241B-533	18
Main Moving Contact Spring	242A-520 (42H-3)	24	242A-520	36
	242A-521 (30H-3)	24		
Main Moving Contact Spring Holder	55B-502	6	55B-502	6
Interphase Barrier	13A-574C	2	13A-574C	2
R.H. End Barrier	13A-575C	1	13A-575C	1
L.H. End Barrier	13A-576C	1	13A-576C	1
Main Braid	27A-500	3	27A-500	3

DESCRIPTION	65H-3 (1600/2000A)	
	PART NUMBER	QUANTITY PER BRKR
Arc Chute Assembly	41A-504D	6
Arc Chute Lower Flash Shield	13A-566B	6
R.H. Front Flash Shield	182A-40A-1	1
L.H. Front Flash Shield	182A-41A-1	1
Moving Arcing Contact	49E-552	6
Stationary Arcing Contact	49E-551	6
Upper Stationary Main Contact (Fixed)	49E-555	6
Upper Stationary Main Contact (Drawout)	49E-554	6
Center Stationary Main Contact	49E-556	6
Main Drawout Contact Assembly	49E-130	12
Main Moving Contact (Wafer Assembly)	49E-575	24
Spacer for Wafer Assemby (Outer)	241B-532	6
Spacer for Wafer Assembly (Inner)	241B-533	24
Main Moving Contact Spring	242A-520	48
Main Moving Contact Spring Holder	55B-502	12
Interphase Barrier	13A-578C	2
End Barrier	13A-172A-1	2
Main Braid	27A-500	6

NOTE: ADDITIONAL SPARE PARTS FOR BREAKERS ELECTRICALLY OPERATED ARE LISTED ON PAGE 2

FPE circuit breakers are subject to continuous product improvement which may result in minor part changes. To ensure that the correct parts are supplied, it is essential that complete nameplate data be provided, especially the serial number, when spare parts are ordered.

Product Data Sheet

Parts Information
Type H-3/HL-3 Circuit Breakers

Recommended Spare Par[illegible]
Type H-3 Circuit Break[illegible]

DESCRIPTION	75H-3 (3200A) PART NUMBER	75H-3 (3200A) QUANTITY PER BRKR	100H-3 (4000A) PART NUMBER	100H-3 (4000A) QUANTITY PER BRKR
Arc Chute Assembly	41A-504D	6	41A-504D	6
Arc Chute Lower Flash Shield	13A-566B	6	13A-612	6
R.H. Front Flash Shield	182A-40A-1	1	182A-40A-1	1
L.H. Front Flash Shield	182A-41A-1	1	182A-41A-1	1
Moving Arcing Contact	49E-552	6	49E-552	6
Stationary Arcing Contact	49E-551	6	49E-551	6
Upper Stationary Main Contact (Fixed)	49E-549	6	49E-623	6
Upper Stationary Main Contact (Drawout)	49E-548	6	49E-623	6
Center Stationary Main Contact	49E-550	6	49E-624	6
Main Drawout Contact Assembly	49E-519	12	49E-509C	12
Main Moving Contact (Wafer Assembly)	49E-575	36	49E-575	36
Spacer for Wafer Assembly (Outer)	241B-532	6	241B-532	6
Spacer for Wafer Assembly (Inner)	241B-533	36	241B-533	36
Main Moving Contact Spring	242A-520	72	242A-520	72
Main Moving Contact Spring Holder	55B-502	6	55B-504 (Inner)	6
			55B-505 (Outer)	12
Interphase Barrier	13A-578C	2	13A-578C	2
End Barrier	13A-172A-1	2	13A-172A-1	2
Main Braid	27A-500	6	27A-500	6

ADDITIONAL PARTS FOR ELECTRICALLY OPERATED BREAKERS

DESCRIPTION	H-3 & HL-3 PART NUMBER	H-3 & HL-3 QUANTITY PER BRKR
MOTOR: 120V AC, DC	183A-513	1
48V DC	183A-517	1
240V AC, DC	183A-520	1
Shunt Close Coil Type A Undervoltage Coil Type A	46A-500-(***)	1
Shunt Trip Coil Type B (SSD Trip Device)	46A-508	1
Shunt Trip Coil Type B (Separate Source) Single Phase Trip Coil Type B	46A-501,2,5,6,7(***)	1
Limit Switch DC Control	249E-8	1
Limit Switch AC Control	249E-9	1
(**)Secondary Control Contact Block (Fixed)	182A-15A-1	1
(**)Secondary Control Contact Block (Moving)	49E-536-1	1
(**)Secondary Control Contact Block For 600V Line Voltage Input Only	49E-536-2	1
Auxiliary Switch - 4 Pole (2NO/2NC)	249A-509B	1
Auxiliary Switch - 8 Pole (4NO/4NC)	249A-510B	1
Auxiliary Switch - 12 Pole (6NO/6NC)	249A-511B	1
Auxiliary Switch - 16 Pole (8NO/8NC)	249A-512B	1
Auxiliary Switch - 20 Pole (10NO/10NC)	249A-513B	1

(**)8 Contact Per Block
Specify Number of Blocks
(***)Specify Type and Voltage

FPE circuit breakers are subject to continuous product improvement which may result in minor part changes. To ensure that the correct parts are supplied, it is essential that complete nameplate data be provided, especially the serial number, when spare parts are ordered.

CLASS 6025P

Parts Information
Type H-3/HL-3 Circuit Breakers

Product Data Sheet

Recommended Spare Parts
Type HL-3 Circuit Breakers

DESCRIPTION	30HL-3 (800A) PART NUMBER	30HL-3 (800A) QUANTITY PER BRKR	50HL-3 (1600/2000A) PART NUMBER	50HL-3 (1600/2000A) QUANTITY PER BRKR
Arc Chute Assembly	41A-504D	3	41A-504D	3
Arc Chute Lower Flash Shield	13A-566B	3	13A-566B	3
Front Flash Shield	182A-542B	1	182A-542B	1
Moving Arcing Contact	49E-552	3	49E-552	3
Stationary Arcing Contact	49E-551	3	49E-551	3
Upper Stationary Main Contact	49E-567	3	49E-568	3
Center Stationary Main Contact	49E-577	3	49E-550	3
Main Drawout Contact Assembly	49E-130	6	49E-573	12
Main Moving Contact (Wafer Assembly)	49E-575	12	49E-575	18
Spacer for Wafer Assembly (Outer)	241B-532	3	241B-532	3
Spacer for Wafer Assembly (Inner)	241B-533	12	241B-533	18
Main Moving Contact Spring	242A-521	24	242A-520	36
Main Moving Contact Spring Holder	55B-502	6	55B-502	6
Interphase Barrier	13A-574C	2	13A-574C	2
R.H. End Barrier	13A-575C	1	13A-575C	1
L.H. End Barrier	13A-576C	1	13A-576C	1
Main Braid	27A-500	3	27A-500	3

DESCRIPTION	75HL-3 (3000A) PART NUMBER	75HL-3 (3000A) QUANTITY PER BRKR	100HL-3 (4000A) PART NUMBER	100HL-3 (4000A) QUANTITY PER BRKR
Arc Chute Assembly	41A-504D	6	41A-504D	6
Arc Chute Lower Flash Shield	13A-566B	6	13A-612	6
R.H. Front Flash Shield	182A-40A-1	1	182A-40A-1	1
L.H. Front Flash Shield	182A-41A-1	1	182A-41A-1	1
Moving Arcing Contact	49E-552	6	49E-552	6
Stationary Arcing Contact	49E-551	6	49E-551	6
L.H. Upper Stationary Main Contact	49E-569-1	6	70.12.013B.1	6
R.H. Upper Stationary Main Contact	49E-569-2	6	70.12.013B.2	6
Center Stationary Main Contact	49E-550	6	49E-624	6
Main Drawout Contact Assembly	49E-519	12	49E-509C	12
Main Moving Contact (Wafer Assembly)	49E-575	36	49E-575	36
Spacer for Wafer Assembly (Outer)	241B-532	6	241B-532	6
Spacer for Wafer Assembly (Inner)	241B-533	36	241B-533	36
Main Moving Contact Spring	242A-520	72	242A-520	72
Main Moving Contact Spring Holder	55B-502	6	55B-504 (Inner)	6
			55B-505 (Outer)	12
Interphase Barrier	13A-578C	2	13A-578C	2
End Barrier	13A-172A-1	2	13A-172A-1	2
Main Braid	27A-500	6	27A-500	6

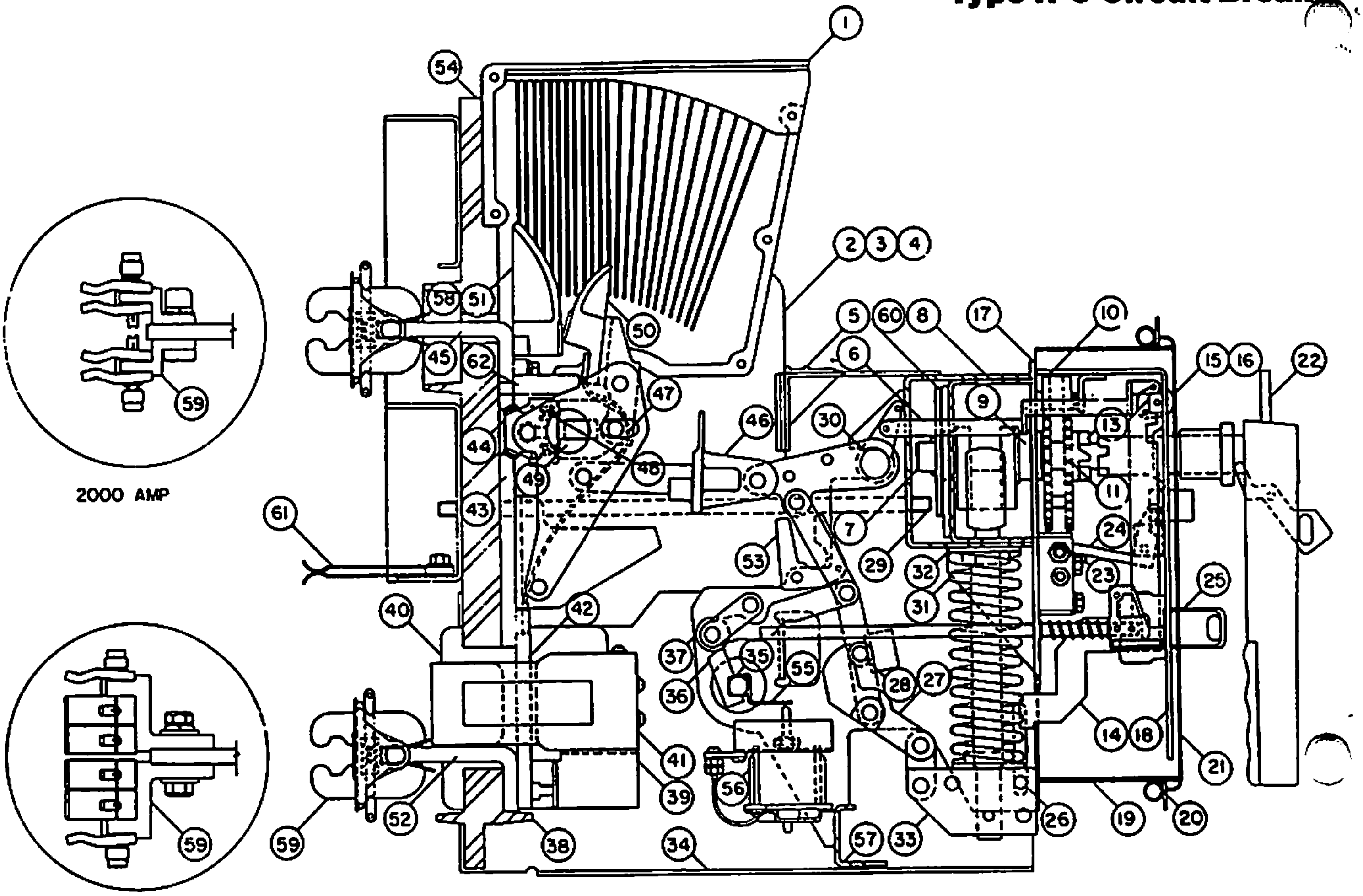
NOTES: Type HL-3 Circuit Breakers utilize (3) Class L Current Limiting Fuses per breaker (Reliance LCL). Select spare fuses based on quantity and ampere rating of fuses installed.

ADDITIONAL SPARE PARTS FOR BREAKERS ELECTRICALLY OPERATED ARE LISTED ON PAGE 2

FPE circuit breakers are subject to continuous product improvement which may result in minor part changes. To ensure that the correct parts are supplied, it is essential that complete nameplate data be provided, especially the serial number, when spare parts are ordered.

Parts Information
Type H-3/HL-3 Circuit Breakers

Part Identification
Type H-3 Circuit Breaker



2000 AMP

4000 AMP

SECTION OF H-3 BREAKER

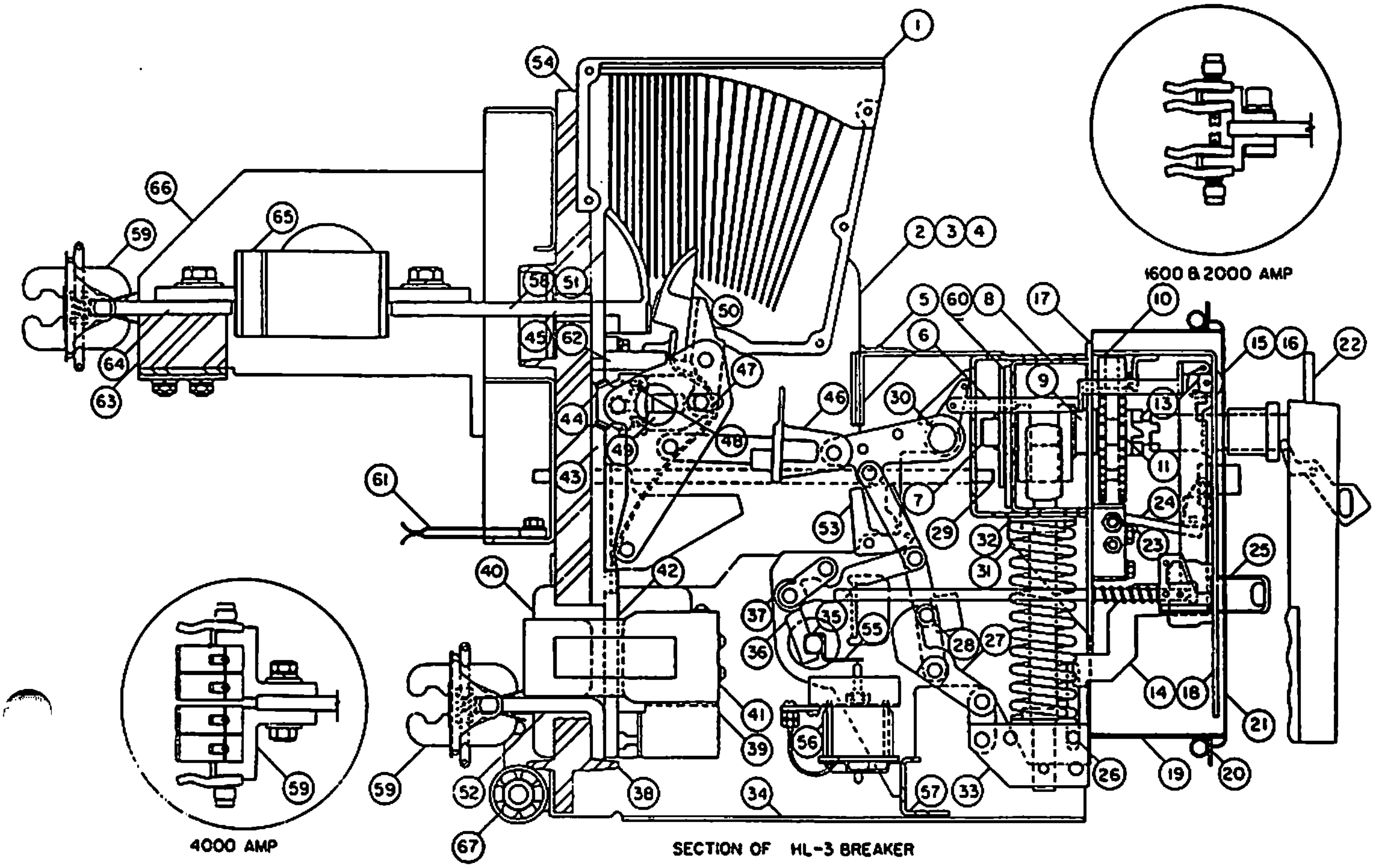
1. Arc Chute Assembly
2. Interphase Barrier
3. R.H. End Barrier
4. L.H. End Barrier
5. Front Flash Shield
6. Closed-Open Link
7. Crank Assembly
8. Crank Box
9. Crank Box Bearings
10. Holding Pawl
11. Ratchet Wheel
12. Oscillating Lever •
13. Clutch
14. Charged-Discharged Link
15. Closed-Open Button
16. Charged-Discharged Button
17. Front Plate
18. Indicator Plate
19. Faceplate Box Assembly
20. Floating Trim
21. Faceplate Assembly
22. Handle Assembly
23. Close Lever
24. Close Latch
25. Trip Rod Assembly
26. Spring Guide Pin
27. Closing Casting
28. Closing Pin
29. Tie Rod Assembly
30. Closing Shaft
31. Main Spring
32. Guide Bushings
33. Clamp Assembly
34. Breaker Frame
35. Trip Shaft
36. Trip Latch
37. Latch Bearing
38. Lower Moulding
39. Sensor Mounting Bracket
40. Barrier
41. Sensor
42. Jumper
43. Centre Stationary Main Contact
44. Main Moving Contact (Wafer Assy)
45. Upper Stationary Main Contact
46. Closing Link Assembly
47. Braid
48. Wafer Contact Spring
49. Spring Holder
50. Moving Arcing Contact
51. Stationary Arcing Contact
52. Load Terminal
53. Anti-Bounce Plate
54. Base Moulding
55. Trip Flipper
56. Trip Coil Assembly
57. Lower Channel
58. Finger Spacer
59. Drawout Contact Assembly
60. SLS Cam
61. Ground Stab
62. Lower Flash Shield

• not shown

Parts Information
Type H-3/HL-3 Circuit Breakers

Product Data Sheet

Part Identification
Type HL-3 Circuit Breakers



4000 AMP

SECTION OF HL-3 BREAKER

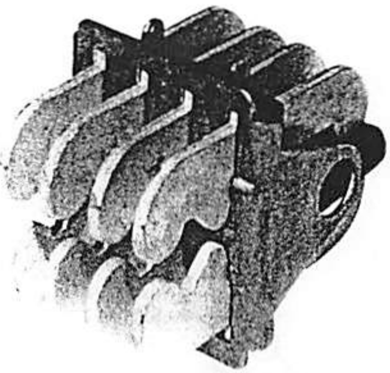
1. Arc Chute Assembly
2. Interphase Barrier
3. R.H. End Barrier
4. L.H. End Barrier
5. Front Flash Shield
6. Closed-Open Link
7. Crank Assembly
8. Crank Box
9. Crank Box Bearings
10. Holding Pawl
11. Ratchet Wheel
12. Oscillating Lever *
13. Clutch
14. Charged-Discharged Link
15. Closed-Open Button
16. Charged-Discharged Button
17. Front Plate
18. Indicator Plate
19. Faceplate Box Assembly
20. Floating Trim
21. Faceplate Assembly
22. Handle Assembly
23. Close Lever
24. Close Latch
25. Trip Rod Assembly
26. Spring Guide Pin
27. Closing Casting
28. Closing Pin
29. Tie Rod Assembly
30. Closing Shaft
31. Main Spring
32. Guide Bushings
33. Clamp Assembly
34. Breaker Frame
35. Trip Shaft
36. Trip Latch
37. Latch Bearing
38. Lower Moulding
39. Sensor Mounting Bracket
40. Barrier
41. Sensor
42. Jumper
43. Centre Stationary Main Contact
44. Main Moving Contact (Wafer Assy)
45. Upper Stationary Main Contact
46. Closing Link Assembly
47. Braid
48. Wafer Contact Spring
49. Spring Holder
50. Moving Arcing Contact
51. Stationary Arcing Contact
52. Load Terminal
53. Anti-Bounce Plate
54. Base Moulding
55. Trip Flipper
56. Trip Coil Assembly
57. Lower Channel
58. Finger Spacer
59. Drawout Contact Assembly
60. SLS Cam
61. Ground Stab
62. Lower Flash Shield
63. Line Side Bar
64. Line Side Terminal
65. Fuse
66. Interphase Barrier
67. R.H.& L.H. Drawout Wheel Assy

* not shown

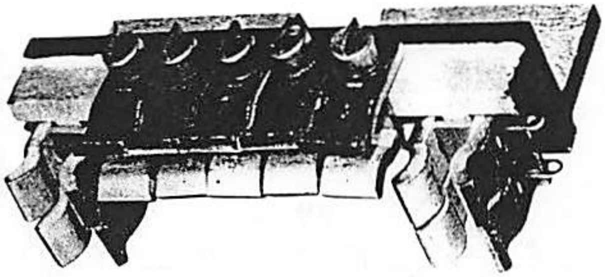
Product
Data
Sheet

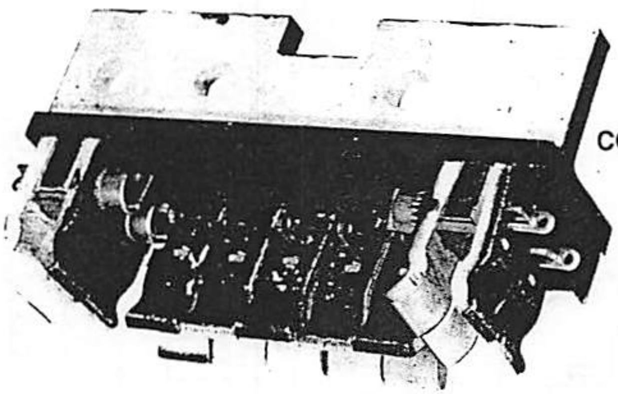
Parts Information
Type H-3/HL-3 Circuit Breakers

Recommended Spare Parts



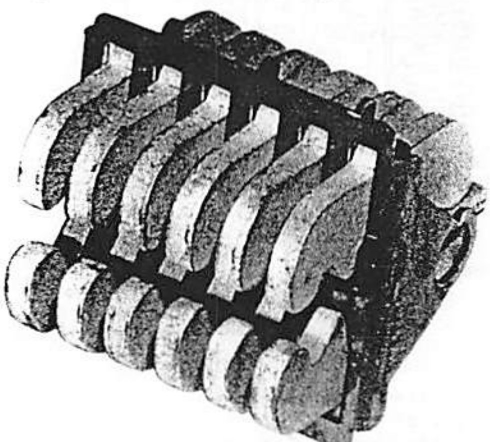
MAIN DRAWOUT
CONTACT ASSEMBLY
(800 Amp)

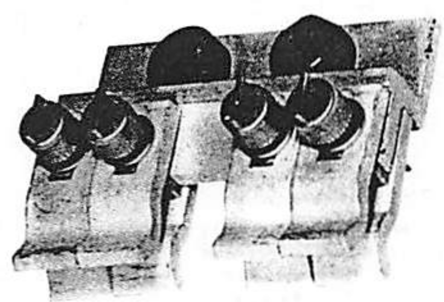




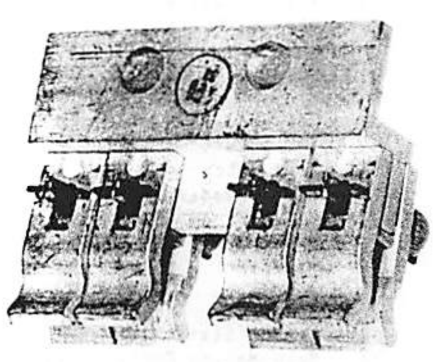
MAIN DRAWOUT
CONTACT ASSEMBLY
(4000 Amp)

MAIN DRAWOUT
CONTACT ASSEMBLY
(1600, 3000 & 3200 Amp)





MAIN DRAWOUT
CONTACT ASSEMBLY
(2000 Amp)



STATIONARY ARCING
CONTACT ASSEMBLY

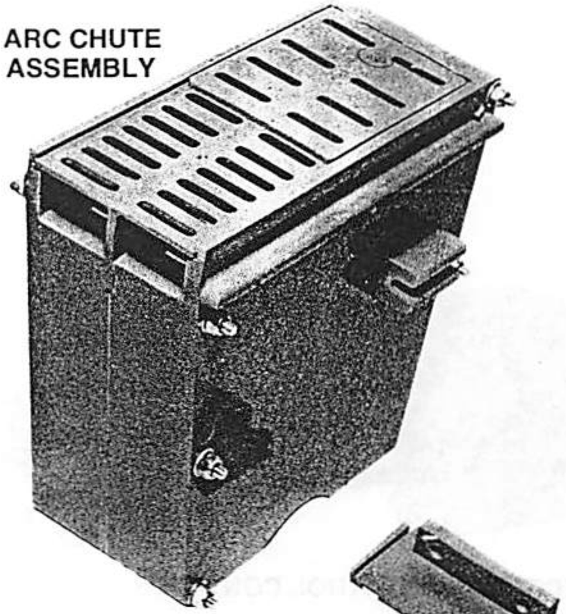
MOVING ARCING
CONTACT ASSEMBL

Parts Information
Type H-3/HL-3 Circuit Breakers

Product Data Sheet

Recommended Spare Parts

MAIN MOVING CONTACT
(WAFER ASSEMBLY)



ARC CHUTE
ASSEMBLY

ARC CHUTE
LOWER FLASH SHIELD

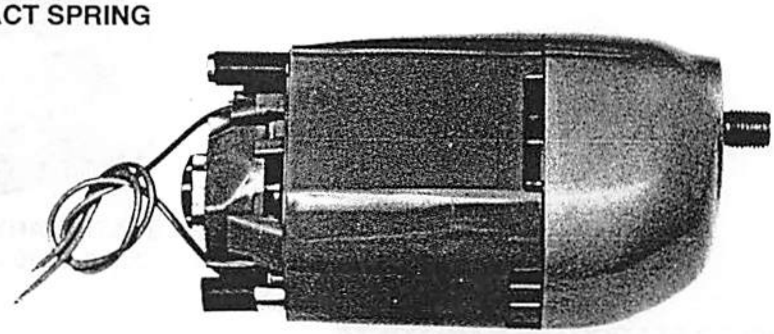
MAIN
BRAIDS

SPACER FOR WAFER
ASSEMBLY (OUTER)

MAIN MOVING
CONTACT SPRING

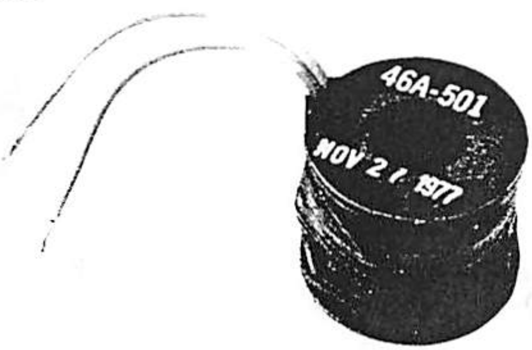
SPACER FOR WAFER
ASSEMBLY (INNER)

MAIN MOVING
CONTACT SPRING GUIDE

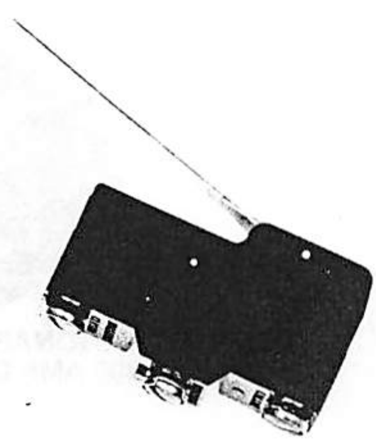


CHARGING MOTOR

SOLENOID COIL
H T TRIP TYPE A
  VOLTAGE TRIP
SHUNT CLOSE



SOLENOID COIL
SHUNT TRIP TYPE B
ANTI-SINGLE PHASE DEVICE



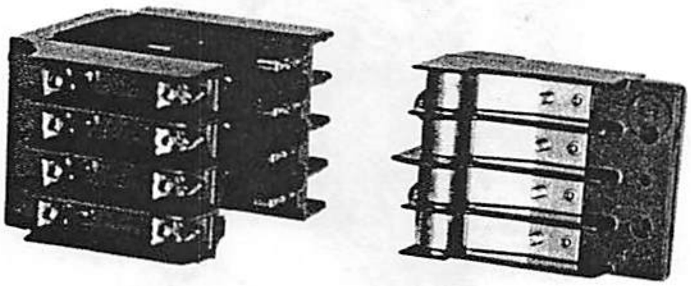
LIMIT SWITCH

Product Data Sheet

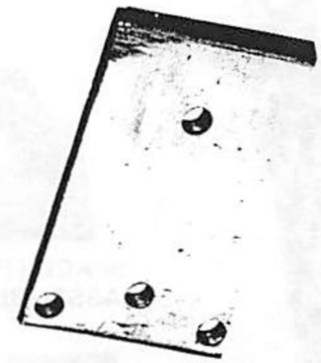
CLASS 6025P

Parts Information
Type H-3/HL-3 Circuit Breakers

Recommended Spare Pa

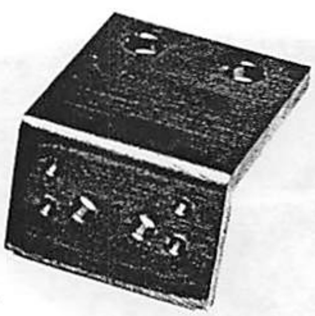


SECONDARY CONTROL CONTACTS



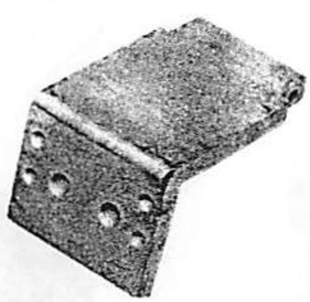
CENTER STATIONARY MAIN CONTACT
(1600, 2000, 3000, 3200, & 4000 AMP)

UPPER STATIONARY MAIN CONTACT
(1600, 3000 & 3200 AMP DRAWOUT)



UPPER STATIONARY MAIN CONTACT
(1600, 3000 & 3200 AMP FIXED,
ALL 2000 & 4000 AMP)

CENTER STATIONARY MAIN CONTACT
(800 AMP)



UPPER STATIONARY MAIN CONTACT
(800 AMP DRAWOUT)

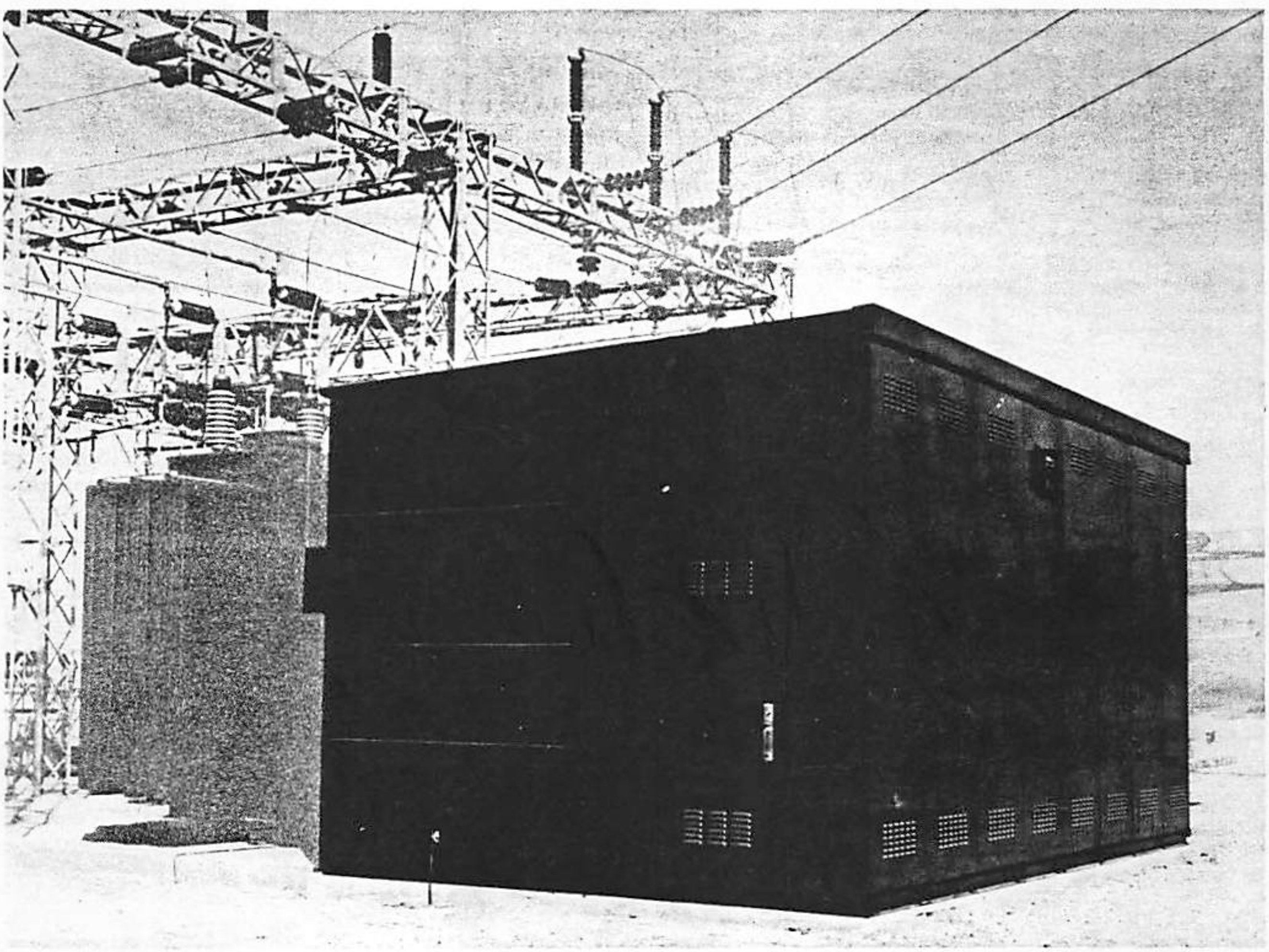
UPPER STATIONARY MAIN CONTACT
(800 AMP FIXED)

IN-820.4A

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

FEDERAL PACIFIC METAL-CLAD SWITCHGEAR

JANUARY 1972



INDEX

List of Illustrations

This manual for job orders shipped beginning March, 1971.

PART I - GENERAL

CONSTRUCTION FEATURES INDOOR OR OUTDOOR:

1. Switchgear Housings and DST-2 Air Circuit Breakers are jig constructed in alignment fixtures to assure interchangeability of breakers. Compartmentalized construction segregates the circuit breaker, main bus, current transformers, potential transformers, and control power transformers.
2. Complete interlocking between the cell and circuit breaker provides safety to personnel and equipment by prevention of incorrect operating procedure.
3. Equipment is designed to reduce installation time, and to comply with ANSI Standards C37.20.

OUTDOOR:

4. Equipment is constructed so that additional sections may be readily added in the field.
5. Protected work-aisle provides ample space for a scheduled maintenance program regardless of weather. Breakers draw out into aisle with sufficient space for interchangeability. The service area is ventilated, waterproof, and adequately lighted; service receptacles are provided.
6. The undercoated structural foundation supports are designed to be self-contained making it necessary to support foundation steel only. This design permits elevating switchgear on supporting structures and thereby reduces flood hazards.
7. Outdoor finish: Three-coat system consisting of a zinc chromate primer, an intermediate coat, and a final ASA-24 dark gray exterior coat.

SHIPMENT

The switchgear is assembled, wired, adjusted and given complete tests at the factory, after which it is inspected and packed for shipment. The air circuit breakers are not shipped in the switchgear compartments, but are packed in separate crates. Each crate is identified, and a complete list of its contents is included in the shipping papers. All instruments and relays are suitably blocked as required to prevent damage to bearings and movements.

Protected work-aisle metal-clad switchgear is shipped in completely assembled sections whenever possible to provide ease of handling and installing. See job assembly drawings and floor plans for details of shipping sections.

REMOVAL FROM CARRIER AND INSPECTION FOR DAMAGE

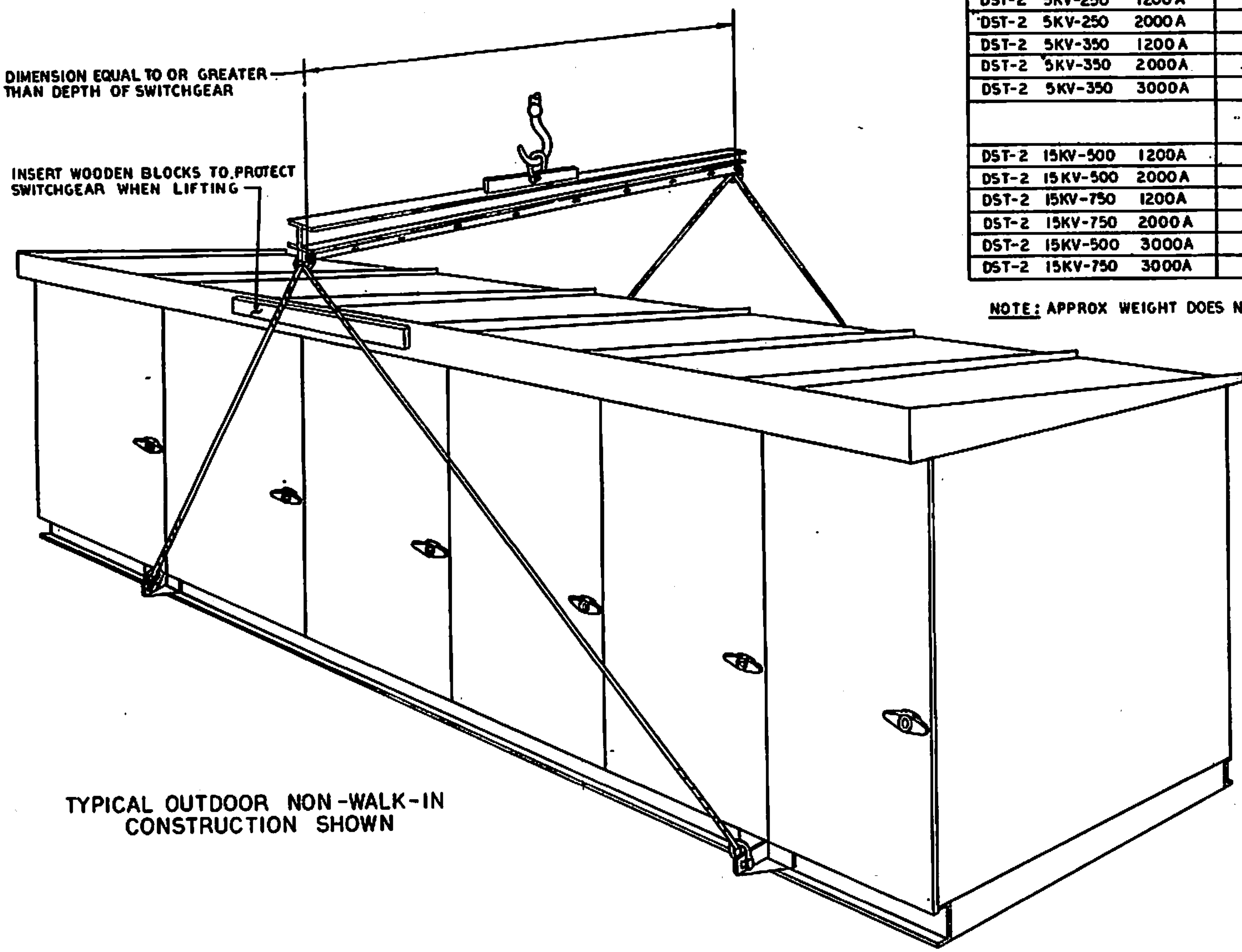
Immediately upon receipt of the shipment, identify all component parts and check them against the shipping list. Make a thorough examination to detect any damage which may have been incurred during transit.

If any damage is discovered, file a claim immediately with the carrier, and send notice of the extent of the damage to the Federal Pacific Electric Company plant from which shipment was made, giving complete identification, carrier's name, and railroad car number if the shipment was made by rail.

The information will enable the company to supply necessary information in support of claim.

MOVING AND LIFTING SWITCHGEAR

1. It is extremely important that care be taken in handling, rigging, hoisting, rolling, or moving assembled switchgear into place. Metal-clad switchgear is designed to be handled only in an upright position and should never be handled in any other way without first consulting with the Switchgear Engineering Department.
2. Each shipping section of indoor switchgear is bolted to a heavy shipping skid which should remain with the gear until it is moved into final location. Each section of outdoor gear is supplied with heavy lifting lugs bolted to the switchgear base.
3. When lifting shipping units with a crane, it is preferable to use two hooks simultaneously, one on each end. Each pair of lifting hooks should be equipped with a spanner bar to prevent excessive distortion. If only a single hook crane is available, arrange spanner(s) to lifting rig as shown on typical outdoor gear lifting drawings 2200C0166 and 2200C0167. (Figures 1 and 2).
4. When cranes are not available, equipment can be rolled into place on shipping skids (indoor) or steel base (outdoor) provided with each shipping section. Pushing or pulling forces should be applied to the skid or base and not the Switchgear.
5. Shipping skids can be removed by using a foot jack in each corner of the shipping section after the switchgear has been moved to its final location.



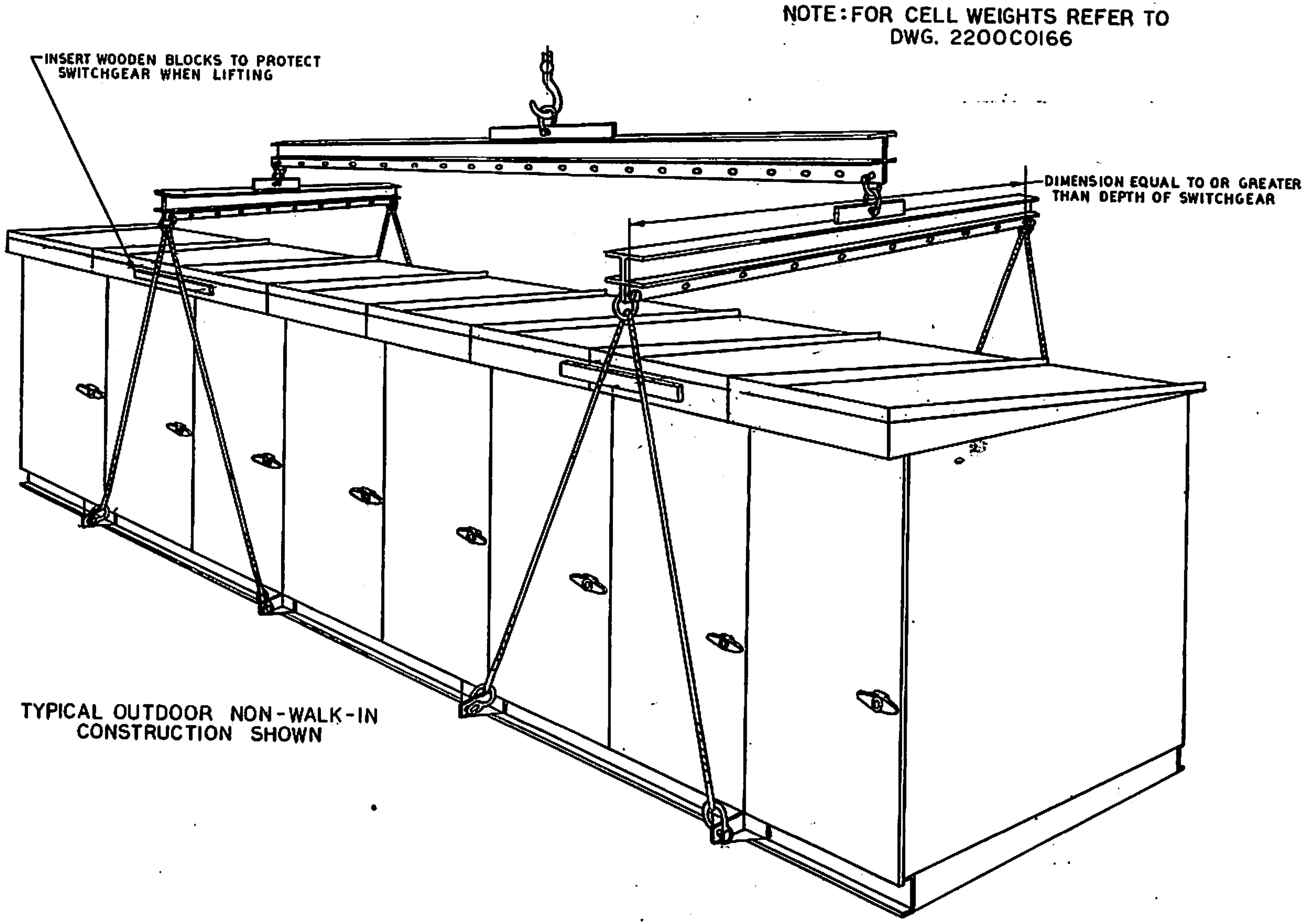
WEIGHTS OF CELL SECTIONS		
RATING OF CELL	WIDTH OF CELL	APPROX NET WEIGHT
DST-2 5KV-250 1200A	26"	2,500 LBS
DST-2 5KV-250 2000A	26"	2,700 LBS
DST-2 5KV-350 1200A	26"	2,800 LBS
DST-2 5KV-350 2000A	26"	2,900 LBS
DST-2 5KV-350 3000A	36"	3,800 LBS
DST-2 15KV-500 1200A	36"	3,000 LBS
DST-2 15KV-500 2000A	36"	3,300 LBS
DST-2 15KV-750 1200A	36"	3,100 LBS
DST-2 15KV-750 2000A	36"	3,400 LBS
DST-2 15KV-500 3000A	36"	3,800 LBS
DST-2 15KV-750 3000A	36"	4,000 LBS

NOTE: APPROX WEIGHT DOES NOT INCLUDE BREAKER

RECOMMENDED METHOD OF LIFTING CELLS (21'-0" LG. MAX) AND ALL WORK AISLE SECTIONS

FPE DWG. NO. 2200C0166

FIGURE 1



RECOMMENDED METHOD OF LIFTING
CELLS (21'-0" LG. AND OVER) AND ALL WORK AISLE SECTIONS

FPE DWG. NO.
2200C0167

FIGURE 2

STORAGE BEFORE INSTALLATION

Protection against loss of equipment is an important precaution. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons and so that it can be quickly located when required in the erection program.

Switchgear equipment, regardless of whether it is to be installed immediately or stored for a while before being erected, should be kept in a dry, clean place. Conditions such as dampness caused by rain or change in temperature, cement dust, etc., should be carefully guarded against. Covering the equipment with a temporary shelter or tarpaulin is frequently necessary both during storage and erection. The longer the period of storage, the greater must be the care taken for protection of the equipment. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 600 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside the units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000V or 2500V megger after heaters have been turned on for approximately one week. A reading of at least 100 megohms should be obtained.

Batteries should be uncrated and put on trickle charge immediately on receipt.

Relay covers should never be left off since the relays are delicate devices and future malfunctions because of moisture and dust could prevent proper tripping of circuit breakers.

Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

FOUNDATION

Federal Pacific Metal-Clad Switchgear is accurately built on true and level bedplates. This care and accuracy insures ease of operation and interchangeability. Equal care during installation should be used.

True and level supports for this equipment are of utmost importance. Little more than ordinary care in laying out and preparing the foundation will be repaid in reduction of cost and labor of installation.

The steel supporting members used in the floor should be held level until the concrete is set. The surface of the floor under the housing should not project above the supporting members. For indoor switchgear only, the surface of the floor should not lie below the supporting members by more than 1/8".

**The floor in front of the housing should not vary more than 1/8" in any square yard and* must not project above *the level of the supporting members. A smooth floor will make rolling of the removable element easier.*

**When installing switchgear where floors already exist, it will usually be desirable to pour a new finished floor above with embedded channels or cut slots for embedding and leveling the supporting channels.*

Encircling loops of reinforcing or building steel around single phase conductors should be avoided in the main cable entrance area if these are rated 600 amperes or above.

FIG. 3 or an equivalent must be used to obtain an adequate foundation. Bolting the switchgear to the foundation is an acceptable method. Welding to the foundation is preferred because it does not require an accurate lining up of holes.

FIG. 4 or an equivalent must be used to obtain an adequate foundation for outdoor equipment. Welding to the foundation is the preferred method of securing.

*For indoor switchgear only.

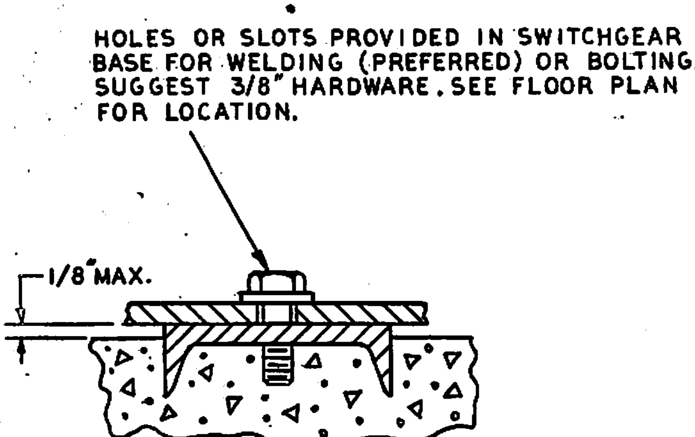


FIGURE 3

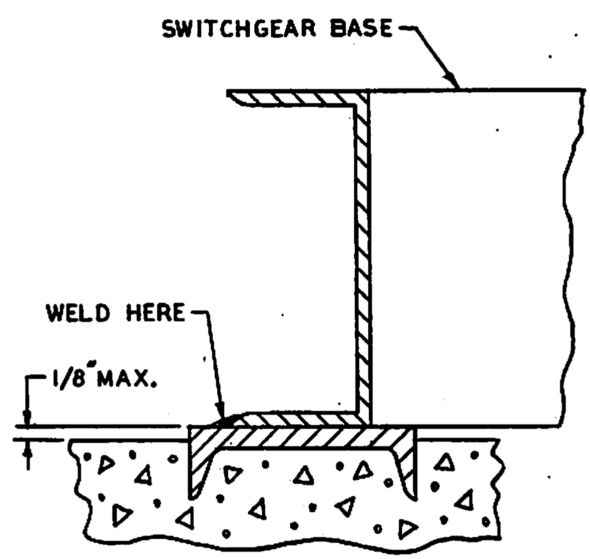


FIGURE 4

PART II - INSTALLATION

HOUSING

INSPECTION

1. Before setting equipment in place, refer to switchgear drawings and, after completely uncrating equipment, check permanent location to see that equipment will properly fit on channels and foundation location. Align and bolt all shipping sections together so that a continuous switchgear installation is obtained. (Refer to Assemblies "A", "B", and "C" below.)
2. Carefully inspect all portions of the circuit breakers for possible damage. 5kV 250 MVA circuit breakers are shipped completely assembled with arc chutes. 15kV and 5kV 350 MVA circuit breakers are shipped separate from arc chutes and may be assembled properly in the protected work aisle and center aisle outdoor houses by use of the arc chute lifting bracket attached to the aisle ceiling. After inspection, the circuit breakers should be carefully inserted and racked into the switchgear cells.
3. Remove shipping braces, inspect for damaged parts, cracked epoxy bus, primary disconnect bushings, bent secondary disconnects, cracked porcelain insulators, wiring insulation — check and report evidence of abuse to equipment.
4. Inspect cells to be certain that power contacts and secondary disconnect contacts located in rear of cell are free of dirt and dust. Cell floor must be clear of all dust and debris to facilitate easy handling of circuit breaker.
5. The breaker is provided with a maintenance closing device for manually closing the breaker. It cannot be used as a manual device to close in the breaker when in the cell. This handle should be used only when the breaker is withdrawn from the compartment.
6. Refer to the circuit breaker Instruction Manual IN-820.11 before inserting breakers into cells.
7. If porcelain entrance or load bushings are mounted in the roof, use flexible connections from incoming and outgoing lines to reduce the strain on the porcelains.
8. Inspect all instrument doors for damage to protective relays.

Control-wiring underground conduit from the control building should terminate inside the switchgear at a level above any existing high-water marks (4" maximum above floor line).

Heaters are furnished in front and rear of each outdoor unit.

The following descriptions and drawings give the general arrangement, sequence of installation, method of fastening the gear to the foundation, location of conduit areas, and other information for the proper location and assembly of the equipment:

ASSEMBLY "A": OUTDOOR PROTECTED WORK AISLE CONSTRUCTION

(See dwg. 2200D0169.)

1. Locate the cell sections accurately on the foundation. When cell equipment is in two sections, locate the sections from the center of the foundation.
2. Check the leveling of the units; use shims where foundation is uneven. Remove lifting lugs.
3. When cells are in two sections and the above are properly leveled and aligned, firmly bolt the bases, cells, and roofs together with the hardware furnished for this purpose.
4. Aisle Section:
   A. When aisle section is in one piece, remove all protective lumber and bracing except wooden horizontal and center vertical braces. Remove lifting lugs.
   B. When aisle section is in two pieces, remove all protective lumber and bracing from each section except wooden horizontal brace, wooden vertical corner and vertical center brace, and open end wooden frame bracing. Remove lifting lugs.

WARNING: UNDER NO CONDITION MAY THE WOODEN HORIZONTAL ROOF SUPPORT BE REMOVED BEFORE ITEM 5 BELOW IS COMPLETED.

5. Slide aisle section(s) into place, making sure that aisle roofs overlap cells and rest on top of cell roofs. Aisle side sheets must be on outside of cell sections.
6. When aisle section is aligned with the cell portion, apply caulk (furnished) between overlapping roof and side sheet surfaces. Firmly bolt bases, roof, and side sheets together and apply cement (furnished) to roof gasket joints.
7. Remove existing wooden braces.
8. Remove floor plates at ends and at base anchoring points.
9. Fasten aisle base to cell base. (See dwg. 2200C0171, Figure 9).
10. Tackweld or anchor the bases to the foundation as indicated on the floor plan drawing.
11. Re-install floor plates.
12. Check and adjust instrument doors for proper alignment to correct possible mishandling during shipment.
13. Complete the assembly of the main and ground buses (when required) by inserting the sections shipped loose for the shipping breaks. (Tighten the bus bar connections per Table "A" on page 6.) Assemble the PVC boots around the main bus joints and fasten together with the nylon hardware furnished. (See instruction page 12.)

14. Re-connect wiring at shipping breaks and where required per wiring diagrams furnished.

NOTE:

A. Customer control wiring connections must be terminated at terminal blocks only — no splicing is permitted.

B. All wiring in conduits must be in accordance with National Electrical Code.

ASSEMBLY "B": OUTDOOR CENTER AISLE CONSTRUCTION

1. Complete items 1, 2, 3, 10, 12, 13, and 14 per assembly "A" above.
2. Bolt aisle-end channels in place.
3. Install floor plates.
4. Assemble end panels of the aisle section.
5. Assemble aisle roofs and seam gaskets.
6. Apply caulk (furnished) between overlapping roof and side sheet surfaces. Firmly bolt roofs and side sheets together and apply cement to roof gasket joints.
7. Check and adjust instrument doors for proper alignment to correct possible mishandling during shipment.

ASSEMBLY "C": OUTDOOR NON-WALK-IN CONSTRUCTION

1. Complete items 1, 2, 3, 10, 12, 13 and 14 per assembly "A" above.

TIGHTENING CONNECTIONS

1. Bus splices at shipping break should be carefully inspected to be certain that good clean, uncontaminated contact is obtained before bolting up tight. A torque wrench should be used.
2. It is also important to be sure that all outgoing cable connections are tightened in the same manner as bus splices.

TABLE A
RECOMMENDED TORQUE
(Values in Foot Pounds)

Type Bolt	Steel*	Everdur
5/16"-18	18	15
3/8"-16	31	21
1/2"-13	55	45
5/8"-11	80	65

*Steel hardware must be SAE 5 or stronger.

FIGURE 5

BUS DUCT

Bus duct connecting between groups of metal-clad switchgear, or between metalclad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the duct. Supports should be provided as indicated on the drawings.

All joints in the bus should be assembled and insulated as described above for main buses. Adjustable joints are provided to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

Outdoor bus duct must be gasketed at the joints between shipping sections.

All removable covers on outdoor bus duct except bottom covers must be gasketed. Do not bolt covers in place until all interior assembly work on the duct is completed and access will no longer be required.

Outdoor bus duct of the 13.8 kv class are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

ADDITION OF UNITS TO EXISTING EQUIPMENT

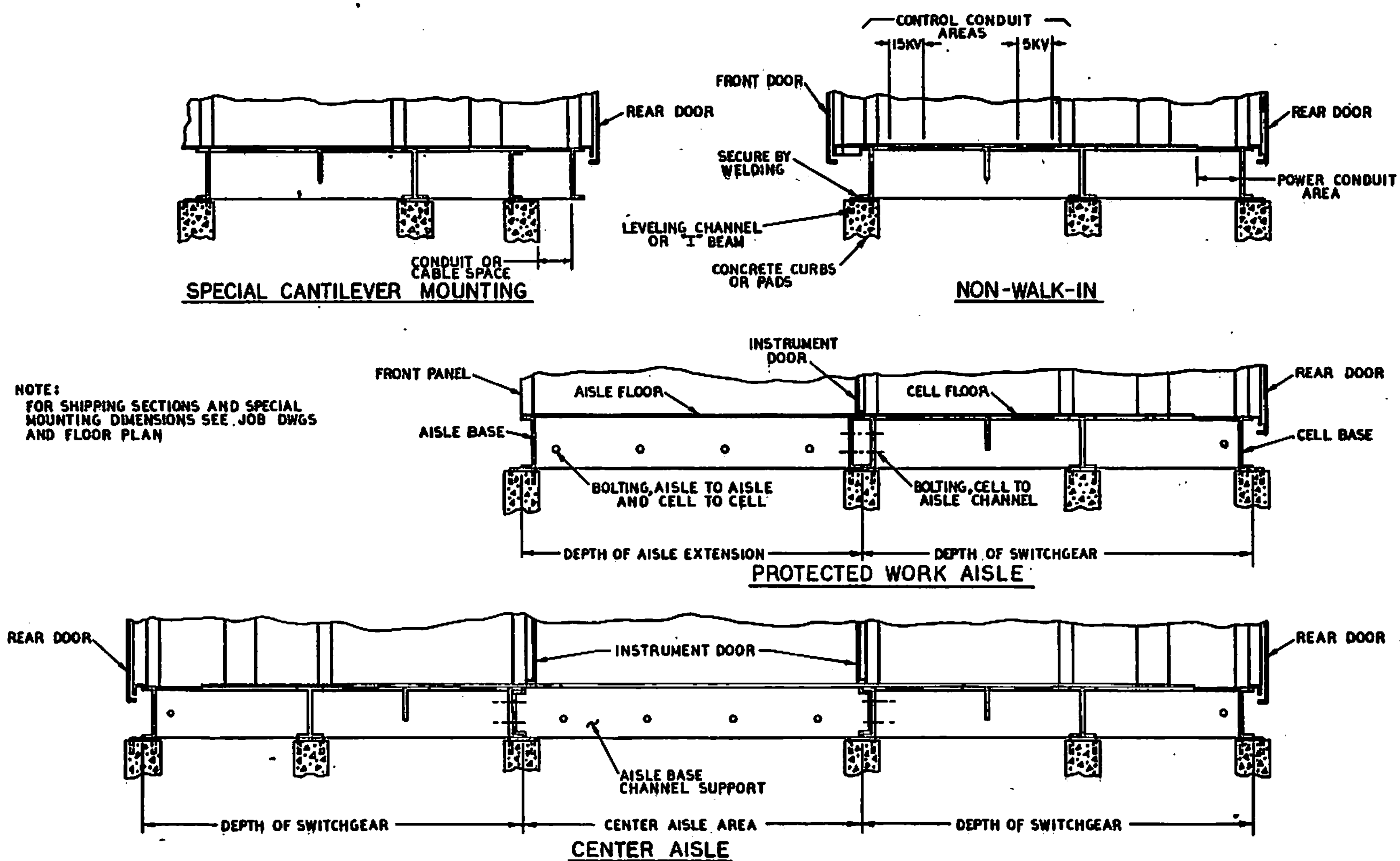
Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment, special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

Dwg. No. 2200C0172 (Figure 10) indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment it is usually necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described in Part II.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections. Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.



METHOD OF MOUNTING AND INSTALLATION OF BASES FOR OUTDOOR HOUSES — FPE DWG. NO. 2200C0168

FIGURE 6

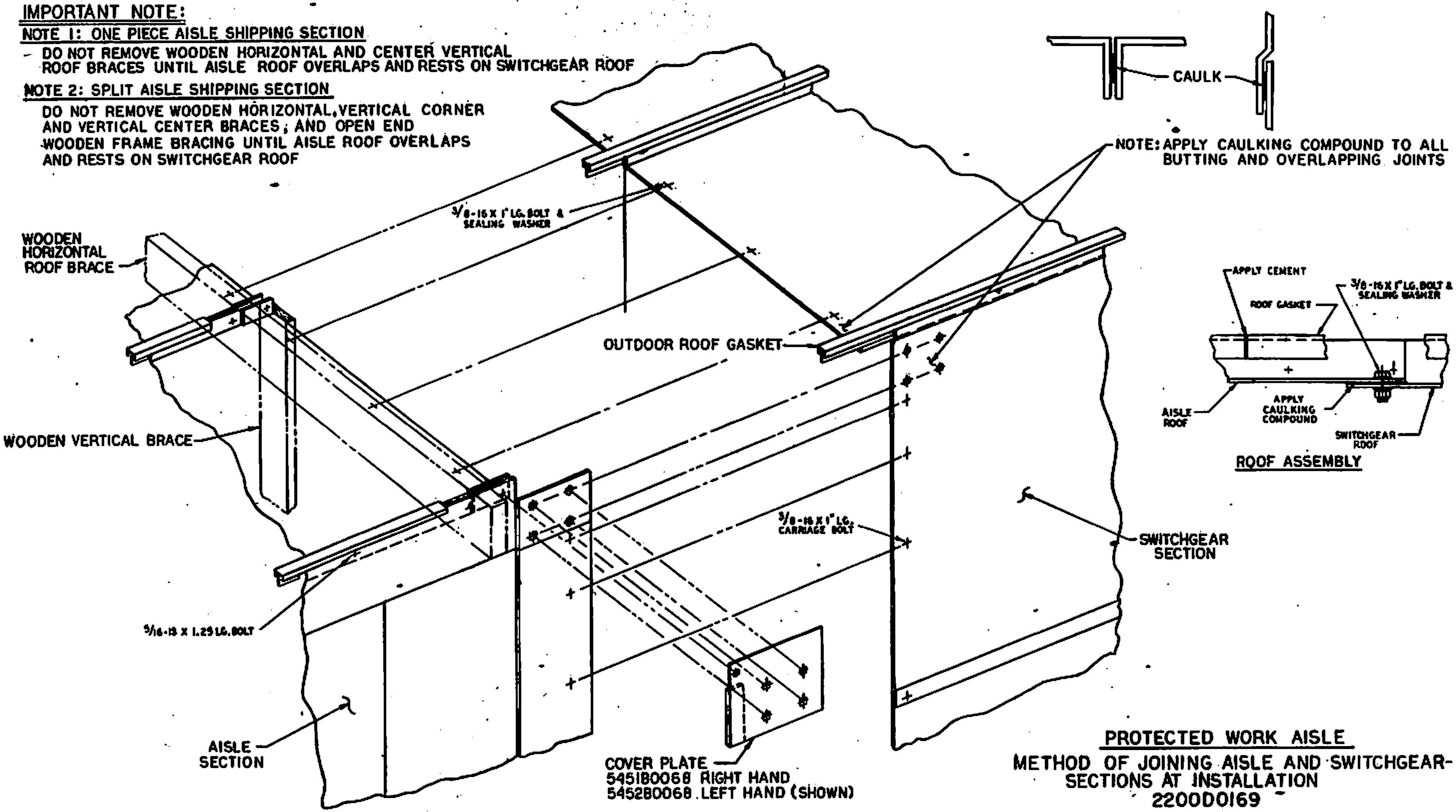
IMPORTANT NOTE:

NOTE 1: ONE PIECE AISLE SHIPPING SECTION

- DO NOT REMOVE WOODEN HORIZONTAL AND CENTER VERTICAL ROOF BRACES UNTIL AISLE ROOF OVERLAPS AND RESTS ON SWITCHGEAR ROOF

NOTE 2: SPLIT AISLE SHIPPING SECTION

DO NOT REMOVE WOODEN HORIZONTAL, VERTICAL CORNER AND VERTICAL CENTER BRACES, AND OPEN END WOODEN FRAME BRACING UNTIL AISLE ROOF OVERLAPS AND RESTS ON SWITCHGEAR ROOF

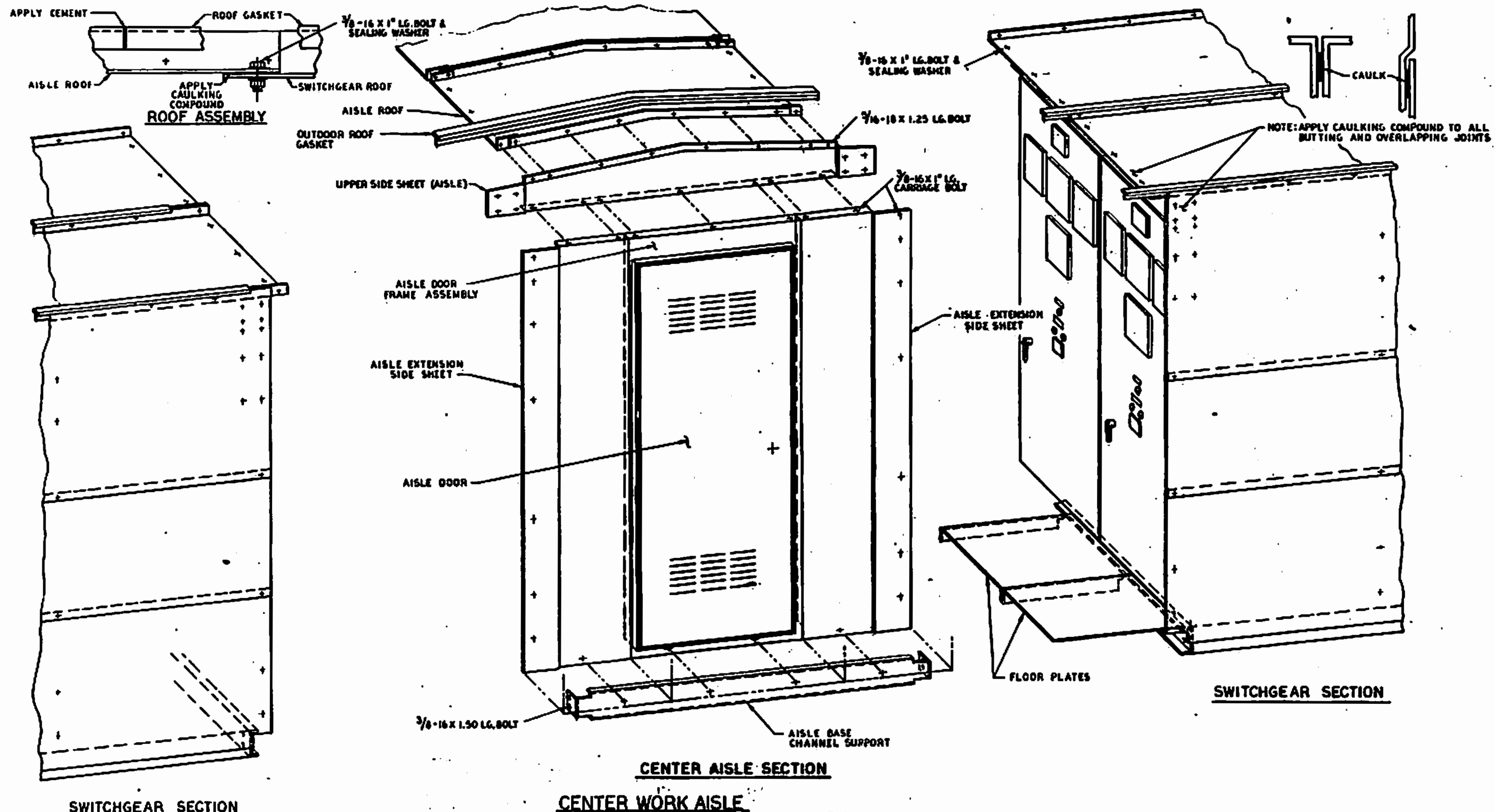


PROTECTED WORK AISLE

METHOD OF JOINING AISLE AND SWITCHGEAR SECTIONS AT INSTALLATION

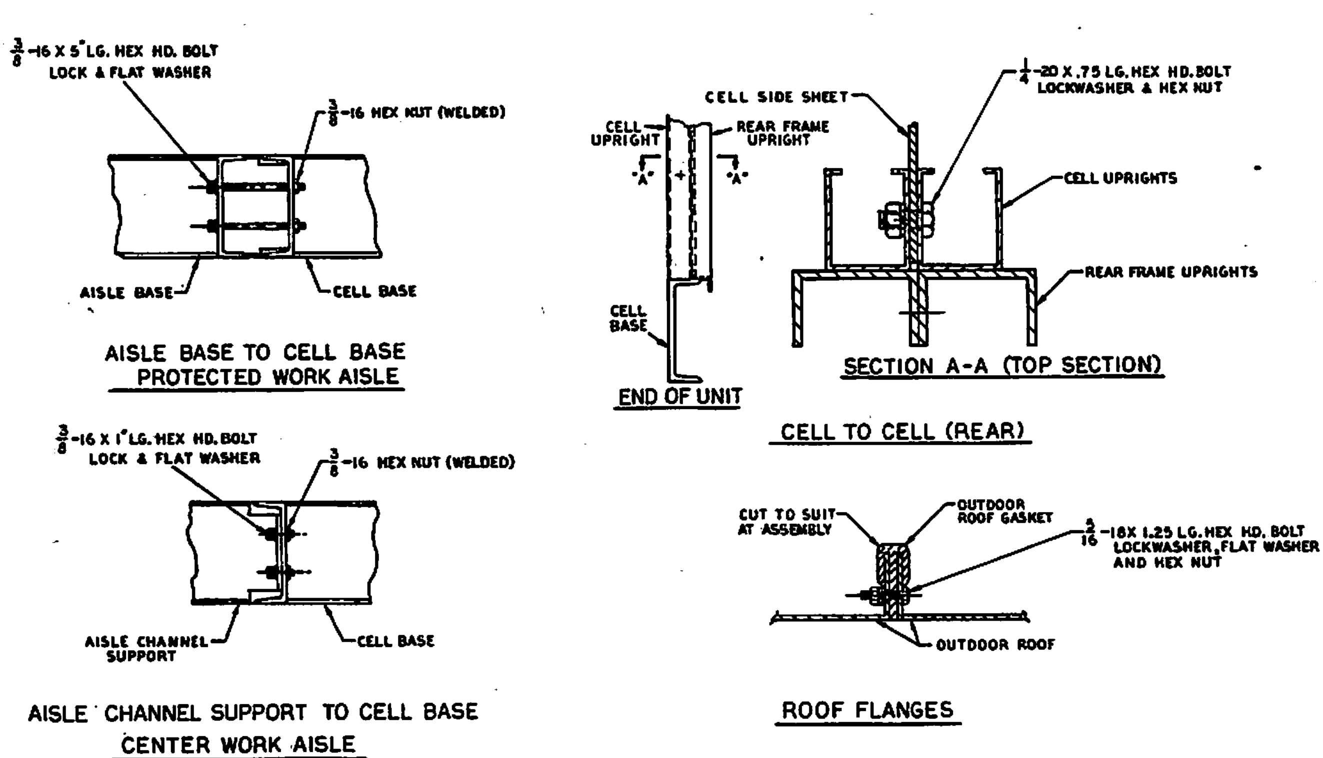
2200D0169

FIGURE 7



CENTER WORK AISLE
METHOD OF JOINING AISLE AND SWITCHGEAR SECTIONS AT INSTALLATION
2200D0170

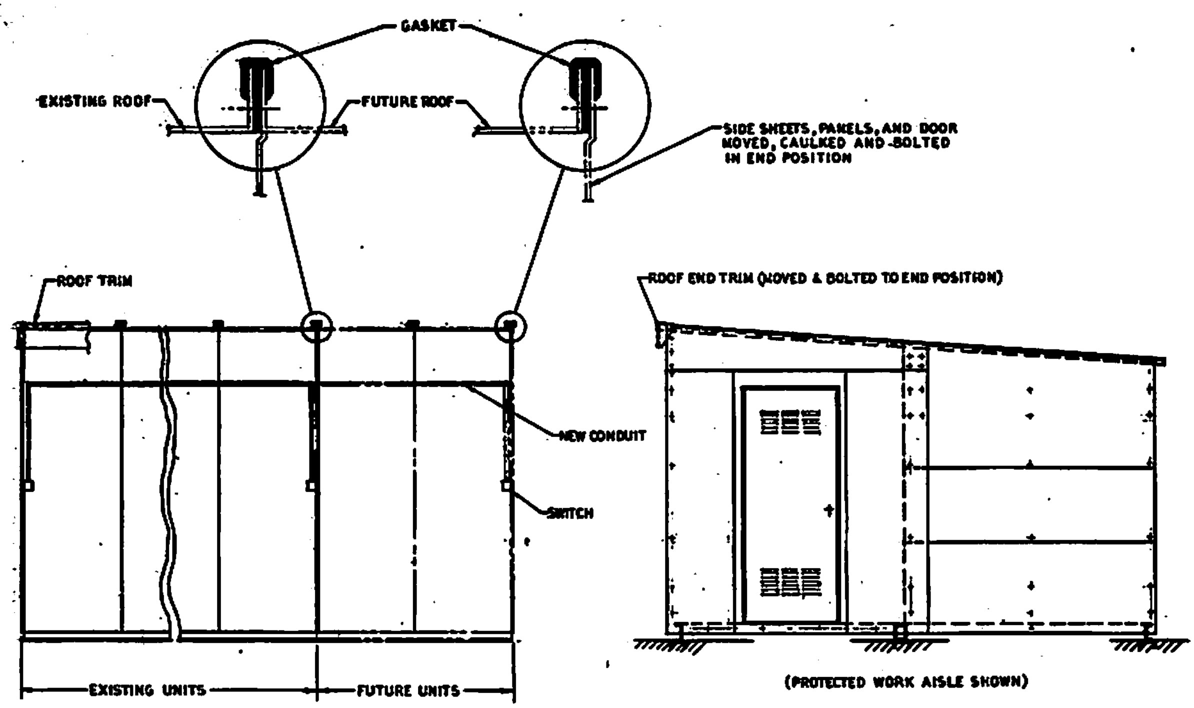
FIGURE 8



Drawing 2200C0171

BOLTING DETAILS

FIGURE 9



FIELD PROCEDURE FOR EXPANSION OF EXISTING OUTDOOR SWITCHGEAR

Drawing 2200C0172

FIGURE 10

EQUIPMENT

BATTERIES

Follow battery manufacturer's instructions carefully when installing the battery. Be sure that ventilation is provided to carry off the fumes. If steel work seems to be affected by the fumes, apply black asphaltum paint.

Make sure that the battery charger is functioning, and that the charging rate is not excessive. Test for specific gravity regularly.

If battery is installed remote from the switchgear, have cables of sufficient size to keep the voltage drop at a minimum.

Be sure battery is charged and no abnormal loads are evident before putting switchgear in service.

WIRING

All incoming and outgoing control connections should be made in accordance with the switchgear schematic and wiring diagrams. After wiring is completed, all connections should be carefully checked against the diagrams to insure that all connections are correct and proper.

The wiring diagram number of each switchgear unit is stamped on the nameplate of the control panel. The wiring diagram number applying to each circuit breaker is stamped on each breaker on the nameplate.

Interconnecting wiring diagrams between the associated equipment are not normally supplied with metal-clad switchgear.

GROUNDING

Each switchgear assembly is provided with a ground bus extending the full length of the complete assembly. Sections of ground bus previously disconnected at shipping breaks must be reconnected when the units are installed.

The ground bus should be connected to the station ground at both ends with as direct a connection as possible and should not be run in metal conduit. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

When switchgear has center aisle construction, insure that the connecting ground bus is connected between opposite aisle sections.

A reliable permanent and low resistance ground connection is necessary for every switchgear installation. A poor ground may be worse than no ground since it gives a false feeling of safety to those working around the equipment. It should also be of sufficient capacity to handle any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus.

CONTROL CIRCUIT FUSES

FPE ECON® CLASS 1330
DUAL ELEMENT CONTROL CIRCUIT FUSES
100,000 AMP RMS A.C.
INTERRUPTING CAPACITY

Catalog # - 250V	Ampere
ECN-1	1
ECN-3.2	3.2
ECN-6.25	6.25
ECN-10	10
ECN-15	15
ECN-20	20
ECN-25	25
ECN-30	30
ECN-35	35
ECN-60	60

These fuses provide instantaneous protection against short circuits plus a high degree of current limiting ability within the sizes listed.

DUMMY BREAKER

Dummy removable elements are used as a means of isolating circuits or bus sections where operation is infrequent and a circuit breaker cannot be economically justified for an interim of time. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the breakers. The studs are connected by shorting bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is racked into position, it connects the line and load side of bus.

Under no conditions must the dummy element be racked into or out of the cell when the bus or the unit is energized. Key interlocks are applied to insure that all sources of power are disconnected before the dummy element can be operated. Floor interlocks are provided to prevent insertion into specific cells.

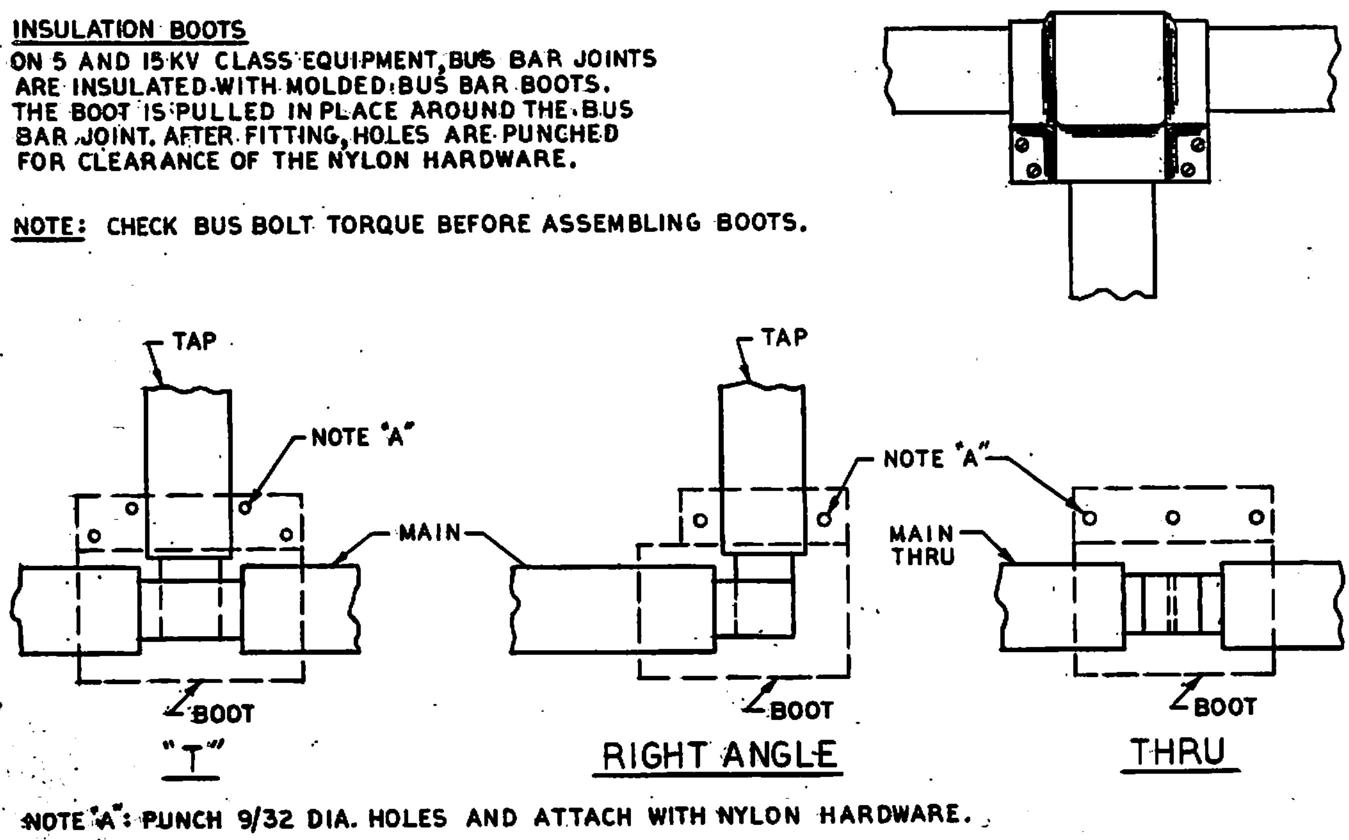


FIGURE 11

TAPED CONNECTIONS

For taped connections use materials as listed in taping instructions, Fig. 12. Extreme care should be taken in taping unusual contour joints with vinyl tape.

Taping a flat or a cylindrical surface such as a bus bar or cable is a relatively simple process in which much the same technique is used whether the tape is paper, cloth, or plastic. Vinyl tape may be stretched *slightly* to help it conform to irregular contours. This is an advantage if properly understood and used correctly, but can be harmful if the tape is stretched unnecessarily to make it "conform." The pressure sensitive adhesive is not designed to withstand large sidewise (shear) forces for a long time; and if the contour is such that the tape tension can be relaxed by a side slippage, some slippage will take place.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

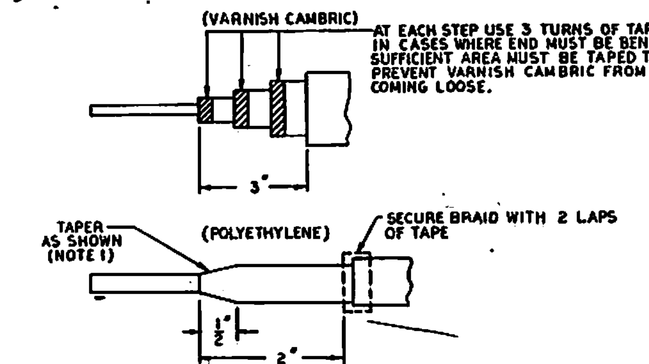
Through-type current transformers are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the side path through the current transformer before being connected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

DESCRIPTION	
VINYL PLASTIC .010THK. 1" WIDE X 36YDS. LG. RED ELECTRICAL TAPE	1
DUX-SEAL® NSG-RED NASHUA CORP. SUMMERVILLE, N.J.	2
ELECTRICAL GLASS TAPE-MEDIUM WEAVE 1-1/2" WIDE X .004THK. 36 YDS. LG. BURLINGTON "HESGON A" OR EQUAL	3
U 310 QT. CAN VARNISH STERLING VARNISH SEWICKLEY, PA.	4



NOTE 1
TAPER MAY BE MADE WITH TYPE "PT" PENCILING TOOL PLM PRODUCTS, 3871 WEST 150TH ST., CLEVLAND, OHIO

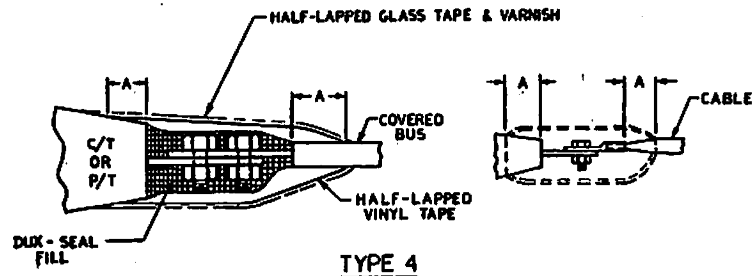
METHOD 1
NON-SHIELDED CABLE TERMINATION

WRAP WITH HALF-LAPPED LAYERS OF TAPE BEGINNING AT ONE END. REVERSE DIRECTION AND CONTINUE APPLYING HALF-LAPPED LAYERS MAKING ONE-HALF OF THE NUMBERS GIVEN IN CHART "A". THESE LAYERS ARE APPLIED WITH JUST SUFFICIENT STRETCH TO INSURE GOOD CONFORMANCE WITH NO AIR VOIDS OR WRINKLES. AFTER THESE LAYERS ARE APPLIED, REVERSE DIRECTION AND APPLY BALANCE OF LAYERS WITH NO STRETCH.

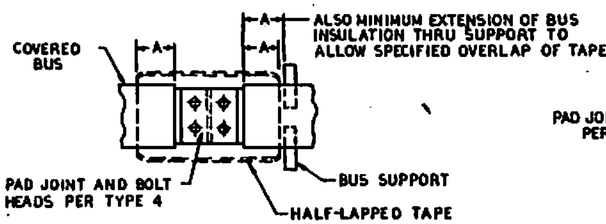
CHART "A"

MAX. VOLTAGE	LAYERS OF TAPE	"A" INSULATION OVERLAP MIN.
600	2	1
5000	6	1½
15000	13	2
23 & 38000	18	4

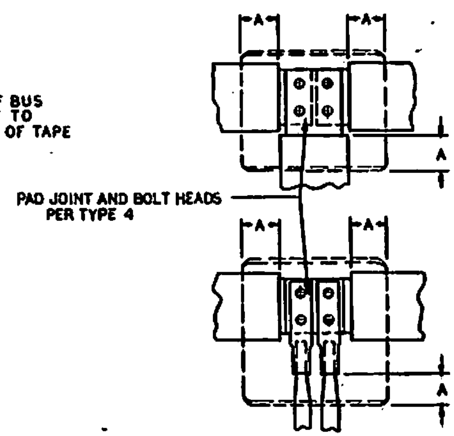
METHOD 2
LAYER OF HALF-LAPPED TAPE
SEE CHART "A"



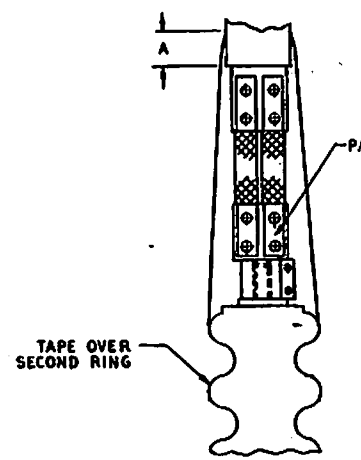
TYPE 4
SPLICE (BUS OR CABLE) TO C/T OR P/T



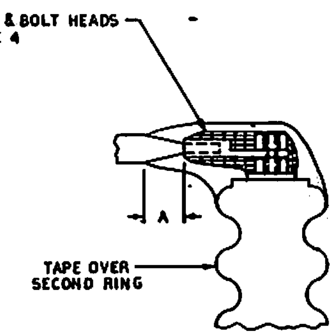
TYPE 3
BUS SPLICE



TYPE 5
"T" BUS & CABLE TO BUS



TYPE 6
BUS-FLEXIBLE CONNECTOR-PORCELAIN TERMINAL



TYPE 7
CABLE TO PORCELAIN TERMINAL

TAPING INSTRUCTIONS

FIGURE 12

PART III - PRE-ENERGIZATION TESTS

PREPARATION

BEFORE STARTING ANY INSPECTION OR TESTING BE SURE PRIMARY CIRCUITS ARE DE-ENERGIZED.

Careful reference should be made to each component instruction leaflet before attempting to place the switchgear in service. If dry-type or oil askarel-filled power transformers are furnished as part of the switchgear equipment, consult their instruction books or leaflets, particularly regarding absorption of moisture, and effects of dust and sand, etc.

The equipment should be checked to be certain no tools or any other equipment have been left in the switchgear. When connections are to be made to or from an electric utility, public or privately-owned, consult their representatives very early in the construction period, as many of them have very strict requirements which must be met before service connections will be made.

Any indication of moisture will require that equipment be dried out before placing in service. Care should be exercised in drying-out operations to be certain that the maximum temperature during the drying period does not exceed 70 to 75° C. on switchgear. In the event it is desired to give the equipment a high potential test before placing in service, this test should only be made after the equipment is thoroughly dry. The value of test voltage should correspond to the voltages listed in Table B. Note that field tests are 75% of the factory test values.

DIELECTRIC TESTS

Dielectric tests are made at the factory to determine the adequacy of insulation. Devices used as part of switchgear assemblies shall be capable of meeting these tests.

Exception — There is certain apparatus such as potential transformers, auto transformers, motor starting, reactors, and motor-operated devices whose standards call for a lower test voltage than those given in Table B. When such devices are used, they must be disconnected during these tests.

Alternating-current test voltage shall have a crest value equal to 1.41 times the values specified. A sine wave shape is recommended. The frequency shall not be less than the rated frequency of the apparatus tested. The test voltage shall be applied for one minute.

Direct-current test voltage, if used in lieu of alternating-current test voltage, shall be 1.41 times the specified alternating-current voltage.

OPERATIONAL TESTS

Upon completion of installation, and inspection of the circuit breakers and other components, together with installation of any incoming and outgoing control connections, it is time to start operational testing. Outgoing feeder cables should not be connected at start of test.

TABLE B
DIELECTRIC TEST VALUES

Rated Voltage	60 Cycle KV Field Test	60 Cycle KV Factory Test	Standard Full-Wave Impulse (Withstand) Tests KV
600 V	1.6	2.2	NA
4.16 kV	14.25	19	60
7.2 kV	27.0	36	95
13.8 kV	27.0	36	95
23 kV	45.0	60	150
34.5 kV	60.0	80	150

FIGURE 13

When the switchgear has electrically operated circuit breakers, they are operated in some installations from local battery or auxiliary control supply, and in other installations are operated from the switchgear bus, or a connection ahead of the incoming master circuit breaker. In the event the primary source of power is locked open, it will be necessary to use an auxiliary source of power to operate the circuit breakers, lamps, bell-alarm switch, undervoltage devices, rectifiers, capacitor shunt trips, etc. Check circuit breakers in "test" and "operate" positions, paying particular attention to good contact between movable stationary secondary contacts in both positions. Check puffer by placing hand over arc chute and feeling puff of air during opening operation. Check that primary disconnect penetration is *at least* ⅛" on cell stabs. Check that breaker mechanism closing springs discharge between "test" and "removed" positions.

Key interlocks should be operated manually to make sure that protection is complete. Remove spare keys to supervisory office.

Each relay and trip device or other component should be operated manually to be certain its contacts perform their required function. Remove any material that was installed at the factory to block parts or devices during shipment. Preliminary settings for test purposes should be applied to relays. The various operational functions are indicated on the schematics and wiring diagrams of the switchgear equipment.

After completion of all operation tests, all relays should be set according to specified requirements. If a coordination study has been made this study should be referred to for the settings. Check that the primary device settings are accepted by the Power Company if required. All trip indicators on the relays should be checked to see that they function properly.

Upon completion of device settings and test, the main incoming and feeder cables should be properly phased out and connected to the switchgear. Incoming and outgoing cables should be braced so as to take mechanical strain off studs of circuit breakers and porcelain supports of various types. Clean out construction materials, dirt, nests, etc.

Inspect for damaged parts, cracked epoxy bus, primary disconnect bushings, bent secondary disconnects, cracked porcelain insulators, wiring insulation — check and report evidence of abuse to equipment.

The entire switchgear structure and all bus duct should be carefully vacuum cleaned (preferred) or blown out, and all rear and side plates that have been removed should be rebolted in place. All secondary and power connections should be tested for grounds with high potential tester or megger. Megger readings of one megohm per thousand volts are acceptable. If readings are lower, equipment should be dried out until insulation resistance values improve to one megohm per thousand volts.

Preferable readings are:

Operating voltage KV	1.2	2.5	5.0	8.66	15	23	38
Insulation Resistance Megohm at 25°C.	12	25	50	100	150	250	400

Check proper operation of doors, transfer trucks, latches, filter units, lighting, hinges, key interlocks (keys and function), gaskets and seals.

On protected work aisle and center aisle O.D. house check that contractor properly assembled and caulked the shipping breaks, and aisle split. Check undercoating, foundation, and for rodent holes.

Check phasing connections of buses (especially at transition points) and connections to transformers and bus ducts. Capacitor trip device — check operation and check that it will hold charge at least 5 minutes by de-energizing primary power as checking operation 5 minutes later. Spot check secondary voltages to make sure proper connections and proper transformer ratios have been selected. Overvoltage can cause premature burnouts of indicating lights. Check lamp burnouts.

Check that C. T. secondaries are not open circuits, especially if going off the board to a remote location. Check that zero seq. C. T.'s have been properly connected and that cable has been properly grounded.

PART IV - MAINTENANCE

The following preventive maintenance program is outlined for medium and high voltage metal-clad switchgear with air-magnetic or low oil content type power circuit breakers.

Should the need occur, the Field Service Department of the Power Equipment Systems Division of Federal Pacific Electric Company is equipped to assist you with any maintenance or repair which may be required throughout the anticipated long life of this equipment.

FPE "On-Site Test Facilities" are available to you. This service includes engineering inspection and testing of electrical equipment planned to supplement your regular maintenance program, to improve equipment reliability and to protect your investment.

MAINTENANCE BENEFITS AND FACILITIES

Basic elements are outlined for a maintenance program of switchgear installations.

A. MAINTENANCE PROGRAM

A well executed program has these benefits:

1. Longer life of switchgear and fewer replacements.
2. Reduced time on repairs and overhauls, and the option of scheduling them at an opportune time.
3. Fewer failures with unexpected outages.
4. Timely detection of any undesirable operating conditions which require correction.
5. Improved plant performance and increased operating economies.

B. MAINTENANCE RECORDS

A file should be established and include:

1. A record of all installed switchgear and its maintenance schedule.
2. Nameplate data of the equipment and its major components, instruction books, renewal parts bulletins and drawings.
3. A list of all items which have to be inspected and what adjustments are to be checked.
4. A record of past inspections and test results.

C. MAINTENANCE TESTS

Maintenance tests are applicable as indicated:

1. Insulation resistance tests of the breakers and of the switchgear bus can be useful in determining the condition of the insulation if they are made regularly. Since definite limits cannot be given for satisfactory insulation resistance, a record must be kept of the readings and comparisons made. Deterioration of insulation and the need for corrective action can be recognized if the instrument readings are progressively lower after each test.
2. High potential tests are not required and are not recommended except in special circumtances, such as after repairs or modifications to the equipment that included the primary circuit. When such tests are necessary, they may be made using 75% of the standard 60-cycle insulation test voltage for new equipment at the factory.
3. After the switchgear has been serviced and adjusted, its operation should be checked before it is returned to service. This can be best done by putting the breaker in the test position and operating it with its associated control and protective devices. If it is desired to test the breaker outside its compartment, use the test-jumper supplied with the switchgear.

D. MAINTENANCE EQUIPMENT

Adequate maintenance equipment should include:

1. Spare parts for at least those parts of the switchgear that are vital to continued operation. Manufacturer's recommended list of spare parts can be used as a guide in combination with operating experience to determine variety and quantity of parts to be stocked.
2. A well-lighted shop equipped with the following:
   a. A test cabinet for air magnetic breakers or an inspection rack.
   b. Maintenance closing device for power breakers.
   c. Test jumper for connecting breaker to control circuit when it is outside its compartment.
   d. Relay test plugs for making tripping, timing and calibration tests of relays.
   e. A selection of ammeters, voltmeters and instrument transformers.
   f. An insulation resistance tester.
   g. An overhead crane or hydraulic lifting device.

FREQUENCY OF INSPECTIONS

It is generally good practice to inspect equipment three to six months after it is first put in service and then inspect and maintain it every one to three years depending on its service and operations conditions. This suggested schedule is only a guide. Conditions that can make more frequent maintenance necessary are:

1. High humidity and ambient temperature.
2. Corrosive atmosphere.
3. Excessive dust and dirt.
4. High repetitive duty.
5. Frequent interruption of faults.
6. Older equipment.
7. History on preceding inspections.

MAINTENANCE PROGRAM FOR SWITCHGEAR

The maintenance program should include the thorough inspection, servicing and adjustment of the following components.

A. METAL-CLAD STATIONARY UNITS AND BUS DUCT

1. Remove accumulated dust and dirt. Vacuum cleaning is recommended.
2. Wipe insulated buses and bus supports with a clean cloth moistened (when necessary) with a petroleum solvent (such as trichlorethylene) or similar cleaner. Wipe insulation dry after cleaning.
3. Inspect buses and connection bars for physical damage, evidence of corona cutting or other conditions that can indicate deterioration of the insulation.
4. If taping has been damaged or needs replacing follow instructions on pages 12 and 13.
5. Inspect alignment and contacting of primary disconnecting devices, checking for signs of abnormal wear or other damage. Note: Discoloration of the silvered surface is not usually harmful unless caused by sulphide deposits which can be removed by a solvent, such as alcohol, or by silver polish.
6. Check adjustments and operation of safety shutters, interlocks, auxiliary and limit switches.
7. Inspect all relays, contactors, switches, fuses and other devices for correct operation.
8. Check tightness of main bus bolts, anchor bolts, and structure bolts, also control connections and continuity of wiring.
9. Check strip heaters and clean air filters at ventilation openings when these are present.
10. Repair damaged paint finishes.
11. Check seals, gaskets, watertightness, etc., of outdoor equipment.

B. POWER BREAKERS

Air magnetic type and low oil content breakers should be maintained on the same schedule as the metal-clad units, or at least every year, or per the following schedule, whichever comes first:

— Air magnetic type — every 2000 non-fault operations, refer to instruction manual IN-820.11.

— Low oil content — every 100 non-fault operations, refer to instruction manual IN-825.0.

It is also recommended that when the normal operating duty is a combination of fault interruptions and repetitive operations, the breaker should be inspected and serviced after a fault operation at or near its interrupting rating. Remove the breaker from its housing for inspection.

1. Wipe insulating parts, including bushings, clean.
2. Inspect alignment, penetration, and condition of movable and stationary contacts. Check their adjustment as described in the instruction book.
3. Check arc chutes for evidence of damage, and replace damaged parts. When arc chutes are removed, blow out dust and loose particles.
4. Clean silver-plated breaker primary disconnecting devices. Whether cleaned or not, lubricate devices by applying a thin film of contact grease.
5. Inspect breaker operating mechanism for loose hardware and missing or broken cotter pins, retaining rings, etc. Examine cam, latch and roller surfaces for damage or excessive wear.
6. Check puffer operation (air magnetic only).
7. Check breaker operating mechanism adjustments and readjust as described in the instruction book. If these adjustments cannot be made within specified tolerances, it will usually indicate excessive wear and need for a complete overhaul.
8. Inspect breaker control wiring for tightness of connections.
9. After the breaker has been serviced, operate it slowly

with closing device to check freedom from binding or friction and check that contacts move to the fully opened and fully closed positions. Check electrical operation either in test position or removed from compartment.

10. Check oil level and dielectric condition (Low oil content only).

11. Check for leaks (Low oil content only).

PART V - SAFETY REQUIREMENTS FOR POWER SWITCHGEAR ASSEMBLIES

Power switchgear assemblies covered by this instruction are characterized by not only high-voltage, but also by high continuous currents and high interrupting requirements. Conformance to the requirements of this publication are deemed adequate to assure normal safety to operating, maintenance, and inspection personnel on the basis that such personnel are Qualified.

1. UNQUALIFIED PERSON — GENERAL PUBLIC
General public is all persons, without exception, who are not qualified in accordance with Section 2.

General public includes unqualified persons who might be authorized by reason of employment or conditions to have access to the area of power switchgear. Examples are plumbers, janitors, owners, etc.

2. QUALIFIED PERSON
For the purpose of this instruction, a qualified person is one who is thoroughly trained, and understands the hazards involved in any area which may be within his responsibility, such as construction, installation, operation, and maintenance of switchgear apparatus. In addition, he has the following qualifications:

(1) Is able to de-energize, clear and tag circuits and equipment in accordance with established safety practices.

(2) Wears protective equipment such as rubber gloves, hard hat, dark glasses, flash-clothes, etc., in accordance with established safety practices, and is trained in their proper care.

(3) Is certified in rendering first aid, especially in the technique of removing a person in contact with a live circuit, and in applying artificial respiration.

3. GENERAL INSTRUCTIONS TO QUALIFIED PERSONS
Qualified persons shall work only on equipment that is completely de-energized from all sources of electric power, including control power.

A. Understand the Equipment — Qualified persons shall learn and understand instruction information furnished.

B. Clearing Equipment for Work — Qualified persons shall consider all circuits and equipment as live at all times until completely de-energized, tested, grounded, tagged or properly identified, and released for work in an authorized manner.

C. Cleaning of Equipment — No cleaning or similar work shall be done by qualified personnel within the reach of parts or equipment unless they have been de-energized and prepared for work in accordance with (B) above.

D. Working Alone — Where Permitted — When alone, a qualified person shall do no cleaning or other work inside compartments or compartment doors and covers unless the equipment to be worked on has been de-energized and prepared for work in accordance with (B) above.

E. Carrying Equipment and Tools — Qualified personnel shall at all times be aware of the hazards associated with carrying and placing equipment and tools such as ladders, brooms, mops, lamp holders, tool belts, tool boxes, keys, etc., in places where circuits may become energized.

F. Removing Tools — Qualified personnel shall exercise care in not leaving tools or keys on buses, doors, panels, equipment cases or tanks, rotating machines and in or on compartments.

PART VI - SWITCHGEAR ACCESSORIES

FOR DST-2 5KV AND 15KV
(Unless otherwise specified items listed below are for both 5KV and 15KV.)

DESCRIPTION	PART NO.
Breaker Racking-In Handle	2251B4202
Breaker Maintenance Closing Lever All 5KV-250 MVA & -350 MVA, 1200 A. & 2000 A.	1551B5628
Breaker Maintenance Closing Device All 15KV and 5KV-350-3000A	1551C5820
Breaker Mechanism Charging Handle	1551A5539
Breaker Test Jumper Cable, 10 Ft. 24 Points (Not required when test cabinet is specified.)	2252C4509
Breaker Test Jumper Cable, 10 Ft. 40 Point	2251C4509
Breaker Outdoor Transfer Truck (6" High) 5KV	2251D4689
Breaker Outdoor Transfer Truck (6" High) 15KV	2251D4690
Breaker Handling Dolly (Indoor)	2251C4842
Breaker Test Cabinet — Indoor:	
1. AC or DC control voltage— "close" and "motor", DC voltage "trip"	2251D4340
2. AC or DC control voltage— "close" and "motor", AC voltage "capacitor trip"	2252D4340

MISCELLANEOUS SWITCHGEAR ACCESSORIES

CELL HEATERS — Complete Assembly	
120 Volts with terminal block 125 watts	2751C0706
208-240-277 Volts with terminal block 220-300-375 watts	2752C0706
120 Volts without terminal block 125 watts	2751C0704
208-240-277 Volts without terminal block 220-300-375 watts	2752C0704
THERMOSTAT	
120-240 Volt Thermostat (Type 11T11) (Close 100°F., Open 110°F.)	237-001

SWITCHGEAR INDICATING LAMPS

Catalog No.	Description	
Indicating Lamps — not including color caps.		
	Voltage AC or DC	**Series Resistor OHMS**
2751-0135	50	800
2752-0135	70	1400
2753-0135	115	2900
2754-0135	125	3200
2755-0135	208	5800
2756-0135	230	6500
2757-0135	250	7100
2758-0135	24	110
Color Caps		
2701-0117	red	
2702-0117	green	
2703-0117	amber	
2704-0117	blue	
2705-0117	white	
Resistors		
	OHMS	**Service Voltage**
2708-0116	110	24
2701-0116	800	50
2702-0116	1400	70
2703-0116	2900	115
2704-0116	3200	125
2705-0116	5800	208
2706-0116	6500	230
2707-0116	7100	250
Indicating Lamp Parts		
064-007	24-E Lamp 24 V. .032-.038 amps.	
2701-0124	Spacer 1/32"	
2751-0119	Receptacle assembly, less Resistor, Bezel and Color Cap.	
2701-0118	Spring Retainer Washer	

FEDERAL PACIFIC ELECTRIC COMPANY

SAFETY REQUIREMENTS FOR POWER SWITCHGEAR ASSEMBLIES

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2. QUALIFIED PERSON

For the purpose of this bulletin, a qualified person is one who is thoroughly trained, and understands the hazards involved in any area, which may be within his responsibility, such as construction, installation, operation and maintenance of switchgear apparatus. In addition, he has the following qualifications:

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(2) Wears protective equipment such as rubber gloves, hard hat, dark glasses, flash-clothes, etc., in accordance with established safety practices, and is trained in their proper care.

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3. GENERAL INSTRUCTIONS TO QUALIFIED PERSONS:

Qualified persons shall work only on equipment that is completely de-energized from all sources of electric power, including control power.

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B. Clearing Equipment for Work - - Qualified persons shall consider all circuits and equipment as live at all times until completely de-energized, tested, grounded, tagged or properly identified, and released for work in an authorized manner.

C. Cleaning of Equipment - - No cleaning or similar work shall be done by qualified personnel within the reach of parts or equipment unless they have been de-energized and prepared for work in accordance with (B) above.

D. Working Alone - - Where Permitted - - When along, a qualified person shall do no cleaning or other work inside compartments or compartment doors and covers unless the equipment to be worked on has been de-energized and prepared for work in accordance with (B) above.

E. Carrying Equipment and Tools - - Qualified personnel shall at all times be aware of the hazards associated with carrying and placing equipment and tools such as ladders, brooms, mops, lamp holders, tool belts, tool boxes, keys, etc., in places where circuits may become energized.

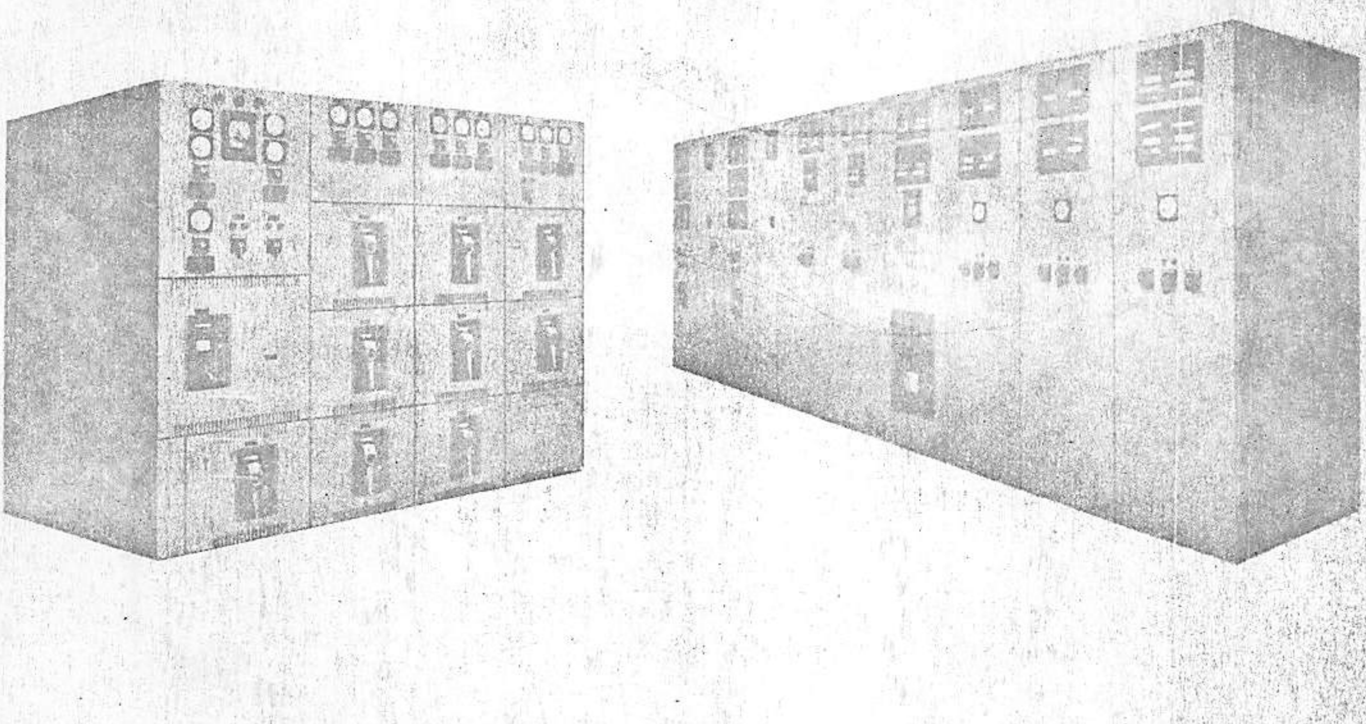
F. Removing Tools - - Qualified personnel shall exercise care in not leaving tools or keys on buses, doors, panels, equipment cases or tanks, rotating machines and in or on compartments.

IN-820.4b

FPE INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

FEDERAL PACIFIC METAL-CLAD SWITCHGEAR AND LOW-VOLTAGE SWITCHGEAR

March 1966



PART I

INSTALLATION AND OPERATION

PART II

MAINTENANCE

PART I

SWITCHGEAR INSTALLATION AND OPERATION

SHIPMENT

The switchgear is assembled, wired, adjusted and given complete tests at the factory, after which it is inspected and packed for shipment. The air circuit breakers are not shipped in the switchgear compartments, but are packed in separate crates. Each crate is identified, and a complete list of its contents is included in the shipping papers. All instruments and relays are suitably blocked to prevent damage to bearings and movements.

REMOVAL FROM CARRIER & INSPECTION FOR DAMAGE

Immediately upon receipt of the shipment, identify all component parts and check them against the shipping list. Make a thorough examination to detect any damage which may have been incurred during transit.

If any damage is discovered, file a claim immediately with the carrier, and send notice of the extent of the damage to the Federal Pacific Electric Company plant from which shipment was made, giving complete identification, carrier's name and railroad car number if the shipment was made by rail.

The information will enable the company to supply necessary information in support of claim.

MOVING AND LIFTING SWITCHGEAR

1. The importance cannot be overstressed regarding the care in handling, rigging, hoisting, rolling or moving assembled switchgear into place. Metal-clad switchgear is designed to be handled only in an upright position and should never be handled in any other way without first consulting with switchgear headquarters design section.
2. Each shipping section of indoor switchgear is bolted to a heavy shipping skid which should remain with the gear until it is moved into final location. Each section of outdoor gear is supplied with heavy lifting lugs bolted to switchgear base.
3. When lifting shipping units with a crane, it is preferable to use two hooks simultaneously, one on each end. Each pair of lifting hooks should be equipped with a spanner bar to prevent excessive distortion. If only a single hook crane is available, arrange spanner to lifting rig as shown on typical outdoor gear drawing 2200-0114. Lifting from front and rear of units permits placing shipping sections side by side for bolting without interference from lifting rig or hook.
4. When cranes are not available, equipment can be rolled into place on shipping skids provided with each shipping section. Pushing or pulling forces should be applied to the skid and not the Switchgear.
5. Shipping skids can be removed by using a foot jack in each corner of the shipping section after the switchgear has been moved to its final location.

STORAGE BEFORE INSTALLATION

Protection against loss of equipment is an important precaution. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons and so that it can be quickly located when required in the erection program.

Switchgear equipment, regardless of whether it is to be installed immediately or stored for a while before being erected, should be kept in a dry, clean place. Conditions such as dampness caused by rain or change in temperature, cement dust, etc., should be carefully guarded against. Covering the equipment with a temporary shelter or tarpaulin is frequently necessary both during storage and erection. The longer the period of storage, the greater must be the care taken for protection of the equipment. It is advisable to place electric strip heaters or lamps within enclosures to raise temperature approximately 10 degrees above outside temperature at all times.

Crated apparatus which is not to be erected immediately will store much better if left crated. It should, however, be inspected to make sure that no damage has been incurred during transit.

When arrangements are made prior to shipment, electric strip heaters circuit can be taken out of crate so that heaters can be energized while switchgear equipment remains in the crates.

ALIGNMENT OF FOUNDATION

Federal Pacific metal switchgear is accurately built on true and level bedplates. This care and accuracy insures ease of operation and interchangeability. Equal care in installation should be used.

A true and level floor for this equipment is of utmost importance. A little more than ordinary care in laying out and preparing the foundation will be repaid in reduction of cost and labor of installation.

The steel supporting members used in the floor should be held level until the concrete is set. The surface of the floor under the housing should not project above the supporting member.

The floor in front of the housing should not vary more than 1/8" in any square yard and *must not project above the level of the supporting members.* The better this floor is finished the easier will be the rolling of the removable breaker unit.

When installing metal-clad switchgear on existing floors it will usually be desirable to pour a new finish floor with embedded channels or cut slots for embedding and leveling the supporting channels.

Encircling loops of reinforcing or building steel around single phase conductors should be avoided in the areas marked for main cables—when these circuits are rated at 600 amperes or above.

One of these methods or its equivalent must be used to obtain an adequate foundation. Fig. 2 and 3 tack welding equipment to floor channels is preferred since this method does not require accurate lining up of bolts.

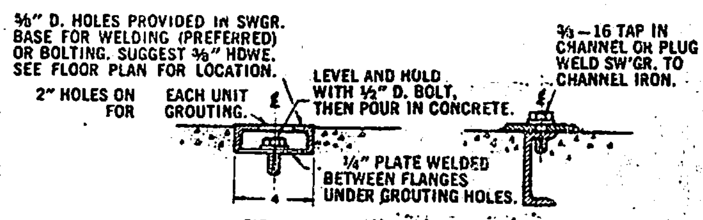
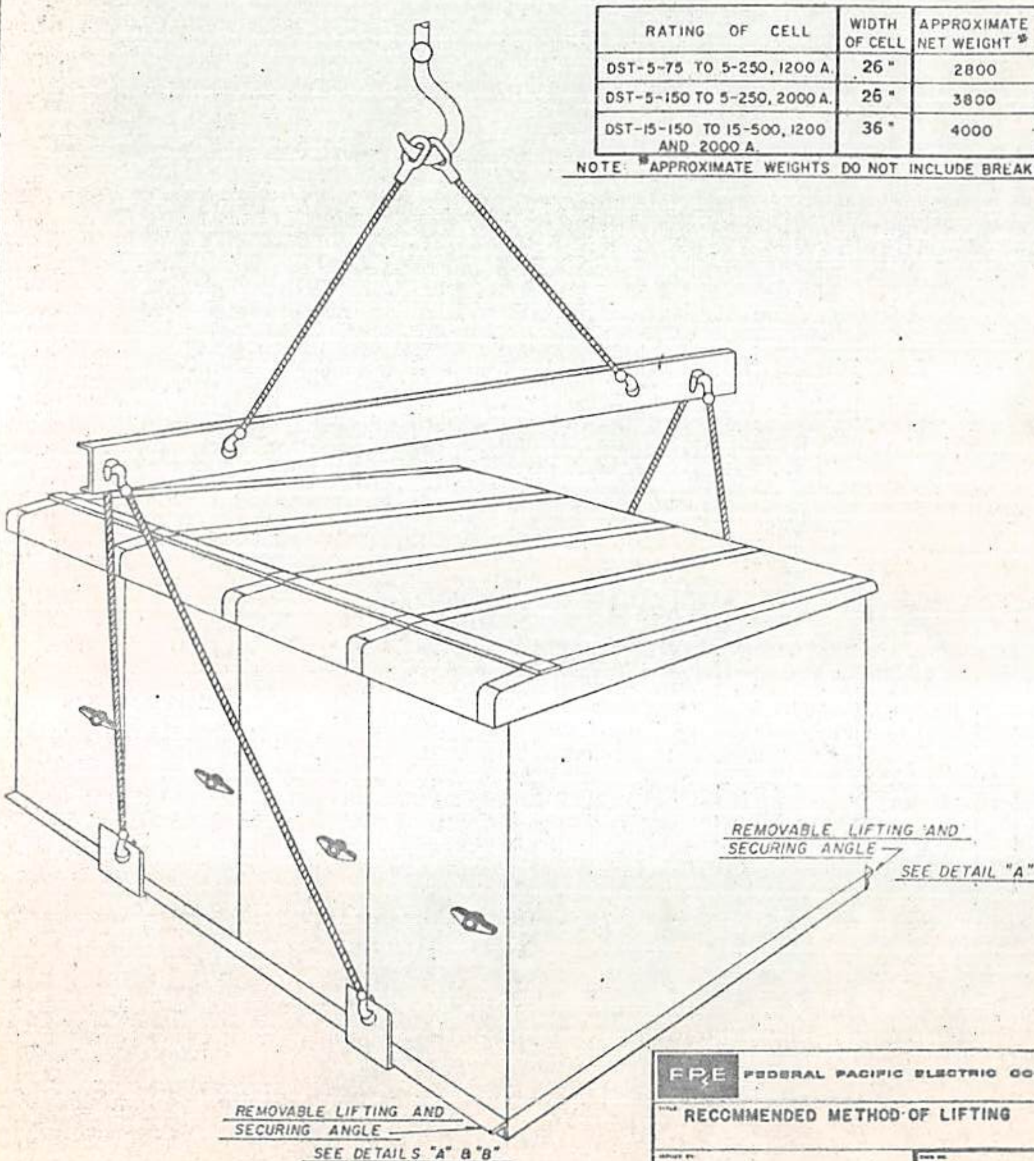
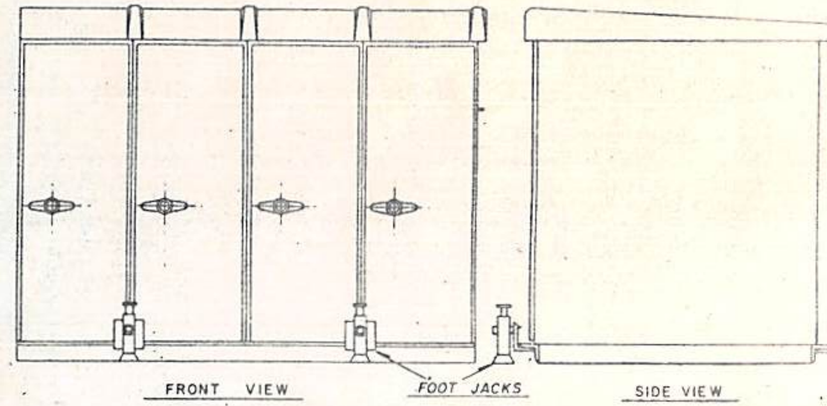


FIG. #2 FIG. #3

RATING OF CELL	WIDTH OF CELL	APPROXIMATE NET WEIGHT *
DST-5-75 TO 5-250, 1200 A.	26"	2800
DST-5-150 TO 5-250, 2000 A.	26"	3800
DST-15-150 TO 15-500, 1200 AND 2000 A.	36"	4000

NOTE: *APPROXIMATE WEIGHTS DO NOT INCLUDE BREAKER





ALTERNATE METHOD OF LIFTING

DETAIL "A"

DETAIL "B"

RECOMMENDED METHODS OF ANCHORING

CONCRETE PAD AND LEVELING CHANNELS TO BE SUPPLIED BY CUSTOMER UNLESS OTHERWISE SPECIFIED.
RECOMMENDED METHODS OF ANCHORING ARE SHOWN IN DETAILS "A" & "B". THE UNITS MAY BE BOLTED, WELDED OR ANCHORED TO THE CHANNEL. SUGGEST 1/2 INCH HARDWARE FOR BOLTING. (HARDWARE SUPPLIED BY CUSTOMER.)

CHANNELS SHOULD BE LEVEL WITH EACH OTHER AND LEVEL OVER THEIR ENTIRE LENGTH (RECOMMENDED SIZE OF CHANNEL 4" X 5.4#/FT.)

FINISHED FLOOR SHOULD NOT BE HIGHER THAN LEVELING CHANNELS AND SHOULD ALSO HAVE SLIGHT PITCH AWAY FROM CHANNELS.

FP&E FEDERAL PACIFIC ELECTRIC COMPANY

RECOMMENDED METHOD OF LIFTING

2200-0114

EQUIPMENT INSTALLATION

A. Before setting equipment in place, refer to switchboard drawings and, after completely uncrating equipment, check permanent location to see that equipment will properly fit on channels and foundation location. Couple and bolt all shipping sections together so that a continuous switchgear installation is obtained.

B. Carefully inspect all portions of the Air Circuit Breakers for possible damage. After inspection, the circuit breakers should be carefully inserted and racked into the switchgear cells.

C. Inspect cells to be certain that male power contacts and secondary control contacts located in rear of cell are free of dirt and dust. It is also important that cell floor be clear of all dust and debris to facilitate easy handling of circuit breaker.

D. The breaker is provided with a *maintenance closing* handle for manually closing the breaker. *It should not be used as a manual device to close in the breaker when in the cell.* This handle should be used only when the breaker is withdrawn from the compartment.

E. Refer to circuit breaker instruction books or leaflets before inserting breakers into cells. (See page 12 for instruction book index.)

BREAKER LIFTING DEVICES

A. For 600 volt gear it is recommended that a device for lifting and lowering FP-25 and FP-50 breakers to and from the breaker compartments be used. For indoor switchgear it is recommended that the purchaser install a monorail crane over the front of the switchgear, or Federal Pacific can supply a hydraulically operated lift-truck as an additional item of equipment. For outdoor switchgear a special hydraulic lift-truck can be supplied (see Index for Accessories).

B. FP-75 breakers are furnished with a lifting spreader, which provides a ready method of placing the breakers in their compartments when a crane is being used.

BATTERIES

Follow battery manufacturer's instructions carefully when installing the battery. Be sure that ventilation is provided to carry off the fumes. If steelwork seems to be affected by the fumes, apply black asphaltum paint.

Make sure that the battery charger is functioning, and that the charging rate is not excessive. Test for specific gravity regularly.

If battery is installed remote from the switchgear, have cables of sufficient size to keep the line drop at a minimum.

OUTDOOR SWITCHGEAR

If porcelain entrance or load bushings are mounted in the roof, use flexible connections from incoming and outgoing lines to reduce the strain on the porcelains.

Small-wiring underground conduit from the control building should terminate inside the switchgear at a level above any existing high-water marks.

Heaters are furnished in front and rear of each unit.

WIRING

All incoming and outgoing control connections should be made in accordance with the switchgear schematic and wiring diagrams. After wiring is completed, all connections should be carefully checked against the diagrams to insure that all connections are correct and proper.

The wiring diagram number of each Switchgear unit is stamped on the inside of the instrument door. The wiring diagram number applying to each Circuit Breaker is stamped on each breaker in a convenient location.

Interconnecting wiring diagrams between the associated equipment is not normally supplied with Metal-Clad and Metal-Enclosed switchgear.

GROUNDING

Each switchgear assembly is provided with a ground bus extending the full length of the complete assembly. Sections of ground bus previously disconnected at shipping breaks must be reconnected when the units are installed.

The ground bus should be connected to the station ground with as direct a connection as possible and should not be run in metal conduit. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

A good reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to handle any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus.

A permanent low resistance ground is essential for adequate protection. A poor ground may be worse than no ground since it gives a false feeling of safety to those working around the equipment.

GROUND DETECTION

On ungrounded low voltage systems (up to 600 volts AC) new switchgear equipment quite often does not include ground detection lamps or voltmeters. Nevertheless it is quite important to check for grounds in the system at intervals.

The simplest method for two-wire single-phase systems is to connect two clear filament lamps of the system voltage in series across the two wires with a ground connection between the two lamps. A ground on one side will short-circuit and darken the lamp on that side. The same general scheme is used for multi-phase systems.

For higher voltages, use potential transformers, or static ground detectors.

CONTROL CIRCUIT FUSES

FPE ECON CLASS 1330
DUAL ELEMENT CONTROL CIRCUIT FUSES
100,000 RMS INTERRUPTING CAPACITY

Catalog #—250 V	Ampere	Catalog #—600 V
ECN-1	1	ECS-1
ECN-3	3	ECS-3
ECN-6	6	ECS-6
ECN-10	10	ECS-10
ECN-15	15	ECS-15
ECN-20	20	ECS-20
ECN-25	25	ECS-25
ECN-30	30	ECS-30
ECN-60	60	ECS-60

These Fuses provide dual protection.

1. Time delay protection against unnecessary blowouts from high inrush currents of breaker solenoid coils and control power transformers.
2. Instantaneous protection against short circuits plus a high degree of current limiting ability within the sizes listed.

TIGHTENING CONNECTIONS

1—Bus splices at shipping break should be carefully inspected to be certain that good clean contact is obtained before bolting up tight. Torque* wrench should be used.

2—It is important also to be sure that all outgoing cable connections are tightened in the same manner as bus splices.

Recommended Torque Values

5/16" Bolt		18 Ft. Lbs.
3/8"	"	21 " "
1/2"	"	45 " "

* Suggested suppliers for ratchet on box torque wrenches, Waldrick Engr. Co., P.O. Bol 398, Huntington Station, New York. And the P. S. Sturtevant Company, Addison, Illinois.

"POLESTIGLAS" INSULATION

(For 15KV class only except when otherwise specified)

It is standard manufacturing practice where practical to insulate all electrical joints except shipping breaks at the factory before shipment. Federal Pacific Electric Co.'s exclusive Polestiglas flame retardent and non-tracking molded and cast materials are used throughout. Where it is impractical to use cast on insulation such as on an outgoing cable connection, flame retardent Polyvinyl tape is supplied.

Instructions for assembling and compounding bus joints, transformer connection etc., with "Polestiglas" insulating compound are—

"Polestiglas" is a two part resin system. It is shipped in separate containers, so that the catalyst, which is about 1% by weight of the resin, when completely stirred and mixed can be poured directly from the large container into the compound box mold.

Casting compound is supplied in separate containers—each container of compound and container of catalyst, when mixed, will fill one compound box.

The identification number of the material supplied with each job is as follows:

Field joints with compound boxes, Current Transformers, etc.	2700-5053
Patching Compound	2700-5054
Catalyst	2700-5051

Picture Number 1 . . . shows the standard assembly of a bus joint with compound box. Assemble compound box as indicated in *picture 2*, mix resin and catalyst in line with instructions furnished with material, and described above, and pour, as illustrated in *picture 3*, up to the top of the mold. This material will then set to a hard non-hydroscopic mass. The black compound box is left in position in this operation, and is not removed. The final joint looks exactly as *picture 3*, with the exception that it is filled with Polestiglas.

An alternate method of making compound boxes in the field is illustrated in picture 4, where a foam mold is supplied. This foam mold is supplied as a unit, and is clamped to the joint that is to be insulated. The foam mold should be waxed inside with Johnson's paste wax before it is assembled on the joint. It is recommended that the outside surface of the compound box and adjacent bus work also be waxed to prevent spill or splashing casting compound from sticking to adjacent surfaces.

Care should be taken to be certain that no wax is used where adhesion is required. The foam mold, when removed from the joint, may be reused providing it is rewaxed. It is important that all vent holes be kept clean in the compound boxes or foam molds to prevent the entrapment of air which will result in voids in the molding. The entire process for assembling the mold and mixing the Polestiglas, takes somewhat less than 15 minutes. For the resin to become solid may take from one to four hours, depending on the ambient temperature. It is advisable, however, when using the foam removable type molds, to check with a screw driver or a pencil, the surface of the Polestiglas to see if the material has hardened, before removing the mold. The material as supplied, will have a viscosity, such that if mixed properly will complete its reaction, making a joint that is non-tracking, corona resistant, and non-hydroscopic.

In operations with other than standard compound boxes type Number 1 and Number 2, communicate with the factory for specifications. Field experience will indicate that boxes can be made in either horizontal or vertical planes. Polestiglas mix can be supplied as a patching compound or filler for small voids, etc.

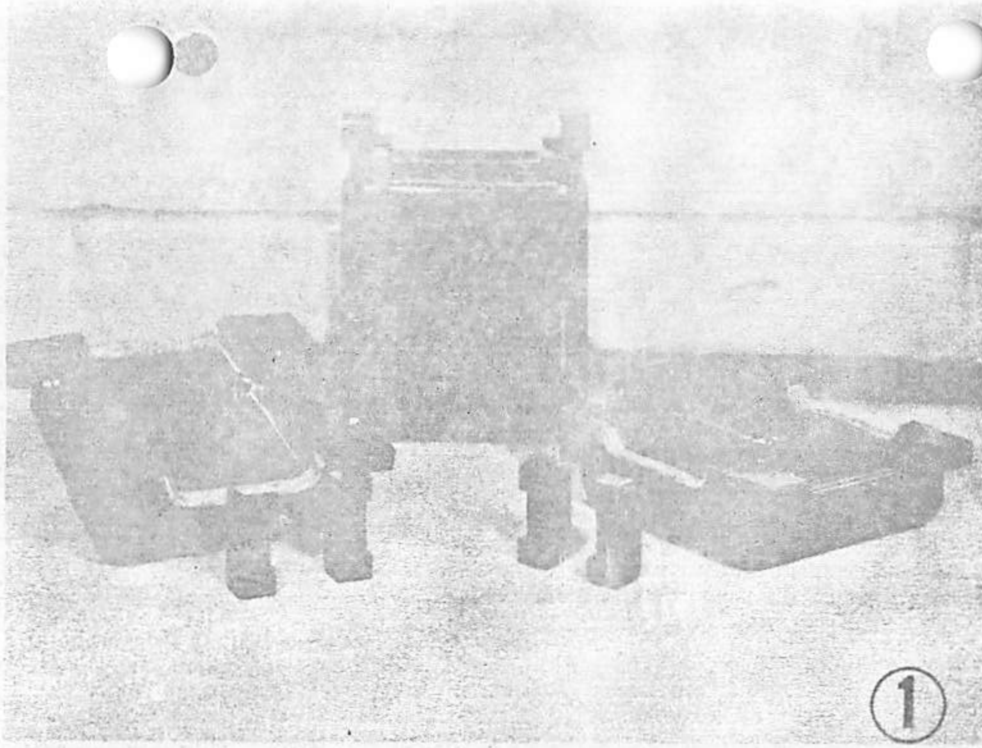
TAPED CONNECTIONS

For taped connections use materials as listed on attached instruction sheet, using copper mesh and conductive tape as shown. Extreme care should be taken in taping unusual contour joints with vinyl tape.

Taping a flat or a cylindrical surface such as a bus bar or cable is a relatively simple process in which much the same technique is used whether the tape is paper, cloth, film or plastic. The tape lies naturally in a spiral, and there are no problems of conformance. However, when a small degree of irregularity is present, it is helpful to use a tape with some elongation so that wrinkles are not created. This property is also useful in guiding the tape to maintain the proper overlap. Vinyl tapes possess this elongation to an exceptional degree. Combined with it is a "memory" in the tape which causes it to contract after application and pull down to a snug fit, minimizing voids or other irregularities in the insulation. This is an advantage if properly understood and used correctly, but can be harmful if the tape is stretched unnecessarily to make it "conform" to certain contours. The pressure sensitive adhesive is not designed to withstand large sidewise (shear) forces for a long time; and if the contour is such that the tape tension can be relaxed by a side slippage, some slippage will take place.

Many surfaces requiring insulation-stress cones, for instance—are of such shape that they cannot be wrapped spirally without excessive stretching of the tape. Usually in such cases a taping method can be devised that will make use of the "memory" or "regain" characteristics of the tape to insure proper insulation.

If the surface is developable (capable of being covered by a flat sheet without stretching), it is always possible to apply the tape in such a way that there are no forces tending to make it slip sidewise. This is done by wrapping along the geodesics of the surface (lines of shortest distance between two points.) The general principle is that of letting the tape lay itself on the surface to be covered; if necessary, the tape can be cut several times for some surfaces.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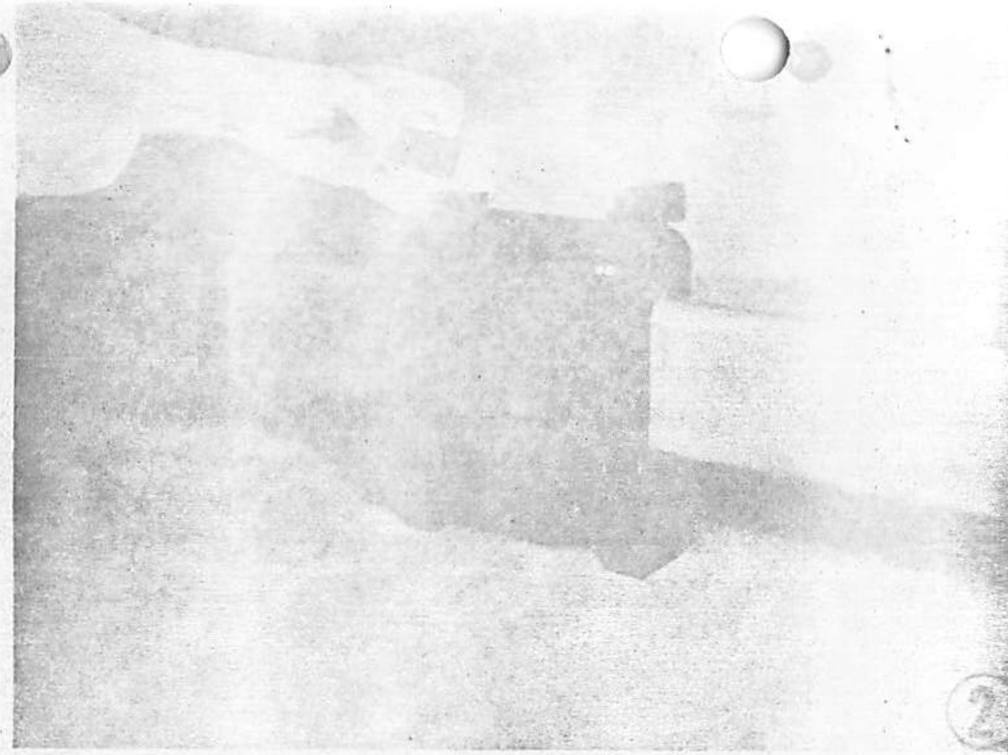
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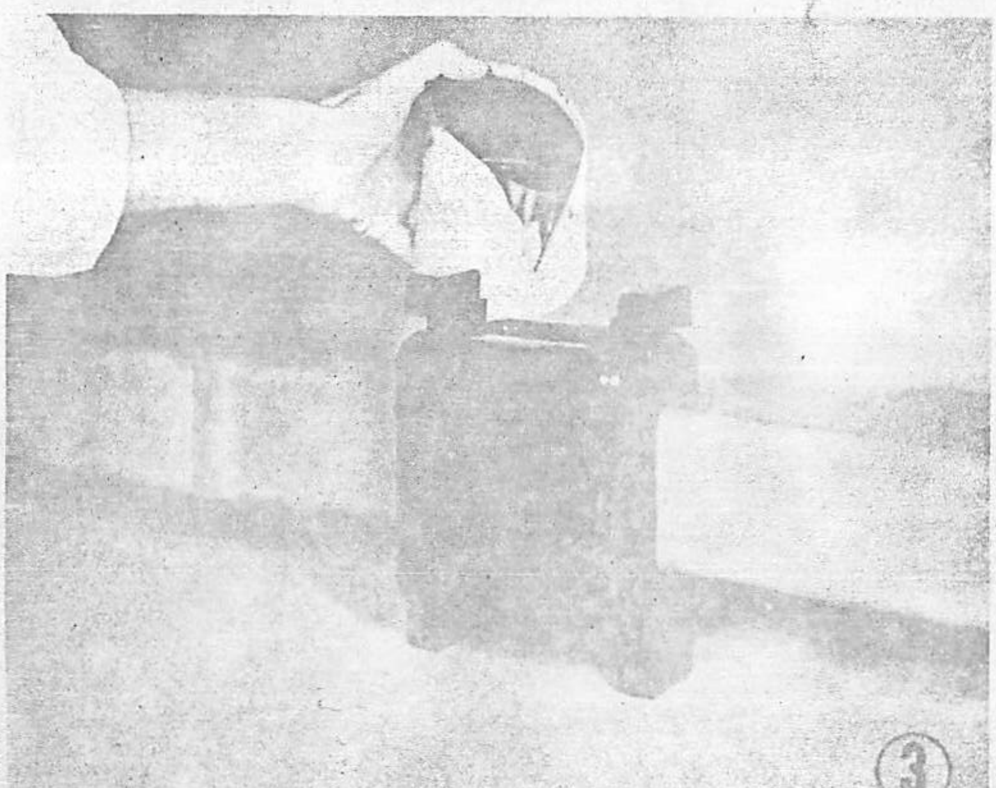
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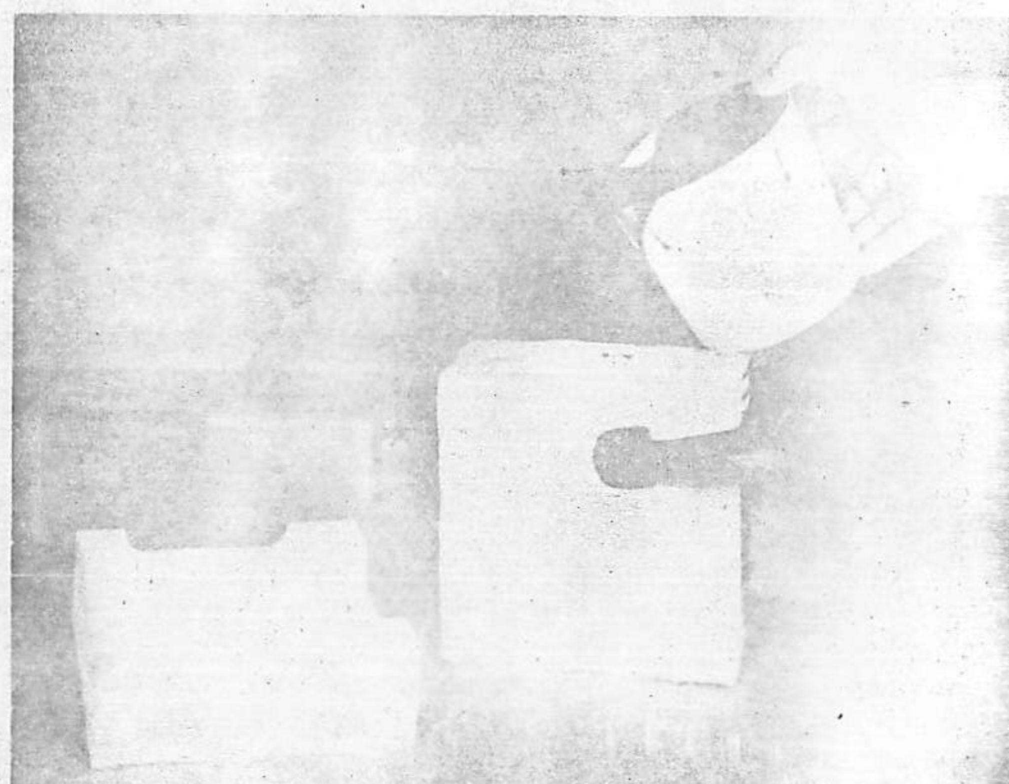


TAPING INSTRUCTIONS

(FROM DRAWING 2751-0442.)

THE FOLLOWING INSTRUCTIONS SHOULD BE FOLLOWED IN TAPING ALL MAIN CONNECTIONS AS REQUIRED ON SWITCHGEAR.

		51	PART NO.	DESCRIPTION	ITEM
		8 ROLLS	150-100	VINYL PLASTIC ELECTRICAL TAPE 1 INCH WIDE X 36 YARDS LG. FLAME RETARDENT	1
		15 FEET	082-009	4 INCH WIDE KNITTED COPPER MESH.	2
		1/2 ROLL	082-012	CARBON BLACK BIAS SEMI-CONDUCTIVE TAPE 1 INCH WIDE X 72 YARDS LONG	3

LAYER OF HALF-LAPPED TAPE. SEE TABLE "A"

FIG. 1

WRAP WITH HALF-LAPPED LAYERS OF .010 TAPE BEGINNING AT ONE END. REVERSE DIRECTION AND CONTINUE APPLYING HALF-LAPPED LAYERS MAKING ONE-HALF OF THE NUMBERS GIVEN IN TABLE "A". THESE LAYERS ARE APPLIED WITH JUST SUFFICIENT STRETCH TO INSURE GOOD CONFORMANCE WITH NO AIR VOIDS OR WRINKLES. AFTER THESE LAYERS ARE APPLIED, REVERSE DIRECTION AND APPLY BALANCE OF LAYERS WITH NO STRETCH.

SERVICE VOLTAGE	LAYERS OF TAPE	"A" CREEPAGE MIN.
750	2	1
5,000	6	1 1/2
15,000	13	2

TABLE "A"

ORDERING INSTRUCTIONS

MAT. SPECIFIED IN GRP. 51 WILL MAKE THE FOLLOWING AMOUNT OF CONNS.	KV.	AMPERAGE
12	5	600
6	5	1200
3	5	2000
3	15	1200
1 1/2	15	2000
1 1/2	5	3000

PART	5000 V. LIGHT AND HEAVY DUTY 600 AMP. QTY.	UNITS	1200 AMP. QTY.	UNITS
1	2 ROLLS	1	4 ROLLS	1
2	8 FEET	1	8 FEET	1
3	1/2 ROLL	1	1/2 ROLL	1

1 UNIT CONSISTS OF MATERIAL FOR 3 CONNECTIONS

PART	15000V. HEAVY DUTY 600 AMP. QTY.	UNITS	1200 AMP. QTY.	UNITS
1	4 ROLLS	1	8 ROLLS	1
2	8 FEET	1	15 FEET	1
3	1/2 ROLL	1	1/2 ROLL	1

1 UNIT CONSISTS OF MATERIAL FOR 3 CONNECTIONS

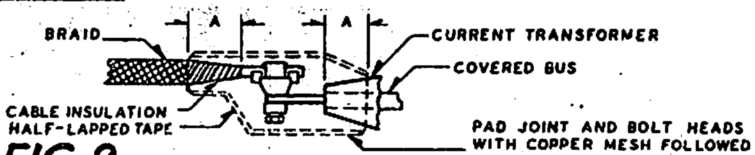


FIG. 2 CABLE CONNECTION

NOTE: FOR STRESS RELIEF CONES REFER TO THE RECOMMENDATION OF THE CABLE MANUFACTURER.

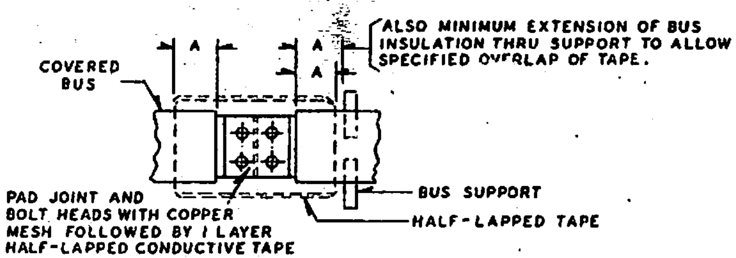


FIG. 3 BUS SPLICE

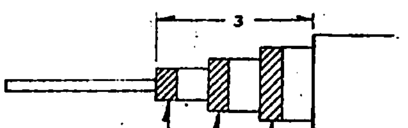


FIG. 4 (VARNISH CAMBRIC)

AT EACH STEP USE 3 TURNS OF TAPE. IN CASES WHERE END MUST BE BENT, SUFFICIENT AREA MUST BE TAPED TO PREVENT VARNISH CAMBRIC FROM COMING LOOSE.

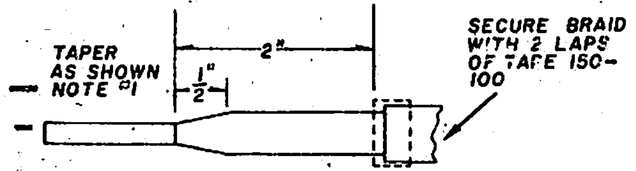


FIG. 4A (POLYETHYLENE)

POTENTIAL TRANSFORMER ETC. CABLE TERMINATION

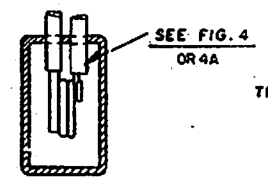


FIG. 5

POTENTIAL TRANSFORMER CONNECTION IN BUS JOINT COMPOUND BOX

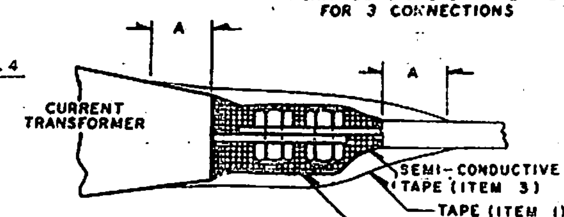


FIG. 6

TRANSFORMER CONNECTION

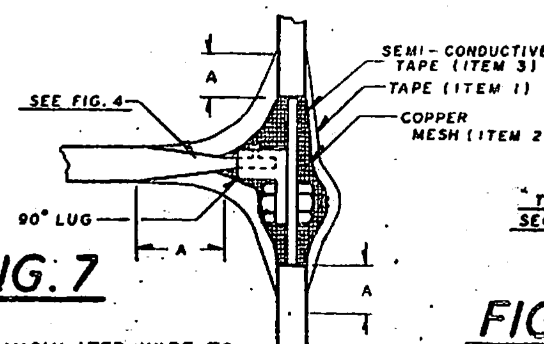


FIG. 7

INSULATED WIRE TO BUS CONNECTION

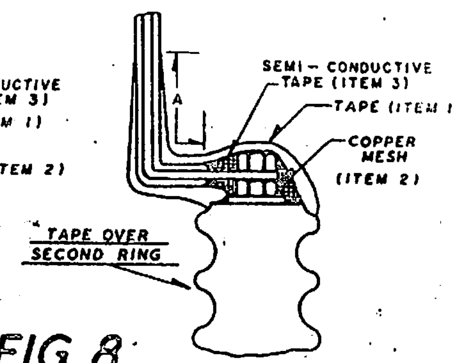


FIG. 8 BUS BAR TO DISCONNECT SWITCH STUD CONNECTION

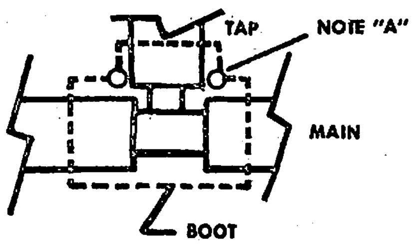
NOTE #1—Taper may be made with Type "PT" penciling tool, product of PLM Products, 3871 West 150th Street, Cleveland, Ohio 44111.

INSULATION BOOTS

On 5KV class equipment electrical joints are insulated with molded bus bar boots. The boot is pulled in place around the bus bar joint. After fitting two (or three as conditions require) holes are punched for clearance of the 10-32 nylon hardware.

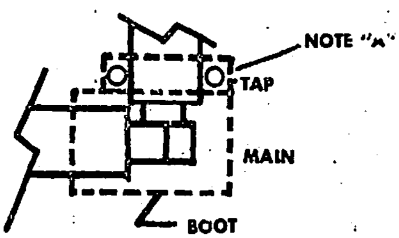
(Insulation boots can be applied to 15KV class when phase to phase clearance is 7" min. and phase to ground clearance is 6" min. If rodgap situation is present increase dimensions by 1 inch.)

TYPICAL BAR CONNECTIONS



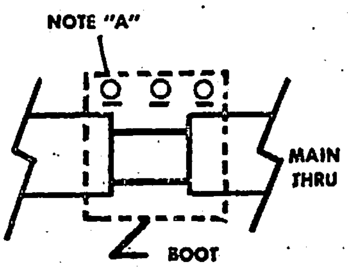
TAKE OFF

	DETAIL	BOOT
1–½ x 3 MAIN, 1–½ x 3 TAP	3300A0042	3307A3239
1–½ x 6 MAIN, 1–½ x 3 TAP	3300A0046	3308A3239
1–½ x 6 MAIN, 2–½ x 3 TAP	3300A0051	3309A3239



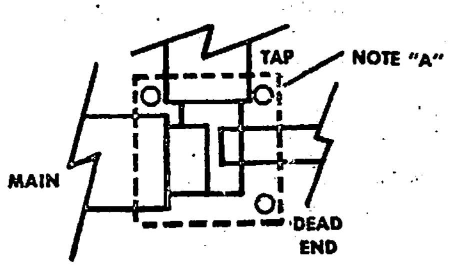
RIGHT ANGLE

	DETAIL	BOOT
1–½ x 3 MAIN, 1–½ x 3 TAP	3300A0044	3307A3239
1–½ x 6 MAIN, 1–½ x 3 TAP	3300A0047	3308A3239
1–½ x 6 MAIN, 2–½ x 3 TAP	3300A0053	3309A3239
1–½ x 6 MAIN, 1–½ x 6 TAP	3300A0050	Refer to Factory



THRU

	DETAIL	BOOT
1–½ x 3	3300A0045	3307A3239
1–½ x 6	3300A0049	3308A3239
2–½ x 3	3300A0054	3310A3239



RIGHT ANGLE WITH DEAD END

	DETAIL	BOOT
1–½ x 3 MAIN, 1–½ x 3 TAP	3300A0043	3307A3239
1–½ x 6 MAIN, 1–½ x 3 TAP	3300A0048	3308A3239
1–½ x 6 MAIN, 2–½ x 3 TAP	3300A0052	3309A3239

NOTE "A": 3 EA 10-32 x 1" LG RD HD NYLON SCREENS AND 10-32 HEX HD NYLON NUTS SUPPLIED WITH EACH BOOT

GETTING READY FOR SERVICE

Careful reference should be made to each component instruction leaflet before attempting to place the switchgear in service. If dry-type or oil or askarel-filled power transformers are furnished as part of the switchgear equipment, consult their instruction books or leaflets, particularly regarding absorption of moisture, and effects of dust and sand, etc.

Any indication of moisture will require that equipment be dried out before placing in service. Care should be exercised in drying-out operations to be certain that the maximum temperature during the drying period does not exceed 70 to 75 degrees centigrade on switchgear. In the event it is desired to give the equipment a high potential test before placing in service, this test should only be made after the equipment is thoroughly dry, allowing approximately 10 days drying time. The value of test voltage should correspond to the voltages listed below.

DIELECTRIC TESTS

The following dielectric tests shall be made to determine the adequacy of insulation. Devices used as part of switchgear assemblies shall be capable of meeting the following dielectric tests.

Exception—There is certain apparatus such as potential transformers, auto transformers, motor starting reactors, and motor-operated devices the standards for which call for lower test voltage than those given below. When such devices are used, they may be disconnected during these tests.

Alternating-current test voltage shall have a crest value equal to 1.41 times the values specified. A sine wave shape is recommended. The frequency shall not be less than the rated frequency of the apparatus tested. The test voltage shall be applied for one minute.

Direct-current test voltage, if used in lieu of alternating-current test voltage, shall be 1.41 times the specified alternating-current voltage.

A. Equipment Rated 60 Volts and Below

That part of assembled equipment rated 60 volts or less shall withstand an alternating-current voltage test of 500 volts.

B. Equipment Rated 61 to 600 Volts

Alternating-current assembled equipment and alternating-current circuits of equipment of higher rated voltage rated 61 to 600 volts shall withstand an alternating-current voltage test of 1000 volts plus twice rated voltage, with a minimum of 1500 volts. Factory Test. When assembled in field and connected, test voltages should be 75% of factory test value.

C. Equipment Rated 601 to 2399 Volts—Alternating Current

Alternating-current assembled equipment rated 601 to 2399 volts shall withstand an alternating current voltage test of 2000 volts plus 2¼ times rated voltage. When assembled in field and connected, test voltages should be 75% of factory value.

D. Equipment Rated 2400 Volts Alternating-Current and Above

Rated Voltage KV	60 Cycle KV Field Conn.	60 Cycle KV Factory	Standard Full-Wave Impulse (Withstand) Tests KV
2.4	11.25	15	45
4.16	14.25	19	60
7.2	27.0	36	95
13.8	27.0	36	95
14.4	37.50	50	110
23	45.0	60	150
34.5	60.0	80	200

The equipment should be checked to be certain no tools on any other equipment have been left in the switchgear. When connections are to be made to or from an Electric Utility, public or privately owned, consult their representatives very early in the construction period, as many of them have very strict requirements which must be met before service connections will be made.

OPERATIONAL TESTING

Upon completion of installation, and inspection of the circuit breakers and other components, together with installation of any incoming and outgoing control connections, it is time to start operational testing. Outgoing feeder cables should not be connected at start of test.

If it is a Power Center with Power Transformer and high-voltage disconnect or interrupter switch ahead of the switchgear, lock the switch in the open position in order to protect the test operator.

Similarly if it is a generating station, the generator breaker should be locked open.

If there are low voltage manual breakers, they may be checked in "test" and "operate" positions. Extreme care should be taken that all contacts and housing switches (if any) align properly.

When the switchgear has electrically operated circuit breakers, they are operated in some installations from local battery or auxiliary control supply, and in other installations are operated from the switchgear bus, or a connection ahead of the incoming master circuit breaker. In the event the primary source of power is locked open, it will be necessary to use an auxiliary source of power to operate the circuit breakers, lamps, bell-alarm switch, undervoltage devices, rectifiers, capacitor shunt trips, etc. Check circuit breakers in "test" and "operate" positions, paying particular attention to good contact between movable and stationary secondary contacts in both positions. Key Interlocks should be operated manually to make sure that protection is complete. Remove spare keys to supervisory office.

Each relay and trip device or other component should be operated manually to be certain its contacts perform their required function. Remove any material that was installed at the factory to block relay contacts during the shipment. Preliminary settings for test purposes should be applied to relays. The various operational functions are indicated on the schematic and wiring diagrams of the switchgear equipment.

After completion of all operational tests, all relays should be set. All trip indicators on the relays should be checked to see that they function properly.

Upon completion of device settings and tests, the main incoming and feeder cables should be properly phased out and connected to the switchgear. Incoming and outgoing cables should be braced so as to take mechanical strain off studs of circuit breakers and porcelain supports of various types.

The entire switchgear structure shoud be carefully vacuum cleaned (preferred) or blown out, and all rear and side plates that have been removed should be rebolted in place. All secondary and power connections should be tested for grounds with high potential tester or merger. Megger readings of one megohm per thousand volts is acceptable. If readings are lower equipment should be dried out until insulation resistance values improve to one megohm per thousand volts. Preferable readings are

Operating Voltage KV	1.2	2.5	5.0	8.66	15
Insulation Resistance Megohm at 25°	12	25	50	150	300

PART II

GUIDE TO SWITCHGEAR MAINTENANCE

A preventive maintenance program is outlined for medium-voltage, metal-clad type switchgear, low voltage metal-enclosed switchgear, and air-magnetic power circuit breakers. The outline lists benefits to be derived, records, tests and facilities required, and inspection and servicing steps.

MAINTENANCE BENEFITS AND FACILITIES

Basic elements are outlined for a maintenance program of switchgear installations.

A. *MAINTENANCE PROGRAM*

A well executed program has these benefits:

1. Longer life of switchgear and fewer replacements.
2. Reduced time on repairs and overhauls, and the option of scheduling them at an opportune time.
3. Fewer failures with unexpected outages.
4. Timely detection of any undesirable operating conditions which require correction.
5. Improved plant performance and increased operating economies.

B. *MAINTENANCE RECORDS*

A file should be established and include:

1. A record of all installed switchgear and its maintenance schedule.
2. Nameplate data of the equipment and its major components, instruction books, renewal parts bulletins and drawings.
3. A list of all items which have to be inspected and what adjustments are to be checked.
4. A record of past inspections and test results.

C. *MAINTENANCE TESTS*

Maintenance tests are applicable as indicated:

1. Insulation resistance tests of the breakers and of the switchgear bus can be useful in determining the condition of the insulation if they are made regularly. Since definite limits cannot be given for satisfactory insulation resistance, a record must be kept of the readings and comparisons made. Deterioration of insulation and the need for corrective action can be recognized if the instrument readings are progressively lower after each test.
2. High potential tests are not required and are not recommended except in special circumstances, such as after repairs or modifications to the equipment that included the primary circuit. When such tests are necessary, they may be made using 75% of the standard 60-cycle insulation test voltage for new equipment.
3. After the switchgear has been serviced and adjusted, its operation should be checked before it is returned to service. This can be best done by putting the breaker in the test position and operating it with its associated control and protective devices. If it is desired to test the breaker outside its compartment, use the nine-foot test-jumper drawing #3352-0017 supplied with the switchgear.

D. *MAINTENANCE EQUIPMENT*

Adequate maintenance equipment should include:

1. Spare parts for at least those parts of the switchgear that are vital to continued operation. Manufacturer's recommended list of spare parts can be used as a guide in combination with operating experience to determine variety and quantity of parts to be stocked.
2. A well-lighted shop equipped with following:
   a. A test cabinet for air magnetic breakers or an inspection rack.
   b. Maintenance closing device for power breakers.
   c. Test jumper for connecting breaker to control circuit when it is outside its compartment.
   d. Relay test plugs for making tripping, timing and calibration tests of relays.
   e. A selection of ammeters, voltmeters and instrument transformers.
   f. An insulation resistance tester.
   g. An overhead crane or hydraulic lifting device.

FREQUENCY OF INSPECTION

It is generally good practice to inspect equipment three to six months after it is first put in service and then inspect and maintain it every one to three years depending on its service and operation conditions. This suggested schedule is only a guide. Conditions that can make more frequent maintenance necessary are:

1. High humidity and ambient temperature, 2. corrosive atmosphere, 3. excessive dust and dirt, 4. high repetitive duty, 5. frequent interruption of faults, 6. older equipment, and 7. history on preceding inspections.

SAFETY PRACTICES

Maintenance employees must follow all recognized safety practices, such as those contained in the National Electrical Safety Code and in company or other local safety regulations during maintenance. All of the units of switchgear to be maintained must be de-energized, tested for potential, grounded and tagged out before removing covers and barriers for access to primary circuits. As is well known, the solid insulation surrounding an energized conductor in power apparatus should not be relied upon to provide protection to personnel. Another example is the maintenance closing device, which is exactly what the name implies and should never be used to close manually a circuit breaker that is connected to an energized circuit. All removable devices, such as the circuit breakers and rollout potential transformers, should be removed from the metal-clad switchgear housing.

MAINTENANCE PROGRAM FOR SWITCHGEAR

The maintenance program should include the thorough inspection, servicing and adjustment of the following components for 2.4-13.8 KV operating service.

A. *METAL-CLAD STATIONARY UNITS*

1. Remove accumulated dust and dirt. Vacuum cleaning is recommended.
2. Wipe insulated buses and bus supports with a clean cloth moistened (when necessary) with a petroleum solvent or similar cleaner. Wipe insulation dry after cleaning.
3. Inspect buses and connection bars for physical damage, evidence of corona cutting or other conditions that can indicate deterioration of the insulation.
4. If taping has been damaged or needs replacing follow instructions on Federal Pacific drawing page 6.
5. Inspect alignment and contacting of primary disconnecting devices, checking for signs of abnormal wear or other damage. Note: Discoloration of the silvered surface is not usually harmful unless caused by sulphide deposits which can be removed by a solvent, such as alcohol, or by silver polish.
6. Check adjustments and operation of safety shutters, interlocks, auxiliary and limit switches.
7. Inspect all relays, contactors, switches, fuses and other devices for correct operation.
8. Check tightness of anchor bolts and structure bolts, also control connections and continuity of wiring.
9. Check strip heaters and clean air filters at ventilation openings when these are present.
10. Repair damaged paint finishes.

B. *MEDIUM VOLTAGE POWER CIRCUIT BREAKERS (AIR MAGNETIC TYPE) 2.4 TO 13.8 KV*

Air magnetic type circuit breakers should be maintained on the same schedule as the metal-clad units, or every 2500 non-fault operations, or at least every six months, whichever comes first. It is also recommended that when the normal operating duty is a combination of fault interruptions and repetitive operations, the breaker should be inspected and serviced after a fault operation at or near its interrupting rating. Remove the breaker from its housing for inspection.

1. Wipe insulating parts, including bushings and the inside of box barriers, clean of smoke and dust. Repair moderate damage to bushing insulation by sanding smooth and refinishing with a clear insulating varnish.
2. Inspect alignment and condition of movable and stationary contacts. Check their adjustment as described in the instruction book.
3. Check arc chutes for evidence of damage, and replace damaged parts. When arc chutes are removed, blow out dust and loose particles.
4. Clean silver-plated breaker primary disconnecting devices. Whether cleaned or not, lubricate devices by applying a thin film of slow aging, heat resistant petrolatum.
5. Inspect breaker operating mechanism for loose hardware and missing or broken cotter pins, retaining rings, etc. Examine cam, latch and roller surfaces for damage or excessive wear.
6. Clean and relubricate operating mechanism. Use a non-hardening grease to lubricate cams, rollers, latches and props, and pins and bearings. We recommend LUBRIPLATE, "AERO" grade, manufactured by Fiske Bros. Refining Company, Newark, N. J.
7. Check breaker operating mechanism adjustments and readjust as described in the instruction book. If these adjustments cannot be made within specified tolerances, it will usually indicate excessive wear and need for a complete overhaul.
8. Check control device for freedom of operation. Replace contacts when badly worn or burned.
9. Inspect breaker control wiring for tightness of connections.
10. After the breaker has been serviced, operate it slowly with closing device to check freedom from binding or friction and check that contacts move to the fully opened and fully closed positions. Check electrical operation either in test position or removed from compartment.

C. *LOW VOLTAGE POWER CIRCUIT BREAKERS 600 VOLT AC*

The preceding information applies in nearly all details to Low Voltage Metal Enclosed (600 Volt AC) switchgear, both indoor and outdoor, the differences are only minor, and are due to physical differences in the switchgear.

METAL-ENCLOSED SWITCHGEAR 600 VOLT MAXIMUM
SWITCHGEAR ACCESSORIES

Description	Part No.
*Breaker Racking-in Handle or Crank	
FP-25 and 50	1101 B 9251
FP-75	1151 C 5036
*Breaker Maintenance Closing Handle	
FP-25 and 50	1151 B 9252
FP-75 (2 Req.)	
Breaker Extension Rails	
FP-75 (2 Req.)	1151 C 5214
*Breaker Emergency Charging Handle	
FP-75 Only	1151 B 5349
Breaker Lift Yoke or Chain (Use With Overhead Crane)	
FP-25 and 50	4051 A 3274
FP-75	167-002
Breaker Hydraulic Lift Truck	
FP-25, 50 and 75 only	2651 B 0200
FP-25 and 50 only	2652 B 0200
FP-25, 50, 75 and 100	2653 B 0200

Description	Part No.
Breaker Racking-In Cranks	
DST-5KV-15KV, 20", 30" & 34" Wide Breakers	2251-0222
DST-5KV-17" Wide Breaker Indoor & Non Walk-in	2252-0222
DST-5KV-17" Wide Breaker Outdoor Walk-in (And right end cell is 17" Breaker otherwise use 2252-0222)	2253-0222*
*Breaker Maintenance Closing Lever	
DST-5-250, 5-350, 15-500 & 15-1000	2251-0215
*Breaker Spring Charging (Stored Energy) Lever	1551-2454
Breaker Test Jumper Cable—9 Ft. (18 Points) (Not required when test cabinet is specified)	3355 B 0017
*Breaker Test Jumper Cable—9 Ft. (30 Points) (Required only if test of brkr. out of cell must include circuit function of the auxiliary contacts)	3354 B 0017
*Breaker Outdoor Transfer Truck	
DST-5KV-20" Wide Breakers	3351-1458
DST-5KV-30" Wide Breakers (except 5-350)	3352-1458
DST-15KV-30" Wide Breakers	3353-1458
Steel & Aluminum Bolted Cell Non-Walkin	
DST-17"-21" Alum. House	2251 D 2851
DST 30" Alum. House	2252 D 2851
DST-17"-21" Steel House	2253 D 2851
DST 30" Steel House	2254 D 2851
DST 30" Steel House 5350 & 15-1000	
DST 30" Steel House 5350 & 15-1000	
*Breaker Handling Dolly—Indoor	
DST-5-75	1551-2825
DST-5-250, 5-350, 15-500, 15-1000	2251-0333
Breaker Test Cabinet—Indoor (Except 15-1000)	
125V DC Close & Trip (4101 D 0116)	3354 D 0070
230V AC Close Cap. Trip (4101 D 0117)	3355 D 0070
230V AC Close Battery Trip (4101 D 0115)	3356 D 0070
250V DC Close & Trip (4101 D 3987)	3357 D 0070
230V AC Close Cap. Trip (4101 D 0117)	3359 D 0070
230V AC Close DC Trip (4101 D 0115)	3360 D 0070
48V DC Close, Trip & Motor (4101 D 5114)	3366 D 0070
125V DC Close, Trip & Motor (4102 D 5114)	3367 D 0070
48V DC Close, Trip & 125V AC Motor (4103 D 5114)	3368 D 0070
125V DC Close, Trip & 125V AC Motor (4104 D 5114)	3369 D 0070
115V AC Close, Motor & DC Trip	3370 D 0070
230V AC Close, Motor & DC Trip	3371 D 0070
230V AC Close, Motor & Cap. Trip	3372 D 0070
Breaker Test Cabinet—Outdoor Specify circuit requirements	3351-0660
Cell Main Contact Wrench—15KV	
DST-15-500	2251-0277
DST-15-1000-3000A	3351-1807
*Hand Closing Lever Gang Operated Disconnect Switch 5 and 15KV (Manual ISG only)	2751-0145
*Arc Chute Lifting Yoke	
DST-5-75, 5-150	1551-2826
DST-15-500, 5-250	1551-0429
DST-5-350	1551-1693
DST-15-1000	1552-1693
*Arc Chute Maintenance Prop	
DST-5-350	1551-2124

* Standard Accessories normally supplied with switchgear. All other items included only where specified.

MISC. SWITCHGEAR ACCESSORIES

Closing Rectifiers — 240 V 60 cycle AC (264V Max) 125 volt DC intermittent duty. AC not to be applied longer than one (1) second nor more than ten (10) times in any one minute period.

	Part No.
100 Amp 4-8-1 Stock, 240V AC. 125 Volt DC	2701-0244
60 Amp 4-8-1 Stock, 240V AC. 125 Volt DC	2702-0244

Arc Suppression Rectifier (DST Breaker only)

125 volt DC—Service 1-Stack	087-004

Hook Stick For Disconnecting Switches

8-foot Stick	3751-0540
10-foot Stick	3752-0540
12-foot Stick	3753-0540
14-foot Stick	3754-0540

Cable Lugs, Cast Eyebolt — Dwg. 2701-0010

Cable Range	
#10W to #2W	2701-0010
2C to 4/oC	2702-0010
250MCM to 500MCM	2703-0010
600MCM to 1000MCM	2704-0010
1250MCM to 1500MCM	2705-0010
1500MCM to 2000MCM	2706-0010

Touch Up Paint

Exterior outdoor dark gray ASA-24	Finish S-18
Interior indoor light gray ASA-61	Finish S-20

Joint Compound Box Ordering Information ½ X 3, ¼ X 3 Conductors Kit

Box & Compound (1 Connection)	2751-0470

Joint Compound Box Ordering Information ½ X 6, ¼ X 6 Conductors Kit

Box & Compound (1 Connection)	2752-0470

For Insulation Boot Ordering, See Page 7

Unit Heaters

Description	Part No.
120-208 Volts, Complete Assembly, 125-375 Watts	2752 B 0569
240-277 Volts, Complete Assembly, 300-375 Watts	2751 B 0569
120-240 Volt Thermostat (Close 55°F, Open 65°C	160-001
277 Volt Thermostat (Close 55°F, Open 65°C)	160-002

Switchgear Indicating Lamps

Catalog No.	Description	
Indicating Lamps—not including color caps.		
	Voltage AC or DC	Series Resistor OHMS
2751-0135	50	800
2752-0135	70	1400
2753-0135	115	2900
2754-0135	125	3200
2755-0135	208	5800
2756-0135	230	6500
2757-0135	250	7100
2758-0135	24	110
Color Caps		
2701-0117	red	
2702-0117	green	
2703-0117	amber	
2704-0117	blue	
2705-0117	white	

Catalog No.	Description	
Resistors		
	OHMS	SERVICE VOLTAGE
2708-0116	110	24
2701-0116	800	50
2702-0116	1400	70
2703-0116	2900	115
2704-0116	3200	125
2705-0116	5800	208
2706-0116	6500	230
2707-0116	7100	250
Indicating Lamp Parts		
064-007	24-E Lamp 24 V. .032-.038 amps.	
2701-0124	Spacer 1/32″	
2751-0119	Receptacle assembly, less Resistor, Bezel and Color Cap.	
2701-0118	Spring Retainer Washer	

Instruction Books

600 V Air Circuit Breaker

FP-25 and 50	IN-810.9
FP-75-3000	IN-810.10

2.4 to 13.8 KV Air Circuit Breaker

DST-15, 250, 500	IN-820.2
DST-5, 150, 250	IN-820.2
DST-5-75,	IN-820.5
Supplement for Stored Energy Spring	IN-820.9
Supplement for Stored Energy Hydraulic	
Ground and Test Device	IN-822.0

Transformer

Dry type Class B Insulation	#32956
Dry Type Class H Insulation	IN-T-7700
Oil Immersed Transformers	IN-T-103
Oil & Askarel Transformers	INT-100
Filtering & Testing Oil	IN-266

Switchgear

Instruction and Maintenance of 4.16 and 13.8 Metal-clad and 600 volt Metal-Enclosed Switchgear	IN-820.4b
Instruction for Installation of Outdoor Switchgear	IN-820.3a

MISC. SWITCHGEAR ACCESSORIES

RELAYS

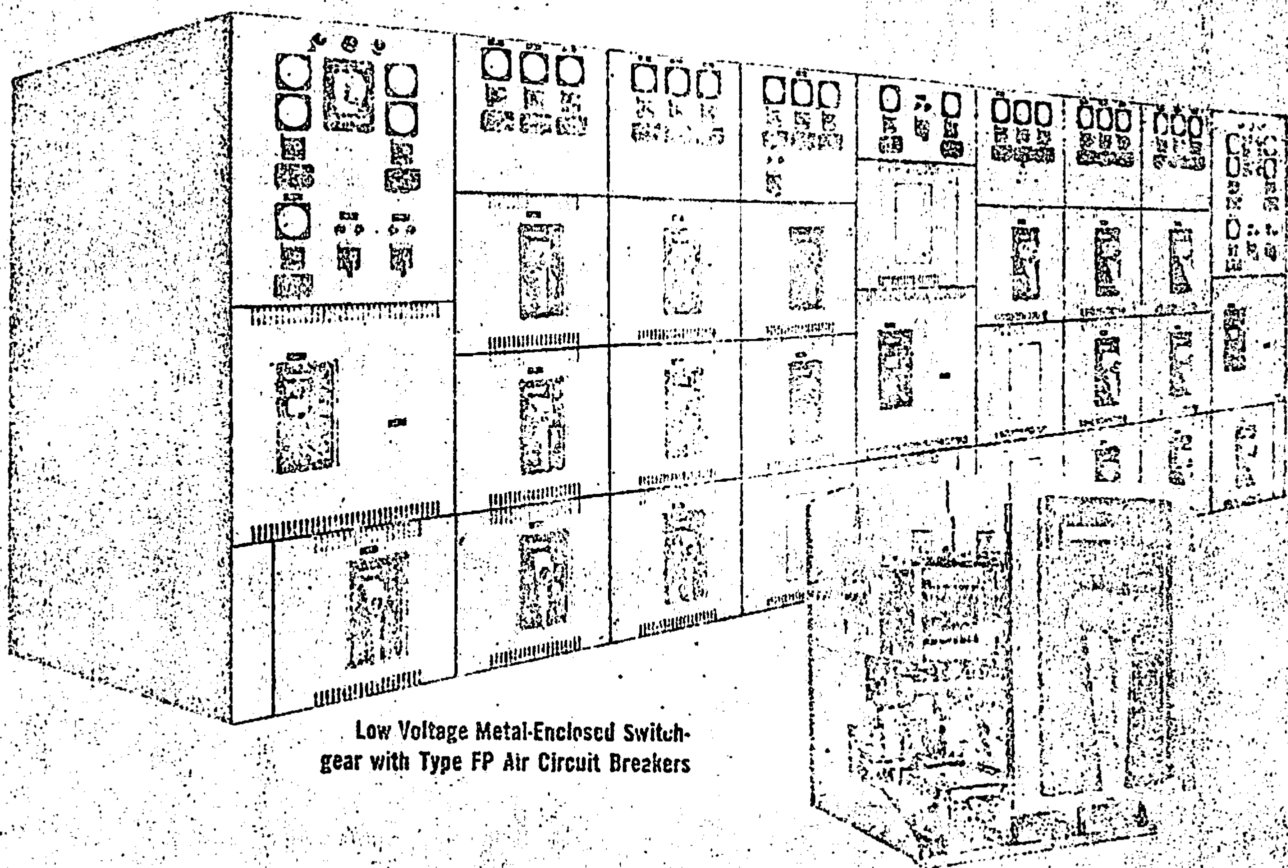
Inverse Time Overcurrent	CDG	IB 5-050
Voltage Controlled Overcurrent	CDGV	IB 5-051
Directional Overcurrent	CDD	IB 6260
Overvoltage and Undervoltage	VDG	IB 6300
Power Directional	WDG	IB 6320
Generator Differential	DDG	IB 6350
Transformer Differential	DDT	IB 6360
DC Timing	VAT	IB 6400
Immediate, Single Shot Reclosing	VAR 11	IB 6420
Multi-Shot Reclosing	VAR 42	IB 6425
Instantaneous Overcurrent	CAG	IB 6450
Instantaneous Voltage	CAA	
and Current Auxiliary	VAA	IB 6460

INSTRUMENTS

Type JA and JD Long Scale SWBD Instruments	IN-350.1

Low Voltage Metal-Enclosed Switchgear

600 Volts a-c—25,000 to 100,000 Amperes IC



Low Voltage Metal-Enclosed Switchgear with Type FP Air Circuit Breakers

FP25-600
Air Circuit Breaker

Federal Pacific Metal-Enclosed Switchgear is specifically designed for use in industrial plants, commercial buildings, and utility companies where a high degree of service continuity and reliability are required. This equipment may be applied at 208, 240, 480, and 600 volts a-c with interrupting ratings up to 130,000 amperes symmetrical, 150,000 amperes asymmetrical.

To provide the industry with the most compact switchgear assembly, Federal Pacific builds Type FP50 air circuit breakers having 50,000 amperes interrupting capacity which may be stacked four high.

Federal Pacific Low Voltage Switchgear utilizes the most modern design concepts providing maximum protection to distribution equipment and complete safety to operating personnel. With cell door closed, circuit breakers can be placed in either of three positions: "Connected" "Test" and "Disconnected" enabling safe maintenance and operating techniques to be employed.

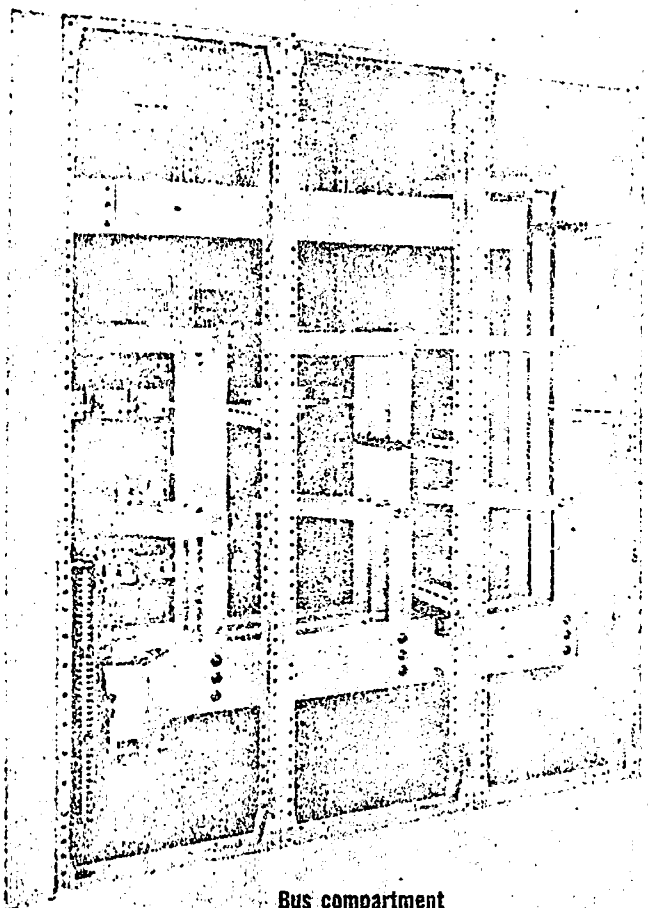
All Federal Pacific circuit breakers employ a stored energy mechanism. This permits safe closing on all circuits because the fast closing speed of the circuit breakers is independent of operator's action, and it is impossible to tease, or slow-close the circuit breaker contacts. The consistent high-speed of the mechanism increases the range of the breaker size that can be safely operated manually, and reduces breaker maintenance by extending contact life.

Every switchgear unit is completely assembled and wired prior to shipment. Rigid testing and quality control procedures insure compliance with the user's requirements and applicable industry standards, including those of ASA, NEMA, and IEEE.

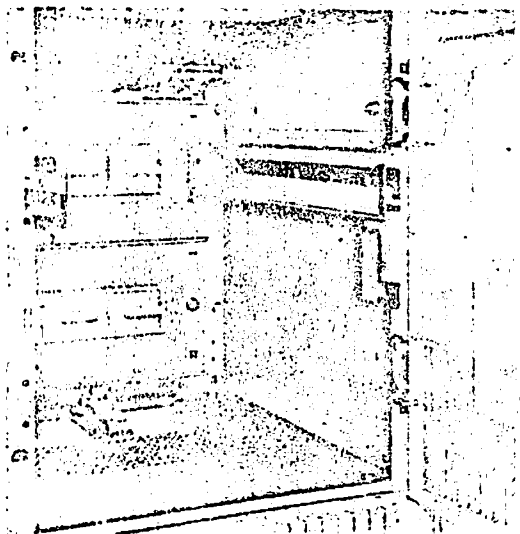
Significant design improvements—primarily in the air circuit breakers—enable Federal Pacific to produce reliable metal-enclosed switchgear and permit considerable savings in their application.

Low Voltage Metal-Enclosed Switchgear

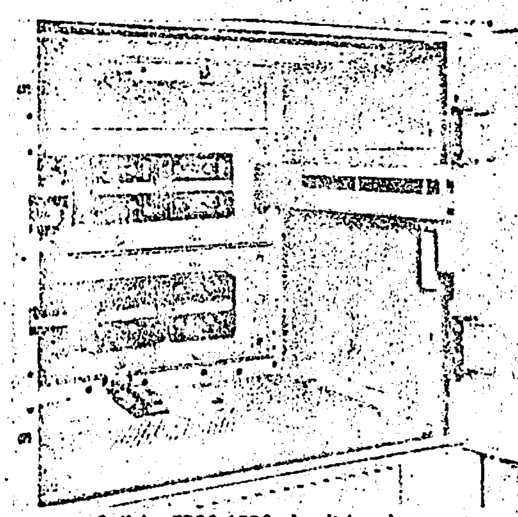
600 Volts a-c—25,000 to 150,000 Amperes IC



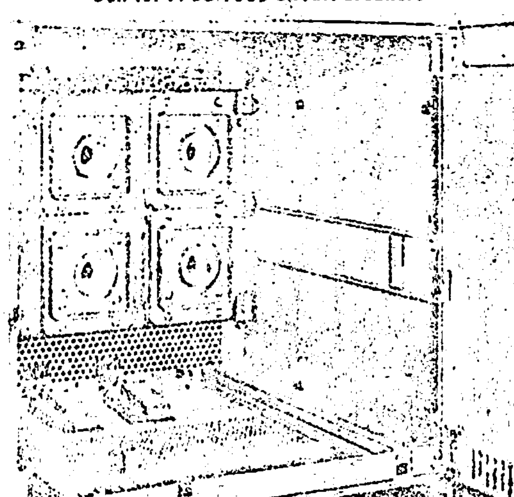
Bus compartment



Cell for FP25-600 circuit breakers



Cell for FP50-1600 circuit breakers



Cell for FP75-3000 circuit breakers

CONSTRUCTION

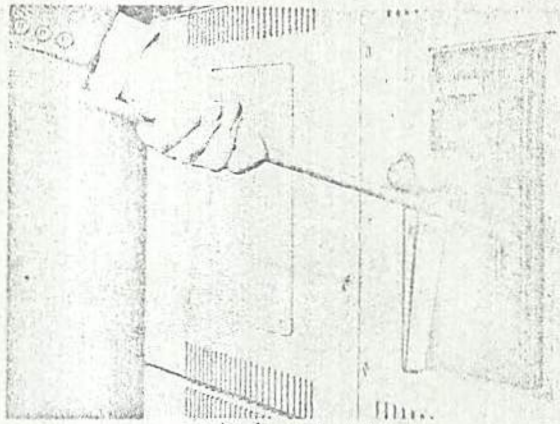
Federal Pacific Low Voltage Switchgear utilizes the most modern design concepts. Circuit breaker cells are made of formed sheet steel and are jig-welded to insure accurate alignment for interchangeability of circuit breakers. Universal bolted frame construction provides the rigid steel framework for the switchgear exterior. Top, side, and rear bus compartments are covered by removable steel plates. Bus bars are heavily silver plated for maximum conductivity and are securely braced to withstand the shocks and magnetic stresses caused by fault currents capable of being produced by the system in which the switchgear is installed.

Terminal blocks for control circuits are located a safe distance from the bus, and are accessible from the rear of the switchboard.

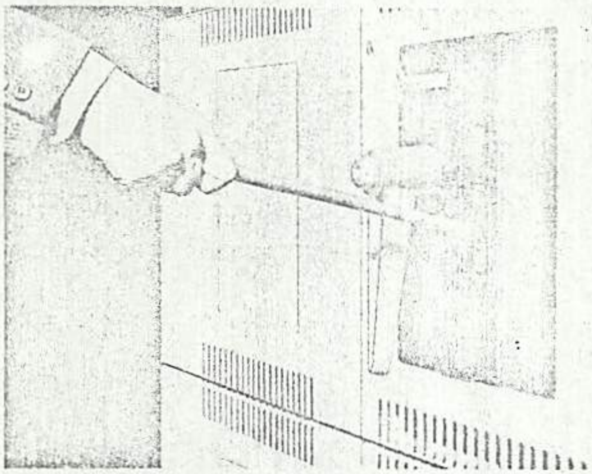
Each breaker cell door is louvered to provide adequate ventilation necessary for the switchgear to stay below the prescribed temperature rise. Prior to painting, all metal parts are completely degreased and given a phosphatizing treatment. This preparation is followed by application of a standard ASA-61 light gray paint that is baked on to provide a durable finish.

THREE POSITION DRAWOUT

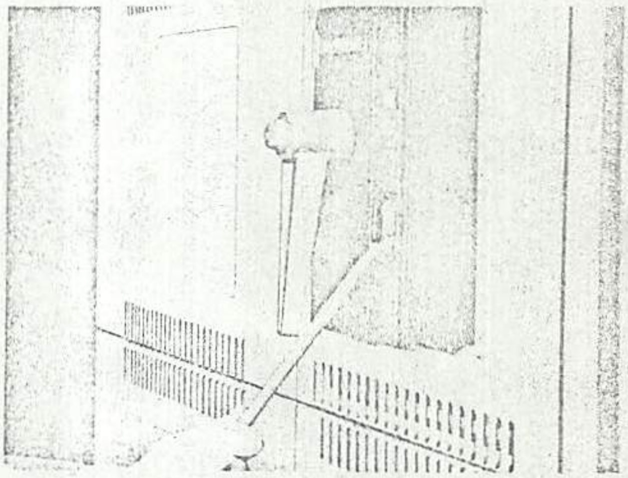
Type FP Breakers can be moved from "Connected" "Test" or "Disconnected" position without opening the cell door. An operating lever is inserted into a drawout cam, and the breaker position is changed by a single stroke. An indicator is clearly visible on the drawout cam for quick, positive identification of the breaker position at all times. The interlock cover plate must be moved before the drawout handle can be placed into the cam. Movement of the cover plate automatically trips the breaker insuring personnel complete safety by making it impossible to move the breaker from any position with the main contacts closed.



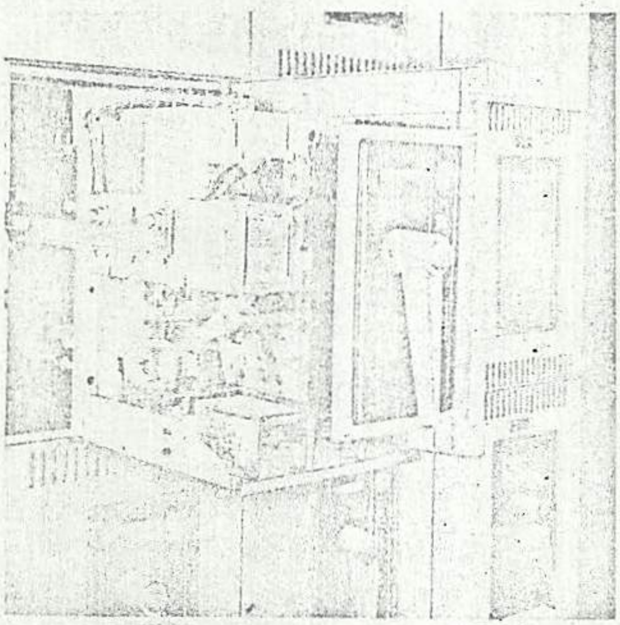
Connected position



Test position



Disconnected position



TELESCOPING ROLLOUT

Breakers can be completely withdrawn from the cell for examination, maintenance, or replacement. Telescoping guide rails rigidly attached to the breaker cell provide a substantial support for the breaker to roll in and out. A positive "stop" at the end of the rails prevents further travel after the breaker has completely cleared the enclosure.

Low Voltage Metal-Enclosed Switchgear
600 Volts a-c—25,000 to 150,000 Amperes IC

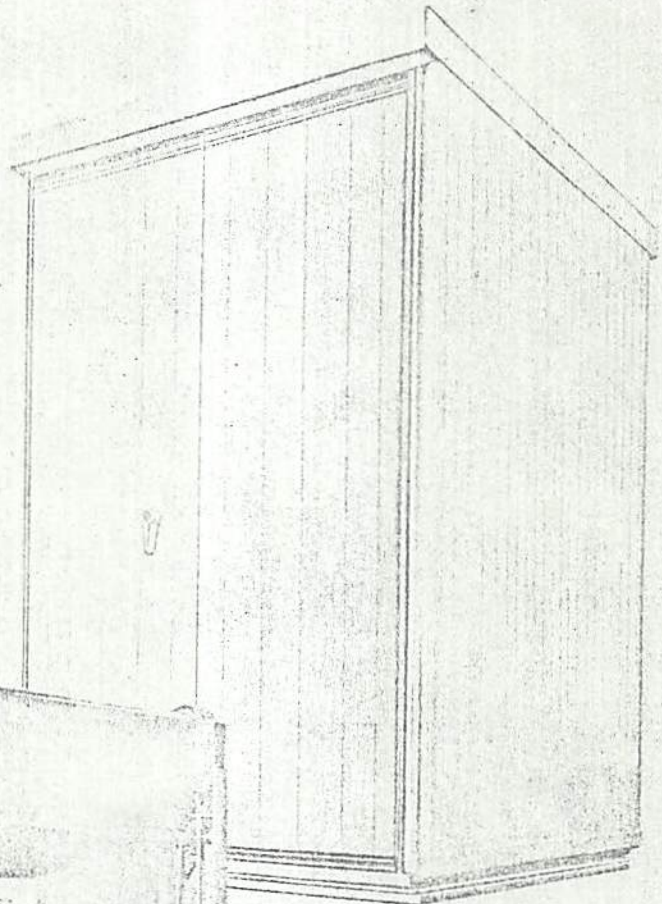
OUTDOOR CONSTRUCTION

A full selection of both steel and aluminum outdoor housings is available—with standard protected-aisle construction. The basic indoor switchgear assembly is mounted on a steel or aluminum base. Then an outdoor enclosure is built around the switchgear. The outdoor housing contains lights and receptacles, as well as screened ventilating louvers and heaters to prevent condensation. Accessibility to the front and rear is provided by doors. Outdoor steel housings are phosphatized followed by an epoxy undercoat and given a finish coating of ASA-24 dark gray paint.

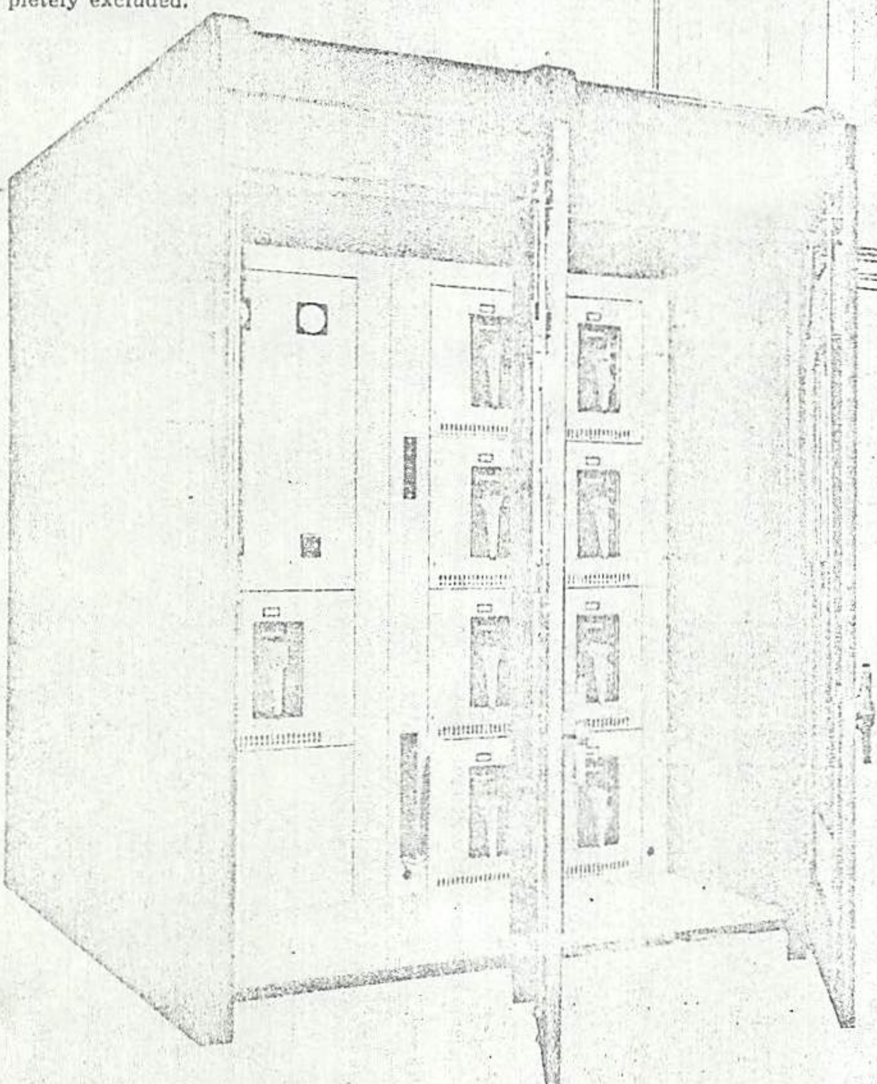
Aluminum outdoor housings may be natural finish or at user's option allodized a light green color. The allodizing process is also a preparation for paint; and either at the time of manufacturing or at a future date, a compatible paint may be applied.

All outdoor switchgear is coated with an automotive type "underseal" to provide protection against deterioration to all surfaces not accessible after installation.

Federal Pacific outdoor enclosures have been tested in accordance with NEMA standards and were found to greatly exceed the requirements in that water was completely excluded.

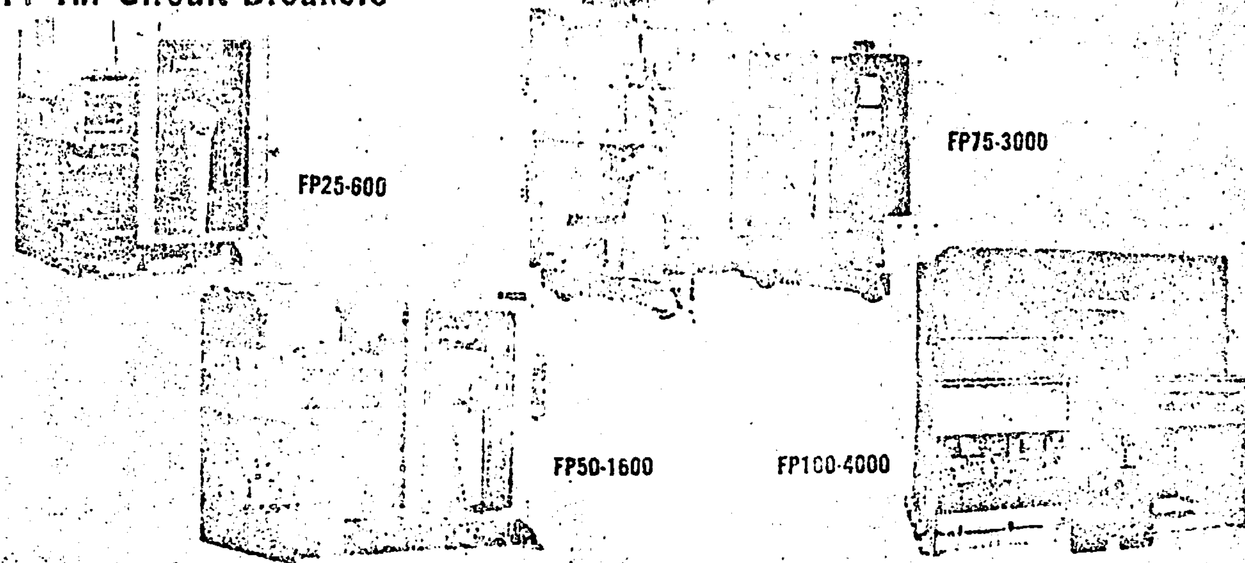


Aluminum Outdoor Housing



Steel Outdoor Housing

FP Air Circuit Breakers



FEATURES: Dependable stored energy operation / Manual—electrical—manual/electrical operation
Field adjustable timing device / Low-loss hinge contacts / Safe, three-position drawout

FP25 Breaker is equipped with a stored energy mechanism and may be provided as a manual, electrical or manual/electrical breaker.

FP50 Breaker is equipped with a stored energy mechanism and may be provided as a manual, electrical or manual/electrical breaker.

The compact design of the FP50-1600 enables it to be stacked four high in a vertical section which reduces the overall size or the assembly.

FP75 and FP100 Breakers are equipped with an electrically operated spring charged stored energy mechanism. These breakers have provisions for emergency manual operation.

FP breakers should be applied within their assigned voltage, continuous current, interrupting and short-time ratings and should be selected to provide the protection required by the other components of the circuit.

FP breakers are equipped with a direct acting over-current trip device. Trip coils should be selected so as to provide the minimum trip setting required. Table I shows the standard coil ratings that are available witn each of the different FP breakers.

TABLE I standard current ratings (amperes)

FP-25		FP-50		FP-75	FP-100
15X	175	15X	225	2000	4000
20X	200	20X	250	2500	5000
30X	225	30X	300	3000	6000
40X	250	40X	350		
50X	300	50X	400		
70	350	70X	500		
90	400	90X	600		
100	500	100X	800		
125	600	125X	1000		
150		150	1200		
		175	1600		
		200			

X These coils are available; however, they must be applied in accordance with table III due to their I^2t withstandability.

INTERRUPTING RATINGS

The breakers, though rated on a symmetrical basis, are tested under maximum asymmetrical conditions with the test circuit X/R ratio being not less than 6.6, which corresponds to an average asymmetry factor of 1.17.

To determine the instantaneous symmetrical short circuit current, use the sub-transient reactance of the rotating apparatus (both synchronous and induction machines) and the impedance values of all intervening portions of the circuit to the point of fault. Note that for these low-voltage systems the impedance of short runs of conductors, bus runs, current transformer and intervening circuit breakers themselves, may become important elements in limiting the total short circuit as they usually represent a relatively high percentage of the total system impedance.

The following table shows both the asymmetrical and symmetrical current interrupting ratings.

TABLE II interrupting ratings

System voltage	Breaker type	Interrupting rating current measured at instant ½ cycle after fault, amperes*: asymmetrical (average 3-phase rms)	symmetrical rms	30 Cycle short-time rating without series trip device, amperes: asymmetrical	symmetrical
481-600	FP-25	25,000	22,000	25,000	22,000
	FP-50	50,000	42,000	50,000	42,000
	FP-75	75,000	65,000	75,000	85,000
	FP-100	100,000	85,000	100,000	85,000
241-480	FP-25	35,000	30,000	25,000	22,000
	FP-50	60,000	50,000	50,000	42,000
	FP-75	75,000	65,000	75,000	65,000
	FP-100	100,000	85,000	100,000	85,000
240 & below	FP-25	50,000	42,000	25,000	22,000
	FP-50	75,000	65,000	50,000	42,000
	FP-75	100,000	85,000	75,000	65,000
	FP-100	150,000	130,000	100,000	85,000

* Rating with instantaneous direct-acting trips only.

STORED ENERGY MECHANISM

Federal Pacific stored energy device, located behind the front plate, has springs that are charged either manually or electrically to provide a constant quick-make of the breaker contacts. The fast closing speed of the breaker is independent of the operator's action, and it is impossible to tease or slow-close the breaker contacts. This consistent high speed increases the range of breaker sizes which can be safely operated manually and reduces breaker maintenance by extending contact life.

Control power requirements are virtually eliminated with stored energy because the charging force is supplied either manually or by a fractional horsepower electric motor. This stored energy operation reduces the control power requirement to a fraction of what was previously required for solenoid operating mechanisms with comparable capabilities.

Stored energy mechanism of the FP Series air circuit breakers consists of a driven cam which charges four springs with sufficient energy to close and latch the breaker. Closing springs are retained in this fully-charged position by a latch until the spring energy is required for a closing operation. This energy is then released to the closing toggle which drives the breaker closed.

One of the support points of the closing toggle is a roller which is held in place by a trigger. Release of this trigger at any time will cause the mechanism toggle to collapse, and the breaker contacts will then assume the "Open Position" and stay in the "Open Position" regardless of any closing effort which may be applied to the mechanism. It is impossible for the springs to discharge and attempt to close the breaker unless the springs have previously reached the fully-charged condition.

Type FP25 and FP50 breakers have an advanced-design, stored energy assembly which may be specified with any one of three different operating mechanisms: manually charged, electrically charged, or a combination manually/electrically charged. The FP75 and FP100 breakers are supplied electrically operated. Provisions for emergency manual-closing is standard.

Manual operation:

Manually spring-charged, stored-energy mechanisms have the energy stored by a front-operated handle rotated clockwise 180°. An indicator on the breaker escutcheon indicates "Spring Charged."

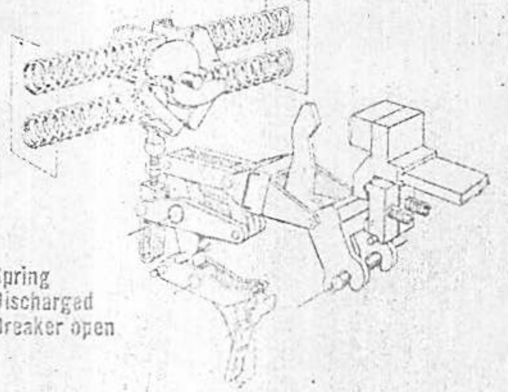
The breaker may be manually closed by pushing a "Close" button or electrically closed by a remote contact which energizes a latch release coil. Manual trip is accomplished by pushing a "Trip" button or by an electric shunt trip coil.

Electrical operation:

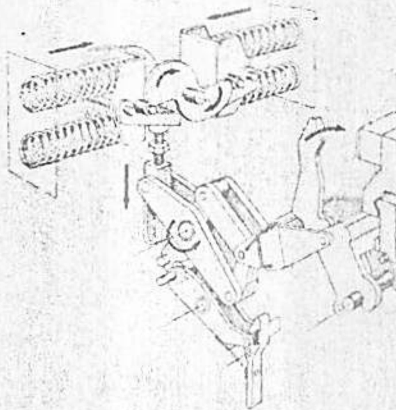
On the FP breakers a fractional horsepower, high-speed a-c/d-c universal motor provides through a ratchet system spring-charging energy in approximately one second.

Motor energy is applied to a gear and ratchet reduction unit which provides high charging torque to the four closing springs. A closing operation may be initiated only after the springs are fully charged, either from a remote source or by pushing a "Close" button on the breaker front plate.

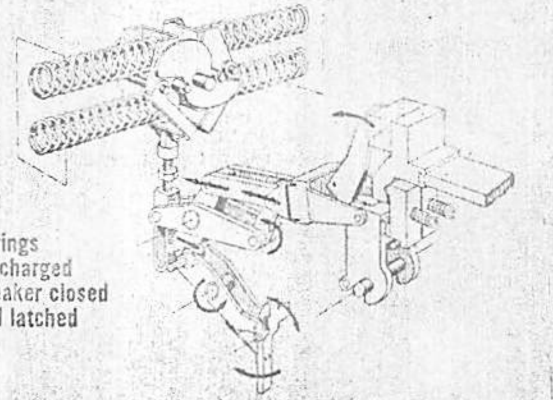
The "Close" button in the face plate of a standard electrically operated breaker closes an electrical contact which energizes a latch-release coil. The use of an electrical "Close" contact facilitates interlocking breakers, providing safer systems. As an option, the breaker may be equipped with a mechanical "Close" button. A trip operation is accomplished by pushing the "Trip" button on the breaker or by remote operation of a shunt trip coil.



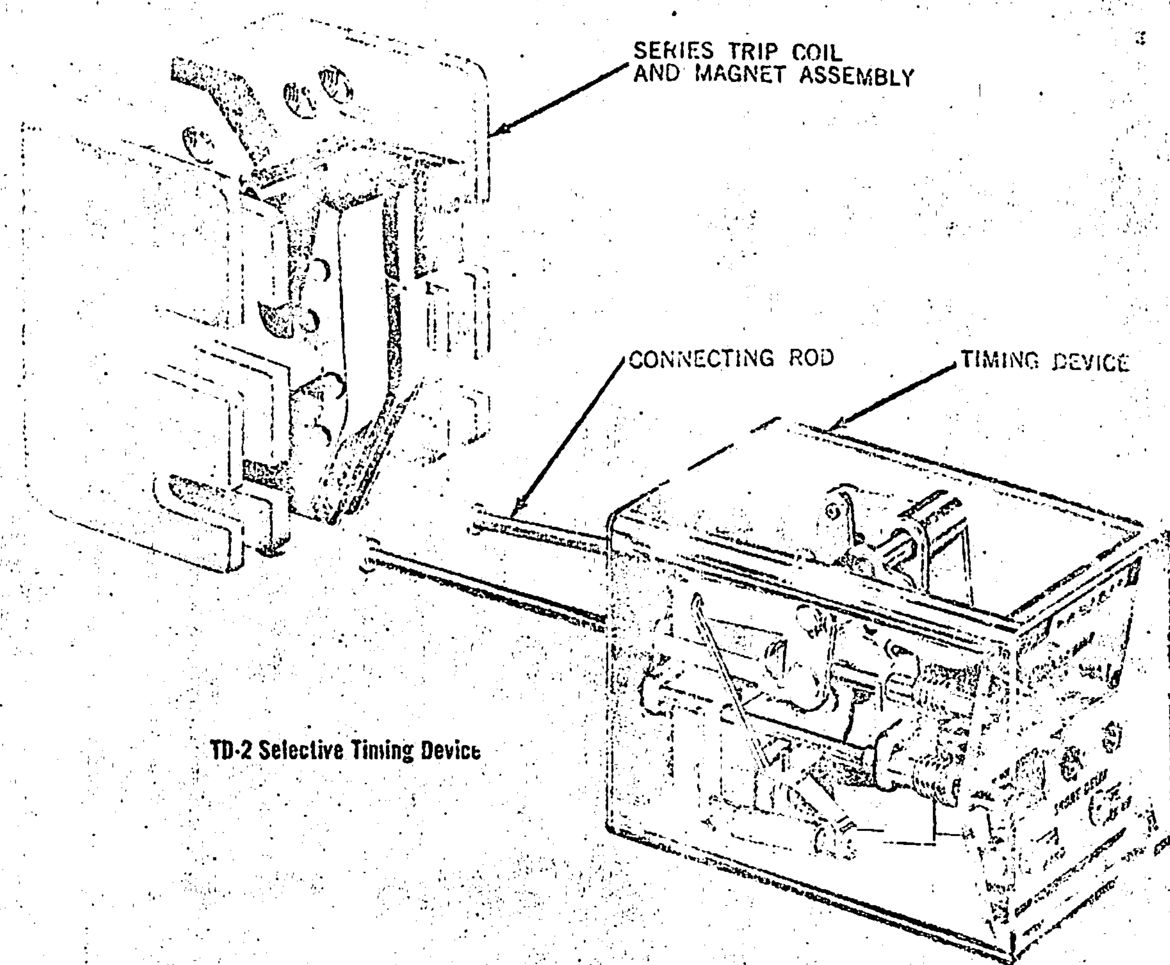
Spring
Discharged
Breaker open



Springs charged
Breaker open



Springs
Discharged
Breaker closed
and latched



TD-2 Selective Timing Device

SERIES TRIP COIL AND MAGNET ASSEMBLY

The Federal Pacific series trip unit consists of two basic components: the series trip coil and magnet assembly plus the timing device. Removable connecting rods join the coil and magnet assembly to the timing device. This unique arrangement permits the timing device to be brought out to the front of the breaker where it is conveniently read and adjusted.

Timing Devices: The FP line of series trip coils, in conjunction with the flexible TD-1 and TD-2 timing devices, permit a wide range of trip characteristics and greatly simplify system coordination.

TD-1 general purpose timing device: Provides long delay pickup adjustable from 80% to 160%. Instantaneous trip is adjustable from 7½ to 15 times coil rating. Three long delay band selections are available—minimum, intermediate, and maximum.

TD-2 selective timing device: Provides long delay pickup and short delay pickup, as well as long delay and short delay band adjustment.

TD-3 zone selective timing device: Provides long delay, short delay pickups and instantaneous trip, as well as long delay and short delay band adjustment.

Other special combinations of trip characteristics can be offered. Requests for additional information on these special devices should be referred to the factory.

Timing device: Timing is obtained by a single element magnet on the general purpose TD-1 timing device and by a dual element magnet on the selective TD-2 timing device. Long delay timing is obtained by the positive displacement of a silicone damping fluid in a dash pot. A simple and rugged mechanical escapement-type mechanism provides short delay.

The timing device is mounted up-front for unobstructed accessibility. Adjusting screws are accessible with breaker in connected position. The transparent case permits quick visual mechanism check. Easily read indicators pinpoint factory-calibrated trip settings. A wide range of special trip characteristics is available.

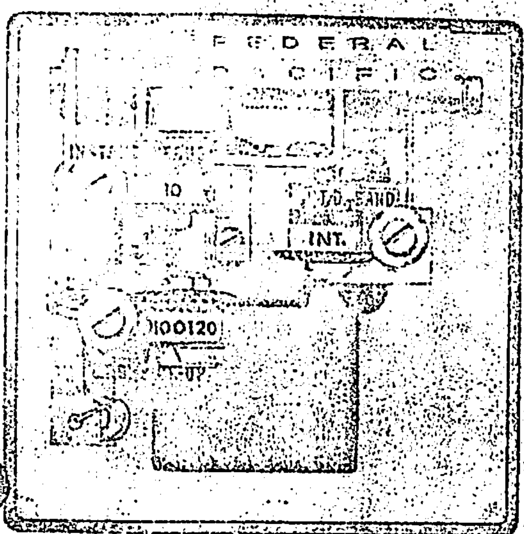
Series Overcurrent Timing Devices

STANDARD CALIBRATED SETTINGS

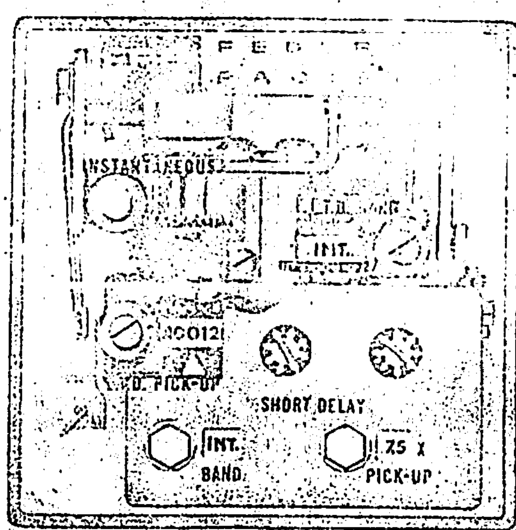
1. Long time delay pickup—80%, 100%, 120%, 140%, 160%.
2. Long delay band—maximum, intermediate, or minimum.
3. Short delay pickup—5, 7.5, or 10 x rated current.
4. Short delay band—maximum, intermediate, or minimum.
5. Instantaneous pickup (high-range)—7½, 10, or 15 x rated current.

   Instantaneous pickup (low-range)—.8, 1.5, or 2.5 x rated current.

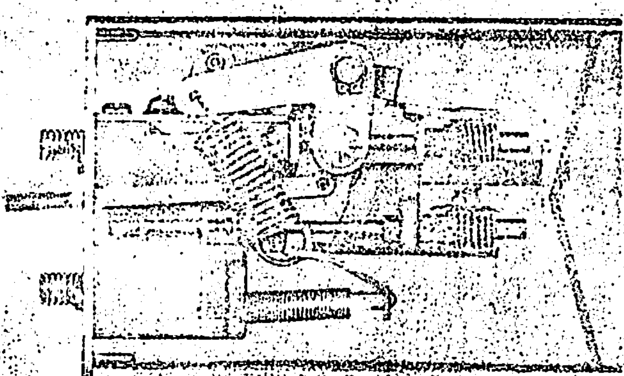
   Instantaneous pickup (FP75 and FP100 Series)—2.5, 5.0, 7.5 x rated current.



TD-1 Timing Device Front View



TD-2 Timing Device Front View


TD-1 Timing Device Side View

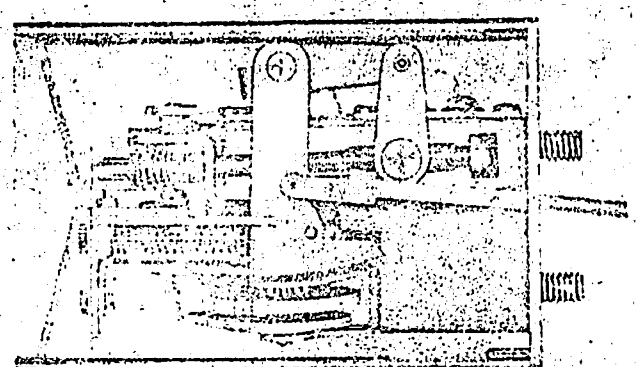

TD-2 Timing Device Side View

TABLE III interrupting ratings—based on minimum trip coil size

INTERRUPTING RATING		TRIP COIL											
		WITH INSTANTANEOUS TRIP			WITH SHORT DELAY TRIP								
					MIN. BAND 6 CYC.			INTER. BAND 14 CYC.			MAX. BAND 30 CYC.		
ASYMMETRICAL AMPERES	SYMMETRICAL AMPERES	240V	480V	600V	240V	480V	600V	240V	480V	600V	240V	480V	600V
15,000	14,000	15	15	15	70	70	70	70	70	70	70	70	70
25,000	22,000	70	70	70	70	70	70	150	150	150	150	150	150
50,000	42,000	150	150	150	250	250	250	250	250	250	250	250	250
60,000	50,000	500	500	—	500	500	—	1000	1000	—	1000	1000	—
75,000	65,000	500	—	—	500	—	—	1000	—	—	1000	—	—
100,000	85,000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
150,000	130,000	4000	—	—	4000	—	—	4000	—	—	4000	—	—

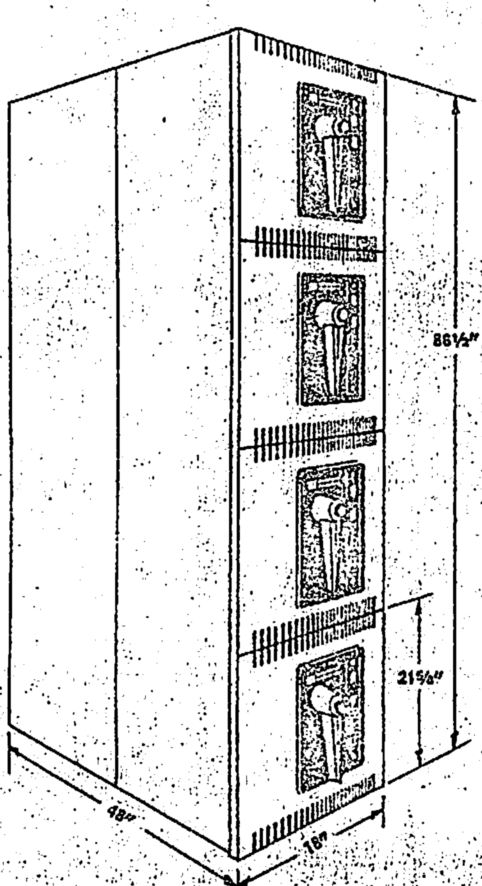
Low Voltage Metal-Enclosed Switchgear

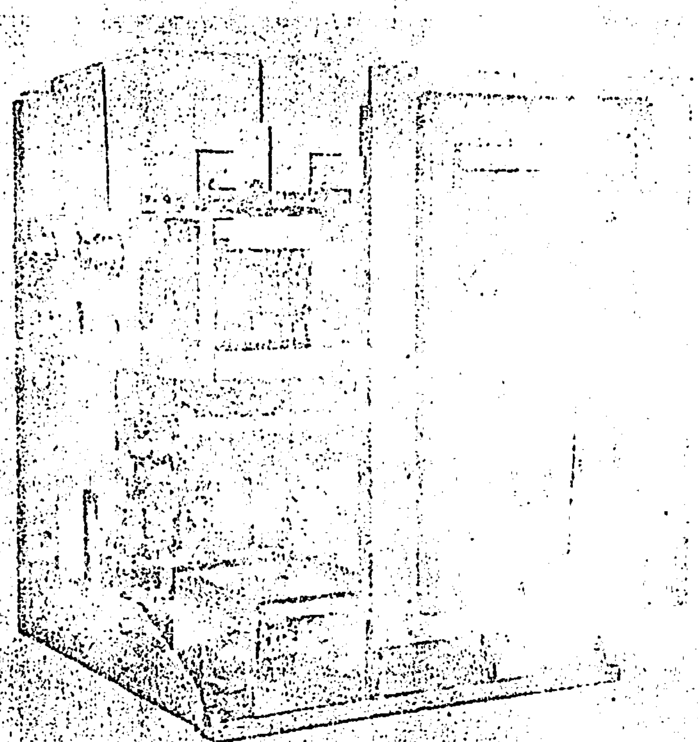
600 Volts a-c—25,000 to 150,000 Amperes IC

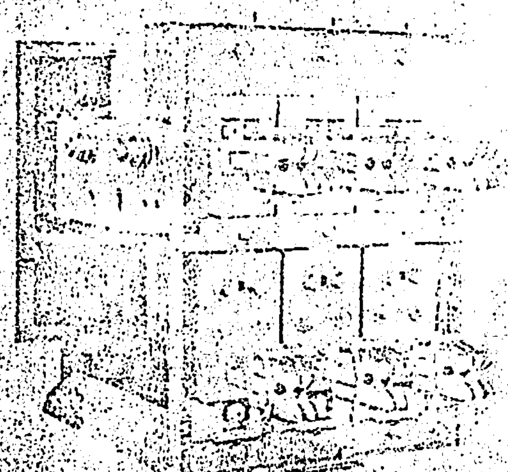
FP25-600 AIR CIRCUIT BREAKERS

STORED ENERGY MECHANISM
Manually, Electrically or Manually/Electrically Operated

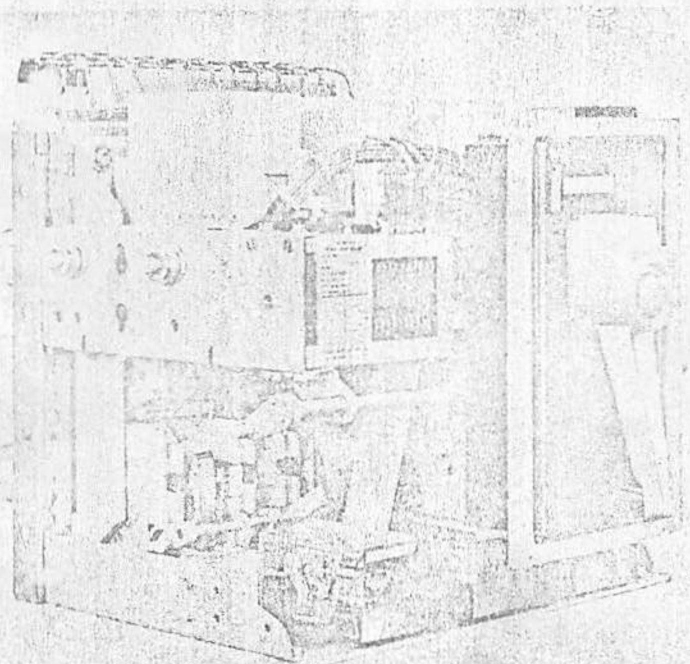
DIMENSIONS:







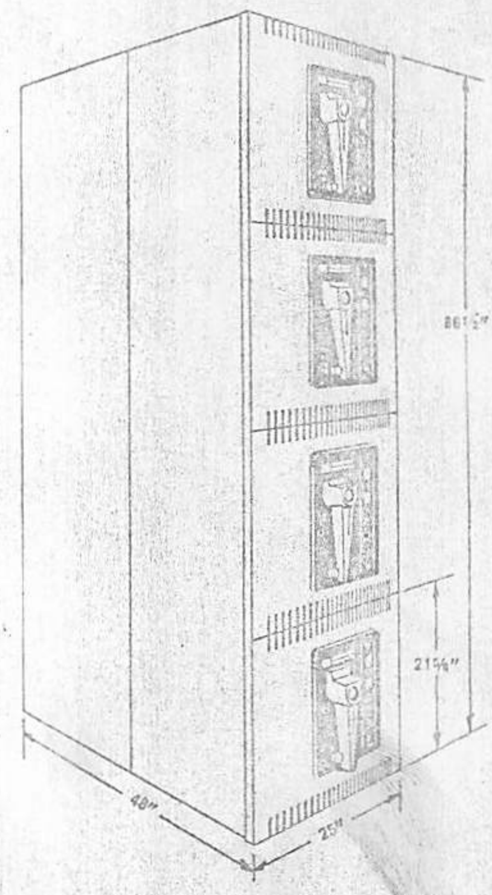
BREAKER TYPE	VOLTAGE	INTERRUPTING RATING CURRENT MEASURED AT ½ CYCLE AFTER FAULTS, AMPERES		30 CYCLE SHORT-TIME RATING WITHOUT SERIES TRIPS, AMPERES		FRAME SIZE CONTINUOUS CURRENT RATING OF CURRENT CARRYING PARTS WITHOUT SERIES TRIPS
		ASYMMETRICAL	SYMMETRICAL	ASYMMETRICAL	SYMMETRICAL	
	600-481	25000	22000	25000	22000	
FP25-600	480-241	35000	30000	25000	22000	600
	240 and Below	50000	42000	25000	22000	

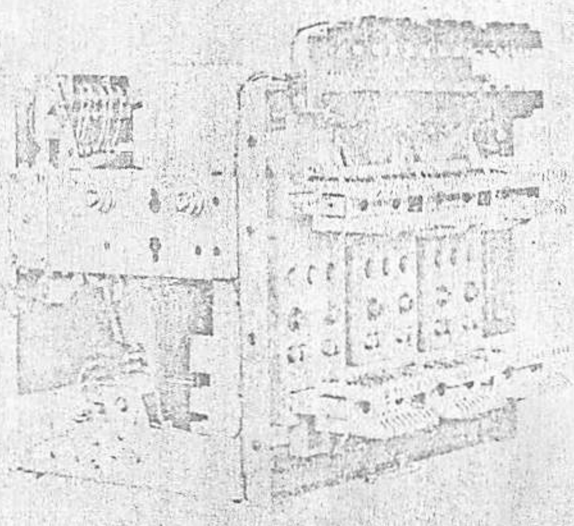


FP50-1600 AIR CIRCUIT BREAKER

STORED ENERGY MECHANISM
Manually, Electrically or Manually/Electrically Operated

DIMENSIONS:



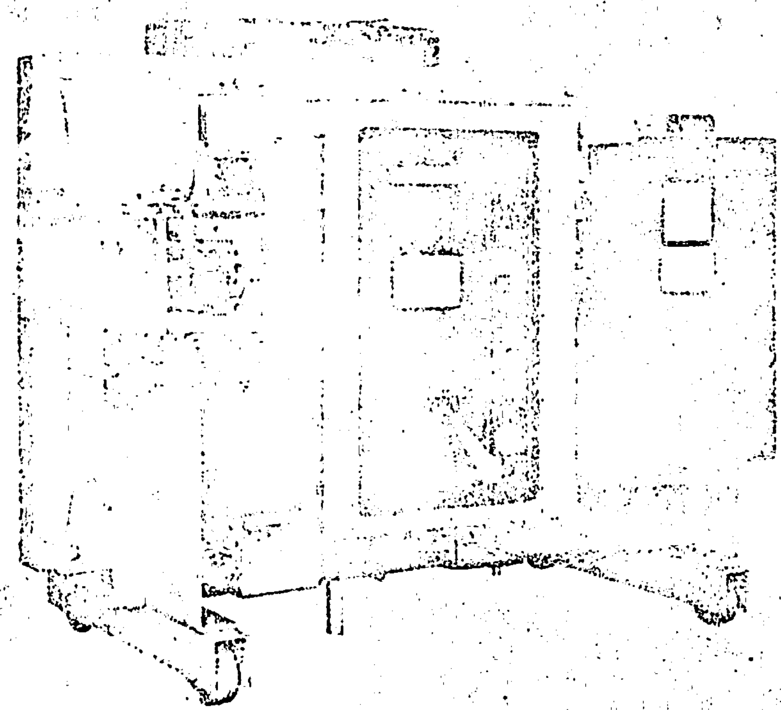


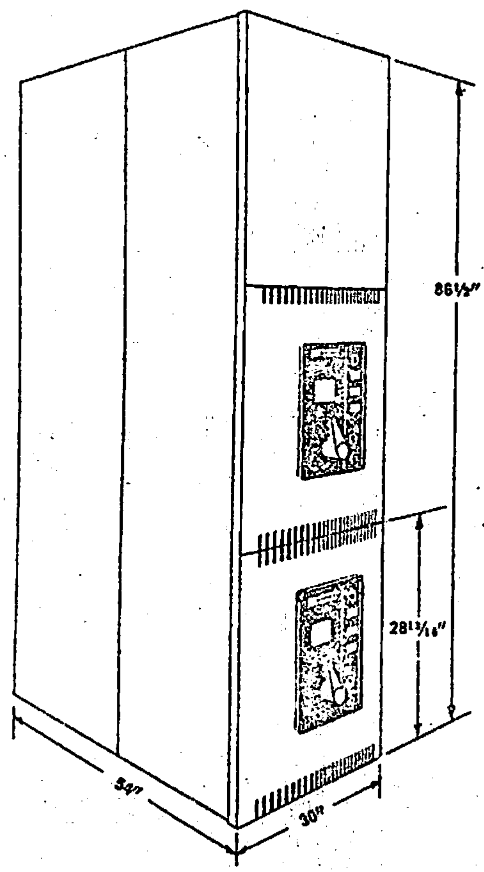
BREAKER TYPE	VOLTAGE	INTERRUPTING RATING CURRENT MEASURED AT ½ CYCLE AFTER FAULTS, AMPERES		30 CYCLE SHORT-TIME RATING WITHOUT SERIES TRIPS, AMPERES		FRAME SIZE CONTINUOUS CURRENT RATING OF CURRENT CARRYING PARTS WITHOUT SERIES TRIPS
		ASYMMETRICAL	SYMMETRICAL	ASYMMETRICAL	SYMMETRICAL	
	600-481	50000	42000	50000	42000	
FP50-1600	480-241	60000	50000	50000	42000	1600
	240 and Below	75000	65000	50000	42000	

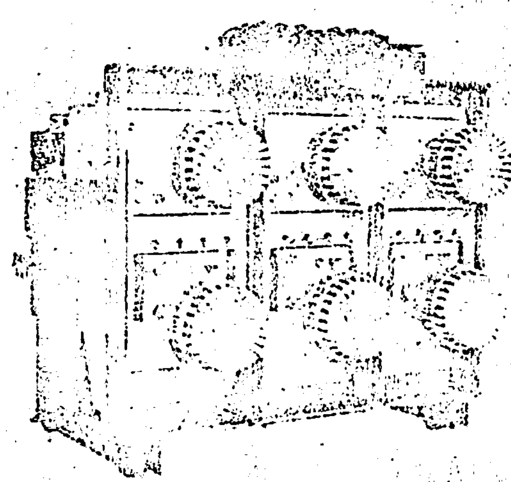
FP75-3000 AIR CIRCUIT BREAKER

Stored Energy Mechanism Electrically Operated

The normal method of operating this breaker is by an a-c/d-c electric motor charged, stored energy mechanism. Provisions are made for manual charge for emergency closing the breaker.



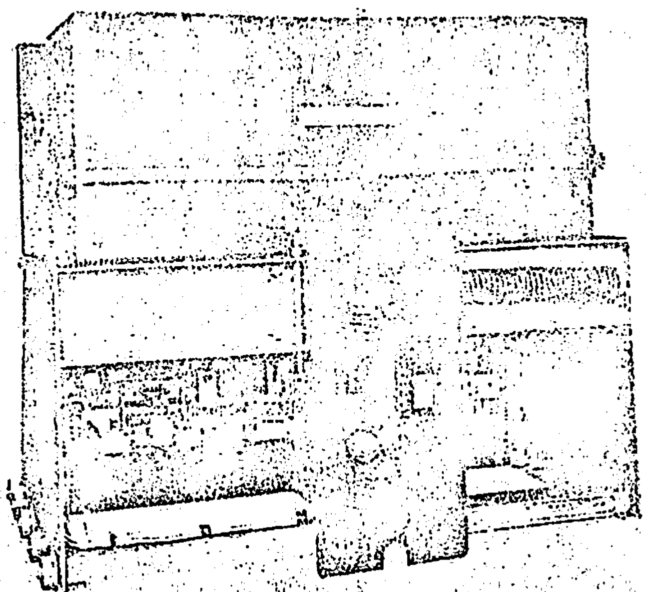


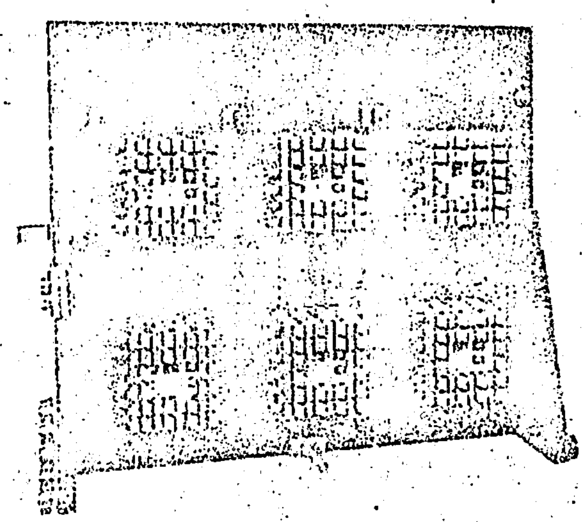


BREAKER TYPE	VOLTAGE	INTERRUPTING RATING CURRENT MEASURED AT ½ CYCLE AFTER FAULTS, AMPERES		30 CYCLE SHORT-TIME RATING WITHOUT SERIES TRIPS, AMPERES		FRAME SIZE CONTINUOUS CURRENT RATING OF CURRENT CARRYING PARTS WITHOUT SERIES TRIPS
		ASYMMETRICAL	SYMMETRICAL	ASYMMETRICAL	SYMMETRICAL	
FP75-3000	600-481	75000	65000	75000	65000	3000
	480-241	75000	65000	75000	65000	
	240 and Below	100000	85000	75000	65000	

Low Voltage Metal-Enclosed Switchgear

600 Volts a-c—25,000 to 150,000 Amperes IC



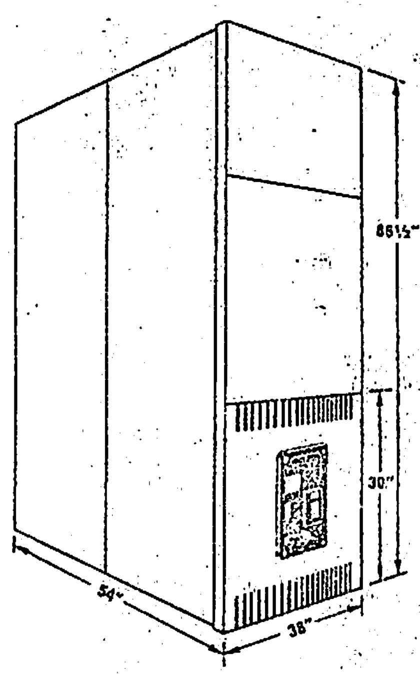


FP100-4000 AIR CIRCUIT BREAKER

Stored Energy Mechanism Electrically Operated

The normal method of operating this breaker is by an a-c/d-c electric motor charged, stored energy mechanism. Provisions are made for manual charge for emergency closing the breaker.

DIMENSIONS:



BREAKER TYPE	VOLTAGE	INTERRUPTING RATING CURRENT MEASURED AT ½ CYCLE AFTER FAULTS, AMPERES		30 CYCLE SHORT-TIME RATING WITHOUT SERIES TRIPS, AMPERES		FRAME SIZE CONTINUOUS CURRENT RATING OF CURRENT CARRYING PARTS WITHOUT SERIES TRIPS
		ASYMMETRICAL	SYMMETRICAL	ASYMMETRICAL	SYMMETRICAL	
FP100-4000	600-481	100000	6500[illegible]	100000	85000	4000-6000
	480-241	100000	85000	100000	85000	
	240 and Below	150000	130000	100000	85000	

AUXILIARY SWITCHES

The auxiliary switch is mounted on top of the stored energy mechanism on the right hand side of the breaker and is operated by the main movable contact. They are rotary cam operated devices ensuring positive opening and closing of the silver-to-silver contacts. The switch is built up with sections, each carrying two contacts either "Normally Open" or "Normally Closed." Contact operation is determined by the shape of the cam and is set at the factory. Field changes can be made by reversing the moving contacts. The position of the contacts can be inspected through a transparent dust cover.

Interrupting ratings are:

Volts	Single Contact Amps	Double Contact Amps
125 V. d-c	2	4
250 V. d-c	1	2
115 V. a-c	30	60
230 V. a-c	15	30

Bell alarm switch: A bell alarm switch attachment is mounted on the right side of the breaker and will function only when breaker is tripped by the overcurrent trip units. The bell alarm can be manually and/or electrically reset. Reclosing breaker also resets the alarm switch. Bell alarm switch is available with either normally open or normally closed contacts.

Shunt trip: The shunt trip attachment is mounted directly above the trip shaft. It is a non-adjustable electro-magnet intended for intermittent duty only, and its circuit is interrupted only by an auxiliary contact.

Shunt close: The shunt close attachment is mounted on top of the stored energy mechanism and is used to electrically discharge the stored energy mechanism and thus to close the breaker. It is a non-adjustable intermittent duty device and its circuit is interrupted by an auxiliary contact.

CIRCUIT BREAKER MAINTENANCE TRUCK

A compact, easy-to-use maintenance lift truck is available for use with Federal Pacific Switchgear. Hydraulically foot-operated, the maintenance truck enables the removal and handing of the largest type Federal Pacific Circuit Breaker by one man. Refer to factory for details.

ARC CHUTES

A parallel arc-splitting system is used to effectively interrupt the arc by dividing the current between two arcs. The arc is confined within two low-volume, high-pressure parallel arc chambers. This means rapid deionization with extremely fast arc extinction.

CONTACT STRUCTURE

The Federal Pacific line of air circuit breakers introduces a full blow-on multipoint contact structure. The circuit breakers have multiple, individually spring-loaded main contacts in each pole, helping to insure a low-resistance current path. A unique configuration of moving and stationary contacts provides current paths which create electrodynamic forces, effectively increasing contact pressures under heavy current conditions. Two copper tungsten arcing contacts per pole (four on the FP75 breakers) divide arc energy and increase contact life. Braid connections have been eliminated and a self-aligning current-carrying hinge completely eliminates pitting, even under the severest fault conditions.

ACCESSORIES FOR FP AIR CIRCUIT BREAKERS
STANDARD DEVICES

	Manual	Electrical	Electrical	Electrical
	FP25 FP50		FP75	FP100
TD-1 Dual Magnetic Time Overcurrent Trip Devices—one per pole	x	x	x	x
Manual Trip Button	x	x	x	x
Manual Close Button	x	—	—	—
Electrical Close Button	—	x	x	x
Position Indicator "Connected", "Test", "Disconnected"	x	x	x	x
Condition Indicator—"Open"-"Closed"	x	x	x	x
Mechanism Indicator "Springs Charged" "Springs Discharged"	x	x	x	x
Attached Manual Closing Handle	x	x	—	—
*Electrical Charging Mechanism 115 a-c, 125 d-c control	—	x	x	x
Closing relay with cut off, seal-in and anti-pump features for maintained contact control	—	x	x	x
Draw-out interlock	x	x	x	x
Padlocking Provision	x	x	x	x
Shunt Close device	—	x	x	x
Shunt trip device—Auxiliary Switch—6 circuit	—	x	x	x†

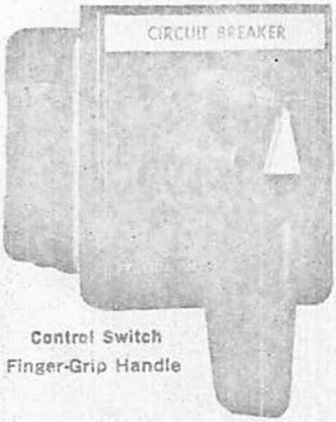
OPTIONAL ACCESSORIES

**Auxiliary Switch—6 Circuits	x	x	x	x‡
Undervoltage device—Instantaneous	x	x	x	x
Time delay	x	x	x	x
Overcurrent bell alarm—hand reset	x	x	x	x
Electrical lockout device	x	x	x	x
Key Interlock	x	x	x	x
Manual Close Button	—	x	x	x
Manual/Electric Close Button	x	x	x	—
Shunt Close Device	x	—	—	—
Shunt Trip Device	x	—	—	—

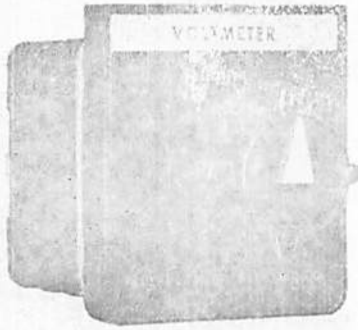
SERIES OVERCURRENT TRIP DEVICES

Long delay and Instantaneous (Standard) TD-1	x	x	x	Type PA
Long delay and Short delay (Optional) TD-2	x	x	x	Type PA
Long delay, Short delay Instantaneous (Optional) TD-3	x	x	x	—
Motor Starting (Optional) TD-4	x	x	x	—
Long delay only (Optional) TD-5	[illegible]	[illegible]	[illegible]	—

** Maximum—12 Circuit
* 48 volt d-c or 250 volt d-c are available.
† Eight circuit, includes four spares.
‡ Four circuit

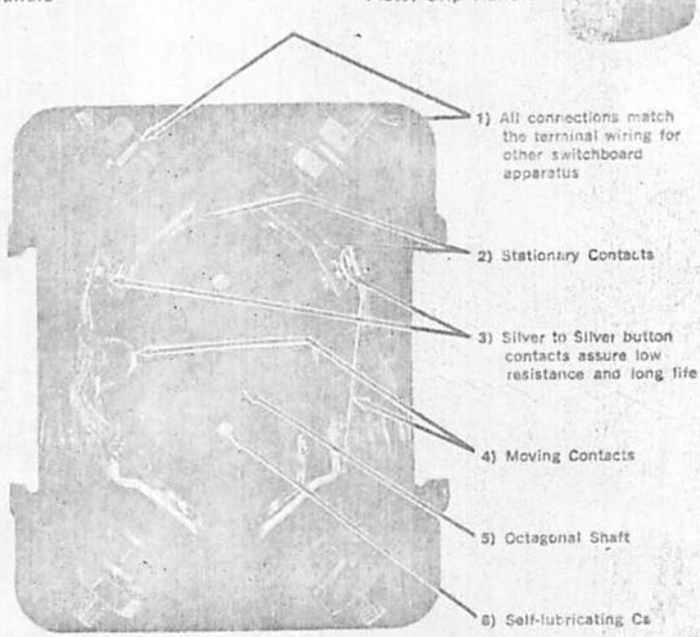


Control Switch
Finger-Grip Handle



Instrument Switch
Radial Handle

Control Switc
Pistol Grip Hand



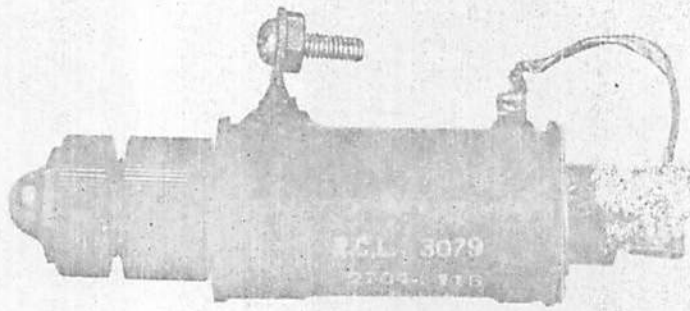
CLASS 9430 INSTRUMENT AND CONTROL SWITCHES

Rotary type instrument and control switches have cam operated, direct acting, silver to silver contacts. Braided shunts are used to carry current around hinge.

Switch can be supplied with 32 single pole circuits or 16 double pole circuits. Both contacts in each unit can be operated independently or simultaneously depending on cam arrangement.

Interrupting capacity is dependent on voltage, current of the circuit and if single or double pole (see table below). Life test exceeds 100,000 operations.

Interrupting Ratings, in Amperes				
Volts	D.C. Non-Inductive	D.C. Inductive	A.C. Non-Inductive	A.C. Inductive
Single Break				
24	20	15	—	—
48	10	7.5	—	—
115	—	—	50	30
125	2.5	2.0	—	—
230	—	—	25	15
250	0.5	0.45	—	—
440	—	—	10	7
600	0.18	0.12	3	2
Double Break				
24	50	40	—	—
48	25	20	—	—
115	—	—	80	60
125	12	7	—	—
230	—	—	50	30
250	2.25	2	—	—
440	—	—	20	15
600	0.3	0.25	6	4



CLASS 9380 INDICATING LAMP FOR PANEL MOUNTING

Switchgear Indicating Lamps will be supplied for use on Switchboards, remote indicating panels, control desks and applications requiring a panel mounted signal or indicating lan .

Color caps are available in five colors; red, green, amber, blue and white. The lamp is a slide base type and rated a 24 volts, .032 to .038 amperes. Receptacles are available with proper resistors for the most commonly used control voltages.

Econ[illegible] Dual Element Cartridge Fuses

[illegible] Delay and
[illegible] Capacity [illegible] RMS Amperes
UL Class [illegible]

RATINGS, DIMENSIONS, PACKAGING—STANDARD SIZES

Amperes		250 VOLTS					600 VOLTS				
			Dimensions					Dimensions			
		Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100	Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100
.1 .15 .2 .3 .4	FERRULE TYPE	ECN.1 ECN.15 ECN.2 ECN.3 ECN.4	2"	9/16"	10	5	ECS.1 ECS.15 ECS.2 ECS.3 ECS.4	5"	13/16"	10	15
.5 .6 .8 1.0 1.125	FERRULE TYPE	ECN.5 ECN.6 ECN.8 ECN1.0 ECN1.125	2"	9/16"	10	5	ECS.5 ECS.6 ECS.8 ECS1.0 ECS1.125	5"	13/16"	10	15
1.25 1.4 1.6 1.8 2.0	FERRULE TYPE	ECN1.25 ECN1.4 ECN1.6 ECN1.8 ECN2.0	2"	9/16"	10	5	ECS1.25 ECS1.4 ECS1.6 ECS1.8 ECS2.0	5"	13/16"	10	15
2.25 2.5 2.8 3.0 3.2	FERRULE TYPE	ECN2.25 ECN2.5 ECN2.8 ECN3.0 ECN3.2	2"	9/16"	10	5	ECS2.25 ECS2.5 ECS2.8 ECS3.0 ECS3.2	5"	13/16"	10	15
3.5 4.0 4.5 5.0 5.6	FERRULE TYPE	ECN3.5 ECN4.0 ECN4.5 ECN5.0 ECN5.6	2"	9/16"	10	5	ECS3.5 ECS4.0 ECS4.5 ECS5.0 ECS5.6	5"	13/16"	10	15
6.25 7 8 9 10	FERRULE TYPE	ECN6.25 ECN7 ECN8 ECN9 ECN10	2"	9/16"	10	5	ECS6.25 ECS7 ECS8 ECS9 ECS10	5"	13/16"	10	15
12 15 17.5 20 25 30	FERRULE TYPE	ECN12 ECN15 ECN17.5 ECN20 ECN25 ECN30	2"	9/16"	10	5	ECS12 ECS15 ECS17.5 ECS20 ECS25 ECS30	5"	13/16"	10	15
35 40 45 50 60	FERRULE TYPE	ECN35 ECN40 ECN45 ECN50 ECN60	3"	13/16"	10	11	ECS35 ECS40 ECS45 ECS50 ECS60	5½"	1 1/16"	10	24
				BLADE WIDTH					BLADE WIDTH		
70 80 90 100	KNIFE BLADE TYPE	ECN70 ECN80 ECN90 ECN100	5⅞"	¾"	5	30	ECS70 ECS80 ECS90 ECS100	7⅞"	¾"	5	48
110 125 150 175 200	KNIFE BLADE TYPE	ECN110 ECN125 ECN150 ECN175 ECN200	7⅛"	1⅛"	1	80	ECS110 ECS125 ECS150 ECS175 ECS200	9⅝"	1⅛"	1	122
225 250 300 350 400	KNIFE BLADE TYPE	ECN225 ECN250 ECN300 ECN350 ECN400	8⅝"	1⅝"	1	170	ECS225 ECS250 ECS300 ECS350 ECS400	11⅝"	1⅝"	1	315
450 500 600	KNIFE BLADE TYPE	ECN450 ECN500 ECN600	10⅜"	2"	1	290	ECS450 ECS500 ECS600	13⅜"	2"	1	500

MIDGET FUSES—Dimensions: Overall length, 1½"; Cap diameter 13/32". Carton quantity: 10

Amperes	Catalog Number	Amperes	Catalog Number	Amperes	Catalog Number	Amperes	Catalog Number
32 VOLTS		250 VOLTS		250 VOLTS		250 VOLTS	
20 25 30	MEN20 MEN25 MEN30	.1 .15 .2 .3 .4	MEN.1 MEN.15 MEN.2 MEN.3 MEN.4	1.25 1.4 1.6 1.8 2.0	MEN1.25 MEN1.4 MEN1.6 MEN1.8 MEN2.0	4 4.5 5 5.6 6.25	MEN4 MEN4.5 MEN5 MEN5.6 MEN6.25
125 VOLTS							
12 15	MEN12 MEN15	.5 .6 .8 1.0 1.125	MEN.5 MEN.6 MEN.8 MEN1.0 MEN1.125	2.25 2.5 2.8 3.2 3.5	MEN2.25 MEN2.5 MEN2.8 MEN3.2 MEN3.5	7 8 9 10	MEN7 MEN8 MEN9 MEN10

Economy [illegible] Current Limiting Time Delay Fuses

[illegible] manufactured [illegible] proposed U.L. Class K-5 Standards [illegible]

RATINGS, DIMENSIONS, PACKAGING—STANDARD SIZES

Amperes		250 VOLTS					600 VOLTS				
			Dimensions					Dimensions			
		Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100	Catalog Number	Overall Length	Cap Diameter	Carton Quantity	Lbs. per 100
.1 .15 .2 .3 .4	FERRULE TYPE	LEN.1 LEN.15 LEN.2 LEN.3 LEN.4	2"	9/16"	10	5	LES.1 LES.15 LES.2 LES.3 LES.4	5"	13/16"	10	15
.5 .6 .8 1.0 1.125		LEN.5 LEN.6 LEN.8 LEN1.0 LEN1.125	2"	9/16"	10	5	LES.5 LES.6 LES.8 LES1.0 LES1.125	5"	13/16"	10	15
1.25 1.4 1.6 1.8 2.0		LEN1.25 LEN1.4 LEN1.6 LEN1.8 LEN2.0	2"	9/16"	10	5	LES1.25 LES1.4 LES1.6 LES1.8 LES2.0	5"	13/16"	10	15
2.25 2.5 2.8 3.0 3.2		LEN2.25 LEN2.5 LEN2.8 LEN3.0 LEN3.2	2"	9/16"	10	5	LES2.25 LES2.5 LES2.8 LES3.0 LES3.2	5"	13/16"	10	15
3.5 4.0 4.5 5.0 5.6		LEN3.5 LEN4.0 LEN4.5 LEN5.0 LEN5.6	2"	9/16"	10	5	LES3.5 LES4.0 LES4.5 LES5.0 LES5.6	5"	13/16"	10	15
6.25 7 8 9 10		LEN6.25 LEN7 LEN8 LEN9 LEN10	2"	9/16"	10	5	LES6.25 LES7 LES8 LES9 LES10	5"	13/16"	10	15
12 15 17.5 20 25 30		LEN12 LEN15 LEN17.5 LEN20 LEN25 LEN30	2"	9/16"	10	5	LES12 LES15 LES17.5 LES20 LES25 LES30	5"	13/16"	10	15
35 40 45 50 60		LEN35 LEN40 LEN45 LEN50 LEN60	3"	13/16"	10	11	LES35 LES40 LES45 LES50 LES60	5½"	1 1/16"	10	24
				BLADE WIDTH					BLADE WIDTH		
70 80 90 100	KNIFE BLADE TYPE	LEN70 LEN80 LEN90 LEN100	5⅞"	¾"	5	30	LES70 LES80 LES90 LES100	7⅞"	¾"	5	48
110 125 150 175 200		LEN110 LEN125 LEN150 LEN175 LEN200	7⅛"	1⅛"	1	80	LES110 LES125 LES150 LES175 LES200	9⅝"	1½"	1	122
225 250 300 350 400		LEN225 LEN250 LEN300 LEN350 LEN400	8⅝"	1⅝"	1	170	LES225 LES250 LES300 LES350 LES400	11⅝"	1⅝"	1	315
450 500 600		LEN450 LEN500 LEN600	10⅜"	2"	1	290	LES450 LES500 LES600	13⅜"	2"	1	500

Type 3-475 Indicating Lamp for Panel Mounting

Type 3-475 Indicating Lamps are designed for use on switchboards, remote indicating panels, control desks and any other applications requiring a panel mounted signal or indicating lamp.

Complete assembly consists of plug assembly, resistor, lamp, bezel and color cap. The indicating lamp can be installed in panels with ¼ inch maximum thickness. Spacers are supplied for panels with less than ⅛ inch thickness.

Color caps are available in five colors: red, green, amber, blue, and white.

RATINGS

The lamp used on all voltages is a telephone switchboard slide base type and is rated at 24 volts, .032 to .038 amperes.

Receptacles are available with proper resistors for the most commonly used control voltages as listed.

INSTALLATION

It is necessary to drill only one 21/32 inch diameter hole. Remove black threaded bezel and color cap, insert bezel through board from front, screw threads into receptacle held at rear of panel, and tighten bezel with fingers.

When lamp is inserted, use care that contacts are parallel with receptacle contacts.

Additional spacers, Cat. No. 2701-0124 (1/32" thick) should be used for panels less than ⅛" thick.

CONNECTIONS

Connect one lead to side terminal screw on resistor, the other to binding screw at the rear of receptacle. The terminals of receptacle are designed for No. 12 wire which may be inserted and squeezed. Smaller sizes should be wrapped around terminal screw.

Resistor pigtail should be connected to the remaining receptacle terminal.

FEATURES

Silicon protection makes the resistor tube suitable for marine, tropical and other service applications with severe atmospheric conditions.

Easy Installations—Minimum parts and simplified construction—requiring a single mounting hole—make installations quick and easy.

Interchangeable Resistors and Color Caps—All receptacles are identical—and differ only in the ohmic value of the resistors and the color of the caps. Resistors or color caps may be readily changed at any time.

Durable Color Cap—Color cap is made of heat resistant plastic material—not readily breakable.

Single Rating Lamp—For all operating voltages.

ing		
age	0-…	S…
50		
70		
115		
…		
ed		
een		
her		
ue		
white		

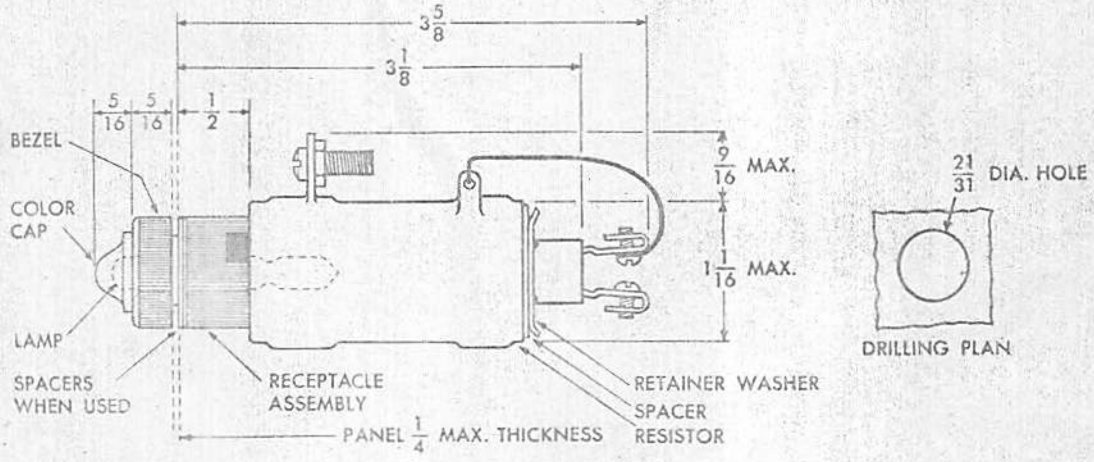
Catalog No.	RESISTORS Description: Ohms	Service Voltage
2708-0116	110	24
2701-0116	800	50
2702-0116	1400	70
2703-0116	2900	115
2704-0116	3200	125
2705-0116	5800	208
2706-0116	6500	230
2707-0116	7100	250
INDICATING LAMP PARTS		
064-007	24-E Lamp 24 V. .032-.038 amp.	
2701-0124 *	Spacer 1/32"	
2751-0119	Receptacle assembly, less Resistor, Bezel and Color Cap.	
2701-0118	Spring Retainer Washer	

…ed on standard assembly. Use on Panels less than 1/8".

ORUERING INFORM…

For a complete indicating lamp assembly—specify both the catalog number of the indicating lamp of the voltage required and the catalog number of the desired color cap.

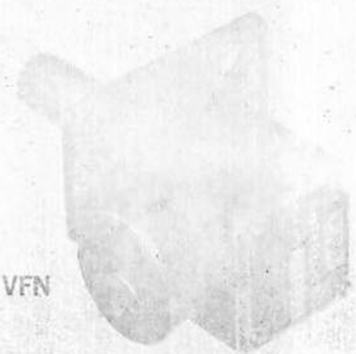
DIM…SIONS



NOTE: ORDER NECESSARY SPACERS CAT. NO. 2701-0124 $\frac{1}{32}$" THICK WHEN PANEL THICKNESS IS LESS THAN $\frac{1}{8}$"

KEY INTERLOCKS

TYPE VB



TYPE VFN

TYPE VD

APPLICATION

Key interlocks are attached to mechanical and electrical devices to insure a safe predetermined sequence of operations. The interlocks are a simple mechanical device that are positive in action but very difficult to defeat and may be attached to any equipment where it is possible to engage moving operators.

Various accessories are available to extend the basic operation of the interlock for control circuit switching. However, it should be remembered that the reliability of such arrangements must depend on the reliability of the control source and should "fail safe" in the event of a power failure.

INTERLOCKS – Type VB, VF, VFN

These interlocks form the basic group of interlocks used in all applications. The choice between locks in this group depends entirely on the mounting arrangement preferred. Housings are of brass either machined from bar stock or cast, and carry the 5/8" diameter brass plunger in exactly the same relationship to the lock.

Plunger travel is 3/4" and the plunger extension from the lock body in the retracted position may be any one of six standard lengths. Non standard projections can be supplied at additional cost.

Standard arrangement is for the key to be removed the "plunger extended" position only. The opposite be supplied at no additional charge when specified.

TYPE VD

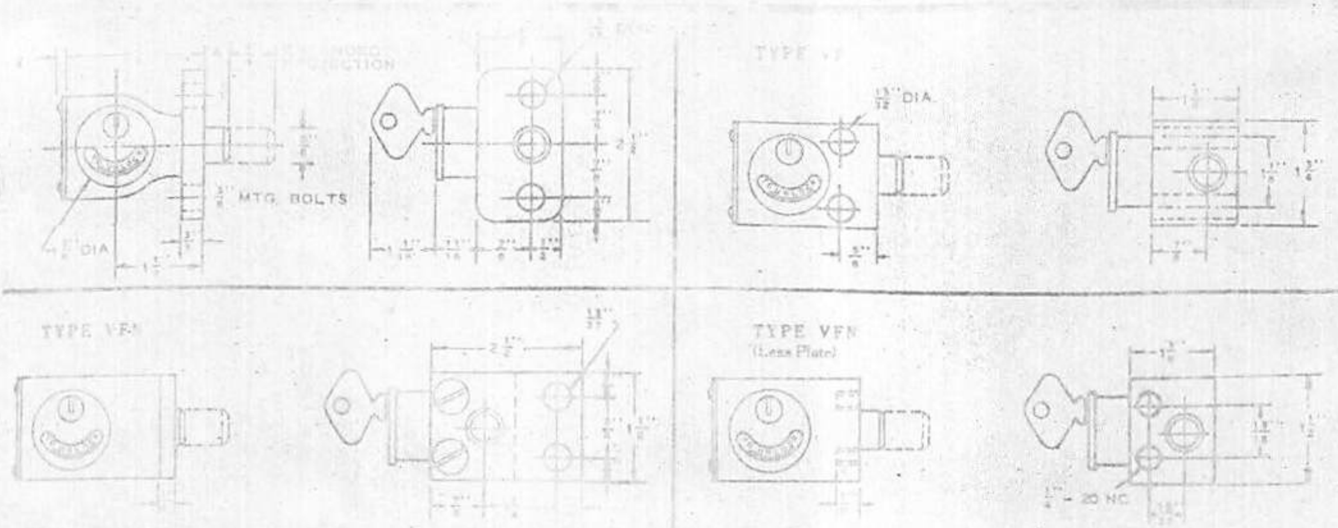
This lock is used on removable or hinged panels and supplied with an accessory latch block which is mounted to the stationary part of the mechanism. The lock housing is mounted on the removable part and once it is removed from the latch block the key is trapped and cannot be removed. In all other respects this lock assembly is identical to the basic locks previously described.

TYPE T

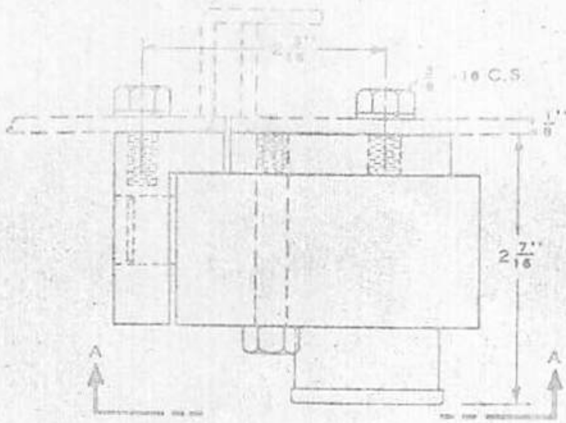
The type T is a transfer interlock designed for a key interchange and usually consists of a master lock and one or more release locks.

In operation the key to the master lock is retained until all the release keys are inserted in the lock assembly, then the master key can be removed and in so doing traps all the release keys.

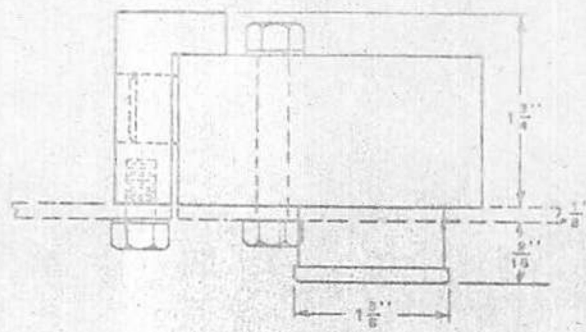
Any combination of master and release keys is possible but it should be noted there is no external plunger for locking operation.



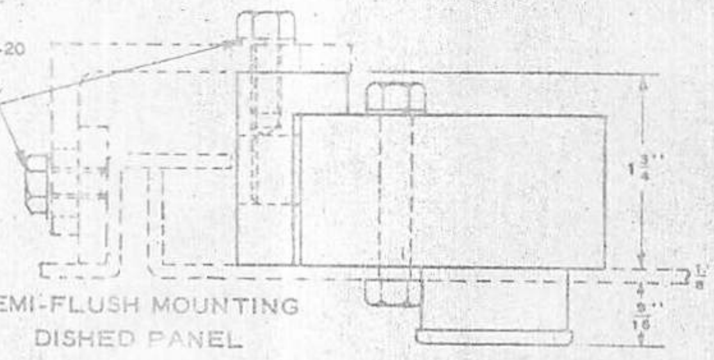
MOUNTING DIMENSIONS



SURFACE MOUNTING
FLAT OR DISHED PANEL

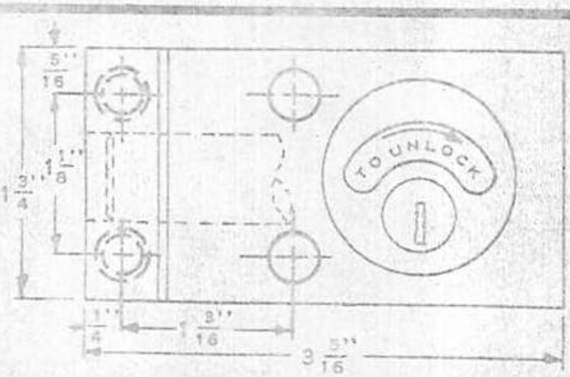


SEMI-FLUSH MOUNTING
FLAT PANEL



SEMI-FLUSH MOUNTING
DISHED PANEL

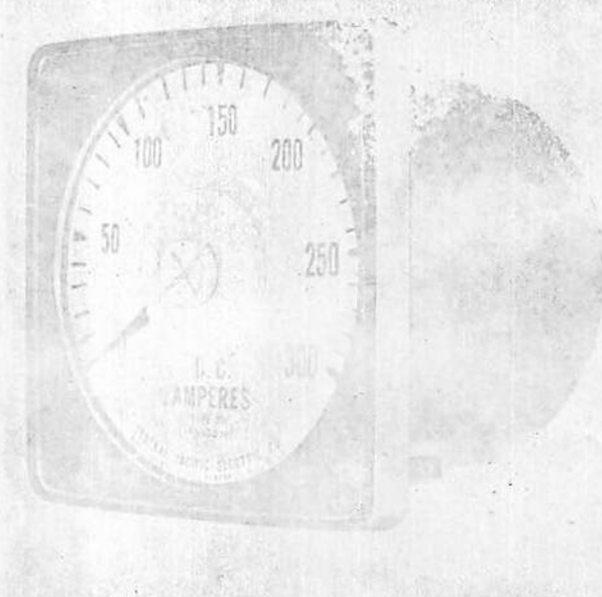
DRILLING DETAIL



Long Scale Instruments

Federal Pacific Long Scale Instruments are designed specifically for control and distribution switchboards.

The instruments combine the ease of reading afforded by a 7 inch scale and the compactness of a 4½-inch panel size. A clearly distinguished pointer, operating over a 250° arc scale, provides for quick and accurate readings at considerable distances.



D-C Instrument—Type JD

CONSTRUCTION

A sturdy metal housing and modern styled front are standardized for all ranges and types in both d-c and a-c movements.

Direct Current (Class 9150 Type JD) instruments employ a high strength magnet system with moving coil accurately balanced on steel pivots in jewel bearings.

Alternating Current (Class 9155 Type JA) ammeters and voltmeters operate on the iron repulsion principle with air damping. Wattmeters are of the dynamometer type with magnetic damping.

FEATURES

Tamper Proof: Studs permanently mounted on case prohibit removal of instrument cover by unauthorized personnel. Instruments are flush mounted on panels up to 1¼".

Accurate: 1% of full scale value.

Zero Adjustment: Zero adjustor is provided on front window for quick and easy scale adjustment.

Standardized: All types and ranges housed in standard casing.

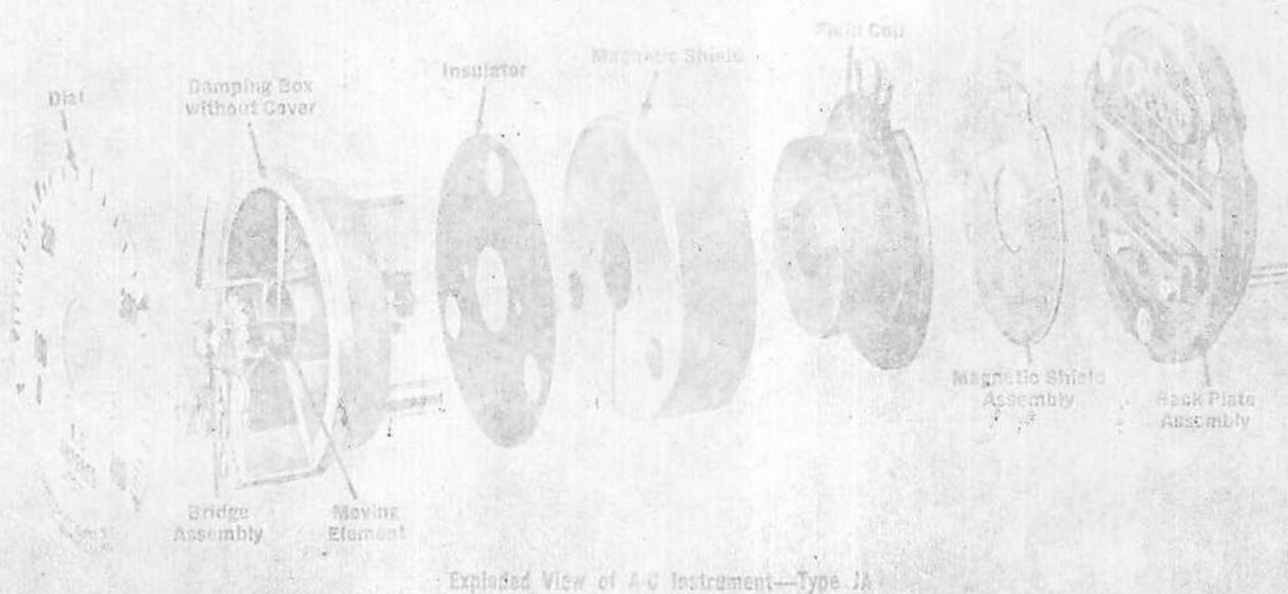
Specification: All instruments conform to ASA standards C 39.1.

Long Scale: 7 inch scale facilitates reading, reduces errors.

Instrument Ranges: Ammeter—5 ampere coil; or self-contained to 20 amperes.

Voltmeter—150 volt coil; or self-contained to 800 volts.

Wattmeter—5 amperes 150 volt coils.



Exploded View of A-C Instrument—Type JA

	...mp.
	...mp.
	...mp.
	...mp.

	...150 v.
	...0 v.
	...0 v.
	300 v.
	...** v.

A-C Single ... ...ote 6)

	0—100 watts
	0—500 watts
...olts	0—1 KW.
...olts	0—1.5 KW.
...volts	0—2 KW.
...20 volts	0—* KW.

...meters (See Note 6)

120 volts	0—* KW.
240 volts	0—* KW.

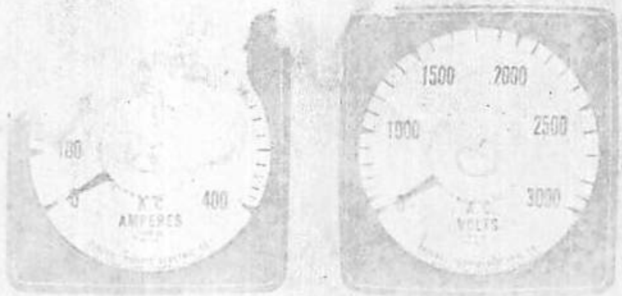
...ters (See Note 6)

208/120 v.	0—* KW.
416/240 v.	0—* KW.

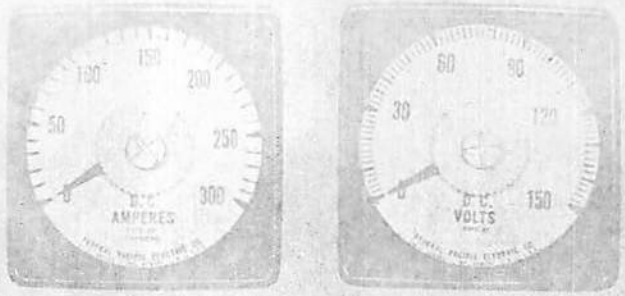
... to suit capacity of 50 mv. ... and furnished with pair of ... Insert value in place of **

... e to suit application, and insert ... D-001MA-3000VV. External re... a. required; available separately.

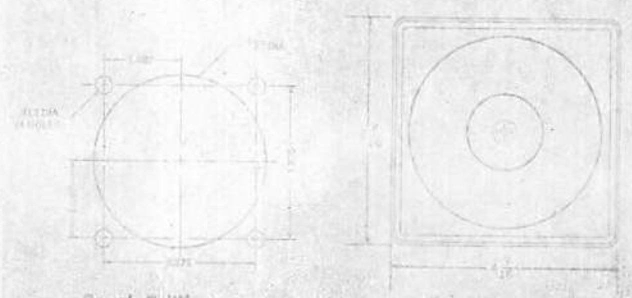
... value to suit primary of current ... 5 amp secondary. Insert this value ... 005AA-250AA.



Typical A-C Instruments—Type JA



Typical D-C Instruments—Type JD

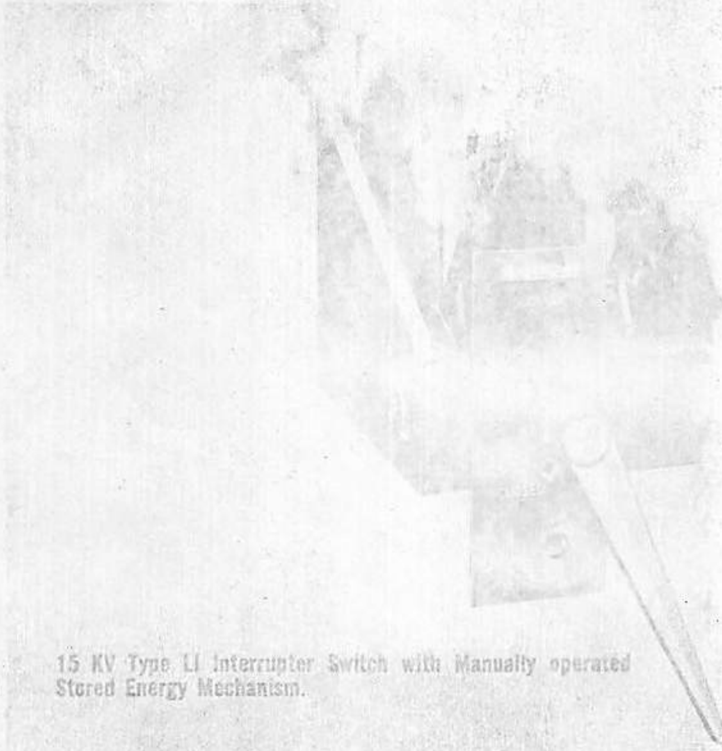


Panel Drilling   Front View

4. Select full scale value to suit primary of potential transformer having 150 v secondary. Insert this value in place of ** e.g. JA-150VV-1500VV.

5. Select full scale value to suit application and insert in place of *. Indicate product of current transformer ratio and potential transformer ratio e.g. JA-001KW/341/120-75KW for use with 300:5 c.t. and 2:1 p.t. indicating 75 KW full scale.

6. Burden on current circuit—2.1 va. per phase. Burden on potential circuit—5.5 va. per phase.



15 KV Type LI Interrupter Switch with Manually operated Stored Energy Mechanism.

Federal Pacific Type LI Indoor Disconnects—equipped with a quick opening interrupter blade—can switch load currents without injury to switch or personnel. The basic three pole switch assembly may be used in conjunction with power fuses and manually or electrically operated stored energy mechanisms. This design flexibility provides wide latitude in specifying the switch or interrupter to fit job requirements.

TYPE LI—STORED ENERGY OPERATED LOAD BREAK SWITCHES

Insulation level, 60 cycles: 19kv, 36kv.

Insulation level, impulse: 60kv, 95kv.

Continuous capacity: 600 amperes.

High fault closing: 40,000 amperes asymmetrical.

Switching capacity-opening: 600 amperes.

Federal Pacific Load Interrupter Switches with stored energy mechanism are quick-make quick-break to protect both operator and equipment should the switch close into a fault.

Utilized with power or current limiting fuses, these switches provide safe, fast, reliable protection for high voltage circuits. As main or branch circuit protection in switchgear or unit substations, load break switches have the advantages of low cost, smaller space requirements, and simplified maintenance.

Applications

Load interrupter switches, fused or unfused, are most commonly applied as:

- Transformer primary switching in unit substations.
- Service entrance switching.
- Wall [illegible] at key locatio[illegible]
- Switching of [illegible] single bus within [illegible]
- To interrupt tr[illegible] exciting current [illegible]

Stored Energy Mech[illegible]

A manually operated [illegible] provides constant high [illegible] speed and force of closing on [illegible] independent of the action of th[illegible]

This stored energy mechan[illegible] which is charged and drive[illegible] shaft. The shaft is rotated b[illegible] unit. Moving the handle [illegible] compresses the spring an[illegible] compressed, further mo[illegible] spring over center and [illegible] driving the contacts c[illegible] To [illegible] handle is rotated dow[illegible] (clock[illegible] tacts are driven open. [illegible] in place by a spring loaded [illegible] from the switch by pulling. [illegible] sition of the switch blades.

Interlocking

Provisions are made for one [illegible] key interlocks to lock the lo[illegible] "open", lock it "closed", lock it [illegible] or any combination of these thre[illegible]

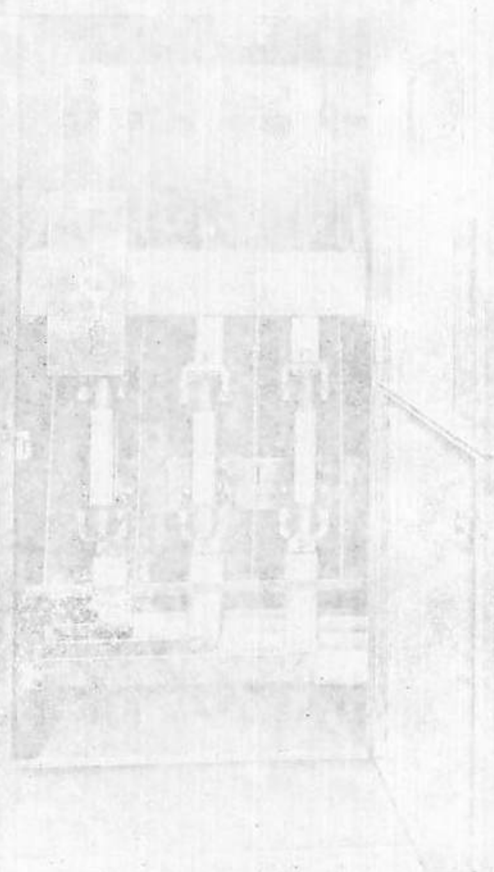
Fuse Kits

Load interrupter switches a[illegible] which include phase barriers, fus[illegible]

INTERRUPTER [illegible]

Nominal kv	[illegible]	[illegible]	Continuous Amps	Fault Closing [illegible] Asym. Stored Energy	Fault Closing [illegible] Asym. Manual*	10 Cycle Momentary, Asym. Amps.	4-Second Short-Time Sym. Amps.	Interrupting Life – Number of Operations: 200 Amp.	Interrupting Life – Number of Operations: 600 Amp.
4.8	[illegible]	[illegible]	600	40,000	[illegible]	40,000	25,000	800	100
13.8	[illegible]	[illegible]	600	40,000	[illegible],000	40,000	25,000	200	100

* Based on rapid [illegible] operating handle to fully closed and latched position.



15 KV Type [illegible] Interrupter Switch with Line Parts and Fuses. (Line Parts and Fuses Not Included with Fuse Kit Assembly.)

SWITCH CATALOG NUMBERS*

Nominal kv	Continuous Amps.	Stored Energy Operating Mechanism	Manual Operating Mechanism
4.8	600	2651—1619	2652—1619
13.8	600	2551—1595	2652—1595

* For electrically operated stored energy mechanisms, add suffix "EO" to catalog numbers followed by operating voltage. For example: [illegible] electrically operated switch with 125 volt d-c motor would be Cat. No. [illegible]51—1619-EO-125 d-c.

FUSE KIT PURCHASING DATA*

Nominal kv	Fuse Type G.E.	Fuse Type S & C	Fuse Type West.	Fuse Kit Catalog Number
4.8	EJO-1-D EJO-1-DD	SM-4 SM-5	CLE-1 CLE-2	2651-1686
13.8	EJO-1-D EJO-1-DD EJO-1-EE	SM-4 SM-5	CLE-1 CLE-2 BA-200, Vented BA-200, with condenser or discharge filter	2652-1686

* Live fuse parts not included.

CONTACT GUARD PURCHASING DATA

Nominal KV	Continuous Amps.	Contact Guard Catalog Number
4.8	600	2651—1665
13.8	600	2652—1665

ORDERING INFORMATION*

When ordering Interrupter Switches be sure to supply the following information:

Switch Catalog Number ....

Voltage Rating .... kv.

Continuous Current Rating .... Amperes.

Fuse Kit Catalog Number ....

Operating Mechanism: Manual ....;

Stored Energy ...., Motor..............................;

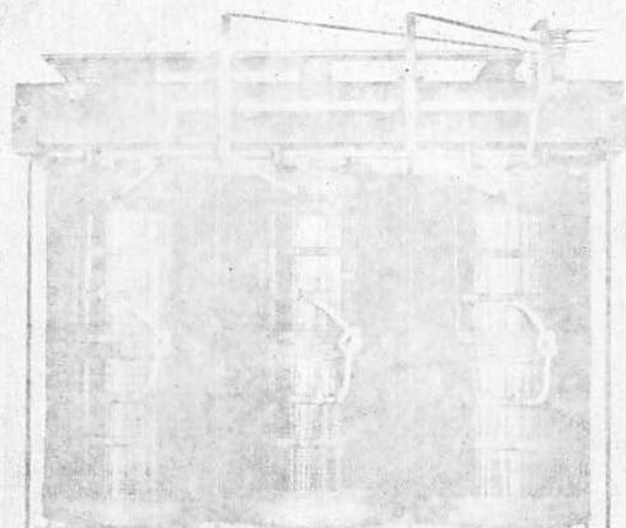
If Motor Operated, Control Voltage: ....a.c. ....d.c.

Contact Guard Catalog Number ....

*NOTE: ONLY FRONT CONNECTED SWITCHES AVAILABLE

IN-E-7700

INSTRUCTIONS FOR INSTALLATION, OPERATION AND MAINTENANCE of TYPE "FH" DRY-TYPE TRANSFORMERS



FEDERAL PACIFIC ELECTRIC COMPANY

Encased Transformers

All Federal Pacific's Type "FH" transformers are shipped mounted on either a skid, or in the case of the smaller sizes, on a pallet. Adequate size and strength of the skid or pallet insures protection during shipment and ease of handling. The transformer housing is covered with a heavy laminated paper and the complete transformer is either banded to the pallet or bolted to the skid.

Core and Coils

Core and coils shipped from the Federal Pacific factory is skid mounted and covered with protected paper wrapping, and have a protective box frame covering the complete structure to insure that the transformer will not be damaged with normal handling during shipment.

INSPECTION UPON RECEIPT

All transformers leaving the Federal Pacific Electric factory are in first-class condition. Therefore, upon arrival at destination a visual inspection should be made prior to unloading, to determine any evidence of rough handling. If damage is evident or any indication of rough handling visible, a claim should be filed immediately with the carrier and notification of this claim should be sent to the Federal Pacific Electric salesman.

HANDLING

Pallets and skids are constructed so that all transformers may be moved by a forklift truck. All transformers may be skidded, dragged or rolled into position on their shipping forms. Lifting eyes are provided on all transformers and are of sufficient strength to permit overhead lifts with a crane.

No standard Federal Pacific transformer should be laid on its side for any reason. All transformers are supported on vibration isolators underneath the core and coil structure and this isolating material could be damaged beyond repair if the transformer is turned on its side.

A spreader bar need only be used on the large power sized encased dry-type transformers. This is because the lifting eyes are fastened to the base and long lifting cables or sling might possibly crush the casing unless a spreader is used.

STORAGE

Dry-type transformers preferably should be stored in a warm dry location with uniform temperature. Ventilating openings should be kept covered to keep out dust. If it is necessary to leave a transformer out of doors it should be thoroughly protected to prevent moisture and foreign material from entering. Condensation and the absorption of moisture can be greatly reduced by the installation of either heat lamps or space heaters. Transformers are expensive items of electrical equipment and should be treated with reasonable care in choice of storage location.

MOUNTING

Type "FH" transformers 225 KVA and below are supplied with Korfund isolators which should be placed under the four corners of the unit when it is floor mounted for full isolation of vibration from the building structure. This isolation in addition to the internal isolating mounts will provide a maximum of vibration isolation and sound reduction. Those transformers suitable for wall mounting are equipped with brackets for this purpose. The heavy angle brackets mounted to the base are designed to carry the transformer's weight when bolted to the building structure. The top slide-type brackets are intended to hold the transformer in an upright position.

Type "FH" transformers 300 KVA and above are also equipped with vibration isolators. However, because of the weight of these transformers, the vibration isolators are made ineffective during shipment by the placement of red shipping bars in parallel with the isolating material. Upon installation *the bolt down items painted red and the shipping bars also painted red should be removed* to permit the core and coils to be effectively isolated.

The bolt down items and isolation shipping bar can be stored within the transformer housing so as to be readily available for use in the event the transformer ever need be removed from its installation site.

LOCATION

For satisfactory operation transformers should be so positioned as not to restrict free air flow through the transformer louvers. No fixed rule applies; however, the larger the air circulation louver, the farther from a wall it should be placed. The small lighting transformer need only be placed two inches from a wall whereas a large power transformer should be placed at least six inches from a wall. Good air circulation is essential in the area in which a dry-type transformer is installed. There should be available at least one hundred cubic feet of air per minute per kilowatt loss of the transformer. Such a volume of air will restrict the ambient air rise in the room to less than 10° centigrade. To determine the air requirements of a planned installation, the KVA size of transformer to be used and its full load total watts loss should be used to calculate the above air requirements.

Transformers weighing in excess of one thousand pounds should be installed close to a main building support to insure a minimum of vibration transmission throughout the structure.

CONNECTIONS

Wiring compartments are provided at the bottom of the transformer enclosure. Knockouts are not provided because of the difficulty of insuring the correct size and the correct location for each installation. However, both ends as well as the rear and bottom of the wiring compartment are suitable cable entrance areas. All transformer terminals are rigidly supported to insure that no damage occurs to the coils during the period the connections are made to the transformer. A complete permanent connection diagram is included as an integral part of the transformer nameplate.

All core and coil structures, although isolated from the transformer casing by vibration isolators, have a flexible grounding connection which insures that all non-current carrying parts are at the same potential. Standard practice of adequately grounding the transformer to the station or circuit ground should be followed. If this procedure is followed no danger will exist for operating or maintenance personnel.

OPERATION

To maintain safe operating conditions do not remove covers or panels over openings in the transformer housing while the transformer is energized.

Caution: No attempt should ever be made to change the tap connection while the transformer is energized.

For all relatively clean and dry indoor installations the Type "FH" transformer will continue to operate satisfactorily under all normal conditions of energization and load. No concern need be expressed over periods of shut down as to the transformer's ability to retain its electrical strength. However, in some instances it is necessary to install Type "FH" transformers out of doors with the protection afforded either by rain shields or a building shelter. Under such conditions of operation the greatest reliability will be obtained if the transformer is continually under load. Condensate may form and ultimately be absorbed in the insulation if an outdoor transformer is de-energized for long periods of time. If such a situation arises the transformer should be inspected for visible signs of moisture on the core and coils before re-energizing. If moisture is observed the transformer should be dried as indicated in the paragraph under DRYING.

Type "FH" transformers may be loaded in accordance with the ASA loading guide for dry-type transformers.

Caution: Under no conditions should Type "FH" transformers be asked to carry more than 110% overload for a long period of time for the reason that extreme temperatures may develop and cause transformer failure. If it is necessary under emergency conditions to exceed this value of loading, fan cooling should be added as an emergency measure. Adequate forced air cooling will permit load increases of 33⅓% of nameplate rating. Type "FH" transformers 501 KVA and above may be purchased with factory supplied supplemental fan cooled rating.

MAINTENANCE

A continuously energized transformer needs periodic maintenance only for the purpose of removing accumulations of dust and dirt from the cooling ducts and conducting surfaces. Failure to remove large accumulations of dust and dirt will ultimately lead to overheating of the transformer and its ultimate failure. Frequency of such cleaning should depend on the environment of the transformer.

[illegible] quire [illegible] to insure [illegible] moisture from the conducting surfaces. [illegible] dirt upon insulation becomes a [illegible] when the insulation absorbs a considerable amount of moisture and the surface is contaminated. It is advisable to inspect and clean any [illegible] transformer suspected of having been contaminated with dirt and moisture, especially prior to re-energizing.

DRYING

It is advisable to dry out a dry-type transformer when it has been known to have been exposed to long periods of high humidity or other moisture. Whenever moisture is visible upon the surface of the insulation, it must be dried out before energization. The application of hot air, radiant [illegible] internal heat sufficient to remove visible signs of moisture is generally all that is required. Failure due to excess moisture may occur over external creepage surfaces readily contaminated by moisture. Therefore, removal of this surface moisture re-establishes dielectric integrity.

Unfortunately insulation resistance tests of the [illegible] liquid filled transformers are of little value on a dry-type transformer. Attempts have been made to specify resistance readings which will indicate transformer dryness and dielectric strength. The nature of the insulation used in dry-type transformers is such that megger readings cannot be relied upon.

FAN EQUIPMENT

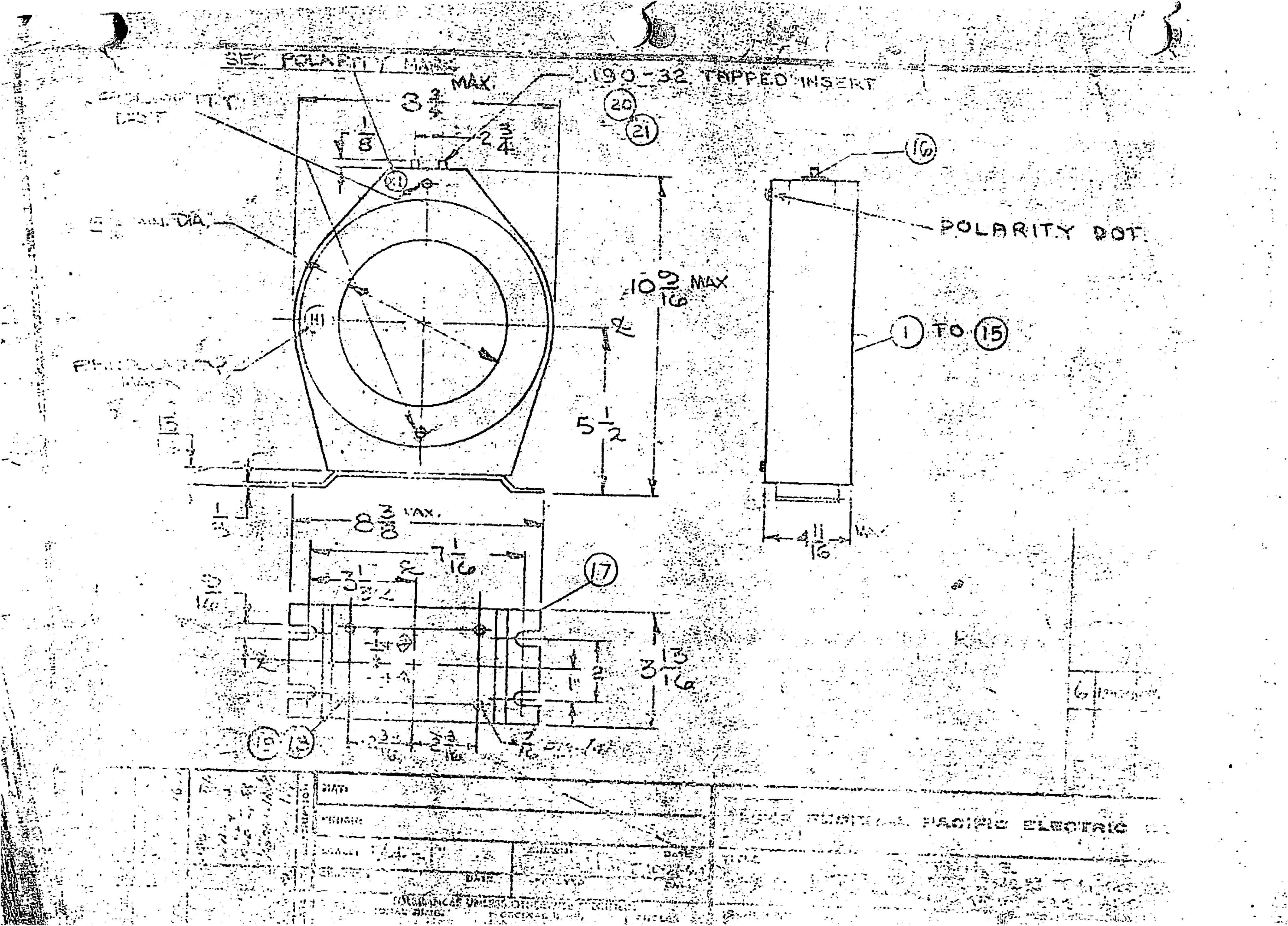
Transformers Type "FH" 501 KVA and above may be supplied with supplemental fan cooling. Fan motor maintenance consists only of periodic lubrication if used frequently. No maintenance is required on the dial-type thermometer and alarm contacts which control the circuit. Since the dial-type thermometer is of the bourdon type, the thermometer either works accurately or not at all. It will only fail to operate if the bourdon tube is punctured and loses its liquid pressure. The control and alarm contacts are of the micro switch variety and suitable for many hundreds of thousands of operations.

SURGE PROTECTION

For normal operation on protected lines dry-type transformers need no surge protection. However, when these transformers are applied to circuits with some exposure to lightning surges it is advisable to protect with suitable lightning arrestors. The Form 28 and Type RM arrestors will give adequate protection when properly chosen for the voltage rating they are to protect.

INSULATION

Caution: Extreme care should be taken to assure that the wire enamel is never damaged. The wire enamel is of an extremely high dielectric strength, it has an exceptional high temperature normal life.


SEE POLARITY MARK
.190-32 TAPPED INSERT
POLARITY DOT
10 9/16 MAX
5 1/2
3 1/4 MAX.
8 3/8 MAX.
7 1/16
3 13/16
4 11/16 MAX
1 TO 15
PACIFIC ELECTRIC