PDOC - 094

STMPO #232
EXTRA C.K.S.

SAN/0499-82
MDC G9705

10 MWe Solar Thermal
Central Receiver Pilot Plant

SOLAR FACILITIES DESIGN INTEGRATION

PLANT MAINTENANCE/TRAINING MANUAL (RADL ITEM 2-37) SECTION 3 — ELECTRICAL APPARATUS, BOOK 1 OF 2

Revised September 1982
July 1981

WORK PERFORMED UNDER
CONTRACT DE-AC03-79SF10499

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647

U.S. Department of Energy

McDonnell Douglas Corporation | Rockwell International Rocketdyne Division | Stearns-Roger | Solar Energy

SAN/0499-82
MDC G9705

10 MWe Solar Thermal Central Receiver Pilot Plant Solar Facilities Design Integration

PLANT MAINTENANCE/TRAINING MANUAL (RADL ITEM 2-37) SECTION 3 — ELECTRICAL APPARATUS, BOOK 1 OF 2

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MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647

PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
SOLAR ENERGY
UNDER CONTRACT DE-AC03-79SF10499

UPDATE FOR

PLANT MAINTENANCE/TRAINING MANUAL

(RADL ITEM 2-37)

SECTION 3 - ELECTRICAL APPARATUS

INSTRUCTIONS:

1. This update is issued to incorporate corrections and additions to the preface, table of contents, and to incorporate additional information in paragraphs 3.1 Transformers, 3.2 Motor Control Centers, 3.3 Substations, 3.4 Junction Boxes, 3.5 Switchgear, and 3.6 Power Panels. This section has been printed in two parts for this update. Discard the original July 1981 issue as the content has been included in this printing.

PREFACE

This document is provided by the McDonnell Douglas Astronautics Company (MDAC) in accordance with Department of Energy Contract Number DE-AC03-79SF10499, Reports and Deliverables List Item 2-37. The material presented here is intended for training and maintenance usage by Southern California Edison Operations Personnel.

Specific notes on the organization and content of the document are as follows:

1. This document is organized in major sections that reflect the top level breakdown of the Master Equipment List as defined in RADL Item 2-19. This is in contrast to the subsystem approach used in designing the plant, however, is consistent with the Southern California Edison operating plant equipment lists.

   Section 1 - Rotating Apparatus
   Section 2 - Stationary Apparatus
   Section 3 - Electrical Apparatus
   Section 4 - Valves
   Section 5 - Instrumentation
   Section 6 - Control and Data Systems
   Section 7 - Collector System
   Section 8 - Special Heliostat Instrumentation and Meteorological Measurements Equipment
   Section 9 - Heating Ventilating and Air Conditioning
   Section 10 - Facilities

2. Assignments to categories are made on the basis of the lowest level tag numbers. For example, maintenance information for the thermal storage extraction pump skid assembly (SA-309) is not listed in the stationary apparatus section, but broken down to the generic categories as defined by the tag number; i.e., pumps (Section 1.2), air operated stop valves (Section 4.2), pressure transmitter (Section 5.2), etc.

3. The Process Instrumentation Section (Section 5.0) is organized on the basis of sensor type as defined by the first letter of the designating tag number. It contains sensor-related information only. Signal conditioning equipment is treated in Section 6.0.

4. The information on the Collector System, which was provided by the Martin Marietta Corp. (MMC) and the major items of the Electrical Power Generation System equipment, provided by Southern California Edison is not provided herein. However, the various sections were structured for their inclusion where applicable.

Technical questions concerning this RADL Item should be directed to Mr. R. G. Riedesel at (714) 896-3357 or Mr. R. J. Perkins at (714) 896-3073.

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3.1 TRANSFORMERS

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
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SCE 0003	Main Transformer	3.1.2	
SCE 0004	Auxiliary Transformer	3.1.3	
SCE 0005	Sta. Service Transformer	3.1.4	
SCE 0006	Cooling Tower Transformer	3.1.5	

3.1.1 TSS Load Center Transformer

3.1.1.1 Identification

Tag Number	Description
PSS 0001	480 Volt load Center A

3.1.1.2 Description

Manufacturer: Abbott Power Corporation
7650 Stage Road
Buena Park, CA 90620

Part No: See attached Abbott Power Corp manual Table of contents of contents for equipment list.

3.1.1.3 Vendor

Abbott Power Corporation

3.1.1.4 Procurement Specification

Stearns-Roger Spec F235.1 (DOE Spec 40E700-19S)

3.1.1.5 Operation/Maintenance

See attached Abbott Power Corporation manual

Note: Instruction for the 480V motor control centers B and C are also included.

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	DRAWING	
23.	LOAD CENTER TRANSFORMER LIQUID FILLED	100-2
	DRAWING #92133	
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BILL OF MATERIAL

CUSTOMER STEARNS-ROGER, INC.
P.O. BOX 5888
DENVER, CO 80217

USER SOLAR PILOT PLANT

CUSTOMER ORDER # 4004621700

CUSTOMER SPECIFICATION # C-21700SRF235-1 SECTION I, II & III

JOB DESCRIPTION

480 VOLT LOAD CENTER INCLUDING:

(1) 5KV, 600A LOAD BREAK SWITCH

(1) 1000 KVA POWER TRANSFORMER

(1) 480V INDOOR SWITCHGEAR

(1) 480V 1600 AMP NON-SEGREGATED BUS DUCT

(2) 480V MOTOR CONTROL CENTER

DESIGN ELEC.:	DESIGN MECH.:	DRAWN BY:	DATE	CHK. BY:	DATE	APP'D. BY:
AC	DW	AC/MA	9/12/80			

Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

PROJ. NO.:	5049
DWG. NO.:	5049-1X
PAGE 1	OF 5

U-COLOR REORDER NO. 1207
U-VEL V-16

NOTES

I **BUS**

PLATING	ALUMINUM WITH TIN PLATED JOINTS
RATING	AS SHOWN IN SINGLE LINE DIAGRAM
SIZE	AS SHOWN IN SECTION VIEW DRAWING
BRACING	22KA

E BELLEVILLE TYPE SPRING WASHERS SHALL BE USED ON BUS JOINTS WITH STEEL BOLTS.

B II **PAINT** ANSI #61 FOR SWITCHGEAR, ANSI #70 FOR LOAD INTERRUPTER SWITCH

DRAWINGS APPROVAL 4 REPRODUCIBLES, 8 PRINTS

FINAL 4 REPRODUCIBLES, 8 PRINTS

III. **MECHANICAL NOTES**

D 1. DESIGN SHALL COMPLY WITH UBC SEISMIC ZONE #3. EQUIPMENT DESIGNED TO WITHSTAND LATERAL SEISMIC FORCES GENERATED BY A GROUND ACCELERATION OF 0.25G. CALIFORNIA CODE APPLIES.

2. EQUIPMENT TO HAVE A SERVICE LIFE OF (30) YEARS.

3. DOORS AND PANELS SHALL BE FLANGED AND ALL CORNERS SHALL BE WELDED AND GROUND OR FORMED ROUND. DOORS AND PANELS SHALL BE HELD IN PLACE BY SLOTTED HEAD SCREWS WITH RETAINERS WHICH SHALL FIT INTO ADJUSTABLE NUTS ON THE FRAME.

4. PROVIDE SUITABLE MEANS FOR LIFTING THE SWITCHGEAR.

5. SHIPPING SECTIONS TO BE IN WATER TIGHT AND DUST PROOF CONTAINERS AS FAR AS COMMERCIAL PRACTICE ALLOWS.

IV **WIRING**

1. REFER TO SPECIFICATION JF16.01.01 PAGE 5 TO 7 FOR WIRING DIAGRAM INSTRUCTIONS.

2. EACH TERMINAL BLOCK SHALL HAVE AT LEAST 20% SPARE TERMINALS

DESIGN ELEC.:	DESIGN MECH.:	DRAWN BY:	DATE	CHK. BY:	DATE	APP'D. BY:
AC		AC/MA	9/12/80			

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PAGE 2 OF 5	

NOTES (CONTINUED)

IV WIRING (CONTINUED)

3. SHORTING TYPE TERMINAL BLOCKS REQUIRED FOR CURRENT TRANSFORMER SECONDARIES.

4. USE RING TONGUE ON WIRING.

C 5. ALL TERMINALS TO HAVE COVERS.

TEST

ALL BUSES AND POWER CIRCUIT BREAKERS SHALL UNDERGO A ONE-MINUTE 60HZ DIELECTRIC WITHSTAND TEST. THE TEST VOLTAGE SHALL BE 2200 VOLTS.

DESIGN ELEC.:	DESIGN MECH.:	DRAWN BY:	DATE	CHK. BY:	DATE	APP'D. BY:
AC		AC/MA	9/12/80			

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PROJ. NO.: 5049
DWG. NO.: 5049-1X
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VU-COLOR REORDER NO. 1208
VU-VEL V-16

REVISIONS

REV.	B/M	PAGE	DESCRIPTION	BY	DATE
B	5049-1 5049-1	3 6	REVISED VENDOR ITEM 8-1 ADDED ITEM 72-1 and 73-1	AC ac	10/8/80
B	5049-1X	2	REVISED NOTE FOR PAINT	AC	11/5/80
	5049-1	1, 2	REVISED DESCRIPTION ITEMS 1-1, 1-2, & 1-3 PER CUSTOMER		
	5049-1	5	ADD ITEM 56-2	AC	11/5/80
C	5049-1	5, 6	REVISED DESCRIPTION, ITEM 56-1, 56-2 & 57-1		
C	5049-1X	3	ADD NOTE #5		11/29/80
D	5049-1X	2	REVISED MECHANICAL NOTE #1, ADDED CALIFORNIA CODE APPLIES.	AC	12/3/80
E	5049-1X	2	REVISED NOTE I TO ADD STEEL BOLTS TO BELLEVILLE SPRING WASHERS.		12/8/80

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PROJ. NO.	5049-
DRAWN BY	AC/MA
DWG. NO.	~~5049-1X~~
PAGE	4 of 5

DRAWING LIST

1-5049-1-1	ELEVATION AND BASE PLAN SWGR.
1-5049-1-2	SECTION VIEW SWGR.
1-5049-2-1	ELEVATION AND BASE PLAN MCC
2-5049-1-1	SINGLE LINE DIAGRAM SWGR.
3-5049-1-1	THREE LINE DIAGRAM SWGR.
3-5049-2-1	THREE LINE DIAGRAM MCC-B
3-5049-2-2	THREE LINE DIAGRAM MCC-C

DESIGN ELEC.:	DESIGN MECH.:	DRAWN BY:	DATE	CHK. BY:	DATE	APP'D. BY:
AC		AC/MA	9/12/80			

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PROJ. NO.: 5049
DWG. NO.: 5049-1X
PAGE 5 OF 5

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3	TOTAL QTY.
1-1	W	DS-416	AIR CIRCUIT BREAKER TYPE DS 480V	1			1
			1600A FRAME 1600A TRIP, MANUALLY				
			OPERATED WITH TYPE LONG TIME, SHORT TIME				
			TRIP CHARACTERISTICS, ALSO WITH MANUAL				
			RESET BELL ALARM 1 N.O., 1 N.C. AND				
			WITH 2 N.O., 2 N.C. AUX. SW. AND SHUNT				
			TRIP @ 125V D.C. (AMPTECTOR IIA)				
			(W FIG. 3B, 11C, 11G)				
1-2	W	DS-206	AIR CIRCUIT BREAKER, TYPE DS 480V		2	2	4
			800AF/600AT MANUALLY OPERATED WITH				
			TYPE LONG TIME AND INSTANTANEOUS TRIP				
			CHARACTERISTICS, ALSO WITH MANUAL				
			RESET BELL ALARM 1 N.O., 1 N.C. AND				
			2 N.O, 2 N.C. AUX. SWITCH AND SHUNT				
			TRIP AT 125V D.C. (AMPTECTOR IIA)				
			(W FIG. 3B, 11C, 11G)				

3.1/1-9

ABBOTT POWER CORPORATION

ENGINEER VC

DESIGNER EL. ____ ME. ____

PROJECT NO. 5049-1

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3			INC	TOTAL QTY.
1-3	W	DS-206	AIR CIRCUIT BREAKER TYPE DS	1						1
			480V 800AF/600AT MANUALLY OPERATED							
			WITH TYPE LONG TIME AND SHORT TIME							
			TRIP CHARACTERISTICS, ALSO WITH MANUAL							
			RESET BELL ALARM 1 N.O., 1 N.C. AND							
			2 N.O., 2 N.C. AUX. SWITCH AND SHUNT							
			TRIP AT 125V DC (AMPTECTOR IIA)							
			(W FIG. 3B, 11C, 11G)							
2-1	W		CELL FOR ITEM 1-1 CIRCUIT BREAKER	1						1
3.11-10										
2-2	W	804A217G01	CELL FOR ITEM 1-2 AND 1-3 PLUS	1	3	3				7
			2 FUTURE							
3-1	W	140D719G04	5KV LOAD SWITCH 600A 3Ø 3W, 40KA						1	1
			FAULT CLOSE NON-FUSIBLE (89)							

ABBOTT POWER CORPORATION

ENGINEER VC

DESIGNER EL. ME.

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3	TOTAL QTY.
5-1	ABBOTT MAGNETICS	350-162	C.T. 1600:5A WITH ACCURACY CLASS OF .3 AT B-0.1 (CT)	3			3
7-1	ABBOTT MAGNETICS	450-480	P.T. 480/120V, 750VA (PT1, PT2)	4			4
8-1 3.1-1-11	W	6F495	CONTROL POWER TRANSFORMER 480V: 120/ 240V SINGLE PHASE, 3 KVA (FOR TRANSFORMER FAN)	1			1
10-1	ABBOTT POWER	2102-02	AMMETER 0-1600A WITH 5A COIL (AM)	1			1
11-1	ABBOTT POWER	2102-05	VOLTMETER 0-600V WITH 0-150V COIL (VM)	1			1

ABBOTT POWER RPORATION

ENGINEER VC

DESIGNER EL. ME.

PROJECT NO. 5049-1

PAGE 4 OF

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3	TOTAL QTY.
24-1	G.E.	12IAV53K1A	TYPE IAV UNDERVOLTAGE RELAY, 55 TO 140V (27UV)		1		1
24-2	G.E.	12IAV51D1A	IAV OVERVOLTAGE RELAY, 199V AC ADJUSTABLE 16-64V (59G)		1		1
34-1	OHMITE	AS DESCRIBED	200 OHM 250 WATT GROUNDING ADJUSTABLE RESISTOR FOR USE WITH ITEM 24-2 (R)		1		1
41-1	G.E.	10AA009	SBM AMMETER SWITCH 4 POSITION (1-2-3-OFF), ROUND HANDLE (AS)	1			1
50-1	FPE	EON-6	6 AMP FUSES, 250V				3
50-2	FPE	JCL-3	3 AMP 600V FUSES				5

ABBOTT POWER CORPORATION

ENGINEER VC

DESIGNER EL. ME.

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3	TOTAL QTY.
50-3	BUSSMAN	JHC 15	CPT PRIMARY FUSES, 600V 15A				2
50-4	FPE	EON-20	CPT SECONDARY FUSES, 250V, 20A				2
53-1	G.E.	116B4078	2 POLE PULL APART FUSE HOLDERS 30A 600V				2
53-2	G.E.	116B4075	3 POLE PULL APART FUSE HOLDERS 30A 600V				1
53-3	MARATHON	F30A2S	30A 2 POLE FUSE HOLDERS				3
56-1	MARATHON	1512.	12 POINT T/B 600V WITH COVERS				LOT
56-2	MARATHON		2 POLE POWER BLOCK WITH COVERS	1	1	1	3

ABBOTT POWER ..RPORATION ENGINEER VC
DESIGNER EL. ME.

PROJECT NO. 5049-1

ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO. 1	2	3			IN	BUS DUCT	TOTAL QTY.
57-1	MARATHON	1504SC	SHORTING T/B 4 POINT (STB) WITH COVERS								1
60-1	BURNDY	YA26 -2N	2/0 LUGS INCOMING CABLES						3		3
63-1	ANIXTER	7315	FLEXIBLE CONNECTOR 550A								
	ROYAL										12
72-1	FPE	PMT-1	THERMOSTAT 22A						1	1	2
73-1	CHROMALOX	OT-1225	HEATER 120V 250W						1	1	2
90-1	W		BREAKER LEVERING-IN CRANK								2
3.11-14											
90-2	W		BREAKER LIFTING YOKE								1
90-3	ABBOTT		TRAVELLING TYPE LIFTING DEVICE								1
	POWER										

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ITEM#	VENDOR	CATALOG # (ABBOTT STOCK #)	DESCRIPTION OF MATERIAL	MATERIAL LOCATED IN UNIT NO.	TOTAL QTY.
100-1	ABBOTT		600 VOLT 1600 AMP NON SEGREGATED PHASE BUS DUCT ALUMINUM BUS WITH STEEL ENCLOSURE OF 11 USS GAGE SHEET STEEL		LOT
100-2			LOAD CENTER TRANSFORMER LIQUID FILLED 1000/1150 KVA 4160 TO 480Y/277V ALL PER SPECIFICATION S-RF2351, C-21700 PAGES II-DS-4, "B" II-DS-8,9 "B" ; II-DS-10-11 PARA 6-A-A; ALL ATTACHED		1
3.11-15					
100-3	W		5 STAR MOTOR CONTROL CENTER 480V 3Ø 3W 60HZ NEMA 12 ENCLOSURE, FRONT OF BOARD, CLASS IB WIRING AND PER CUSTOMER SPECIFICATION C-21700 S-RF235.1 SEC I, II AND DWGS. E2-3 AND E2-4		2

ABBOTT POWER CORPORATION

ENGINEER ______ VC

DESIGNER EL. ______ ME. ______

LETTER OF CLARIFICATION

1. CUSTOMER SPECIFICATION S-R F 235.1 CALLED FOR TIN PLATED AND SILVER PLATED BUS JOINTS. ABBOTT POWER WILL FURNISH TIN PLATED ALUMINUM BUS JOINTS FOR SWITCHGEAR, BUS DUCT AND MOTOR CONTROL CENTER. CUSTOMER APPROVAL REQUESTED.

2. CUSTOMER GENERAL SPECIFICATION JF16.0240 REQUIRES WELDED ALUMINUM BUS JOINTS, HOWEVER, ABBOTT POWER'S STANDARD USES BOLTED JOINTS. CUSTOMER APPROVAL FOR USING ABBOTT POWER'S STANDARD IS REQUESTED.

3. CUSTOMER SPECIFICATION S-RF 235-1 II-DS-10 CALLED FOR BREAKER LIFTING DEVICE. TRAVELLING TYPE LIFTING DEVICE AS SHOWN ON DRAWING 1-5049-1-1 WILL BE PROVIDED.
   CUSTOMER IS REQUESTED TO CHECK AND APPROVE.

4. SWITCHGEAR AND BUS DUCT WILL BE PAINTED ANSI #61 LIGHT GREY AND MOTOR CONTROL CENTER WILL BE PAINTED WITH MANUFACTURER'S STANDARD TWO TONE GREY ANSI #24/70. CUSTOMER APPROVAL IS REQUESTED.

5. SINGLE LINE DIAGRAM OF THE MOTOR CONTROL CENTER IS PART OF CUSTOMER'S SPECIFICATION. ABBOTT POWER WILL NOT FURNISH SINGLE LINE DIAGRAM FOR THE MOTOR CONTROL CENTER. CUSTOMER APPROVAL IS REQUESTED.

6. CUSTOMER SPECIFICATION S-R F235.1 - III DS-4 SPECIFIED FOR STARTER OR CIRCUIT BREAKER DESIGNATION WHICH IS DIFFERENT FROM MANUFACTURERS STANDARD. A CROSS REFERENCE NUMBER IS PROVIDED ON THE THREE LINE DIAGRAM FOR CUSTOMER REFERENCE.

7. SIZE OF THE MOTOR CONTROL CENTER WILL BE AS SHOWN ON DRAWING #1-5049-2-1.CUSTOMER IS REQUESTED TO CHECK AND APPROVE.

8. MOTOR CONTROL CENTER WILL BE WIRED ACCORDING TO CUSTOMER WIRING DIAGRAM JF30.40.05 (3/14/79), JF30.40.10 (5/1/79), SK-E75 (7/11/80) AND SK-E76 (7/11/80) AND SPARE CONTACTS WILL BE FURNISHED AS SHOWN ON THESE WIRING DIAGRAMS. CUSTOMER IS REQUESTED TO CHECK AND APPROVE.

A

DESIGN ELEC.:	DESIGN MECH.:	DRAWN BY:	DATE	CHK. BY:	DATE	APP'D. BY:
AC		AC/MA	9/15/80			

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PROJ. NO.: 5049
DWG. NO.: 5049-L
PAGE 1 OF 1

/U-COLOR REORDER NO. 1208
/U-VEL V-16

LINE 1
LINE 2
LINE 3

LINE 1
LINE 2

LINE 1

NO.	QTY	LINE 1	LINE 2	LINE 3	LET'S	SIZE
1	1	LOAD CENTER - A	480V 1600A		7/16"	5"X3"
1A	1	C.P.T.	COMPARTMENT		1/8"	3"X1"
1B	1	MAIN BREAKER	1600AF/1600AT		1/8"	3"X1"
1C	1	FEEDER	800AF/600AT	MCC-B	1/8"	3"X1"
1D	1	P.T.	COMPARTMENT		1/8"	3"X1"
2A	1					
2B	1	FEEDER	800AF/600AT	P301	1/8"	3"X1"
	1	FEEDER	800AF/600AT	P302	1/8"	3"X1"
2D	1	SPACE			1/8"	3"X1"
3A	1					
3B	1	FEEDER	800AF/600AT	P303	1/8"	3"X1"
3C	1	FEEDER	800AF/600AT	P304	1/8"	3"X1"
3D	1	SPACE			1/8"	3"X1"

REVISION		BY	DATE
B			
A			

TITLE: LOAD CENTER A
ADDRESS: 10 M We SOLAR PILOT PLANT
DAGGETT, CA.

DR. BY: AC/MA
DATE 11/6/80
CHK. BY:
DATE
APP'D. BY:
PROJ. NO.: 5049
CUST. NO.: 4004C21700
DWG. NO.: PAGE 1 OF 1
NAMEPLATE SCHEDULE
5049-NP

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INSTALLATION & MAINTENANCE INSTRUCTIONS
FOR
NONSEGREGATED PHASE BUS SYSTEM

INSTALLATION & MAINTENANCE INSTRUCTIONS
FOR
NONSEGREGATED PHASE BUS SYSTEM

The following instructions apply to handling, installation and maintenance of the equipment supplied to you under contract # 40046217cc

Please refer to the drawings located in this manual for further reference.

I. Receiving, Inspection & Handling

The following steps should be taken when handling and storing the equipment.

1. Configuration and size of bus duct will determine height to be stacked not to exceed 8 ft. in height. All standard size straight duct will be stacked 4 high.
   All other irregular shaped ducts, I.E. bends, elbows, etc will be shipped singly or stacked depending on shape and size.
   All duct support beams and hardware will be shipped and stacked for convenience of handling.

2. All bus duct should be wrapped with special seal corrugated cardboard and sealed with polyethylene sheeting. Bus duct when stacked will be separated by 2 X 4 wood dividers wrapped in cardboard to protect painted surfaces.
   One half inch steel banding will be utilized to strap duct together. Packaging will last indefinitely if items are not stored in direct sunlight or at temperatures below 32°F.
   Bus duct may be stored outside only in dry environment with 15% humidty or less. Otherwise all duct should be stored indoors along with all assembly hardware, bus bar, insulating boots, etc.

3. All other bus system components such as bus duct supports may be stored outdoors as long as protection against moisture is provided.

4. Equipment should be stored so that all like items for one particular station are stored together bearing in mind that items to be installed first should be stored last thus allowing easy access to material. If prolonged storage is necessary, periodic inspection should be performed to assure packaging remains intact, taking special precautions against entrance of water which may cause future failure of equipment. Check stability of stacked items to prevent crushing or marring of the equipment.

II. INSTALLATION

A. Weathertight Splice Boots

The following steps should be used when installing the weathertight splice boots.

1. Open the boot, and apply to the raised flat surfaces that will contact the bus bar sleeving and the raised flat area provided for the clamping screws, a 1/2" minimum wide 1/8 thick layer of Dow Corning Silicone Rubber Sealant Cat. No. 732-CL11

2. With the boot still open, gently center and lower it over the splice area.

3. Press the boot closed and install clamping screws.

4. It will not be necessary to wipe off excess sealant that may push out. Be certain no holes, or unsealed areas remain.

5. The sealant will set dry to the touch in 30 minutes and completely cure in 24 hours. It will not become brittle.

6. Note: Install boot wherever possible with the nylon clamping screw holes down

II. MAINTENANCE

A. Cleaning

In cleaning the housing we suggest you use plain detergent and water, however when cleaning the bus, use only mineral spirts, Do not use petroleum base products on the bus sleeving. It may cause a drying effect and cause the sleeving to crack and become brittle.

B. Maintenance Schedule

We recommend that the bus systems be spot checked every two years for excessive dirt, moisture and proper torque on splices.

We also recommend a complete cleaning of bus with mineral spirits and bus duct with detergent and water every six years.

RECEIVING, INSPECTION AND HANDLING

I. Receiving

All packages, cases or crates leaving the factory are clearly marked at convenient places with case number, Abbott job number, customer order number and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping section.

The contents of each package of the shipment are listed on the packing slip. This slip is forwarded with the shipment and put on the outside of the cases. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the packing slip before discarding the packing material. Notify the Abbott Power Corporation immediately if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packaging of electrical equipment. Upon receipt of any apparatus an immediate inspection snould be made for any damage sustained while en route. If damage is evident or an indication of rough handling is visible, a claim for damage should be filed immediately with the transportation company and Abbott Power Corporation should be notified promptly. Information as to damaged parts, case number, and Abbott job number should accompany the claim. In cases where there is no external damage to the crate, and the damage is not discovered until after crating is removed, the claim should be made on the basis of concealed damage. Concealed damage must be reported within 15 days. In all cases where claims for damages must be made, action should be taken quickly, as lapse of time may void the claim.

II. Handling

Before unpacking, indoor equipment may be moved by a forklift or a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Methods of handling outdoor equipment is the same as indoor, except the skid (the six inch channel base on the bottom of the assembly) will allow some sliding or skidding of the switchgear on the foundation surface.

III. Storage

If it is necessary to store equipment for any length of time, the following precautions should be taken:

1) Uncrate the equipment.

2) Store in a clean dry place and cover with canvas or plastic to prevent deposit of dirt or other foreign substances on movable parts and electrical contact surfaces.

3) Batteries should be uncrated and put on trickle charge immediately on receipt.

4) If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent condensation.

Approximately 250 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters. If the equipment has been subject to moisture it should be tested with a 1000V or 2500V megger. A reading of at least 200 megohms should be obtained.

5) Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

IV. Description

Each switchgear unit is made up of a secondary and a primary enclosure.

1. Secondary Enclosure

The secondary enclosure is normally located on the front of the switchgear or breaker withdrawal side, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the required instruments, control and protective devices. The terminal blocks, fuse blocks and some control devices are mounted inside the enclosure, normally above the breaker and a wireway is provided to allow the passage of control wires between units.

2. Primary Enclosure

The primary enclosure contains the high voltage equipment and connections arranged in compartments to confine the effects of faults and to minimize the damage.

3. Circuit Breaker Removable Element

The removable element consists of a circuit breaker with a trip-free operating mechanism mounted directly on the circuit breaker frame, interlock mechanism, the removable portion of the primary and secondary disconnecting devices, the operating mechanism control devices and necessary control wiring. Circuit breakers may be equipped with wheels or slides for easy removal and insertion.

The circuit breaker interlock mechanism is designed to obstruct the operator from removing the breaker from the connected position unless the circuit breaker is in the open position. This interlock is also designed to prevent the circuit breaker from being closed in an intermediate position when being removed or inserted into the cubicle. The secondary disconnecting device is used for connecting outside control circuits to the circuit breaker, operating mechanism trip and closing coils - this device makes contact automatically when the removable element is properly positioned in its enclosure. All removable elements furnished on a particular requisition and of like design and ratings are completely interchangeable with each other. The removable elements as well as the stationary elements (cells) are built by the particular circuit breaker manufacturer with factory jigs and fixtures thus insuring interchangeability.

4. Primary Disconnecting Device

The primary disconnecting devices utilize materials of various alloys to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design being backed up by heavy duty springs to insure contact pressure.

5. Bus Compartment

The main buses are enclosed in a metal compartment with removable covers to provide accessibility.

The bus is supported by an insulating material which is practically impervious to moisture and an excellent dielectric. The bus insulation can be either molded on the bars or sleeving which slides over the bar except at joints where the insulation is completed by either compound filled boxes, molded boots or tape.

6. Current Transformers and Cable Compartment

Current transformers, where possible are mounted in the breaker compartment over the porcelain insulators behind a barrier or in the cable compartment where provision is made for connecting the purchaser's primary cable by means of potheads or cable clamps.

7. Potential Transformer Compartment

Potential transformers are in a separate compartment and their location is dictated by the particular switchgear layout. In walk-in weatherproof design, the transformers will be accessible from the walk-in aisle where possible.

The transformers are mounted on a movable support equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected. In this position the transformer fuses may be safely removed and replaced. A barrier mounted at the rear of the carriage prevents access to all live parts.

8. Dummy Removable Element

If required, a dummy removable element can be provided and is used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the breaker and may be connected to provide a continous current path through the bus.

Under no circumstances should the dummy element be connected or disconnected when the bus is energized. Key interlocks are applied to insure that all sources of power are disconnected before the dummy element can be inserted or removed.

9. Fuse Disconnecting Device

Current limiting fuses with high interrupting rating are frequently used in metal-clad switchgear to protect transformers or circuits where circuit breakers cannot be economically or functionally justified.

The fuses are mounted on a movable support equipped with disconnecting devices.

When fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which grounds the fuses after they are disconnected. In this position the fuses may safely be removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current but should not be used to interrupt load current. Mechanical or key interlocks are used to prevent operation while the load is connected. This is generally accomplished by interlocking, in which the circuit breakers must be locked open before the disconnecting device can be opened or closed.

10. Grounding and Test Device

The grounding and test device provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cable or equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance and by using potential transformers, it can be used for phasing out cables. The three studs of the device are similar to those of the circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions, the bus or line side. To indicate the proper placement of the studs on the device, each position is marked "Line" or Bus".

To use, the device is rolled or slid into the metal-clad housing in place of the circuit breaker and racked into position the same as the circuit breaker.

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the Abbott Power Corporation for the particular requisition.

These drawings include arrangement drawings, wiring and schematic diagrams and a bill of material. Mats, screens, railings, etc., which are external to the switchgear, but which may be required to meet any local codes, unless required by the requisition, must be furnished by the purchaser.

I. Location

The recommended aisle space required at the front and rear of the equipment is shown on the arrangement drawing. The space in front must be sufficient to allow the insertion and removal of the ciruit breaker, and their transfer to other units.

The space at the rear must be sufficient for cable installation, for inspection and maintenance, and on some equipment to draw out potential transformers.

Preparation of Floor-Anchoring

II. Indoor Equipment

The station floor must be strong enough to prevent sagging due to the weight of the equipment and to withstand the impact stress caused by opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1½ times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the structure, and the equipment be completely aligned prior to final anchoring.

It is recommended that floor channel sills be embedded in the concrete. These sills must be level and straight with respect to each other and flush with the finished floor. Care should be taken to provide a smooth, hard and level floor under and in front of the equipment to facilitate installation and removal of the circuit breaker. If the floor is not level and flush with the floor channels it will be difficult to handle the breaker because it will not be level with respect to the stationary element and may not allow for the opening of hinged panels. Recommended practice is to weld the switchgear structure to the floor channels using a tack weld at the center of each unit, front and rear as well as the ends. See figures 1 and 2.

Provision should be in the floor for conduits for primary and secondary cables, located in the area shown on the base plan. In the event primary and secondary cables are top entry, provision must be made to seal the area of entry to prevent foreign objects and dirt from entering the compartment.

III. Outdoor Equipment

Outdoor equipment can be furnished with or without a walk-in aisle. Primary and secondary conduits should be installed in the area shown on the base plan prior to putting the equipment into place.

1. Outdoor Equipment Assembly (Non-Walk-In)

Mounting sills should be embedded in concrete and level. If the equipment is shipped in more than one section, all sections should be placed on the mounting sills and the sections bolted together with hardware supplied. Refer to the "Assembly Hardware" list of material shipped, for the proper size bolt to be used on the indicated assembly.

Prior to placing the shipping splits together, cover all outside edges on the top and sides of the assembly that bolt together with the caulking compound supplied with the hardware.

Level and plumb the entire assembly. This may necessitate placing shims at intervals between each compartment of the assembly if the mounting sills are not level. Weld the assembly to the mounting sills. If shims are used for leveling and the 6" channel base does not sit flush on the leveling sills, grout around the outside of the base to prevent the entry of dirt, snow, rodents, etc..

Bolt on the roof caps over the shipping splits. See figure 4.

Prior to completing the assembly and preserving the integrity of the weatherproofing care should be taken to protect the instruments and insulation system from the elements.

After completing the assembly of the equipment in position, the space heaters should be energized, from a temporary source if necessary.

2. Outdoor Equipment (Walk-In Aisle)

When specified, outdoor equipment can be furnished with a weatherproof operating aisle. This equipment can be furnished in one of two ways. The equipment compartments, complete with walk-in aisle can be shipped complete in multiples of 2-3 compartments. These shipping sections are then assembled as described in "Outdoor Equipment Assembly (Non Walk-In) and the assembly when complete will include the walk-in section of the equipment.

When otherwise specified this type of equipment will be shipped in multiple sections of 5-6 compartments of switchgear sections and multiples of walk-in aisle sections separate. The switchgear sections should be installed and mounted as described in Outdoor Equipment Assembly (Non-Walk-In). After this has been completed the walk-in section should be installed and attached to the switchgear section. After all sections are installed and joined together the roof cap should be installed as described in Outdoor Equipment Assembly (Non-Walk-In) with the addition of the roof caps between the switchgear and aisle sections. See figure 5.

The above procedure describes installation of a protected aisle enclosure with switchgear on one side only. If the aisle is common to two lineups of switchgear, the procedure will require slight modification. Refer to furnished drawings and instructions for specific requirements.

3. Bus Ducts

Bus ducts connecting between groups of metal-clad switchgear, or between metal-clad switchgear and other apparatus, should be installed as shown on the furnished arrangement drawings. Supports should be provided as indicated on the assembly drawings. Refer also to figure 3.

All joints in the bus including adjustable joints, should be assembled and insulated with tape or boots. Adjustable joints are provided in long runs of bus duct 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.

For outdoor bus ducts all removable covers should have gasketing material installed at the factory. Joints at shipping splits should be gasketed, as per furnished drawings.

If outdoor bus ducts are equipped with strip heaters, connect these in accordance with furnished wiring diagrams, before energizing the bus.

4. Ground Bus

The ground bus is bolted to the switchgear frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. Where the equipment is shipped in more than one group, the sections of the ground bus must be connected by using the splice plates furnished with the equipment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place, and to insure that all parts of the equipment, other than live parts, are at ground potential.

5. Lightning Protection

If not already installed in switchgear, it will be the responsibility of the purchaser to provide adequate lightning protection to protect the equipment and personnel from damage due to lightning.

6. Ground Fault Current Transformers

Through-type current transformers are furnished, where specified, for sensitive protection against ground faults.

Where shielded cables are used, the grounded sheath or jacket should not pass through the ground fault transformer. Armored cable should be terminated and grounded prior to entering the transformer.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

7. Main Bus Assembly

The main bus bars and other connection bars may be either copper or aluminum. In either case the connection surfaces will be silver plated.

All field assembled joints in conductors, regardless of material or method of insulation, should be made as follows:

Wipe silver clean. Do not use abrasive on the silvered surface. A sufficient quantity of conductive grease should be applied to the joint at each contact area so that the complete contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened.

Bolt splice plates and bus bars together following enclosed installation instructions and the following torque value:

1/2-13	480 in.-lbs.	40 ft.-lbs.
3/8-16	219 in.-lbs.	18.25 ft.-lbs.

Install the proper insulating boot over the joint.

8. Primary Connections:

The primary cable connections in most cases are reached through the bolted or hinged panels at the rear. Refer to installation drawings for specific locations.

Before any cable connections are made, the cables should be identified to indicate the phase relationship with the switchgear connections. There are two common methods of making primary cable connections; clamp type and potheads.

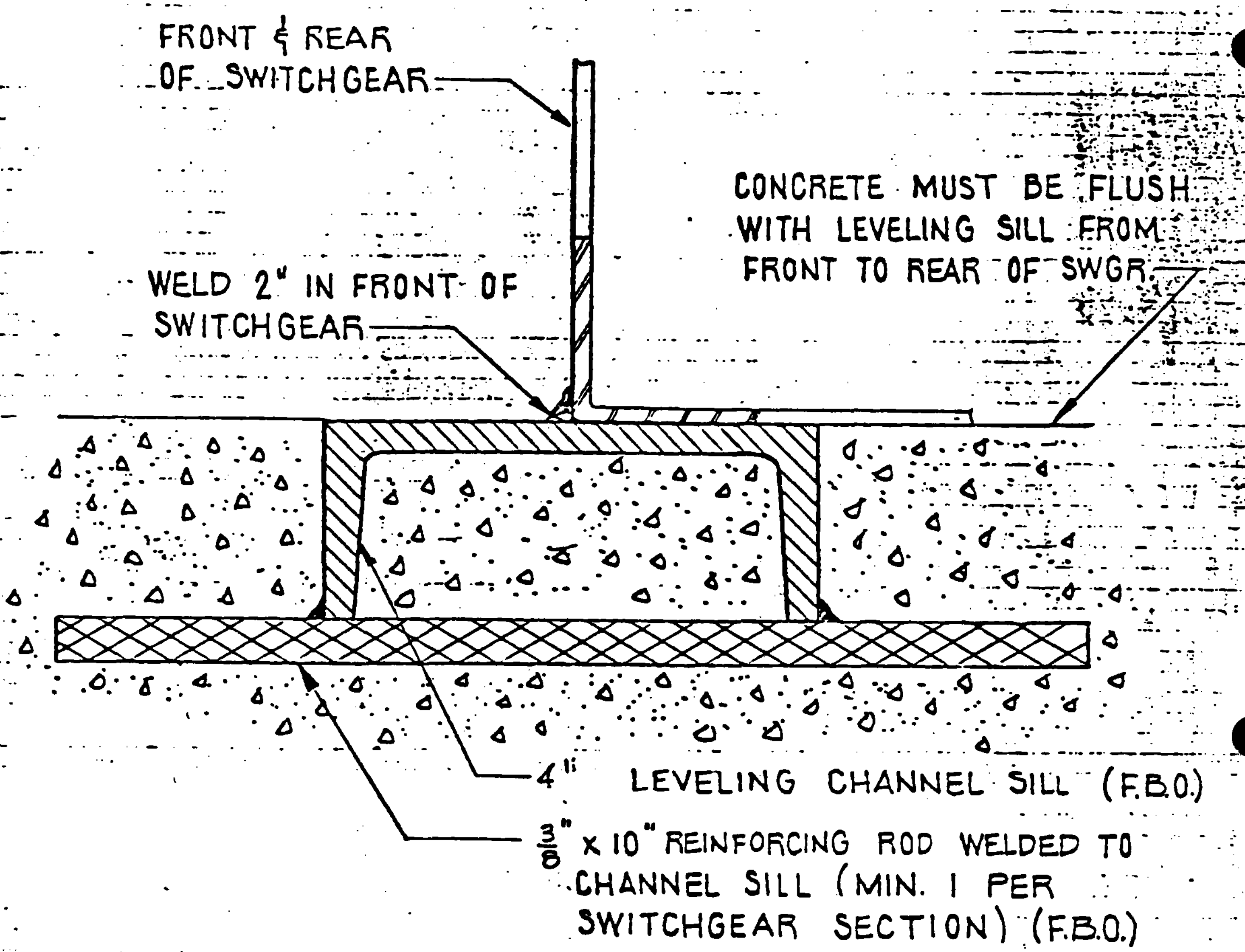
9. Control Cables:

When control conduits are used, entering from either, top, bottom or side, the conduit should be securely fastened by locknut and should not extend more than 4 inches when entering from the bottom.

Connect the cables to the termination blocks in accordance with the wiring diagrams furnished.

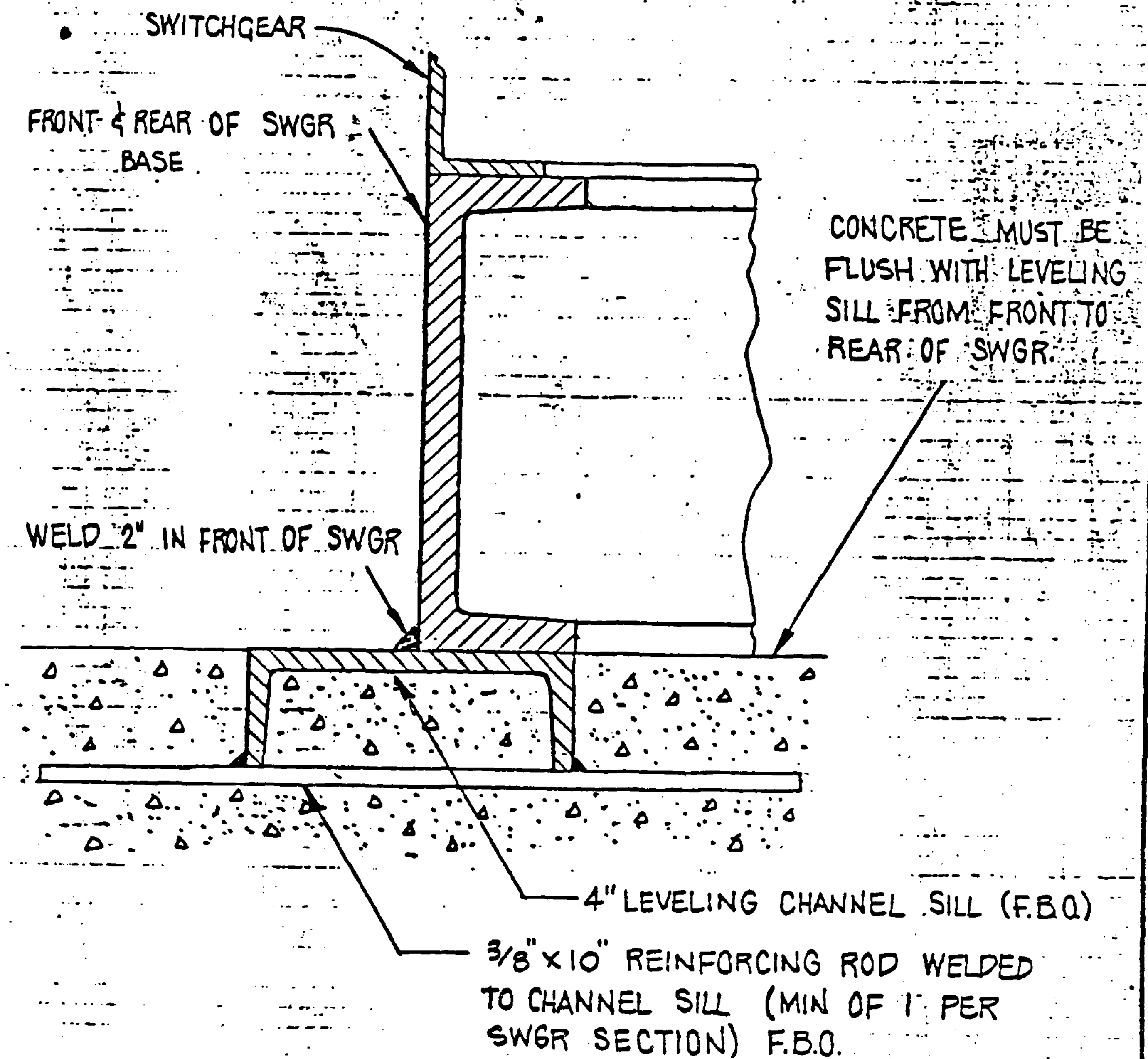
The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop during operations.

Where units have been split for shipment, any control or secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wire can be reconnected. The wires will be cut to length, terminated, and formed before being folded back so that a minimum of time will be required for reconnecting them.



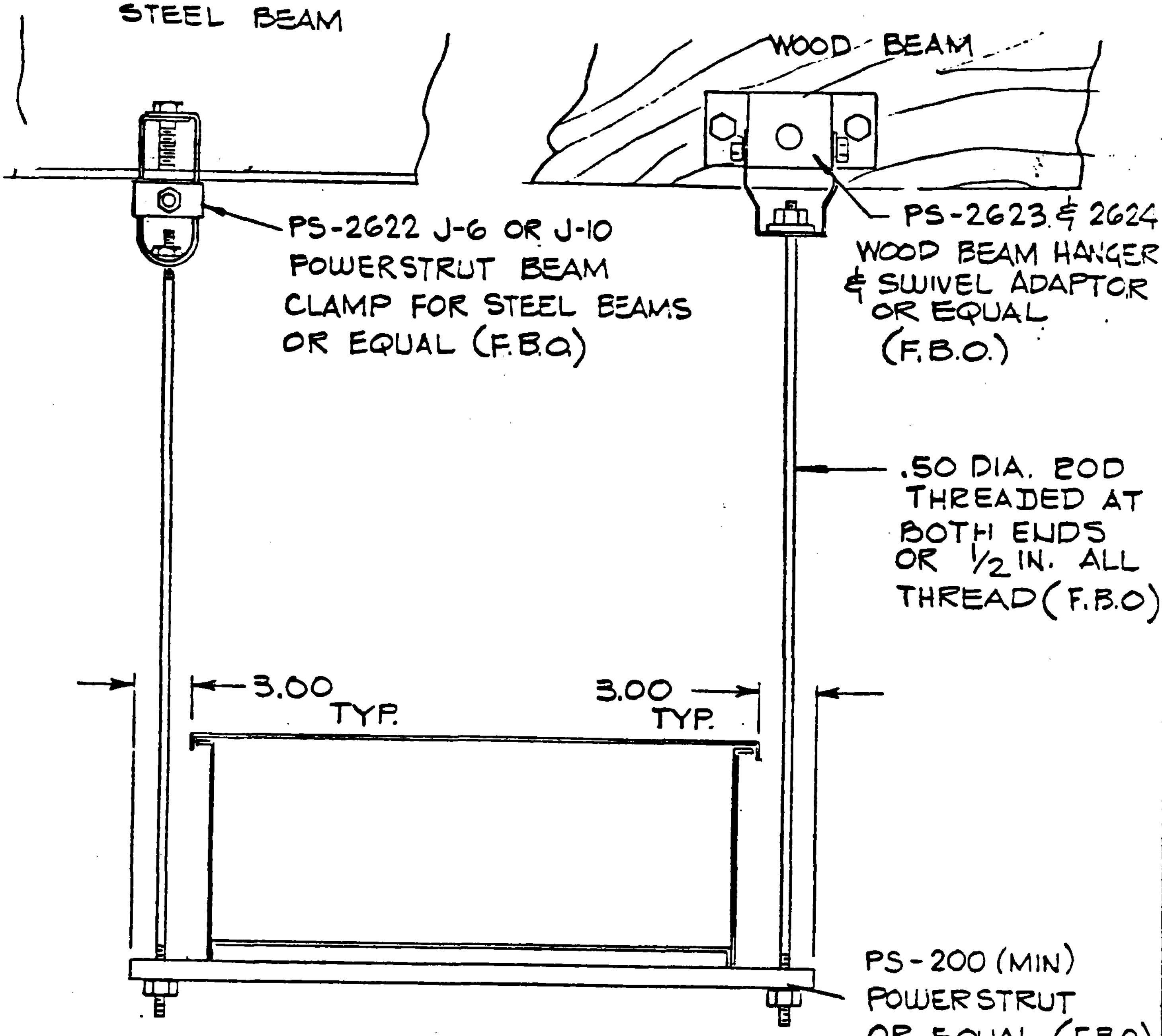
RECOMMENDED SWITCHGEAR
MOUNTING PROVISIONS

FIGURE #1



RECOMMENDED SWGR MTG.

FIGURE # 2



MAXIMUM 5 FT. CENTERS BETWEEN SUPPORTS.

RECOMMENDED INDOOR BUS DUCT SUPPORTS

FIGURE #3

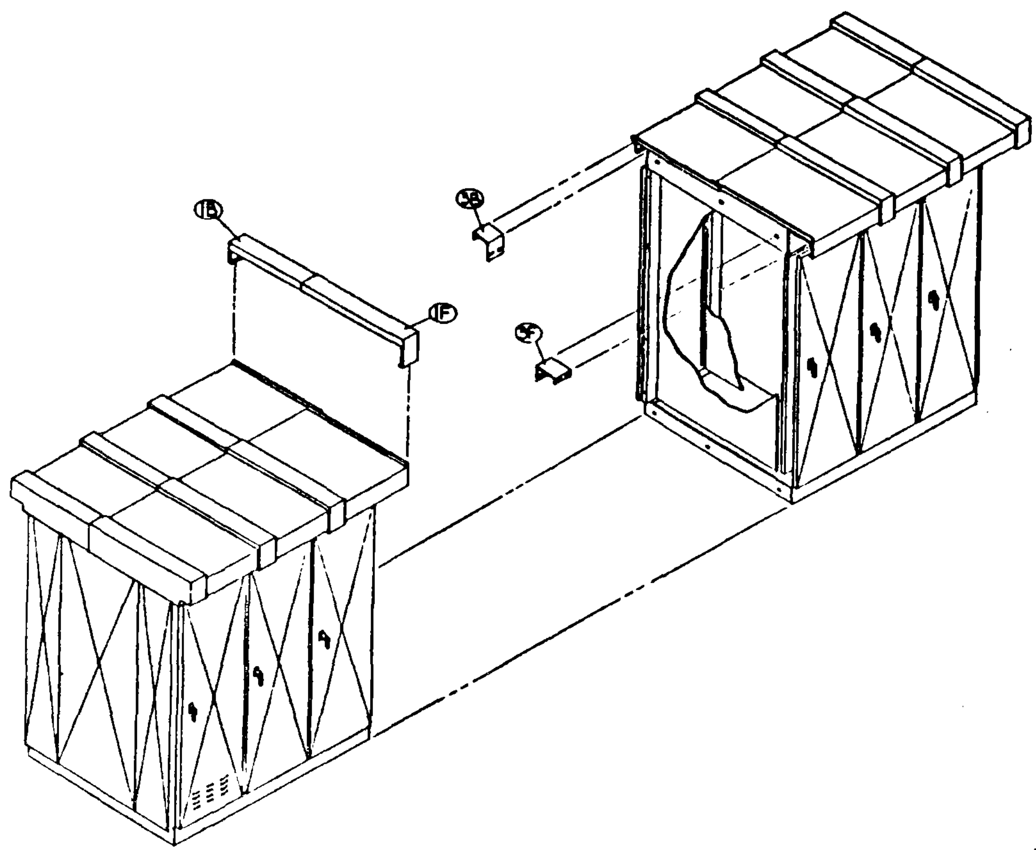


FIGURE #4
TYPICAL OUTDOOR
NON WALK-IN UNIT

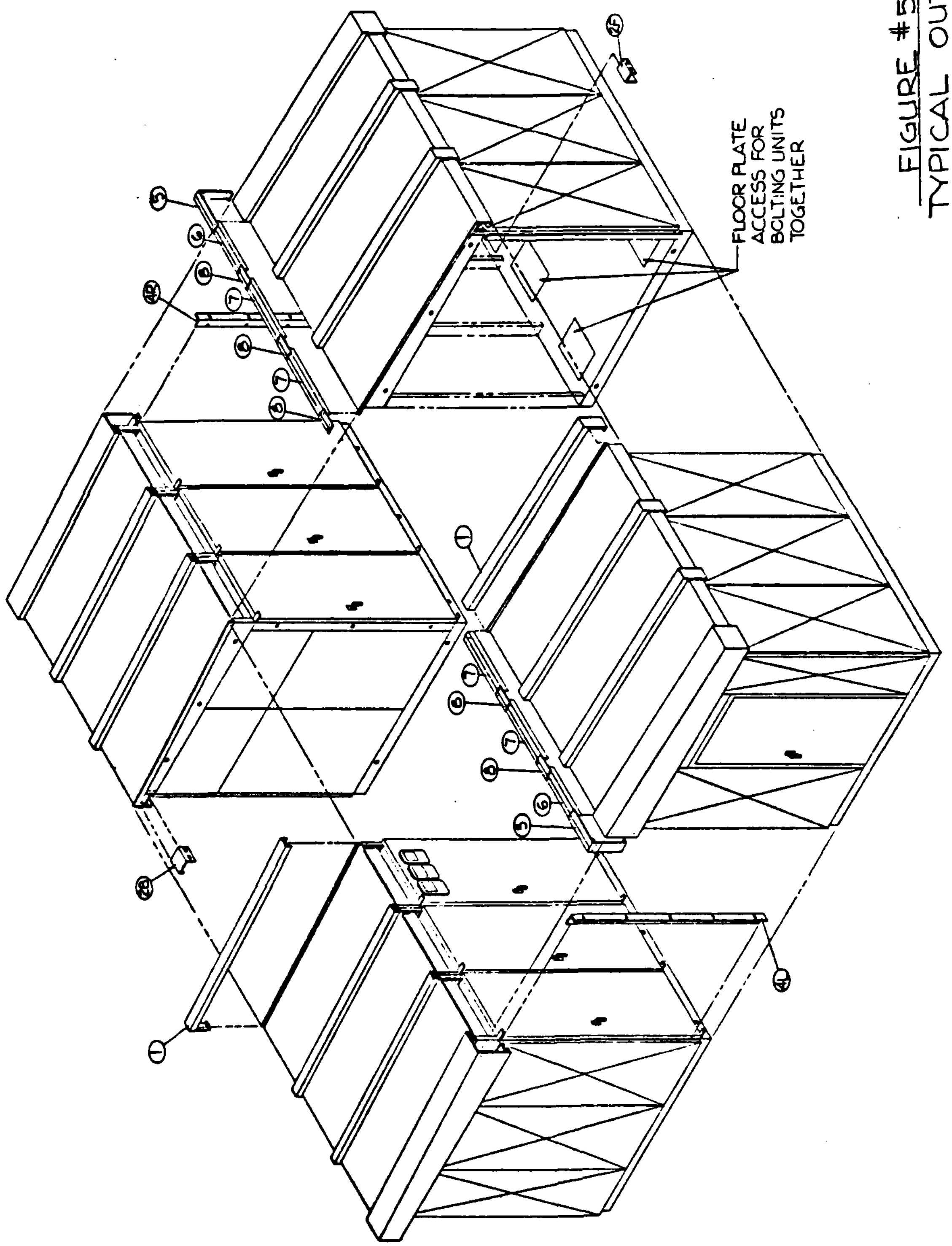


FIGURE #5
TYPICAL OUTDOOR WALK-IN UNIT

GENERAL GUIDELINES
FOR
SWITCHGEAR
MAINTENANCE AND TESTING

This publication is only a general guideline for Installation/Maintenance and does not intend to cover all aspects of work or specifications. Not all items in this publication are intended to describe your equipment and only applicable sections should be adhered to. For desired specifications of assembly components, please consult applicable manufacture's literature and publications.

GENERAL GUIDELINES FOR SWITCHGEAR MAINTENANCE AND TESTING

GENERAL GUIDELINES
FOR
SWITCHGEAR
MAINTENANCE AND TESTING

The following is a general guide for safe and economical testing and maintenance of switchgear and associated equipment. It is not intended to cover equipment of any particular manufacturer or problems unique to specified conditions. Instead, it is a basic outline applicable to most switchgear and substation maintenance programs.

For specific maintenance problems or recommendations refer to the required manufacturer's literature found elsewhere in this manual.

I. Safety

All maintenance and testing must be done on apparatus de-energized from the commercial a-c service. Where temporary feed for power is required to keep vital circuits in continuous operation, care should be taken to isolate these circuits from the equipment being serviced, with prior approval of a customer representative who is familiar with the system. Prior to any testing, all incoming power cables must be checked to determine that all electrical power has been removed and that temporary leads are not backfeeding into the equipment being serviced.

II. Schedules

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant operating and local conditions will dictate the frequency of inspection and maintenance requirements.

For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction books furnished for each device.

Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

III. Records

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of test made, the condition of equipment and repairs and adjustments that were made.

Caution

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

The primary circuits of metalclad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

IV. Switchgear

1. Enclosures

Switchgear enclosures should be inspected for evidence of leakage of water, dust, etc., and should be appropriately repaired, by caulking or other suitable means. Any portions of the switchgear that show signs of rust or oxidation should be resurfaced and painted to assure metal enclosure integrity.

2. Auxiliary Equipment

Assure that all auxiliary equipment such as interior lighting, exterior lighting, heaters, battery chargers, batteries, fans, etc., are fully operational within manufacturer's specifications. Repair or replace appropriate parts as needed.

3. Electrical Connections

Whether it be bus bar or cable connections within the switchgear enclosure assure that all connections are tight, and corrosion free. All conductors and connections should be insulated and protected against corona, tracking, and insulation breakdown.

All main conductors should be tested for insulation breakdown between the conductor and ground, and between other conductors.

4. Air Circuit Breakers

4A) Disconnects

Check disconnects for freedom of movement, galling or friction in moving parts. Check for signs of heating on current carrying parts, loose or missing hardware and broken or missing cotter keys or retainer rings. Replace missing or broken parts and lubricate as per manufacturer's specifications.

4B) Main Contacts

Clean contacts and free from oxide or corrosion. Maintain 80% or better contact mating on knife or butt type contact surface.

Check contact overtravel and positive stops. 1/16 to 1/32 inch overtravel is recommended to permit wiping action when contacts close. Set stops so as to limit overtravel to a safe amount, usually 1/16 to 1/8 inch. Check for proper operation high current disconnects and gangtype disconnects having main arcing contacts.

4C) Operating Mechanisms

The operating mechanism should be inspected for loose or broken parts; missing cotter pins or retaining keepers; missing nuts and bolts and for binding or excessive wear. All moving parts are subject to wear. Long-wearing and corrosion resistant materials are used by manufacturers and some wear can be tolerated before improper operation occurs.

Excessive wear usually results in loss of travel of the breaker contacts. It can affect operation of latches; they may stick or slip off and prematurely trip the breaker. Adjustments for wear are provided in certain parts. In others replacement is required.

The closing and tripping action should be quick and positive. Any binding, slow action, delay in operation, or failure to trip or latch must be corrected prior to returning to service.

4D) <u>Circuit Breaker Auxiliaries</u>

Inspect the closing motor or solenoid, shunt trip, auxiliary switches and bell alarm switch for correct operation, insulation condition and tightness of connections.

Check on-off indicators, spring-charge indicators, mechanical and electrical interlocks, key interlocks and padlocking fixtures for proper operation and lubricate where required. In particular, test the positive interlock feature which prevents the insertion and withdrawal of the circuit breaker while it is in the closed position.

The protective relay circuits should be checked by closing the breaker in the test position and manually closing the contacts of each protective relay to trip the circuit breaker.

Trip devices on low voltage breakers may be the electro-mechanical series overcurrent type with an air or fluid dash pot for time delay. These devices should be periodically tested for proper calibration and operation with low voltage-high current test devices. Calibration tests should be made to verify that the performance of the breaker is within the manufacturer's published curves. It is very important that the manufacturer's calibration curves for each specific breaker rating be used and take into account that current-time curves are plotted as a band of values rather than a single line curve. It should be realized that short time calibration cannot be checked accurately because factory calibration equipment has synchronized timing devices to insure symmetrical currents whereas field test equipment features random closing and may product asymmetrical currents resulting in faulty readings. If the trip devices do not operate properly, the calibration and timing components should be repaired or replaced in line with the manufacturer's recommendations.

If the breakers are equipped with static tripping devices, they should be checked for proper operation and timing in line with the manufacturer's recommendations. Some manufacturer's recommend replacement of electro-magnetic devices with static devices in the interest of realizing more precision and a higher degree of reliability with the latter devices.

5. Molded Case Circuit Breakers

Molded case circuit breakers should be kept clean of external contamination so that internal heat can be dissipated normally. Further, a clean case will reduce potential arcing conditions between live conductors and between live conductors and ground. The structural strength of the case is important in withstanding the stresses imposed during fault current interruptions. Therefore, an inspection should be made for cracks in the case and replacements made where required.

Excessive heat in a circuit breaker can cause a malfunction in the form of nuisance tripping and possibly an eventual failure. The most common cause of excessive heat is loose connections. Periodic maintenance checks should involve a routine tightening of the circuit breaker terminals and bus bar connections. Molded case circuit breakers having noninterchangeable trip units are properly adjusted, tightened and sealed at the factory. Those having interchangeable trip units installed away from the factory could overheat if not tightened properly during installation. All connections should be maintained in accordance with manufacturers' recommendations.

When testing circuit breaker tripping characteristics, it is recommended that the overcurrent tests be performed on individual poles at 300 percent of rated current. The reaction of the circuit breaker to this overload is indicative of its reaction throughout its entire overcurrent tripping range. This load is chosen as the test point because it is relatively easy to generate the required current in the field and the wattage per pole from line to load is large enough, so the dissipation of heat in the nonactive pole spaces is minor and does not affect the test results appreciably.

6. Relays

6A) Protective Relays

Inspect relay for loose terminals, lock screws and other parts; for filings or other foreign material in magnet gaps; for burned or dirty contacts; for sticky contact back-stops; for dirty, worn or broken bearings or other cause for sluggish operation; for damaged or maladjusted indicator targets or holding devices. Performance tests of the relays will vary somewhat with the type of relay.

For a visual inspection, remove cover. Inspect the cover gasket, check glass for tightness in the frames, cracks, etc.. Clean glass inside and out.

First open trip circuit. Follow manufacturer's directions carefully since they will differ. Open the latches that hold the relay in the case and carefully remove relay from case. Remember electrical connections to the cases are still "hot".

Remove foreign material in the relay, such as dust, filings, etc.. Use dry compressed air 25 psi or lower.

Remove any rust or filings from disc or magnet poles with a magnet cleaner or brush.

Check clearance between magnet poles to assure that they do not rub.

Inspect relays for presence of moisture.

Clean or replace pitted or burned contacts if necessary.

Perform four types of tests for overcurrent relay testing; zero set, pick-up, time-current characteristics, and target and seal-in operation.

For overcurrent instantaneous relays, consult manufacturer's instruction leaflet to identify current terminals and contact terminals.

For over/under voltage relays, consult manufacturer's instruction leaflet to identify potential terminals and contact terminals. Then perform the zero set, pick-up, and timing tests.

For directional overcurrent relays, test the unit for pick-up and timing as for an overcurrent relay except the directional unit contacts must be blocked closed for this test or the overcurrent unit will not operate.

For percentage differential relays, again consult manufacturer's instruction book for proper connections and information on characteristics.

After completion of the electrical test, replace relays in their drawout compartments and mechanically operate the relay to check the wiring continuity to assure it will trip the proper equipment.

6B. Auxiliary Relays

Inspect auxiliary relays for dirt, dust, burned contacts, and proper operation. If applicable clean relay of dirt and dust. Burnish contacts for proper contact surface connection. Test relay for proper operation. Repair or replace as needed.

7. Transformers

Visually inspect for chipped petticoats, fractured porcelain, etc., and replace any damaged parts. Clean all bushings as well as check gaskets for positioning, resilience and leaks. In general, clean insulators by polishing with a soft cloth dipped in solvent or utilizing a bushing cleaner. Never use water or caustic solutions to remove oxide and dirt deposits on porcelain glaze or resort to abrasives, steel wool or wire brushing. When the surface is clean, polish with a soft, dry cloth.

Remove rust on bushing caps and flanges by sanding, then primer and paint for application to metal surfaces.

"Ratio" test the transformer using a turns ratio counter to assure proper output voltage. Remove and analyze samples of the insulating liquid to establish the dielectric strength, acidity content, color, and specific gravity.

Inspect pressure relief diaphragms to assure that they are properly seated and seal the unit.

Check tap changer mechanism for proper operation.

For dry type transformers, in addition to the above, inspect and clean bushings; check and tighten connections as required. Clean the windings by vacuum or compressed air.

These tests should be performed on a two to three year schedule.

8. Meters

All meters due to their construction are delicate and must be handled and operated in the appropriate manner. Inspect each meter for abuse that could cause internal damage. Inspect the meter glass, the meter face, case and connection. Check for free movement of the needle. Apply the appropriate electrical component (ie..AC/DC volts, or AC/DC current) to give half scale reading. Apply the component to obtain a full scale reading. Check meter reading for accuracy. Normal tolerance is 10%, unless specific meters require more stringent requirements.

9. Switches

Safety, disconnect, transfer and pressure contact switches have a tendency to build up high resistance across the contacts if not operated frequently. Several manufacturers have designed this apparatus in such a manner as to make it difficult to actually see the contacts and moving parts. Where possible, clean the main contact of the switch, adjust and place a thin film of lubricant on them. Check fuse clips, connections to the bus or cable, and switchboards mounting and handles for tightness and proper alignment. When applicable, check the tension on the contacts when signs of discoloration caused by heating are noticed.

Due to the design of switch equipment, it is not necessary to perform electrical tests as in the case of a circuit breaker. However, there is one test that will indicate if the operating mechanism of the switch has deteriorated to the extent that the probability of failure in the near future is great. This test is called the ductor test and measures in millivolts the contact resistance drop. After exercising the switch several times, cleaning and making any adjustments necessary, with a ductor test set the resistance drop across each phase to be measured. If the drop exceeds 50 millivolts or has greater than $\pm$ 20% variation between phases, part replacement is recommended.

10. Auxiliary Equipment

10A) Motors

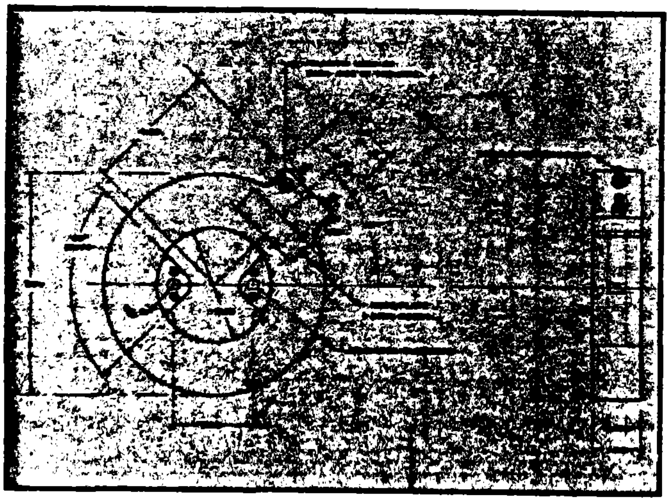
When applicable inspect motors for loose hardware, fittings, connections, and brushes. Inspect motor shaft for binding shaft rotation or excessive shaft end travel. Test motor windings with D.C. megohm meter for insulation breakdown.

10B) Lightning Arrestors

Lightning arrestors are generally sealed components, free of maintenance except for an occasional cleaning and mechanical inspection. Clean the arrestor thoroughly when inspecting the transformer. Check tightness of all bolted connections to ground and retighten as necessary. Megger (1000v.) test value should read infinity unless internal resistors are used in the manufacture of the lightning arrestor. Replace low reading or grounded arrestors.

Abbott

CURRENT TRANSFORMER
Model 350

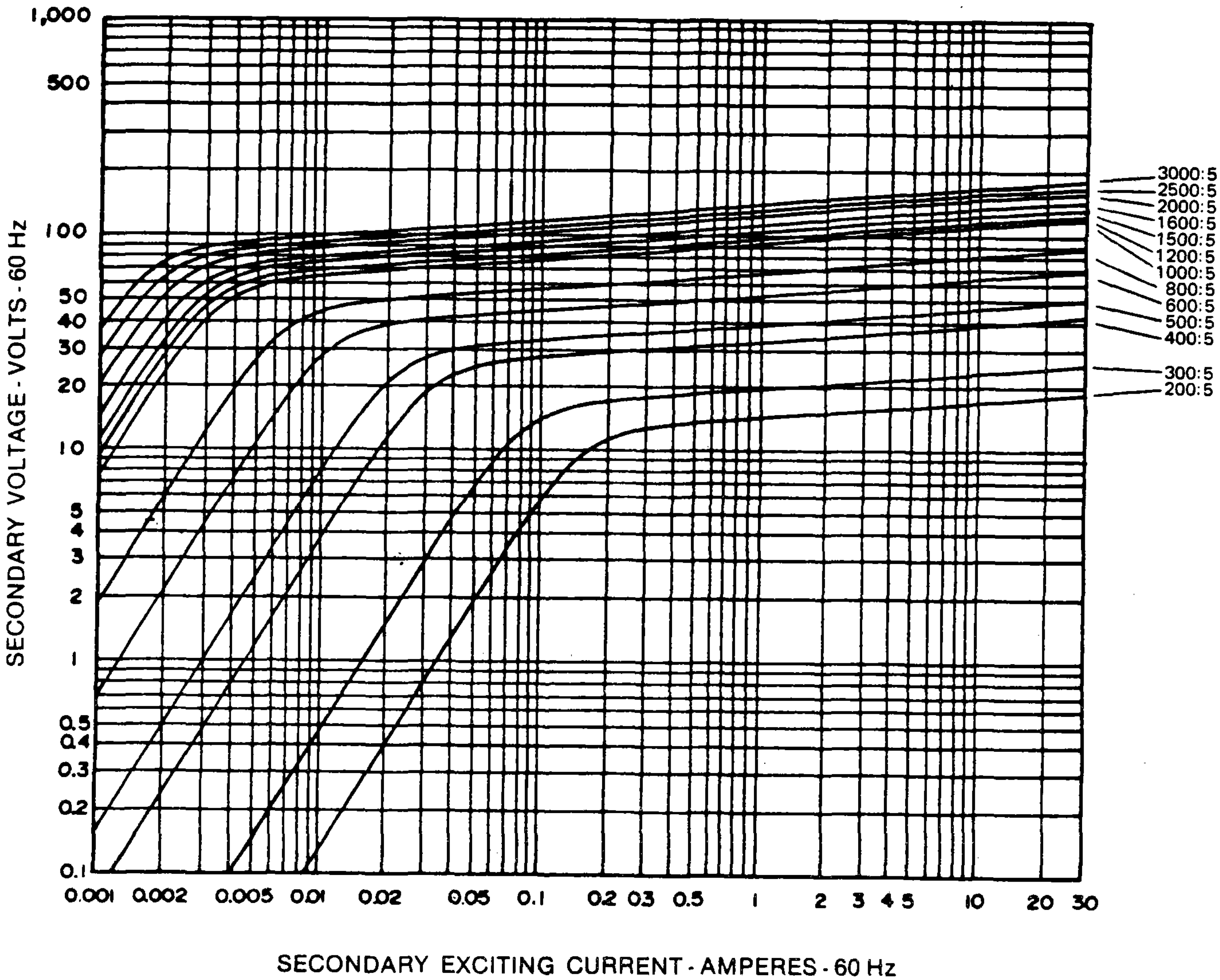


- **CASE:** Molded Reinforced Plastic.
- **APPLICATION:** Metering. Designed to fit over bus behind Westinghouse DS breaker.
- **INSULATION CLASS:** 600 Volts
- **FREQUENCY:** 25-60 Hz
- **IMPULSE LEVEL:** 10 KV
- **CONTINUOUS THERMAL CURRENT RATING FACTOR:** 1.33 @ 30°C Ambient;1.0 at 55°C Amb.

CAT. NO.	CURRENT RATING [illegible]	ANSI ACCURACY CLASSIFICATION — 60 Hz		CAT. NO.	CURRENT RATING [illegible]	ANSI ACCURACY CLASSIFICATION — 60 Hz	
		B-0.1	B-0.2			[illegible]	[illegible]
350-101	100:5	1.2	[illegible]				
350-151	150:5	1.2	[illegible]	[illegible]	800:5	[illegible]	[illegible]
350-201	200:5	1.2	[illegible]	[illegible]	1000:5	[illegible]	[illegible]
350-301	300:5	0.6	0.6	[illegible]	1200:5	[illegible]	[illegible]
350-401	400:5	0.6	0.6	[illegible]	1500:5	0.3	[illegible]
350-501	500:5	0.6	[illegible]	[illegible]	1600:5	0.3	[illegible]
350-601	600:5	0.6	0.6	[illegible]	2000:5	[illegible]	[illegible]

CURRENT TRANSFORMER MODEL 350

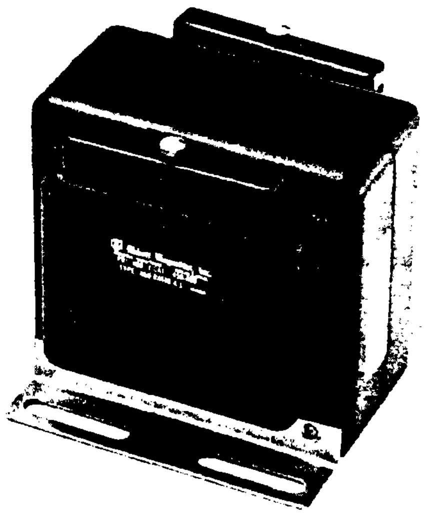
TYPICAL EXCITATION CURVE



CURRENT RATING (amperes)	SECONDARY RESISTANCE (Ohms) @ 25°C
100:5	.024
150:5	.030
200:5	.048
300:5	.068
400:5	.095
500:5	.120
600:5	.143
800:5	.190
1000:5	.192
1200:5	.230
1500:5	.213
1600:5	.230
2000:5	.280

Abbott

POTENTIAL TRANSFORMER
Model 450



The Abbott Magnetics Model 450 is designed for use with all types of electrical indicating, metering, recording instruments and protective relays in electrical power systems. The magnetic core and coils are mounted in a reinforced plastic case with a metal mounting base. The unit is epoxy filled to insure insulation qualities.

Secondary and primary windings are fully insulated and terminated at threaded studs. The units are supplied with terminal covers.

Winding ratios are indicated on the nameplate as well as on the side of each unit as shown in the outlined drawing above.

- FREQUENCY: 60 Hz
- STANDARD SECONDARY VOLTAGE: 120 V
- INSULATION CLASS: 600 V, 10 Kv, Full Wave BIL
- ACCURACY CLASS: 0.3 class at W, X, M, Y: 1.2 at Z
- CONTINUOUS THERMAL CURRENT RATING FACTOR: 750 VA at 30°C Amb., 500VA at 55°C Amb.
- WEIGHT: 22 lb.

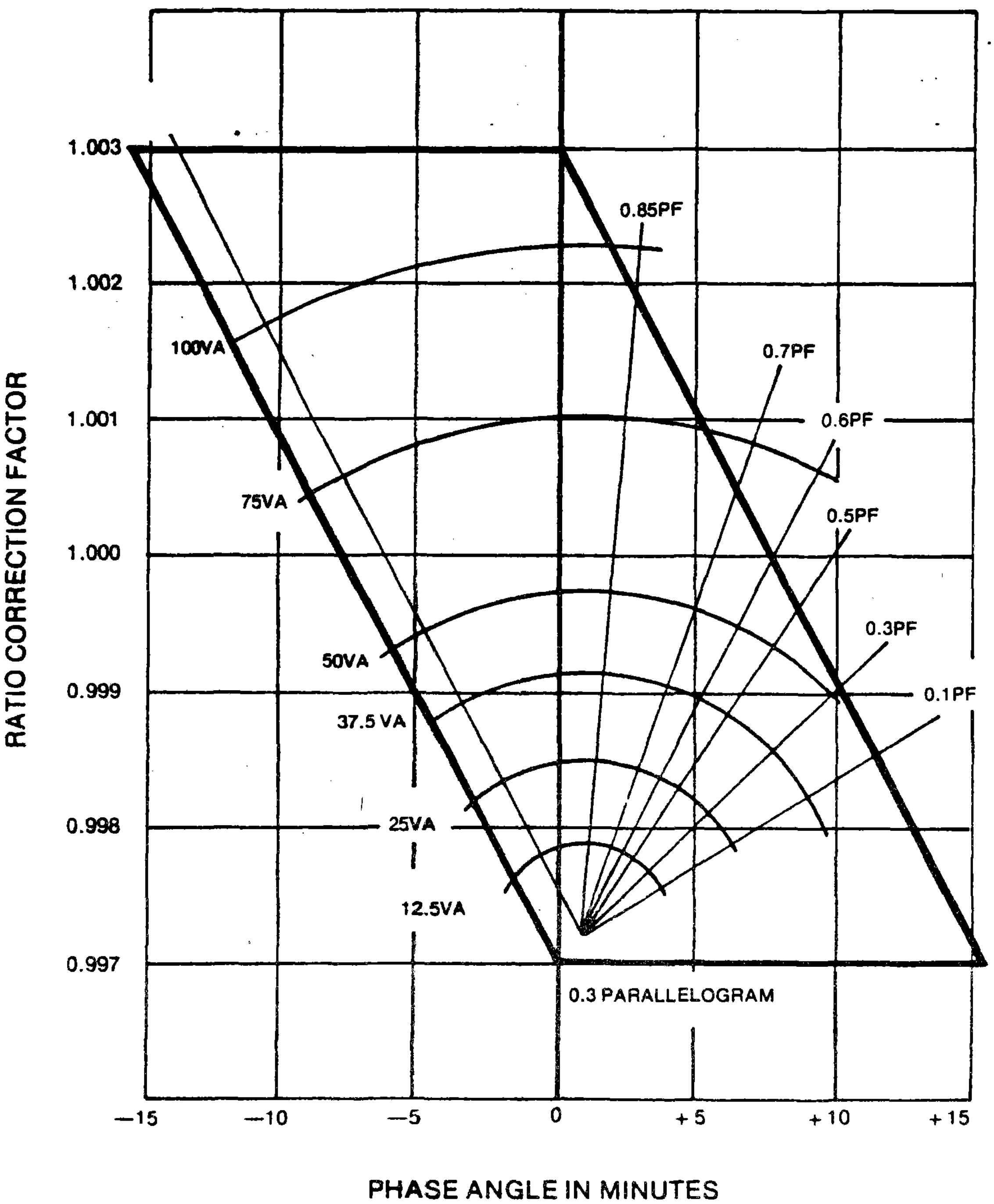
450-120	120/208Y	1:1
450-240	240/416Y	2:1
450-288	288/500Y	2.4:1
450-300	300/520Y	2.5:1
450-480	480/480Y	4:1
450-600	600/600Y	5:1

Other ratios and burden capacities available upon request.

Continued on reverse side.

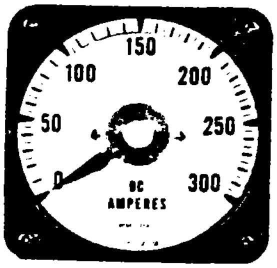
POTENTIAL TRANSFORMER MODEL 450

TYPICAL PERFORMANCE

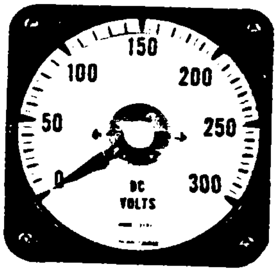


YEW

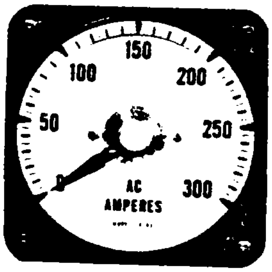
medallion series



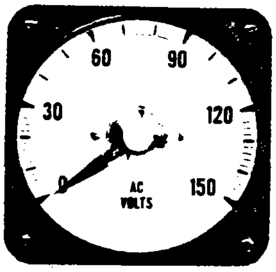
Model 2101
DC Amps



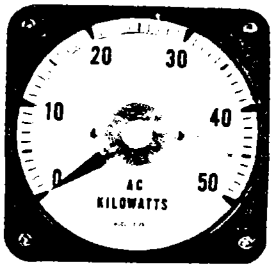
Model 2101
DC Volts



Model 2102
AC Amps



Model 2102
AC Volts



Model 2105
AC Power (single phase)

GENERAL SPECIFICATIONS

Principle of Operation: See descriptions below.
Accuracy: See accuracy specifications below.
Position of use: Vertical (Scale)
Full Scale Deflection Angle: 250° (except Synchroscopes: 360°)
Full Scale Length: Approx. 7¼″ (183 mm)
Pointer: Sword type, black
Scale Plate: Platform type, white

[illegible]: ABS, black. Meets UL94/ASTM 635-68
Cover: Methacrylic acid resin with anit-static processing on both sides
Standard Color: Black (Munsell N 1.5/0)

Terminal Plate: Phenol resin, black. Meets UL94/ASTM 635-68
Mounting Screw: 5 mm in diameter
Measuring Terminal: 5mm in diameter (nut type)
Dimensions: See page 12

Weight: Model 2101 ...... Approx. 0.91 lbs. (0.4 kg)
Model 2102 Ammeter .... Approx. 1.3 lbs. (0.6 kg)
Model 2102 Voltmeter ....Approx. 1.1 lbs. (0.5 kg)
Models 2105 & 2106 ....Approx. 2.2 lbs. (1 kg)
Models 2107 & 2108 ... Approx. 1.3 lbs. (0.6 kg)
Model 2109 .... Approx. 3.7 lbs. (1.7 kg)

Dielectric Test Voltage: 2,600V AC for one minute between the electrical circuit and the case.

MODELS AVAILABLE

MODEL			DESCRIPTION	ACCURACY
210			CIRCULAR SCALE SWITCHBOARD INSTRUMENTS	
	1	DC	AMMETERS & VOLTMETERS (Moving Coil Type)	±1.0% of full scale value
	2		AMMETERS & VOLTMETERS (RMS Sensing Transducer Type)	±1.0% of full scale value
	5		WATTMETERS (Pulse-width Modulation Type)	±1.0% of full scale value
	6		VARMETERS (Pulse-width Modulation Type)	±1.0% of full scale value
	7	AC	POWER FACTOR METERS (Phase Angle Sensing Transducer Type)	±4° in phase angle
	8		FREQUENCY METERS (Frequency Sensing Transducer Type)	±0.5% of full scale value
	9		SYNCHROSCOPES (Moving Iron Type)	

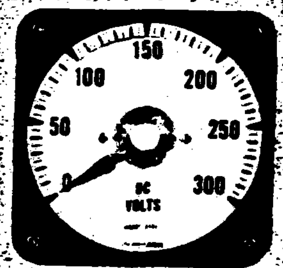
Example: Model 2105 ...... Circular Scale Switchboard AC Wattmeter

EXTERNAL SHUNTS & MULTIPLIERS .... Pages 13 & 14
EXTERNAL CURRENT & POTENTIAL TRANSFORMERS ... Pages 14 & 15

YEW

medallion series

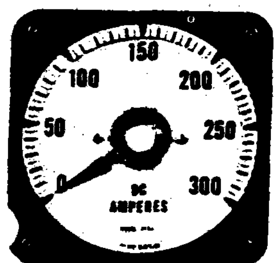
MODEL 2101 DC VOLTMETER (Moving Coil Type)



CATALOG NUMBER	FULL SCALE VALUE	APPROX. CURRENT LOSS	
2101-21	30V	1mA	
2101-22	50V		
2101-23	100V		
2101-24	150V		
2101-25	300V		
2101-26*	1mA		

Notes: *1. For higher ranges than 300V, use External Multiplier (see page 14) with a 1mA DC Voltmeter.

MODEL 2101 DC AMMETER (Moving Coil Type)



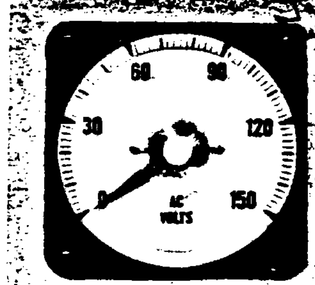
Catalog No.	Full Scale Value	Approx. Internal Resistance Or Voltage Drop	Price
2101-01	500 μA	670Ω	$88.00
2101-02	1mA	190Ω	88.00
2101-03	2mA	17Ω	88.00
2101-04	5mA	8.2Ω	88.00
2101-05	10mA	Voltage Drop 50mV	88.00
2101-06	20mA		88.00
2101-07	50mA		88.00
2101-08	100mA		88.00
2101-09	200mA		88.00
2101-10	500mA		88.00

Catalog No.	Full Scale Value	Approx. Internal Resistance Or Voltage Drop	
2101-11	1A	Voltage Drop 50mV	
2101-12	1.5A		
2101-13	2A		
2101-14	3A		
2101-15	5A		
2101-16	10A		
2101-17	15A		
2101-18	20A		
2101-19	30A		
2101-20	*50mV	2mA	

Notes: *1. For higher ranges than 30A, use External Shunt with a 50mV DC Ammeter. (See page 13)
2. A pair of special 59" (0.05Ωx2) leads are supplied with each 50mV DC Ammeter.

For industrial transmitters, 4-20 mA with a 0-100% scale is available for

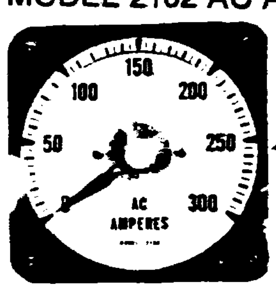
MODEL 2102 AC VOLTMETER (RMS Sensing Transducer Type)



CATALOG NUMBER	FULL SCALE VALUE	APPROX VOLT-AMPER LOSS	
2102-05	150V	0.8VA	
2102-06	300V	1.8VA	
2102-09	600V	1.2VA	
2102-07	Expanded scale 70 to 130V*	0.5VA	
2102-08	Expanded scale to 140 to 260V*	1.0VA	

Notes: 1. For higher ranges than 600V, use Potential Transformers (see page 14) with a 150V AC Voltmeter.
*2. Accuracy within expanded portion of the scale: 1.5%.

MODEL 2102 AC AMMETER (RMS Sensing Transducer Type)



CATALOG NUMBER	FULL SCALE VALUE	APPROX VOLT-AMPER LOSS	
2102-01	1A	0.4VA	
2102-02	5A		
2102-03	Two fold—extended (5 to 10A)		
2102-04	Three fold—extended (5 to 15A)		

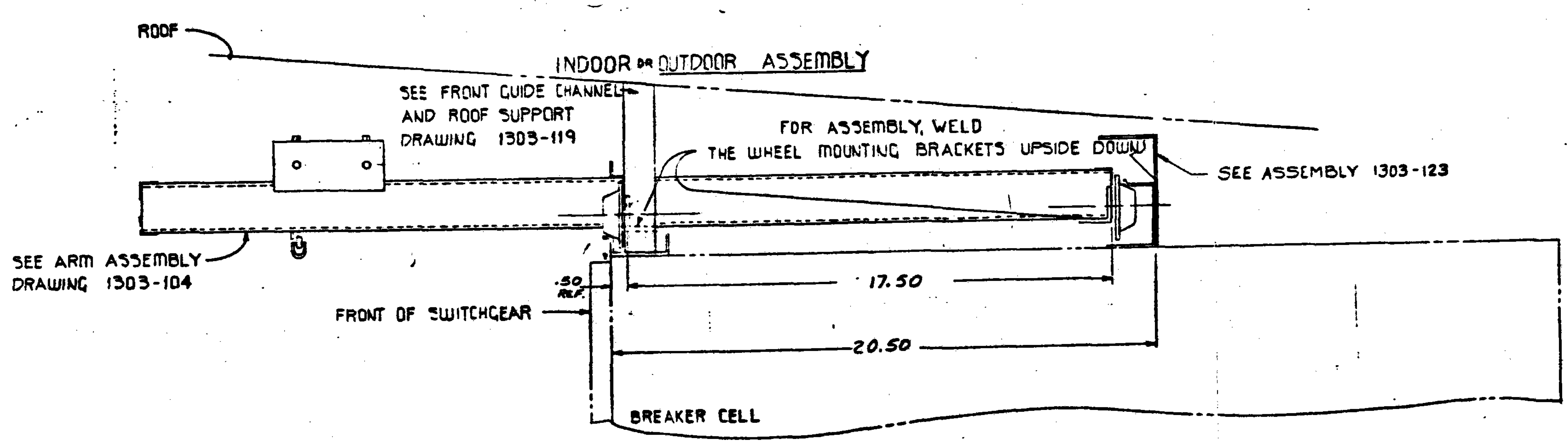
Note: 1. For higher ranges than 5A, use External Current Transformer (see page 15) with a 5A AC Ammeter.

3.1.1-53

REVISIONS

LTR	DESCRIPTION	DATE	BY	APPD
A	1750 DIM WAS ADJUSTABLE 2050 WAS 2100 MAX. DELETED INDOOR ASSY	12-1-76	E.W.S.	

NOTES:
1.



QTY	RQ'D	PART NO.	DESCRIPTION	ITEM

LIST OF MATERIAL

MATERIAL	TOLERANCES .XX ± .03 / .XXX ± / ANGLES ±	DRAFT. E.K.	DATE	Abbott Power Corporation, 3960 STAGE ROAD · BUENA PARK, CALIFORNIA 90620, A MEMBER OF	TITLE: INSTALLATION FOR LIFTING CRANE	NEXT ASSY
WEIGHT		CHK'R SHULTS	DATE			DWG NO 1303-100
		APP'D	DATE			

3.1.1-54

5

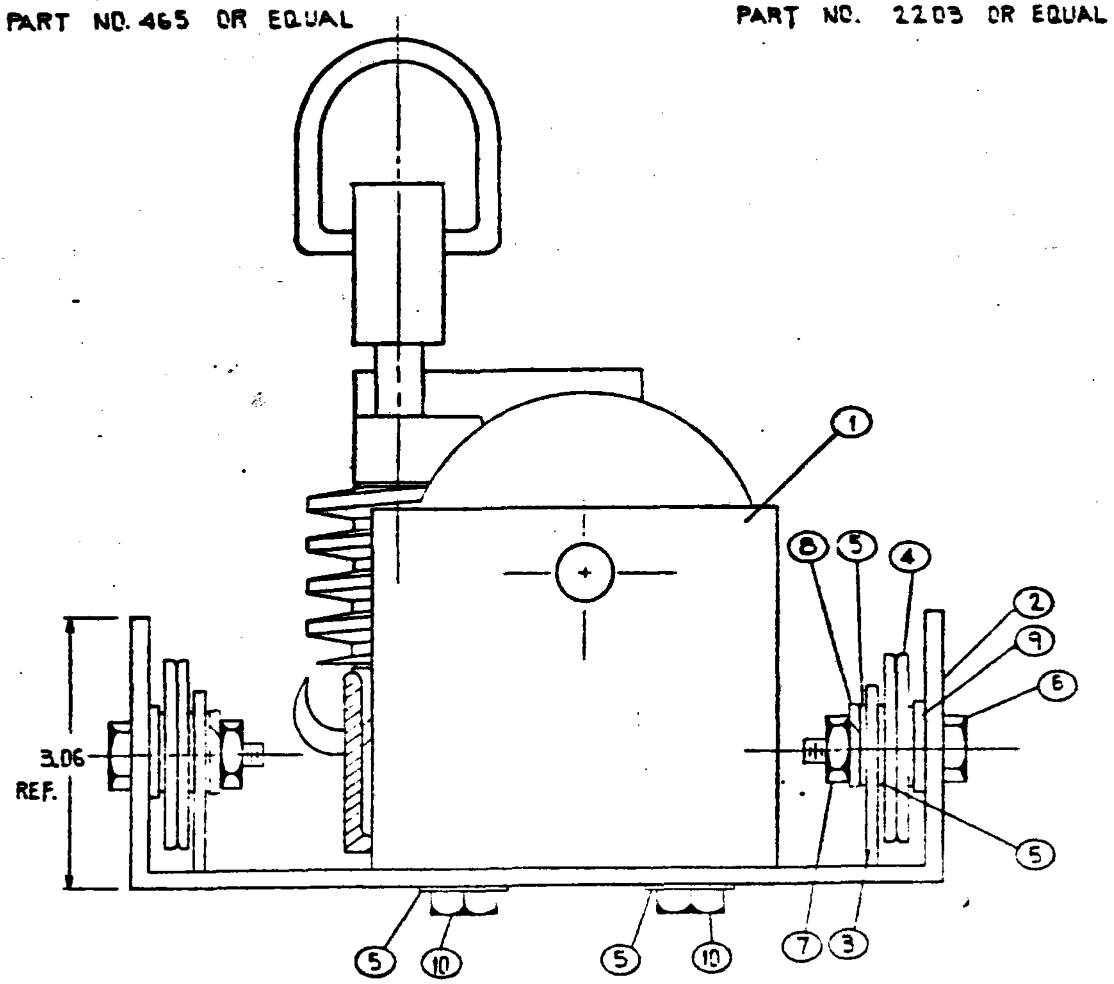
REVISIONS				
LTR	DESCRIPTION	DATE	BY	APPD
A	REVISED ROPE [illegible] WAS 1 REQD - DELETED ITEM 12 ADDED ITEM 13	[illegible] 78	[illegible]	

NOTES:

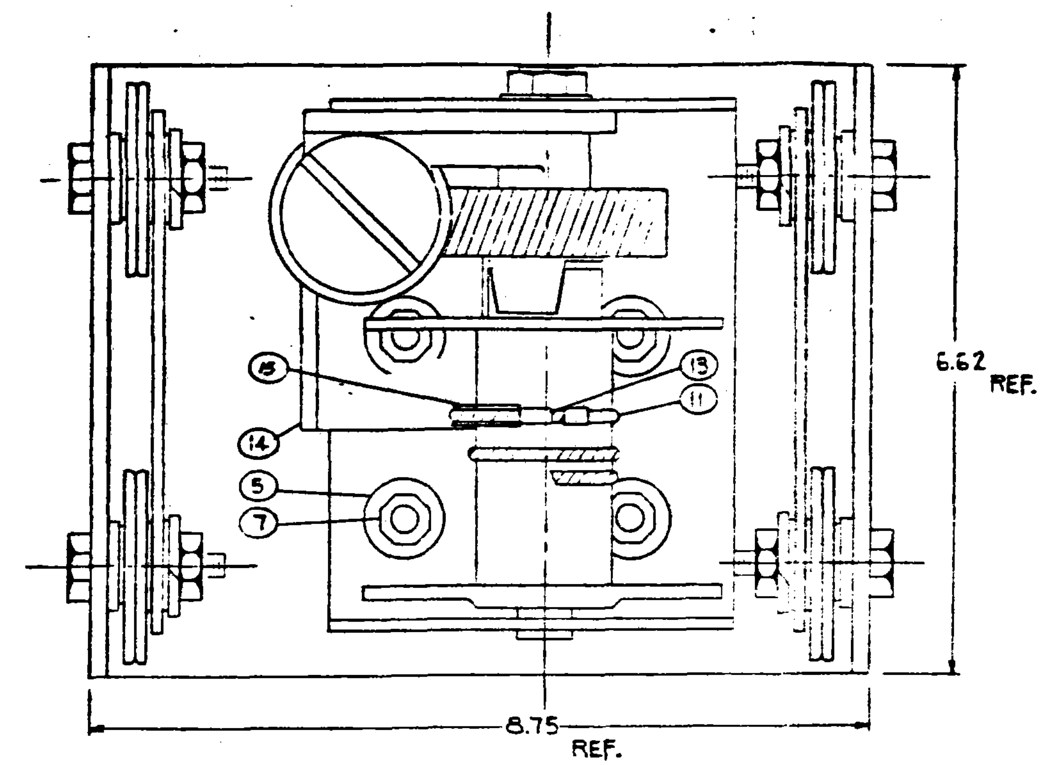
⚠1 WINCH MAY BE PURCHASED FROM:
THERN INC.
WINONA, MINN. 55987
PART NO. 465 OR EQUAL

⚠2 WHEEL MAY BE PURCHASED FROM:
NICE BALL BEARING CO.
PHILADELPHIA, PA. 19140
PART NO. 2203 OR EQUAL

⚠3 HOOK MAY BE PURCHASED FROM:
LAUGHLIN OR EQUAL
PART NO. A-325
CHAIN SIZE 3/8



FRONT VIEW



TOP VIEW

⚠4 FERRULE DUPLEX MAY BE PURCHASED FROM
NEWCO, KANSAS CITY, MO. OR EQUAL, SIZE
3/16 INCH WIRE ROPE BREAKING STRENGTH 4200# - 7×19

QTY REQD	PART NO	DESCRIPTION	ITEM
1		CABLE LOOP	15
1	1303-122	HOOK RETAINING BRACKET	14
2	⚠4	FERRULE DUPLEX	13
		CABLE, STL, FLEX, GALV. 7×19	11
4		BOLT ($5/16$-18 × 1.50)	10
4		FLAT WASHER ($5/16$ BOLT .125 THK)	9
8		LOCK WASHER ($5/16$ BOLT .125 THK)	8
8		NUT ($5/16$-18)	7
4		BOLT ($5/16$-18 × 1.75)	6
16		FLAT WASHER ($5/16$ BOLT .06 THK)	5
4	⚠2	WHEEL	4
2	1303-103	WHEEL SUPPORTS	3
1	1303-102	LIFTING CRANE FRAME	2
1	⚠1	WINCH	1

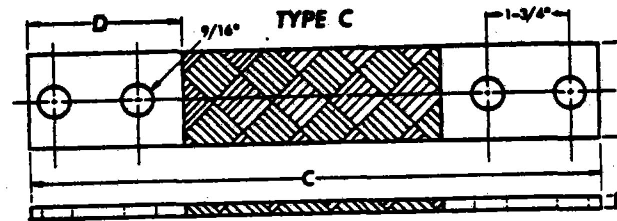
LIST OF MATERIAL

MATERIAL	TOLERANCES .xx = ± .03 .xxx = ± ANGLES ±	DRAFT	DATE	Abbott Power Corporation, 7460 STAGE ROAD · BUENA PARK · CALIFORNIA 90620, A MEMBER OF NEMA	TITLE: WINCH ASSEMBLY TRAVELING CRANE	NEXT ASSY 1303-100
WEIGHT		CHK'R	DATE			DWG NO 1303-101
		APP'D	DATE			

ANIXTER ROYAL
ROYAL ELECTRIC MANUFACTURING CO., INC.
(Effec. 11/1/78)

FLEXIBLE CONNECTORS

TYPE C



Catalog No.	Ampere Rating	Number and Size of Braid	Dimensions in Inches			
			A	B	C	D
7312	200	1 - 76800 CM	1	1/8	12	3
7313	350	2 - 76800 CM	1	1/4	12	3
15841	400	3 - 76800 CM	1	5/16	12	3
7314	450	1 - 302400 CM	1 1/2	5/16	12	3
7315	550	1 - 76800 CM 1 - 302400 CM	1 1/2	3/8	12	3
15842	650	2 - 76800 CM 1 - 302400 CM	1 1/2	13/32	12	3
15843	750	3 - 76800 CM 1 - 302400 CM	1 1/2	7/16	12	3
7317	800	2 - 302400 CM	1 1/2	1/2	12	3
15844	900	2 - 76800 CM 2 - 302400 CM	1 1/2	5/8	12	3
15845*	1000	3 - 302400 CM	1 1/2	13/16	12	3
15846*	1200	4 - 302400 CM	1 1/2	1	12	3

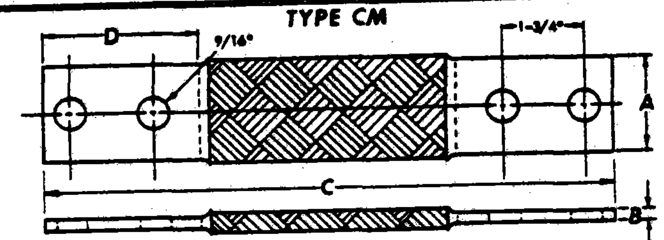
* Catalog #15845 consists of (1) #7314 and (1) #7317.

* Catalog #15846 consists of (2) #7317.

__Example for Ordering:__ - #7315 Royal Type C Flexible Braid Connectors "C" Dimension 16".

Type C Flexible Connectors will carry rated capacity indoors. Wire is tinned before stranding. Ferrules are completely silverplated to provide lowest contact resistance. Standard length is 12" overall. Specify length required if longer or shorter than standard. Ferrules can be furnished to any length specified.

TYPE CM

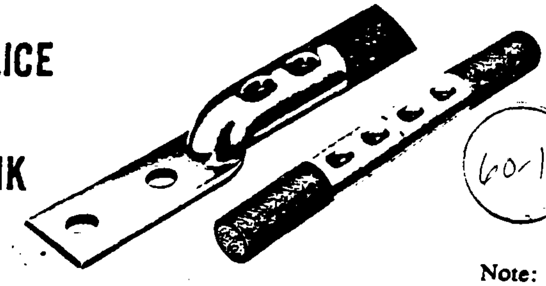


Catalog No.	Ampere Rating	Number and Size of Braid	Dimensions in Inches			
			A	B	C	D
	200	1 - 76800 CM	1	1/8	12	3 1/4
18168	350	2 - 76800 CM	1	1/4	12	3 1/4
18169	400	3 - 76800 CM	1	5/16	12	3 1/4
18170	450	1 - 302400 CM	1 1/2	5/16	12	3 1/4
18171	550	1 - 76800 CM 1 - 302400 CM	1 1/2	3/8	12	3 1/4
18172	650	2 - 76800 CM 1 - 302400 CM	1 1/2	13/32	12	3 1/4
18173	750	3 - 76800 CM 1 - 302400 CM	1 1/2	7/16	12	3 1/4
18174	800	2 - 302400 CM	1 1/2	1/2	12	3 1/4
18175	900	2 - 76800 CM 2 - 302400 CM	1 1/2	5/8	12	3 1/4
18176	1000	3 - 302400 CM	1 1/2	13/16	12	3 1/4
18177	1200	4 - 302400 CM	1 1/2	1	12	3 1/4

__Example for Ordering:__ - #18172 Royal Type CM Flexible Braid Connectors 650 Amperes, "C" Dimension 10".

Type CM Flexible Connectors will carry rated capacity indoors. Wire is tinned before stranding. Ferrules are completely silverplated to provide lowest contact resistance. Standard length is 12" overall. Specify length required if longer or shorter than standard. Ferrules can be furnished to any length specified.

TERMINAL and SPLICE
For Copper
HYLUG and HYLINK
Types YA, YS



60-1

NEST AND INDENTOR AS LISTED RESULTS IN THIS TYPE OF INDENT

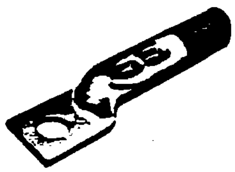
DIE SET AS LISTED RESULTS IN A CIRCUMFERENTIAL CRIMP

Copper HYLUG and HYLINK compression connectors for copper wire. All sizes are tin-plated to resist corrosion.

Note: Die indexes and tooling listed between the heavy lines apply to the conductor and connectors listed within the same lines. Both HYDENT and over head die sets are listed.

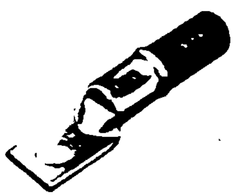
CONDUCTOR	STUD SIZE	NO. OF HOLES IN PAD	CATALOG NUMBER		C	N	DIE INDEX	DIE TYPE	TOOLS, DIE SET CATALOG NO., &					
			TERMINAL	SPLICE					MD6	Y34A	Y35	Y45*	Y48B	Y60B†
6 Str.	1/4	1	YA6C	YS6C	3/8	1/4	7	NEST INDENTOR	—	A6CD Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA6C-2N		13/16	5/8	7	DIE SET	—	A5CR 2	U5CRT 2	—	—	—
4 Str.	1/4	1	YA4C	YS4C	7/16	1/4	8	NEST INDENTOR	—	A4CD Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA4C-2N		13/16	5/8	8, 161, 242	DIE SET	— W161 2 W242 4	A4CR 2 A161 1 A242 2	U4CRT 2 U161 1 U242 2	—	— — C242 1	— — L242 1
3 Str.	5/16	1	YA3C	YS3C	1/2	3/8	9	NEST INDENTOR	—	A3CD Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA3C-2N		13/16	5/8	9, 162, 203	DIE SET	— — —	A3CR 2 — A203 2	U3CRT 2 — U203 2	—	—	—
2 Str.	5/16	1	YA2C	YS2C	5/8	3/8	10	NEST INDENTOR	—	A2CD Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA2C-2N		13/16	5/8	10, 162	DIE SET	— W162 5	A2CR 2 A162 1	U2CRT 2 U162 1	—	— C162 1	—
1 Str.	5/16	1	YA1C	YS1C	11/16	3/8	11	NEST INDENTOR	—	A1CD Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA1C-2N		13/16	5/8	11, 276	DIE SET	—	A1CR 2 A276 4	U1CRT 2 U276 4	—	—	—
1/0 Str.	5/16	1	YA25	YS25	3/4	3/8	12	NEST INDENTOR	—	A25D Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA25-2N		13/16	5/8	12, 163	DIE SET	— W163 4	A25R 2 A163 2	U25RT 2 U163 2	—	— C163 2	—
2/0 Str.	3/8	1	YA26	YS26	13/16	7/16	13	NEST INDENTOR	—	A26D Y34PR 1	—	—	—	—
	1/2	2 NEMA	YA26-2N			5/8	13, 164, 241	DIE SET	— W164 4 W241 3	A26R, 2 A164, 2 A241 2	U26RT, 2 U164, 2 U241 2	—	— C164, 2 C241 1	—
3/0 Str.	1/2	1	YA27	YS27	15/16	1/2	14	NEST INDENTOR	—	A27D Y34PR 1	—	—	—	—
		2 NEMA	YA27-2N			5/8	14, 243	DIE SET	— W243 3	A27R 2 A243 2	U27RT 2 U243 2	—	—	—
4/0 Str.		1	YA28	YS28	1	1/2	15	NEST INDENTOR	—	A28D Y34PR 1	—	—	C28D Y48PR 1	—
		2 NEMA	YA28-2N		1 1/16	5/8	15, BG, 243	DIE SET	— W-BG 2 W243 3	A28R 2 — A243 2	U28RT 2 U-BG 2 U243 2	—	C28R 2 — C243 1	— — L243 1

Type YA (cont.)

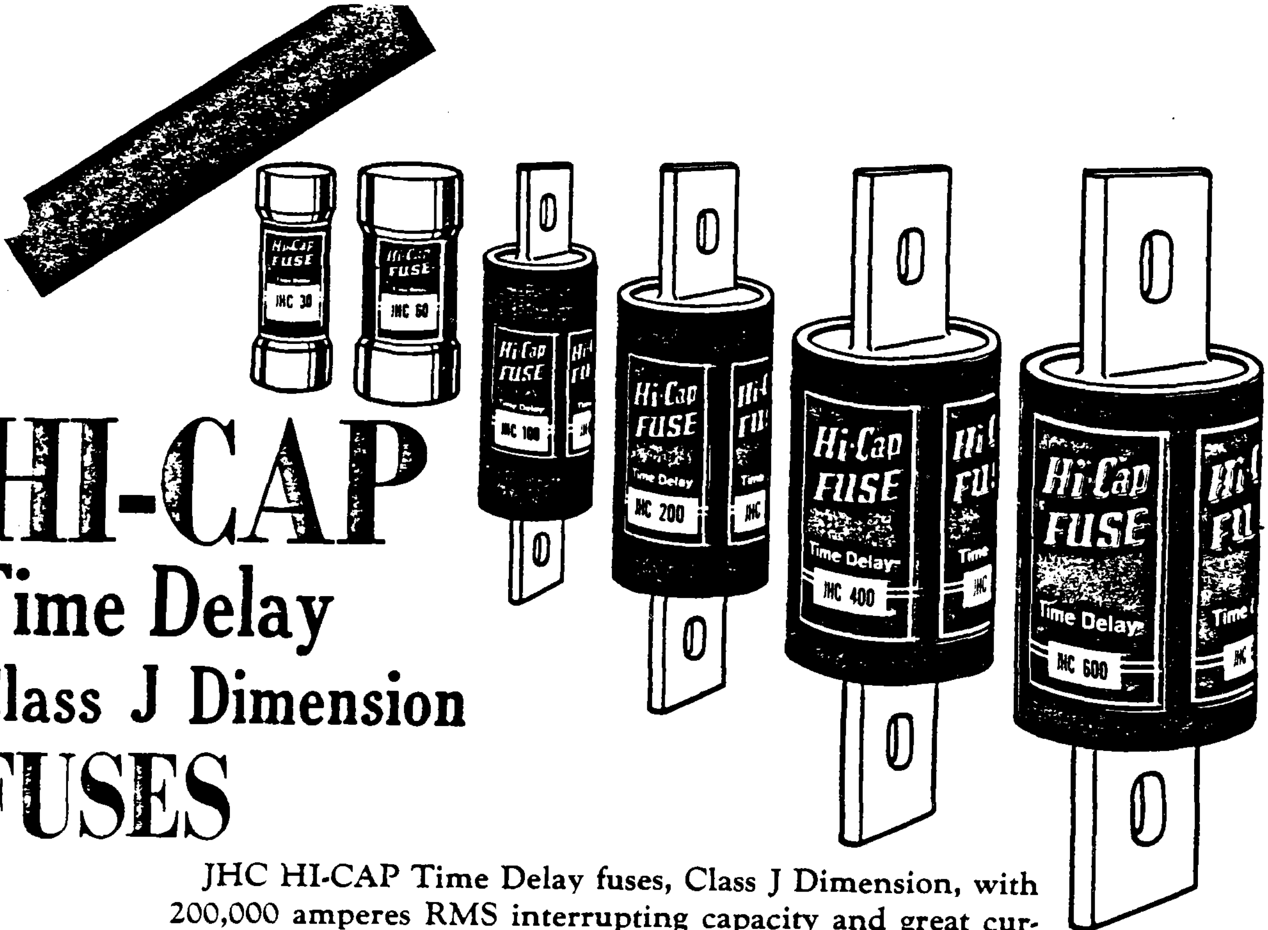


Catalog Number	Copper Conductor Coml Awg	Stud Size	Wgt. Per 100	Carton Qty.
YA25	1/0 Str.	5/16	6.2	10
YA26	2/0 Str.	3/8	7.7	10
YA27	3/0 Str.	1/2	8.9	10
YA28	4/0 Str.	1/2	12	10
YA29	250	1/2	16	10
YA30	300	1/2	20	10
YA31	350	1/2	25	10
YA32	400	5/8	32	10
YA34	500	5/8	44	10
YA36	600	5/8	69	6
YA39	750	5/8	85	6
YA40	800	5/8	99	6
YA44	1000	5/8	130	6
YA46	1500	3/4	210	3
YA48	2000	3/4	300	3
YA6C-2	6 Str.	1/4	7	10
YA6C-2N	6 Str.	1/2	7.8	10
YA4C-2	4 Str.	1/4	7.5	10
YA4C-2N	4 Str.	1/2	8.3	10
YA2C-2	2 Str.	5/16	8	10
YA2C-2N	2 Str.	1/2	8.8	10
YA1C-2	1 Str.	5/16	8.5	10
YA1C-2N	1 Str.	1/2	9.3	10
YA25-2	1/0 Str.	5/16	8.2	10
YA25-2N	1/0 Str.	1/2	9	10
YA26-2N	2/0 Str.	1/2	10.7	10
YA27-2N	3/0 Str.	1/2	13.2	10
YA28-2N	4/0 Str.	1/2	16	10
YA29-2N	250	1/2	19	10
YA30-2N	300	1/2	24	10
YA31-2N	350	1/2	29	10
YA32-2N	400	1/2	37	10
YA34-2N	500	1/2	51	10
YA36-2N	600	1/2	74	6
YA39-2N	750	1/2	89	6
YA40-2N	800	1/2	96	6
YA44-2N	1000	1/2	134	6
YA46-2N	1500	1/2	220	3
YA48-2N	2000	1/2	320	3
YA44-4	1000	3/8	130	6
YA46-4	1500	1/2	210	3
YA48-4	2000	1/2	320	3

HYLUG Type YA-LB

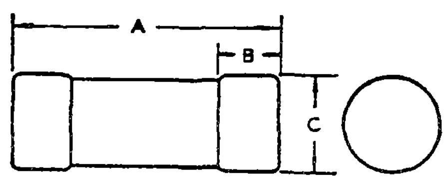


Catalog Number	Copper Conductor ASTM Class H	Copper Conductor ASTM Class M	Copper Conductor Stud Size	Wgt. Per 100	Carton Qty.
YA3C-LB	4	4	5/16	3	25
YA1C-LB	2	2	5/16	3.7	10
YA25-LB	1	1	5/16	4.7	10
YA26-LB	1/0	1/0	3/8	5.9	10
YA27-LB	2/0	2/0	1/2	7.3	10
YA28-LB	3/0	3/0	1/2	9.3	10
YA29-LB	4/0	4/0	1/2	13	10
YA30-LB	250	250	1/2	15	10

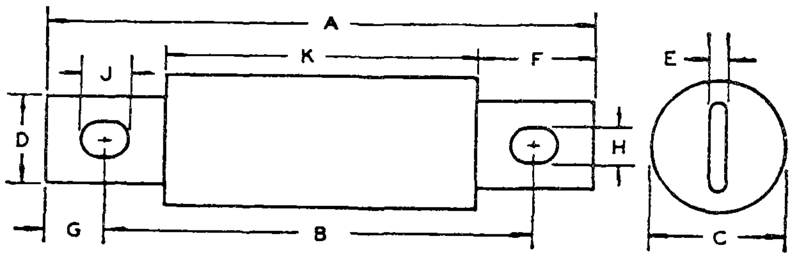


HI-CAP
Time Delay
Class J Dimension
FUSES

JHC HI-CAP Time Delay fuses, Class J Dimension, with 200,000 amperes RMS interrupting capacity and great current limitation — to which has now been added substantial time delay. CSA Listed at 100,000 amperes.

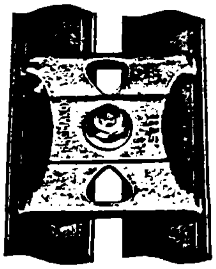


Symbol	Ampere Rating	Dimensions in Inches A	B	C
JHC	15 to 30	2¼	½	13/16
	35 to 60	2⅜	⅝	1 1/16

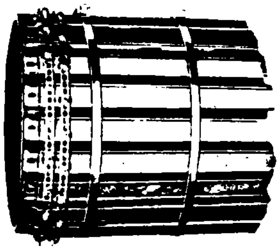


Symbol	Ampere Rating	A	B	C	D	E	F	G	H	J	K
		Dimensions in Inches									
JHC	65 to 100	4⅝	3⅝	1⅛	¾	⅛	1	½	9/32	⅜	2⅝
	110 to 200	5¾	4⅜	1⅝	1⅛	3/16	1⅜	11/16	9/32	⅜	3
	225 to 400	7⅛	5¼	2⅛	1⅝	¼	1⅞	15/16	13/32	17/32	3⅜
	450 to 600	8	6	2½	2	⅜	2⅛	1	17/32	11/16	3¾

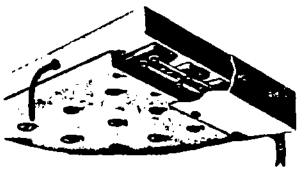
FOR DETAILED INFORMATION — ASK FOR BUSS BULLETIN JHCS



Utility clamps secure strip elements to flat surfaces or surfaces with large radii such as large tanks. Threaded studs are welded to surface, heaters are positioned, then clamps are bolted down. Where more than one clamp is used, tighten nuts and then back off ½ turn to allow for expansion.



Clamping bands can be used to firmly fasten strips longitudinally to large-diameter cylindrical surfaces.



Milled plate. Heaters may be held in position in platens and similar objects with a steel plate recessed to heaters' width, thickness and positions, then screwed to the working plate or surface.

Oven mounting. Easy application of strip elements to ovens may be made simply with the use of welded-on studs and secondary insulation bushings (see Additional Features).
Mounting holes in tabs are slotted to allow for expansion.

MAXIMUM WORK TEMPERATURES

Strip elements can generally be used in the following applications at maximum temperatures shown without exceeding capability if properly installed:

Free Air	Air Temp.
Chrome steel sheath	950°F
Moving Air—air volume at 16 fps	Air Temp.
Rust-resisting iron sheath	425°F
Chrome steel sheath	950°F
Clamp-on	Work Temp.
Rust-resisting iron sheath	300°F
Chrome steel sheath	700°F

The above maximum work temperatures are based on **10 watts per square inch.** If elements have a lower watt density, work temperature may be increased.

MAXIMUM SHEATH TEMPERATURES

Rust-resisting iron	750°F
Chrome steel	1200°F
Incoloy	1600°F

EXCLUSIVE CONSTRUCTION

High-quality, coiled nickel-chrome resistor wire is uniformly spaced over the width and length of the strip element, then embedded in high-grade refractory material which both insulates the wire and transfers heat rapidly. Refractory is then compressed to rock hardness and maximum density under tremendous hydraulic pressure to improve heat transfer from coil to sheath. Elements are oven baked at high temperatures to semi-vitrify and mature the refractory.

Installation

Chromalox strip elements in most cases can be applied with standard hardware. However, for firm contact and best heat transfer, stocked Chromalox strip heater clamps are recommended. See page 13. Instruction Bulletin P00400 is packed with each shipment.

Thermostatic Control

Automatic temperature controls may be selected and installed as described in Controls Section.

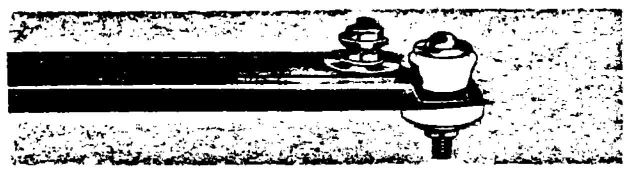
Connecting Lead Wires

should be nickel-plated copper, nickel or alloy. Copper will oxidize and loosen connections. Refer to page 79 for wire, bus bar, etc.

High-voltage Use

Where line voltage is above 300V (600V maximum), Chromalox strip elements can be connected in series for air heating, providing they are mounted on secondary insulation bushings (see below). Maximum voltage for clamp-on installations is 480V to ground.

additional features—see following tables for ordering information



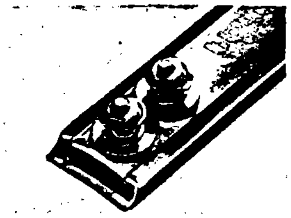
Secondary Insulation Bushings

Needed at each end of strip heaters when connected in series on line voltages above 300V.

Note: To accommodate bushings, a 17/32" x 11/16" dia. hole is substituted for the standard slot in each mounting tab when bushings are on same purchase order as strip heaters; otherwise, 17/32" x 11/16" dia. mounting hole in tabs should be specified for heaters. Additional price includes two bushings, hardware and enlarging mounting holes. **All types except NS.**

Ceramic Post Terminal Insulators

Use with insulated wire to protect against electrical shock . . . to wire several heaters where Bx or conduit is not required. Wires can leave heater terminals at any angle. For strip heaters only. **All types except NS and SN.**

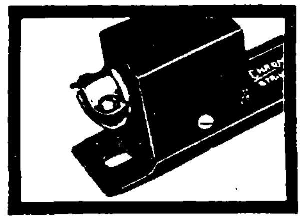


Without Mounting Tabs

Permits installing more heat in a given confined space.

Specify "without mounting tabs" if this feature is needed.

All types except NS.



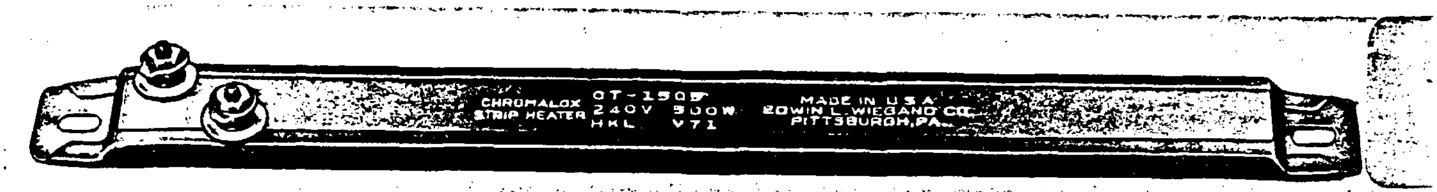
Protective Terminal Cover

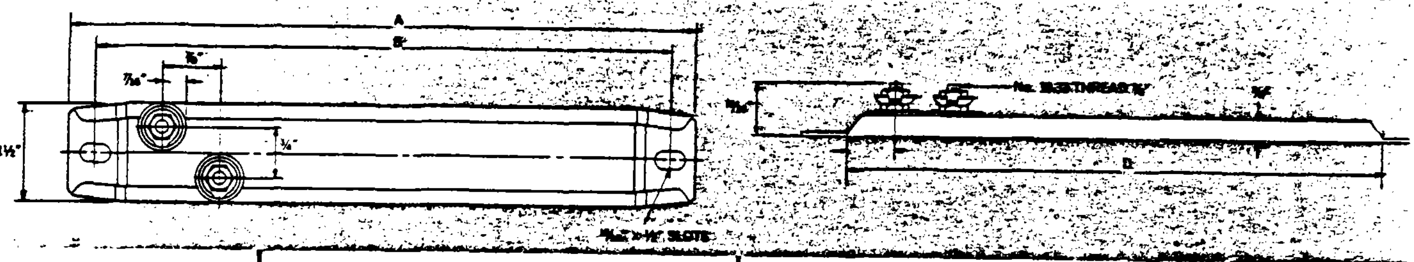
Guards terminals from spillovers, dripping, grounding or short circuits.

Removable cover, with BX fitting, is shipped separately.

Types PT and SE only.

1½" wide





DIMENSIONS—Inches A Overall Length	B Mtg. Hole Center	D Without Mtg. Tabs	RUST-RESISTING IRON SHEATH (See pg. 6 for max. sheath and work temp.) Volts	Watts	Watts Per Sq. In.	Catalog Number	Product Code No. (PCN)	CHROME STEEL SHEATH (See pg. 6 for max. sheath and work temp.) Volts	Watts	Watts Per Sq. In.	Catalog Number	Product Code No. (PCN)	Approx. Net Wt. Lbs.
7½	6½	6	120	150	11	OT-715	129314	120	200	15	OT-702	129613	.50
			240	150	11	OT-715	129322	240	200	15	OT-702	129621	.50
8	7	6½	120	150	10	OT-815	129330	120	250	17	OT-802	129630	.56
			240	150	10	OT-815	129349	240	250	17	OT-802	129648	.56
			120	175	12	OT-817	129357	120	400	27	OT-804	129656	.56
			240	175	12	OT-817	129365	240	400	27	OT-804	129664	.56
10½	9½	9	120	250	10	OT-1025	129373	120	350	15	OT-1003	129672	.75
			240	250	10	OT-1025	129381	240	350	15	OT-1003	129680	.75
12	11	10½	...	...	..	....	......	120	400	17	OT-1004	129699	.88
			...	...	..	....	......	240	400	17	OT-1004	129701	.88
			120	250	8	OT-1225	129390	120	250	8	OT-1202	129710	.88
			240	250	8	OT-1225	129402	240	250	8	OT-1202	129728	.88
			...	...	..	....	......	120	350	14	OT-1203	129736	.88
			...	...	..	....	......	240	350	14	OT-1203	129744	.88
			...	...	..	....	......	120	500	17	OT-1205	129752	.88
			...	...	..	....	......	240	500	17	OT-1205	129760	.88
14	13	12½	120	300	8	OT-1430	129410	120	500	14	OT-1405	129779	1.0
			240	300	8	OT-1430	129429	240	500	14	OT-1405	129787	1.0
15¼	14¼	13¾	120	325	8	OT-1532	129437	120	500	12	OT-1505	129795	1.13
			240	325	8	OT-1532	129445	240	500	12	OT-1505	129808	1.13
17⅞	16⅞	16⅜	120	350	6.5	OT-1835	129453	120	500	10	OT-1805	129816	1.38
			240	350	6.5	OT-1835	129461	240	500	10	OT-1805	129824	1.38
			120	375	7	OT-1837	129470	120	750	15	OT-1807	129832	1.38
			240	375	7	OT-1837	129488	240	750	15	OT-1807	129840	1.38
			120	500	10	OT-1850	129496	120	1000	19	OT-1801	129859	1.38
			240	500	10	OT-1850	129509	240	1000	19	OT-1801	129867	1.38
19½	18½	18	120	350	6	OT-1935	129517	120	500	9	OT-1905	129875	1.5
			240	350	6	OT-1935	129525	240	500	9	OT-1905	129883	1.5
			120	500	8	OT-1950	129533	120	750	13.5	OT-1907	129891	1.5
			240	500	8	OT-1950	129541	240	750	13.5	OT-1907	129904	1.5
			...	...	..	....	......	120	1000	18	OT-1901	129912	1.5
			...	...	..	....	......	240	1000	18	OT-1901	129920	1.5
21	20	19½	120	500	8	OT-2150	129550	120	750	12	OT-2107	129939	1.63
			240	500	8	OT-2150	129568	240	750	12	OT-2107	129947	1.63
23¾	22¾	22¼	120	500	7	OT-2450	129576	120	500	7	OT-2405	129955	1.81
			240	500	7	OT-2450	129584	240	500	7	OT-2405	129963	1.81
			120	750	10	OT-2475	129592	120	750	10	OT-2407	129971	1.81
			240	750	10	OT-2475	129605	240	750	10	OT-2407	129980	1.81
			...	...	..	....	......	120	1000	14	OT-2401	129998	1.81
			...	...	..	....	......	240	1000	14	OT-2401	130008	1.81

Specify: Quantity, Catalog No., PCN, Volts, Watts, Strip Heaters. For additional features (page 6) available for Type OT, add: Without Mounting Tabs; Secondary Insulation Bushings—PCN 255716; Protective Terminal Cover—Catalog No. OT-AC-1, PCN 129242; Set of Two Ceramic Post Terminal Insulators—Part No. 1-41059, PCN 259805.

Classification of Cartridge Fuses

By Underwriters' Laboratories, Inc.

CARTRIDGE FUSES 0-600 VOLTS

NOT LABELLED AS CURRENT-LIMITING

"MISCELLANEOUS"
Midget Dimension, etc. Not used for branch circuit protection.
U.L. Standard No. 198.6

Dimensions per Table 2.3 of U.L. Standards No. 198B and Table 2 of U.L. Standards No. 198.3
0-600 amperes
250 and 600 volts

Class H: Interrupting ability not over 10,000 amperes. Tested and listed per U.L. Standards for Fuses No. 198B. Neither Class letter nor interrupting rating on labels.

Non-renewable "One Time" Fuses. May be labelled Time Delay if min. of 10 secs. at 500% is met.
ECONOMY: EON, EOS

Renewable Fuses
ECONOMY: ERN, ERS

Class K: Tested and labelled for interrupting rating of 50,000, 100,000 or 200,000 rms amps ac per NEC par. 240-60C. Tested and labelled per U.L. Standards No. 198.3. Required by Stds. to have a specific degree of current limitation but may NOT be so labelled per NEC par. 240-60b. Time Delay (min. of 10 sec. at 500% of rating) optional. Class and int. rating printed on label. All Economy Fuse Class K fuses have 200,000 amp. interrupting rating.

Class K-1: High degree of current limitation.
ECONOMY: NCL, SCL

Class K-5: Very good degree of current limitation.
ECONOMY: LEN, LES
(Time Delay)

Class K-5: Good degree of current limitation.
ECONOMY: ECN, ECS
(Time Delay)

Class K-9: Fair degree of current limitation. Usually supplied as Time Delay.
No longer made by Economy.

LABELLED AS CURRENT-LIMITING

Tested and Listed per U.L. Standards No. 198.2 for Current Limiting Fuses. These fuses are non-interchangeable with other classes per NEC 240-60b. Must meet U.L. established degree of Current Limitation.

Class G: 0-60 amps. or less, 300 Volts or less. Time delay of at least 12 secs. at 200% rating. Labelled with interrupting rating of 100,000 rms symm. amps. (Not made by Economy Fuse.)

Class J: 0-600 amps., 600V or less. Labelled as "Current Limiting" and for 200,000 symm. amps., ac interrupting rating. No time delay. Dimensions not interchangeable with other fuse classes.
ECONOMY: JCL.

Class L: 601-6000 amps., 600V or less. Labelled as "Current Limiting" and for 200,000 symm. amps., ac interrupting rating. No time delay. Fuses bolt to bus bars.
ECONOMY: LCL

Class R: Meet all Class K 100,000 amp requirements plus measured current limitation at 50,000 and 200,000 amps. Labelled Current Limiting and all have 200,000 amp. interrupting rating. Resemble Class K plus rejection feature to meet 1975 NEC par. 240-60b. Economy Fuse offers Class K combined with Class R as in table below.

SELECTION CHART

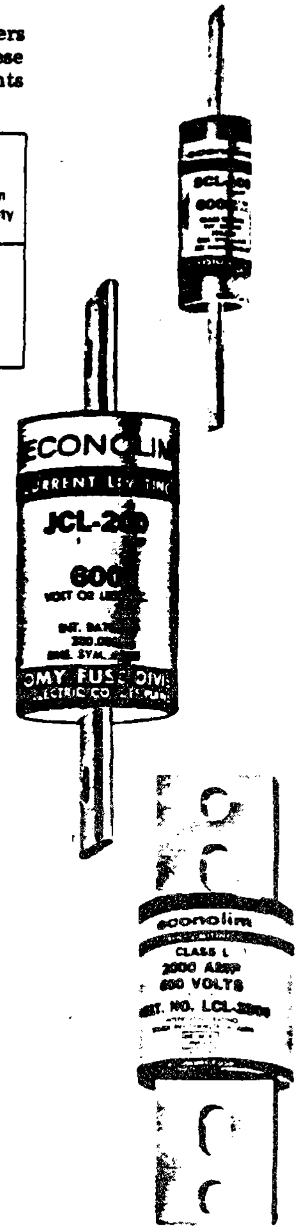
TRADE NAME →		ECO®		Economy® Renewable		ECON®		ECON-LIMITER®		ECONOLIM®					ECO®	ECON®
DESCRIPTION		Catalog Symbol Identification														
		EON	EOS	ERN	ERS	ECN	ECS	LEN	LES	NCL	SCL	JCL	LCL	MCL	MOL	MEN
	U. L. CLASS	H	H	H	H	RK5	RK5	RK5	RK5	RK1	RK1	J	L	"Miscellaneous"		
INTERRUPTING RATING	Not Over 10,000 Amps	X	X	X	X										X	X
	100,000 Amps. a.c.													X		
	200,000 Amps. a.c.					X	X	X	X	X	X	X	X			
DEGREE OF CURRENT LIMITATION	Excellent									X	X	X	X	X		
	Very Good							X	X							
	Good					X	X									
DIMENSIONS	13/32" x 1-1/2"													X	X	X
	"N.E.C."	X	X	X	X	X	X	X	X	X	X					
	Non-interch. Dim. per U.L.											X	X			
VOLTS (a.c.)	250 or less	X		X		X		X		X					X	X
	600 or less		X		X		X		X		X	X	X	X		
TIME-DELAY MIN. OF 10 SEC. AT 500%						X	X	X	X							

Econolim® Current-Limiting, Energy Limiting, and High Interrupting Capacity Fuses

Fuses under the trademark "Econolim" are manufactured with silver links, quartz-sand filler, and melamine tubes. This line includes Underwriters' Laboratories, Inc. Classes K-1, J, and L, as well as midget dimension MCL fuses (see page 35). All of these fuses have a high degree of current limitation with low I^2t energy let-through and low peak let-through current as well as the highest interrupting rating recognized by U.L. for low voltage fuses. Ask for detailed technical data by the FPE Class Number shown.

CLASS 1317 Econolim® High Interrupting Capacity Fuses, U.L. Class K-1

Use on applications for fault currents up to 200,000 amperes, where very fast clearing is required to limit current and where fuse holders are of NEC dimensions. Ideal for protection of molded case circuit breakers with inadequate interrupting ratings. These fuses meet the current limiting requirements of U.L. Class K-1 standards.



Standard Rating, Amp	These fuses meet U.L. standards for Class K-1 and are electrically similar to Class J but will fit "NEC" fuse clips. 250 VOLTS OR LESS: Cat. No.			600 VOLTS OR LESS: Cat. No.			Carton Quantity
1, 3, 6, 10, 15, 20, 25, 30	Catalog			Catalog			10
35, 40, 45, 50, 60	Symbol			Symbol			10
70, 80, 90, 100	"NCL"			"SCL"			1
125, 150, 175, 200	followed			followed			1
225, 250, 300, 350, 400	by			by			1
450, 500, 600	amperes			amperes			1

CLASS 1318 Econolim® Current-Limiting Fuses, U.L. Class J

Applications of this type fuse are for fault currents up to 200,000 amperes, for high degree of current limitation, and to comply with NEC paragraph 240-23(b). For use only in Class J fuse holders which will not accept Class H or K fuses. *Note:* No U.L. listed Class J fuses have time delay.

Standard Rating Amp	Class J Dimensions. Will not fit standard NEC fuse spacing. 600 VOLTS OR LESS: Cat. No.	Net Each	Carton Quantity
1, 3, 6, 10, 15, 20, 25, 30	Catalog		10
35, 40, 45, 50, 60	Symbol		10
70, 80, 90, 100	"JCL"		1
125, 150, 175, 200	followed		1
225, 250, 300, 350, 400	by		1
450, 500, 600	amperes		1

CLASS 1319 Econolim® Current-Limiting Fuses, U.L. Class L

Used on installations for fault currents up to 200,000 amperes, for mounting in bolted pressure switches, service interrupters, switchgear, and fused air circuit breakers. Ideal for protection of large circuit breakers which may not have adequate interrupting ratings.

Amperes†	Catalog Numbers	Net Each	Carton Quantity
601	LCL601		1
800	LCL800		1
1000	LCL1000		1
1200	LCL1200		1
1600	LCL1600		1
2000	LCL2000		3
2500	LCL2500		3
3000	LCL3000		3
4000	LCL4000		3
5000	*LCL5000		3
6000	*LCL6000		3

* For 4001-6000 amperes, specify whether 4 or 6 hole drilling is desired.
† Other ratings available on request.

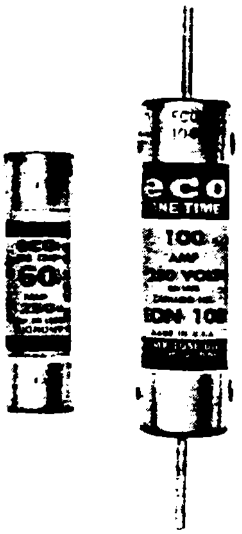
CLASS 1312A Econolim® Type RF Fuses

Econolim Type RF fuses for protection of rectifier equipment are made and available in 130, 250, 500 and 600 volt ratings. Ask for special descriptive catalog sheets Class 1312A.

Military-Specification Fuses: FPE-Economy Fuse can provide fuses to meet Department of Defense Specification MIL-F 15160D or E, and WF-1726 as "qualified products." We also qualify under proposed specification WF-1814.
General Services Administration Fuses: FPE-Economy Fuse can provide fuses under the various parts of GSA Specification W-F-791d and e.

ECO® "One-Time" Non-Renewable Fuses, U.L. Class H. Federal Specification WF-1726

CLASS 1340



ECO® "ONE-TIME" CARTRIDGE FUSES are UL listed and labelled as Class H for use on circuits where available fault currents do not exceed 10,000 amperes. They feature caps rolled into the tubes, staking to prevent cap rotation, links visibly soldered to caps and stamped-in-brass identification. This fuse provides lowest cost short-circuit protection. For detailed data, ask for Class 1340 Descriptive Sheets.

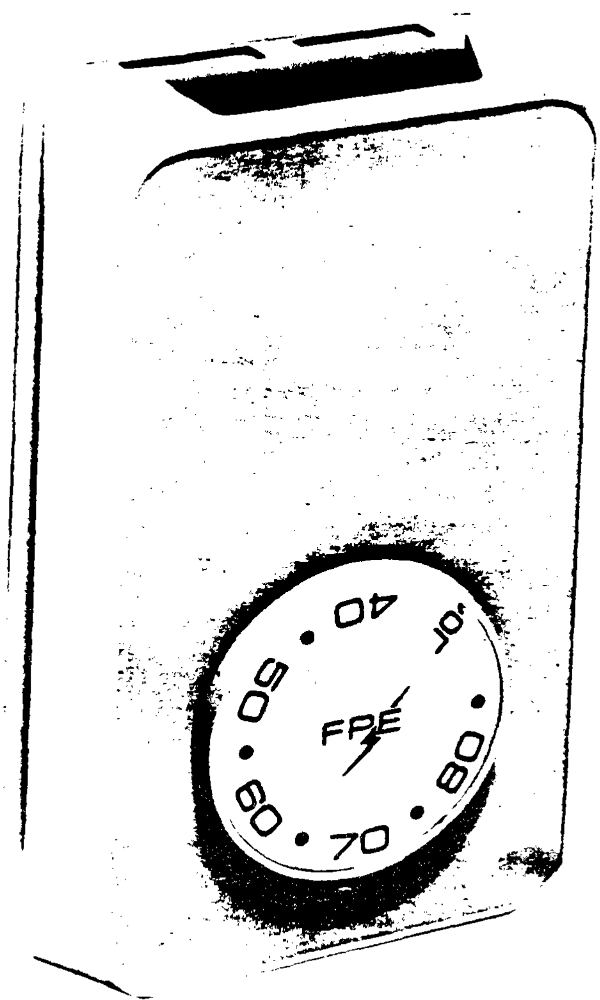
Amperes*	Catalog Number	List Each			Per Carton
250 VOLTS					
1, 3, 6, 10, 15, 20, 25, 30 35, 40, 46, 50, 60	Catalog Symbol "EON" followed by amperes				10 10
70, 80, 90, 100 110, 125, 150, 175, 200					5 1
225, 250, 300, 350, 400 450, 500, 600					1 1
600 VOLTS					
1, 3, 6, 10, 15, 20, 25, 30 35, 40, 45, 50, 60	Catalog Symbol "EOS" followed by amperes				10 10
70, 80, 90, 100 110, 125, 150, 175, 200					5 1
225, 250, 300, 350, 400 450, 500, 600					1 1

*Ferrule type, 60 amp and below. Knife blade type, 65 amp and above.

FPE

CLASS 1190.3

LINE VOLTAGE ELECTRIC HEAT THERMOSTAT SERIES PMT



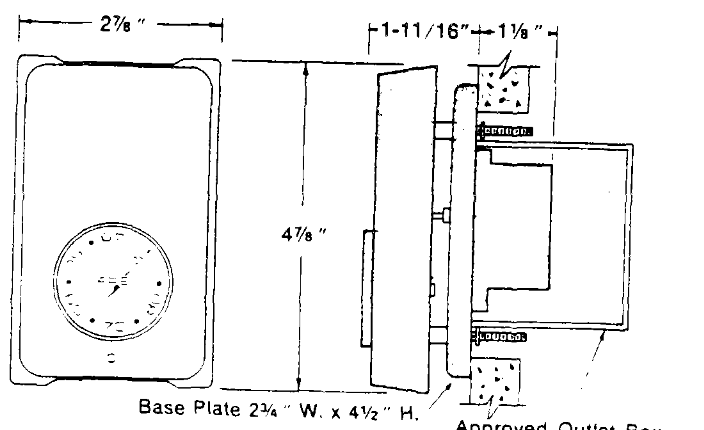
EXCLUSIVE DESIGN: Federal Pacific's exclusive construction (patented) has three insulating air spaces and two heat shields for excellent performance with constant comfort temperature and low droop. Other patents pending.

SMARTLY STYLED: The smartly styled, mist beige color acrylic cover blends with the decor of any room. Easy-to-read gold dial has actual temperature numbers with a wide range of settings from 40° to 85°F.

SNAP ACTION SWITCH: Bi-metal actuated, quick-make, quick-break switch eliminates interference noises.

LIMIT KIT: High limit kit (field selected) is especially desirable for those applications where maximum limited heat range is desired.

THERMOMETER KIT: Easily installed in the field. Glass thermometer is mounted in decorative plastic housing. Attaches to thermostat with pressure sensitive adhesive backing.



3.1.1-65

LINE VOLTAGE ELECTRIC HEAT THERMOSTAT

DESCRIPTION AND ORDERING INFORMATION

Catalog Number PMT1	Catalog Number PMT2'
Single line break (single pole) single throw switch. Makes and breaks electrical load — switch closes on temperature fall.	Double line break. Two single pole single throw switches. Opens all ungrounded conductors of electrical load when in "OFF" position only. Makes and breaks single load—switch closes on temperature fall.

SPECIFICATIONS

Control Range	Volts AC	Ampacity	Watts Non-Inductive
40°F. to 85°F.	120 Vac.	22 Amps.	2640
	208 Vac.	22 Amps.	4566
	240 Vac.	22 Amps.	5280
	277 Vac.	19 Amps.	5280

ACCESSORIES

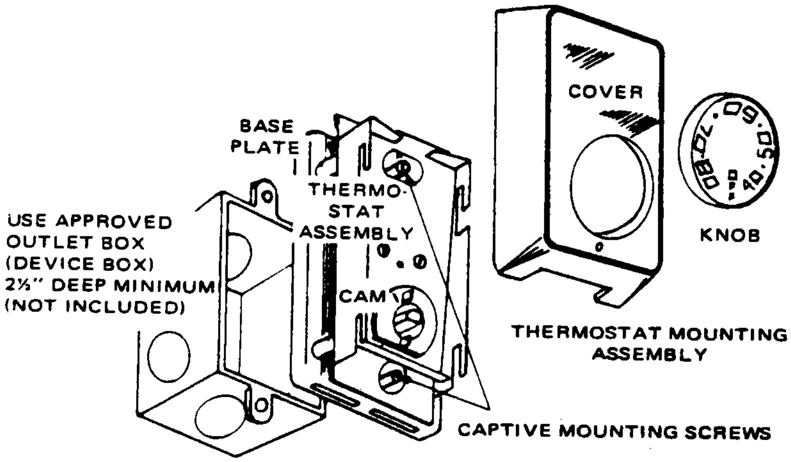
Catalog Number	Description
PATTK	Thermometer kit. Glass thermometer mounted in decorative plastic housing. Pressure sensitive adhesive backing for field mounting to stats.
ULK	Temperature limit kit. Provides tamper proof, adjustable upper temperature limit.*Field installed in all models.

SUGGESTIONS FOR CORRECT INSTALLATION OF WALL THERMOSTATS

The best location for a thermostat is on an inside wall or partition, 50 to 54 inches above the floor.

Precautions to be observed:

1. Install thermostat at least 3 feet from doorways.
2. Do not install in stairwells or draft areas.
3. Install thermostat so that air can circulate freely around the unit. Do not block with shelving, etc.
4. Avoid heat from hot pipes, ducts, lamps, TV's and similar appliances. Heat from wall switches may also affect a thermostat.
5. Rooms not separated by walls, such as living-dining areas, should be controlled by a single thermostat.



INSTALLATION PROCEDURE

1. Remove knob by pulling out.
2. Remove snap-on cover. Pull out bottom and lift up and off.
3. Wire as shown in schematic diagram below.
4. Fasten to box with captive screws.
5. Replace snap-on cover.
6. Line up flat of cam shaft, with flat in knob recess and press knob back in place.

WIRING PROCEDURE

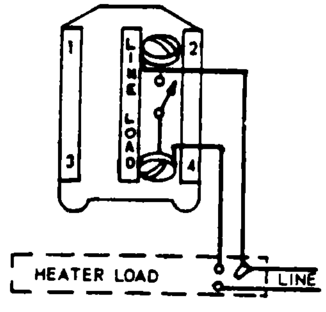
1. Wire lengths should be cut to minimum code requirements.
2. Strip wires 3/8 to 1/2 inch long.
3. Note LINE and LOAD markings near switch terminals. Do Not reverse these connections or thermostat will not operate properly.
4. Insert wire leads under the terminal screws as shown. Tighten securely. Loose connections run hot and will affect the performance of the thermostat.
5. Rotate the cam to "LO" or "OFF" position. This allows the "flat" at the top of the cam to clear the screw driver blade.
6. Mount thermostat to outlet box using a small shank screw driver. This will avoid damage to the bi-metal. The base plate mounting slots are designed to bend ?ward the outlet box during tightening. This simplies the installation by eliminating any thermostat distortion.

WIRING DIAGRAMS

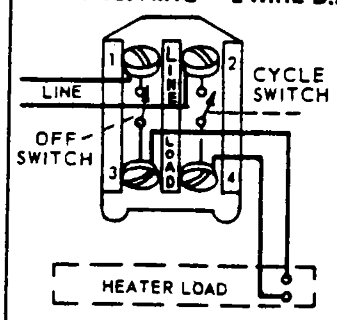
CAUTION

DO NOT REVERSE LINE AND LOAD CONNECTIONS TO THE THERMOSTAT

CAT. NO. PMT1 2 WIRE S.P.



CAT. NO. PMT2 2 WIRE D.P.



Terminals are approved for copper or aluminum wire.

Type IAV

Time Delay Voltage Relays

DESCRIPTION

The Type IAV relays are single phase induction disk relays designed to respond, with time delay, to either an increasing or a decreasing voltage, or both. Some models are frequency compensated, and some include an instantaneous unit (hinged armature type). Most models listed in the Selection Guide include a target seal-in unit on all contacts.

The basic mechanism of all models is an induction-disk unit with either a tapped coil or a tapped resistor for setting pickup.

[In the overvoltage models, the relay is calibrated on increasing voltage to close the normally open contact at tap setting. The time dial adjusts the angle through which the disk rotates and, hence, the time delay.]

In the undervoltage models, the relay is calibrated on decreasing voltage to close the normally closed contact at tap setting. The time dial adjusts the angle through which the disk rotates at voltages above tap setting.

In the combined overvoltage and undervoltage models, the relay is calibrated on increasing voltages to close the normally open contacts at tap setting and on decreasing voltages to close the normally closed contacts at various percentages of tap setting.

For the undervoltage and combined undervoltage and overvoltage relays, the two connecting plug S2 case is used to prevent false tripping when the relay is removed or replaced. Either plug completes the coil circuit and thus opens the normally closed contact used with undervoltage operation. Both plugs are needed to complete the contact circuits.

APPLICATION

OVERVOLTAGE RELAYS

Type IAC overvoltage relays are used for protection against simple overvoltage, but other applications are also common. They are applied to ground detection, both on feeders and on ac generators, and they are also used in timed switching arrangements, where their dependability and accuracy make them preferable to purely mechanical timing relays.

For protection against overvoltage in a three-phase system, use the IAV51A relay (Fig. 2). For instantaneous protection as well as time delay, use the IAV71B.

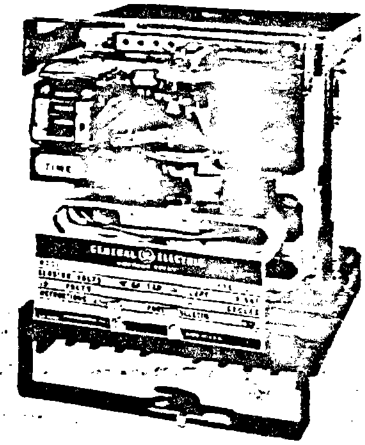
For the detection of grounds on ungrounded three-phase systems, two methods are in general use. One measures the zero sequence potential (Fig. 4), and the other measures the actual voltage between the system neutral and ground (Fig. 6).

For the circuit of Figure 4, use Type IAV51D, a low pickup relay which has its operating circuit tuned to the rated frequency. The potential transformers used in this circuit are connected grounded-Y primary, broken- delta secondary. The primaries should have ratings equal to the line-to-line voltage of the system, and the secondaries can have ratings of either 67 or 115 volts.

Select a relay model with a continuous rating of three times the potential transformer secondary voltage. This is necessary because, when a ground occurs, the zero sequence voltage may be up to three times the normal transformer secondary voltage. Thus, with a potential transformer secondary rated 67 volts, use a 199-volt relay coil. For ground fault protection of ac rotating machines, use a circuit similar to that shown in Figure 6 applying Type IAV51D or IAV51K relays. These are low-pickup relays whose coil circuits are tuned by capacitors to their rated frequencies. The circuits are thus rendered only one-eighth as sensitive to the third harmonic as they are to the rated frequency.

In Figure 6, a distribution transformer is connected between the machine neutral of the generator and ground. Normally there is no voltage on the transformer but during a fault, there is a voltage with a worst-case magnitude equal to the phase-to-ground value.

Greater sensitivity can be obtained by choosing a distribution transformer with higher secondary voltage. In such a case, the relay will not carry the fault voltage continuously, and provision must be made to de-energize the operating coil using an auxiliary relay. The short-time rating for bot IAV51D and IAV51K is 360 volts for 1 seconds.



(Photo 8043218)
Fig. 1. Type IAV71A overvoltage relay (out of case)

The IAV51M relay may be used for a definite time delay and the time is adjustable from 3 to 30 seconds by means of a time dial. Operating time is defined as the time to close the contacts with voltage suddenly raised from zero to the rated value.

UNDERVOLTAGE RELAYS

For simple undervoltage protection, select the IAV relay according to the time voltage characteristic required.

In a typical automatic-preferred emergency throwover scheme, the undervoltage contacts of the IAV54E relay are used to trip the circuit breaker in the normal source circuit, and the auxiliary switch (52b) of this normal source breaker permits the voltage closing contacts of an IAV51A relay in the emergency source to close its circuit breaker.

COMBINED UNDERVOLTAGE AND OVERVOLTAGE RELAYS

Types IAV53, IAV69, IAV70, and IAV73 relays are time-delay, over- and undervoltage relays having two contacts, one of which closes on overvoltage and the other on undervoltage.

REFERENCES:

Dimensions .... Section 7380
How to Order .... Section 7210
Prices .... Section 7212
Instruction Books .... Section 7206
Target and Contact Data .... Section 7381
Relay Standards .... Section 7382
Renewal Parts Information .... Section 7395-99
Sales Office .... Section 95, Back Cover

Type IAV
Time Delay Voltage Relays

FREQUENCY COMPENSATION

The following Type IAV relays are frequency compensated:

Overvoltage relays—IAV71, IAV72
Undervoltage relays—IAV74A
Undervoltage and Overvoltage relays—IAV73A, IAV73B

These relays have uniform characteristics over a frequency range of 30-90 Hertz. A typical application is on systems supplied by hydro-generators, where the frequency tends to increase when faults occur. Frequency compensation is provided by an R-C circuit across the wound shading coils of the induction disk operating coil and core unit.

CHARACTERISTICS

Type IAV relays will continuously withstand rated voltage on all taps, and tap voltage on all taps above rated voltage. For the minimum and maximum taps shown in the list below, the following intermediate taps are available:

Tap Range	Taps Available
5.4-20	5.4, 7.5, 12.5, 20
10-40	10, 15, 25, 40
16-64	16, 24, 40, 64
28-112	28, 42, 70, 112
55-140	55, 64, 70, 82, 93, 105, 120, 140
110-280	110, 128, 140, 164, 186, 210, 240, 280
220-560	220, 256, 280, 328, 372, 420, 480, 560

The overvoltage relays and the undervoltage relays are provided with time dials for adjustment of time delay.

The combined under- and overvoltage relays are made both with and without time-delay adjustment. Models IAV53, -69, and -73 have time delays which are functions of the setting of the undervoltage contacts. Model IAV70 has a time dial which permits adjustment of time delay independently of the voltage settings.

TRIPPING CIRCUITS AND CONTACT RATINGS

The current carrying rating of the contact circuit is determined by whether the relay has a seal-in unit and by the tap used on the seal-in coil. Without a seal-in unit the relay contacts will close and carry 30 amperes for tripping duty and 2 amperes continuously at control voltages of 250 volts dc or less. Refer Section 7381 for data on target seal-in units.

SELECTION GUIDE—Type IAV

General Description	Rated Volts Ac	Tap Range Volts		Target Seal-in	Contacts	Model Numbers		Case Size	Approx Wt, lb (kg)	
		Min	Max			60 Hertz	50 Hertz		Net	Ship
OVERVOLTAGE (DEVICE No. 59)										
General duty, overvoltage and control switching. Time delay 1 to 10 seconds at 1.6 times tap setting.	115 208 230 460	55 70 110 220	140 140 280 560	0.2/2	1-N.O.	12IAV51A1A A7A A2A A3A	12IAV51A4A A9A A5A A11A	S1	12 (5.4)	15 (6.8)
Same as IAV51A except 2 N.O. Contacts large seal-in	115 199 230	55 70 110	140 140 280	0.2/2 (1)	2-N.O.	12IAV52A1A A7A A2A	12IAV52A4A A9A A5A			
Low Pick-up										
Ground detection on 3-phase systems and on generator stator windings. Time delay 0.75 to 7.5 seconds at 200% of tap setting, 4 seconds on N.O. 10 TDS.	115* 199* 345*	10 16 28	40 64 112	0.2/2	1-N.O.	12IAV51D2A D1A D9A	12IAV51D5A D4A D10A	S1	12 (5.4)	15 (6.8)
	67*	5.4	20			12IAV51K1A	12IAV51K2A	S1†	13 (5.9)	16 (7.3)
Same as IAV51D or IAV51K except 2 N.O. Contacts	199*	16	64		2-N.O.	12IAV52D1A	......	S1	12(5.4)	15(6.8)
	67*	5.4	20			12IAV52K1A	12IAV52K2A	S1†	13 (5.9)	16 (7.3)
Timing Applications										
Relay circuit closes with time delay. Fixed pickup voltage. Time delay: to 30 seconds at rated volts.	115 208 230		55 100 110	0.2/2	1-N.O.	12IAV51M1A M4A M3A	12IAV51M2A	S1	12 (5.4)	15 (6.8)
Frequency Compensated										
Frequency sensitive applications. Otherwise same as IAV51A compensated 30-90 Hertz	115	55	140	0.2/2	1-N.O.	12IAV71A1A	12IAV71A3A	S1	13 (5.9)	16 (7.3)
Frequency compensated; instantaneous unit ... frequency compensated; for hydro-generator applications; general duty for ac generator overvoltage protection and voltage regulator backup. 1 to 10 second time delay.	115 230 230	55 110 110	140 280 280			12IAV71B2A‡ B5A‡ B6A△	12IAV71B3A‡			
Same as IAV71A except 2 N.O. Contacts	115	55	140		2-N.O.	12IAV72A1A	......			
Same as IAV72A except includes ... with 1 N.O. Contact	115 230	55 110	140 280			12IAV72B1A‡	12IAV72B4A‡ B3A‡			
Same as IAV72B except includes ... with 2 N.O. Contacts	115	55	140			......	12IAV72C3A‡			

* IAV51D, 51K, 52D, and 52K — 10 Second Rating at 360 volts
† Includes external capacitor
‡ Inst. unit adjustable 120-200 volts
△ Inst. unit adjustable 180-300 volts

Type IAV
Time Delay Voltage Relays

SELECTION GUIDE—Type IAV

General Description	Rated Volts Ac	Tap Range Volts Min	Tap Range Volts Max	Target Seal-in	Contacts	Model Number 60 Hertz	Model Number 50 Hertz	Case Size	Approx Wt, lb (kg) Net	Approx Wt, lb (kg) Ship
UNDERVOLTAGE (Device No. 27)										
5 Sec Time Delay at zero volts if set on No. 10 TD Time Range 1 to 13 sec at 80% of tap.	67 115 208 230 460	32 55 110 110 220	80 140 280 280 560	0.2/2	1 N.C.	12IAV54E14A E1A E13A E2A E3A	...... 12IAV54E4A E5A E6A	S2	12 (5.4)	16 (7.3)
30 Sec Time Delay at zero volts if set on No. 10 TD	115 230 460	55 110 220	140 280 460			12IAV54F1A F2A F3A	...... 12IAV54F4A			
75 Sec Time Delay at zero volts on No. 10 TD	115 460	55 220	140 560			12IAV54H1A H2A	....			
Same as IAV54E except no Seal-in	115 230 460	55 110 220	140 280 560	None		12IAV54J1A J2A J3A	.... 12IAV54J4A			
5 Sec Time Delay same as IAV54E except 2 N.C.	115 230 460	55 110 220	140 280 560	0.2/2	2 N.C.	12IAV55C1A C2A C3A	12IAV55C4A C5A C9A			
30 Sec Time Delay	115 230	55 110	140 280			12IAV55F1A F2A	....			
75 Sec Time Delay	115	55	140			12IAV55H1A	......			
Frequency Compensated										
5 Sec Time Delay at zero volts on No. 10 TDS. Compensated 30-90 Hz	115	55	140	0.2/2	1 N.C.	12IAV74A1A	......	S2	13 (5.9)	17 (7.7)
OVER- AND UNDERVOLTAGE (Device No. 27/59)										
General duty; electrically separate contacts with target seal-in unit in series with each contact; UV adjustable from 60 to 90% of OV tap setting. Time delay 1.1 sec. at zero volts; 0.4 sec. at 2 x tap. setting.	115 230 460	55 110 220	140 280 560	0.2/2 (2)	1 N.C. 1 N.O.	12IAV53K1A K2A K3A	12IAV53K4A K5A K11A	S2	13 (5.9)	17 (7.7)
Automatic control schemes; same as IAV53K except target seal-in units are omitted	115 230 460	55 110 220	140 280 560	None		12IAV53L1A L2A L3A	12IAV53L4A L5A			
Similar to IAV53K except target seal-in units are omitted. Time delay 0.5 sec. at zero volts.	115 460	55 220	140 560			12IAV53N1A N3A	....			
General duty; common connection between contacts; OV setting is independent of UV adjustment; UV adjustable from 60 to 90% of OV tap setting; target and seal-in unit in series with each contact.	120 208 240	55 110 110	140 280 280	0.2/2 (2)		12IAV69A1A A4A A2A	12IAV69A3A			
Automatic control schemes; same as IAV69A except target seal-in units are omitted	120 240	55 110	140 280	None		12IAV69B1A B2A	12IAV69B3A			
General duty; common connection between contacts; UV setting fixed at 90% or more of OV tap setting; target seal-in unit in series with each contact; adjustable time delay 30 seconds max. on complete loss of V.	120 240	55 110	140 280	0.2/2 (2)		12IAV70A1A A2A	....			
Automatic control schemes; same as IAV70A except target seal-in units are omitted	120 240	55 110	140 280	None		12IAV70B1A B2A	12IAV70B3A			
Frequency Compensated										
General duty; same as IAV53K except Frequency Compensated. 30-90 Hz	115	55	140	0.2/2 (2)	1 N.C. 1 N.O.	12IAV73A1A	......	S2	13 (5.9)	17 (7.7)
Automatic control schemes; same as IAV53L except Frequency Compensated. 30-90 Hz				None		12IAV73B1A	......			

New information.

(C/C)

Data subject to change without notice

RA 700, 701, 702, 722, 723, 731-737

Type IAV

Time Delay Voltage Relays

DIAGRAMS AND CHARACTERISTICS

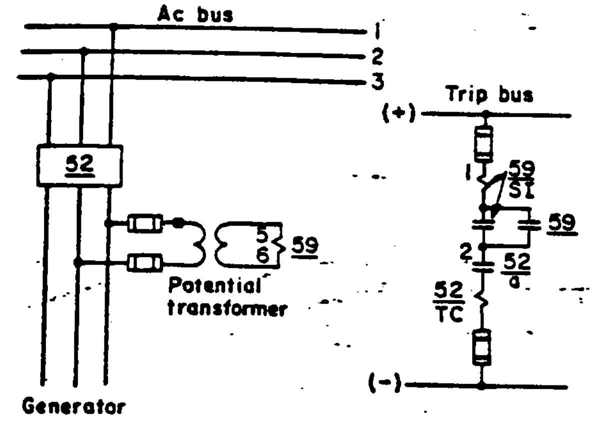


Fig. 2. Typical external for Type IAV51A used for overvoltage protection.

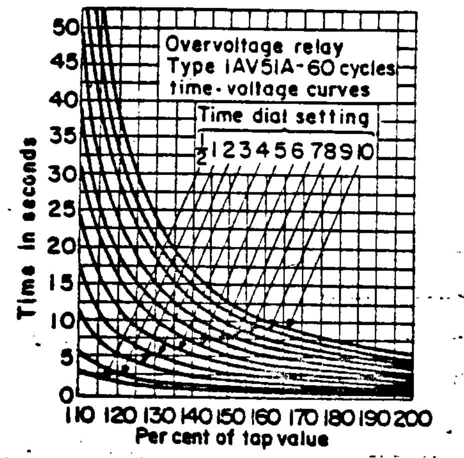


Fig. 3. Typical Time Voltage curve for Types IAV51A, 71 and 72

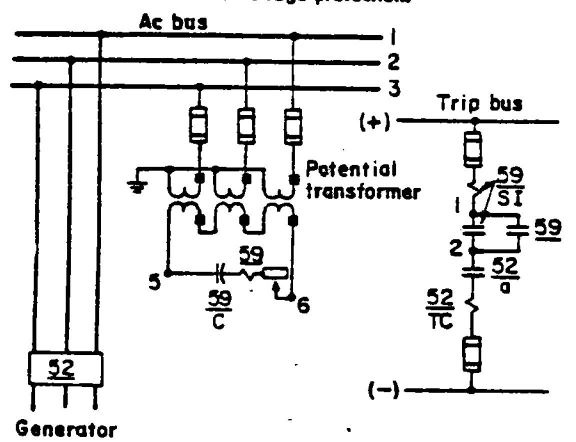


Fig. 4. Typical external for ground fault protection 3ph. Ungrounded system Type IAV51D

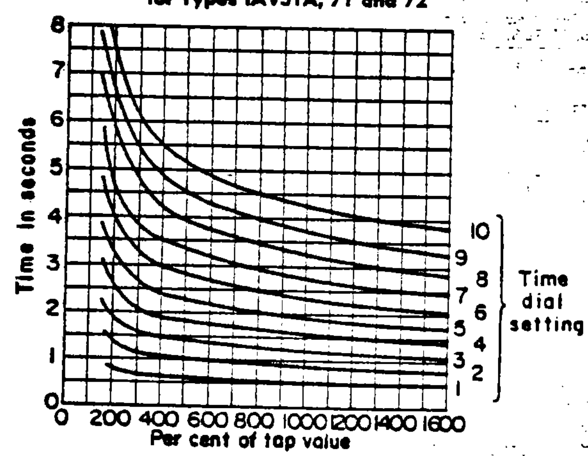


Fig. 5. Typical Time Voltage curve for Types IAV51D and 51K

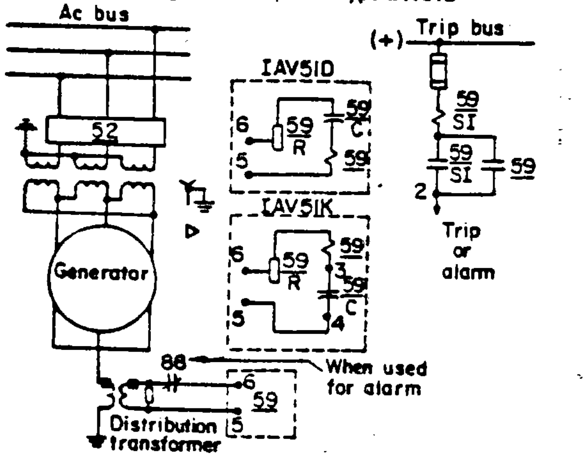


Fig. 6. Typical external for ground fault protection of an ac rotating machine Type IAV51D or 51K

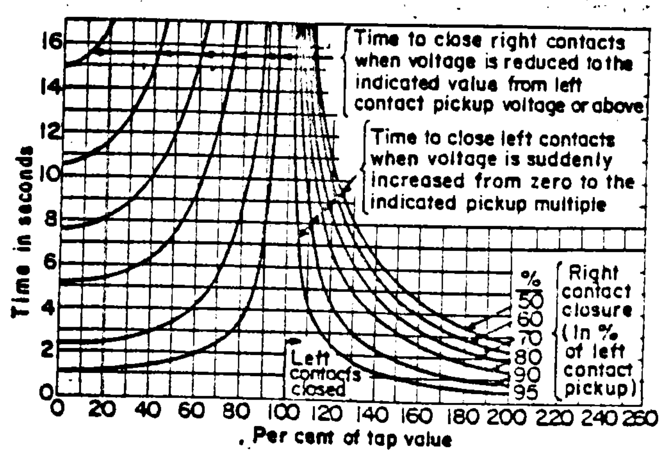
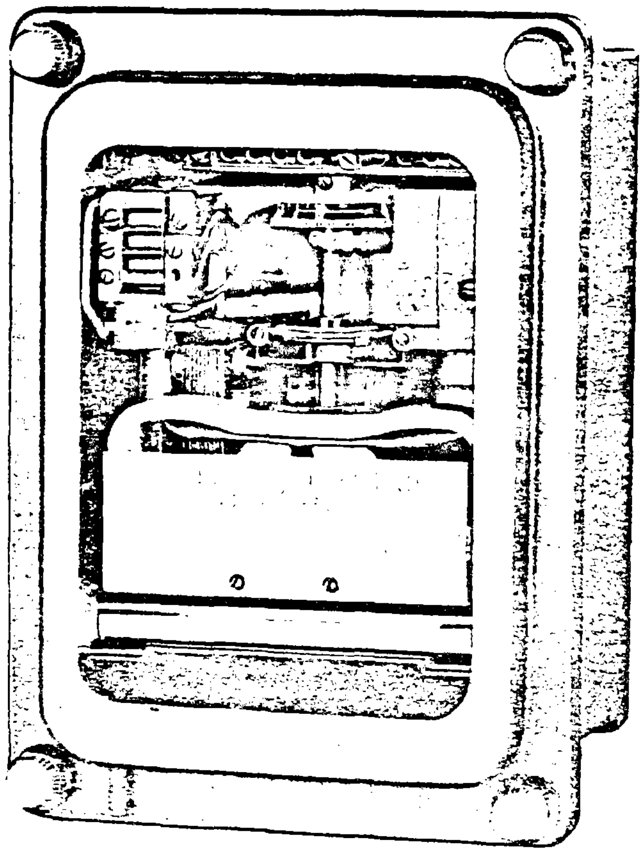


Fig. 7. Typical Time Voltage curve for Types IAV53K, 53L, 73A and 73B

INSTRUCTIONS

GEH-1814D
Supersedes GEH-1814C

VOLTAGE RELAYS



Types

IAV51A	IAV53D
IAV52A	IAV53K
IAV53A	IAV53L
IAV53B	IAV53M
IAV53C	IAV53N

GENERAL ELECTRIC

3.1.1-71

CONTENTS

VOLTAGE RELAYS
TYPES
IAV51A
IAV52A
IAV 53A, 53B, 53C, 53D, 53K, 53L, 53M and 53N

DESCRIPTION

Type IAV relays are single-phase, voltage operated, induction-disk relays with adjustable time delay. * The IAV51A and IAV52A are overvoltage relays. The IAV53A, B, C, D, K, L, M, N are over- and undervoltage relays.

APPLICATION

These IAV relays are used for protection against alternating current overvoltage, for permissive control and tripping of automatic equipment, and for ground detection on equipment and feeders.

* Fig. 10 shows the typical connections for the application of an IAV51A relay for protection against overvoltage in a three-phase system. The IAV52A can be used for applications requiring two trip output * circuits. The operating time characteristics for these relays are shown in Fig. 12.

* Fig. 11 shows the connection diagram for IAV53 over- and undervoltage relays. The IAV53A has separate normally open and normally closed contacts with seal-in units on each contact. A typical application for permissive control and tripping of automatic equipment would utilize the normally open contact to enable the machine breaker closing circuit when normal machine voltage is present, and the normally closed contact to operate the machine breaker trip circuit for undervoltage conditions. The operating time characteristics * for the IAV53A and IAV53B relays are shown in Fig. 13. The IAV53D time characteristics are shown in Fig.14.

The IAC53C is designed for ground fault protection, and would normally be applied with a phase-to-neutral connection, giving 58 percent of rated voltage. The relay is adjusted to have a 10-second operating time for either a ground on the connected phase (0 volt operates the UV contact), or a ground on another phase (rated volts operates the OV coil).

RATINGS AND BURDENS

The operating circuit ratings available are shown in Table I. The operating coil will stand rated voltage continuously on any tap and will stand tap voltage continuously on the taps above rated voltage.

TABLE I

	VOLTAGE RATINGS							
RELAY	300 Hz	140 Hz	100 Hz	60 Hz	50 Hz	40 Hz	35 Hz	25 Hz
IAV51A	115		115	115 208 230 460	115 208 230 460	115 199		115 199 230
IAV52A				115 199 230 460	115 199 230			115 199 230

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

* Indicates revision

TABLE I (Con't.)

RELAY	VOLTAGE RATINGS							
	300 Hz	140 Hz	100 Hz	60 Hz	50 Hz	40 Hz	35 Hz	25 Hz
IAV53A		115	115	115 230 460	115 230		230	115 230
IAV53B				115 230 460	115 230			115
IAV53C				115 199	115 199			115 199
IAV53D			115	115 240				115

The current-closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying ratings are affected by the selection of the tap on the seal-in coil as indicated in Table II.

TABLE II

FUNCTION	AMPERES	
	2-Amp TAP	0.2-Amp TAP
Tripping Duty	30	3
Carry Continuously	3	0.3

The two-ampere tap has a d-c resistance of 0.13 ohms and a 60 cycle impedance of 0.53 ohms while the 0.2-ampere tap has a seven-ohm d-c resistance and a 52 ohm 60 cycle impedance. The tap setting used on the seal-in element is determined by the current drawn by the trip coil.

The 0.2-ampere tap is for use with trip coils that operate on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage. If this tap is used with trip coils requiring more than two amperes, there is a possibility that the seven-ohm resistance will reduce the current to so low a value that the breaker will not be tripped.

The two-ampere tap should be used with trip coils that take two amperes or more at minimum control voltage, provided the tripping current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes an auxiliary relay should be used, the connections being such that the tripping current does not pass through the contacts of the target and seal-in coil of the protective relay.

The above data in regard to contact rating applies to all relays covered by these instructions except the Types IAV53B and IAV53D which do not have seal-in units. In these cases, the contact ratings are limited in their current-carrying capacity by the interrupting ratings as shown below:

FUNCTION	VOLTS	AMPERES	
		a-c	d-c
Make and	125	1.5	0.3 **
interrupt	250	0.75	0.15 **
at	600	0.00	0.00

** Noninductive Load

REPRESENTATIVE

Burdens for the various relay types are given in Table III.

TABLE III

RELAY TYPES	VOLTAGE RATING	TAP ** SETTING	VOLT-AMPS	POWER FACTOR	WATTS
60 - CYCLE BURDENS					
IAV51A & IAV52A	115	140	1.3	0.34	0.4
		120	1.8	0.35	0.5
		105	2.4	0.34	0.7
		93	3.1	0.33	0.9
		82	3.9	0.32	1.2
		70	5.4	0.31	1.7
		64	6.6	0.31	2.1
		55	9.2	0.35	3.2
IAV53A, IAV53B, & IAV53D	115	140	2.2	0.32	0.7
		120	3.0	0.30	0.9
		105	4.0	0.31	1.2
		93	5.4	0.31	1.7
		82	7.0	0.32	2.2
		70	9.9	0.34	3.4
		64	12.0	0.36	4.3
		55	17.0	0.39	6.6
IAV53C	115	NO TAPS	5.7	0.29	1.7
50 - CYCLE BURDENS					
IAV51A & IAV52A	115	140	1.2	0.34	0.4
		120	1.6	0.34	0.5
		105	2.1	0.34	0.7
		93	2.8	0.38	1.9
		82	3.6	0.36	1.3
		70	5.1	0.34	1.7
		64	6.2	0.34	2.1
		55	8.2	0.34	2.9
IAV53A & IAV53B	115	140	1.9	0.32	0.6
		120	2.5	0.30	0.8
		105	3.4	0.29	1.0
		93	4.6	0.31	1.4
		82	6.0	0.32	1.9
		70	8.4	0.35	2.9
		64	12.9	0.29	3.7
		55	13.2	0.35	4.6
IAV53C	115	NO TAPS	4.8	0.32	1.6
25 - CYCLE BURDENS					
IAV51A & IAV52A	115	140	1.1	0.50	0.5
		120	1.5	0.49	0.8
		105	2.1	0.49	1.0
		93	2.7	0.47	1.2
		82	3.4	0.49	1.7
		70	4.8	0.49	2.4
		64	5.8	0.49	2.9
		55	8.2	0.49	4.0

**Minimum pickup volts.

TABLE III (Con't.)

RELAY TYPES	VOLTAGE RATING	TAP ** SETTING	VOLT-AMPS	POWER FACTOR	WATTS
25 - CYCLE BURDENS (Con't.)					
IAV53A & IAV53B	115	140	1.7	0.32	0.5
		120	2.3	0.30	0.7
		105	2.9	0.30	0.9
		93	4.2	0.30	1.3
		82	5.3	0.32	1.7
		70	7.5	0.34	2.6
		64	9.5	0.34	3.3
		55	12.9	0.39	5.0
IAV53C	115	NO TAPS	4.2	0.38	1.6

**Minimum pickup volts.

CHARACTERISTICS

The Type IAV51A is an overvoltage relay with single-circuit closing contacts which close when the voltage increases to pickup value as set on the tap block. The time delay in closing the contacts is determined by the setting of the time dial at the top of the shaft. The time-voltage characteristics of this * relay are shown in Fig. 12.

The IAV52A relay is similar in every respect to the IAV51A relay except that it has additional contacts * for closing a second circuit. The time-voltage characteristics are shown in Fig. 12.

The IAV53A relay is an under-and overvoltage relay with double-throw contacts. The left-hand contacts close as the voltage increases to some predetermined value. The right-hand contacts close when the voltage decreases to some lower value. Between these two voltage values both contacts are open. Time-voltage * characteristics are shown in Fig. 13.

The Type IAV53B relay differs from the Type IAV53A relay in that it does not have seal-in elements. * Time-voltage characteristics are shown in Fig. 13.

The Type IAV53C relay is similar to the Type IAV53A relay except that there are no taps on the coil. The relay is adjusted to close its right contacts in 10 seconds when the voltage is reduced from 58 percent rated voltage to zero voltage; with this calibration the relay closes its left contacts in approximately 10 seconds when the voltage is increased from 58 percent of rated voltage to rated voltage. These relays are used connected line-to-ground so that under normal conditions the relay receives 58 percent of rated phase-to-phase voltage and both relay contacts are open. If the phase to which the relay is connected is grounded, the relay voltage goes to zero and the right-hand contacts close in 10 seconds. If either of the other two phases are grounded, the relay voltage increases to rated voltage and the left-hand contacts close in approximately 10 seconds.

The IAV53D relay is similar to the Type IAV53B relay except that it has a shorter time curve. Time- * voltage characteristics are shown in Fig. 14.

* The Type IAV53K is similar to the Type IAV53A, IAV53L to IAV53B, IAV53M to IAV53C and IAV53N toIAV53D. All four relays are in the double-end case with contacts connected between the upper and lower blocks and operating coils connected to both blocks. The purpose of this is to avoid false tripping of the breaker if the connecting plugs are removed and subsequently reinserted with the relay in the reset position, i.e., circuit opening contacts closed. Insertion of either plug causes the relay to pick up; both plugs must be in place before the contact circuits are completed. See internal connections Fig. 6-8 for coil and contact circuits.

CONSTRUCTION

These relays are of the induction disk construction. The disk is actuated by a potential operating coil on a laminated U-magnet. The disk shaft carries the moving contact, which completes the trip or alarm circuit when it touches the stationary contact or contacts. The disk shaft is restrained by a spiral spring [illegible]ve the proper contact closing voltage, and its motion is retarded by permanent magnets acting on the [illegible] to give the correct time delay.

* There is a seal-in unit mounted to the left of the shaft as shown in Fig. 15. This unit has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close, the

* Indicates revision

seal-in unit picks up and seals in. When the seal-in unit picks up, it raises a target into view which latches up and remains exposed until released by pressing a button beneath the lower-left corner of the cover.

The case is suitable for either surface or semi-flush panel mounting and an assortment of hardware is p..vided for either mounting. The cover attaches to the case and also carries the reset mechanism when one is required. Two of the cover screws have provision for a sealing wire.

The case has studs or screw connections at both ends or at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring-backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug which completes the circuits. The outer blocks, attached to the case, have the studs for the external connections, and the inner blocks have the terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is fastened to the case by thumbscrews holds the connecting plug in place.

To draw out the cradle from a single ended case, the cover must first be removed. Then the connecting plug can be drawn out. In so doing, the trip circuit is first opened, then the voltage circuits are opened. After the connecting plug has been removed, the lower latch can be released and the cradle easily drawn out. To replace the cradle, the reverse order should be followed.

RECEIVING, HANDLING AND STORAGE

RECEIVING

These relays, when not shipped as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of the relay, an examination should be made for any damage sustained during shipment. If injury or rough handling is evident, a damage claim should be filed once with the transportation company and the nearest General Electric Sales Office should be notified .mptly.

HANDLING

Reasonable care should be exercised in unpacking the relay in order that none of the parts are damaged or the adjustments disturbed.

STORAGE

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust, and metallic chips.

ACCEPTANCE TESTS

Immediately upon receipt of the relay an INSPECTION AND ACCEPTANCE TEST should be made to insure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed.

If no pickup value for the left contact is specified on the requisition for the relays with tap blocks, the relay is shipped with the tap plug in the fifth tap. If pickup is specified, the tap plug is set in the tap corresponding to this value. If a specified value does not coincide with one of the taps the tap plug is put in the tap nearest the required value (the lower tap is used if the value is half way between two taps) and the spring is adjusted to obtain the required pickup.

VISUAL INSPECTION

Check the nameplate stamping to insure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other ..ns of physical damage and that all screws are tight. Check that the shorting bars are in the proper location(s) and that they are properly formed (see Fig. 9).

* Indicates revision

CAUTION

EVERY CIRCUIT IN THE DRAWOUT CASE HAS AN AUXILIARY BRUSH. IT IS ESPECIALLY IMPORTANT ON CURRENT CIRCUITS AND OTHER CIRCUITS WITH SHORTING BARS THAT THE AUXILIARY BRUSH BE BENT HIGH ENOUGH TO ENGAGE THE CONNECTING PLUG OR TEST PLUG BEFORE THE MAIN BRUSHES DO. THIS WILL PREVENT CT SECONDARY CIRCUITS FROM BEING OPENED.

MECHANICAL INSPECTION

1. On relays which have time dials, the dials will be set at zero before the relay leaves the factory. It is necessary to change this setting in order to open the relay contacts.

2. On all relays with locked time dials, make sure the two time-dial locking screws are tight. These locking screws are to prevent the dial from moving when the relay is subjected to high operating torque.

3. The moving contact should be fastened securely in its support and should engage the stationary contact about in the middle or at least 1/16 inch inside the periphery of the stationary contact.

•4. The stop arm leaf spring should deflect about 1/64 inch and the stop arm should clear the molded block by at least .020 inch.

5. Any foreign material must be cleaned out of stator air gaps. Clearance between the disk and either the drag magnet or U-magnet should be at least 0.010 inch for any position of the disk.

6. End play of the disk should be from 0.005 inch to 0.010 inch. End play should not be so great as to allow the disk to strike the U-magnet or the drag magnet. Check that top and bottom pivot and bearing screws are tight.

7. There should be no noticeable friction in the rotating structure.

8. Rotate the time dial to the zero position. Check by means of a neon lamp that the contacts just close. There should be approximately 1/32 inch wipe on the stationary contact. If the contact does not close, adjust the disk position by backing off the two clamping screws on the stop arm and rotating the stop arm relative to the cutout in the disk. This provides a coarse adjustment. Retighten the clamping screws.

   For fine adjustment of contact closing, run the stationary contact brush in or out by means of its adjusting screw; after this adjustment, check that the screw is held firmly in its support.

9. On double-throw relays, the support post of the upper spring should clear the insulating plate by at least 1/64 inch.

ELECTRICAL TESTS

A. DRAWOUT RELAYS GENERAL

Since all drawout relays in service operate in their cases, it is recommended that they be tested in their cases or an equivalent steel case. In this way any magnetic effects of the enclosure will be accurately duplicated during testing. A relay may be tested without removing it from the panel by using a 12XLA13A test plug. This plug makes connections only with the relay and does not disturb any shorting bars in the case. Of course, the 12XLA12A test plug may also be used. Although this test plug allows greater testing flexibility, it also requires CT shorting jumpers and the exercise of greater care since connections are made to both the relay and the external circuitry.

B. POWER REQUIREMENTS GENERAL

All alternating-current operated devices are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that alternating-current devices (relays) will be affected by the applied waveform.

Therefore, in order to properly test alternating-current relays it is essential to use a sine wave of current and/or voltage. The purity of the sine wave (i.e. its freedom from harmonics) cannot be expressed as a finite number for any particular relay, however, any relay using tuned circuits, R-L or RC networks, or saturating electromagnets (such as time-overcurrent relays) would be essentially affected by non-sinusoidal wave forms.

Similarly, relays requiring d-c control power should be tested using d-c power and not full wave rectified power. Unless the rectified supply is well filtered, many relays will not operate properly due to the dips in the rectified power. Zener diodes, for example, can turn off during these dips. As a general rule the d-c source should not contain more than 5 percent ripple.

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C. PICKUP VOLTAGE TEST

The pickup voltage should be checked on one or more taps on relays which close contacts on increasing voltage. The drop-out voltage should be checked on one or more taps on relays which close contacts on decreasing voltage. See relay nameplates for values of pickup or drop-out voltages (closing voltages, right left contact).

D. TIME-VOLTAGE TEST

The time-voltage curves should be checked for one or more settings.

* Recommended test connections for the above test are shown in Fig. 17 for the overvoltage relays such as the Types IAV51A and IAV52A. The under- and overvoltage relays such as the Types IAV53A, IAV53B, IAV53C and IAV53D can be checked for time of closing left contacts by using connections shown in Fig. 17, and for closing right contacts by the connections shown in Fig. 18. Of course the seal-in unit shown in the figure is not used in the case of the IAV53B and IAV53D, but all stud numbers are correct. Stud numbers 1 and 2 should be substituted for stud numbers 9 and 10 on Fig. 18 for testing the undervoltage contacts of the Type IAV53C relay. (See internal diagram, Fig. 5.) See internal connections, Figs. 6-8, for contact and coil connections for IAV53K, IAV53L, IAV53M and IAV53N.

INSTALLATION

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other imperfections. If any trouble is found, it should be corrected in the manner described under MAINTENANCE. Check the nameplate for model number and rating.

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to faciliate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel drilling dimensions are shown in Fig. 19 for relay Types IAV51A, IAV52A and IAV53C. Fig. 20 shows outline and panel drilling for relay Types IAV53A, IAV53B and IAV53D. Fig. 21 shows the outline and panel drilling for relay Types IAV53K, IAV53L, IAV53M and IAV53N.

CONNECTIONS

* Internal connections are shown in Figs. 1 to 8 for the various relays.

GROUND CONNECTIONS

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B&S gage copper wire or its equivalent.

FIELD INSTALLATION TESTS

Before the relay is put in service, the pickup voltage and time-voltage tests described in ACCEPTANCE TESTS (ELECTRICAL TESTS) should be made to determine that the adjustments have not been disturbed.

The relay may be tested while mounted on the panel, either from its own or another source of power, by inserting a separate testing plug in place of the connecting plug. Or, the cradle can be drawn out and replaced by another which has been laboratory tested.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

In view of the vital role of protective relays in the operation of a power system it is important that a periodic test program be followed. It is recognized that the interval between periodic checks will vary depending upon environment, type of relay and the user's experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to his individual requirements it is suggested that the points listed under INSTALLATION PROCEDURE be checked every six months.

* Indicates revision

MAINTENANCE

DISK AND BEARINGS

The lower jewel may be tested for cracks by exploring its surface with the point of a fine needle. If is necessary to replace the jewel, the jewel should be turned up until the disk is centered in the air gap, after which it should be locked in position by the set screw provided for the purpose.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility of the tool insures the cleaning of the actual points of contact. Sometimes an ordinary file cannot reach the actual points of contact because of some obstruction from some other part of the relay.

Fine silver contacts should not be cleaned with knives, files or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described above can be obtained from the factory.

SERVICING AND ADJUSTMENTS

TARGET AND SEAL-IN UNIT

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2-ampere tap.

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2-ampere tap.

For trip coils operating on currents ranging from 2 to 30 amperes at the minimum control voltage, place the tap plug in the 2.0-ampere tap.

The tap plug is the screw holding the right-hand stationary contact of the seal-in element. To cha the tap setting, first remove the connecting plug. Then, take a screw from the left-hand stationary con...ct and place it in the desired tap. Next, remove the screw from the other tap, and place it in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Screws should not be in both taps at the same time as pickup for direct current will be the higher tap value and a-c pickup will be increased.

VOLTAGE SETTING

The voltage at which the contacts operate may be changed by changing the position of the tap plug in the tap block at the top of relay for relays such as the IAV51A, IAV52A, IAV53A, IAV53B, and IAV53D which have tapped coils. The range of this adjustment is from 55 to 140 volts on the 115 volt ratings, 70 to 140 volts on the 199 volt ratings, 110 to 280 volts on the 208, 230 and 240 volt ratings, and 220 to 560 volts on the 460 volt ratings.

The pickup of the relay for any voltage tap is adjusted by means of a spring-adjusting ring. The • ring may be turned by inserting a tool in the notches around the edge (see Fig. 15.) By turning the ring, the operating voltage of the relay may be brought into agreement with the tap setting employed if, for some reason, this adjustment has been disturbed. The adjustment also permits any desired setting between the various taps. The relay is adjusted at the factory to operate from any time-dial position at a minimum voltage within five percent of the tap setting for the relays with the tapped coils mentioned above. For those relays with untapped coils, pickup occurs at a voltage which is eight percent of rated voltage. The relays reset at 80 percent of the operating value on all the overvoltage relays. Operating voltage for the overvoltage relays is the minimum voltage for a given tap setting at which the contacts just make.

On the under- and overvoltage relays such as the IAV53A, IAV53B, IAV53C, and IAV53D, the operating voltage for a given tap setting is the minimum voltage at which the left-hand contacts close. The right-hand contacts will then close at a certain percentage of operating voltage. If it is desired to change this percentage, the right-hand moving contact may be rotated on the shaft after first loosening the clamping screws that hold it in place. Changing the position of this contact gives an adjustment of the ... to close the right-hand contacts between 50 and 95 percent of the voltage which closes the left-hand contacts. Changing the position of the right-hand contacts changes the voltage at which the left-hand contacts close. Hence, simultaneous adjustments for closing left and right contacts must be made to obtain a desired characteristic.

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TIME SETTING

The time of operation of the overvoltage relays is determined primarily by the setting of the time dial, while that for the under-and overvoltage relays is determined by the spread of the contacts as explained under VOLTAGE SETTING. Further adjustment is obtained by moving the permanent magnet along its supporting shelf; moving the magnet in toward the back of the relay decreases the time while moving it out increases the time.

* Fig. 12 shows the time-voltage characteristics of the Type IAV51A and IAV52A relays with the dial setting for obtaining each characteristic. To make time settings, set the time dial to the number required (to give the desired characteristic) by turning it until the number lines up with the notch in the adjacent frame. The time indicated by the curves is the time required to close the relay contacts when the voltage is suddenly increased from a value below pickup to the value on the curve.

* Fig. 13 shows the characteristics of the Type IAV53A and IAV53B relay. The time characteristic of the relay is automatically determined by the setting of the ratio of the voltage to close the right contacts * to the voltage to close the left contacts. Fig. 14 shows the time-voltage characteristics of the Type IAV53D relay. No curve is given for the Type IAV53C since its time-voltage characteristics are explained under the section heading CHARACTERISTICS.

The time-voltage characteristics are plotted in percent thus making them applicable for all tap settings.

BEARING AND CONTACTS

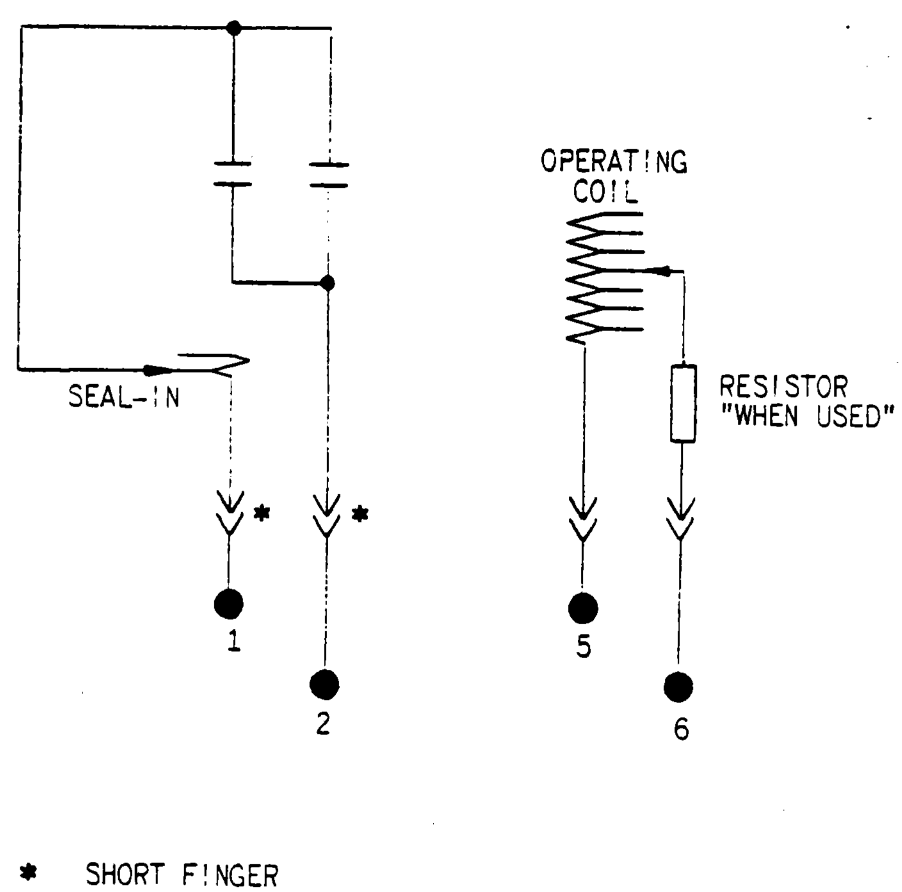
See MAINTENANCE.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any of those worn, broken or damaged. Parts bulletin number GEF-2149 gives a list of those most subject to wear in ordinary operation and to damage due to possible abnormal conditions.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted as shown by Figs. 15 and 16, and give complete nameplate data, including serial number. If possible give the General Electric Company's requisition on which the relay was furnished.

* Indicates revision



* Fig. 1 (K-6209664-6) INTERNAL CONNECTIONS OF THE TYPE IAV51A RELAY, FRONT VIEW

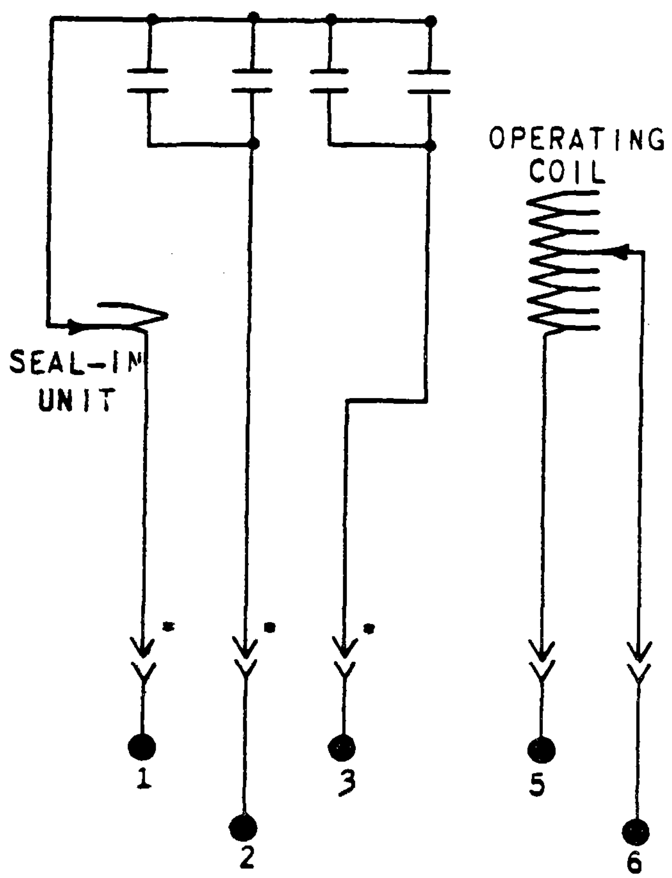


Fig. 2 (K-6209665-3) INTERNAL CONNECTIONS OF THE TYPE IAV52A RELAY, FRONT VIEW

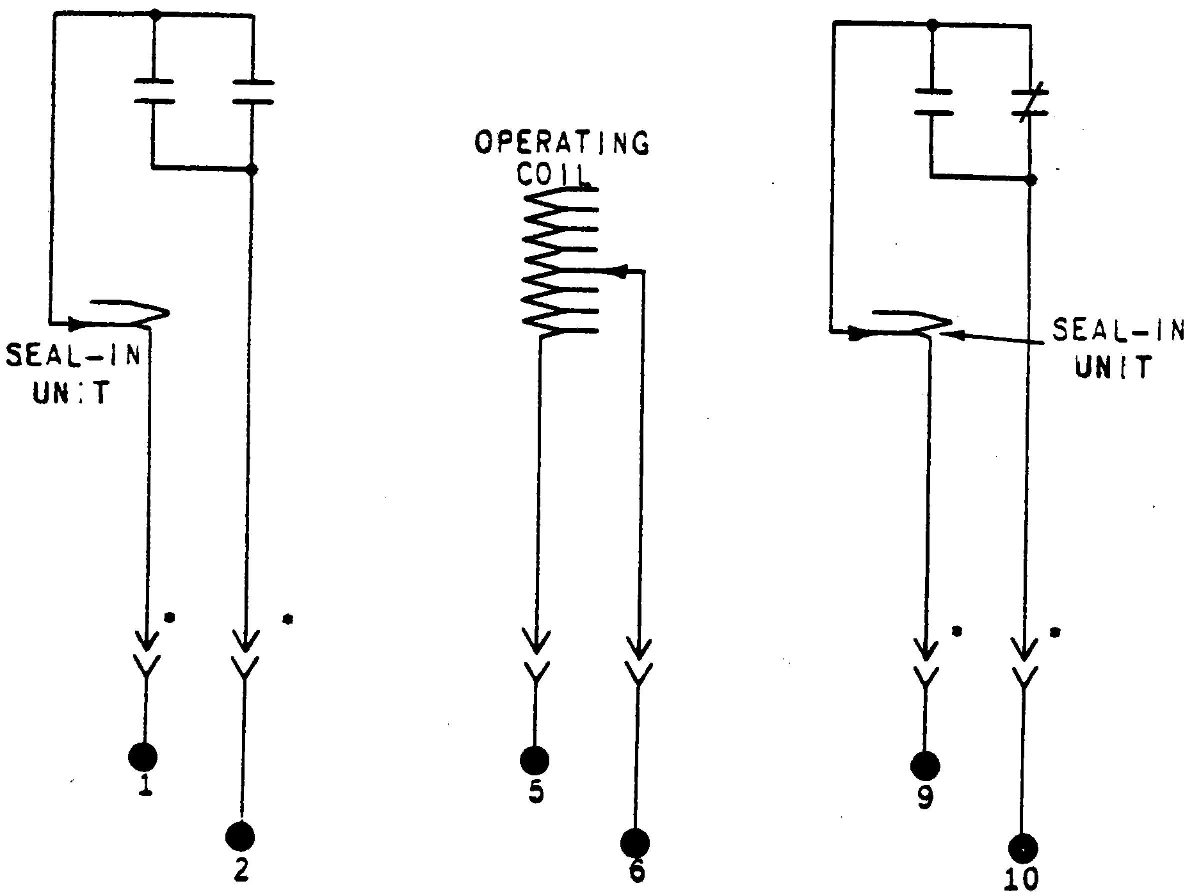


Fig. 3 (K-6209666-3) INTERNAL CONNECTIONS OF THE TYPE IAV53A RELAY, FRONT VIEW

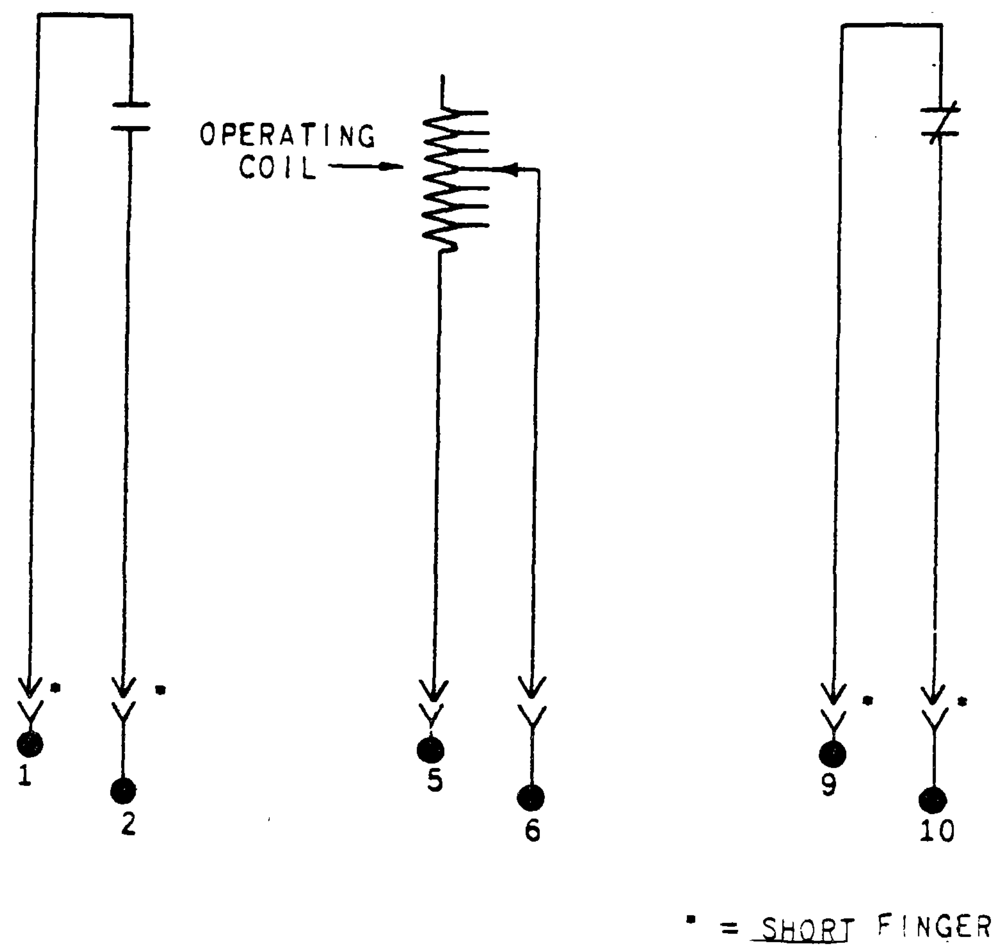


Fig. 4 (K-6400143-2) INTERNAL CONNECTIONS OF THE TYPES IAV53B AND IAV53D RELAYS, FRONT VIEW

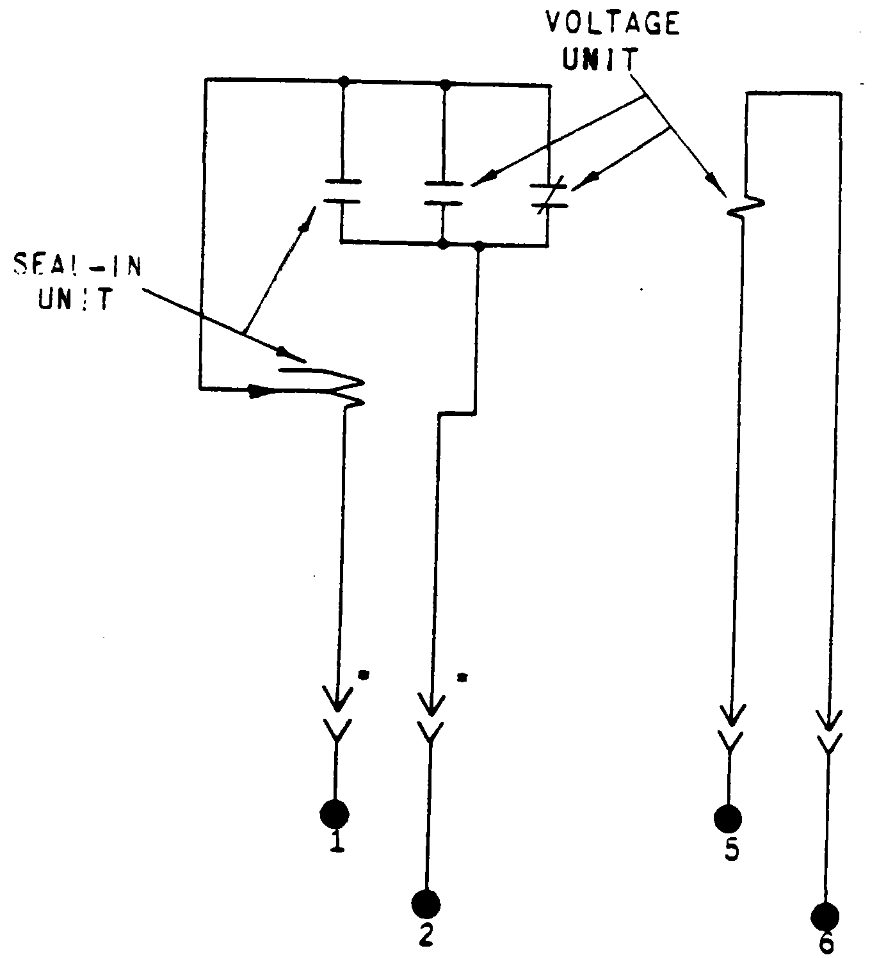


Fig. 5 (K-6400385-2) INTERNAL CONNECTIONS OF THE TYPE IAV53C RELAY, FRONT VIEW

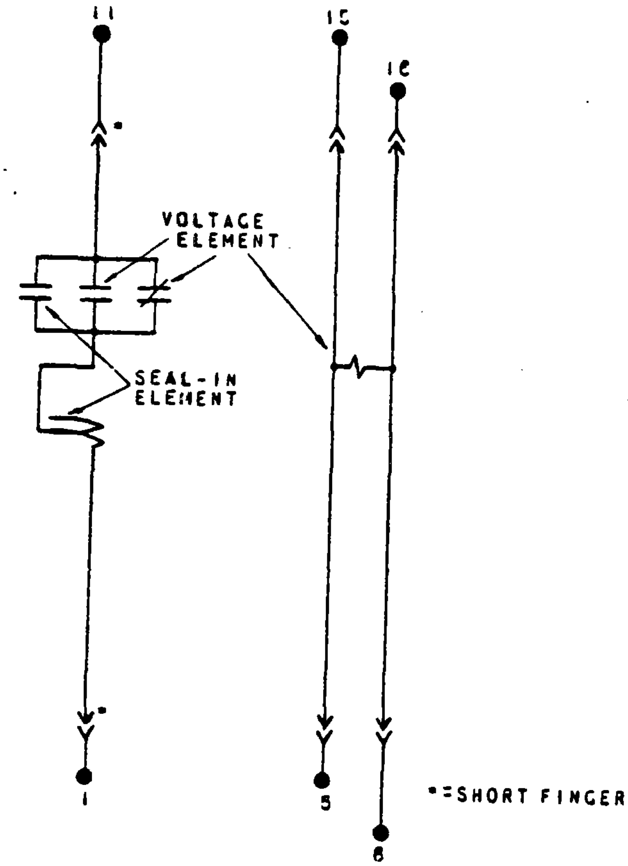


*Fig. 6 (K-6556579-0) INTERNAL CONNECTION DIAGRAM FOR TYPE IAV53M RELAY

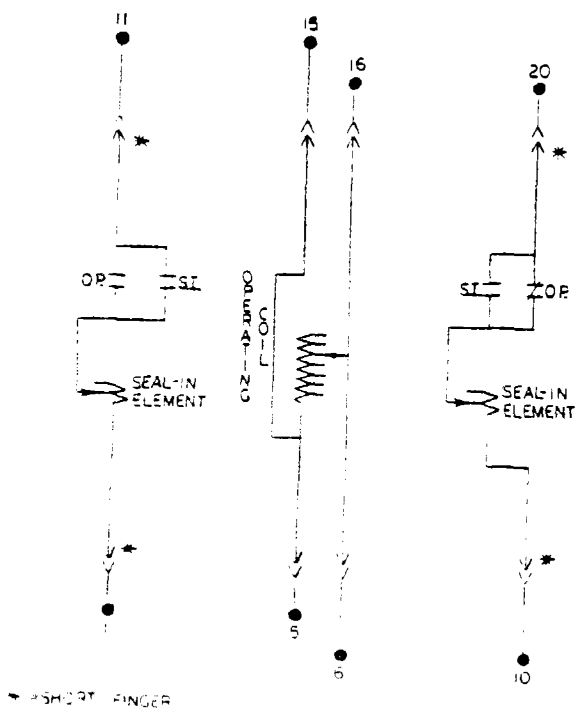


*Fig. 7 (K-6556475-1) INTERNAL CONNECTION DIAGRAM FOR TYPE IAV53K RELAY

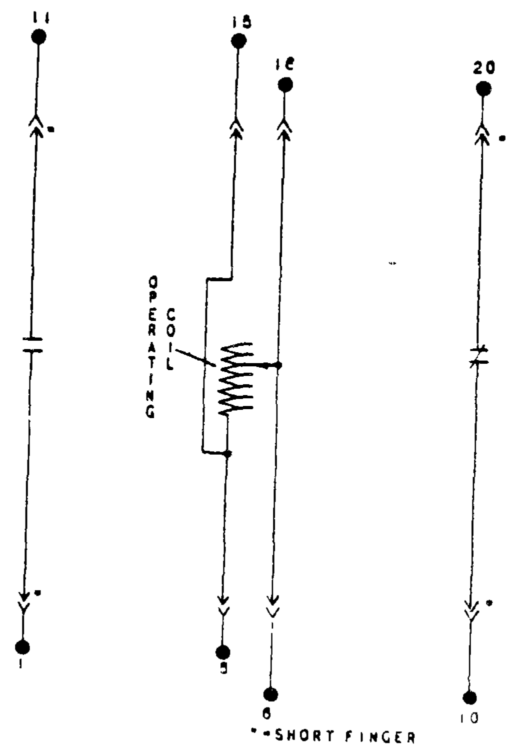


*Fig. 8 (K-6556476-0) INTERNAL CONNECTION DIAGRAM FOR TYPE IAV53L AND IAV53N RELAYS

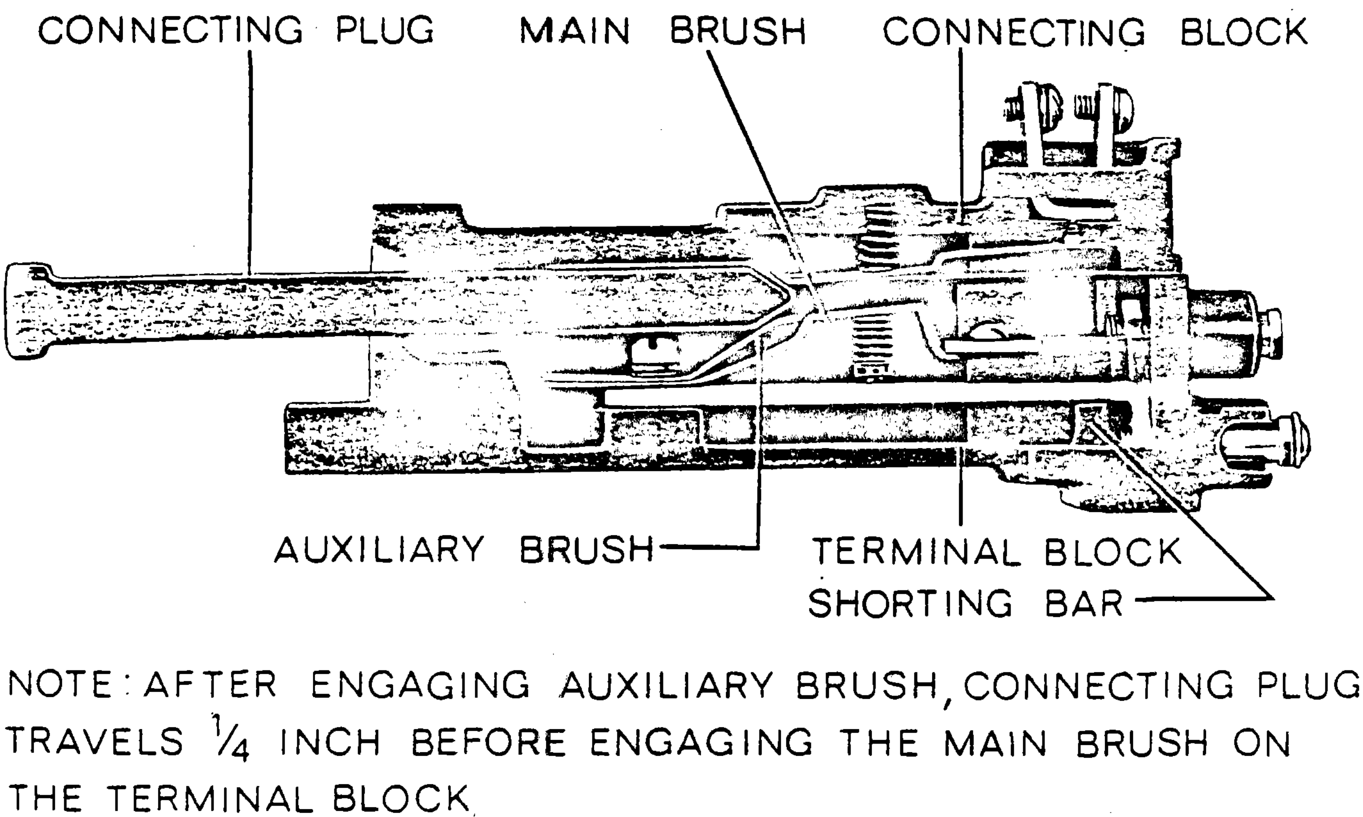
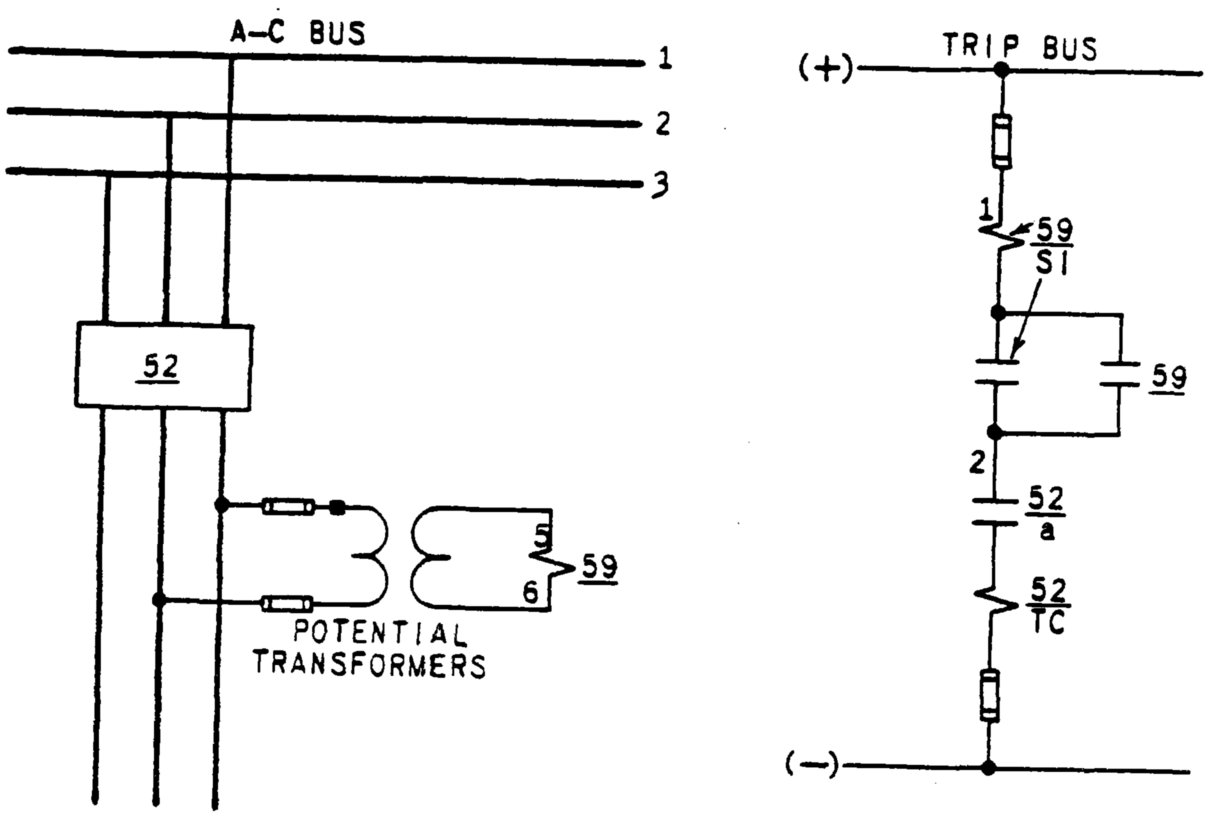


*Fig. 9 (8025039) CROSS SECTION OF DRAWOUT CASE SHOWING POSITION OF AUXILIARY BRUSH



DEVICE FUNCTION NUMBERS

52 – POWER CIRCUIT BREAKER
59 – A–C OVERVOLTAGE RELAY, TYPE IAV51A
a – AUXILIARY CONTACT CLOSED WHEN BREAKER CLOSES
SI – SEAL–IN UNIT WITH TARGET
TC – TRIP COIL

*Fig. 10 (K-6375692-1) CONNECTION DIAGRAM FOR THE TYPE IAV51A RELAY USED FOR OVERVOLTAGE PROTECTION

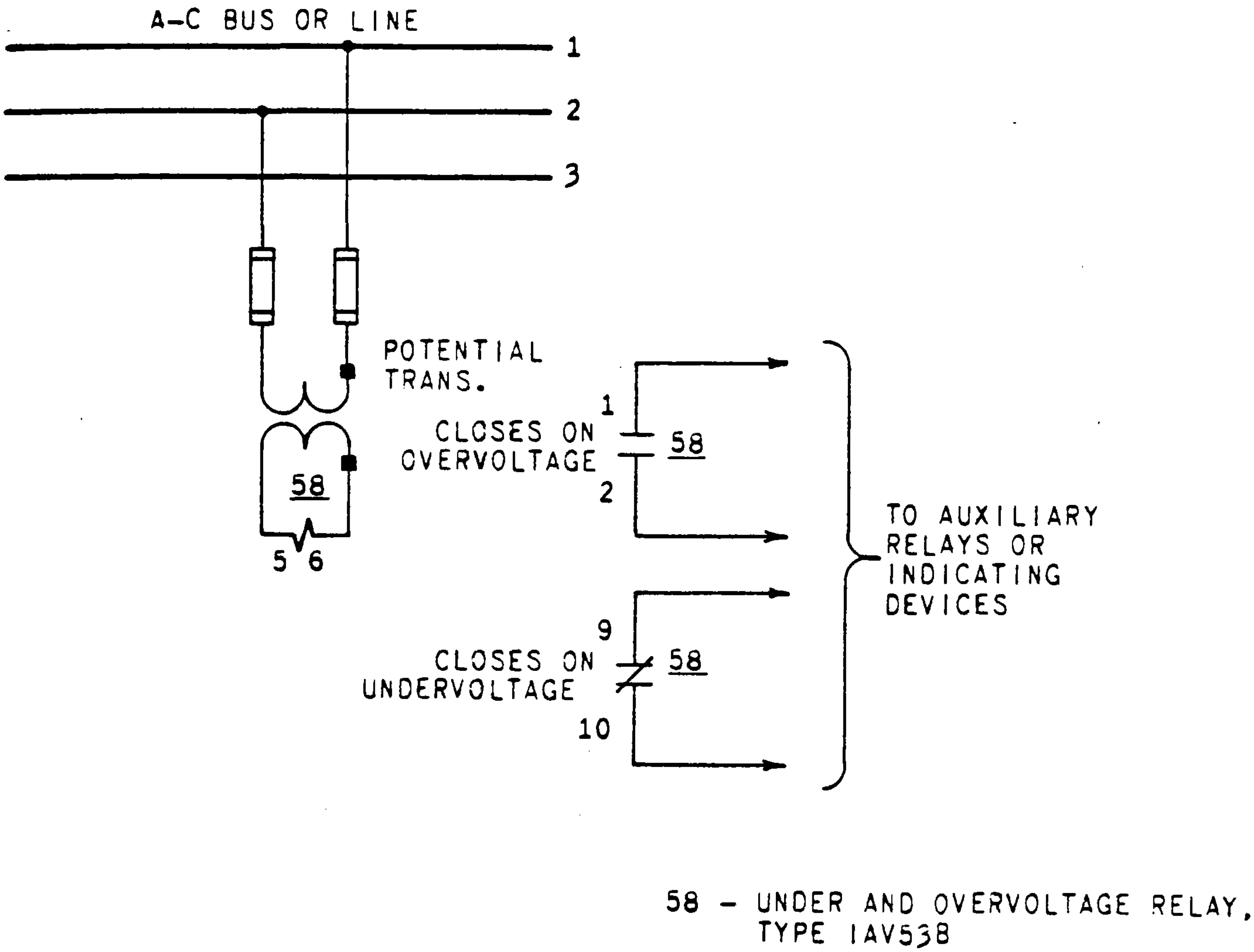


*Fig. 11 (K-6400200-1) CONNECTION DIAGRAM FOR THE TYPE IAV53 RELAY

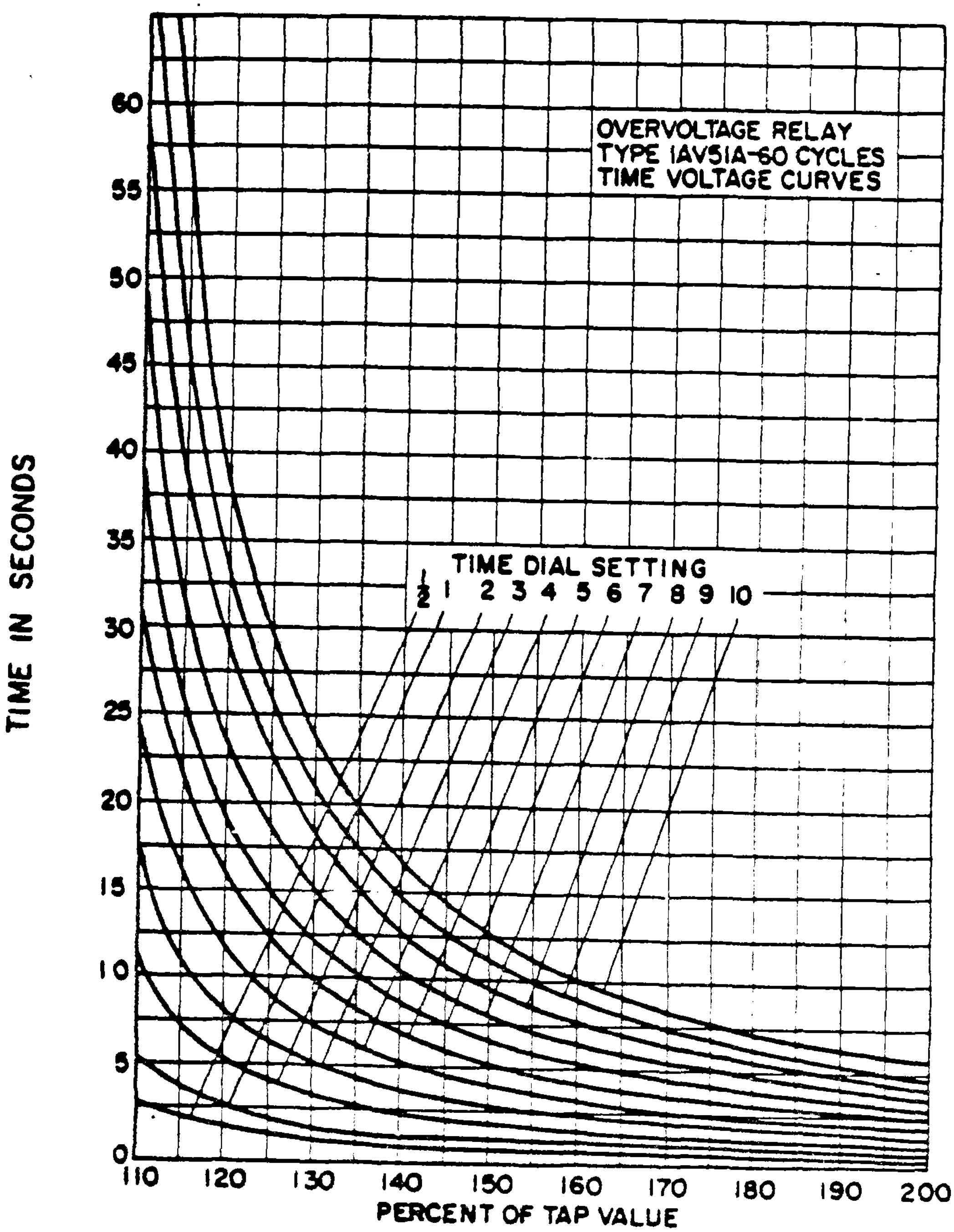


*Fig. 12 (8918488A) TIME-VOLTAGE CURVE TYPES IAV51A AND IAV52A RELAYS (±15% TOLERANCE)

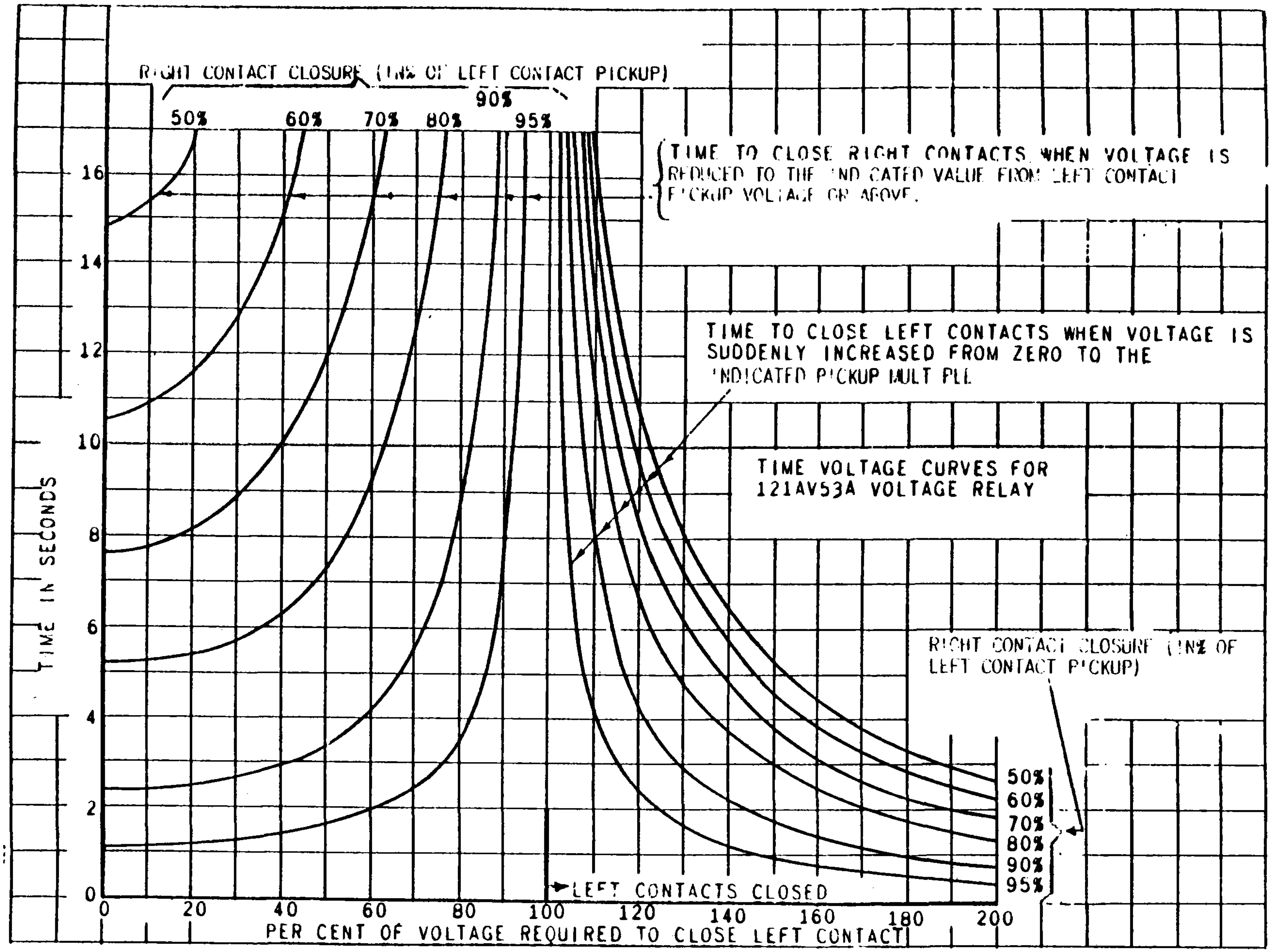


*Fig. 13 (K-6306849-3) TIME-VOLTAGE CURVES FOR TYPES IAV53A AND IAV53B RELAYS (±15% TOLERANCE)

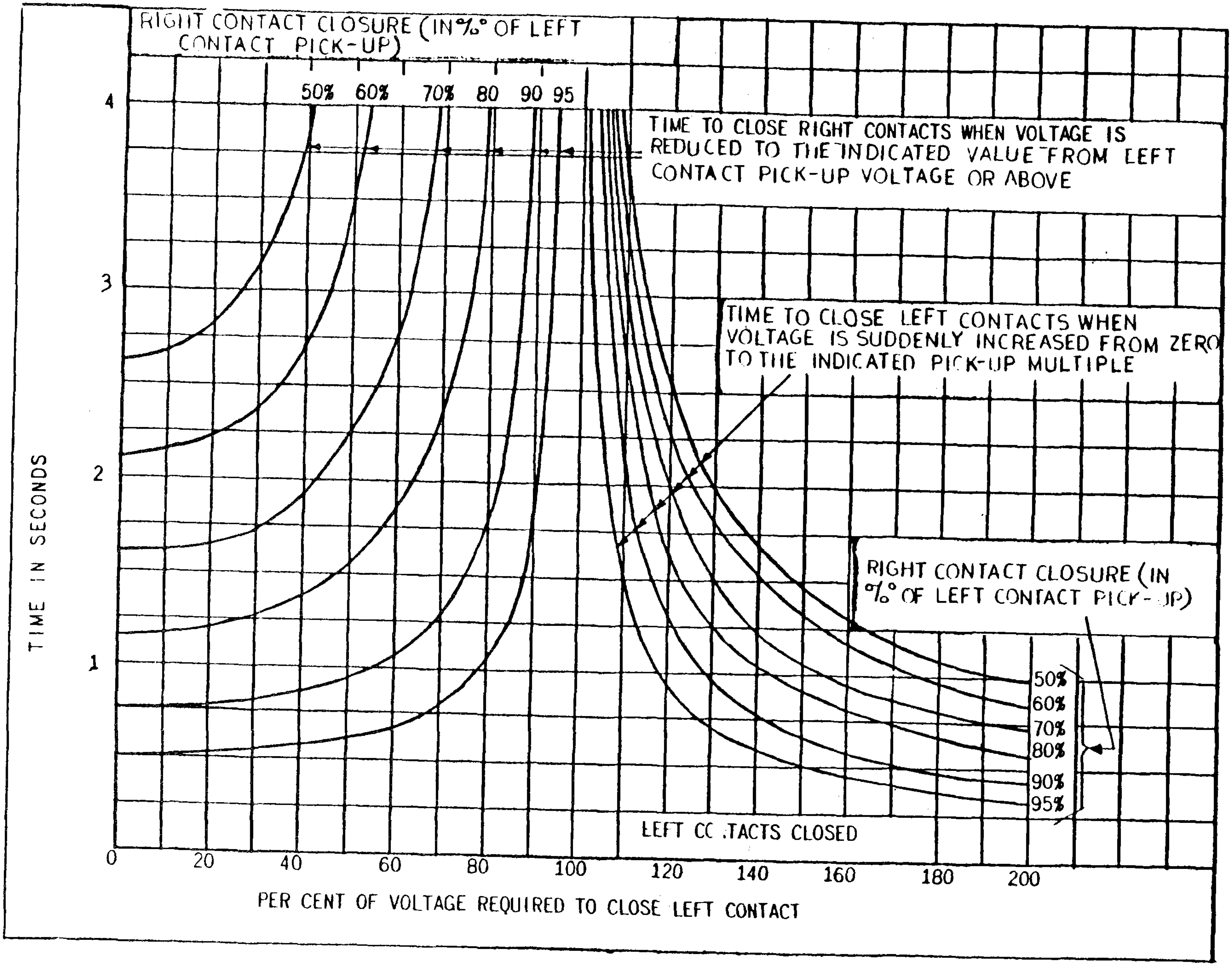


*Fig. 14 (104A8993-1) TIME-VOLTAGE CURVES FOR TYPE IAV53D RELAY (±15% TOLERANCE)

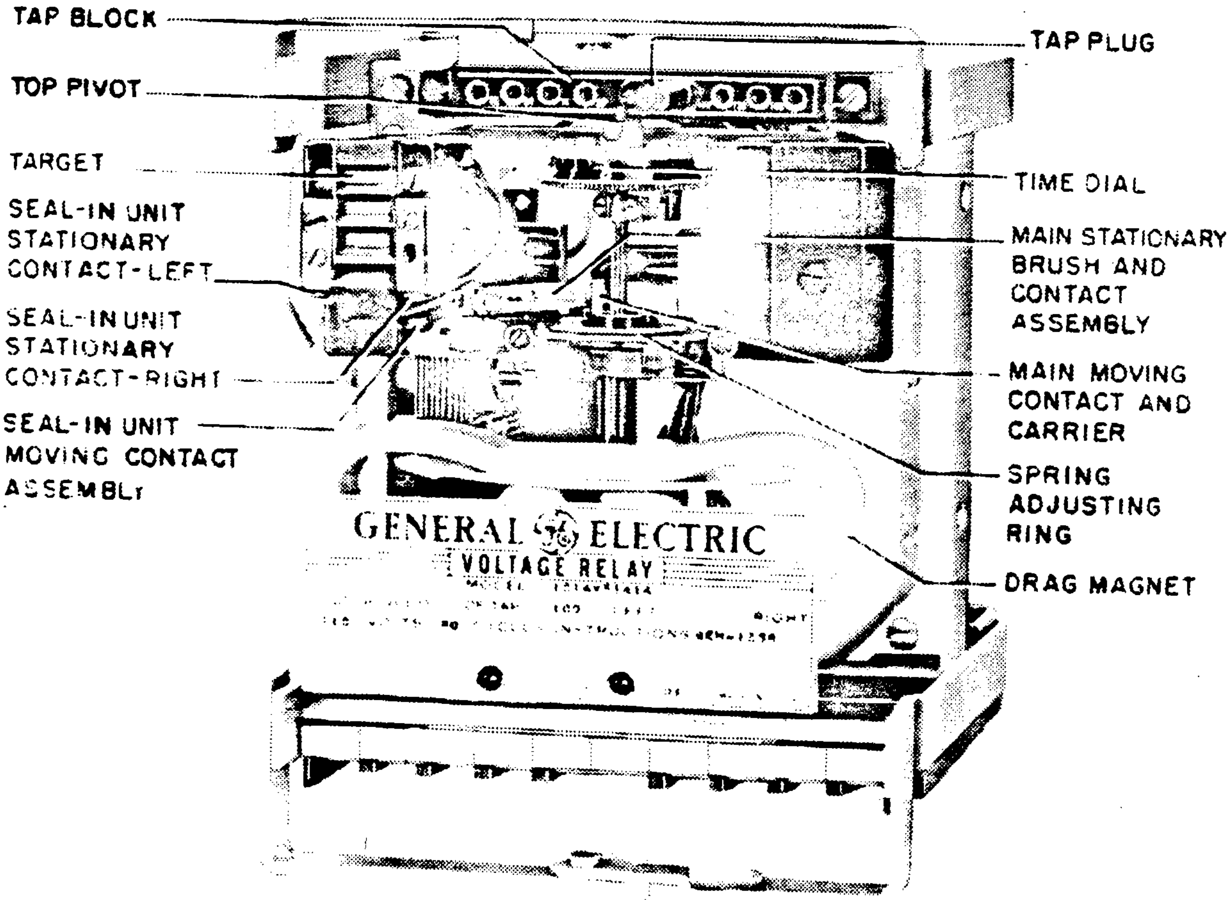


*Fig. 15 (8007378) FRONT VIEW OF TYPE IAV51A RELAY WITHDRAWN FROM CASE

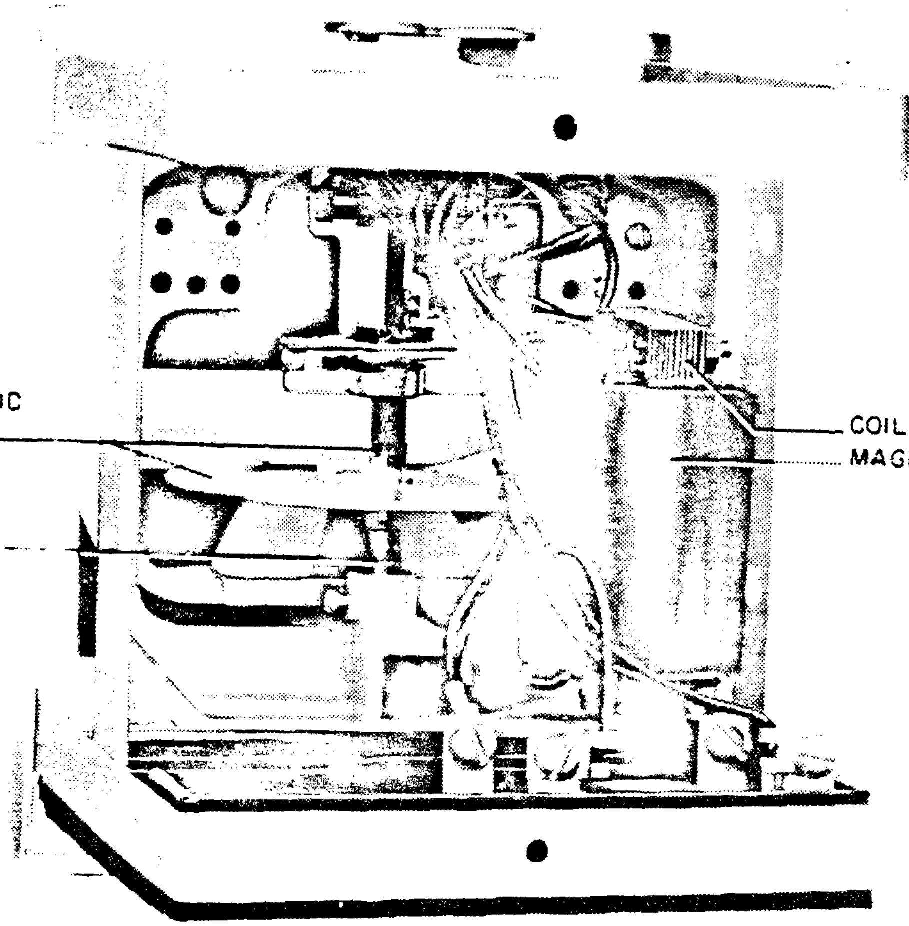
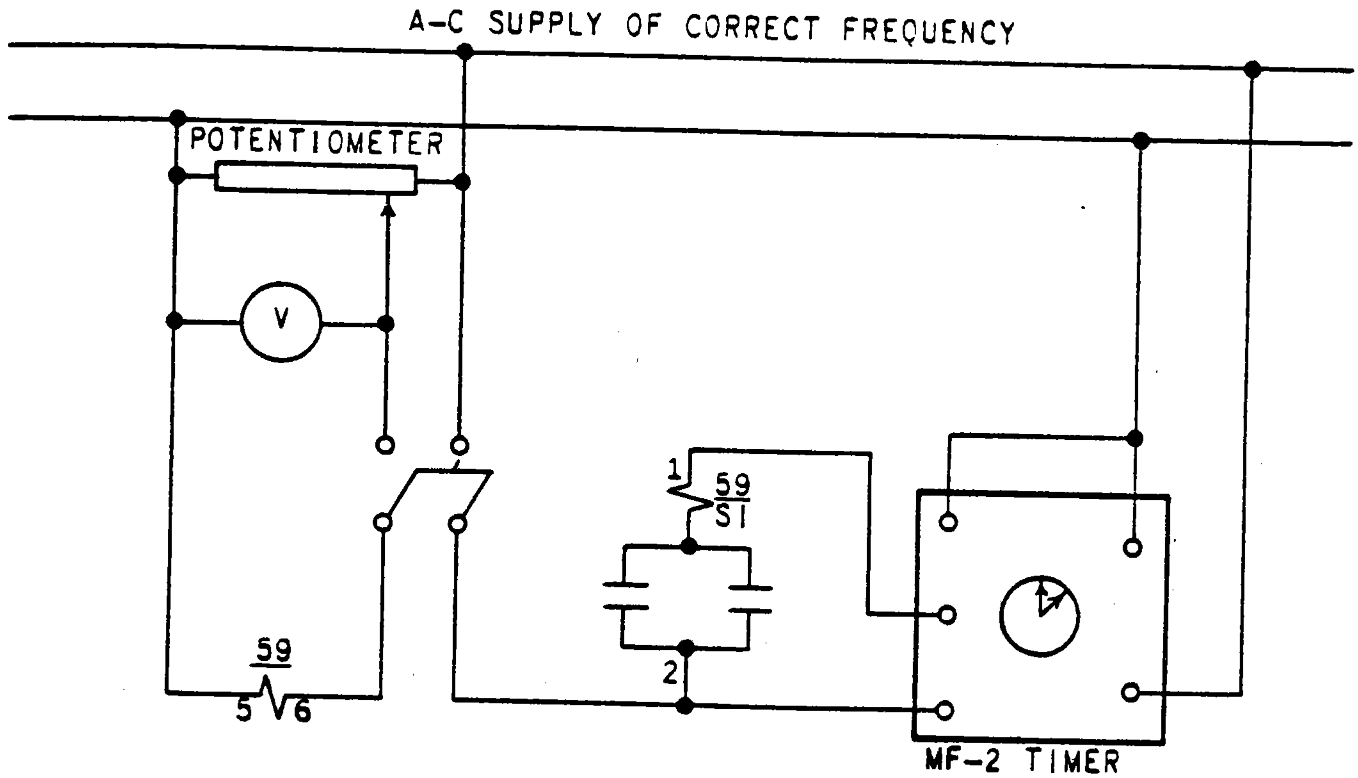


*Fig. 16 (8007379) BACK VIEW OF TYPE IAV51A RELAY WITHDRAWN FROM CASE

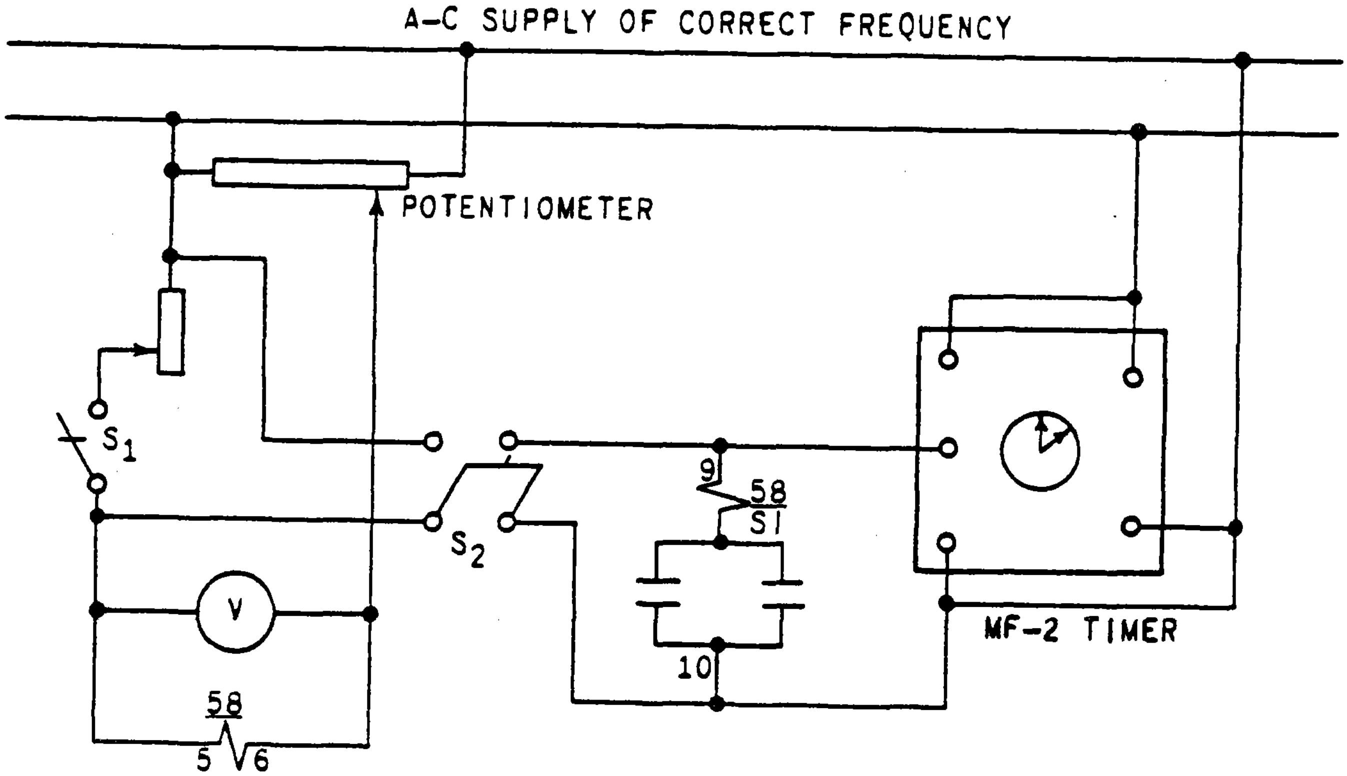


DEVICE FUNCTION NUMBERS

59 - OVERVOLTAGE RELAY TYPE IAV

SI - SEAL-IN UNIT WITH TARGET

*Fig. 17 (K-6154391-2) TEST CONNECTIONS FOR OVERVOLTAGE RELAYS



DEVICE FUNCTION NUMBERS

58 - UNDER AND OVERVOLTAGE RELAY, TYPE IAV53

SI - SEAL-IN UNIT WITH TARGET.

*Fig. 18 (K-6375693-1) TEST CONNECTIONS FOR UNDERVOLTAGE CONTACTS OF OVER-AND UNDERVOLTAGE RELAYS

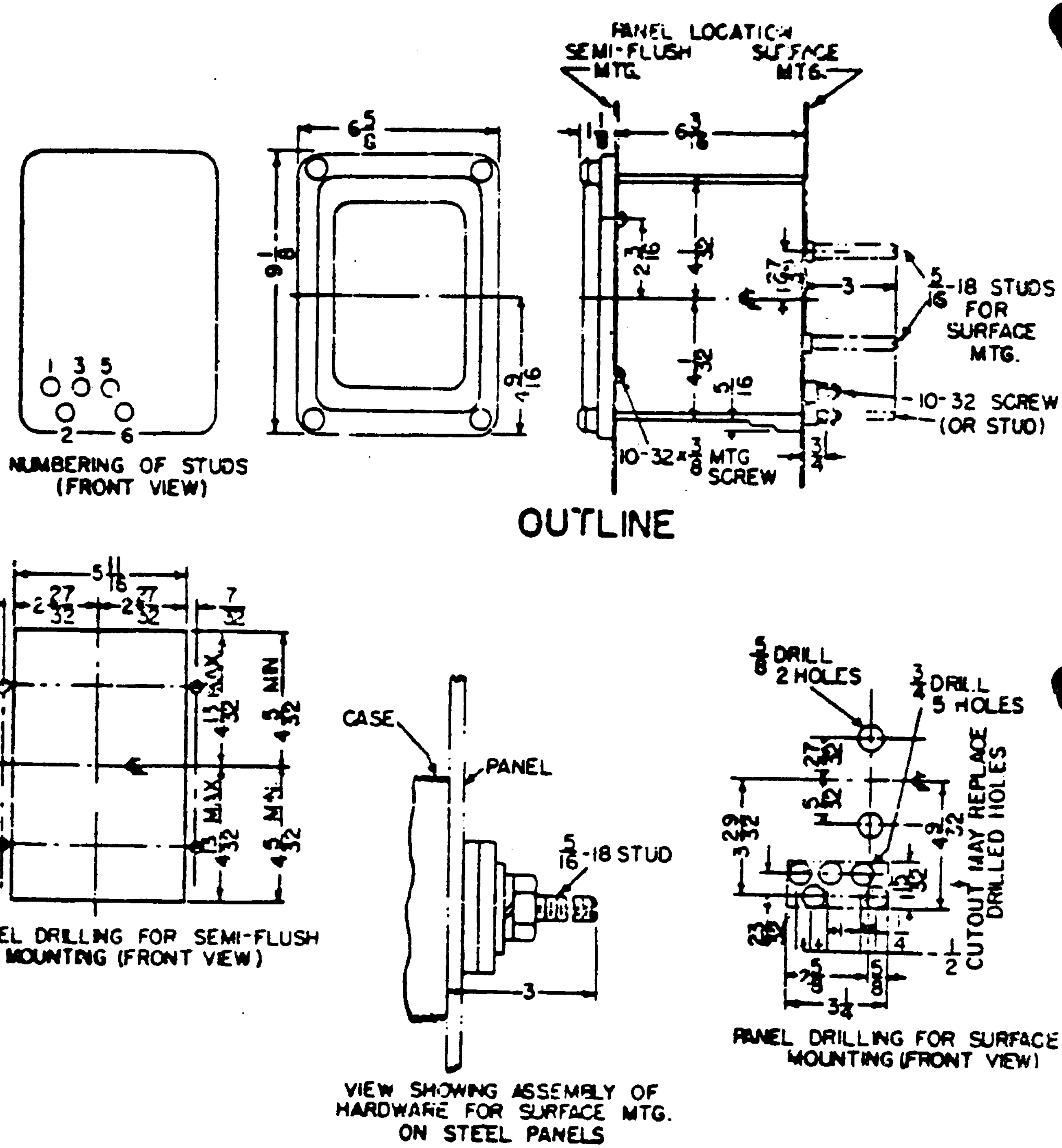


*Fig. 19 (K-6209270-2) OUTLINE AND PANEL DRILLING FOR RELAY TYPES IAV51A, IAV52A, IAV53C

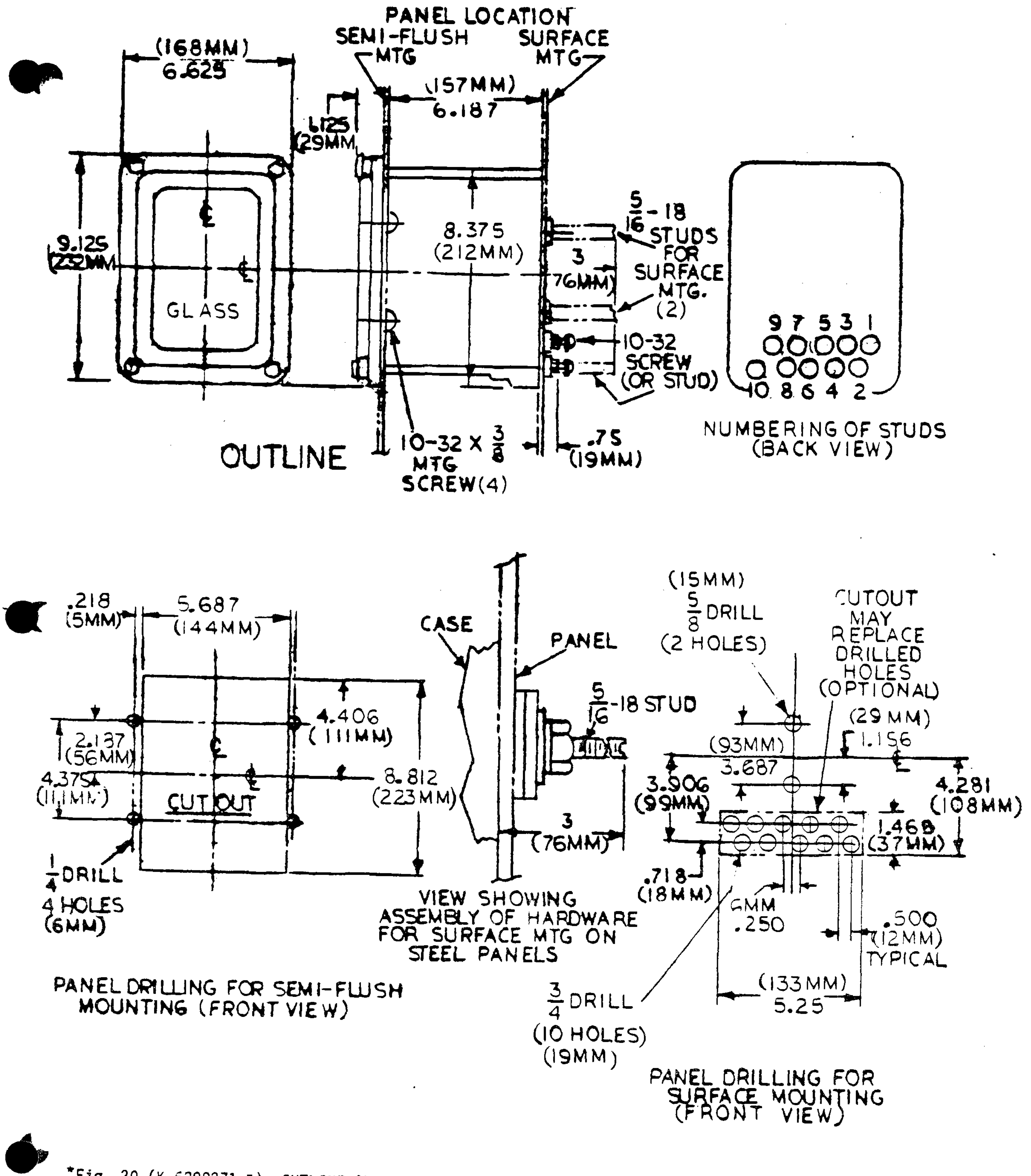


*Fig. 20 (K-6209271-5) OUTLINE AND PANEL DRILLING FOR RELAY TYPES IAV53A, IAV53B AND IAV53D

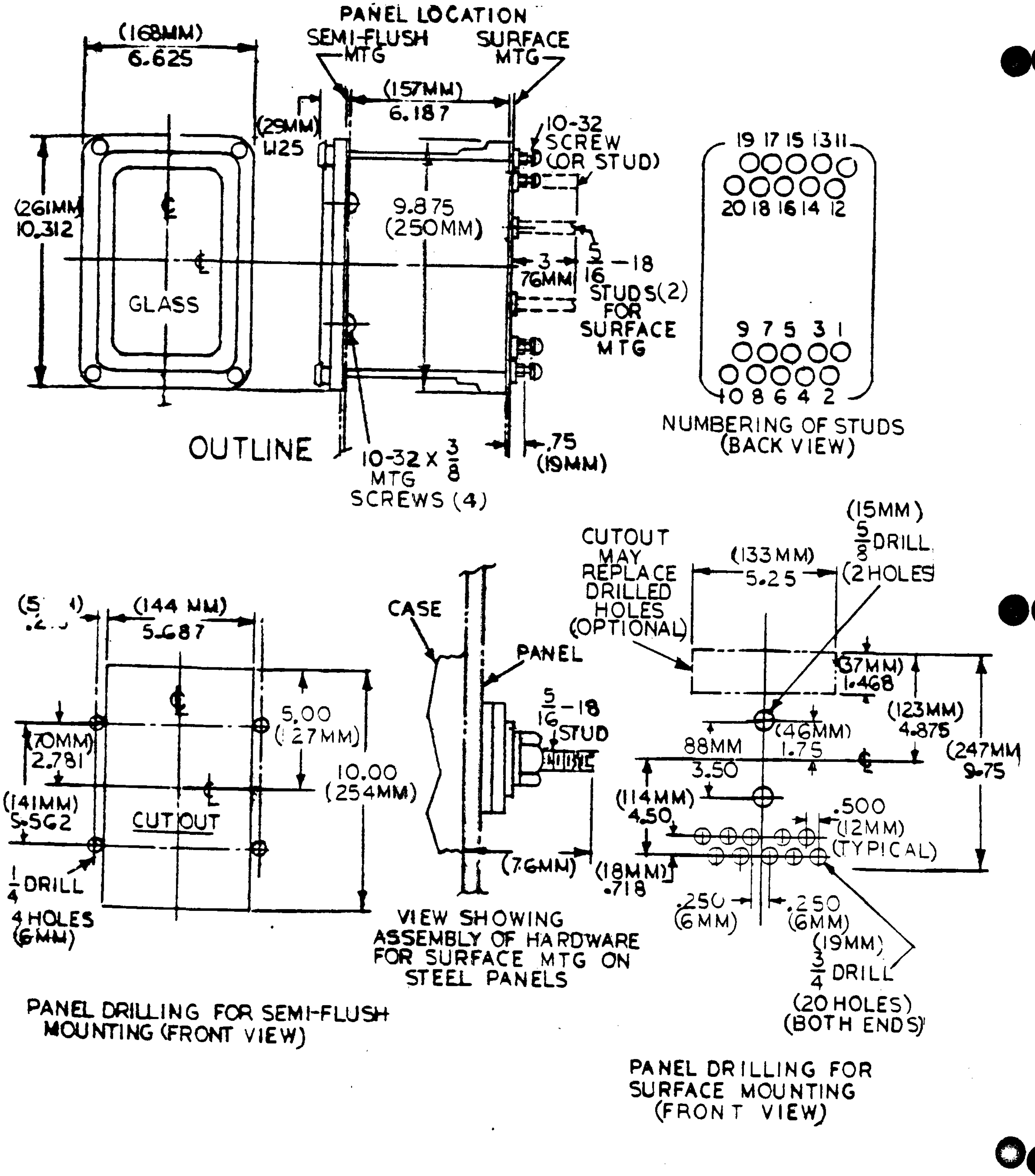


*Fig. 21 (K-6209272-4) OUTLINE AND PANEL DRILLING DIMENSIONS FOR RELAY TYPES IAV53K, IAV53L AND IAV53M RELAYS

GENERAL ELECTRIC COMPANY
POWER SYSTEMS MANAGEMENT BUSINESS DEPT.
PHILADELPHIA, PA. 19142

GENERAL ELECTRIC

RENEWAL PARTS

TYPE IAV
VOLTAGE RELAYS

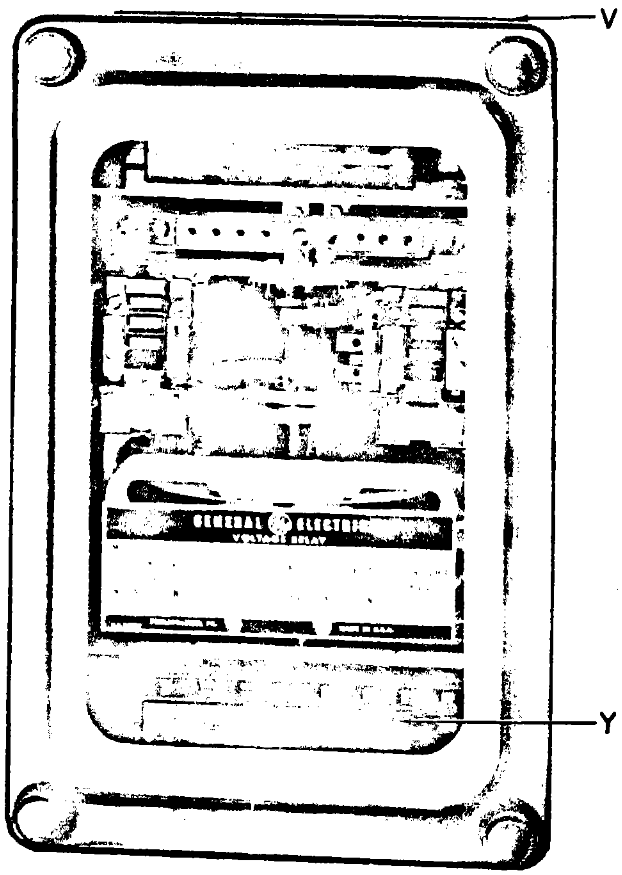


Fig. 1. Typical IAV relay

ORDERING INSTRUCTIONS

1. Always specify the complete nameplate data of the relay.
2. Specify the quantity, catalog number (if listed), reference number (if listed), description, and this bulletin number.
3. Standard hardware, such as screws, bolts, nuts, washers, etc., is not listed in this bulletin. Such items should be purchased locally.
4. For prices, refer to the nearest office of the General Electric Company.

GENERAL ELECTRIC

HOW TO USE THIS BULLETIN

Relay models covered by this bulletin are listed in the left hand column of the tabulation beginning on page 3.

To find the catalog number of a renewal part:

(1) From illustrations on pages 1 and 2, find reference letter for required part.

(2) Locate reference letter and/or description of part in column headings at top of tabulation.

(3) Note numeral at intersection of reference letter column and model number line. This numeral, when added to reference letter, provides key to catalog number of part, which is listed in table on page indicated.

Example:

To find catalog number of stationary main contact for Model 12IAV51A7A relay:

(1) Figure 2 on page 2 indicates that reference letter for stationary main contact is "G".

(2) Locate reference letter "G" in column headings on page 3.

(3) At intersection of "G" column and Model 12IAV51A7A line find numeral "1". Complete reference symbol is therefore "G-1". Referring to page 9, catalog number is found to be 6209430G1 (one required per relay).

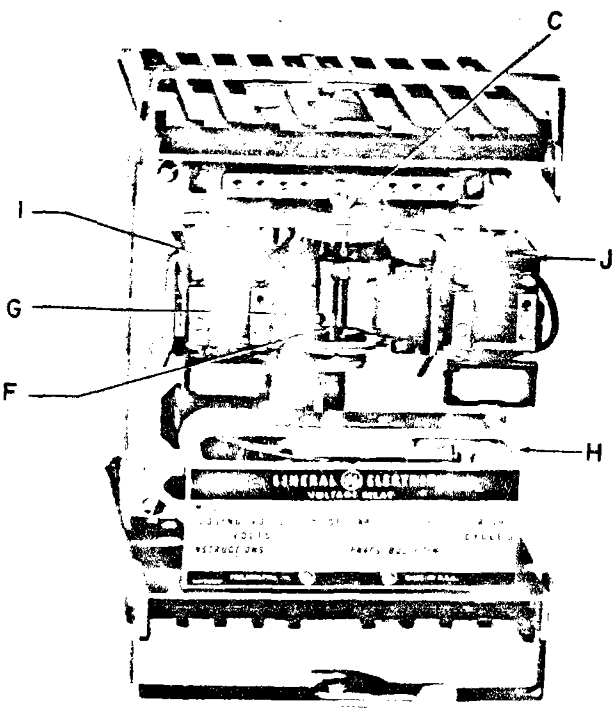


Fig. 2. Typical IAV relay, front view

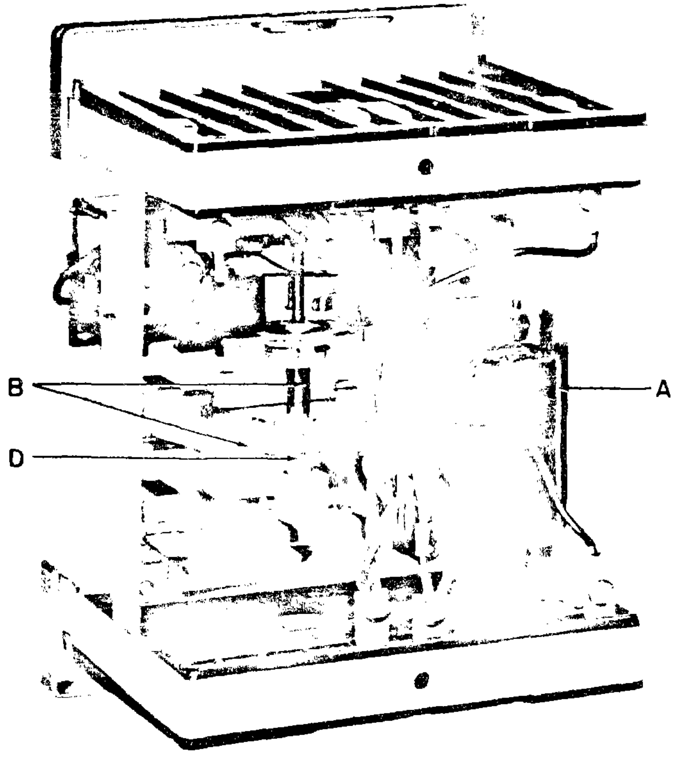


Fig. 3. Typical IAV relay unit, back view
NOTE: Resistor locations vary.

Relay Model Number	Operating Coil Assembly	Disk and Shaft Assembly	Top Bearing	Jewel Screw Assembly	Moving Contact and Spring Assembly, Upper	Moving Contact and Spring Assembly, Lower	Stationary Contact	Drag Magnet	Seal-in Unit, Left	Seal-in Unit, Right	Instantaneous Unit	Resistor (Adjustable)	Resistor (Fixed)	Capacitor	End Plate	Terminal Block Assembly, Upper	Terminal Block Assembly, Lower	Connecting Plug
Page	8	8	8	8	8	8	9	9	9	9	9	9	9	9, 10	10	10	10	10
Ref.	A*δ	B	C	D	E*†	F*	G*	H	I*	J*	O*†	S*†	T*†	U†	V	W†	X†	Y
12IAV51A1A	17	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A2A	18	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A3A	19	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A4A	3	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A5A	6	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A6A	22	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A7A	31	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A8A	35	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A9A	37	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A10A	40	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A11A	41	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A12A	43	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A13A	47	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A14A	86	1	1	1	-	3	1	4	1	-	-	-	-	-	1	-	8	1
51A15A	99	1	1	1	-	3	1	-	1	-	-	-	-	-	1	-	8	1
ø12IAV51C1A	52	1	1	1	-	2	2	4	1	-	-	-	-	4	1	-	8	1
ø51C2A	53	1	1	1	-	2	2	4	1	-	-	-	-	2	1	-	8	1
ø51C3A	54	1	1	1	-	2	2	4	1	-	-	-	-	4	1	-	8	1
ø51C4A	68	1	1	1	-	2	2	4	1	-	-	-	-	9	1	-	8	1
ø51C5A	66	1	1	1	-	2	2	4	1	-	-	-	-	7	1	-	8	1
ø51C6A	67	1	1	1	-	2	2	4	1	-	-	-	-	8	1	-	8	1
ø51C7A	70	1	1	1	-	2	2	4	1	-	-	-	-	2	1	-	8	1
ø51C8A	72	1	1	1	-	2	2	4	1	-	-	-	-	9	1	-	8	1
12IAV51D1A	52	1	1	1	-	2	2	4	1	-	-	10	-	4	1	-	8	1
51D2A	68	1	1	1	-	2	2	4	1	-	-	9	-	8	1	-	8	1
51D3A	53	1	1	1	-	2	2	4	1	-	-	6	-	1	1	-	8	1
51D4A	54	1	1	1	-	2	2	4	1	-	-	10	-	4	1	-	8	1
51D5A	68	1	1	1	-	2	2	4	1	-	-	9	-	9	1	-	8	1
51D6A	70	1	1	1	-	2	2	4	1	-	-	6	-	1	1	-	8	1
51D7A	77	1	1	1	-	2	2	4	1	-	-	10	-	4	1	-	8	1
51D8A	78	1	1	1	-	2	2	4	1	-	-	9	-	9	1	-	8	1
ø12IAV51H1A	52	1	1	1	-	2	2	7	1	-	-	-	-	4	1	-	8	1
ø12IAV51J2A	53	1	1	1	-	2	2	4	1	-	-	7	-	2	1	-	8	1
12IAV51K1A	62	1	1	1	-	2	2	4	1	-	-	8	-	-	1	-	6	1
51K2A	73	1	1	1	-	2	2	4	1	-	-	8	-	-	1	-	6	1
12IAV51M1A	52	1	1	1	-	1	1	5	1	-	-	-	-	-	1	-	8	1
51M2A	54	1	1	1	-	1	1	5	1	-	-	-	-	-	1	-	8	1
51M3A	79	1	1	1	-	1	1	5	1	-	-	-	-	-	1	-	8	1
12IAV52A1A	17	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A2A	18	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A4A	3	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A5A	6	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A6A	22	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A7A	31	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A8A	35	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A9A	37	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1
52A10A	40	1	1	1	-	5	6	7	2	-	-	-	-	-	1	-	9	1

* Recommended for stock for normal maintenance
† Not shown
δ Assembly of laminations, pole pieces, coil and tap block
ø Obsolete models – if parts are needed, give quantity, catalog number, description and complete nameplate reading when ordering

Relay Model Number	Operating Coil Assembly	Disk and Shaft Assembly	Top Bearing	Jewel Screw Assembly	Moving Contact and Spring Assembly, Upper	Moving Contact and Spring Assembly, Lower	Stationary Contact	Drag Magnet	Seal-in Unit, Left	Seal-in Unit, Right	Instantaneous Unit	Resistor (Adjustable)	Resistor (Fixed)	Capacitor	End Plate	Terminal Block Assembly, Upper	Terminal Block Assembly, Lower	Connecting Plug
Page	8	8	8	8	8	8	9	9	9	9	9	9	9	9, 10	10	10	10	10
Ref.	A*δ	B	C	D	E*†	F*	G*	H	I*	J*	O*†	S*†	T*†	U†	V	W†	X†	Y
12IAV52B1A	17	1	1	1	-	5	6	7	4	-	2	-	3	-	1	-	2	1
12IAV52C1A	52	1	1	1	-	4	4	4	2	-	-	-	-	4	1	-	9	1
ø52C2A	53	1	1	1	-	4	4	4	2	-	-	-	-	2	1	-	9	1
ø52C3A	54	1	1	1	-	4	4	4	2	-	-	-	-	4	1	-	9	1
ø52C4A	63	1	1	1	-	4	4	4	2	-	-	-	-	8	1	-	9	1
ø52C5A	66	1	1	1	-	4	4	4	2	-	-	-	-	7	1	-	9	1
ø52C6A	67	1	1	1	-	4	4	4	2	-	-	-	-	8	1	-	9	1
ø52C7A	70	1	1	1	-	4	4	4	2	-	-	-	-	2	1	-	9	1
12IAV52D1A	52	1	1	1	-	4	4	4	2	-	-	5	-	4	1	-	9	1
12IAV53A1A	1	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A2A	2	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A3A	26	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A4A	14	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A5A	15	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A6A	13	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A7A	23	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A8A	28	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A9A	34	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
53A10A	39	3	1	1	1	1	5	7	5	1	-	-	-	-	1	-	1	1
12IAV53B1A	1	3	1	1	1	1	5	7	-	-	-	-	-	-	1	-	1	1
53B2A	2	3	1	1	1	1	5	7	-	-	-	-	-	-	1	-	1	1
53B4A	14	3	1	1	1	1	5	7	-	-	-	-	-	-	1	-	1	1
53B5A	15	3	1	1	1	1	5	7	-	-	-	-	-	-	1	-	1	1
53B6A	13	3	1	1	1	1	5	7	-	-	-	-	-	-	1	-	1	1
ø12IAV53B1R	1	3	1	1	1	1	5	4	-	-	-	-	-	-	‡3	-	‡12	‡3
ø53B2R	2	3	1	1	1	1	5	4	-	-	-	-	-	-	‡3	-	‡12	‡3
ø53B4R	14	3	1	1	1	1	5	4	-	-	-	-	-	-	‡3	-	‡12	‡3
ø53B5R	15	3	1	1	1	1	5	4	-	-	-	-	-	-	‡3	-	‡12	‡3
ø53B6R	13	3	1	1	1	1	5	4	-	-	-	-	-	-	‡3	-	‡12	‡3
12IAV53C1A	57	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
53C2A	58	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
53C3A	59	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
53C4A	60	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
53C5A	58	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
53C6A	61	3	1	1	1	1	5	5	1	-	-	-	-	-	1	-	8	1
12IAV53D1A	1	3	1	1	1	1	5	4	-	-	-	-	-	-	1	-	1	1
53D2A	42	3	1	1	1	1	5	4	-	-	-	-	-	-	1	-	1	1
53D3A	13	3	1	1	1	1	5	4	-	-	-	-	-	-	1	-	1	1
53D4A	2	3	1	1	1	1	5	4	-	-	-	-	-	-	1	-	1	1
12IAV53E1A	69	3	1	1	2	2	5	4	-	-	-	-	-	-	1	-	1	1
53E2A	59	3	1	1	2	2	5	4	-	-	-	-	-	-	1	-	1	1
12IAV53K1A	1	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K2A	2	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2

* Recommended for stock for normal maintenance
† Not shown
δ Assembly of laminations, pole pieces, coil and tap block
‡ Basic model number covers drawout case, semi-flush mounting. For drawout case surface mounting, affix 'S' in place of 'R'
ø Obsolete models – if parts are needed, give quantity, catalog number, description and complete nameplate reading when ordering

Relay Model Number	Operating Coil Assembly	Disk and Shaft Assembly	Top Bearing	Jewel Screw Assembly	Moving Contact and Spring Assembly, Upper	Moving Contact and Spring Assembly, Lower	Stationary Contact	Drag Magnet	Seal-in Unit, Left	Seal-in Unit, Right	Instantaneous Unit	Resistor (Adjustable)	Resistor (Fixed)	Capacitor	End Plate	Terminal Block Assembly, Upper	Terminal Block Assembly, Lower	Connecting Plug
Page	8	8	8	8	8	8	9	9	9	9	9	9	9	9, 10	10	10	10	10
Ref.	A*δ	B	C	D	E*†	F*	G*	H	I*	J*	O*†	S*†	T*†	U†	V	W†	X†	Y
12IAV53K3A	26	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K4A	14	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K5A	15	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K6A	13	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K7A	23	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K8A	28	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K9A	34	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K10A	39	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K11A	41	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
53K12A	97	3	1	1	1	1	5	7	5	1	-	-	-	-	-	4	7	2
12IAV53L1A	1	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L2A	2	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L3A	26	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L4A	14	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L5A	15	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L6A	13	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L7A	47	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
53L8A	34	3	1	1	1	1	5	7	-	-	-	-	-	-	-	4	7	2
12IAV53M1A	57	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M2A	58	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M3A	59	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M4A	60	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M5A	58	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M6A	61	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
53M7A	74	3	1	1	1	1	5	5	1	-	-	-	-	-	-	3	5	2
12IAV53N1A	1	3	1	1	1	1	5	4	-	-	-	-	-	-	-	4	7	2
53N3A	26	3	1	1	1	1	5	4	-	-	-	-	-	-	-	4	7	2
12IAV54C1A	10	2	1	1	-	8	3	7	1	-	-	-	-	-	1	-	10	1
54C2A	12	2	1	1	-	8	3	7	1	-	-	-	-	-	1	-	10	1
54C3A	27	2	1	1	-	8	3	7	1	-	-	-	-	-	1	-	10	1
12IAV54E1A	20	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E2A	21	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E3A	16	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E4A	7	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E5A	8	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E6A	36	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E7A	11	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E8A	30	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E9A	9	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E10A	33	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
∅54E11A	24	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E12A	89	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E13A	21	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E14A	94	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
54E15A	96	2	1	1	-	6	3	4	1	-	-	-	-	-	-	3	5	2
12IAV54F1A	10	2	1	1	-	8	3	7	1	-	-	-	-	-	-	3	5	2
54F2A	12	2	1	1	-	8	3	7	1	-	-	-	-	-	-	3	5	2

* Recommended for stock for normal maintenance
† Not shown
δ Assembly of laminations, pole pieces, coil and tap block
∅ Obsolete models – if parts are needed, give quantity, catalog number, description and complete nameplate reading when ordering

Relay Model Number	Operating Coil Assembly	Disk and Shaft Assembly	Top Bearing	Jewel Screw Assembly	Moving Contact and Spring Assembly, Upper	Moving Contact and Spring Assembly, Lower	Stationary Contact	Drag Magnet	Seal-in Unit, Left	Seal-in Unit, Right	Instantaneous Unit	Resistor (Adjustable)	Resistor (Fixed)	Capacitor	End Plate	Terminal Block Assembly, Upper	Terminal Block Assembly, Lower	Connecting Plug
Page	8	8	8	8	8	8	9	9	9	9	9	9	9	9, 10	10	10	10	10
Ref.	A*δ	B	C	D	E*†	F*	G*	H	I*	J*	O*†	S*†	T*†	U†	V	W†	X†	Y
12IAV54F3A	49	2	1	1	-	8	3	7	1	-	-	-	-	-	-	3	5	2
54F4A	27	2	1	1	-	8	3	7	1	-	-	-	-	-	-	3	5	2
54F5A	98	2	1	1	-	8	3	7	1	-	-	-	-	-	-	3	5	2
12IAV54H1A	25	2	1	1	-	7	3	7	1	-	-	-	-	-	-	3	5	2
54H2A	50	2	1	1	-	7	3	7	1	-	-	-	-	-	-	3	5	2
12IAV54J1A	20	2	1	1	-	6	3	4	-	-	-	-	-	-	-	3	5	2
54J2A	21	2	1	1	-	6	3	4	-	-	-	-	-	-	-	3	5	2
54J3A	16	2	1	1	-	6	3	4	-	-	-	-	-	-	-	3	5	2
54J4A	36	2	1	1	-	6	3	4	-	-	-	-	-	-	-	3	5	2
12IAV55C1A	20	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C2A	21	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C3A	16	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C4A	7	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C5A	8	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C6A	11	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C7A	30	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C8A	38	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
55C9A	36	2	1	1	-	9	5	4	2	-	-	-	-	-	-	2	5	2
12IAV56B4HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B5HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B6HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B7HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B8HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B9HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B10HN	75	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B11HN	76	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B12HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B13HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
56B14HN	51	5	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
12IAV58B1A	51	1	1	1	-	3	3	4	3	-	1	3	3	11	1	-	3	1
58B2A	51	1	1	1	-	3	3	4	3	-	1	3	3	12	1	-	3	1
58B3A	64	1	1	1	-	3	3	4	3	-	3	3	3	13	1	-	3	1
58B4A	51	1	1	1	-	3	3	4	3	-	1	6	3	11	1	-	3	1
58B5A	51	1	1	1	-	3	3	4	3	-	4	3	4	11	1	-	3	1
ø12IAV58B1R	51	1	1	1	-	3	3	4	3	-	1	3	3	-	‡3	-	‡13	‡3
ø58B2R	51	1	1	1	-	3	3	4	3	-	1	3	3	-	‡3	-	‡13	‡3
ø58B3R	64	1	1	1	-	3	3	4	3	-	3	3	5	-	‡3	-	‡13	‡3
ø58B4R	51	1	1	1	-	3	3	4	3	-	1	6	3	-	‡3	-	‡13	‡3
ø58B5R	51	1	1	1	-	3	3	4	3	-	4	3	4	-	‡3	-	‡13	‡3
12IAV60B1A	51	1	1	1	-	5	6	4	4	-	2	3	3	-	1	-	4	1
60B2A	51	1	1	1	-	5	6	4	4	-	2	3	3	-	1	-	4	1
60B3A	64	1	1	1	-	5	6	4	4	-	5	3	5	-	1	-	4	1
60B4A	51	1	1	1	-	5	6	4	4	-	6	3	4	-	1	-	4	1

* Recommended for stock for normal maintenance

† Not shown

δ Assembly of laminations, pole pieces, coil and tap block

‡ Basic model number covers drawout case, semi-flush mounting. For drawout case surface mounting, affix 'S' in place of 'R'

ø Obsolete models – if parts are needed, give quantity, catalog number, description and complete nameplate reading when ordering

Relay Model Number	Operating Coil Assembly	Disk and Shaft Assembly	Top Bearing	Jewel Screw Assembly	Moving Contact and Spring Assembly, Upper	Moving Contact and Spring Assembly, Lower	Stationary Contact	Drag Magnet	Seal-in Unit, Left	Seal-in Unit, Right	Instantaneous Unit	Resistor (Adjustable)	Resistor (Fixed)	Capacitor	End Plate	Terminal Block Assembly, Upper	Terminal Block Assembly, Lower	Connecting Plug
Page	8	8	8	8	8	8	9	9	9	9	9	9	9	9, 10	10	10	10	10
Ref.	A*δ	B	C	D	E*†	F*	G*	H	I*	J*	O*†	S*†	T*†	U†	V	W†	X†	Y
12IAV69A1A	90	4	1	1	-	4	7	5	6	2	-	-	-	-	-	4	5	2
69A2A	91	4	1	1	-	4	7	5	6	2	-	-	-	-	-	4	5	2
12IAV69B1A	90	4	1	1	-	4	7	5	-	-	-	-	-	-	-	4	5	2
69B2A	91	4	1	1	-	4	7	5	-	-	-	-	-	-	-	4	5	2
69B3A	95	4	1	1	-	4	7	5	-	-	-	-	-	-	-	4	5	2
12IAV70A1A	92	1	1	1	-	3	7	6	6	2	-	-	-	-	-	4	5	2
70A2A	93	1	1	1	-	3	7	6	6	2	-	-	-	-	-	4	5	2
12IAV70B1A	92	1	1	1	-	3	7	6	-	-	-	-	-	-	-	4	5	2
70B2A	93	1	1	1	-	3	7	6	-	-	-	-	-	-	-	4	5	2
12IAV71A1A	45	1	1	1	-	3	1	4	1	-	-	2	-	3	1	-	8	1
71A3A	45	1	1	1	-	3	1	4	1	-	-	2	-	22	1	-	8	1
12IAV71B2A	45	1	1	1	-	3	1	4	3	-	7	2	9	3	1	-	14	1
71B3A	45	1	1	1	-	3	1	4	3	-	7	2	9	22	1	-	14	1
71B4A	88	1	1	1	-	3	1	4	3	-	7	-	9	-	1	-	14	1
71B5A	85	1	1	1	-	3	1	4	3	-	7	2	9	3	1	-	14	1
71B6A	85	1	1	1	-	3	1	4	3	-	7	2	10	3	1	-	14	1
12IAV72A1A	45	1	1	1	-	5	6	4	2	-	-	2	-	3	1	-	9	1
12IAV72B1A	45	1	1	1	-	5	6	4	2	-	7	2	9	3	1	-	4	1
72B3A	85	1	1	1	-	5	6	4	2	-	7	2	9	22	1	-	4	1
12IAV73A1A	44	3	1	1	1	5	5	7	5	1	-	2	-	3	-	4	7	2
73A2A	48	3	1	1	1	5	5	7	5	1	-	-	-	-	-	4	7	2
12IAV73B1A	44	3	1	1	1	5	5	7	-	-	-	2	-	3	-	4	7	2
12IAV74A1A	46	2	1	1	-	6	3	4	1	-	-	2	-	5	-	3	5	2

* Recommended for stock for normal maintenance
† Not shown
δ Assembly of laminations, pole pieces, coil and tap block

Ref. Symbol	Fig. No.	Catalog Number	No. Per Relay
OPERATING COIL ASSEMBLY			
A-1	3	721-6293205G7	1
A-2	3	G8	1
A-3	3	G14	1
A-4	3	G27	1
A-5	3	G28	1
A-6	3	G29	1
A-7	3	G30	1
A-8	3	G31	1
A-9	3	G35	1
A-10	3	G37	1
A-11	3	G41	1
A-12	3	G42	1
A-13	3	G43	1
A-14	3	G49	1
A-15	3	G50	1
A-16	3	G54	1
A-17	3	G57	1
A-18	3	G58	1
A-19	3	G62	1
A-20	3	G63	1
A-21	3	G64	1
A-22	3	G79	1
A-23	3	G86	1
A-24	3	G90	1
A-25	3	G111	1
A-26	3	G112	1
A-27	3	G113	1
A-28	3	G117	1
A-29	3	G119	1
A-30	3	G120	1
A-31	3	G121	1
A-32	3	G123	1
A-33	3	G125	1
A-34	3	G127	1
A-35	3	G132	1
A-36	3	G135	1
A-37	3	G144	1
A-38	3	G147	1
A-39	3	G148	1
A-40	3	G149	1
A-41	3	G151	1
A-42	3	G155	1
A-43	3	G158	1
A-44	3	G164	1
A-45	3	G169	1
A-46	3	G171	1
A-47	3	G176	1
A-48	3	G180	1
A-49	3	G183	1
A-50	3	G191	1
A-85	3	G203	1
A-86	3	G204	1
A-88	3	G211	1
A-89	3	G216	1
A-90	3	G217	1
A-91	3	G218	1
A-92	3	G219	1
A-93	3	G220	1
A-94	3	G225	1
A-95	3	G226	1
A-99	3	G227	1
A-96	3	G228	1
A-97	3	G231	1
A-98	3	G232	1
A-51	3	721-6293206G5	1
A-52	3	G28	1
A-53	3	G29	1
A-54	3	G32	1
A-55	3	G39	1

Ref. Symbol	Fig. No.	Catalog Number	No. Per Relay
OPERATING COIL ASSEMBLY (Cont'd)			
A-56	3	721-6293206G40	1
A-57	3	G57	1
A-58	3	G58	1
A-59	3	G59	1
A-60	3	G60	1
A-61	3	G61	1
A-62	3	G68	1
A-63	3	G69	1
A-64	3	G70	1
A-65	3	G73	1
A-66	3	G79	1
A-67	3	G80	1
A-68	3	G89	1
A-69	3	G90	1
A-70	3	G91	1
A-71	3	G97	1
A-72	3	G101	1
A-73	3	G108	1
A-74	3	G109	1
A-75	3	G122	1
A-76	3	G123	1
A-77	3	G133	1
A-78	3	G140	1
A-79	3	G148	1
DISK AND SHAFT ASSEMBLY			
B-1	3	721-6293210G1	1
B-2	3	G3	1
B-3	3	G4	1
B-4	3	G2	1
B-5	3	G6	1
TOP BEARING			
C-1	2	721-6209409G1	1
JEWEL SCREW ASSEMBLY			
D-1	3	721-6209457G1	1
MOVING CONTACT AND SPRING ASSEMBLY (UPPER)			
E-1	†	721-6158531G7	1
E-2	†	G10	1
MOVING CONTACT AND SPRING ASSEMBLY (LOWER)			
F-1	2	721-6158531G1	1
F-2	2	G2	1
F-3	2	G3	1
F-4	2	G5	1
F-5	2	G6	1
F-6	2	G12	1
F-7	2	G13	1
F-8	2	G14	1
F-9	2	G15	1
F-10	2	G16	1
F-11	2	G17	1

† Not shown

Ref. Symbol	Fig. No.	Catalog Number	No. Per Relay
MAIN STATIONARY CONTACT			
G-1	2	721-6209430G1	1
G-2	2	G2	1
G-3	2	G3	1
G-4	2	G2	2
G-5	2	G3	2
G-6	2	G4	2
G-7	2	G4	1
δ DRAG MAGNET			
H-4	2	721-237C749G1	1
H-5	2	G2	1
H-6	2	G3	1
H-7	2	G4	1
SEAL-IN UNIT (LEFT)			
I-1	2	721-6293203G1	1
I-2	2	G2	1
I-3	2	G3	1
I-4	2	G4	1
I-5	2	G11	1
I-6	2	G203	1
SEAL-IN UNIT (RIGHT)			
J-1	2	721-6293203G5	1
J-2	2	G202	1
INSTANTANEOUS UNIT			
O-1	†	721-6293204G24	1
O-2	†	G29	1
O-3	†	G37	1
O-4	†	G43	1
O-5	†	G62	1
O-6	†	G81	1
O-7	†	721-6293203G120	1
RESISTOR (ADJUSTABLE)			
S-1	†	721-403A321P2	1
S-2	†	P3	1
S-3	†	P4	1
S-4	†	P13	1
S-5	†	P15	1
S-6	†	P20	1
S-7	†	P21	1
S-8	†	P23	1
S-9	†	P30	1
S-10	†	P42	1
RESISTOR (FIXED)			
T-1	†	721-5901218G1-3750	1
T-2	†	721-403A322P19	1
T-3	†	P23	1
T-4	†	P26	2
T-5	†	P79	1
T-9	†	P116	1
T-6	†	P140	1
T-10	†	P183	1
T-7	†	721-403A323P3	1

Ref. Symbol	Fig. No.	Catalog Number	No. Per Relay
CAPACITOR			
U-1	†	721-21F802	1
U-2	†	21F803	1
U-3	†	21F804	1
U-22	†	21F805	1
U-4	†	21F807	1
U-5	†	21F808	1
U-6	†	21F809	1
U-7	†	21F811	1
U-8	†	21F813	1
U-9	†	21F815	1
U-10	†	21F816	1
U-11	†	21F902	1
U-12	†	21F903	1
U-13	†	21F906	1
U-14	†	21F914	1
END PLATE			
V-1	1	721-237C740G1	1
V-2	1	721-6128447P1	2
V-3	1	P1	1
TERMINAL BLOCK ASSEMBLY (UPPER)			
W-1	†	721-6418058G42	1
W-2	†	G127	1
W-3	†	G236	1
W-4	†	G292	1
TERMINAL BLOCK ASSEMBLY (LOWER)			
X-1	†	721-6418058G23	1
X-2	†	G24	1
X-3	†	G67	1
X-4	†	G89	1
X-5	†	G126	1
X-6	†	G178	1
X-7	†	G292	1
X-14	†	G65	1
X-8	†	721-6418060G3	1
X-9	†	G4	1
X-10	†	G5	1
X-11	†	G23	1
X-12	†	721-6193049G23	1
X-13	†	G67	1
CONNECTING PLUG			
Y-1	1	721-6118736G5	1
Y-2	1	G5	2
Y-3	1	G1	1
Y-4	1	G1	2

† Not shown

δ Specify complete relay model number when ordering drag magnet

CONTACT BLOCK ASSEMBLY

Relay Model Type	Lower Contact Block Catalog No.	Upper Contact Block Catalog No.	Relay Model Type	Lower Contact Block Catalog No.	Upper Contact Block Catalog No.
12IAV51A	721-6193048G9	-	12IAV54E	721-6193048G118	721-6193048G228
51C	6193048G9	-	54F	6193048G118	6193048G228
51D	6193048G9	-	54H	6193048G118	6193048G228
51H	6193048G9	-	54J	6193048G118	6193048G228
51J	6193048G9	-	55C	6193048G118	6193048G119
51K	6193048G95	-	56B	-	-
51M	6193048G9	-	57A	6193048G9	-
52A	6193048G22	-	58B	6193048G3	-
52B	5193048G258	-	60B	6193048G92	-
52C	6193048G22	-	69A	6193048G118	6193048G279
52D	6193048G22	-	69B	6193048G118	6193048G279
53A	6193048G12	-	70A	6193048G118	6193048G279
53B	6193048G12	-	70B	6193048G118	6193048G279
53C	6193048G9	-	71A	6193048G9	-
53D	6193048G12	-	71B	6193048G103	-
53E	6193048G12	-	72A	6193048G22	-
53K	6193048G279	721-6193048G279	72B	6193048G92	-
53L	6193048G279	6193048G279	73A	6193048G279	6193048G279
53M	6193048G118	6193048G228	73B	6193048G279	6193048G279
53N	6193048G279	6193048G279	74A	6193048G118	6193048G228
54C	6193048G9	-			

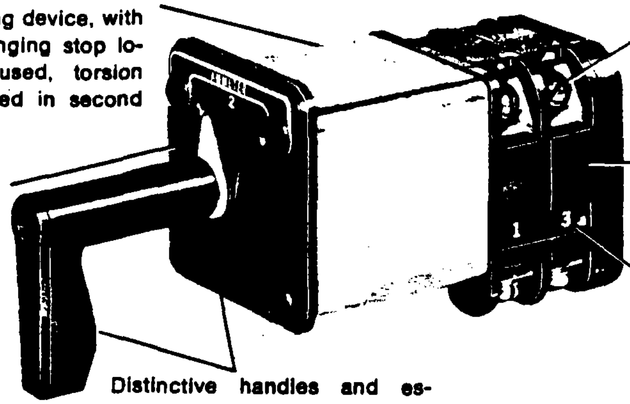
EXTERNAL AUXILIARIES

Relay Model No.	Resistor Catalog No.	Resistor No. Req.	Capacitor Catalog No.	Capacitor No. Req.
12IAV51K1A	---	-	721-28F914	1
12IAV51K2A	---	-	28F914	1
12IAV56B4HN	721-365A436P805	1	21F918	1
12IAV56B5HN	365A436P804	1	21F918	1
12IAV56B6HN	365A436P804	1	21F918	1
12IAV56B7HN	365A436P803	1	21F918	1
12IAV56B8HN	365A436P805	1	21F918	1
12IAV56B9HN	365A436P805	1	21F918	1
12IAV56B10HN	---	-	21F905	1
12IAV56B11HN	365A436P864	1	21F900	1
12IAV56B12HN	365A436P803	1	21F918	1
12IAV56B13HN	365A436P870	1	21F918	1
12IAV56B14HN	365A436P805	1	21F918	1
12IAV58B1R	---	-	26F330	1
12IAV58B2R	---	-	23F10	1
12IAV58B3R	---	-	23F2	1
12IAV58B4R	---	-	26F330	1
12IAV58B5R	3887726	1	26F330	1
12IAV60B1A	---	-	28F902	1
12IAV60B2A	---	-	28F903	1
12IAV60B3A	---	-	28F906	1
12IAV60B4A	IC9006C102B	1	28F902	1

GENERAL ELECTRIC COMPANY
SWITCHGEAR BUSINESS DEPARTMENT
PHILADELPHIA, PA 19142

GENERAL ELECTRIC

3-79 (2M)



8040787

The SBM Compact Cam-operated

- Control and transfer
- For control panels and switchboards
- Up to 600 volts

The SBM is a compact, positive acting switch for control and transfer service on panels and switchboards, 600 volts and under. Up to 10 stages, 2 contacts per stage can be provided, with independent action, both electrically and mechanically, through eight positions.

Ideal For Switchboards—

—The SBM switch is especially adaptable for switchboard applications where space is at a premium. When a control switch is required for use in an explosion-proof or watertight enclosure, space is normally not a controlling factor, and the SB-1 switch, which is somewhat larger, is used.

The SBM switch is normally supplied for mounting on panels up to ¼ inch thick. If requested, it can also be supplied for mounting on panels of one and a half inches.

Compact design of the SBM switch permits close center-to-center line mounting distances and, at the same time, easy access to the terminals for wiring. Also, since the switch is enclosed, there is no need for clearance at the back of the panel to remove a separate cover. This further reduces space requirements.

Ratings

The SBM switch is rated for a mechanical life of 500,000 operations. The electrical ratings are 600 volts ac or dc, 20 amps continuous or 250 amps for three seconds. The interrupting rating depends upon the voltage and character of the circuit. The table below illustrates the interrupting duty of a single contact and contacts in series when various conditions exist on a circuit.

SBM is recognized under the component program of Underwriters' Laboratories, Inc.

Interrupting Rating (amperes)

Circuit Volts	Non-inductive		Inductive	
	Number of Contacts			
	1	2 in series	1	2 in series
24 dc	10	30	8	25
48 dc	8	25	6	18
125 dc	5	15	4	10
250 dc	1	3	1	2.5
600 dc	0.4	0.8	0.3	0.7
115 ac	40	75	24	50
230 ac	25	50	12	25
460 ac	20	30	10	20
600 ac	15	25	8	12

Construction Features

8040785

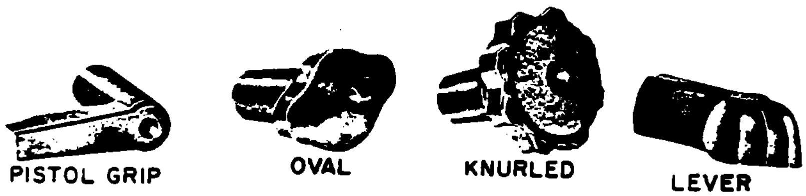
Escutcheons

Two basic types of escutcheons are available: the standard and the target. The standard type shown on the left is a molded black phenolic material with white lettering for clear reading of the positions. A target type escutcheon, shown in the middle, is normally furnished on breaker control switches. An aluminum front plate houses the target mechanism with a window in the center to show green for the trip position, red for the closed position, and black for the pull-to-lock position. The target has a slip action so that it will remain green when the handle returns to NORMAL from the TRIP position, and red when it returns from the CLOSE position. This shows the operator the last operation of the switch.

On the right a modified standard is shown with keyways for use with a removable type handle.

Aluminum circuit designation plates are available for all three types.

The standard and keyed escutcheons can be furnished in painted colors of red, green, yellow, blue, gray, orange, brown, and white, but must be specified on each order.



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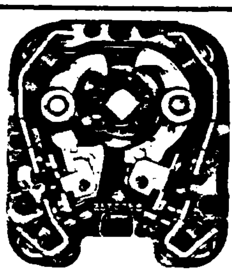
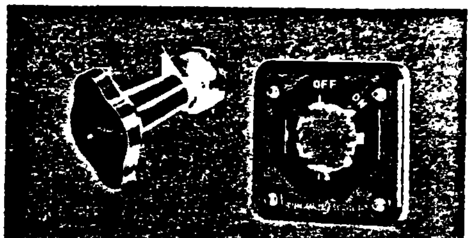
Handles

Four types of molded black phenolic handles shaped for easy gripping are available with the SBM switch: pistol grip, oval, knurled, and lever. Any of the standard handles except the lever, may be adapted for removable handle keying. A fixed handle may be easily removed for replacement by a screw in the front of the handle. A white pointer, furnished with the handles (except the lever) and mounted near the escutcheon, give a clear identification of the position that the handle is in. For match and line up with SB-1 switches, type SB-1 pistol grip, oval, knurled, and round handles can be furnished for use with SBM switches. The same colors are available for the handles as were listed for the escutcheons.


8040794

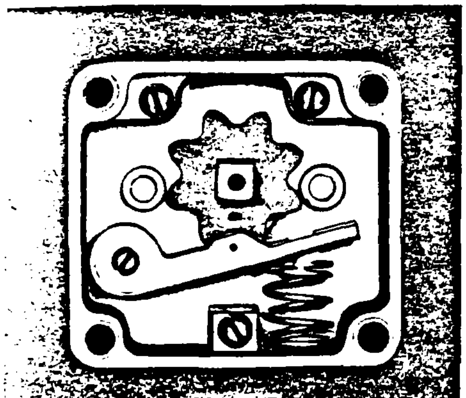
Cams and Contacts

The silver to silver contacts of the SBM switch are of double-break design, as seen at left, which reduces arcing and subsequent pitting of contacts. Each contact is operated by a double surface cam, one surface for closing, the other surface for opening. This construction provides opening and closing action not dependent on springs.



Slip Cams

The slip cam is basically used on breaker control switches. The slip action enables a contact to remain closed or open after returning to the normal (12 o'clock) position from either the CW or CCW positions.



Positioning

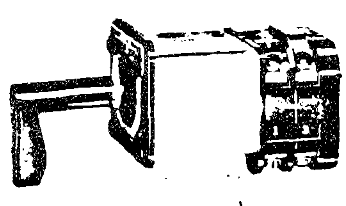
Contacts of the SBM switch are positively positioned by a detent wheel mounted on a square shaft and acted upon by a spring-loaded roller arm. If the shaft of the 45° switch is not rotated more than one-half the distance between positions, it will snap back to its prior position. If rotated more than half the distance between positions, it will snap to the next position. The 90° switch has the same positive detent action when in position, but the snapping action is not as prominent. Up to eight positions are available with 45° or 90° between positions.

Terminal Connections

Terminal connections are brought to the corners of each stage, allowing screw connections to be made over a large angle. This angular displacement of connection points allows the switches to be mounted on three-inch centers or less.

Jumpers

Jumpers are furnished assembled, where required, on all standard listed switches. For special switches or unlisted switches, separate jumpers can be ordered.



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Jumper 307V515 (Same Stage)

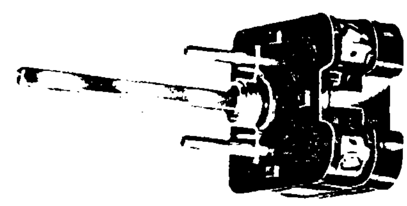
Jumper 307V512 (Adjacent Stage)

Contacts Handle End.		Positions 3	2	1
	1			X
	2		X	
	3	X	X	

Break-Before-Make Contacts

Contacts on SBM switches are normally non-overlapping (break-before-make). This sequence is illustrated above, which shows that contact No. 1 opens before contact No. 2 closes.

Another normal function is illustrated by contact No. 3, which is shown closed in two adjacent positions. When switching between these positions, this contact will always remain closed.



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Spring Action

Torsion springs return the switch handle to or towards the 12 o'clock or No. 3 position. The travel of the handle is limited to 90° to either side of this position. The switches may be furnished with spring return both ways, or only one way, with maintaining action in the opposite direction. You can also have spring return from position No. 1 (9 o'clock) to position No. 2 (10 o'clock) and/or spring return from position No. 5 (3 o'clock) to position No. 4 (2 o'clock) with maintained action in the other positions. Torsion springs are housed in the rear half of the positioning chamber. There is no need to modify the chamber to accommodate the springs.

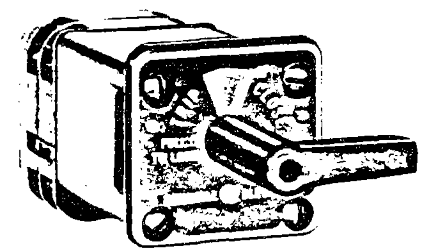
Contacts Handle End (Odd / Even)		*	3	*	2	*	1	*	Off
	1	X	X	X	X	X		X	X
	2					X	X	X	
	3	X	X	X		X	X	X	X
	4			X	X	X			
	5	X		X	X	X	X	X	X
	6	X	X	X					

10AA009

Overlapping Contacts

Overlapping contacts (make-before-break) contribute to the versatility of the SBM switch.

Typical overlapping contacts are shown on model switch 10AA009. The asterisk (*) indicates an intermediate (non-feel) position, and shows the contacts overlapping. In the 10AA009 when turning from the OFF position to reading position "1" (Phase 1), contact 2 closes at the intermediate position and before contact 3 which remained closed through the intermediate position, opens.



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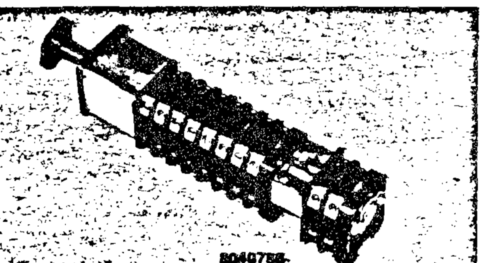
Pull-To-Lock

A pull-to-lock mechanism is designed for spring-return switches. When the handle is turned to the 9 o'clock position, it can be pulled out and locked in that position. When the handle is pushed in, the handle spring returns to the normal position. This pull-to-lock feature does not actuate contacts, but merely prevents the spring return of the handle.

Add-A-Stage

A one-half inch extension is provided on the rear of all switches with one to eight stages. This extension enables a maximum of two additional stages to be easily and economically coupled to the existing switch in the event more contacts are required. Maximum number of stages is 10 (20 contacts).



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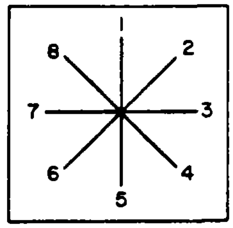
INCORRECT

CONTACTS HANDLE END		8	7	6	5	4	3	2	1
1 2	1								X
	2							X	
3 4	3						X		
	4					X			
5 6	5				X				
	6			X					
7 8	7		X						
	8	X							

CORRECT

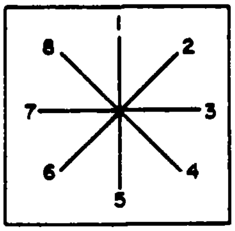
CONTACTS HANDLE END		8	7	6	5	4	3	2	1
1 2	1								X
	2				X				
3 4	3							X	
	4			X					
5 6	5						X		
	6		X						
7 8	7					X			
	8	X							

(Column heading in both tables: POSITIONS (BACK VIEW))



ESCUTCHEON (FRONT VIEW)

Fig. 5. Diagram of unworkable and correct arrangement



ESCUTCHEON (FRONT VIEW)

CONTACTS HANDLE END		8	7	6	5	4	3	2	1
	1					X	X		X
	4	X	X						
	5	X			X				
	8				X	X	X		X

(Column heading: POSITIONS (BACK VIEW))

Fig. 6. Contact arrangement to meet cam limitations

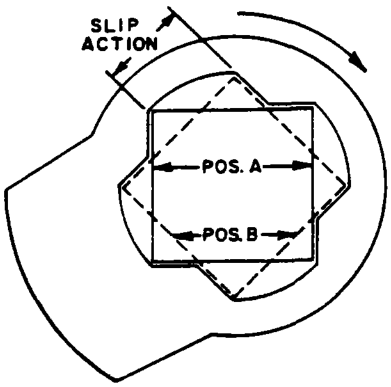


Fig. 7. Diagram showing 45-degree slip action of cam

CONTACTS HANDLE END		Close	Norm after close	Norm after trip	Trip
1 2	1	X			
	2				X
3 4	3	X			X
	4	X			
5	5		X	X	
7 8	7	X	X		
	8	X	X		

(Column heading: POSITIONS)

Fig. 8. Breaker control switch model 16SB1B2

(INCORRECT)

		2	2N	1N	1
1 2	1			X	X
	2		X	X	

(CORRECT)

		2	2N	1N	1	
1	1			X	X	SLIP
4	4		X	X		STANDARD

LIMITATION NO. 1
(SB-1, 9 & 10)

(INCORRECT)

		3	3N	2N	2	1
1 2	1			X	X	
	2			X	X	

(CORRECT)

		3	3N	2N	2	1
1 2	1			X	X	X
	2			X	X	X
3 4	3		X	X	X	
	4		X	X	X	

LIMITATION NO. 2
(SBM, SB-1, 9 & 10)

(INCORRECT)

		2	2N	1N	1
1 2	1			X	
	2			X	

(CORRECT)

		2	2N	1N	1
1 2	1			X	X
	2			X	X
3 4	3		X	X	
	4		X	X	

LIMITATION NO. 3
(SBM, SB-1, 9 & 10)

Limitation No. 1 (SB-1, -9 & -10)

A slip contact and standard contact cannot be on the same stage, as shown in the top diagram.

A stage must be added and contacts split up, as shown in the bottom diagram, one contact per stage. (Does not apply to SBM)

Limitation No. 2 (SBM, SB1, -9 & -10)

On a 4-position pull-to-lock switch the slip contact cannot be closed in the 2N and 2 positions (As shown in the top diagram) without closing in position 1. To accomplish this a stage is added, and the contacts are connect in series as shown in the bottom diagram.

Limitation No. 3 (SBM, SB-1, -9 & -10)

A contact cannot be closed in the normal after position without also closing in the position itself, as shown in the top diagram. To accomplish this, a stage must be added and the contacts set up as shown in the bottom diagram, with the contacts placed in series by jumpers. Jumpers required are shipped loose with the switch.

Fig. 9. Slip-cam limitations

Overlapping Contacts

GENERAL

Contacts on Type SB switches are normally non-overlapping (break-before-make). This sequence is illustrated in Fig. 10 which shows that Contact No. 1 opens before Contact No. 2 closes, when turning from Position 1 to Position 2. Another normal function is illustrated by Contact No. 3, which is shown closed in two adjacent positions (Positions 2 and 3). When switching between these positions, the contact will always remain closed. There are some circuits where this action is not desired, such as switching current transformers to an ammeter. Here, the contacts must overlap (make-before-break) to prevent damaging the meter.

SBM SWITCH

To get this overlapping action on the contacts, 90 degrees between positions is required. Figure 11 illustrates an ammeter switch (similar to Model 10AA009) with overlapping contacts. The overlapping action takes place in the intermediate positions (Positions 2, 4, 6, and 8). The intermediate position is identified by an "X" in the block above this position in the operating requirement table. Contacts 1 and 2 are shown overlapping in the intermediate Positions 4 and 6. Contact 2 is shown making in intermediate Position 4 before Contact 1 breaks, when going from Position 3 (OFF) to Position 5 (PHASE 1), and Contact 1 will make before Contact 2 breaks, when going from Position 5 to Position 7.

Figure 12 illustrates an ammeter switch for three independent current transformers (similar to Model 10AA013). This switch also has overlapping contacts and intermediates at Positions 2, 4, 6, and 8; however, the overlapping action takes place between the intermediate position and the actual position. The "X" on the line between the positions of the contacts identifies this action. When turning from Position 5 (PHASE I) to Position 7 (PHASE II), Contact 1 makes before Contacts 2 and 3 break. Also, Contact 2 and 3 break before Contacts 4 and 5 make, and Contacts 4 and 5 make before Contact 6 breaks. All this action takes place within the 90 degrees between positions, by use of a special cam.

SB-1, -9, AND -10 SWITCHES

Basically, the overlapping action is the same as with the SBM switch, but it is not limited to positions which are 90-degrees apart.

To get a make-before-break action, as shown in Fig. 13, a minimum of 37½ degrees between positions is required. To get a make-before-break as shown in Fig. 14, a minimum of 60 degrees is required. The flexibility of the SB-1, -9, and -10 switch allows the combination of 37½ degrees and 60 degrees in the same switch to give you an ammeter switch which reads as many as six, independent, current transformers with either 1 or 2 OFF's (see Fig. 15).

A special contact sequence which requires a contact to close in adjacent positions, but to open momentarily between them, is shown by Contact 1 in Figure 16. A minimum of 60 degrees between positions is required. When less than 60 degrees is required, use two contacts in parallel, as shown in Fig. 17.

CONTACTS HANDLE END		POSITIONS 3	2	1	
1 2	1			X	
	2		X		
3	3	X	X		

Fig. 10. Typical non-overlapping (break-before-make) sequence

AMMETER
OFF
3 1
2

CONTACTS ODD EVEN		8	7	6	5	4	3	2	1
INTER. POSITION		X		X		X		X	
POSITIONS		8	7	6	5	4	3	2	1
	1	X	X	X		X	X	X	X
	2			X	X	X			
	3	X		X	X	X	X	X	X
	4	X	X	X					
	5	X	X	X	X	X	X	X	
	6	X						X	X

Fig. 11. Overlapping contacts for SBM ammeter-type switch connected at end of secondary

AMMETER
OFF
3 1
2

CONTACTS ODD EVEN		8	7	6	5	4	3	2	1
INTER. POSITION		X		X		X		X	
POSITIONS		8	7	6	5	4	3	2	1
	1	XX	XX	XX	XX	XX	XX	XX	XX
	2			X	XX				
	3			X	XX				
	4	X	XX						
	5	X	XX						
	6	XX	X	XX	XX	XX	XX	XX	X
	7	XX	XX	XX	XX	XX	XX	XX	X
	8							X	XX
	9							X	XX

Fig. 12. Overlapping contacts for SBM ammeter-type switch, with three independent circuits

AMMETER
1 2 3

CONTACTS HANDLE END		3	Inter	2	Inter	1
1 2	1	X	X			
	2		X	X	X	X
3 4	3				X	X
	4	X	X	X	X	

Fig. 13. Overlapping contacts for SB-1 ammeter-type switch connected at end of secondary (two current transformers)

To prevent operation of equipment by unauthorized persons, switches with removable handles are available. The handle is keyed to a specific escutcheon, to be inserted and removed in a designated position. Handles can also be mutually keyed to other escutcheons, so that they are either interchangeable or non-interchangeable with other switches.

This feature is available for SBM, SB-1, and SB-9 switches, but ordering procedures differ.

SBM SWITCHES

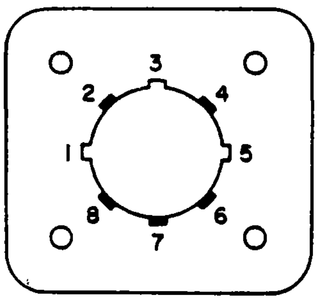


Fig. 18. SBM switch keyed escutcheon with eight available keyway locations. Keyways 1-3-5 are shown

The keyed escutcheon on the SBM switch (Fig. 18) has eight possible keyway locations. Three are normally used and are assigned by the factory. The choice is influenced by several factors:

a. If the handle is to be interchangeable with that of another switch, the position in which each handle is to be removeable must be considered.

b. If the handle is to be non-interchangeable, the keyways assigned to other removeable handles in the same panel must be considered.

c. If no special instruction is given by the customer when he orders, the factory will assign keyways at random; if more than one SBM switch has a removable handle, they will be keyed to be non-interchangeable.

A removable handle is furnished as a separate item, not with the switch it operates, because in some cases the single handle operates many switches. The handle is keyed so that it will fit through the keyways on the escutcheon in a specific position.

When ordering a removable handle, specify the type, the position in which it is to be removable, and the switch or switches it will be used with. The factory will assign the handle. To identify SBM removable handles, see Table 1.

TABLE 1 Nomenclature guide for SBM removable handles

1st Number	2nd Number	1st Letter	2nd Letter	3rd No.	4th No.	5th No.
Handle Type	Removable in Position	Common Code	Action of Rotation	Escutcheon Keyways		
1 = Knurled	1	W	W = CW & CCW	1	1	1
2 = Oval	thru		L = CCW (special)	thru	thru	thru
3 = Pistol grip	8		R = CW (special)	8	8	8

Example 1: 21WW135

This oval handle has keys at positions which, when it is in position 1, or nine o'clock, will line up with escutcheon keyways 1, 3, and 5. It is therefore removable in position 1.

SB-1 & SB-9 SWITCH

The keyed escutcheon for the SB-1 & SB-9 switch is normally furnished with three keyways (see Fig. 19). The circumferential location of the keyways will vary, depending on the location, etc., in which the handle is to be removable. The location of the keyways is assigned by the factory.

Table 2 gives a list of standard keyed escutcheons and the proper removable handle for removing the handle in both the vertical (12 o'clock) position and 90° ccw (9 o'clock) position. Escutcheons 6016164P-2 thru P-14 are used on switches if the throw does not exceed 90° on either side of the vertical (12 o'clock) position, and P-23, 24 and 25 are used when the throw does exceed this limit.

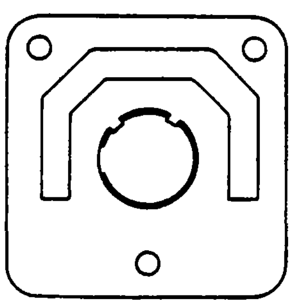


Fig. 19. SB-1 escutcheon for use with removable handle 3.1.1-118

Oval handles 16SB1CC1 thru 32 are listed with direction and degree of throw from the positions in which they are removable. The code letters A thru Z in the left hand column identify the escutcheons used on the basic unlisted switches.

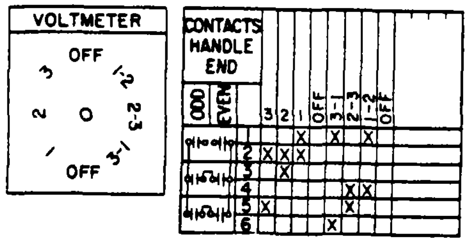
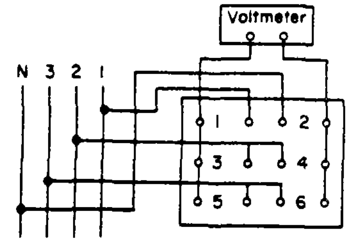
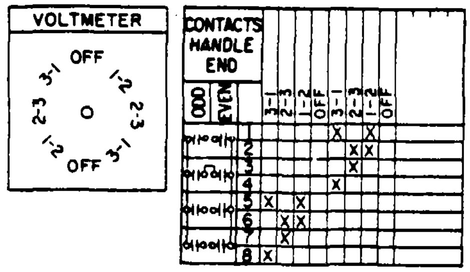
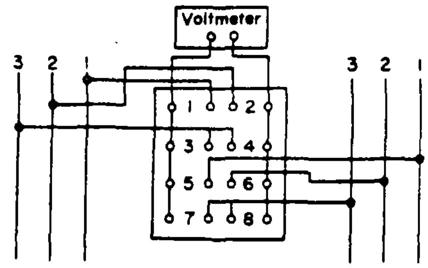
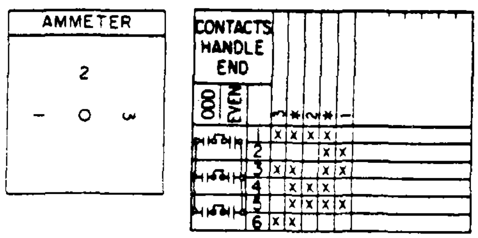
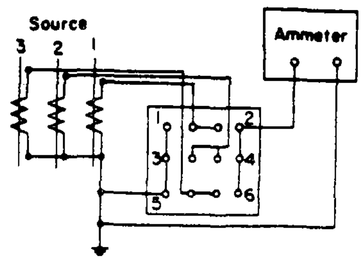
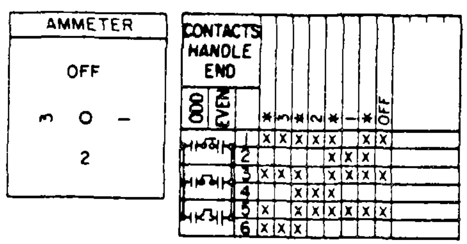
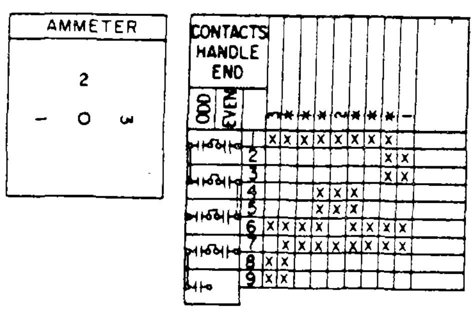
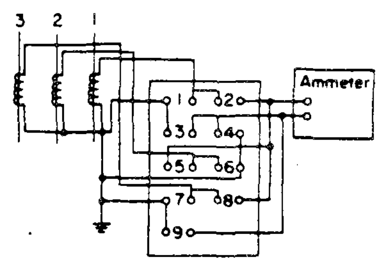
Example: 16SB1AB300SAM3Y, the 2nd form letter A identifies a keyed escutcheon 6016164P-3.

When a special keyed escutcheon is required, different from any of those listed, the code letter "X" is used followed by the part number.

Example: 16SB1AB300SX34M2Y.

All keyed escutcheons will now have the part number stamped at the bottom left hand corner instead of the code letters previously stamped at the bottom righthand corner. If the code letter or other indentification is desired, it will be stamped at the bottom righthand corner by requisition only (three characters maximum). The 16SB1CC oval type removable handle will now have the form number only stamped on the lower face of the handle. Those removable handles which have metal shanks (6119745G) will have the group number stamped on the shank. When a switch with a keyed escutcheon for a removable handle is ordered, be sure to specify the position in which the handle is to be removable. If an existing handle will be used, give the number of the existing handle.

Contact Diagrams for SBM Switch

NO.	DESCRIPTION	ESCUTCHEON & CONTACT DIAGRAM	WIRING DIAGRAM
Fig. 30.	**VOLTMETER TRANSFER SWITCH, three-phase, transfers four wires phase-to-phase and phase-to-neutral, *Model No. 10AA006.* Knurled handle.**		
Fig. 31.	**VOLTMETER SWITCH, two three-phase, three-wire circuits, *Model No. 10AA007.* Knurled handle.**		
Fig. 32	**AMMETER TRANSFER SWITCH, three CT's (connect at end of secondary), *Model No. 10AA008.* Knurled handle.**		
Fig. 33.	**AMMETER TRANSFER SWITCH, three CT's with off (connect at end of secondary), *Model No. 10AA009.* For wiring, see Fig. 32. Knurled handle.**		
Fig. 34.	**AMMETER TRANSFER SWITCH, three independent circuits, *Model No. 10AA010.* Knurled handle.**		

x in all contact diagrams denotes contacts closed

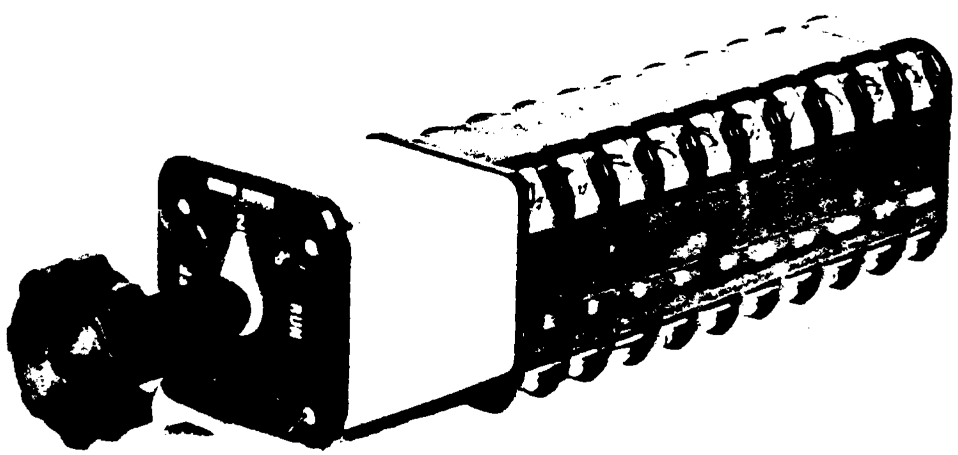
INSTRUCTIONS

GEH-2038C

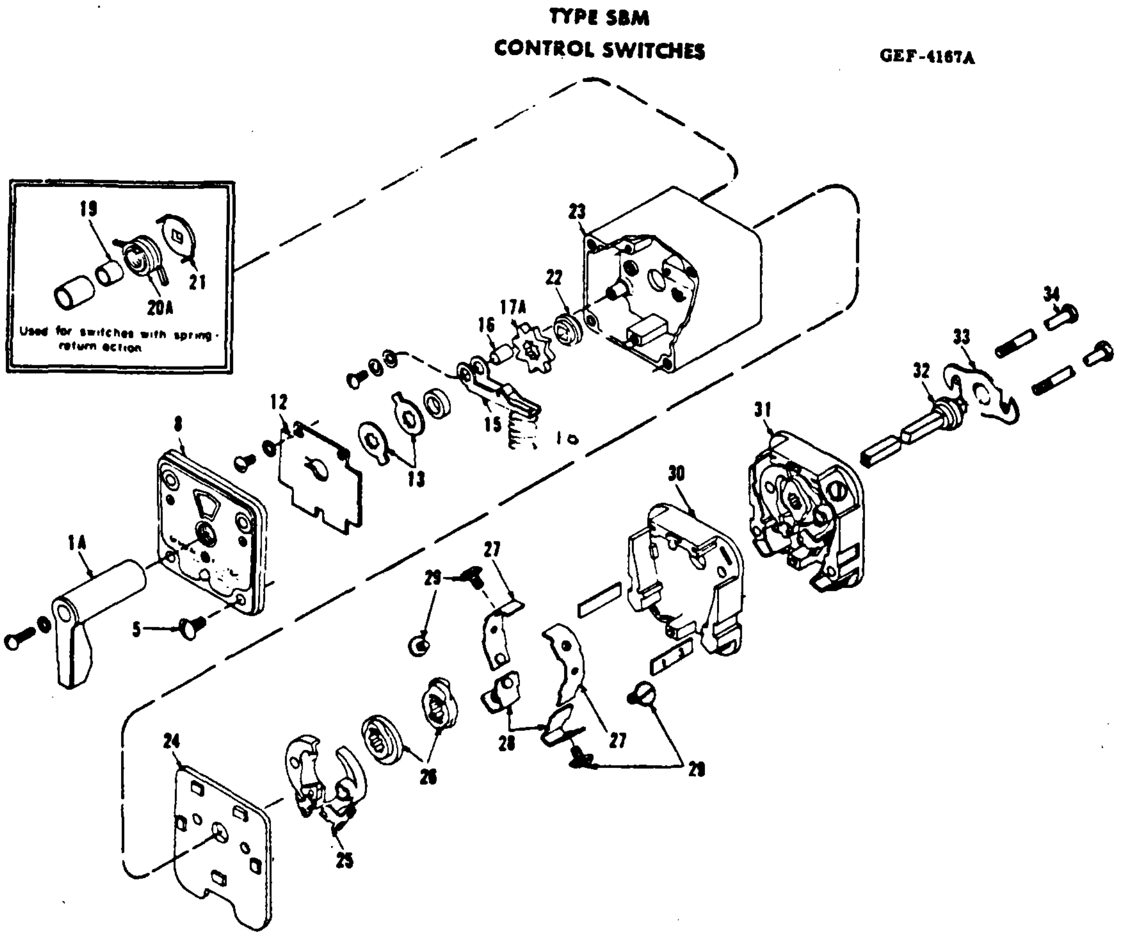
SUPERSEDES GEH-2038B

CONTROL AND TRANSFER SWITCH

Type SBM



GENERAL ELECTRIC



1A	Handle	22	Front Bearing
5	Mounting Screw	23	Front Support
8	Target Escutcheon	24	Barrier Cover
12	Front Plate	25	Cam Follower and Moving Contact Assembly
13	Stops	26	Cams for Contacts
15	Rocker Arm	27	Upper Stationary Contact
16	Sleeve	28	Lower Stationary Contact
17A	Positioning Wheel	29	Terminal Screw
18	Positioning Spring	30	Barrier
19	Sleeve	31	Barrier Assembly
20A	Torsion Spring	32	Rear Bearing
21	Spring Actuator	33	Bearing Retainer
		34	Tie Bolt

Fig. 1 (0184B5484-0) Exploded View of Type SBM Switch

CONTROL AND TRANSFER SWITCH
TYPE SBM

DESCRIPTION

INTRODUCTION

The Type SBM switches are cam operated devices having two mechanically and electrically separate contacts per stage. The switch is totally enclosed, having no cover. The contact terminals are brought out to the corners, allowing screw connections to be made over a large angle. The switch is so constructed so as to allow the addition of 1 or 2 extra stages to the switch with a minimum of effort.

APPLICATION

The Type SBM switches are intended primarily for the control of electrically operated devices such as circuit breakers, small motors and magnetic switches, and for the transfer of meters, instruments and relays.

OPERATION

The Type SBM switches are rotary cam operated switches. Rotation of the shaft causes contacts to open or close, depending upon the shape and setting of the cams. Each stage consists of two mechanically nd electrically separate contacts. This is ac-omplished by means of two cams and two cam followers, assembled with moving contacts.

Each cam is constructed so as to have two operating surfaces. These surfaces operate on the cam follower. The cam follower has two tips which are located in offset horizontal planes lining up with the two cam operating surfaces. Thus, as the cam is rotated, one surface operates against the closing cam follower tip, while the opening cam follower tip is relieved. Both cam follower tips are always in contact with the cam surfaces. This allows for a positive closing and opening action not dependent upon springs.

Each cam follower has a spring loaded moving contact assembled to it. The compression spring acts to give adequate contact pressure when a contact is closed. The moving contact is held to the cam follower by a pin passing through a hole in the cam follower and angled slot in the moving contact. As the contacts close, the moving contact slides along this slot while compressing the spring thus causing relative motion or "wipe" between moving and stationary contacts.

Some applications, particularly of momentary contact switches, which have a torsion spring to return the switch to a central-neutral position, require a contact action which lags behind the switch motion (lost motion or slip contacts). Such contacts use cams with a special loose fit on the shaft. When the shaft has turned far enough tc close or open these contacts, it can be rotated 45 degrees in the reverse direction without moving the cams, but beyond this point, the cam moves with the shaft and the contacts either open or close as the case may be.

Momentary contact switches have a torsion spring that returns the switch to a central or neutral position when the handle is released after operation to a side position or positions. This torsion spring is designed for maximum of 90 degrees operation to each side of the central position. The torsion spring may have one end cut off or tied back in such a manner as to be effective on one side of the central position only. That is, the switch may have momentary contact to one side of the central position and maintaining contacts to the other side.

In some momentary contact (spring return) switches, a locking device is provided by which the shaft may be held against the action of the torsion spring by pulling out the handle when the switch is turned to one of the side positions.

POSITIONING

A detent wheel, mounted on the square shaft and acted upon by a spring loaded roller arm, gives positive positioning action to the switch.

REMOVABLE HANDLES

The removable handle option may be obtained with up to 3 keyways in the escutcheon. The keyway locations are at the discretion of the customer. The handle is removable in one position. Any style handle can be used for this operation.

ADD-A-STAGE

A shaft extension is provided to enable an additional stage to be coupled to the existing switch in the event that more contacts are required when the switch is in the hands of the customer.

RATINGS

The switch is rated for a mechanical life of 500,000 operations. The electrical rating is 600 volts, 20 amperes continuous. The interrupting rating depends on several factors; namely, voltage, current and inductance of the circuit. It may be necessary to use two or more contacts in series to insure adequate interrupting ability on highly inductive circuits. The interrupting ratings are shown in Table I.

TABLE I

Circuit Voltage	Non-Inductive Cir.		Inductive Circuit	
	Number of Contacts			
	1	2(in ser)	1	2(in ser)
24 DC	10.0	30.0	8.0	25.0
48 DC	8.0	25.0	6.0	18.0
125 DC	5.0	15.0	4.0	10.0
250 DC	1.0	3.0	1.0	2.5
600 DC	0.4	0.8	0.3	0.7
115 AC	40.0	75.0	24.0	50.0
230 AC	25.0	50.0	12.0	25.0
460 AC	12.0	25.0	5.0	15.0
600 AC	10.0	20.0	8.0	12.0

CONSTRUCTION

The Type SBM switch is built up with a series of stages which are nested into each other, an operating shaft, a front support and a rear support.

The complete stack is tied together with two tie bolts threaded into the front support. These tie bolts also act as a bearing for the cam follow in each stage. Each stage consists of four statior contacts and two moving contacts, (double break construction) two cams and two cam followers. The cams are mounted on the operating shaft. In case only one contact is required in a stage, a cam follower assembly is omitted.

CONTACT IDENTIFICATION

The contacts are marked for identification using a standard system. On each side of the switch midway on the barriers, is a confined marking strip. These strips are located between the two screws which define a contact. The marking strip on the right side, front view, looking toward the rear is numbered 1, 3, 5, etc. starting at the panel end. Those on the left side are marked 2, 4, 6, etc. If a contact is omitted the terminal screws are also omitted for that contact.

ENCLOSURES AND MOUNTING

The basic switch is totally enclosed except for an opening in the bottom to allow for a visual inspection of the contacts.

All switches are furnished for mounting in panels 3/32 to 1/4 inch thick. Variation in panel thickness is taken up by the use of two saddle washers mounted between the handle and escutcheo-

INSTALLATION

RECEIVING

Immediately upon receipt of a switch, examine it for any damage sustained in transit. If injury or rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office. The switches are completely assembled and packed in individual cartons before shipment.

If the switches are for stock purposes or not for immediate installation, they should be left in the shipping carton and stored in a clean dry location.

MOUNTING

For panel mounted switches, holes should be provided in the panel as shown in Fig. 2.

To mount a switch on a panel, first remove the handle and escutcheon, including where provided, the position-indicating pointer and the curved spring washers (saddle spring). Next, hold the switch in place on the back of the panel and insert the mounting screws through the escutcheon, panel, and spacers (if used) into the switch front support, but do not tighten the mounting screws. Attach the pointer, saddle springs and handle. Align the escutcheon on the panel.

When mounting removable-handle switches be certain that the shaft of the switch is properly positioned, so the handle is easily removed before the mounting screws are tightened.

MAINTENANCE

SERVICING

CONTACT CLEANING

At regular intervals, the switch contacts should be inspected for wear and burning. An opening at the bottom of the switch has been provided for this. (see Fig.3) If the contacts are slightly pitted or coated with sulphide, they should be cleaned with a flexible burnishing tool similar to that included in the XRT relay tool kit.

WARNING: Since many of the parts of this switch are molded of a polycarbonate material, DO NOT use any lubricants and/or cleaning agents in any form (incl- ing aerosol sprays commonly available). Hyd. carbons (oils and related products may chemically attack such parts resulting in possible switch failure.

RENEWAL PARTS

TYPE SBM
CONTROL SWITCHES

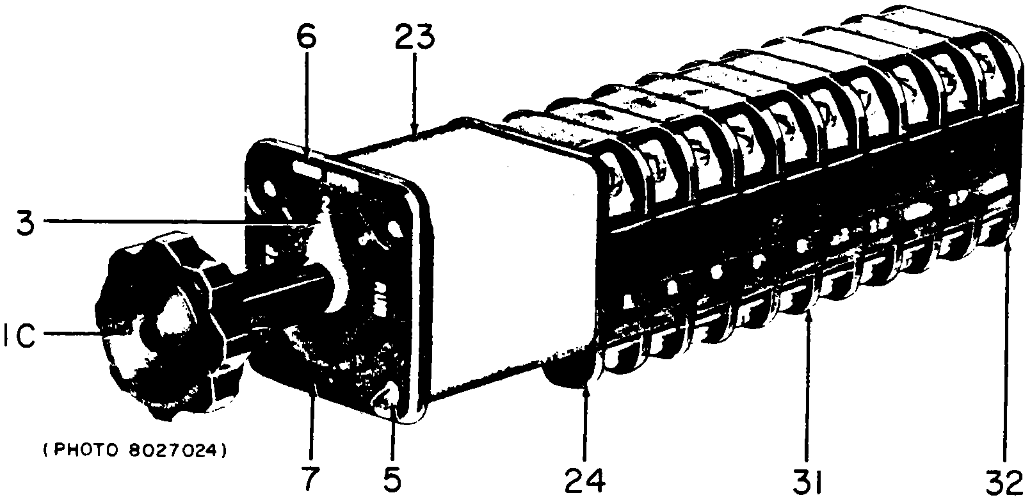


Fig. 1. Typical SBM control switch (fixed knurled handle, standard escutcheon, and ten stages of maintained contacts).

ORDERING INSTRUCTIONS

1. Always specify the complete nameplate data of the switch.
2. Specify the quantity, catalog number (if listed), reference number (if listed), description, and this bulletin number.
3. Standard hardware, such as screws, bolts, nuts, washers, etc., is not listed in this bulletin. Such items should be purchased locally.
4. For prices, refer to the nearest office of the General Electric Company.

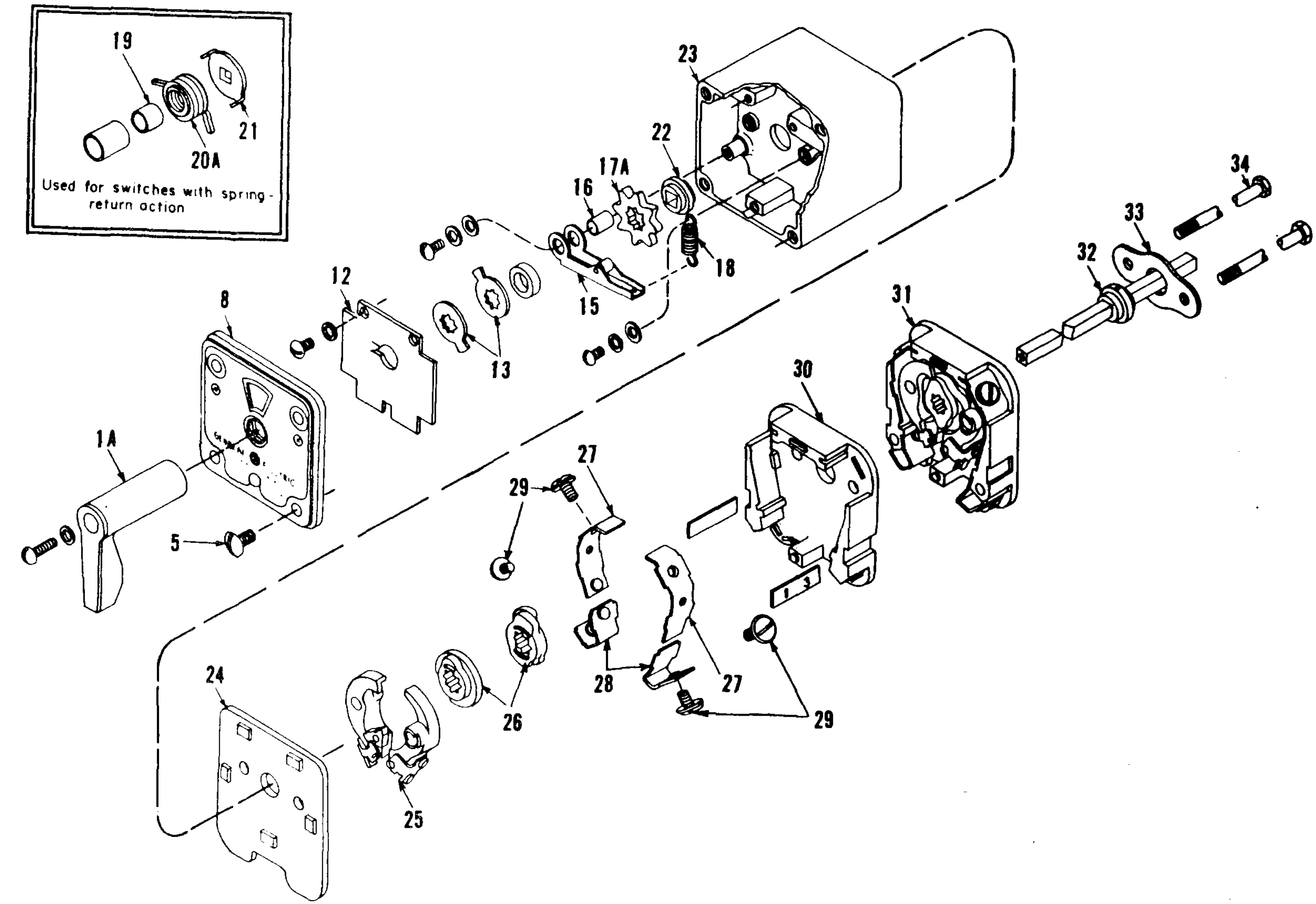


Fig. 2. Exploded view of typical two-stage type SBM switch. Maintained contact construction shown. For spring return action, references 19, 20, and 21 replace references 15, 16, 17, and 18.

PRINCIPAL RENEWAL PARTS

Ref. No.	Catalog Number	Description
1A	888B208AAP1	Handle, fixed, pistol grip
†1B	888B208ABP1	Handle, fixed, oval
1C	888B208ACP1	Handle, fixed, knurled
†1D	6248034P2	Handle, fixed, lever
†2A	127A6780G1	‡Handle assembly, removable, standard
†2B	127A6780G3	‡Handle assembly, removable, engraved "R"
†2C	127A6780G4	‡Handle assembly, removable, engraved "1"
3	307V511P1	White pointer for handle
†4	307V516	Spring washer for pointer
5A	6049905P1	Mounting screw, 3/32 - 1/4 inch panel
5B	6049905P8	Mounting screw, 1 - 1 1/2 inch panel
6	NP-202491	Circuit designation plate (specify engraving)
7	127A6768P1	Escutcheon, fixed handle, no target (specify engraving)
8A	127A6757G1	Escutcheon, fixed handle, with target (specify engraving)
8B	127A6757G2	Escutcheon, fixed handle, with target ("TRIP" - "CLOSE")
8C	127A6757G3	Escutcheon, fixed handle, with target ("STOP" - "START")
8D	127A6757G4	§Escutcheon, fixed handle, with target (specify engraving)
8E	127A6757G5	§Escutcheon, fixed handle, with target ("TRIP" - "CLOSE")
8F	127A6757G6	§Escutcheon, fixed handle, with target ("STOP" - "START")
†9	888B207P1	‡Escutcheon, removable handle (specify engraving)
†10	127A6763P1	§Locking plate
†11	307V508P1	Shaft coupling (removable handle switches only)
12	127A6753P1	Front plate
13	127A6754P1	Stop wheel (standard)
†14A	127A6764G1	§Stop wheel and shaft assembly, 3/32 - 1/4 inch panel
†14B	127A6764G2	§Stop wheel and shaft assembly, 1-1 1/2 inch panel
15	127A6772G1	Roller arm assembly
16	6074939P91	Roller arm bearing sleeve
17A	127A6774P1	Index wheel, 8 points, 45 degree spacing
†17B	127A6774P2	Index wheel, 7 points, 45 degree spacing
†17C	127A6774P3	Index wheel, 4 points, 90 degree spacing
†17D	127A6774P4	Index wheel, 3 points, 90 degree spacing
*18	127A6781	Positioning spring
19	307V510P1	Torsion spring sleeve
*20A	127A6775P1	Torsion spring, standard (spring return CW and CCW)
*†20B	307V513P1	Torsion spring, special (spring return CCW to normal only)
*†20C	307V513P2	Torsion spring, special (spring return CW to normal only)
21	127A6760G1	Torsion spring actuator
22	127A6755P2	Front bearing
23	237C755P1	Front support
24	237C756P1	Barrier cover plate
*25	127A6770G1	Cam follower and moving contact assembly
26	237C759P(¶)	Cam
*27	127A6749G1	Stationary contact, upper
*28	127A6751G1	Stationary contact, lower
29	6047297P1	Connection screw
30	237C757P1	Intermediate barrier only (no contacts)
31	237C758P1	πRear support only (no contacts)
32	Δ	Rear bearing and shaft assembly
33	NP-202490	Rear bearing retainer and nameplate
34	127A6756G(◊)	Tie bolt

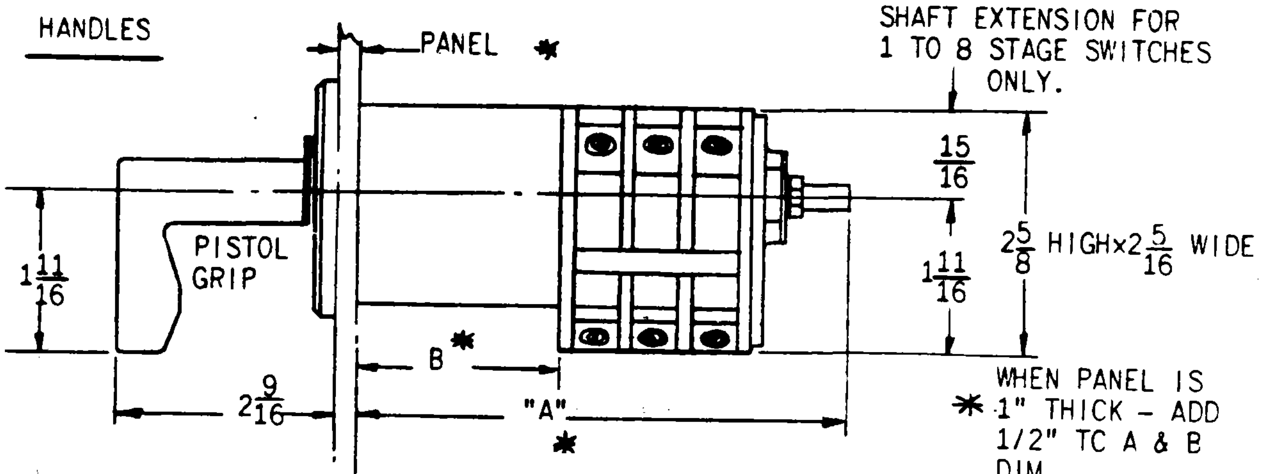
* Recommended for stock for normal maintenance.
† Not shown.
‡ Specify switch number, type of handle, and position in which removed.
§ Pull-to-lock switches only.

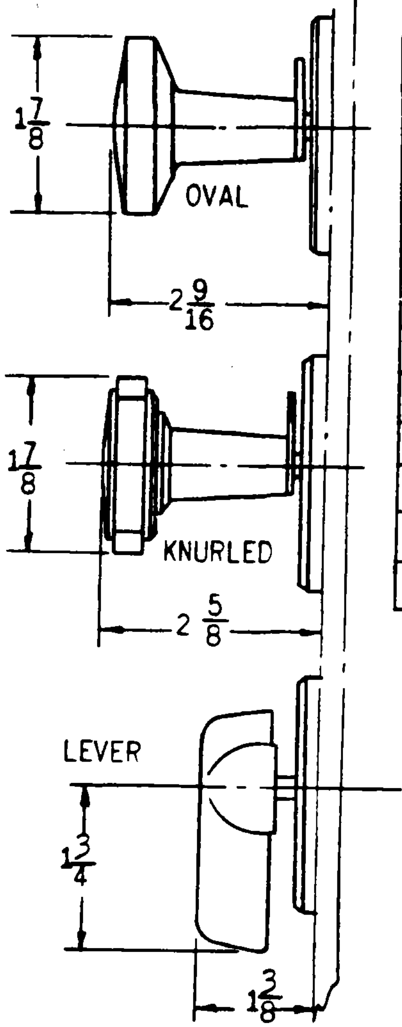
¶ Specify numeral molded in cam.
π Uses same contacts as intermediate barrier (References 27, 28, and 29).
Δ Specify model number of switch.
◊ Specify number of stages in switch.

GENERAL ELECTRIC COMPANY
SWITCHGEAR BUSINESS DEPARTMENT
PHILADELPHIA, PA 19142

GENERAL ELECTRIC

10–76 (5M)





NO. OF STAGES	STANDARD SWITCH PT.	"A"	B	PULL TO LOCK SWITCH PT.	"A"	B	REMOVABLE HANDLE SW. PT	"A"	B
1	1	3-7/8	2-1/8	21	4-9/16	2-7/8	41	4-3/4	3-1/16
2	2	4-1/2		22	5-3/16		42	5-3/8	
3	3	5-1/8		23	5-13/16		43	6	
4	4	5-3/4		24	6-7/16		44	6-5/8	
5	5	6-3/8		25	7-1/16		45	7-1/4	
6	6	7		26	7-11/16		46	7-7/8	
7	7	7-5/8		27	8-5/16		47	8-1/2	
8	8	8-1/4		28	8-15/16		48	9-1/8	
9	9	8-1/2		29	9-3/16		49	9-1/4	
10	10	9-1/8		30	9-13/16		50	10	

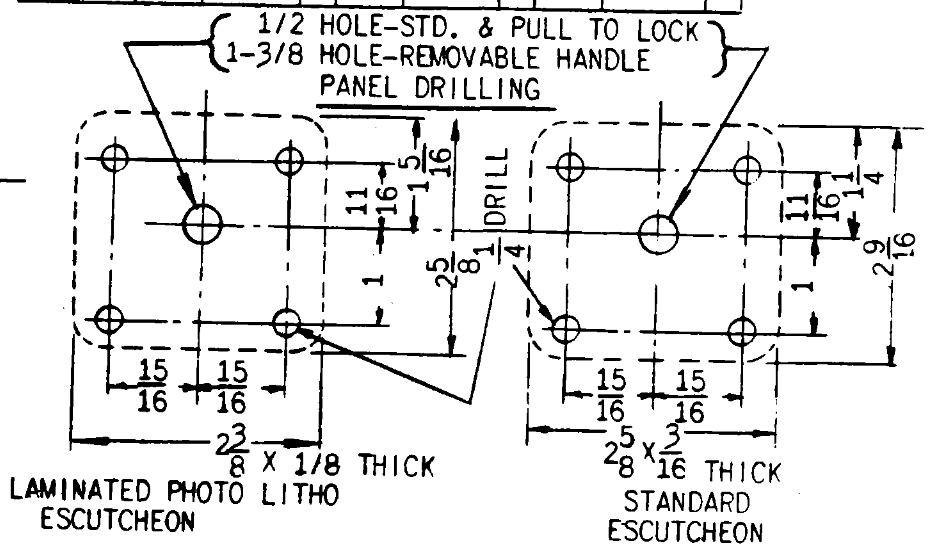


Fig. 2 (127A6779-6)

Fig. 2 Outline and Panel Drilling of Type SBM Switch

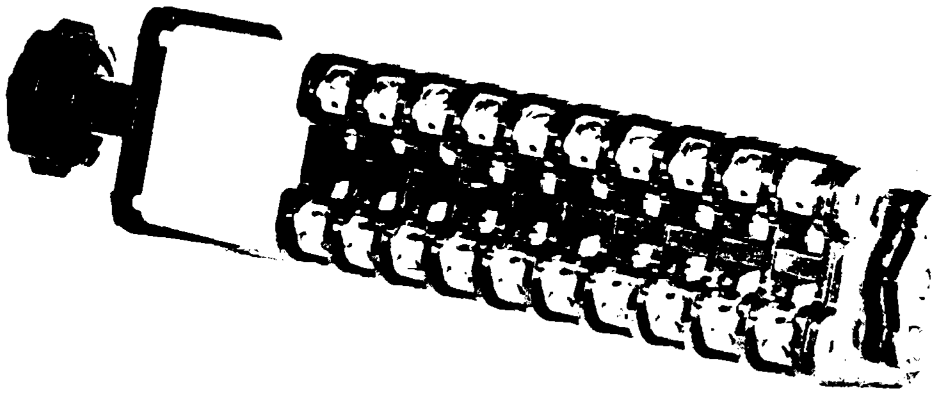


Fig. 3 Bottom View of Type SBM Switch

Fig. 3 (8027023)

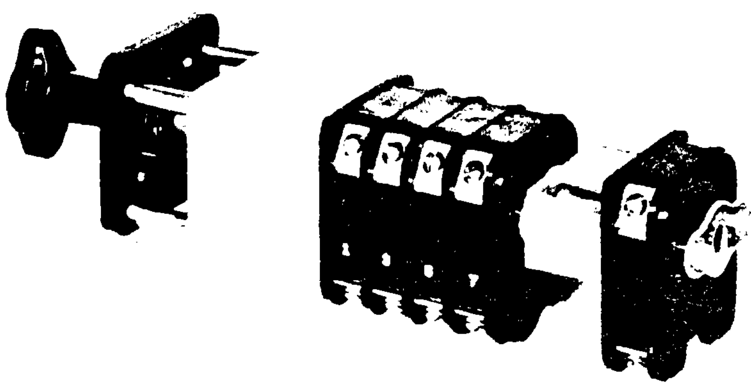


Fig. 4 View of Type SBM Switch with Additional Stage in Position

Fig. 4 (8027022)

REPAIR AND REPLACEMENT

In some cases, it is desirable to either replace a contact stage or to add an additional amount of contacts.

In such cases, it might be advantageous not to disturb the existing switch but to add directly to the present switch. In order to do this, the proper contact sequence should be ordered (no more than two stages) noting that this is for adding to an existing switch. These parts will be received assembled with a U-shaped bracked and a coupling with a square hole will also be received. Fig. 4 shows a Type SBM switch with an additional stage already in position.

To install these additional contacts, loosen the two tie bolts at the rear of the switch about 3/32 inch. Slide the loose bracket over the shaft and tie bolts so that the inner part of the bracket slot rests on the tie bolts between the tie bolts and nameplate. Tighten the tie bolts. Slide the coupling over the shaft extension on the present switch, then slide the shaft extension on the new barrier assembly into the coupling, keeping the shaft of the new contact barriers in the proper position to give the correct contact sequence corresponding to the handle position. This should cause the side holes in the two U-shaped brackets to line up. Fasten the brackets together with the hardware supplied.

If it is desired to disassemble the switch for any reason, the following procedure should be followed: Place an identifying mark on the handle end of shaft corresponding to a position on the escutcheon such as 12 O'clock. Remove the escutcheon. Remove the three screws fastening the front plate to the front support. If there are stops in the front support, the position relative to the shaft identification mark should be noted. Remove the stops, spacer and star wheel if they are present.

Unscrew the tie bolts and remove the front support. If any torsion springs are present, pull one tie bolt back far enough so that one arm of the torsion spring can be sprung away from the spring actuator. Remove the spring actuator, spring and any spacers present. Remove the molded cover plate exposing the contacts of the first stage.

Each cam has one number and seven letters around the shaft opening on one side of the cam and eight letters on the other side of the cam. When removing cams, mark the letter of the cam which corresponds to the shaft identification mark; thus cam and cam followers are removed in succession. This is done to each succeeding barrier.

When reassembling, it is only necessary to stack the cams back into the shaft in the same order as taken off, keeping the proper cam letter lined up with the shaft identification mark.

Before tightening the tie bolts into the front support, make sure that all the barriers are properly nested.

The parts which fit into the front support may now be assembled, placing the stops, if present, in their proper position with respect to the shaft identification mark.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted, and give complete nameplate data.

GENERAL ELECTRIC COMPANY
POWER SYSTEMS MANAGEMENT BUSINESS DEPT.
PHILADELPHIA, PA. 19142

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4-64 10-77

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CLF® Fuses, Current-limiting

High-interrupting Capacity

Current Rating: 3–4000 Amperes   Interrupting Rating: 200,000 Amperes, rms Symmetrical

WELDING FUSE (800–2000 amps, 600 volts ac)

Similar in short-circuit protection characteristics to the Class L fuse, the welding fuse is specifically designed for welding circuit applications.

Switchgear Equipment Products-P(R2100

Rating (volts/amps)	Catalog Number	★	Rating (volts/amps)	Catalog Number	★
600/800 600/1000 600/1200	GF30W8 GF30W10 GF30W12		600/1600 600/2000	GF30W16 GF30W20	

CLASS J FUSE ADAPTER KITS

A new adapter kit permits 225–600-ampere Class J fuses to mount in 600-volt Class K5 fuse spacings. This kit comprises adapter bars which bolt directly to the fuse tangs.

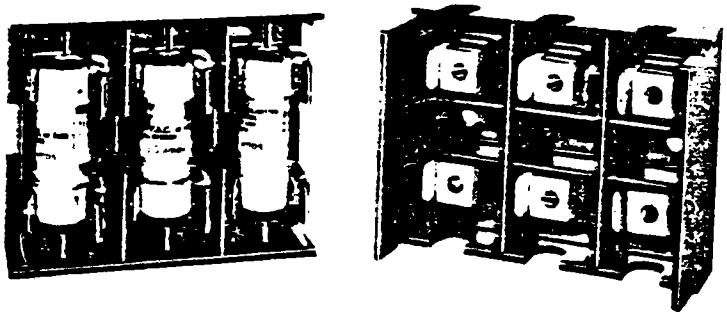
Switchgear Equipment Products-P(R2100

Amperes	Class J fuse	Catalog number for adapter kit for Class K5 mounting	★
225	GF8B225	011687113G1	
250	GF8B250	011687113G1	
300	GF8B300	011687113G1	
350	GF8B350	011687113G1	
400	GF8B400	011687113G1	
450	GF8B450	011687113G2	
500	GF8B500	011687113G2	
600	GF8B600	011687113G2	

CLASS J PULLOUT BLOCK

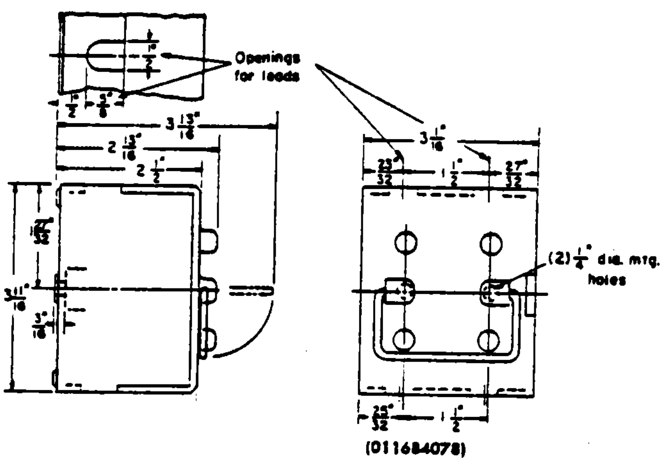
(1–30 amperes, 600 or less volts)

Poles	Amperes	Catalog No.	★	Dim. Fig.
2	1-30	011684078		7A
3	1-30	011684075		7B



(Photo 1226009)

Fig. 7. Class J pullout block



(011684078)

Fig. 7A

Class J Pullout Blocks Dimensions

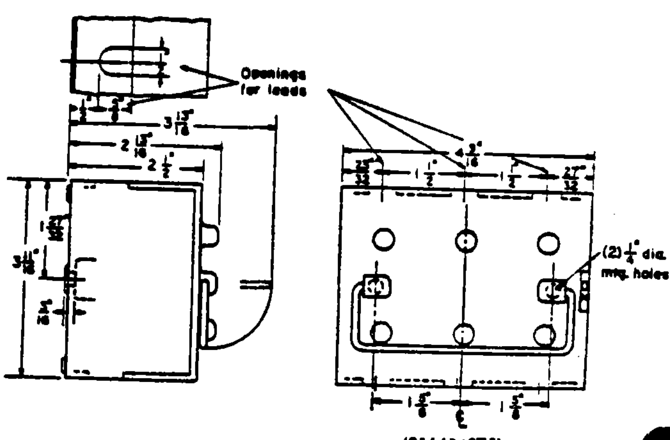


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Fig. 7B

★Changed since May 10, 1976 issue.

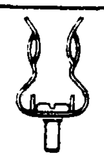
FUSE HOLDERS

53-3

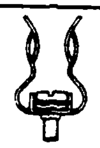
CLASS H & CLASS R

30/60 AMP - 250/600 VOLT

100-600 AMP - 250/600 VOLT

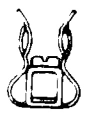


S = Screw Connector



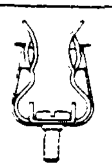
SP = Sems Pressure Connector

CLASS H FUSE CLIPS

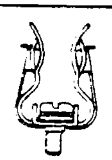


B = Box Connector

R = Reinforcing Spring



S = Screw Connector



SP = Sems Pressure Connector

CLASS R FUSE CLIPS

B = Box Connector

CATALOG NUMBER AND SPECIFICATIONS

CLASS H CAT. NO.	CLASS R CAT. NO.	POLES	VOLTS	AMPS	CLASS H & R FUSE SIZE	UL	CSA
F30A1S	R30A1S	1	250	30	All holders accept fuses 9/16" Diameter x 2" Long	Yes	Yes
F30A2S	R30A2S	2	250	30		Yes	Yes
F30A3S	R30A3S	3	250	30		Yes	Yes
F30A1SP	R30A1SP	1	250	30		Yes	Yes
F30A2SP	R30A2SP	2	250	30		Yes	Yes
F30A3SP	R30A3SP	3	250	30		Yes	Yes
F30A1B	R30A1B	1	250	30		Yes	Yes
F30A2B	R30A2B	2	250	30		Yes	Yes
F30A3B	R30A3B	3	250	30		Yes	Yes
6F30A1S	6R30A1S	1	600	30	All holders accept fuses 13/16" Diameter x 5" Long	Yes	Yes
6F30A2S	6R30A2S	2	600	30		Yes	Yes
6F30A3S	6R30A3S	3	600	30		Yes	Yes
6F30A1SP	6R30A1SP	1	600	30		Yes	Yes
6F30A2SP	6R30A2SP	2	600	30		Yes	Yes
6F30A3SP	6R30A3SP	3	600	30		Yes	Yes
6F30A1B	6R30A1B	1	600	30		Yes	Yes
6F30A2B	6R30A2B	2	600	30		Yes	Yes
6F30A3B	6R30A3B	3	600	30		Yes	Yes
SCREW CONNECTIONS ARE AVAILABLE FOR 60 AMP - 600 VOLT APPLICATIONS (CONSULT FACTORY)							
6F60A1B	6R60A1B	1	600	60	Accepts fuses 1-1/16" Diameter x 5-1/2" Long	Yes	Yes
6F60A2B	6R60A2B	2	600	60		Yes	Yes
6F60A3B	6R60A3B	3	600	60		Yes	Yes
F60A1S	R60A1S	1	250	60	All holders accept fuses 13/16" Diameter x 3" Long	Recognized	No
F60A2S	R60A2S	2	250	60		Recognized	No
F60A3S	R60A3S	3	250	60		Recognized	No
F60A1B	R60A1B	1	250	60		Listed	Yes
F60A2B	R60A2B	2	250	60		Listed	Yes
F60A3B	R60A3B	3	250	60		Listed	Yes
F100A1B	R100A1B	1	250	100	Accept fuses 1" Diameter x 5-7/8" long.	Yes	Yes
F100A2B	R100A2B	2	250	100		Yes	Yes
F100A3B	R100A3B	3	250	100		Yes	Yes
6F100A1B	6R100A1B	1	600	100	Accept fuses 1-1/4" Diameter x 7-7/8" long	Yes	Yes
6F100A2B	6R100A2B	2	600	100		Yes	Yes
6F100A3B	6R100A3B	3	600	100		Yes	Yes
F200A1B	R200A1B	1	250	200	Accepts fuse 1-1/2" Diam. x 7-1/8"	Yes	Yes
F200A3B	R200A3B	3	250	200		Yes	Yes
6F200A1B	6R200A1B	1	600	200	Accepts fuse 2-1/2" x 9-5/8"	Yes	Yes
6F200A3B	6R200A3B	3	600	200		Yes	Yes
F400A1B	R400A1B	1	250	400	Accepts fuses 2" Diam. x 8-5/8"	Yes	Yes
F400A3B	R400A3B	3	250	400		Yes	Yes
6F400A1B	6R400A1B	1	600	400	Accepts fuses 2-1/2" Diam. x 11-5/8"	Yes	Yes
6F400A3B	6R400A3B	3	600	400		Yes	Yes
F600A1B	R600A1B	1	250	600	Accepts fuse 2-15/16 x 10-3/8"	Yes	Yes
F600A3B	R600A3B	3	250	600		Yes	Yes
6F600A1B	6R600A1B	1	600	600	Accepts fuse 3-13/32 Diam. 13-3/8"	Yes	Yes
6F600A3B	6R600A3B	3	600	600		Yes	Yes

Reinforcing Members are available for 30 and 60 Amp fuse holders on request — add "R" before the above catalog number. Reinforcing Members are standard on 100, 200 and 400 Amp fuse holders.
Reinforcing Members are standard on 30 through 400 Amp Class R fuse holders.

MARATHON SPECIAL PRODUCTS bowling green, ohio 43402 telephone: (419) 352-8441

Consult engineering catalog for diagrams and dimensions.

DIMENSIONS: 30 Amp - 250 Volt. Class H

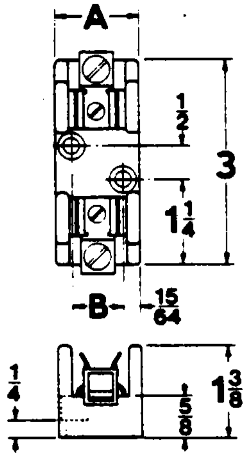


Fig. I

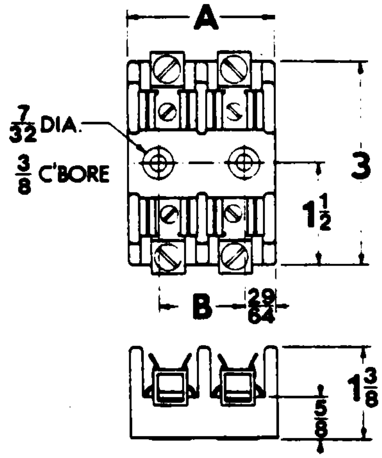


Fig. II

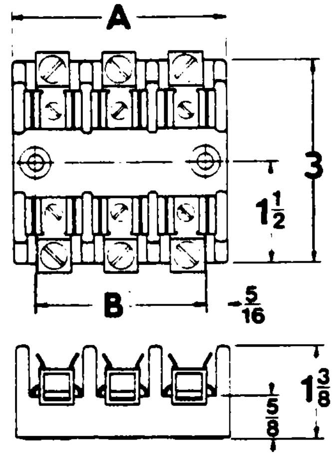


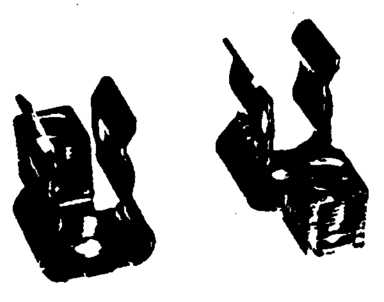
Fig. III

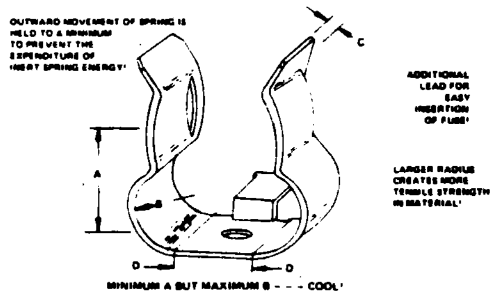
DIAGRAM DIMENSIONS

CAT. NO.	FIG. NO.	A	B
F30A1S	I	1-7/32	3/4
F30A2S←	II	2-5/32	1-1/4
F30A3S	III	3-1/8	2-1/2
F30A1SP	I	1-7/32	3/4
F30A2SP	II	2-5/32	1-1/4
F30A3SP	III	3-1/8	2-1/2
F30A1B	I	1-7/32	3/4
F30A2B	II	2-5/32	1-1/4
F30A3B	III	3-1/8	2-1/2

(Catalog dimensions are for reference only, not to be construed as inspection standards)

MARATHON'S "COOL CLIP®" DESIGN





Resistance - a most fundamental property of electricity in relation to its conductor. The higher the resistivity of the conductor the higher heat level generated with the passage of current. In fusing applications, this heat must be dissipated. The heat generated in a fuse clip can actually reduce the life of the fuse, clip and conductor as well as the protection power of the fusing device.

No longer is it necessary for heat buildup to rob equipment of protection and extended life. Utilize our "Cool-Clip", a revolutionary new fuse clip that is the result of an extensive anylitical optimization process.

"Minimum A but maximum B" is the secret behind the "Cool-Clip". Extremely good contact between the fuse and "Cool-Clip" causes the fuse and clip to operate considerably cooler than other clips.

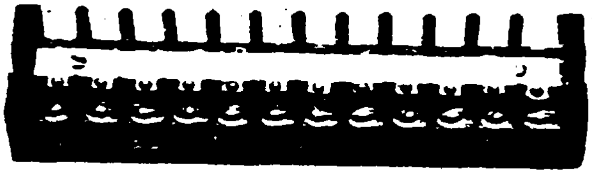
Minimum outward movement of the spring at points "C" means a minimum expenditure of energy; the fuse is held in place with more force. The greater "B" distance reduces to near nothing the possibility of exerting excess pressure at stress point "D". No more broken or sprung fuse clips.

Subject to change without notice.

HEAVY DUTY

56-1
57-1

TERMINAL BLOCK - BARRIER TYPE



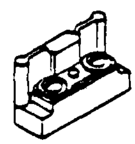
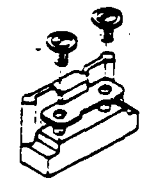
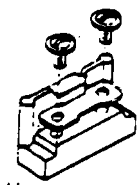
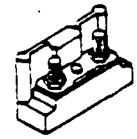
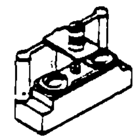
*Refer to Bulletin 5.0 for Heavy Duty Ratings and Standards in Marathon's engineering catalog.

ELECTRICAL RATING
—600 Volt*
—up to 75 Amps depending on termination used*
— Wire Range
will accommodate up to a #10 AWG wire in accordance with the National Electrical Code
Screws—Brass, nickel plated, 10-32x7/16 serrated washer head, standard.

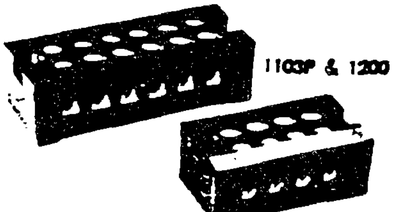
1500 Series
5/8" Line to line spacing
U Slot Mount

1600 Series
21/32" Line to line spacing
Inboard Mount

CATALOG NUMBER AND SPECIFICATIONS

1500 / 1600		1500 DJ / 1600 DJ		1500 DJSV / 1600 DJSV		1500 ST / 1600 ST		1500 SC / 1600 SC	
									
non removable connector marking strip included		removable connector, with brass insert, marking strip included		removable connector, with brass insert, removable cover included		10/32 stud connector, marking strip included		short circuiting bar with brass insert, 4 shorting pins per block	
No. of term.	Cat. No.	No. of term.	Cat. No.	No. of term.	Cat. No.	No. of term.	Cat. No.	No. of term.	Cat. No.
4	1504	4	1504DJ	4	1504DJSV	4	1504ST	4	1504SC
6	1506	6	1506DJ	6	1506DJSV	6	1506ST	6	1506SC
8	1508	8	1508DJ	8	1508DJSV	8	1508ST	8	1508SC
12	1512	12	1512DJ	12	1512DJSV	12	1512ST	12	1512SC
4	1604	4	1604DJ	4	1604DJSV	4	1604 ST	4	1604 SC
6	1606	6	1606DJ	6	1606DJSV	6	1606 ST	6	1606 SC
8	1608	8	1608DJ	8	1608DJSV	8	1608 ST	8	1608 SC
12	1612	12	1612DJ	12	1612DJSV	12	1612 ST	12	1612 SC

TERMINAL BLOCK - ENCLOSED TYPE



1103P & 1200

1100

1100 Series

ELECTRICAL RATING
—300 Volts*
—55 Amps*
—Wire size - #14-#6 AWG Copper

1103P & 1200 Series

ELECTRICAL RATING
—1103P Series, 600 Volt - 70 Amps*
—1200 Series, 600 Volt - 70 Amps*

Wire Range	1103P	1200
	#14-#4 AWG Copper	#18-#4 Copper
	#8-#4 AWG Aluminum	#12-#4 Aluminum

CATALOG NUMBER

SERIES -	1100	1103P	1200
NO. OF TERM.	CAT. NO.	CAT. NO.	CAT. NO.
2	1102		1202
3		1103P	
4	1104		1204
6	1106		1206
7	1107		
8	1108		
12	1112		

MARATHON SPECIAL PRODUCTS bowling green, ohio 43402 telephone: (419) 352-8441

Consult engineering catalog for diagrams and dimensions.

MARATHON
special products

DIMENSIONS: 1500 Series

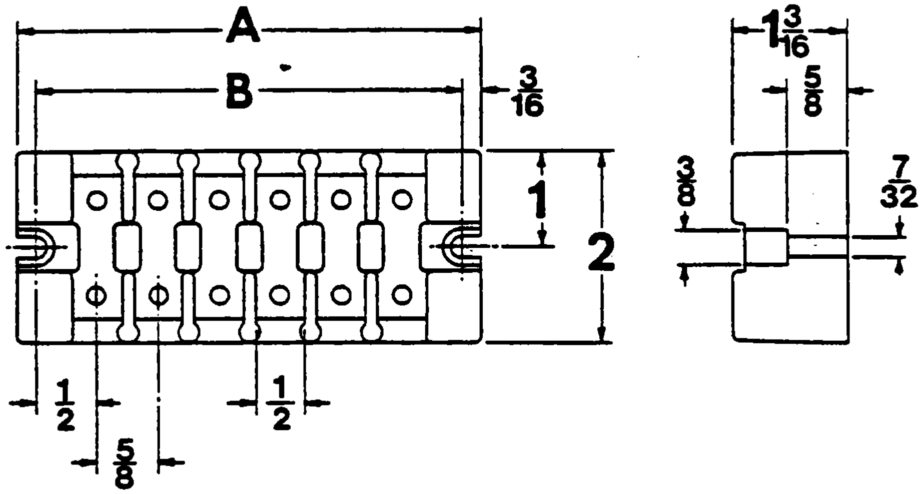
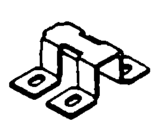


DIAGRAM DIMENSIONS			
Catalog Number	No. of Lines	A	B
1504	4	3-1/4	2-7/8
1506	6	4-1/2	4-1/8
1508	8	5-3/4	5-3/8
1512	12	8-1/4	7-7/8

(Catalog dimensions are for reference only, not to be construed as inspection standards)

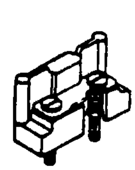
AVAILABLE OPTIONS

MCJ—multiple circuit jumper



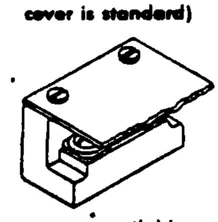
Construction — 1/16" Copper
Available cut to length
or in strips of 72 Circuits

BM—back mounted stud configuration



Consult factory

Covers—
(Note: on all DJSV parts cover is standard)

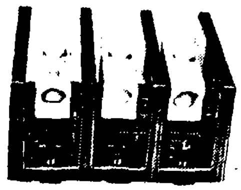


Hinge covers available
"H" after Cat. No.
Black or White PVC, imprinting is available upon request.

Subject to change without notice.

POWER BLOCKS

*Refer to Bulletin 2.0 for Power Block Ratings and Standards.



600 VOLTS* TWO AND THREE CIRCUITS
(ONE CIRCUIT AVAILABLE ON SPECIAL REQUEST)

GENERAL INFORMATION

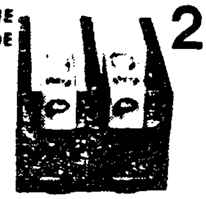
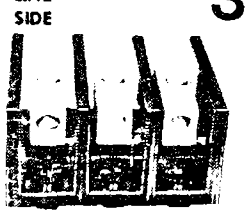
APPLICATION
Designed for use with heating, air conditioning and refrigeration, elevator systems, material handling equipment, control panels, motor control, switchgear and any area where a reliable connector is needed to harness power.

HARDWARE
Connector - one piece aluminum or copper tin plated
Base - general purpose phenolic

ELECTRICAL RATING
- 600 volts*
- Wire range #14 AWG — 600 MCM, aluminum or copper wire depending on block selected
- Double and triple circuits are standard
- Single circuits available on request

STANDARDS
U.L. Recognized File No. E62806
C.S.A. Certified File No. 19766

CATALOG NUMBER AND SPECIFICATIONS

Number of Circuits	LINE		LOAD		Catalog Number
	Wire Range	Openings Per Circuit	Wire Range	Openings Per Circuit	
LINE SIDE 2  LOAD SIDE	#2-#14 AWG	1	#2-#14 AWG	1	1422552
	1/0-#14 AWG	1	1/0-#14 AWG	1	1422120
	1/0-#6 AWG (Cu)	1	1/0-#6 AWG (Cu)	1	1422121
	2/0-#14 AWG	1	2/0-#14 AWG	1	1422572
	250 MCM-#6 AWG	1	250 MCM-#6 AWG	1	1432123
	250 MCM-#6 AWG (Cu)	1	250 MCM-#6 AWG (Cu)	1	1432124
	350 MCM-#6 AWG	1	350 MCM-#6 AWG	1	1432126
	600 MCM-#4 AWG	1	600 MCM-#4 AWG	1	1442557
	350 MCM-#4 AWG	2	350 MCM-#4 AWG	2	1452129
LINE SIDE 3  LOAD SIDE	#2-#14 AWG	1	#2-#14 AWG	1	1423552
	1/0-#14 AWG	1	1/0-#14 AWG	1	1423120
	1/0-#6 AWG (Cu)	1	1/0-#6 AWG (Cu)	1	1423121
	2/0-#14 AWG	1	2/0-#14 AWG	1	1423572
	250 MCM-#6 AWG	1	250 MCM-#6 AWG	1	1433123
	250 MCM-#6 AWG (Cu)	1	250 MCM-#6 AWG (Cu)	1	1433124
	350 MCM-#6 AWG	1	350 MCM-#6 AWG	1	1433126
	600 MCM-#4 AWG	1	600 MCM-#4 AWG	1	1443557
	350 MCM-#4 AWG	2	350 MCM-#4 AWG	2	1453129

ORDERING CODE

Series — 143 | 3 | XXX

No. of Circuits — 3

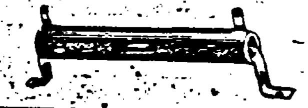
XXX — Non-Descript Numerical Sequence

2

POWER BLOCKS

MARATHON SPECIAL PRODUCTS
DIVISION OF MARATHON ELECTRIC
BOWLING GREEN, OHIO 43402

OHMITE Fixed Power Resistors



Lug type, wire-wound with vitreous enamel. Wire of the finest alloy and largest possible size is used for each resistance. Uniform close spacing of turns is maintained by the vitreous enamel coating. Wire securely welded to terminal lugs. Tol. ±5% 1 ohm and up, ±10% below. Shpg. wt. 10-50 watts—4 oz. 100-225 watts—1 lb.

STYLE 270-12 (12 WATT — Size 1¾" × 5/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F1200	3723	.51	4.86
13F1201	3730	1.0	3.46
13F1202	3734	1.5	2.83
13F1204	3742	3.3	1.91
13F1205	3746	4.7	1.60
13F1207	3754	10	1.10
13F1208	3756	12	1.00
13F1211	3762	22	.74
13F1212	3764	27	.67
13F1215	3770	47	.53
13F1218	3776	82	.38
13F1219	3778	100	.35
13F1221	3782	150	.28

Stock No.	Type	Resis. Ohms	Max. Amps.
13F1222	3784	180	.26
13F1228	3796	560	.15
13F1231	3802	1,000	.11
13F1232	3804	1,200	.10
13F1233	3806	1,500	.089
13F1235	3810	2,200	.074
13F1236	3812	2,700	.067
13F1239	3818	4,700	.051
13F1243	3826	10,000	.032

STYLE 270-25 (25 WATT — SIZE 2" × 5/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F720	0200J	1	5.00
13F721	0200K	2	3.54
13F722	0200L	3	2.88
13F723	0200A	5	2.24
13F724	0200B	10	1.58
13F725	0200R	15	1.29
13F726	0200C	25	1.00
13F727	0200D	50	.71
13F728	0200E	75	.58
13F729	0200F	100	.50
13F730	0200G	150	.41
13F731	0200H	200	.35
13F732	0201	250	.32
13F733	0202	500	.22
13F734	0203	750	.18
13F735	0204	800	.17
13F736	0205	1,000	.16

Stock No.	Type	Resis. Ohms	Max. Amps.
13F737	0206	1,500	.13
13F738	0207	2,000	.12
13F739	0208	2,500	.10
13F740	0209	3,000	.091
13F742	0211	4,000	.079
13F743	0212	5,000	.070
13F744	0213	6,000	.064
13F745	0214	7,500	.057
13F746	0215	10,000	.050
13F747	0216	12,000	.045
13F748	0217	15,000	.036
13F749	0218	20,000	.031
13F750	0219	25,000	.028
13F752	0224	50,000	.019
13F753	0229	100,000	.009

STYLE 270-50 (50 WATT — SIZE 4" × 5/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F798	0400J	1	7.07
13F760	0400A	5	3.16
13F761	0400B	10	2.23
13F762	0400C	25	1.41
13F763	0400D	50	1.00
13F764	0400E	75	.82
13F765	0400F	100	.71
13F766	0400G	150	.58
13F767	0400H	200	.50
13F768	0401	250	.45
13F769	0402	500	.32
13F771	0405	1,000	.22
13F772	0406	1,500	.18

Stock No.	Type	Resis. Ohms	Max. Amps.
13F773	0407	2,000	.16
13F774	0408	2,500	.14
13F775	0409	3,000	.13
13F776	0410	4,000	.11
13F777	0411	5,000	.10
13F779	0413	8,000	.079
13F780	0414	10,000	.071
13F782	0416	15,000	.057
13F784	0418	25,000	.045
13F786	0420	50,000	.026
13F788	0422	100,000	.018
13F799	0428	250,000	.010

STYLE 270-100 (100 WATT — SIZE 6½" × ¾")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F800	0600A	5	4.47
13F801	0600B	10	3.16
13F802	0601	25	2.00
13F803	0602	50	1.41
13F804	0603	75	1.15
13F805	0604	100	1.00
13F806	0605	150	.82
13F807	0606	250	.63
13F808	0607	500	.45

Stock No.	Type	Resis. Ohms	Max. Amps.
13F810	0609	1,000	.32
13F812	0611	2,000	.22
13F813	0612	2,500	.20
13F814	0613	3,000	.18
13F815	0614	5,000	.14
13F817	0616	10,000	.10
13F819	0618	20,000	.071
13F823	0622	50,000	.045
13F826	0625	100,000	.028

STYLE 270-225 (225 WATT — SIZE 10½" × 1⅛")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F830	0900A	5	6.72
13F831	0900B	10	4.74
13F832	0901	25	3.00
13F833	0902	50	2.12
13F834	0903	[illegible]	1.73
13F835	0904	[illegible]00	1.50
13F836	0905	150	1.25
13F837	0906	250	.75
13F838	0907	500	.67
13F839	0908	750	[illegible]
13F840	0909	1,000	.47
13F841	0910	1,500	.37

Stock No.	Type	Resis. Ohms	Max. Amps.
13F842	0911	2,000	.34
13F843	0912	2,500	.30
13F844	0913	3,000	.27
13F845	0914	5,000	.21
13F847	0916	10,000	.15
13F849	0918	20,000	.11
13F850	0919	25,000	.095
13F852	0921	40,000	.075
13F853	0922	50,000	.067
13F856	0925	100,000	.047

[illegible]able Dividohm® Power Resistors OHMITE

[illegible] Enameled Resistors make ideal voltage dividers for original equipment and replacement in [illegible] and other apparatus. Handy for obtaining odd resistance values, for adjusting circuits and for use [illegible] which must be set to meet various line voltages. Resistance is changed by moving the adjustable lug [illegible] can be made to any wire along the length of the resistor making voltages lower than rated voltage available [illegible] wattage rating applies only when the entire resistance is in the circuit. Tolerance: 10%. Avg. Shipping wt.: 12-50 [illegible] 4.0 oz.; 100-225 Watts, 1 lb.

STYLE 210-12 (12 WATT—SIZE 1¾"x5/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F500	[illegible]	[illegible]	[illegible]
13F501	[illegible]	[illegible]	[illegible]
13F502	[illegible]	[illegible]	2.00
13F503	1004	5	1.54
13F504	[illegible]	7.5	1.26
13F505	1006	10	1.09
13F506	1007	15	.89
13F507	1008	20	.77
13F508	1009	25	.69
13F509	1010	50	.49
13F510	1011	75	.40
13F511	1012	100	.34
13F512	1013	150	.28
13F513	1014	200	.24
13F514	1015	250	.22

Stock No.	Type	Resis. Ohms	Max. Amps.
13F515	[illegible]	[illegible]	[illegible]
13F517	[illegible]	400	[illegible]
13F518	1019	500	[illegible]
13F520	[illegible]	750	[illegible]
13F522	1023	1,000	.11
13F524	1025	1,500	.089
13F525	1026	2,000	.077
13F527	1028	2,500	.069
13F528	1029	3,000	.063
13F530	1031	4,000	.055
13F532	1033	5,000	.049
13F534	1035	7,000	.042
13F535	1036	7,500	.040
13F539	1040	10,000	.035

STYLE 210-25 (25 WATT—SIZE 2"x9/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F550	0360	1	5.00
13F551	0360B	2	3.54
13F552	0361	3	2.88
13F553	0362	5	2.24
13F554	0362B	7.5	1.82
13F555	0363	10	1.58
13F556	0364	15	1.29
13F557	0364B	20	1.12
13F558	0365	25	1.00
13F559	0366	50	.71
13F560	0367	75	.58
13F561	0368	100	.50
13F562	0369	150	.41
13F563	0370	200	.35
13F564	0371	250	.32

Stock No.	Type	Resis. Ohms	Max. Amps.
13F565	0371B	300	.29
13F566	0371C	400	.25
13F567	0372	500	.22
13F568	0373	750	.18
13F570	0375	1,000	.16
13F571	0375B	1,250	.14
13F572	0376	1,500	.13
13F573	0377	2,000	.12
13F575	0378	2,500	.10
13F576	0379	3,000	.091
13F580	0382	5,000	.070
13F581	0383	6,000	.064
13F587	0385	10,000	.050
13F590	0388	20,000	.031
13F591	0389	25,000	.028

STYLE 210-50 (50 WATT—SIZE 4"x9/16")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F600	0560	5	3.16
13F601	0561	10	2.23
13F602	0562	25	1.41
13F603	0563	50	1.00
13F604	0564	75	.82
13F605	0565	100	.71
13F606	0566	150	.58
13F607	0567	200	.50
13F608	0568	250	.45
13F609	0568B	300	.41
13F610	0568C	400	.35

Stock No.	Type	Resis. Ohms	Max. Amps.
13F611	0569	500	.32
13F612	0570	750	.26
13F613	0572	1,000	.22
13F615	0573	1,500	.18
13F616	0574	2,000	.16
13F617	0575	2,500	.14
13F622	0578	5,000	.10
13F628	0581	10,000	.071
13F631	0584	20,000	.050
13F635	0588	50,000	.026
13F638	0591	100,000	.018

STYLE 210-100 (100 WATT—SIZE 6½"x¾")

Stock No.	Type	Resis. Ohms	Max. Amps.
13F670	0956A	1	10.00
13F671	0956B	2	7.07
13F672	0956C	3	5.77
13F673	0956D	4	5.00
13F650	0956	5	4.47
13F651	0957	10	3.16
13F652	0958	25	2.00
13F653	0959	50	1.41

Stock No.	Type	Resis. Ohms	Max. Amps.
13F654	0960	100	1.00
13F655	0960B	250	.63
13F656	0961	500	.45
13F657	0962	1,000	.32
13F658	0962B	1,500	.26
13F659	0963	2,500	.20
13F660	0964	5,000	.14
13F661	0965	10,000	.10
13F669	0973	100,000	.028

STANDARD ADJUSTABLE LUGS

For Dividohms—Bakelite knob type

Stock No.	Type	Description
13F710	2122	For 25, 50 Watt
13F711	2126	For 100 Watt
13F712	2134	For 225 Watt

For Dividohms—Screw driver type

Stock No.	Type	Description
13F713	2115	For 12 Watt
13F714	2121	For 25, 50 Watt
13F715	2125	For 100 Watt
13F716	2133	For 225 Watt

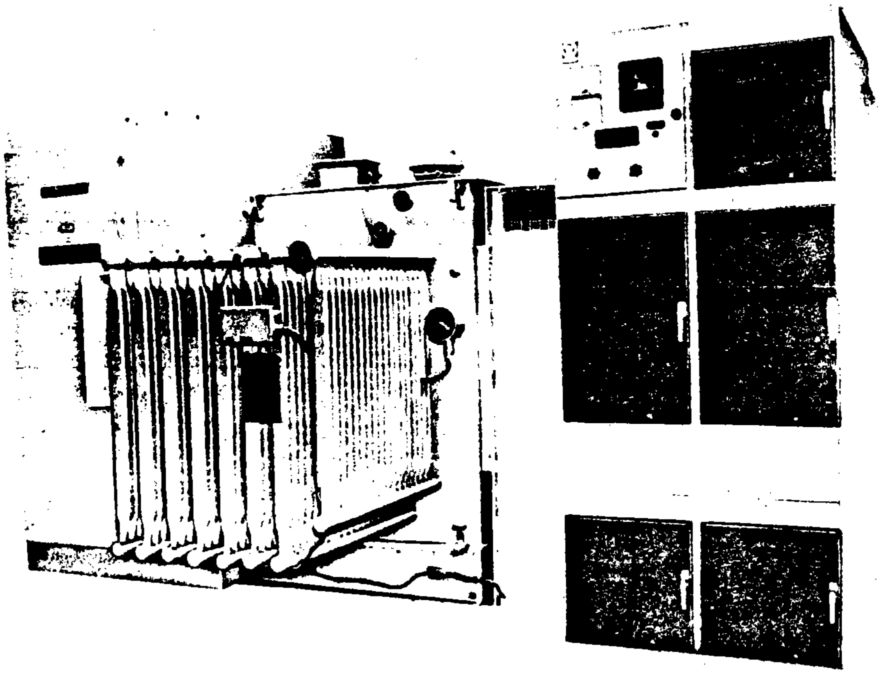
Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, Pa. 15112 U.SA.

Descriptive Bulletin
32-850

November, 1978
Supersedes DB 32-850
dated February 1978
E,D,C/1941, 1961/DB

112.5 to 2500 Kva
Primary—2400-13800 Volts Ac
Secondary—208Y/120-600 Volts Ac

Power Centers Including Type DS Switchgear.



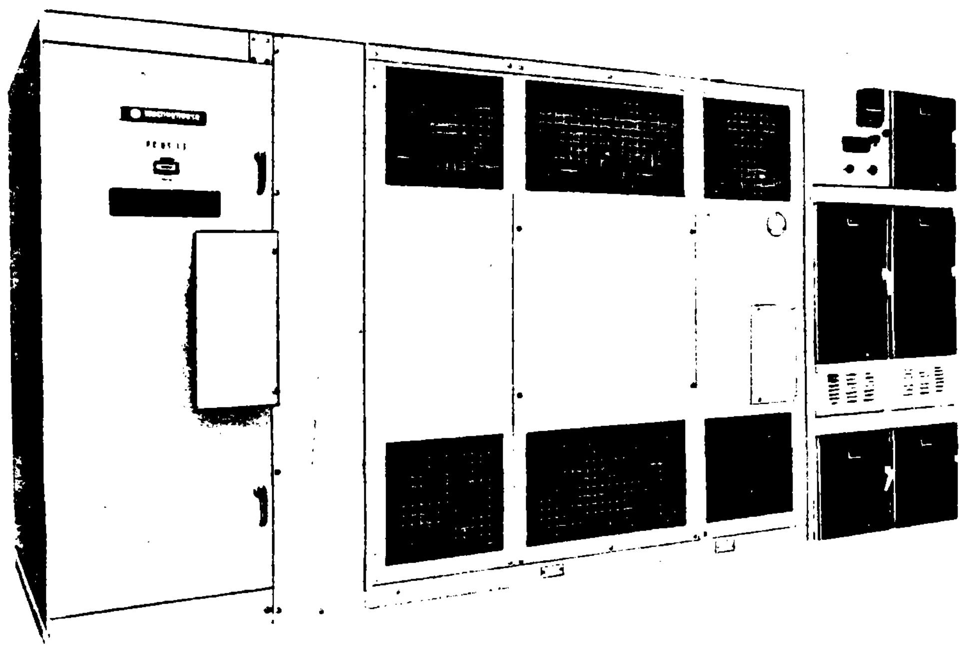


Table of Contents

Definition

A Power Center is defined as a coordinated assembly consisting of 3 phase transformers with high voltage incoming line sections and an assembly of Type DS Low Voltage Switchgear, with the following parameters:

Transformer Kva—112.5 thru 2500
High Voltage—2400 V thru 13,800 V
Low Voltage—208, 240, 480 or 600 V

Power centers may be indoor or outdoor, with a selection of high voltage incoming sections and a choice of transformer types as shown under "components," and an arrangement of Type DS Switchgear to suit the application.

Power centers as defined herein come within the category of "Secondary Unit Substations" as defined in NEMA Standards.

Why Power Centers?

Power centers follow the modern system concept of locating transformers as close as practicable to areas of load concentration at utilization voltages, thus minimizing the lengths of secondary distribution cables and buses. This concept provides several basic advantages over older methods, such as:

- Reduced power losses.
- Improved voltage regulation.
- Improved service continuity.
- Reduced likelihood of faults.
- Increased flexibility.
- Minimized installation expense.
- Availability of non-flammable types of transformers eliminates necessity of vaults.
- Efficient space utilization.

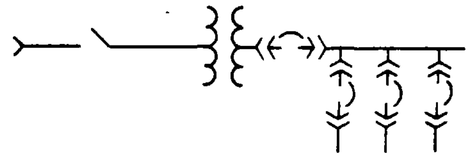
Advantages of Westinghouse Power Centers

- Single responsibility.
- Complete coordination, both mechanical and electrical.
- Extreme flexibility, with wide choice of components and ratings to meet exact application requirements.
- Optimum safety to operators.
- Modern design.
- Meets all ANSI, IEEE and NEMA Standards.

Types of Systems

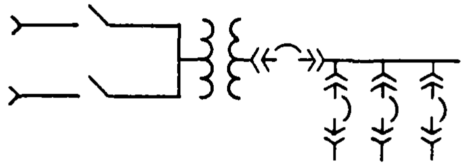
A. Simple Radial

- Simplest and least costly.
- Easy to coordinate.
- No idle parts.



B. Primary Selective Radial

Similar to simple radial, with added advantage of spare primary incoming cable circuit. By switching to spare circuit, duration of outage from cable failure is limited.



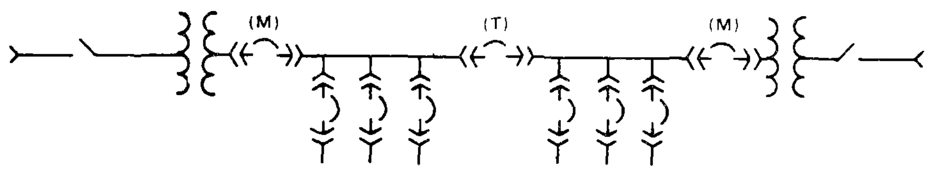
C. Secondary Selective

Normally operates as two electrically independent unit substations, with bus tie breaker(T) open, and with approximately half of total load on each bus. In case of failure of either primary incoming circuit, only one bus is affected, and service can be promptly restored by opening main breaker (M) on dead bus and closing tie breaker(T). This operation can be made automatic, with duration of outage on either bus limited to a few seconds.

Since the transformers are not continuously paralleled, secondary fault currents and breaker application are similar to those on radial unit substations.

Either transformer can be removed from service and isolated with no interruption of service on either bus, by first closing the tie breaker and then opening the associated main breaker.

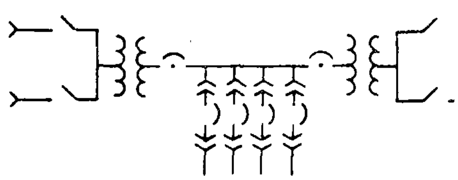
Service continuity and substation capacity can be further improved by substituting selector type primary switches, as in B.

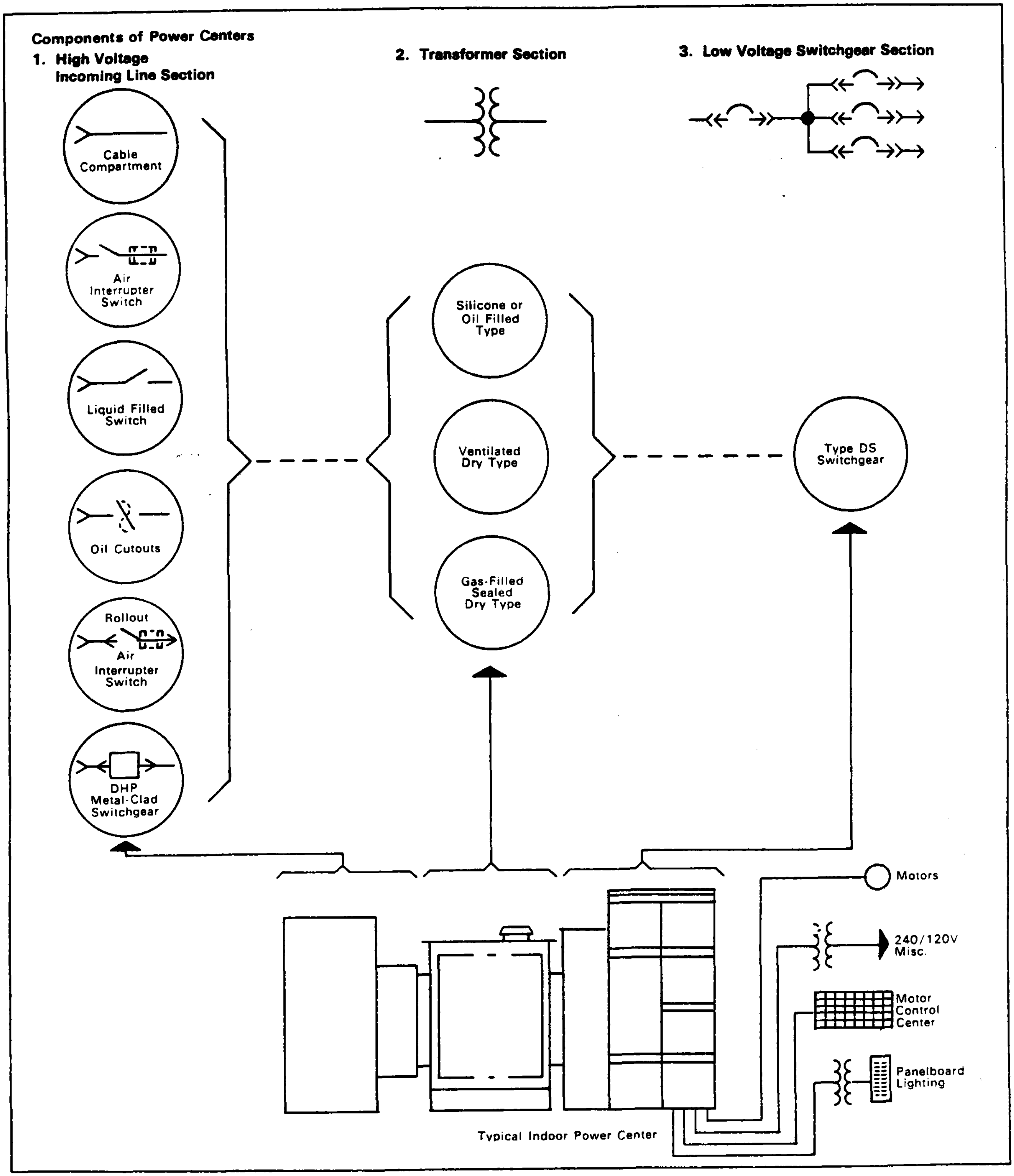


D. Spot Network

The transformers are paralleled through network protectors. In case of primary voltage failure, the associated protector automatically opens. The other protector remains closed, and there is no "dead time" on the bus, even momentarily. When primary voltage is restored, the protector automatically checks for synchronism and recloses.

- Secondary voltage regulation is improved by paralleled transformers.
- Secondary fault capability is increased by paralleled transformers, and the feeder breakers must be selected accordingly.
- Primary switches are usually selector or duplex type, so that transformers can be transferred to alternate live sources, thus shortening duration of overloads.




Components of Power Centers
1. High Voltage Incoming Line Section
2. Transformer Section
3. Low Voltage Switchgear Section
Cable Compartment
Air Interrupter Switch
Liquid Filled Switch
Oil Cutouts
Rollout Air Interrupter Switch
DHP Metal-Clad Switchgear
Silicone or Oil Filled Type
Ventilated Dry Type
Gas-Filled Sealed Dry Type
Type DS Switchgear
Motors
240/120V Misc.
Motor Control Center
Panelboard Lighting
Typical Indoor Power Center

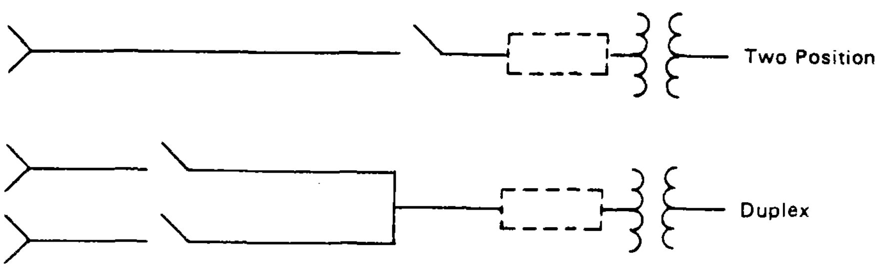
Incoming Line Section

A. Air Interrupter Switch

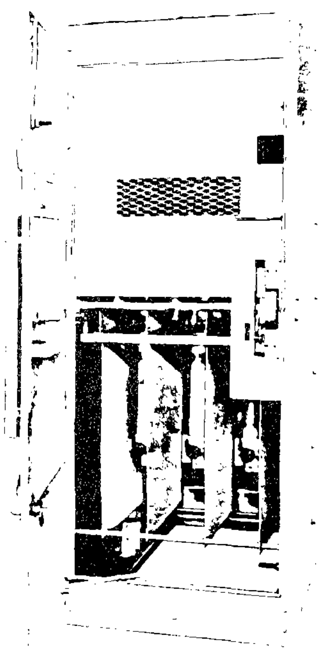
Primary Power Switch, Type PPS
(for liquid transformers only)

Features
- Quick-make, quick-break stored energy spring mechanism.
- De-ion arc interruption.
- Switch parts molded in tough cast resin, with transparent blade housings.
- Safety interlock between access door and switch mechanism.
- Adequate insulated cable connections to transformer bushings.
- Furnished fused or unfused; fuses either CLE current limiting or RBA non-current limiting type.
- Proven reliability.

Configurations Available

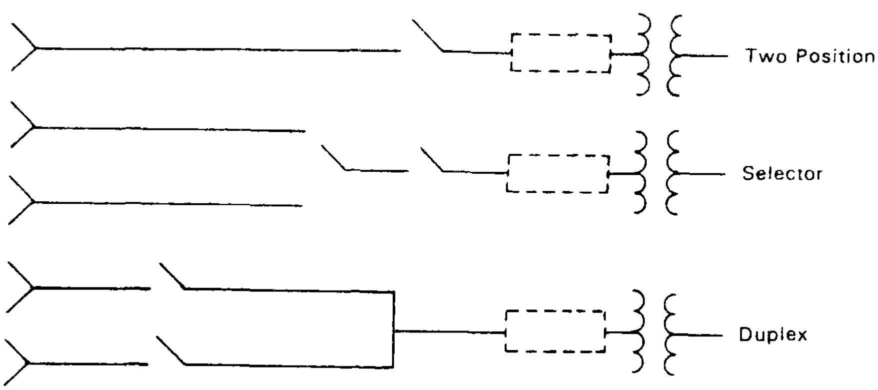


Load Interrupter Switch, Type WLI
(standard for Ventilated Dry and Gas Filled transformers; optional for liquid transformers)



Features
- Quick-make, quick break stored energy spring mechanism.
- De-ion arc interruption.
- Positive switch position indication by operating mechanism.
- Safety interlock between access door and mechanism.
- Adequate insulated cable connections to transformer terminals; bare or insulated bus connections optional.
- Furnished fused or unfused; all CLE, CLT and RBA fuses available.
- Proven reliability.

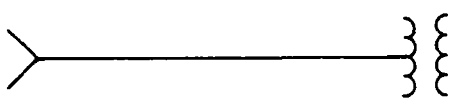
Configurations Available

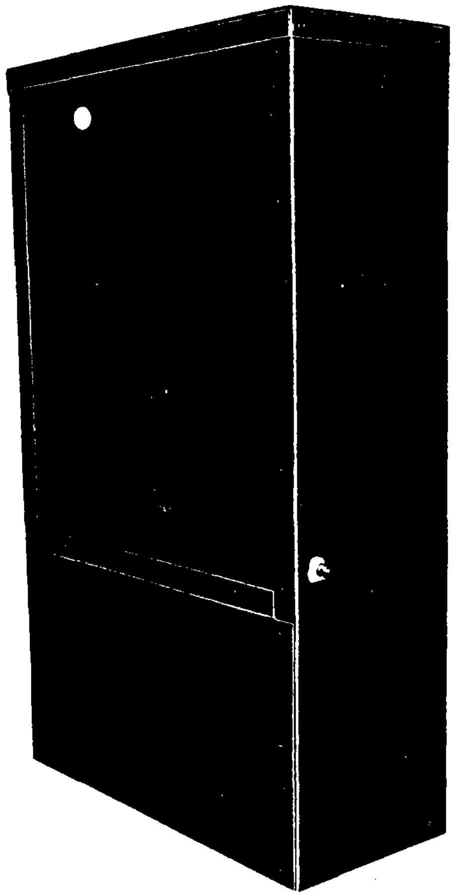


Further Information
DB 31-935

B. Cable terminal compartment only, air filled.

Available with all transformer types. Extends to floor and completely encloses cables and terminals. Arranged for either bottom or top cable entrance.

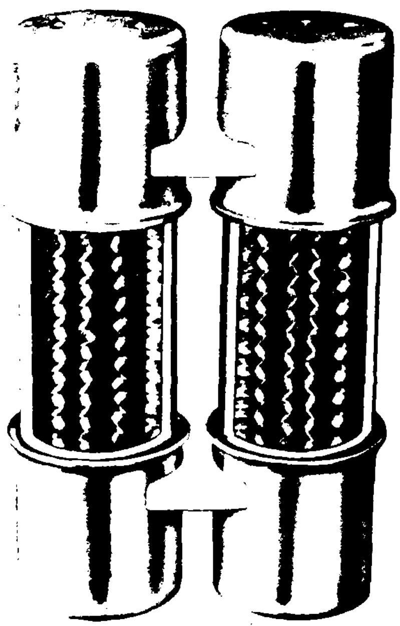




C. Miscellaneous Types of High Voltage Incoming Equipment

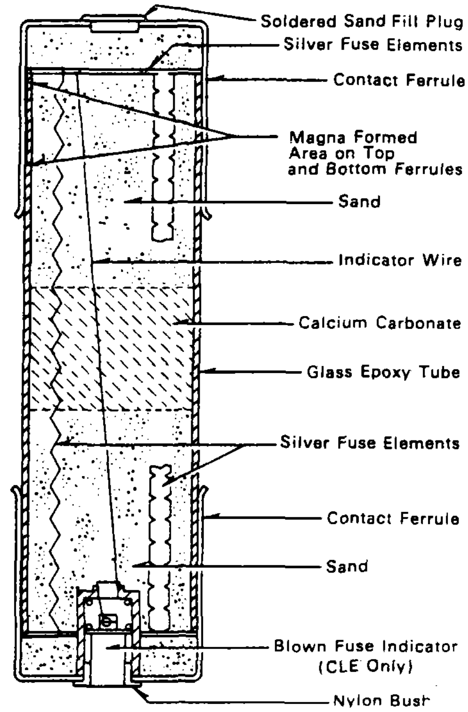
1. Type FSP load-interrupter switchgear units, metal-clad switchgear construction, with "rollout" air switch elements, fused or unfused, 15 Kv, indoor or outdoor. Fuses are Type CLE current limiting only, voltage to suit application.
2. Type DH-P "Porcel-Line" metal-clad switchgear, 5 Kv to 15 Kv, 75 to 1000 Mva interrupting rating, indoor or outdoor.
3. Liquid Filled Switch.
4. Oil Fused Cutouts.

Type CLE and CLT current limiting non-expulsion, non-refillable fuses.



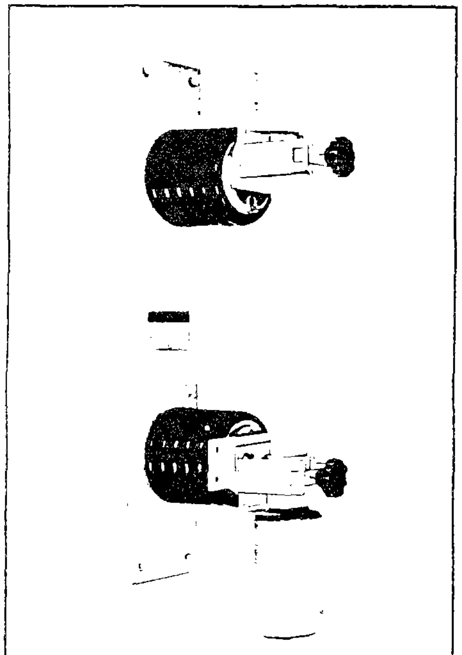
Cutaway view of type CLE-2 fuse showing pure silver elements.

Type CLE and CLT power fuses are basically of inorganic construction, the only organic material used being the glass-resin outer casing and the plastic indicator. The fuse elements are pure silver designed to combine maximum load carrying ability with the most favorable short circuit interruption characteristics, plus being "fatigue proof." This added feature is made possible by bending or spiralling the element prior to assembly, making the element structurally stronger and distributing expansion uniformly to withstand the most severe type of duty cycling without failure. These fuses are filled with a high purity silica sand of controlled grain size, and sandwiched between the sand filling is an additional layer of pulverant arc quenching material. The addition of this band of filler to the fuse changes its melting characteristics and facilitates low current interruption making it more suitable for transformer protection.



Cross-section drawing showing component parts a type CLE-1 fuse unit.

Type RBA non-current limiting, refillable, expulsion type fuses.

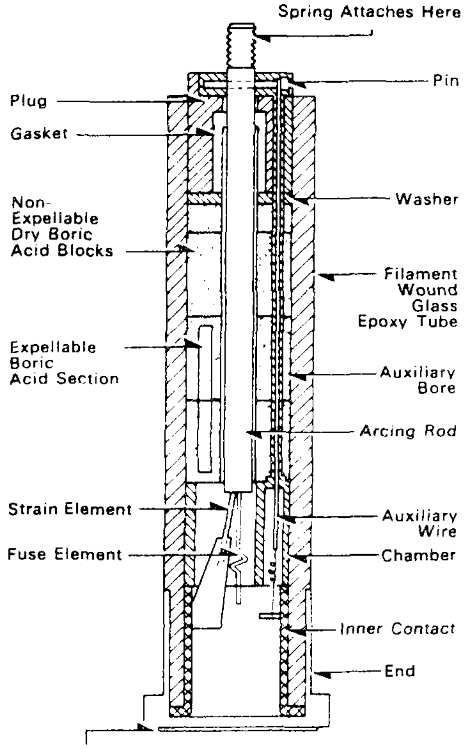


RBA-400 Non-Disconnect Mounting with Fuseholder and Discharge Filter.

Fuse Refill

The boric acid refill is probably the most important component of the RBA fuse. It is designed to interrupt currents of short circuit magnitude within ½ cycle, and through its two de-ionizing chambers in parallel, have selective operation and interruption for both low-current and high current faults. This is achieved by movement of the arc through the boric acid cylinder by a helical spring and rod. Intense heat from the arc, as it strikes, decomposes the dry boric acid. On decomposition the boric acid forms water vapor and inert boric oxide. The electrical interruption is caused by the steam de-ionizing the arc as it is drawn through the cylinder by the action of the spring and rod. The high particle turbulence of boric acid causes the rate of de-ionization in the cylinder to exceed the ionization rate of the electrical arc. This action prevents the arc from restriking.

Upon operation of the fuse under fault condition, the fuse holder is disconnected, the fuse refill removed, and replaced with a new refill.



Transformer Section

Liquid Filled Transformers

Advantages
Standardized bushing height of 55 inches for all ratings allows subsequent uprating at minimum cost.

A proven rectangular core and coil design, pioneered by Westinghouse in 1954, is used in conjunction with a computer program to provide rugged, dependable service and an optimized design.

Insuldur system of thermally stabilized insulating material—allows user 12% additional Kva capacity of 55/65°C rated units or maximum 55°C Kva capacity at 40°C average ambient.

An automated plant, designed specifically for the production of rectangular core form transformers, assures uniform quality and shipping expediency.

General Design Features
These transformers are designed for indoor or outdoor use—oil or Silicone immersed—with a standard temperature rise of 65°C. Either a flange or throat can be furnished on the high and low voltage side for connections to primary and secondary equipment.

High and low voltage terminals are located on opposite sides of the unit for a "straight-thru" line-up. Bushing height is standardized at 55 inches to permit ease of coordination with other equipment and later uprating at minimum costs.

Cooling is accomplished through flat, tubular coolers welded to the tank wall. A welded-on tank cover/handhole provides sealed tank oil preservation. Standard tank pressure is 5 psi.

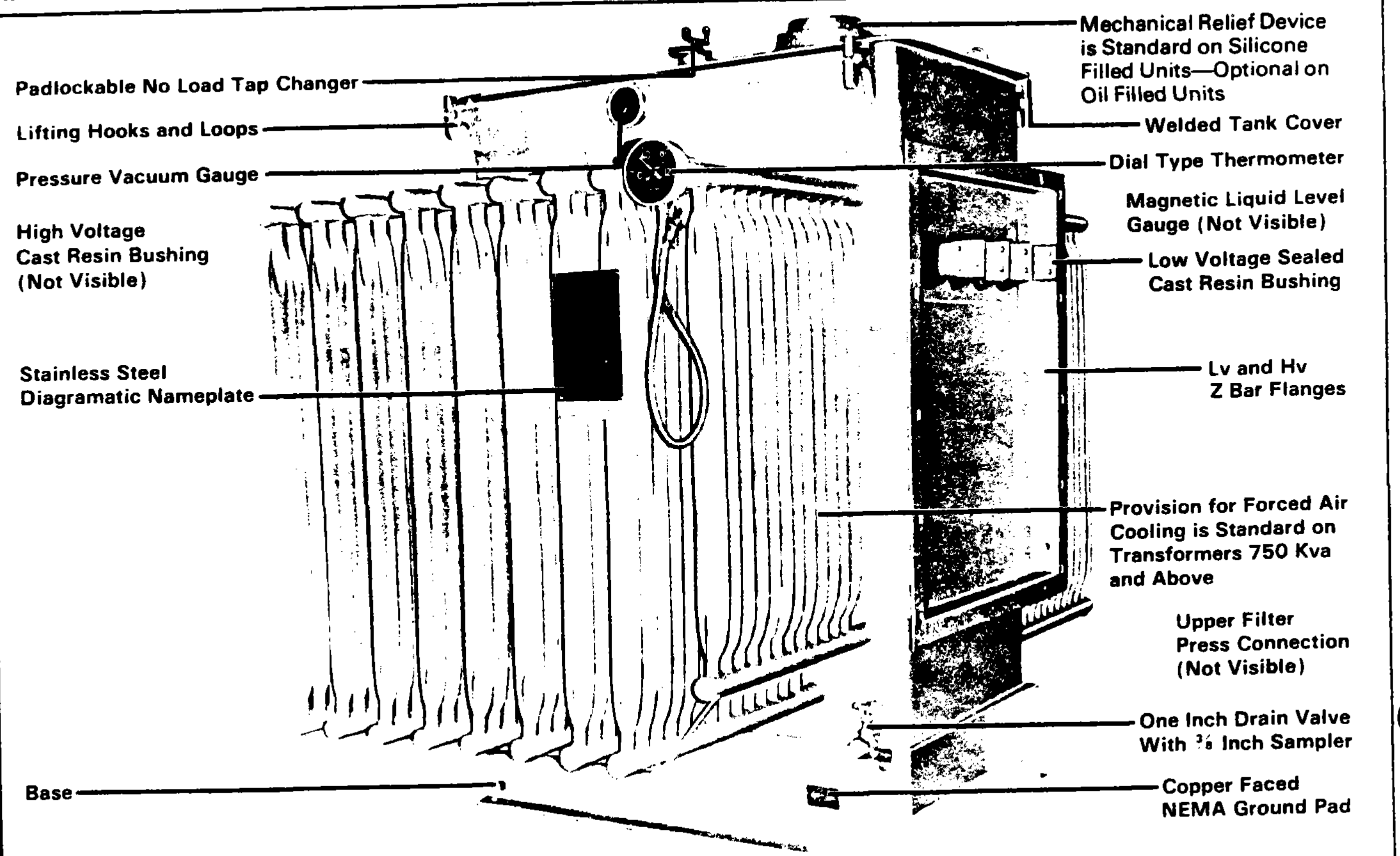
Lifting hooks are provided for lifting the entire unit and lifting loops for lifting the tank cover. The base is designed for skidding in any direction.

Standard Finish
The Westinghouse standard finish is a three-coat system applied as follows:

A. All surfaces are shot blasted or pickled to a semi-white metal to form a completely clean surface.
B. A caustic wash and phosphatized coating to inhibit corrosion and furnish a base for high mechanical strength of paint bonding.
C. An epoxy-melamine primer coat cured in oven at 150° C.
D. A Westinghouse top coat, composed of an alkyd-melamine enamel paint system containing special pigments selected to give long outdoor service in varying climatic exposures and maintain attractive appearance, is applied and given a baked finish at 150° C.
E. An air-dry version of Item D is applied to touch up units prior to shipment.

Standard outdoor tank color is ANSI No. 24. ANSI No. 70 can be supplied but must be specified. Other colors or other paints may be available on special request. Standard indoor color is ANSI No. 61 light grey.

Standard Features and Accessories



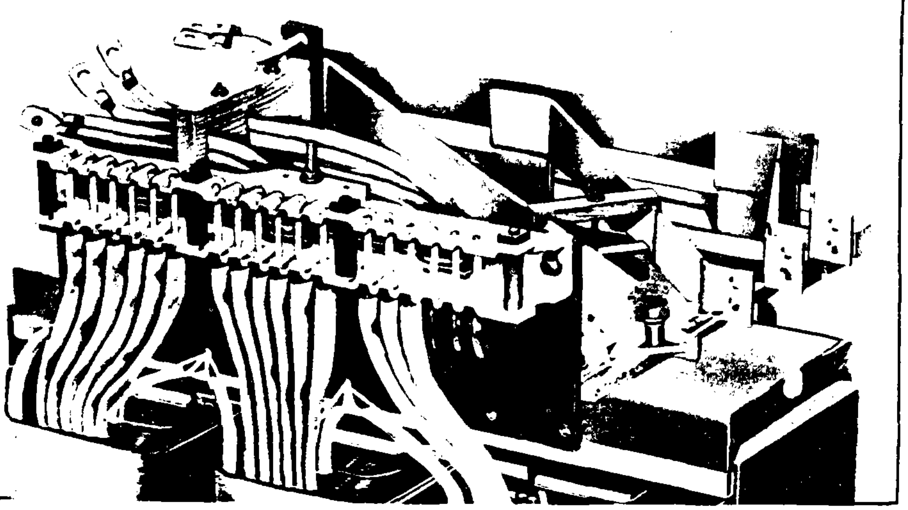
Rectangular Core and Coils

WSS Tap Changer

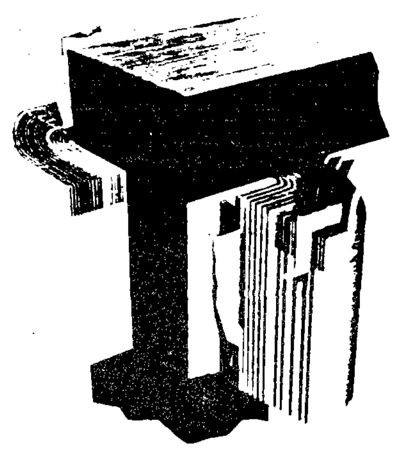
The Westinghouse externally operated WSS tap changer provides positive sequence line voltage changes under de-energized conditions. An in-line assembly, the WSS features through-type stationary contact *studs rigidly supported by a molded plastic* channel. Moving contacts are spring loaded, silver plated copper which move along the stationary line by means of a rack and pinion.

This design has no rivets, bolts or nuts, thus assuring the proper contact of current carrying parts when taps are changed. The WSS benefits the user through a reduction of repair or replacement costs by eliminating faulty tap changer operation—*the cause of failure in 20% of all power transformers.*

WSS Tap Changer

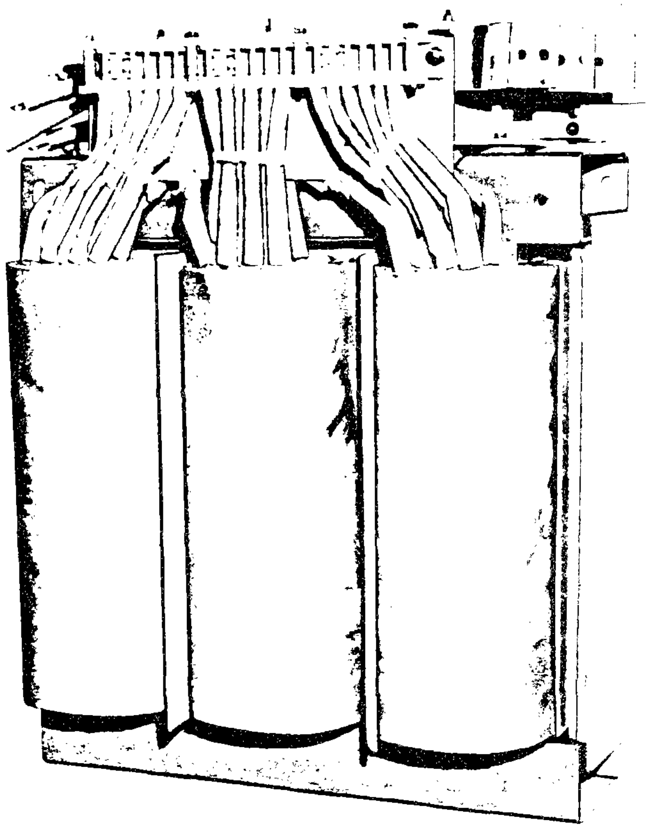


Rectangular Aluminum Wound Coils



The Westinghouse rectangular wound coil features aluminum conductor in both high and low voltage windings. The low voltage winding is accomplished on a constant tension machine and consists of full width sheet aluminum extending the full height of the coil. High voltage strap aluminum is wound directly over the low voltage winding on a constant tension traversing machine. Layer to layer and high to low insulation is diamond epoxy paper which when heat treated bonds the complete coil into a solid configuration.

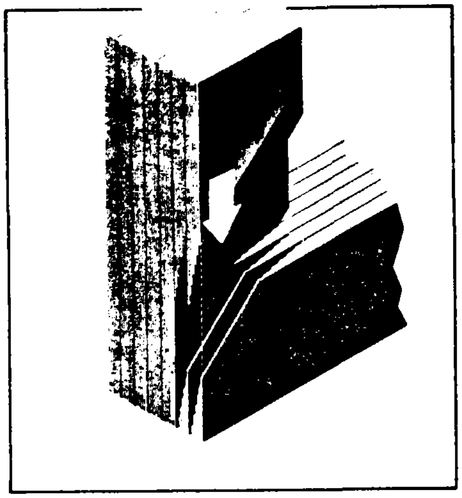
The advantage of low voltage sheet aluminum is a continuous cross section of conductor that allows the electrical centers of high and low voltage windings to easily align themselves, virtually eliminating the vertical component of short circuit force.



Rectangular Core and Coils

The benefit is a coil so uniform and compact, the chance of windings overlapping during short circuit is minimized, reducing failure rate, repair and/or replacement cost.

Step-Lap Core



The Westinghouse exclusive stacked core provides a superior flux path by utilizing the patented step-lap joining of core legs to top and bottom yokes. Hand stacked Hypersil steel punchings with interlocking laminations can be more uniformly and rigidly braced to prevent shifting during service.

The user can benefit through reduced sound levels, lowered iron and total losses, and decreased exciting current to lower total operating cost.

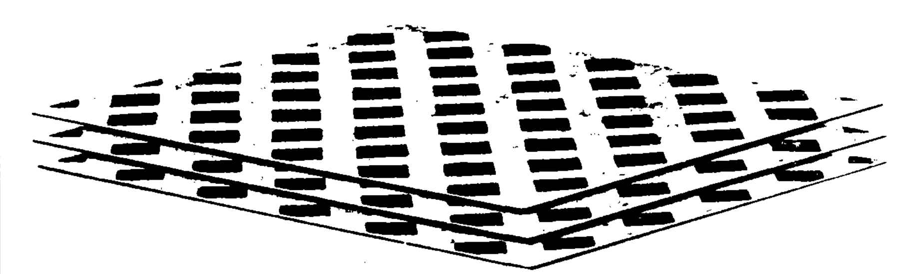
On wye-wye units a fourth leg is added to provide a path for circulating third harmonic flux during unbalance condition.

Welded Frame

The Westinghouse exclusive welded frame provides a superior six piece supporting structure for the core and coils. End plates are thick steel slabs that are assembled in a mechanical and pressure jig around the core and coils, then welded to top and bottom plates to form a rigid structure that will not loosen during assembly, shipment, or in service. To determine the thickness of members used (even the thickness of welds), a short circuit calculation is made for each unit to determine the forces of short circuit.

The result is an assembly that restrains more effectively vertical and horizontal components of force, decreasing the probability of failure during severe short circuits.

This benefits the user by a reduction in repair or replacement costs and a reduction in downtime that means loss of service or lost production.

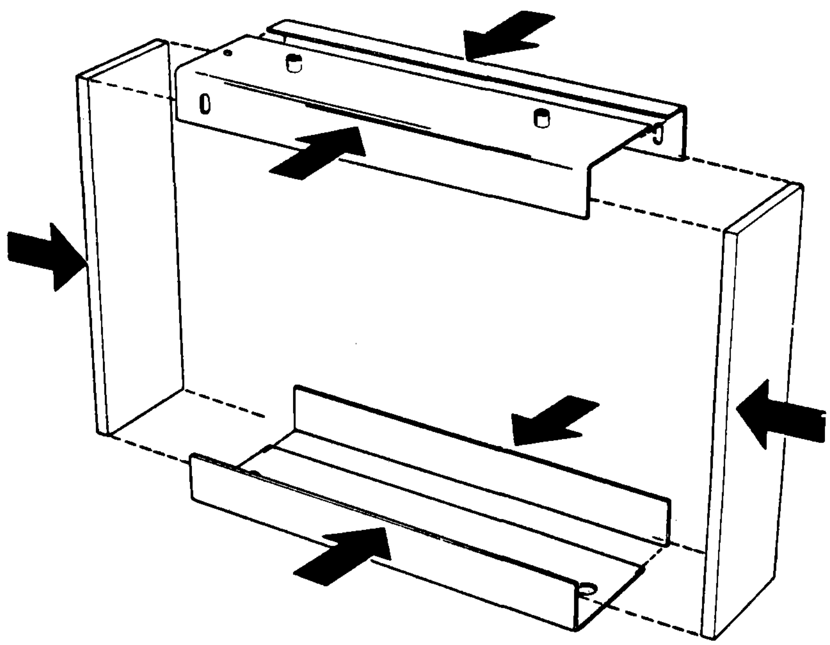


Super Insuldur Insulation

Super Insuldur Insulation

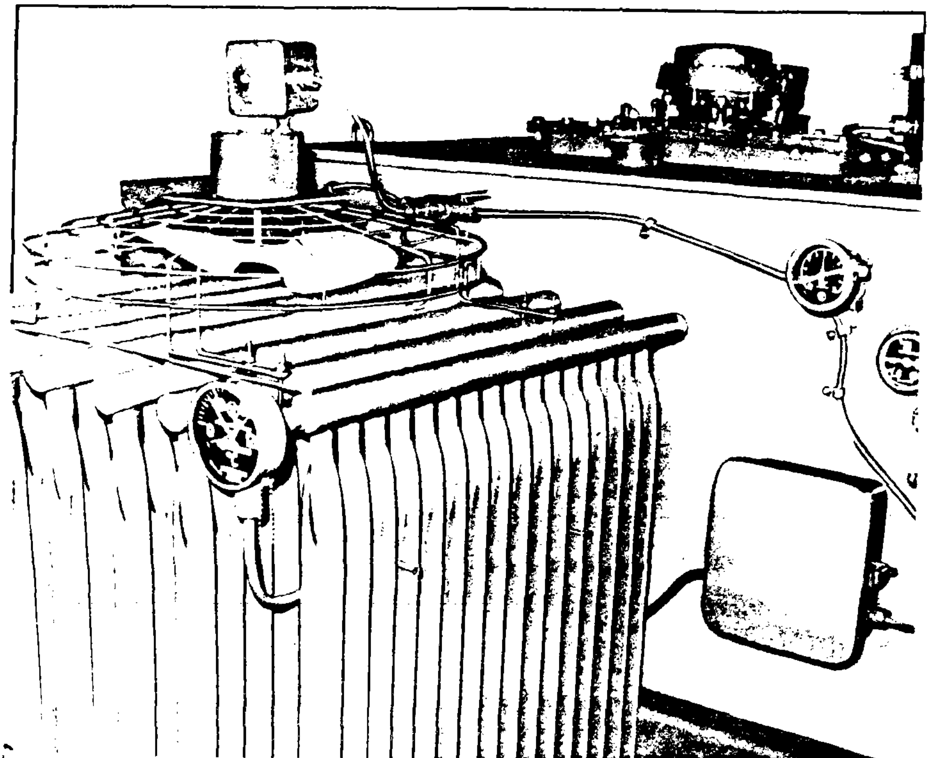
The Westinghouse Super Insuldur Insulation effectively upgrades cellulose insulating materials thermally for increased load and overload capability. The chemical stabilizers in the Insuldur process retard insulation breakdown under severe temperature conditions. Dimensional changes in the insulating materials are minimized, insuring a tighter structure. The result is greater strength and coil integrity throughout the life of the transformer.

The user benefit is a coil that better withstands short circuit and allows an operation at 10°C higher temperature on a 55°C rated unit with a 12% increase in Kva capacity.



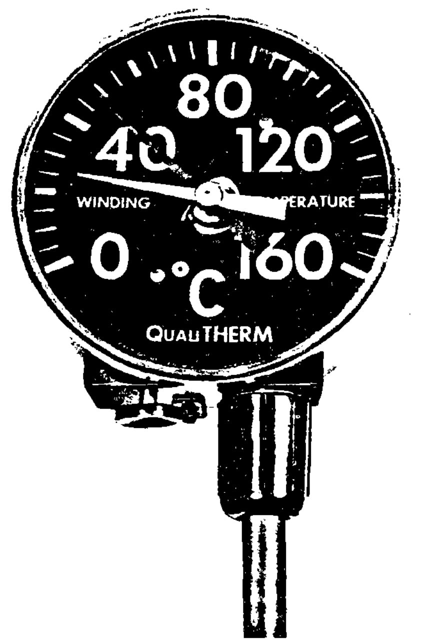
Welded Frame

Optional Accessories

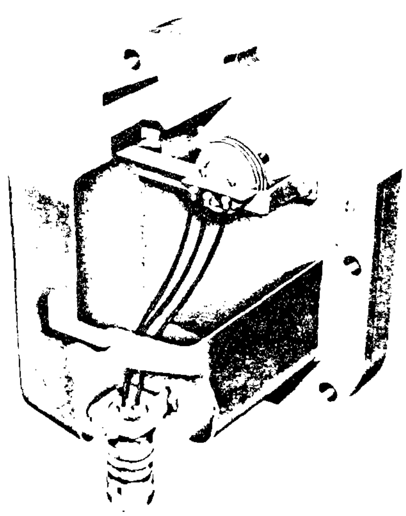


Forced Air Cooling—Provisions for fan cooling are included on transformers 750 Kva and larger. Complete fan cooling equipment is available and when in operation will give the following OA/FA ratings:

750 Kva OA	862 Kva FA
1000 Kva OA	1150 Kva FA
1500 Kva OA	1725 Kva FA
2000 Kva OA	2300 Kva FA
2500 Kva OA	3125 Kva FA



Dial Hot Spot—Dial hot spot winding temperature equipment including a current transformer may be specified.



Sudden Pressure Relay—A Westinghouse sudden pressure relay for protection against excessive damage due to internal faults may be specified. It operates when a significant rate of rise of internal gas pressure is exceeded.

Alarm Contacts—SPDT Alarm contacts may be added to the thermometer, liquid level gauge and pressure relief device.

Further Information
Prices: Price List 47-150

Dimensions: Technical Certification Section 47-159.

Fault Protection and Indication—Reprint 200

Rectangular Coil Core Form Transformers: SA-10099

Bulletin IC/FF—38R Monsanto Askarel Guide

Westinghouse Insuldur: SA-9025B

Why Westinghouse Rectangular Coil Core Form Transformers Withstand Short Circuits: M-7205

The South Boston Value Story: MA-375.

Dry Type Transformers

Application
Ventilated and gas filled sealed dry type transformers are ideally suited for indoor and outdoor applications. Ventilated units may be installed in practically any indoor location not subject to submersion or to a high concentration of destructive fumes, or outdoor with a weather-proof case. Gas filled sealed dry type units offer the ultimate in safety and low maintenance with high impulse levels. They can be installed indoor or outdoor or completely submersed.

Benefits

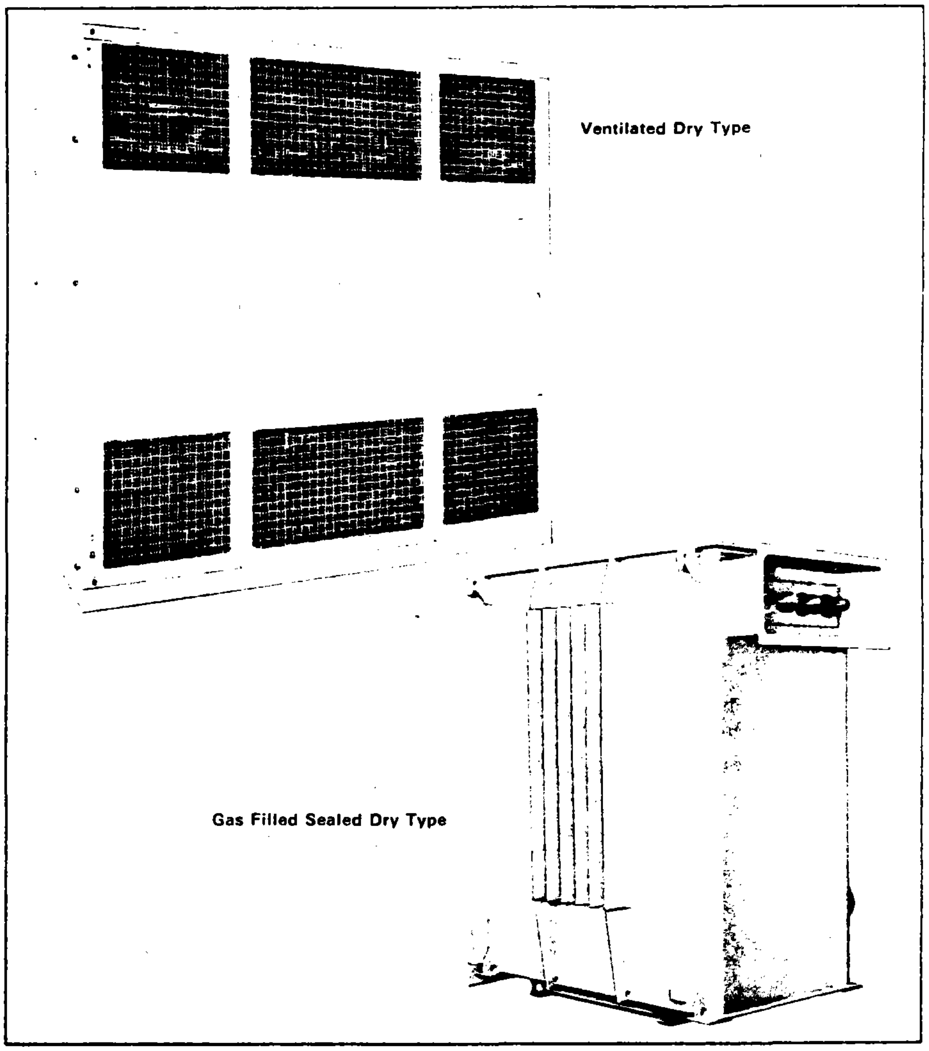
Reliability and Long Life
- Windings are protected by Nomex* insulation having very high temperature and dielectric characteristics.
- A 220°C fully coordinated insulation system is used.
- Each prototype unit is subjected to a complete set of short circuit calculations which have been verified by full size testing.
- Coil types are coordinated with voltage application, i.e., Barrel type/cylindrical coils on 1.2 and 5 Kv class; Disc coils on 8.6 and 15 Kv class.
- The ventilation system is engineered to assure proper operating temperature in the coils.
- On FA units air is positively directed under pressure through the coil ducts at high speed to assure thermal operation under the 220°C allowable limit.

Low Environmental Cost—
Safety and Versatility
- Ventilated dry type transformers are supplied with lightning arresters when specified allowing confident application to any exposed line regardless of line BIL.
- Air insulated and cooled by natural convection, these transformers release no toxic gases and are fire and explosion resistant. Elimination of these principal liquid-filled transformer potential hazards makes them especially desirable for installation in schools, hospitals, hotels, theatres, factories, etc., where large groups of people are present.
- Where space limitations are a consideration ventilated dry type, transformers offer lower weight and absence of liquid allowing their mounting in such places as balconies to save floor space and yet provide safe operation.
- Gas filled sealed dry type transformers are the safest transformers available with a completely hermetically sealed heavy gauge steel tank—they can be installed anywhere.

Value

Proven Methods and Materials
- Westinghouse testing standards are the highest in the industry. New designs are given complete load, short circuit, and insulation tests to prove methods and materials used in manufacture. Verified production line models receive standard quality control inspections and tests by our most experienced personnel. Certified reports on routine tests can be obtained on all units, and special tests or reports can be obtained by special orders.

Further Information
Prices:
PL 47-330
Description:
DB47-351
Ordering Information and Dimensions:
DS 47-370



Ventilated Dry Type

Gas Filled Sealed Dry Type

Insulation Class
Dry type transformers are insulated with 220°C system materials with temperature ratings as follows:

Maximum Ambient	Average Rise	Hottest Spot Winding Temperature Rise
40°C	150°C	180°C
40°C	115°C	145°C
40°C	80°C	110°C

Maintenance
Dry type transformers are practically maintenance free, except for periodic inspection of the connections. On ventilated dry type transformers any accumulation of dust or dirt should be removed by brushing or blowing dry air on the unit. See IL 47-067-1. Gas filled sealed dry type transformers only require periodic checks of pressure and temperature. They require less maintenance than liquid filled or open ventilated dry type transformers.

Design Features

1. Case—Ventilated Dry Type
The case has removable panels for access to the taps and core and coil inspection and the complete case structure can be removed and knocked down to reduce size and weight for rigging into tight locations. The case is constructed of 13 gauge steel and painted ANSI #61 light gray.

Standard case accessories are: jack pads, ground pad, diagrammatic nameplate, provisions for rolling, and protected ventilation grille.

Gas Filled Sealed Dry Type
Sealed Tank
The transformer will be of sealed tank construction to prevent breathing. Tank will be hermetically sealed and will be tested at 15 psi pressure. It will be provided with welded-on ¼" thick Yukon coolers.

Shot Blast
The case and coolers will be cleaned by shot blast and phosphatized before the paint is applied.

Finish
Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or dark gray ANSI No. 24 (outdoor).

The transformer will be insulated and cooled with C_2F_6 fluorocarbon gas.

Bushings
The transformer tank will be fitted with rolled flange, inert arc welded bushings for the high voltage and low voltage connections to insure that the tank is hermetically sealed.

2. Core and Coil Assembly

Core and coil assemblies are rigidly braced to withstand mechanical forces under line fault conditions and to resist vibration and shock forces during shipment.

Coils are concentrically assembled on the core legs and rigidly positioned laterally by spacers between the inner-most insulating cylinder and the core. Horizontal and vertical stresses set up during faults do not exceed the inherent strength of the conductors and support system.

3. Core

Ventilated Dry Type and Gas Filled Sealed Dry Type
Material used to form the core is non-aging, cold rolled, high permeability silicon steel. Bulk material is cut to width and sheared to length by especially hardened and ground cutters to prevent edge damage and burrs that would short between laminations and reduce core efficiency.

Core laminations are firmly clamped by structural steel members for greater strength and lower noise levels. The insulation on the core clamps prevent a metallic short across the stacked laminations. Core clamps and all structural parts are grounded to prevent an induced voltage buildup.

The resulting compact, rigidly clamped structure formed by the core and coil assembly provide a low loss, low sound level design with the strength to withstand repeated short circuit forces.

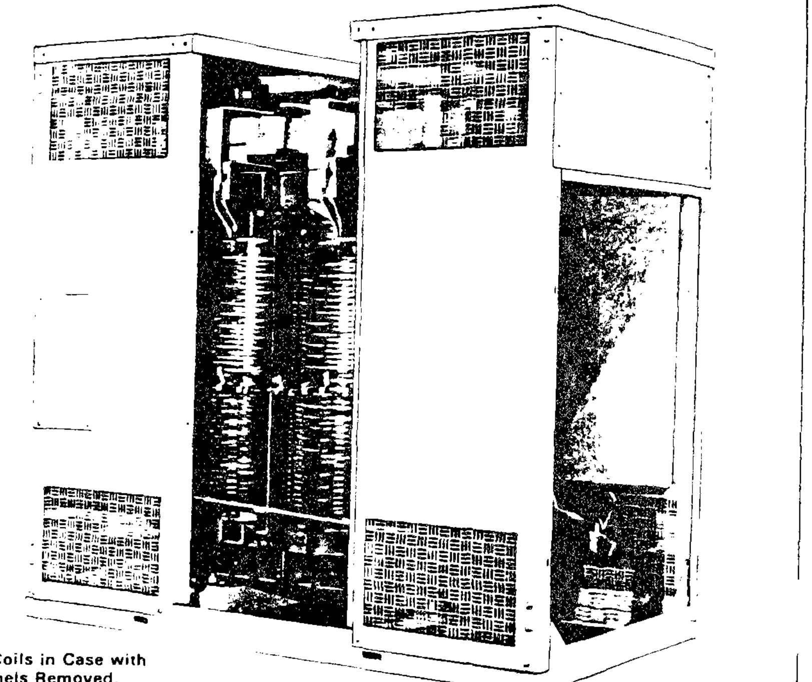
4. Coils

Ventilated Dry Type and Gas Filled Sealed Dry Type

Conductor Material
Aluminum is the standard conductor material. Where design considerations require, copper may be substituted.

Insulation
The insulating structure of the coil is designed for operation at 220 degrees Centigrade hot spot temperature (150°C average rise). High voltage conductor insulation and layer insulation is DuPont Nomex®. This tough, long life high temperature (Class H) Nomex® material is especially resistant to humidity and repeated thermal cycling.

The low voltage coils are usually of cylindrical or strip construction and high voltage coils are usually of the continuous pancake or random wound disc type construction. Large air ducts provide insulation between windings and form vertical cylinders for natural ventilation. The free area in the pancake coils between porcelain spacers further facilitates the flow of cooling air.



Core and Coils in Case with Access Panels Removed.

5. Taps

Ventilated Dry Type
The taps can be reached from the front or back by removing a panel which also protects tampering with the taps.
The taps are rigidly supported by brazing them on the central section of the HV coils. Taps are changed by moving the flexible bolted links from one connecting point to the other. To simplify these changes, the connections are clearly identified.

Gas Filled Sealed Dry Type
De-energized Tap Changer
A tap changer will be supplied to permit changing connections in the high voltage windings from outside the transformer case. The tap changer is designed for operation only when the transformer is de-energized. Provision will be made for padlocking in any position. A packing gland seals the operating shaft at the tank wall. The external housing prevents gas loss due to permeability through the gland packing material. The housing cover may be either gasketed or soldered.

6. Arresters

Ventilated dry type power centers are supplied with RM arresters when specified to provide maximum surge protection for the transformer and associated secondary equipment.

Located in the transformer section, the RM arresters protect against a possible double surge voltage at the transformer terminals even though arresters may be used on the incoming line. The possibility of exceeding BIL level due to reflected voltages is dependent on length and character of cable and steepness of surge.

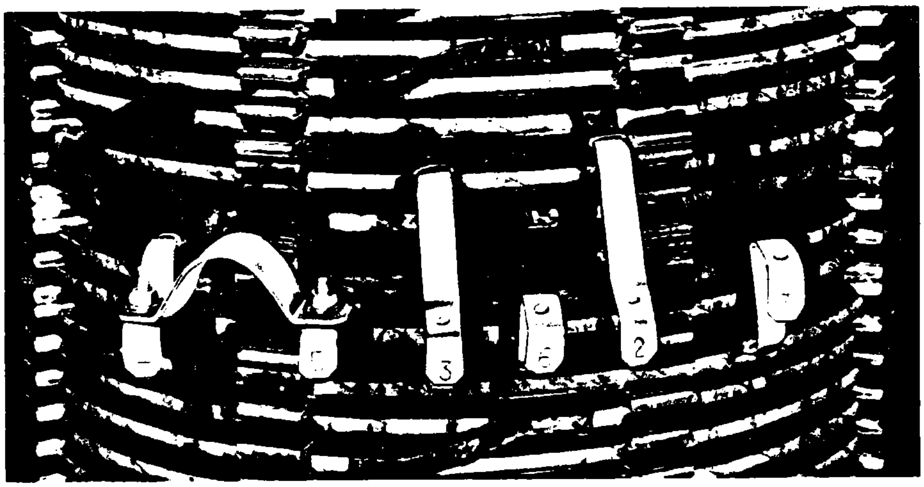
This protection has added importance when LV apparatus or equipment in use has a lower BIL level than the LV transformer winding. Due to electrostatic coupling, a surge transmitted through a transformer could be as much as 1½ to 2 times as great as would be anticipated on the basis of turns ratio alone and could damage this LV equipment. Therefore, RM arrester at HV terminals are desirable.

In applying arresters, it should be remembered to use an arrester with a sparkover to operate below the BIL of the apparatus and to install the arresters at the apparatus to be protected.

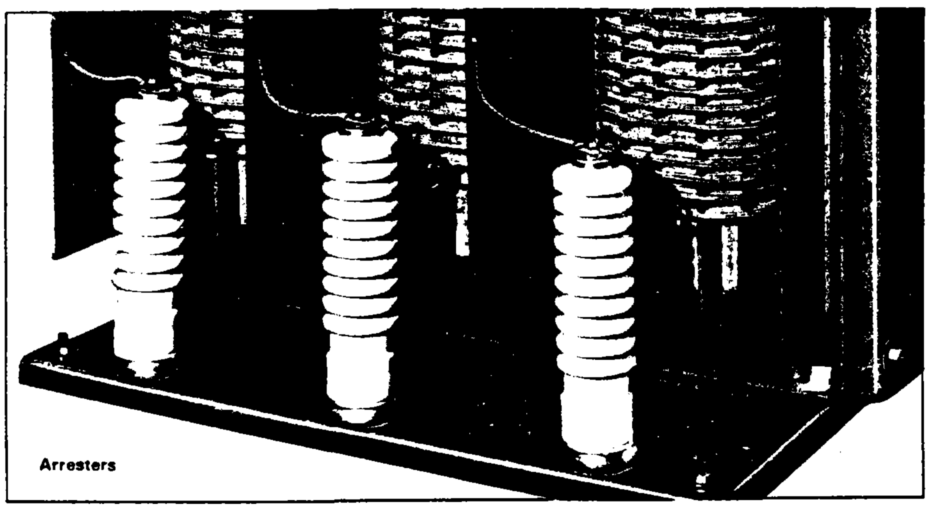
7. Isomode Pad (Vibration Dampeners) On Ventilated Dry Type Units
After removal of the shipping braces, the core and coil assembly rests on rubber Isomode pads to isolate normal core vibrations from the case, foundation or any conduit or bus duct connected to the case.

Coil Impregnation
High temperature moisture and chemical resistant varnish maintains superior bond strength, high dielectric strength and good power factor at elevated temperatures associated with 220°C insulation systems. The thermal aging characteristics, thermal stability and physical resistance to common solvents exceeds that of commonly used varnishes. The resistance to alkalis, acids, and moisture is excellent. High and low voltage coils are impregnated with this varnish and baked before assembly.

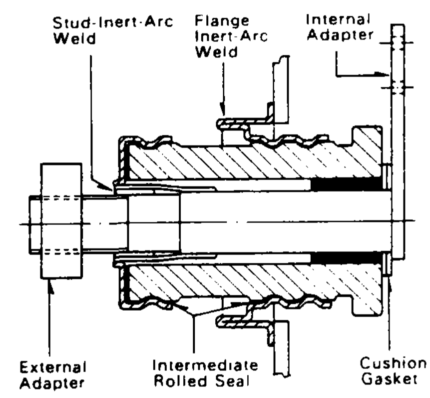
Bushings on Gas Filled Sealed Dry Type Transformers
Gas filled transformers are equipped with rolled flange, inert arc welded bushings, type RFW, for the HV and LV outlets. These bushings insure a hermetically sealed tank while allowing flexibility for conductor expansion and contraction.



Taps



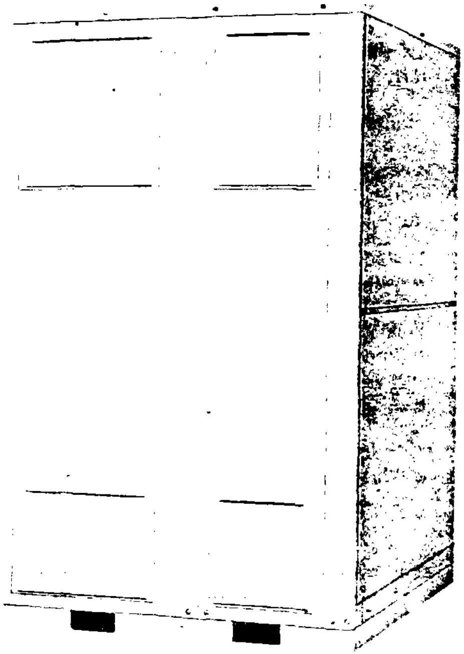
Arresters



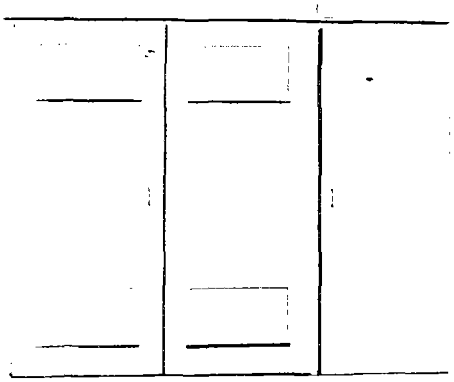
Rolled Flange Bushing

Accessories—Ventilated Dry Type

Outdoor Cases



Standard Outdoor Case



Tamper-Resistant Outdoor Case

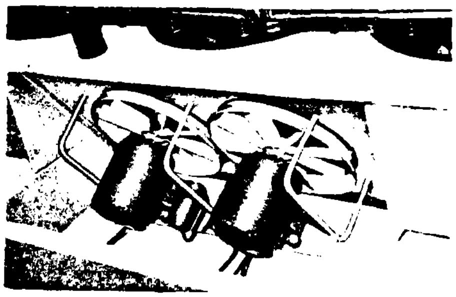
Outdoor Cases
Ventilated dry type units are available with outdoor and outdoor tamper-resistant construction.

Special ventilating grills allow required cooling air to flow in and out of the case but block the passage of rain, fine spray or wind-driven snow.

An extra dip and bake of varnish and appropriately located space heater protect against damage to the core and coils from condensation during thermal cycling.

Cooling on Ventilated Dry Type Units

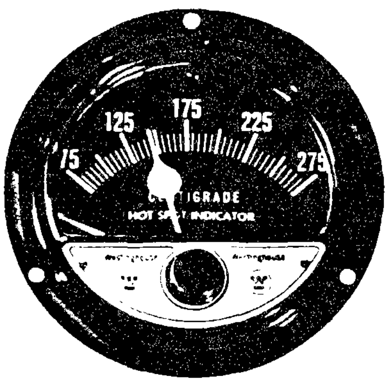
Small Units



Large Units

Forced air cooling is available on all units 300 Kva and above. With air blast equipment in operation the units have forced cooled ratings of 133 percent of the self-cooled rating. Single phase 230 volt fan motors are turned on or off by a Type TRC winding temperature relay.

Hot Spot Relay



Included on all AA/FA units and available as an optional accessory on AA units, the Hot Spot Relay indicates winding hot spot temperature.

The Hot Spot Temperature is an indication of the load being carried by the transformer. Alarm contacts are furnished to signal overload conditions. On fan cooled units, a separate set of contacts turn the fans on when the AA rating is exceeded.

type AA/FA units and available as an optional accessory on ventilated dry type AA self-cooled units.

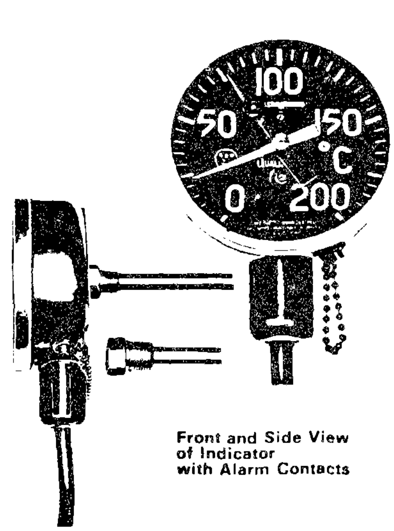
Description
The type TRC Opt-i-Therm is a thermocouple actuated, optically isolated temperature indicator and control. The instrument indicates hottest spot temperature in degrees centigrade and provides contacts for starting and stopping cooling fans, operating alarm signals and lights and actuating breaker trip coils or initiating other shut down or load reduction procedures.

The actuating thermocouple is wound into the transformer low voltage coil at the point of highest temperature. The instrument, therefore, indicates the actual hottest spot temperature of the transformer rather than a simulated hot spot temperature from conventional instruments.

The ability of this type TRC relay to more accurately measure hot spot temperatures offers three benefits: 1. The ability to safely and reliably carry heavier overloads. 2. The ability to size a transformer more nearly to the actual load which means lower first cost. 3. More accurate fan control has the benefit of longer transformer life and fewer failures.

Gas Filled Sealed Dry Type Transformers

Temperature Indicator Hot Gas, Two Switch, Dial Type, Submersible, Direct Mounted



Front and Side View of Indicator with Alarm Contacts

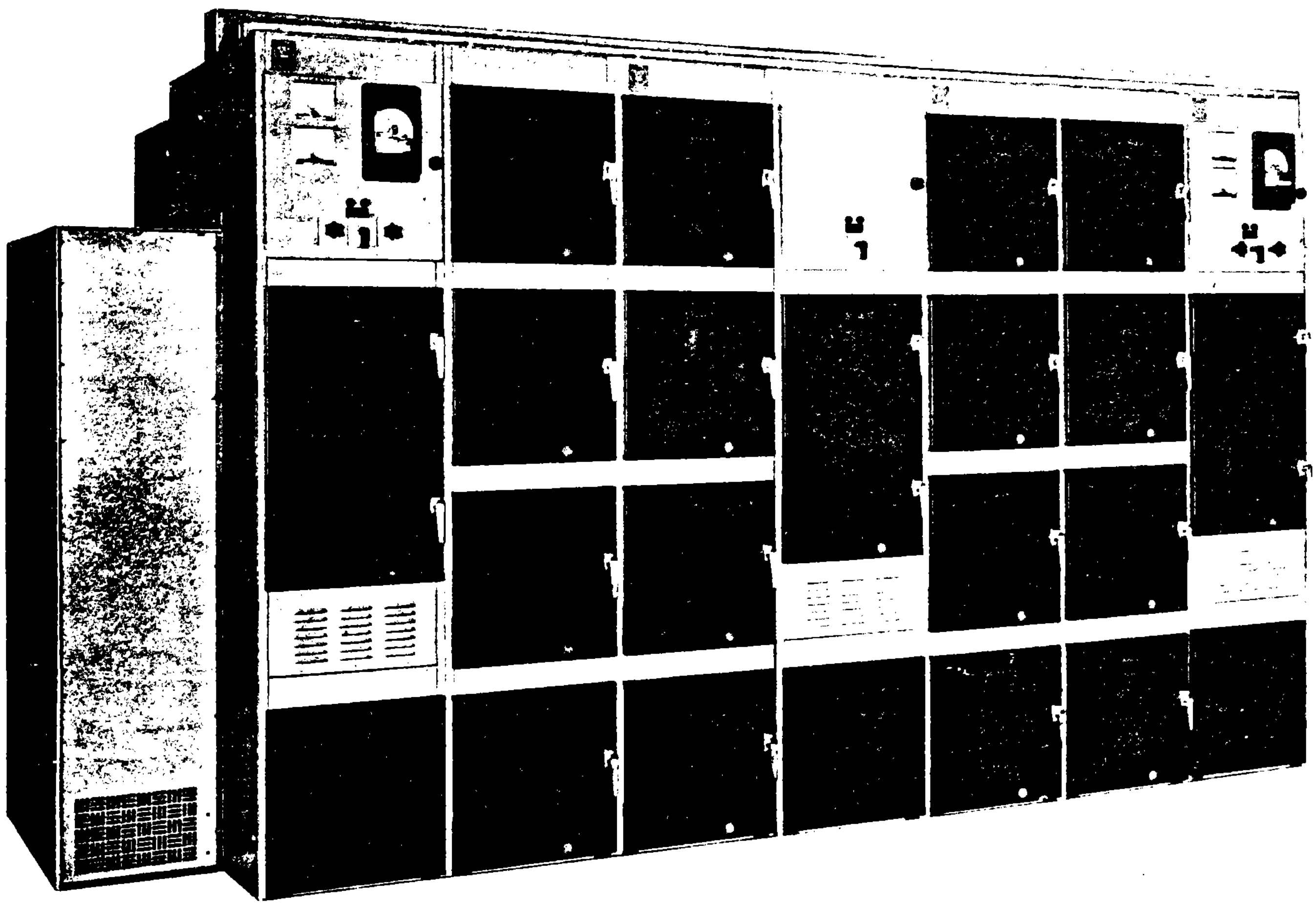
A dial-type thermometer with alarm contacts with maximum resettable indicating hand will be provided. It will indicate the temperature of the gas above the core and coils.

Type DS Low Voltage Switchgear Section

Modern design Type DS Low Voltage Metal Enclosed Switchgear and Circuit Breakers provide

- Integral solid-state type breaker tripping systems
- "Metal-clad" safety features
- Two-step stored-energy breaker closing
- Glass polyester insulation

and many other features for coordinated, safe, convenient, trouble-free and economical control and protection of low-voltage distribution systems.



Ratings
600 volts ac
50 to 4000 Amperes continuous
22,000 to 200,000 amperes interrupting capacity

Features
Two-Tone Standard Indoor Finish—Pearl gray (ANSI No. 61) with contrasting charcoal gray on breaker compartment doors.

Four Position Drawout—Breakers can be in connected, test, disconnected or remove position with compartment doors closed.

Standard Welded Aluminum Main Buses—Reduce maintenance. Purchaser's connections are silver plated copper. (All-copper buses optional).

Wiring Protection—Provided by slotted plastic wiring channels with removable covers, and enclosed steel troughs for inter-unit cross wiring.

Isolated Incoming Connections—Reduce possibility of fault transmission between incoming source and main bus.

Protection During Levering Operation—When levering the breaker between the connected, test and disconnected positions, the operator is fully protected by a steel barrier (faceplate) from contact with live parts and from arcs and hot gases.

Two-Step Stored Energy Closing Mechanism—Spring charging (1) and spring release to close breaker (2) are independent operations, and always give positive control of the instant of closing.

Motor Operated Stored-Energy Closing Mechanisms are supplied on electrically operated breakers. Standard control voltages are 48, 125 and 250 dc, and 120 and 240 ac.

Remote Closing and Tripping can be accomplished with manually operated breakers, by charging the closing mechanism manually, and closing and tripping it remotely through electric spring release and shunt trip coils; available as optional attachments.

Closing Spring Automatic Discharge—Mechanical interlocking automatically discharges the closing springs when the breaker is removed from its compartment.

Breaker Inspection—When withdrawn on the rails, breaker is completely accessible for visual inspection; tilting is not necessary. The rails are permanent parts of every breaker compartment.

Current Transformers for metering and instrumentation are mounted in the breaker compartments, and are front accessible. Accuracies meet ANSI Standard C37.20, Section 20-4.6.3 for Low Voltage Metal Enclosed Switchgear.

Integral Solid-State Type Breaker Overcurrent Trip Systems—provide maximum reliability and excellent repeatability, and require minimum maintenance. No external control source is required. Continuous stepless current pickup and time delay adjustments are made with sealed potentiometers, with no fixed taps or bands and no contact corrosion. Two types available: Standard Amptector II-A and Optional Amptector I-A.

Ground Fault Tripping is available optionally as an integral part of Amptector I-A.

Change in Trip Rating—The overcurrent trip pickup range is established by the rating of the current sensors on the breaker. A continuous long delay pickup adjustment 50% to 125% of sensor rating is provided. The sensors can be readily changed to provide a different pickup range.

Glass Polyester Insulation—Westinghouse-produced glass polyester, with excellent mechanical, dielectric and thermal properties, is used for the insulation system.

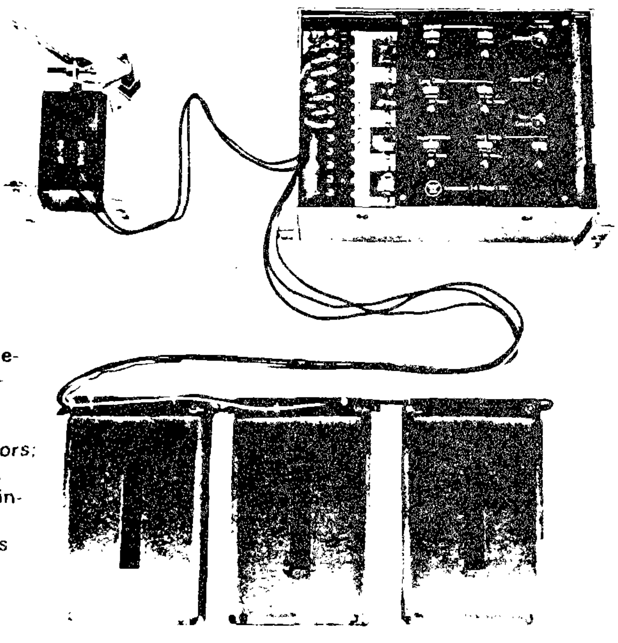
Double Steel Safety Barrier in front of each breaker during normal operation provides maximum safety.

Interphase Barriers—on breakers provide maximum insulation security. The barriers are easily removable for breaker inspection.

Provision for Padlocking—All breakers include provision for padlocking open to prevent electrical or manual closing. This padlocking also secures the breaker in the connected, test or disconnected position by preventing levering.

Ease of Inspection and Maintenance—Type DS switchgear and breakers are designed for maximum accessibility and the utmost facility of inspection and maintenance.

Conformity to Standards—Type DS switchgear and breakers conform to the following standards: NEMA SG3 & SG5; ANSI C37.13, C37.16, C37.17 & C37.20 (IEEE No. 27).



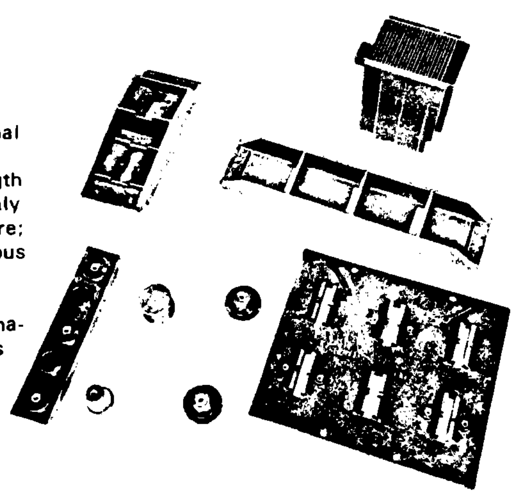
Solid-State Trip
Provides continuous wide-range adjustability. Step-type adjustment is eliminated. Energy and signal provided by current sensors; no potential connections. Long delay, short delay, instantaneous and ground-fault protection in various combinations.

Metal-Clad Safety Features

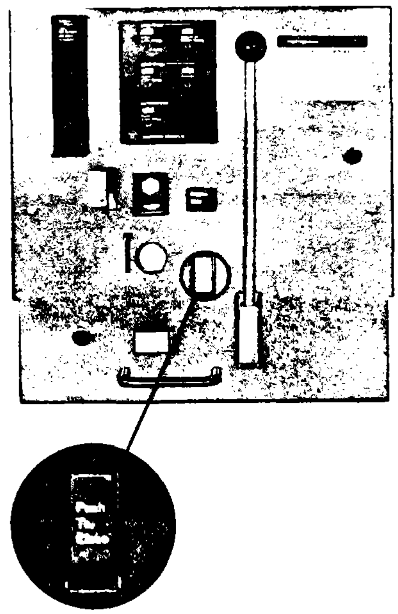
Outer door with quick-opening latches closes compartment completely with breaker in or out. All controls are protected from unauthorized or accidental operation. Full-sized metal shield on breaker face protects operator from live parts, arcs and hot gases while operating, racking or checking Amptector settings. Double interlocked device prevents racking until contacts are open; contacts can't be closed until racking is complete. Separate cable entrance and bus compartments can be provided; removable barriers give access to bus compartment for inspection or cleaning.

Glass Polyester Insulation

Offers far better mechanical, thermal and electrical properties than phenolics. It has the mechanical strength to resist shortcircuit forces; is highly resistant to heat, flame and moisture; and has been designed with generous creepage distances. Often used on 5 Kv and 15 Kv metal-clad switchgear—Westinghouse gives these materials to you on all insulating parts in Type DS 600 volt switchgear.



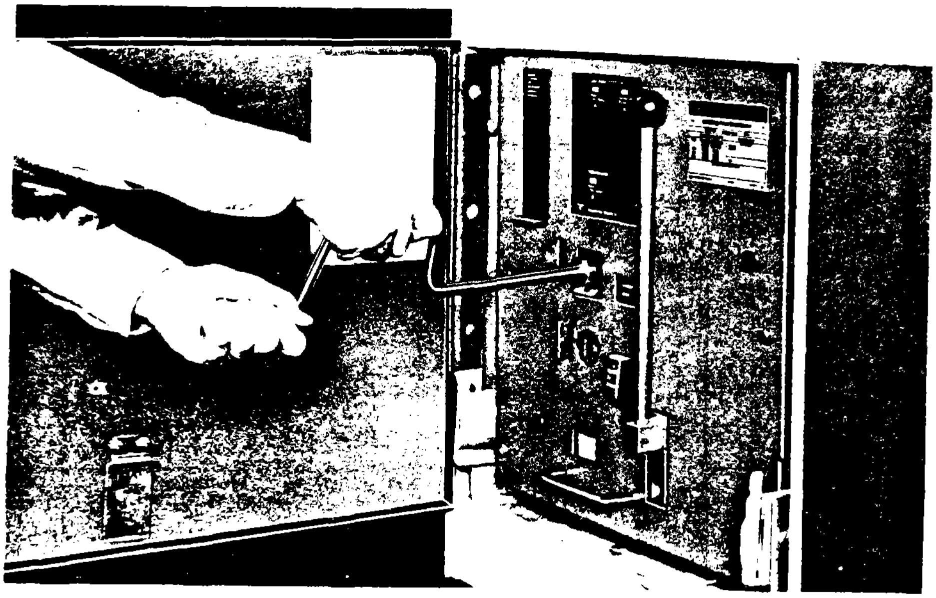
Two-step Stored-energy Closing



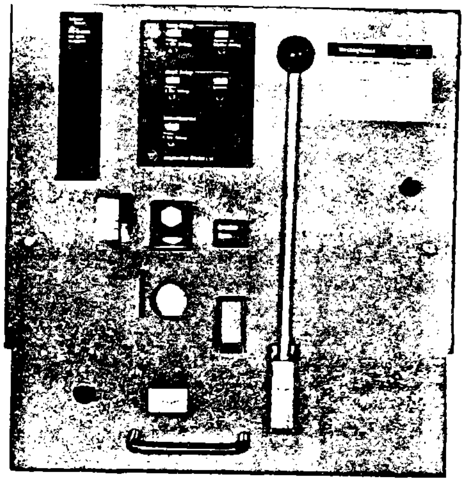
Gives operator positive control of closing after spring mechanism is charged. Breaker can't close while you're still charging. Operation is optional-full manual, full electric, or manual charge and remote electric release.

On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually by pumping an accessory lever 10 to 12 times and released mechanically.

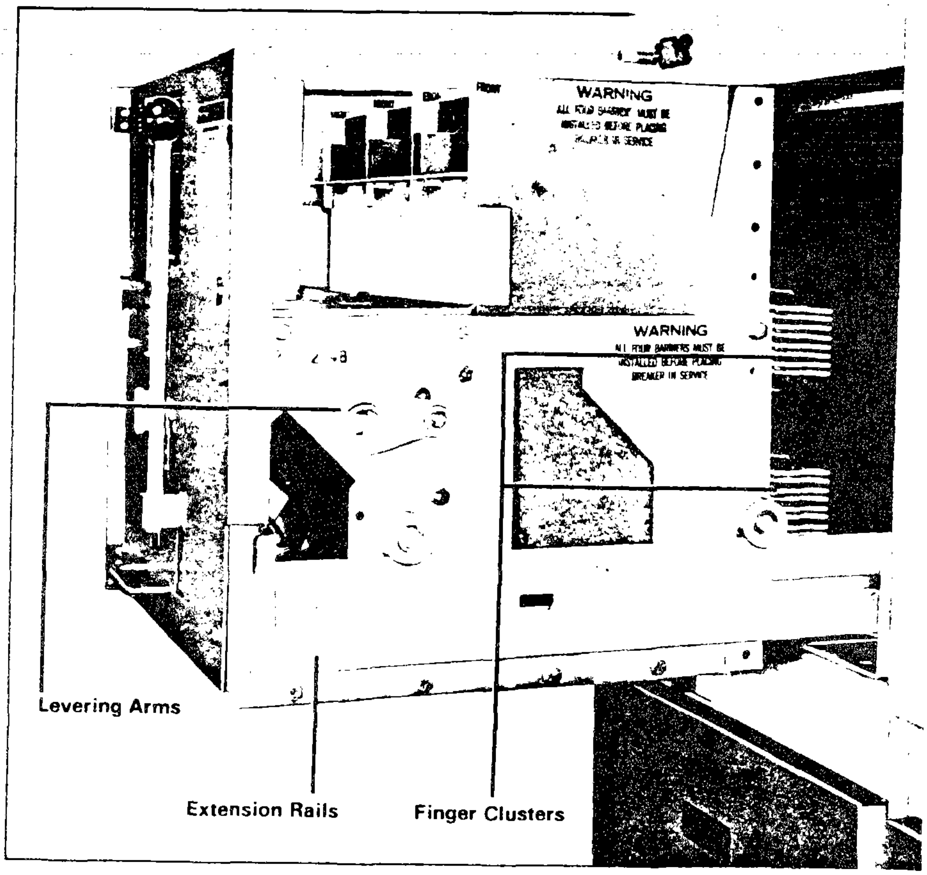
An interlock discharges the closing springs as the breaker is removed from the compartment. The system is patterned after 5 Kv and 15 Kv metal-clad switchgear.



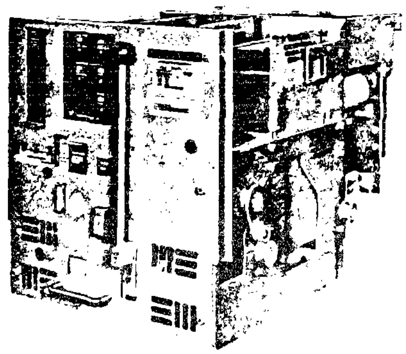
DS Breaker Levering Operation



DS Breaker Faceplate



DSL Breakers and Combinations



Type DSL Breakers are coordinated combinations of Type DS breakers and series connected current limiting fuses. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand and interrupting ratings of "downstream" circuit components.

Arc Chute

There are three basic means of extinguishing an arc: lengthening the arc path; cooling by gas blast or contraction; deionizing or physically removing the conduction particles from the arc path. It was the discovery by Westinghouse of this last method which made the first large power air circuit breaker possible.

The De-ion® principle is incorporated in all of these circuit breakers. This makes possible faster arc extinction for given contact travel; assures positive interruption and minimum contact burning.

Levering Mechanism

The worm gear levering mechanism is self-contained on the breaker drawout element and engages slots in the breaker compartment. A removable crank is used to lever the breaker between the Connected-Test-Disconnected positions.

Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the tripped position.

Stored Energy Mechanism

A cam-type closing mechanism closes the breaker. It receives its energy from a spring which can be charged by a manual handle on the front of the breaker or by a universal electric motor.

Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

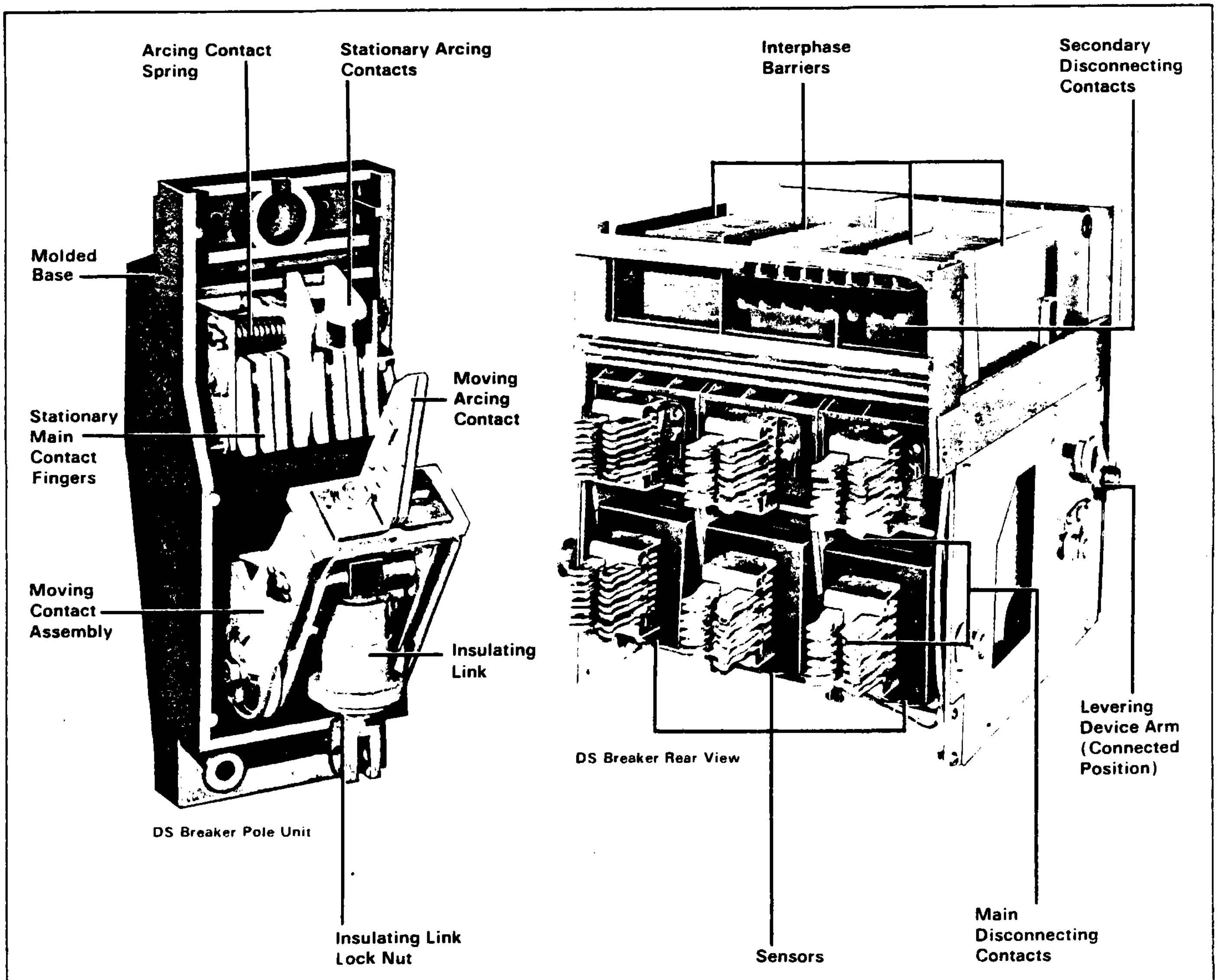
Contacts

All air circuit breakers have solid block, silver tungsten, inlaid main contacts. This construction insures lasting current-carrying ability, which is not seriously impaired even after repeated fault interruptions or repeated momentary overload.

It is not necessary to provide a substantial margin of safety above the actual circuit load current to prevent contact deterioration.

The main contacts are of the butt type and are composed of a multiplicity of fingers to give many points of contact without alignment being critical.

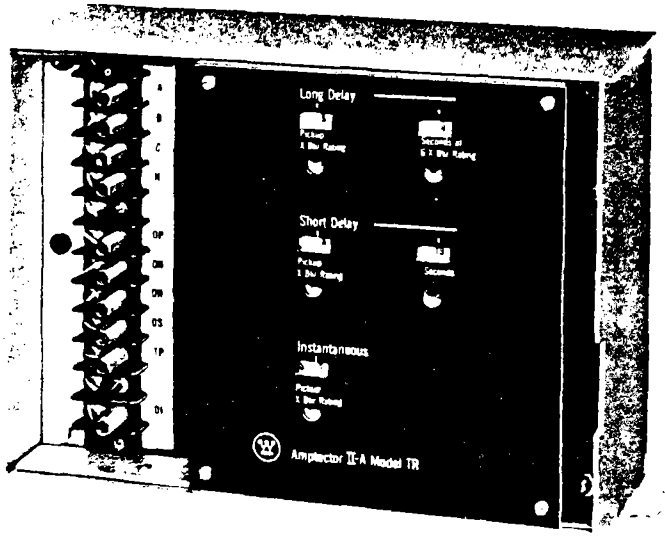
All Type DS breakers are available as either manually or electrically operated.



DS Breaker Pole Unit

DS Breaker Rear View

Standard Amptector II-A Solid-State Trip



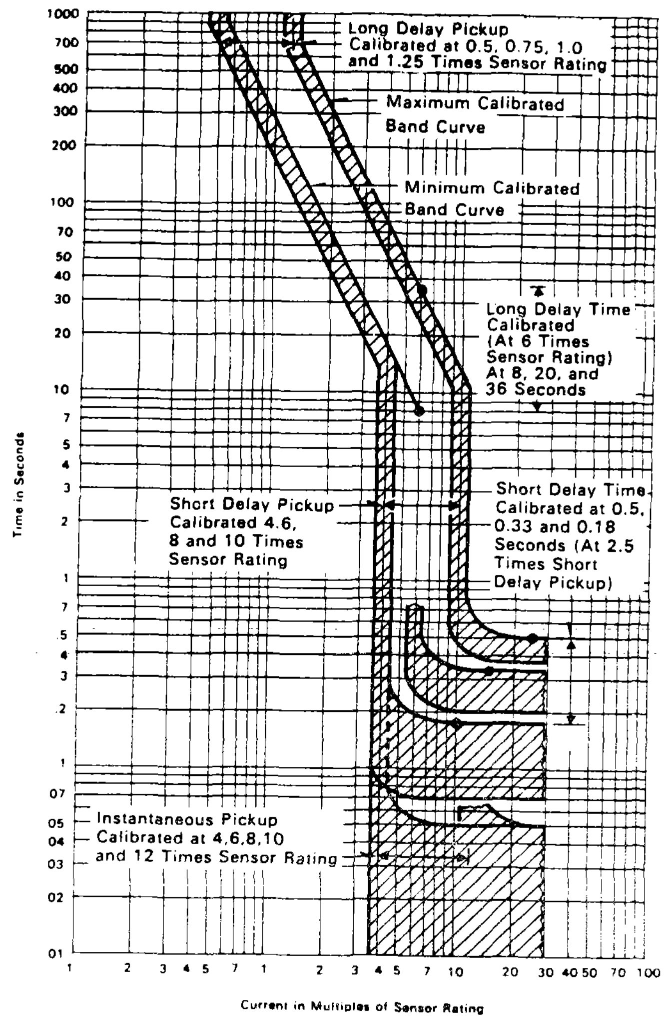
The Westinghouse Amptector II-A is a solid-state device that provides adjustable overcurrent tripping for Westinghouse Type DS low-voltage a-c power circuit breakers. Only one Amptector II-A is required per breaker, and it receives all its energy from a set of sensors—one mounted on each pole of the breaker. It develops an output for an associated trip actuator when preselected conditions of current magnitude and duration are exceeded.

The device can be supplied in three models or combinations of three independent continuously adjustable overcurrent tripping functions: long delay, short delay and instantaneous. These models are:

DU (Dual)—Long delay and instantaneous
SE (Selective)—Long delay and short delay
TR (Triple)—Long delay, short delay and instantaneous

Model DU is the basic standard, and will be supplied when not otherwise indicated or required.

Amptector II-A Characteristics



Amptector I-A and II-A

Each Amptector includes terminal receptacles to permit easy field checking of operation and calibration with an external power supply. A specially designed portable test device with a plug to match the Amptector receptacle is available to provide the utmost in simplicity for checking Amptector operation.

Available Sensor Ratings

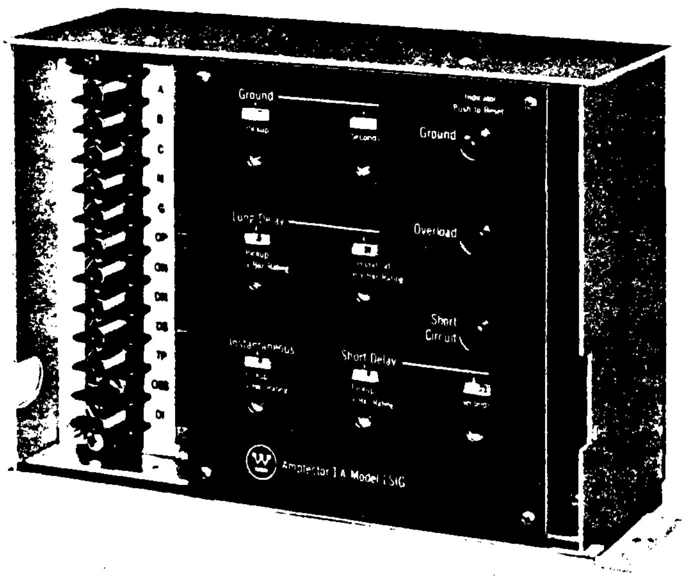
Breaker	Frame Size, Amperes	Sensor Ratings, Amperes
DS-206, DSL-206 or DS-206S	800	50, 100, 150, 200, 300, 400, 600, 800
DS-416, DSL-416 or DS-416S	1600	100, 150, 200, 300, 400, 600, 800, 1200, 1600
DS-420	2000	2000
DS-632	3200	2400, 3200
DS-840	4000	4000

The narrow-band characteristic curves graphically illustrate the close coordination obtainable in breaker systems with Amptector tripping devices. Repeatability within 2%.

The particular breaker current rating for any breaker frame size is determined by the rating of the sensor used.

The breaker current rating for any frame size can be changed by simply changing the sensors, which are easily removed from the breaker drawout element. The wide range of long-delay pickup makes one set of sensors suitable for a number of current ratings. The Amptector itself need not be changed when the associated sensors are changed.

Optional Amptector I-A Solid-State Trip



Offers all of the features of Standard Amptector II-A, plus:

- Integral ground fault protection (optional), with adjustable pickup and delay.
- Resettable operation indicators for Ground, Overload and Short circuit.

Amptector I-A can be supplied in various combinations of four independent continuously adjustable overcurrent tripping functions:

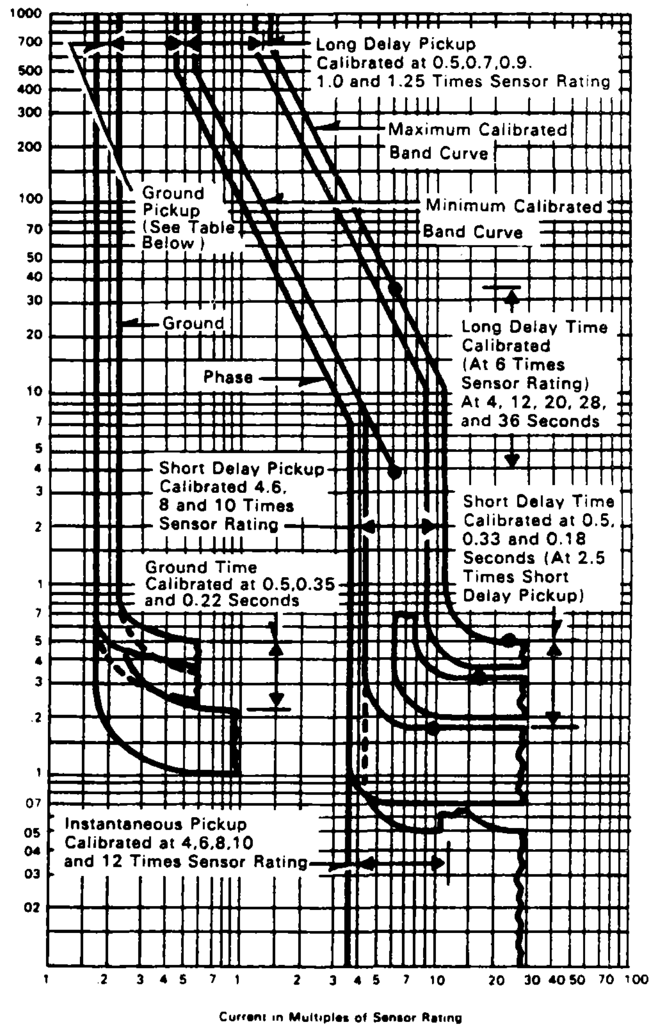
Long delay (L)
Short delay (S)
Instantaneous (I)
Ground (G)

The following combinations are available:

LI	LIG
LS	LSG
LSI	LSIG

Model LI is the basic standard and will be supplied when not otherwise indicated.

Amptector I-A Characteristics



Amptector I-A

Ground Pick-Up Value—Amperes

Dial Setting	50	100	150	200	300	400	600	800	1200	1600	2000	2400	3200	4000	Secondary Current ①
	Sensor Rating														
A	13	57	60	65	80	110	145	180	260	330	400	530	640	800	1.0
B	18	67	75	85	110	150	205	260	385	505	600	770	1000	1200	1.5
C	22	75	85	100	130	185	250	325	480	625	760	960	1200	N.A.	1.9
D	33	100	120	145	200	270	385	500	730	970	1200	N.A.	N.A.	N.A.	3.0

All pick up values may vary ± 10%

① Current of this value from the secondary of an external ground transformer will cause the ground element to function. Ground element pick-up can also be tested using this value. All sensors must be disconnected during test.

Optional Breaker Attachments and Accessories

(a) Shunt trip on manually operated breakers, for any standard control voltage. An auxiliary switch is also required.

(b) Auxiliary contacts on manually operated breakers, usually consisting of one 4 contact auxiliary switch. Maximum of three 4 contact auxiliary switches available on any breaker, manually or electrically operated. The contact rating is 10 amperes. (Two 4 contact switches are standard on each electrically operated breaker.)

(c) Compartment position switch ("TOC"), 6 or 12 contact, actuated by movement of drawout breaker between the connected and test positions. Most common uses are for disconnecting remote control circuits of electrically operated breaker, and for bypassing "b" interlocking auxiliary contacts, when breaker is withdrawn to test position.

(d) Undervoltage trip (ac and dc available). Acts to trip the breaker when the Voltage on its solenoid coil is insufficient to restrain a spring-loaded core. The dropout point is within 30 to 60 percent of the nominal coil voltage and is not adjustable. Available as either instantaneous or time delay type. The time delay is within 2 to 7 seconds after zero voltage occurs, and is not adjustable. The device automatically resets when the breaker opens; approximately one minute is required for resetting of the time delay type.

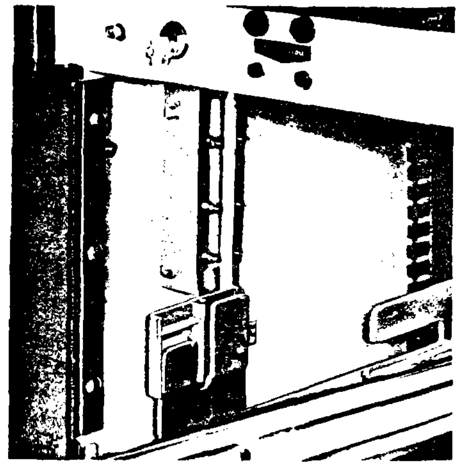
(e) Overcurrent trip switch (OTS). A latching type switch with two independent contacts either normally open or normally closed. Operates only when the breaker is tripped automatically on an overload or fault condition (including Amptector I-A integral ground fault tripping). It may be used for alarm and/or interlocking circuits. Resetting is done by a pushbutton on the breaker face plate, or by a remote switch through an optional reset coil.

(f) High load switch (HLS—available with Amptector I-A only). A self resetting relay which picks up on an overload condition at a lower value than the long delay pickup setting of the tripping device, thus, giving advance warning of an overload condition. The device is completely independent of the overcurrent tripping system, does not trip the breaker, and does not replace any protection in any phase. Adjustment is from 60 to 100 percent of the long delay pickup setting. The time delay is fixed and is approximately one minute. One normally open contact is provided.

(g) Electric Lockout (Manual Breakers). In order to close the breaker after manually charging the closing mechanism, it is necessary to operate an electrical pushbutton on the breaker faceplate. This pushbutton is in series with any required external interlocking. The mechanical "push-to-close" bar is made inoperative when the breaker is in the connected position. An electric spring release attachment (operated by the electrical pushbutton), a charged-spring limit switch, and an auxiliary switch are required.

(h) Electric close release on manually operated breakers, for any standard control voltage. Breaker can be closed by remote control switch or pushbutton after spring is manually charged. A charged-spring limit switch and an auxiliary switch are also required.

(i) Key interlock. Operative only after breaker has been withdrawn beyond disconnected position. Blocks any breaker from being levered into compartment. Breaker can be stored in compartment, and can be completely removed for maintenance or for use as a spare without disturbing interlock. No modification of breaker required.



Key Interlock—Blocking Position

(j) Operation counter.

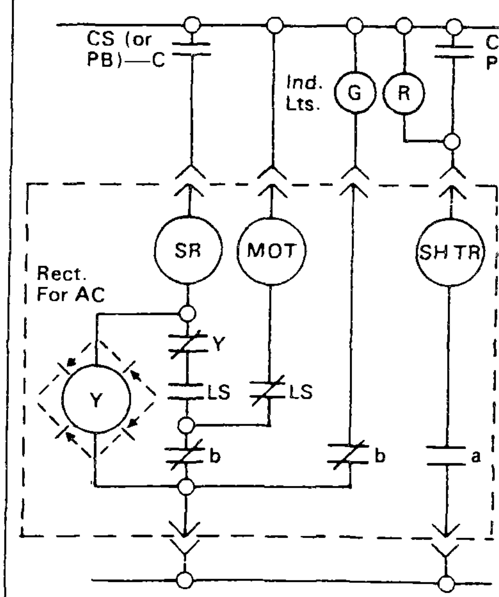
(k) Ac capacitor trip.

(l) Latch check switch.

(m) Mechanical interlock.

Standard Control Diagram

Standard control diagram for Type DS electrically operated breaker, for ac or dc control source.

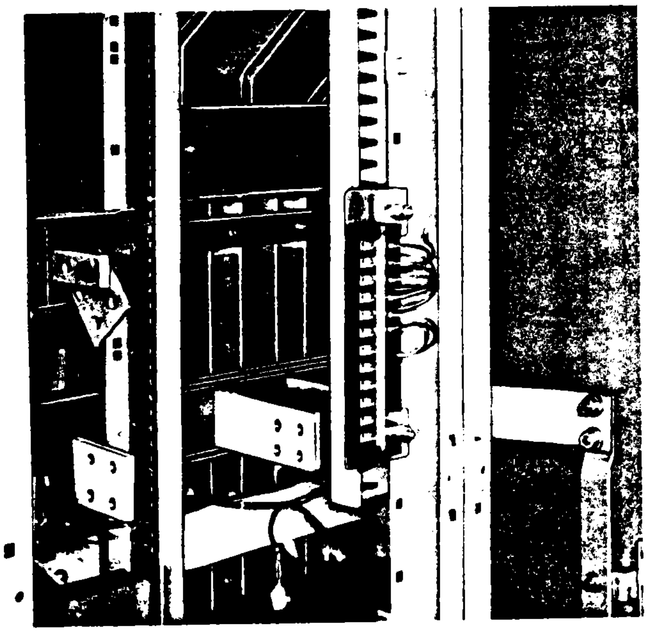


Legend

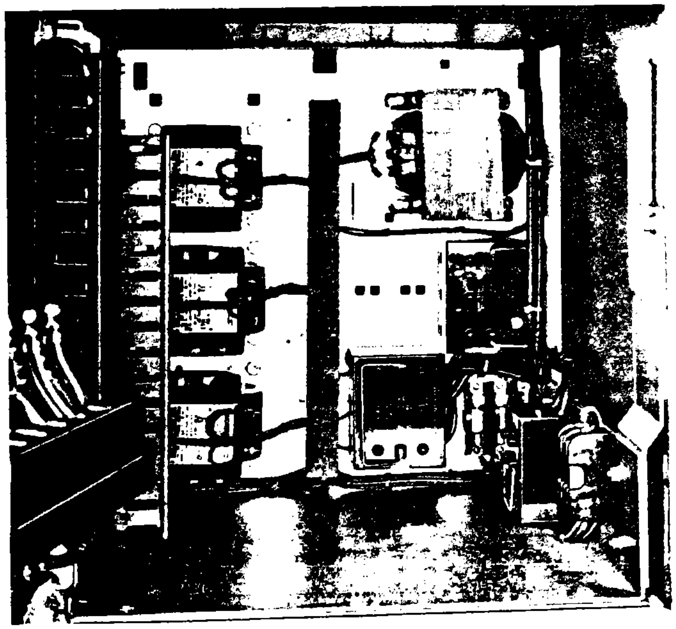
LS —Limit Sw. for Closing Spring
MOT —Motor for Spring Charging
SH TR—Shunt Trip
SR —Spring Release
Y —Anti-Pump Relay

Description of Operation

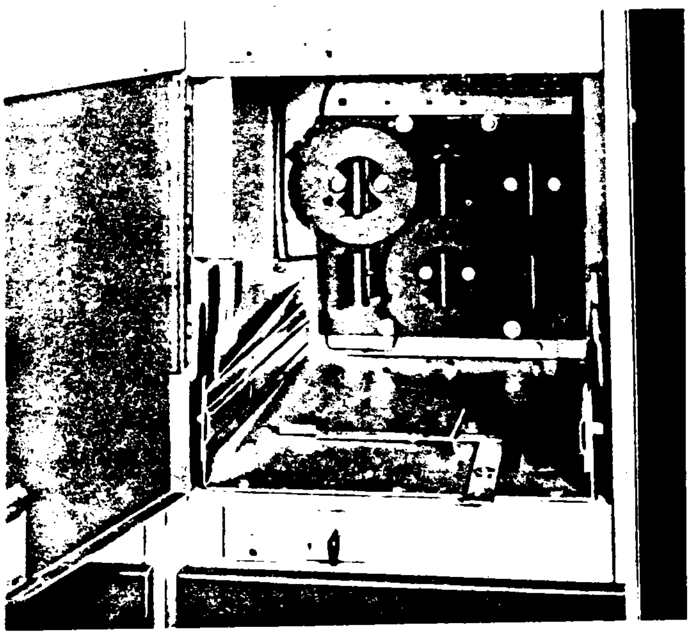
1-When Bkr opens, motor is energized through LS & "b" contact.
2-Motor runs and charges Closing Spring.
3-When Closing Spring fully charged, LS contacts reverse.
4-Closing CS-C contact energizes SR Coil through Y, LS & "b" contacts.
5-When Breaker closes, "b" opens and Y Coil is energized in series with SR Coil.
6-Y contact opens to open SR Coil circuit & prevent pumping should breaker open while CS-C is held closed. Y Coil has very low drop-out voltage.



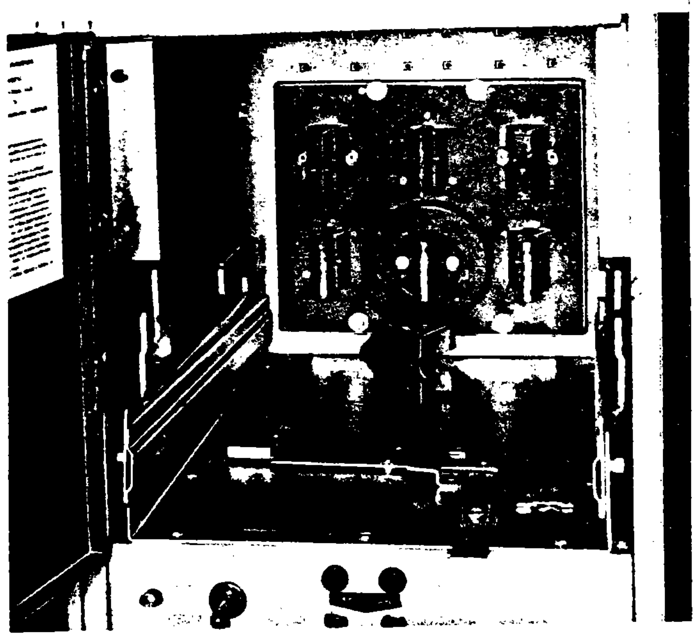
Terminal Blocks



Potential Transformer and Control Power Transformer with Primary and Secondary Fuses



Current Transformers



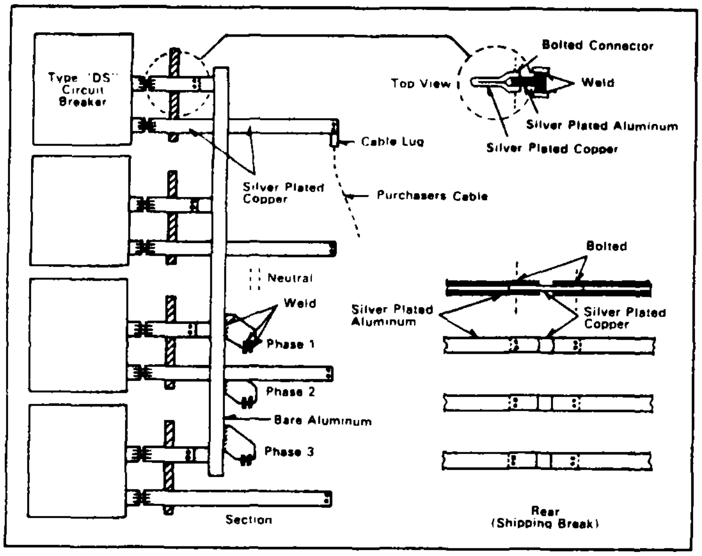
Insulating Boots

Insulation
All insulation is Westinghouse glass polyester, which has been compounded to include the dielectric and mechanical strength necessary for the application. It is highly resistant to heat, flame and moisture, and has been designed with generous creepage distances.

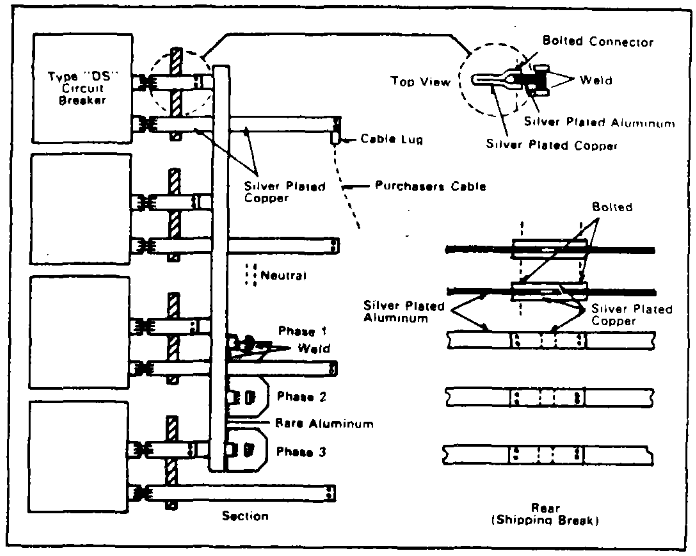
Bus Isolation
The incoming line is isolated from the main bus to reduce the possibility of fault transmission between them. Bus sections are also isolated at a bus tie breaker.

Wiring
Enclosed plastic wiring troughs are used throughout the switchgear. Control circuit terminal blocks are mounted on the rear frame where they are readily accessible for purchaser's connections and inspection. Main circuit terminals may be oriented to suit cable entrance.

Buses and Connections



1600 and 2000 Ampere Bus and Risers

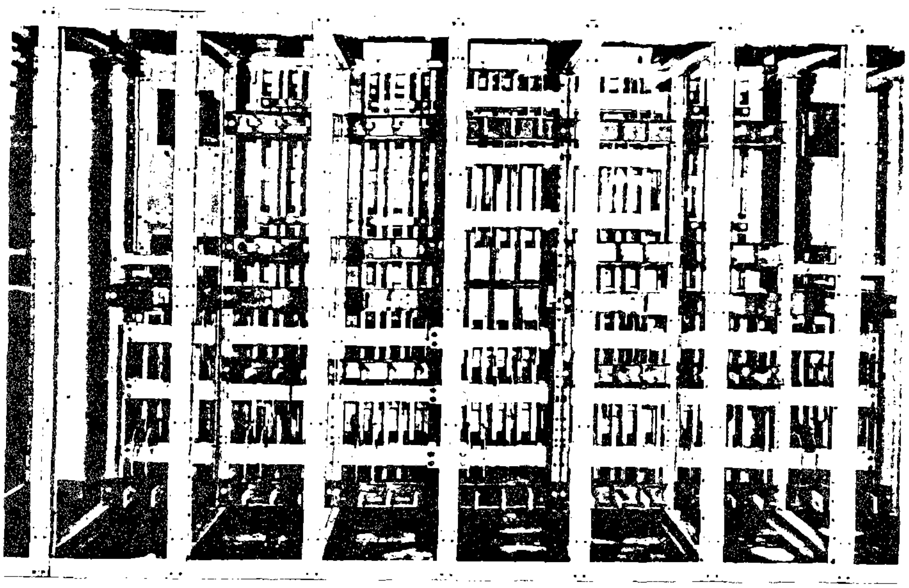


3200, 4000 and 5000 Ampere Bus and Risers

Available main bus ratings in Type DS switchgear are 1600, 2000, 3200, 4000 and 5000 amperes. All ratings are based on a standard temperature rise of 65°C above a maximum ambient air temperature of 40°C outside of the switchgear enclosure.

Details of standard bare welded aluminum main buses, in conjunction with silver plated copper for shipping breaks and for field connections, are shown above.

Optional bare copper main buses with silv plated bolted joints are available.



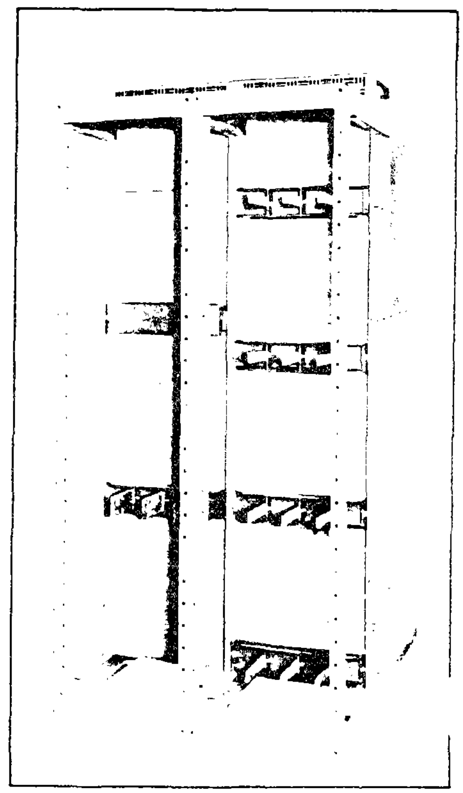
Bus and Cable Compartment with Barriers Removed

The rear portion of the switchgear assembly houses the main bus, connections, and terminals.

A ground bus is furnished the full length of the switchgear assembly and is fitted with terminals for purchaser's connections.

Rear covers are the bolt-on type. They are split into two horizontal sections to facilitate handling during removal and installation.

If the purchaser desires, steel barriers will be furnished to separate the main bus and connections from the purchaser's connection compartment.



Cable Connection Compartment with Barriers in Place

Type RCT Meter Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type*						ANSI Meter Accuracy Classification	
DS-206	DS-416	DS-420	DS-632	DS-840	Ratio	B-0.1	B-0.2
					100/5	1.2	—
					150/5	1.2	—
					200/5	1.2	1.2
					300/5	0.6	0.6
					400/5	0.6	0.6
					600/5	0.6	0.6
					800/5	0.3	0.3
					1200/5	0.3	0.3
					1500/5	0.3	0.3
					1600/5	0.3	0.3
					2000/5	0.3	0.3
					2500/5	0.3	0.3
					3000/5	0.3	0.3
					4000/5	0.3	0.3
					5000/5	0.3	0.3
					6000/5	0.3	0.3

*Also for Types DSL-206, DSL-416, DSL-632 and DSL-840 limiter type equipments.

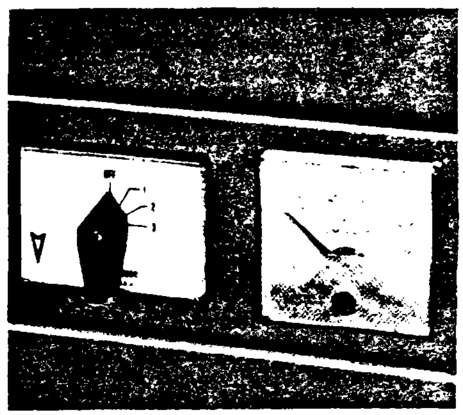
Current transformers with meter accuracy classifications at higher burdens and/or suitable for relaying are also available. They will be mounted in the rear cable connection compartment.

Control Voltages and Currents

Standard control voltages, rated control currents and standard ranges are as follows:

Control Voltage	48 Dc	125 Dc	250 Dc	120 Ac	240 Ac
Close current (SR), amp.	5.0	2.0	1.0	3.0	2.0
Shunt trip current, amp.	5.0	2.0	1.0	2.0	1.0
Spring charge motor amp.	7.5	3.0	1.5	3.0	1.5
Control voltage range:					
Close—	38-56	100-140	200-280	104-127	208-254
Trip —	28-56	70-140	140-280	60-127	208-254

Motor currents are running currents; inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.



Potential Transformers
Potential transformers are rated 10 Kv BIL, and are protected by both primary and secondary fuses. The primary fuses are dead front safety pullout type, NEMA Class J.

Control Power Transformers
Control transformers are provided when required for Ac control of circuit breakers, space heaters, and/or transformer fans. Like potential transformers, they are protected by pullout type primary fuses and also secondary fuses.

Switchgear Accessories
Standard accessories furnished with each Type DS switchgear assembly include:

- One breaker levering crank.
- One manual spring charging lever, if electrically operated breakers are included.
- Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers. One additional set is provided for each size breaker furnished.

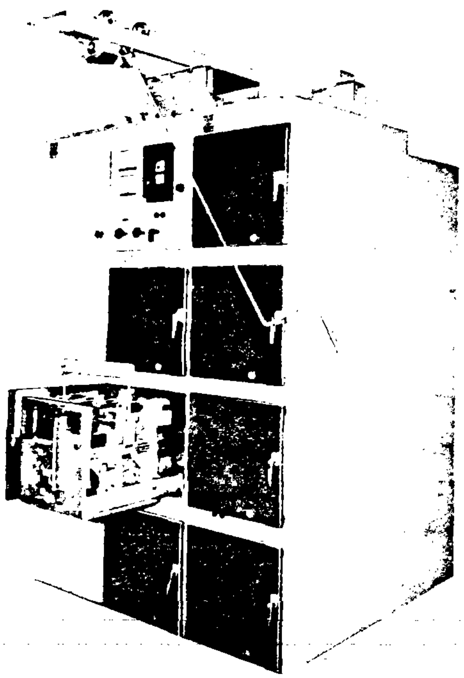
Test plugs are furnished when "Flexitest" relays, Flexitest watthour meters or Flexitest Type FT-1 test switches are mounted on the switchgear.

Miscellaneous
For feeder circuit instrumentation, small 2 inch 2% accuracy class ammeters and Type W-2 ammeter switches can be mounted on the horizontal stationary panels adjacent to the breaker compartment doors. The ammeters and switches are immediately associated with definite breaker circuits. Other devices, such as control pushbuttons, indicating lights and test switches can be mounted on these panels, within space limits. Removable covers provide access to wiring.

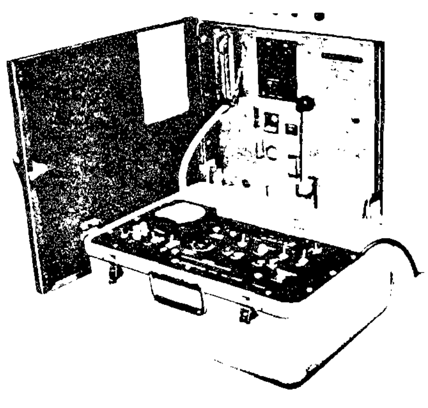
Interference interlocks are supplied on breakers and in compartments where the compartments are of the same physical size, to insure that a Type DS-206 breaker cannot be inserted into a compartment intended for a Type DS-416 or DS-420 breaker, and a Type DS-416 or DS-420 breaker cannot be inserted into a compartment for a Type DS-206 breaker.

Standard wire is Type SIS, stranded copper, polyethylene insulated, No. 14 AWG minimum, with crimped insulation grip ring tongue terminals.

Optional Accessories

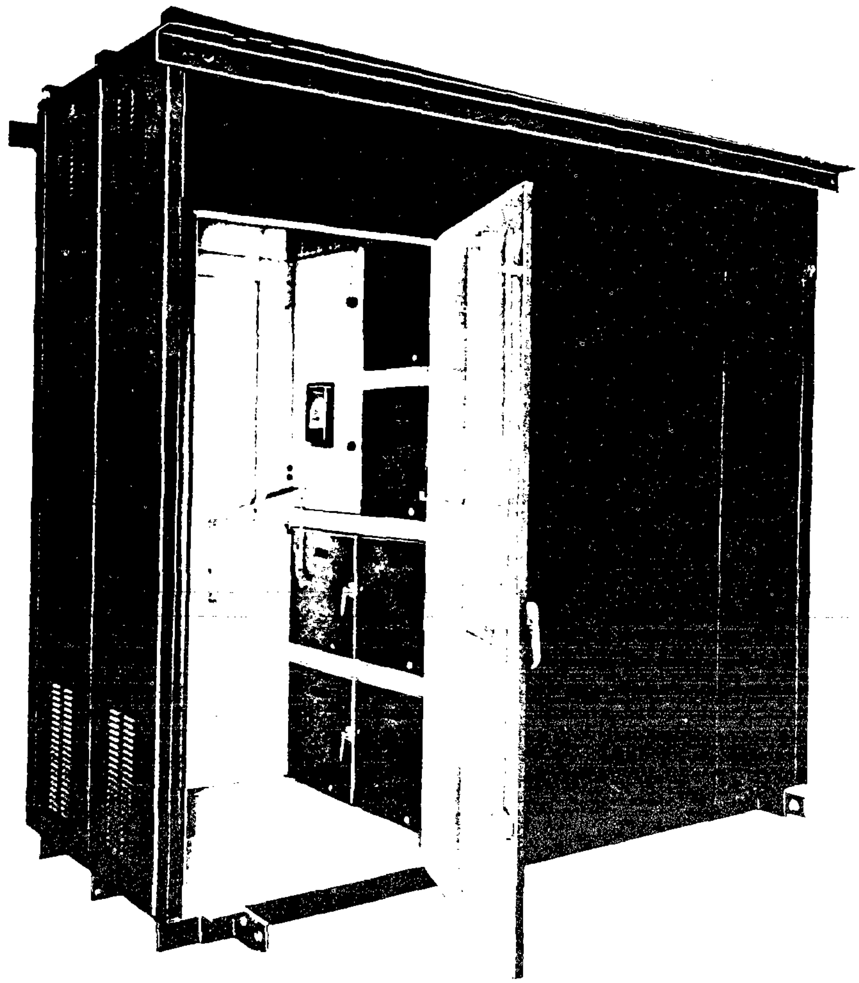


- Traveling type circuit breaker lifter, rail mounted on top of switchgear.
- Floor running portable circuit breaker transfer truck with manual lifting mechanism. Requires approximate 60" deep front aisle space.
- Test cabinet for electrically operated breakers, with pushbuttons, control cable and receptacle, for separate mounting.



- Portable test kit for testing and calibration of Amptector trip devices. Utilizes standard 120 volt, 20 ampere single phase 60 Hz supply, available from any outlet.

Outdoor Type DSO Switchgear



Type DSO outdoor switchgear consists of standard Type DS indoor structures assembled in a heavy gauge completely weatherproof enclosure, with a generous internal "walk-in" front operating aisle extending through all units of the assembly. A reinforced access door with holder, provision for padlocking and "panic" hardware is provided at each end of the aisle.

Standard features also include:
- Bolted hinged rear doors for access to cable and bus compartments.
- Labyrinth door openings.
- Filtered ventilation openings.
- Traveling type geared breaker lifter.
- Space heaters.
- Lighting outlets and convenience receptacles.
- Rigid base structure; no channels required.
- Walk-in aisle within shipping group shipped completely asembled.

The interior finish is similar to indoor switchgear. The standard exterior finish is ANSI No. 24 dark blue-gray. An asphalt coating is provided on the underside and base.

Metal Enclosed Bus Runs

For connecting outdoor transformers through building walls to indoor switchgear, low voltage metal enclosed buses in ratings from 600 amperes to 5000 amperes are available. These buses can also be used for bus tie circuits between separate low voltage switchgear assemblies.

Design and construction follow Low Voltage Switchgear Standards, with bare aluminum or copper conductors with silver plated bolted joints and glass polyester supports. Momentary ratings (minimum 50,000 amperes) are as required. Standard finish colors are ANSI No. 61 pearl gray indoor and No. 24 dark blue-gray outdoor.

Application Data, Dimensions and Weights

Air Interrupter Switch Ratings

Primary Power Switch, Type PPS
(for liquid transformers only)

- 15 Kv, 95 Kv BIL (fuse voltage to suit application).
- 600 A continuous and load interrupting.
- 61,000 A asymmetrical momentary, 40,000 A asymmetrical fault close rating.

Load Interrupter Switch, Type WLI
(standard for Ventilated Dry and Gas Filled transformers; optional for liquid transformers)

- 5 Kv, 60 Kv BIL, and 15 Kv, 95 Kv BIL.
- 600 A and 1200 A continuous and load interrupting.
- Momentary ratings 40,000 A and 80,000 A asymmetrical.
- Fault close in ratings 20,000 A, 40,000 A and 61,000 A asymmetrical

Transformer Primary Fuse Application

System Circuit Volts	Fuse Data Identification Type	Kv	Maximum Amperes	Interrupting Rating Amperes Symm.	Equiv. 3 Ph. Mva	Max. Transf. Kva Rating ① Self Cooled	Forced Air
2400	CLE-1	2.4	225X	50,000	205	670	780
	CLE-2	2.4	450X	40,000	165	1335	1560
	RBA-200	8.3	200E	19,000	80	600	695
	RBA-400	8.3	400E	37,500	150	1190	1385
	RBA-800	8.3	720E	37,500	150	2140	2500
4160	CLE-1	5.5	225X	50,000	360	1155	1350
	CLE-2	5.5	450X	50,000	360	2315	2700
	RBA-200	8.3	200E	19,000	137	1030	1200
	RBA-400	8.3	400E	37,500	270	2055	2400
	RBA-800	8.3	720E	37,500	270	3700	4320
4800	CLE-1	5.5	225X	50,000	415	1335	1560
	CLE-2	5.5	450X	50,000	415	2675	3120
	RBA-200	8.3	200E	19,000	158	1190	1385
	RBA-400	8.3	400E	37,500	310	2375	2775
	RBA-800	8.3	720E	37,500	310	4280	5000
6900	CLE-1	8.3	125E	50,000	600	1065	1245
	CLE-2	8.3	200E	40,000	480	1705	2000
	RBA-200	8.3	200E	16,600	200	1705	2000
	RBA-400	8.3	400E	29,400	350	3415	3985
	RBA-800	8.3	720E	29,400	350	6150	7170
	CLT	8.3	300C	50,000	600	2560	2985
7200	CLE-1	8.3	125E	50,000	625	1115	1300
	CLE-2	8.3	200E	40,000	500	1785	2080
	RBA-200	8.3	200E	16,600	205	1785	2080
	RBA-400	8.3	400E	29,400	365	3565	4160
	RBA-800	8.3	720E	29,400	365	6420	7500
	CLT	8.3	300C	50,000	625	2670	3110
12,000	CLE-1	15.5	65E	85,000	1770	905	1030
	CLE-2	15.5	125X	85,000	1770	1745	1985
	CLE-3	15.5	200X	50,000	1040	2790	3175
	RBA-200	15.5	200E	14,400	300	2970	3465
	RBA-400	15.5	400E	29,400	610	5945	6930
	CLT	15.5	175C	50,000	1040	2595	3025
12,470	CLE-1	15.5	65E	85,000	1835	940	1070
	CLE-2	15.5	125X	85,000	1835	1810	2060
	CLE-3	15.5	200X	50,000	1080	2900	3300
	RBA-200	15.5	200E	14,400	310	3085	3600
	RBA-400	15.5	400E	29,400	635	6170	7200
	CLT	15.5	175C	50,000	1080	2695	3140
13,200	CLE-1	15.5	65E	85,000	1945	1000	1135
	CLE-2	15.5	125X	85,000	1945	1920	2180
	CLE-3	15.5	200X	50,000	1145	3070	3490
	RBA-200	15.5	200E	14,400	330	3265	3810
	RBA-400	15.5	400E	29,400	670	6530	7620
	CLT	15.5	175C	50,000	1145	2855	3330
13,800	CLE-1	15.5	65E	85,000	2030	1045	1185
	CLE-2	15.5	125X	85,000	2030	2000	2280
	CLE-3	15.5	200X	50,000	1195	3200	3650
	RBA-200	15.5	200E	14,400	330	3415	3985
	RBA-400	15.5	400E	29,400	670	6830	7970
	CLT	15.5	175C	50,000	1195	2985	3480

	For Self Cooled Transformers	For Forced Air Transformers
Type CLE Current Limiting Fuses: Through 7.2 Kv Fuse Rating—	1.4	1.2
14.4 Kv Fuse Rating—	1.49	1.31
Type RBA Expulsion Type Non-Current Limiting Fuses, all Ratings—	1.4	1.2
Type CLT Current Limiting Fuses, all Ratings	1.4	1.2

① Maximum Transformer Kva Ratings are based on Ratios of Maximum Fuse Current Rating to Transformer Full Load Current (I_F/I_T) as listed at left. For a 55°C Rise Liquid Filled Transformer, use the Kva Rating for 65°C rise (55°C rating x 1.12).

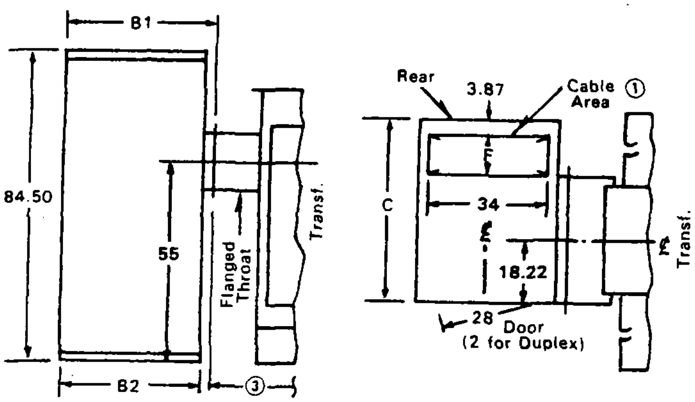
These applications are subject to modification when specific factors such as Transformer Characteristics, other Protective Devices, Coordination Requirements and Load Variations may indicate a different I_F/I_T Ratio.

Caution: Primary Fuses must not be relied upon for clearing Secondary Ground Faults

Note: The type RBA interrupting ratings shown are those of the discharge filter type, in which the noise is minimized and deionization of expulsion gases is assured.

Dimensions of High Voltage Incoming Line Sections—Inches (Approximate)

Type PPS Air Interrupter Switch (For Liquid Filled Transformer Only)



Front Elevation

Plan

Switch Arrangement	Single Unit, 2 Position	Duplex (2 Units)
B1 (Total)	40.99	79.23
B2 (Over Base)	39.74	77.98
Depth C Over Base	Cable Space ① F	
49.86	11	
59.86 ②	21 ②	

③ Transf. Flange-to-flange Dimension plus approx. 9".

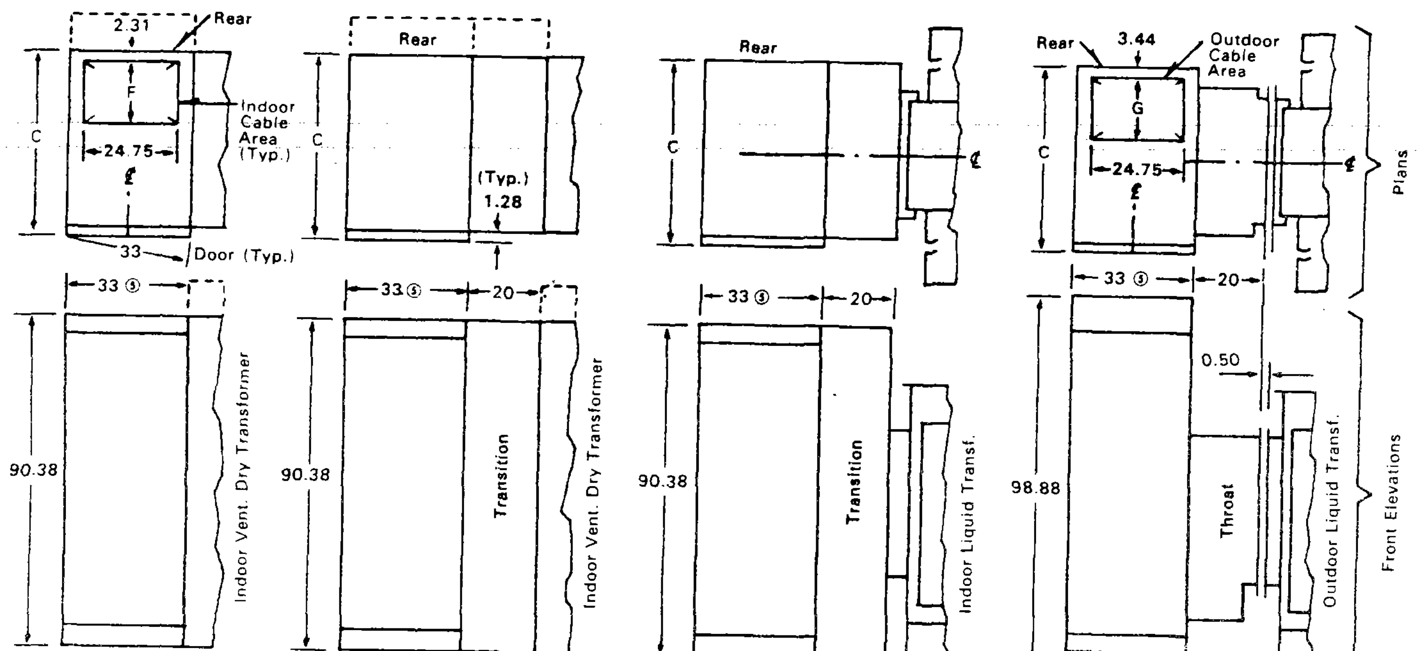
① 2 Cable areas for Duplex arrangement.

② Required for Loop Feed Potheads.

Dimensions approx. same for both indoor and outdoor.

Approx. Weights: Pounds	Single Unit, Unfused — 1500	Duplex, Unfused — 3000	Fuses, set of three — 200

Type WLI Air Interrupter Switch (Single Units as Shown; See Note for Duplex)



Ins. Cable Conn's. only

Bus Connections

Cable or Bus Conn's.

Cable or Bus Conn's.

Note: Two (2) units each 33 (or 36) wide, with two (2) cable areas, required for duplex arrangements.

Unit Depth C	Cable Sp. F(I.D.)	Cable Sp. G(O.D.)
① 49.28	16.97	15.84
② 55.28	22.97	21.84
③ 60	27.69	26.56
④ 62	29.69	28.56
70	37.69	36.56
80	47.69	46.56

① Provides 18" max. stress cone space for top entrance.

② Required for add'l stress cone space for top entrance, or for 54" deep dry type transformer case.

③ Min. for single unit selector type, 5 Kv, with bottom entrance; top entrance 70".

④ Min. for single unit selector type, 15 Kv, with bottom entrance; top entrance 80".

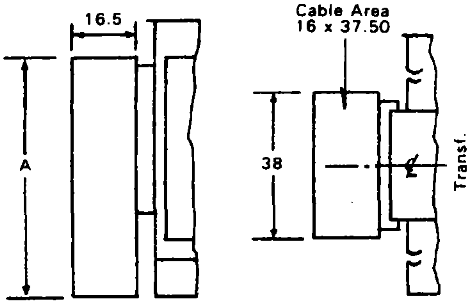
⑤ Except 15 Kv with 61,000 A (fault close) rating 36" wide.

Min. depth with pothead: 5 Kv 49.28; 15 Kv 55.28

For gas filled sealed dry type transformer, refer to Westinghouse.

Approximate Weights—Lb.
Single unit, 2 pos., unfused: indoor 1500; outdoor 1800. (Use two for Duplex.)
Single unit selector, unfused: indoor 1800; outdoor 2100.
Indoor transition—300.
Outdoor throat—200.
Fuses, set of 3—200.

Cable Entrance Compartment

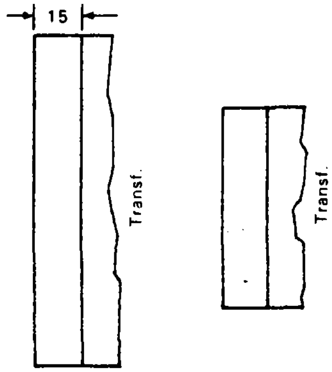


Height A
Bottom Entr. – 65.25
Top Entrance – 87

Approx. Weight
300 Lb.

Compt. for Gas Filled Sealed Dry Transf. similar except height "A" as required.

Front Elevation Plan
For Liquid Filled Transformer, Indoor or Outdoor



Height and Depth of Compartment same as Transformer case

Approx. Weight –
300 Lb.

Front Elevation Plan
For Ventilated Dry Transformer

3 Phase Transformer Secondary Ampere Ratings

		Liquid Filled 55/65°C Rise			Liquid Filled 65°C Rise		Ventilated Dry 150°C Rise		Sealed Dry 150°C Rise
Base Kva	Sec. Volts	OA 55°	OA 65°	FA 65°	OA	FA	AA	FA	AA
300	208	833	933	—	833	—	833	1111	833
	240	722	808	—	722	—	722	962	722
	480	361	404	—	361	—	361	481	361
	600	289	323	—	289	—	289	385	289
500	208	1389	1556	—	1389	—	1389	1852	1389
	240	1203	1347	—	1203	—	1203	1604	1203
	480	601	674	—	601	—	601	802	601
	600	481	539	—	481	—	481	641	481
750	208	2083	2333	2683	2083	2396	2083	2778	2083
	240	1804	2021	2324	1804	2075	1804	2406	1804
	480	902	1011	1162	902	1038	902	1203	902
	600	722	808	929	722	830	722	962	722
1000	208	2778	3111	3578	2778	3194	2778	3704	2778
	240	2406	2695	3099	2406	2767	2406	3208	2406
	480	1203	1347	1549	1203	1383	1203	1604	1203
	600	962	1077	1239	962	1106	962	1283	962
1500	480	1804	2021	2324	1804	2075	1804	2406	1804
	600	1443	1616	1859	1443	1659	1443	1924	1443
2000	480	2406	2695	3099	2406	2767	2406	3208	2406
	600	1924	2155	2478	1924	2213	1924	2565	1924
2500	480	3008	3368	4211	3008	3759	3008	4010	3008
	600	2406	2694	3367	2406	3008	2406	3208	2406

Transformer Standards

Dimensions and Weights as listed in the Tables are based on the following:

1. Standard Base Kva Ratings: 300-500-750-1000-1500-2000-2500.
2. 3 Phase, 60 Hertz, Two Windings.
3. Standard Temperature Rise (See Tables) above ambient air temperature of 40°C (104°F) maximum and 30°C (86°F) average in any 24-hour period.
4. Maximum Altitude of 1000 meters above sea level for full rating (3300 feet).
5. Standard High Voltages: 2400-4160-4800-6900-7200-12000-12470-13200-13800, delta connected only.
6. Standard High Voltage Taps: two approximately 2½% full capacity above and two below rated voltage.
7. Standard Low Voltages (no taps):①
   208y/120 (1000 Kva max.)
   240 delta (1000 Kva max.)
   480 delta (all ratings)
   480y/277 (all ratings)
8. Aluminum Winding Conductors.
9. No Series-Parallel or Delta-Wye Terminal Boards.
10. Standard Accessories.
11. Standard Surface Preparation, Finish Processes, Materials and Colors.
12. Standard Tests in accordance with ANSI Standard Test Code (see below).
13. HV and LV Basic Impulse Levels, Impedance and Sound Levels in line with the following Tables.

① 600 Y and 600 △ also available.

Standard Insulation Levels—Kv BIL

High Voltage Rating	Liquid Filled Transformer HV	Liquid Filled Transformer LV (600 Max.)	Vent. Dry Transformer HV	Vent. Dry Transformer LV (600 Max.)	Gas Filled Transformer HV	Gas Filled Transformer LV (600 Max.)
2400	45	30	25	10	45	30
4160	60	30	25	10	60	30
4800	60	30	25	10	60	30
6900	75	30	35	10	75	30
7200	75	30	35	10	75	30
12000	95	30	50	10	95	30
12470	95	30	50	10	95	30
13200	95	30	50	10	95	30
13800	95	30	50	10	95	30

Impedances (±7½% Tolerance):

Kva	Vent-Dry Transformer	Gas Filled Transformer	Liquid Filled Transformer
300	②	5.0%	5.0%
500	5.75%	5.0%	5.0%
750	5.75%	5.75%	5.75%
1000 ①	5.75%	5.75%	5.75%
1500	5.75%	5.75%	5.75%
2000	5.75%	5.75%	5.75%
2500	5.75%	5.75%	5.75%

① 8.0% impedance standard as alternate, if requested, at 480 volts low voltage

② 6.3% for 5 Kv; 5.0% for 8.6 and 15 Kv

Standard Guaranteed Sound Levels—Decibels

Max. Base Kva (Self Cooled)	Liquid Filled Transformer OA	Liquid Filled Transformer FA	Vent. Dry Transformer AA	Vent. Dry Transformer FA	Gas Filled Transformer AA
300	55	—	58	67	57
500	56	—	60	67	59
750	58	67	64	67	63
1000	58	67	64	68	63
1500	60	67	65	69	64
2000	61	67	66	71	65
2500	62	67	68	71	66

ANSI Standard Tests

1. Resistance measurements.
2. Ratio tests.
3. Polarity and phase relation.
4. No-load loss.
5. Exciting current.
6. Impedance and load loss.
7. Applied potential test.
8. Induced potential test.
9. Temperature test or tests will be made on one unit of an order, covering one or more units of a given rating. Tests will be made only when there is no available record of a temperature test per ANSI Standards on a duplicate or essentially duplicate unit.

Transformer Kva Ratings, 3 Phase

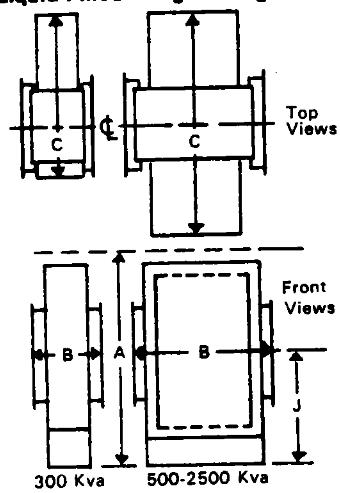
In addition to their basic self-cooled (AA or OA, 100%) Kva ratings, modern Westinghouse standard Secondary Unit Substation Transformers of the liquid filled and ventilated dry types are designed for continuous operation at the following supplementary self-cooled and fan-cooled (FA) Kva ratings:

Liquid Filled 55/65°C Rise OA 55°C	55/65°C Rise OA 65°C	55/65°C Rise FA 55°C	55/65°C Rise FA 65°C	65°C Rise OA	65°C Rise FA	Ventilated Dry Type 150°C AA Rating	Ventilated Dry Type 150°C FA Rating
300	336	—	—	300	—	300	400
500	560	—	—	500	—	500	667
750	840	862	966	750	862	750	1000
1000	1120	1150	1288	1000	1150	1000	1333
1500	1680	1725	1932	1500	1725	1500	2000
2000	2240	2300	2576	2000	2300	2000	2667
2500	2800	3125	3500	2500	3125	2500	3333

Gas filled sealed Dry Type Transformers are available as AA self cooled (100%) only.

Transformer Dimensions and Weights—Inches (Approximate)

Liquid Filled—High Voltage 13800 Maximum, Low Voltage 600 Maximum Indoor or Outdoor



Kva Self Cooled (OA)	65°C Temp. Rise, 80°C Hot Spot B①	C	Weight Lb.	55°C Temp. Rise, 65°C Hot Spot B①	C	Weight Lb.
300	②	②	②	②	②	②
500	47	51	4565	47	63	4840
750	47	70	5340	47	84	5800
1000	50	78	6675	51	92	7180
1500	53	92	7965	53	112	8635
2000	57	101	9540	59	114	10840
2500	61	110	11730	65	120	12730

② Refer to Westinghouse

Standard Fixed Dimensions

A—Oil 86, 88 with optional relief device. Silicone 88.

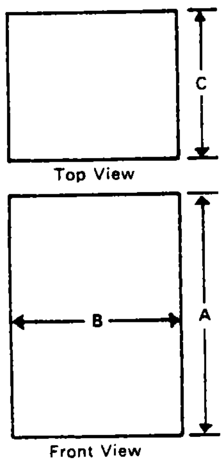
J—Height to centerline of HV & LV bushings 55

Shipping Dimensions

- For Z-bar on HV and LV, add approximately 13 inches.
- For LV bus duct, add approximately 19 inches.

① B Dimension is between Z-bar flanges on HV and LV ends not including bushing projection. Add approximately 9 inches to B Dimension for HV or LV bus duct throat.

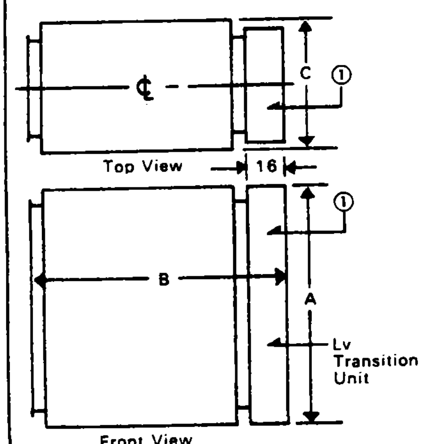
Ventilated Dry Type, 150°C Temperature Rise, Low Voltage 600 Maximum, Indoor①



Kva Self Cooled (AA)	Hv 2400, 4160 or 4800Δ 25 Kv BIL Dimensions A	B	C	Weight Lb.	Hv 6900 or 7200Δ 35 Kv BIL or Hv 12000, 12470, 13200 or 13800Δ 50 Kv BIL Dimensions A	B	C	Weight Lb.
300	90⅜	60	54	2500	90⅜	60	54	3350
500	90⅜	60	54	3150	90⅜	60	54	4100
750	90⅜	60	54	4050	90⅜	60	54	4700
1000	90⅜	60	54	5200	90⅜	90	48	6600
1500	100	90	48	8100	100	90	48	8600
2000	100	90	48	9500	100	100	54	10000
2500	100	100	54	11100	105	100	54	11700

① Refer to Westinghouse for outdoor applications.

Gas Filled Dry Type, 150°C Temperature Rise, Low Voltage 600 Maximum, Indoor or Outdoor



Kva (AA)	Hv 2400Δ, 45 Kv BIL, or 4160 or 4800Δ, 60 Kv BIL Dimensions A	B①	C	Weight Lb.	Hv 6900 or 7200Δ, 75 Kv BIL, or 12000, 12470, 13200 or 13800Δ 95 Kv BIL Dimensions A	B①	C	Weight Lb.
300	83	95	47	6800				
500	86	98	50	7000	86	98	50	7000
750	91	103	54	8500	91	103	54	8500
1000	96	108	57	10000	96	108	57	10000
1500	102	114	63	13000	102	114	63	13000
2000	108	120	66	17000	108	120	66	17000
2500	112	122	70	21000	112	122	70	21000

① For indoor only. For outdoor, omit Lv transition unit and Z-bar flanges, and substitute flanged throat; reduce B 6 in. for 15 Kv class and 9 in. for 5 Kv class Hv.

Application—Type DS Air Circuit Breakers

Standards
Type DS circuit breakers meet or exceed all applicable requirements of the latest ANSI Standards C37.13 and C37.16

System Voltage and Frequency
Type DS breakers are designed for operation on Ac systems only, 60 Hz or 50 Hz, 600 volts maximum.

Continuous Current Ratings
Unlike transformers, generators and motors, circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application take into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Type DS breaker is limited to 125% of the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a Type DS-416 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 times 1.25 or 1000 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F) outside of the switchgear enclosure.

Altitude
The breakers are applicable at their full voltage and current ratings up to a maximum altitude of 6600 feet (2000 meters) above sea level. When installed at higher altitudes, the ratings are subject to correction factors in accordance with IEEE and NEMA Standards.

Repetitive Duty
Repetitive breaker opening and closing, such as in frequent motor starting and stopping, are covered by ANSI Standards C37.13 and C37.16. These Standards list the number of operations between servicing (adjusting, cleaning, lubrication, tightening, etc.) and the total numbers of operations under various conditions without requiring replacement of parts, for the various breaker frame sizes.

For motor starting duty, when closing starting currents up to 600% and opening running currents up to 100% of the breaker frame size, at 80% power factor or higher, the endurance or total operations (not requiring parts replacement) will be as follows:

Type DS-206—1400
Type DS-416— 400

The frequency of operation should not exceed 20 starts in 10 minutes or 30 in one hour.

Unusual Environmental and Operating Conditions

Special attention should be given to applications subject to the following conditions:

1. Damaging or hazardous fumes, vapors, etc.
2. Excessive or abrasive dust.

   For such conditions, it is generally recommended that the switchgear be installed in a clean, dry room, with filtered and/or pressurized clean air. This method permits the use of standard indoor switchgear, and avoids the derating effect of non-ventilated enclosures.
3. Salt spray, excessive moisture, dripping, etc.

   Optional drip-proof top covers and space heaters in indoor switchgear, or outdoor weatherproof enclosures, may be indicated, depending upon the severity of the conditions.
4. Excessively high or low ambient temperatures.

   For ambient temperatures exceeding 40°C, and based on a standard temperature rise of 65°C, the continuous current ratings of breaker frame sizes, and also buses, current transformers, etc., will be subject to a derating factor calculated from the following formula:

$$\sqrt{\frac{105^\circ\text{C Total—Special Ambient, }^\circ\text{C}}{105^\circ\text{C Total—}40^\circ\text{C Standard Ambient}}}$$

Interrupting ratings of Type DS breakers at system voltages are given in the following table.

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes With Instantaneous Trip 208-240V	480V	600V	With Short Delay Trip ①② 208-240V	480V	600V
DS-206	800	42,000	30,000	30,000	30,000	30,000	30,000
DS-206S	800	50,000	42,000	42,000	42,000	42,000	42,000
DS-416	1600	65,000	50,000	42,000	50,000	50,000	42,000
DS-416S	1600	65,000	65,000	50,000	65,000	65,000	42,000
DS-420	2000	65,000	65,000	50,000	65,000	65,000	50,000
DS-632	3200	85,000	65,000	50,000	65,000	65,000	50,000
DS-840	4000	130,000	85,000	65,000	65,000	65,000	65,000
				85,000	85,000	85,000	85,000

① Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DS-840 which is 65,000.

Maximum voltages at which the interrupting ratings apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

Interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15 second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of ½ second each, with a 15-second interval of zero current between the two periods.

The circuit breakers are not adversely affected by very low outdoor ambient temperatures, particularly when energized and carrying load currents. The standard space heaters in weatherproof switchgear will raise the temperature slightly and prevent condensation.

5. Abnormal vibration or shock.

   Applications involving such conditions should be referred to Westinghouse with complete data.

6. Abnormally high repetitive and frequency of operation.

   In line with "Repetitive Duty" above, a lesser number of operations between servicing, and more frequent replacement of parts, may be indicated.

System Application
Tables 3A through 3D on Pages 37 and 38 list the calculated secondary short circuit currents and applicable main secondary and feeder breakers for secondary unit substation switchgear.

The short circuit currents are calculated by dividing the transformer basic (100%) rated amperes by the sum of the transformer and primary system impedances, expressed in "per unit." The transformer impedance percentages are standard for most secondary unit substation transformers. The primary impedance is obtained by dividing the transformer base (100%) Kva by the primary short-circuit Kva. The motor contributions to the short circuit currents are estimated as approximately 4 times the motor load amperes, which in turn are based upon 50% of the total load for 208 volts and 100% for all other voltages.

Higher transformer impedances and/or lower percentages of motor loads will reduce the short circuit currents correspondingly. Supplementary transformer ratings (see Tables on Page 40) will not increase the short circuit currents, provided the motor loads are not increased.

The Tables do not apply for 3 phase banks of single phase distribution transformers, which usually have impedances of 2% to 3% or even lower. The short circuit currents must be recalculated for all such applications and the breakers selected accordingly.

Main Transformer Secondary Breakers
Transformer secondary breakers are required or recommended for one or more of the following purposes:

1. To provide a one-step means of removing all load from the transformer. The NEC limits the maximum number of feeder breakers on a transformer bus without a main breaker to six (6).
2. To provide transformer overload protection in the absence of an individual primary breaker, and/or when primary fuses are used.
3. To provide the fastest clearing of a short circuit in the secondary main bus.
4. To provide a local disconnecting means, in the absence of a local primary switch or breaker, for maintenance purposes.
5. For automatic or manual transfer of loads to alternate sources, as in double ended secondary selective unit substations.
6. For simplifying key interlocking with primary interrupter switches.

Main secondary breakers as selected in Tables 3A thru 3D have adequate interrupting ratings, but not necessarily adequate continuous current ratings. They should be able to carry continuously not only the anticipated maximum continuous output of the transformer, but also any temporary overloads.

Maximum capabilities of transformers of various types, in terms of Kva and secondary current, are given on Pages 40 and 42. It will be noted that the maximum ratings will often require the substitution of larger frame main breakers than those listed in Tables. Even if a self-cooled transformer only is considered, it should be remembered that with ratings of 750 Kva and higher (except for gas-filled transformers), provision for the future addition of cooling fans is automatically included. It is recommended that the main breaker have sufficient capacity for the future fan-cooled rating, plus an allowance for overloads if possible, particularly since load growth cannot always be predicted.

The same considerations should be given to the main bus capacities and main current transformer ratios.

Bus Sectionalizing (Tie) Breakers
The minimum recommended continuous current rating of bus sectionalizing or tie breakers, as used in double ended secondary selective unit substations or for connecting two single ended substations, is one-half that of the associated main breakers. The interrupting rating should be at least equal to that of the feeder breakers. It is common practice to select the tie breaker of the next frame size below that of the main breakers. However, many users and engineers prefer that the tie breaker be identical to and interchangeable with the main breakers, so that under normal conditions it will be available as a spare main breaker.

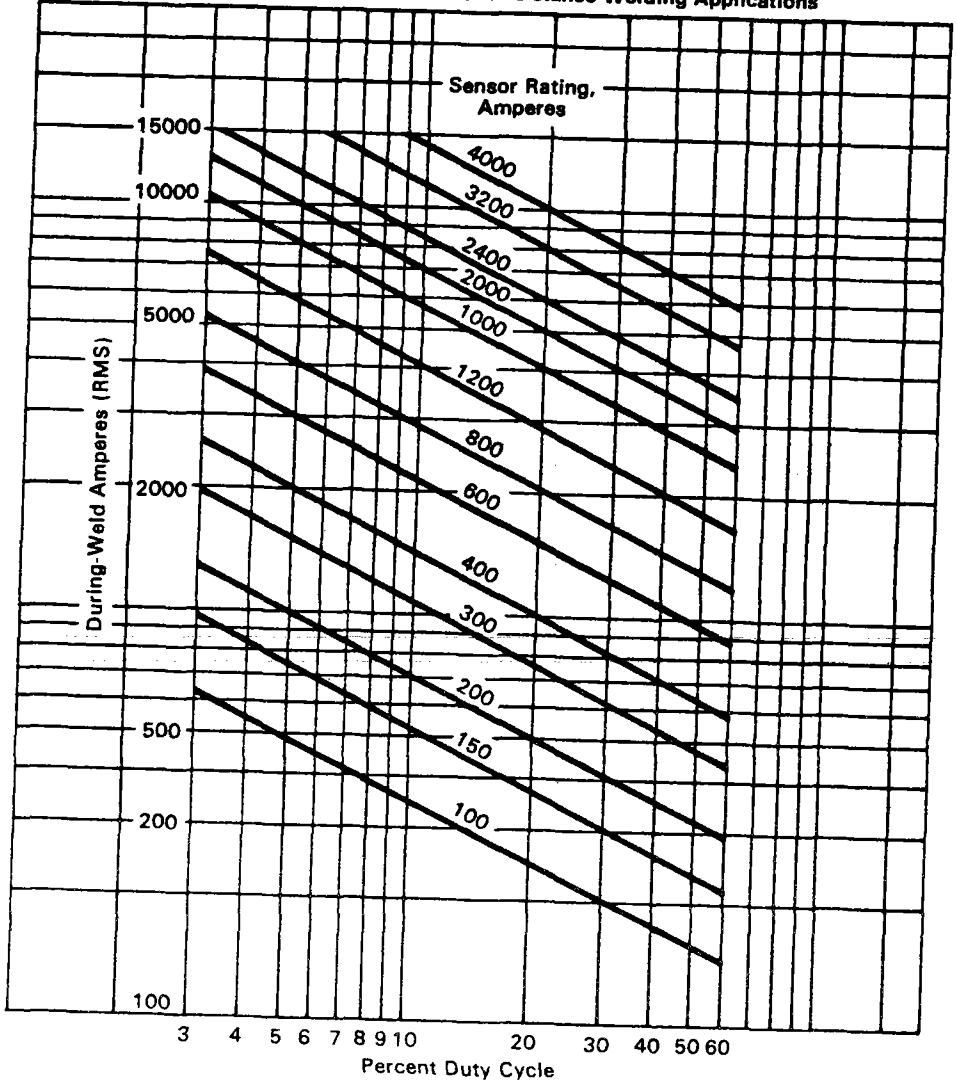
The tie breaker should be equipped with the same type of tripping devices (long and short delay or long delay and instantaneous) as the main breakers.

Generator Breakers
In most applications where generators are connected through breakers to the secondary bus, they are used as emergency standby sources only, and are not synchronized or paralleled with the unit substation transformers. Under these conditions, the interrupting rating of the generator breaker will be based solely on the generator Kva and sub-transient reactance. This reactance varies with the generator type and Rpm, from a minimum of approximately 9% for a 2 pole 3600 Rpm turbine driven generator to 15% or 20% or more for a medium or slow speed engine type generator. Thus the feeder breakers selected for the unit substation will usually be adequate for a standby generator of the same Kva as the transformer.

Most generators have a 2-hour 25% overload rating, and the generator breaker must be adequate for this overload current. Selective type long and short delay trip devices are usually recommended for coordination with the feeder breakers, with the long delay elements set at 125% to 150% of the maximum generator current rating for generator protection.

In the case of two or more paralleled generators, Type CRN-1 antimotoring reverse power relays are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring Type DS-632 or DS-840 breakers, Type COV voltage-restraint type overcurrent relays are recommended.

Type DS Breaker Sensor Selection Guide for Resistance Welding Applications



Resistance Welding Feeder Breakers

The application of Type DS breakers to resistance welding circuits is shown on the Sensor Selection Guide.

Sensor ratings only are given; the breaker frame will also be as required for interrupting ratings.

Type DS breaker solid state tripping devices are well suited for this service, since the chattering, noise, wear and calibration changes experienced in electro-mechanical devices are eliminated.

These applications are based on Amptector II-A or Amptector I-A long delay and instantaneous trip devices with the following settings:

Long delay pickup 1.0 times sensor rating
Long delay time 36 seconds.
Instantaneous trip setting 2 times average weld amperes (during-weld amperes times percent duty cycle) or higher.

Feeder Breakers—General
Circuit breakers for feeder circuit protection may be manually or electrically operated, with long and short delay or long delay and instantaneous type trip devices, and trip settings, as required for the specific circuit and load requirements.

Feeder breakers as selected in Tables 3A thru 3D have adequate interrupting ratings, and are assumed to have adequate continuous current ratings for maximum load demands.

General purpose feeder breakers, such as for lighting circuits, are usually equipped with long delay and instantaneous trip devices, with the long delay pickup set for the maximum load demand in the circuit. Where arcing fault protection is required, the instantaneous trip setting should be as low as practicable consistent with inrush requirements.

Motor Starting Feeder Breakers
These breakers are usually electrically operated, with long delay and instantaneous tripping characteristics for motor running, locked rotor and fault protection.
The breaker sensor rating should be chosen so that the long delay pickup can be set at 125% for motors with a 1.15 service factor or at 115% for all other motors.

When system short circuits are less than 40 times the motor full load current, the motor breaker tripping characteristic should include a short delay characteristic for greater fault protection.

Group Motor Feeder Breakers
Typical loads for such circuits are motor control centers. The feeder breakers may be either manually or electrically operated as preferred, and are usually equipped with long and short delay trip devices for coordination with the individual motor circuit devices. The minimum long delay pickup setting should be 115% of the running current of the largest motor in the group plus the sum of the running circuits of all other motors.

Ground Fault Protection With Westinghouse Amptector I-A Static Trip

Distribution Systems
The power distribution in three phase low voltage systems can be three or four wire distribution. The three wire distribution can be served from either delta or wye sources, but the four wire distribution is obtained from wye source only. Fig. No. 1 shows three wire distribution with delta source and Fig. No. 2 shows three wire distribution with wye source. It is significant on Fig. No. 2, that the wye connection of a transformer secondary does not necessarily mean four wire distribution in switchgear. This is worthwhile to note because four wire distribution is quite frequently assumed when the transformer secondary is wye connected. The low voltage system is three phase four wire distribution only if a fourth wire is carried through the switchgear and single phase loads are connected to feeder breakers. This fourth wire is the neutral bus. The neutral bus is connected to the neutral of the wye connected transformer secondary as shown on Fig. No. 3. The standard neutral bus capacity is one half of the phase bus current carrying capacity but full capacity neutral busses are also available on request.

Three or four wire systems can be grounded or ungrounded in service. Generally where the source is delta connected it is ungrounded, but in some very rare cases it is grounded at one corner of the delta or at some other point. When the source is wye connected it can be grounded or ungrounded and when grounded the grounding is at the neutral. When low voltage systems are grounded they are generally solidly grounded. However occasionally the grounding is through a resistor. Three and four wire solidly grounded systems are shown on Fig. No. 4 and 5. At present the new installations are mostly solidly grounded or ungrounded low voltage systems with a definite trend toward the increase of the solidly grounded systems. An ungrounded low voltage system is a good operating system if it is equipped with a ground detection device and if the operators and maintenance crew are trained to locate the initial ground and clear it as soon as practical. The grounded neutral system results in a ground current as soon as any ground occurs on a phase conductor and if the current exceeds the setting of the protective device it will operate and isolate the fault.

Need For Ground Fault Protection
If the magnitude of all ground currents would be large enough to operate the short delay or instantaneous elements of the phase overcurrent trip devices there would be no problem in solidly grounded systems. Unfortunately this is not the case, because low magnitude ground currents are quite common. Low level ground currents can exist if the ground is in the winding of a motor or a transformer or if it is a high impedance ground. Low level ground currents may also be due to an arcing type ground. The arcing type grounds are the source of the most severe damages to electrical eqiupment. The lower limit of the arcing ground currents is unpredictable and the magnitude may be considerably below the setting of the breaker phase overcurrent trip devices.

Since the breaker phase overcurrent trip devices cannot provide fast protection against low magnitude ground faults there is a need for an additional protective device. This additional device is not to operate on normal overloads and it is to be sensitive and fast enough to protect against low magnitude grounds. It is also important that this additional ground protecting device be simple and reliable. The Westinghouse Amptector I-A solid-state tripping system including an optional "ground element" will assure good ground fault protection.

The Ground Element
The ground element of the solid-state trip is part of the Amptector I-A and is in addition to the usual phase protection. The ground element has a continuously adjustable pickup with calibrated marks as shown in Table 2 and a continuously adjustable time delay with calibrated marks at 0.22-0.35-0.50 seconds. The input current to the Amptector I-A terminals can be provided by:

(a) Residual connection of phase sensors with residual circuit connected to ground element terminals. This is the Westinghouse East Pittsburgh Low Voltage Switchgear standard ground protection system. This produces pickup values as shown in Table 2.

(b) External ground sensing current transformer directly connected to ground element terminals. This is one of the unique features of the Westinghouse Amptector. This means that this external ground sensor will trip the breaker on grounds without the use of external relay and without the application of a breaker shunt trip and external power source. The lower the CT ratio the more sensitive the ground fault protection.

Ground Fault Protection Application and Coordination

In well designed systems the continuity of service is very important. For reliable service continuity selective tripping is applied between main tie and feeder breakers and the downstream protecting devices for phase to phase faults. *Similar selective tripping is desirable when breakers trip on grounds.* The application of ground protection on main breakers only may assure good ground protection, however it will not provide good service continually because the main breaker will trip on grounds which *should have been cleared by feeder breakers.* When the switchgear itself feeds the loads directly the applied ground protection must be such that on a load circuit ground the associated feeder breaker will trip first. Therefore for proper protection and for good service continuity main tie and feeder breakers *all should* be equipped with ground protection. Ground protection is not required for non-automatic tie breakers having no phase overcurrent protection.

The necessary coordinated tripping is not easily accomplished when the switchgear feeds into downstream sub-distribution *panels which do not have* ground protection. If full selective tripping is required the downstream protecting devices should also be equipped with ground protection. If not, the system designer will face a coordination problem in obtaining selectivity between the low pickup and fast tripping *switchgear breaker* ground elements and phase overcurrent protective devices. This is a very difficult problem because of the time-current tripping characteristic of the phase overcurrent protective devices. When such coordination is desired, the ground element pickup must be increased in order to *"desensitize"* the device. It is obvious that when the ground element is set at its highest setting, valuable protection is lost for low magnitude arcing ground currents. If higher ground element pickup is attempted to achieve coordination with fairly large sized downstream phase devices the *ground protection* setting approaches the characteristic of a short time phase element and the ground protection will lose its true meaning and not provide the expected protection.

In view of the above it is evident that properly applied ground protection requires ground elements as far down the system to the loads as practical. For best results down stream molded case breakers *should* have individual ground protection. This would result in excellent ground protection because ground elements of switchgear and downstream breakers having similar tripping characteristic can be coordinated.

Coordination between switchgear breaker ground elements and downstream branch circuit fuses is not practical. This is due to the basic fact that the blowing of one phase fuse will not clear a ground on a three phase system. The other two phase fuses will let the load "single-phase" and also continue to feed the ground through the load as shown in Figure 6.

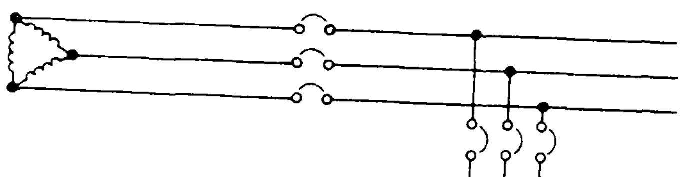


Figure 1. 3 Wire Distribution, Delta Source (Ungrounded)

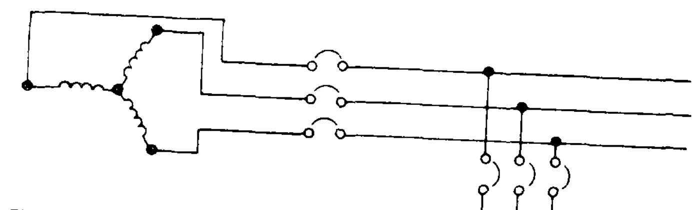


Figure 2. 3 Wire Distribution, Wye Source (Ungrounded)

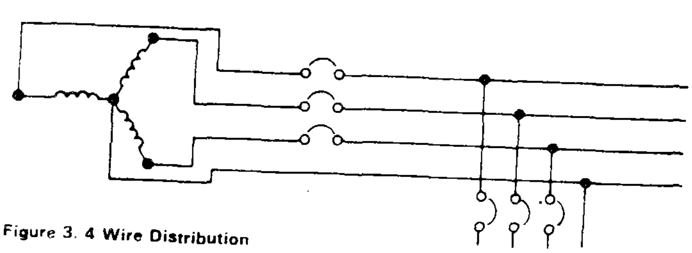


Figure 3. 4 Wire Distribution

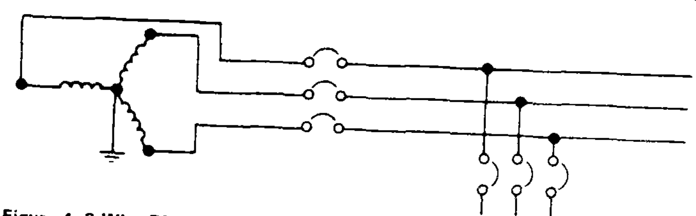


Figure 4. 3 Wire Distribution Solidly Grounded System

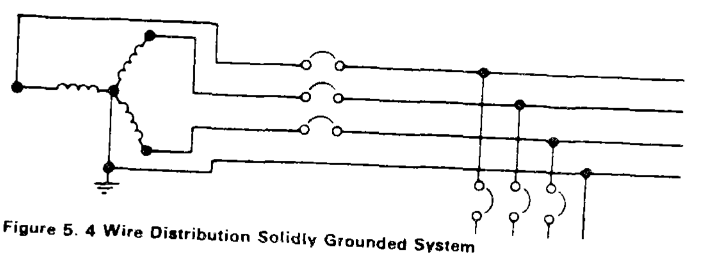


Figure 5. 4 Wire Distribution Solidly Grounded System

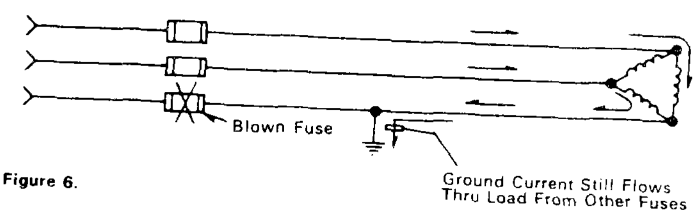


Figure 6.

Table 2

Dial Setting	Sensor Rating 50	100	150	200	300	400	600	800	1200	1600	2000	2400	3200	4000	Secondary Current ①
	Ground Pick-Up Value—Amperes														
A	13	57	60	65	80	110	145	180	260	330	400	530	640	800	1.0
B	18	67	75	85	110	150	205	260	385	505	600	770	1000	1200	1.5
C	22	75	85	100	130	185	250	325	480	625	760	960	1200	N.A.	1.9
D	33	100	120	145	200	270	385	500	730	970	1200	N.A.	N.A.	N.A.	3.0

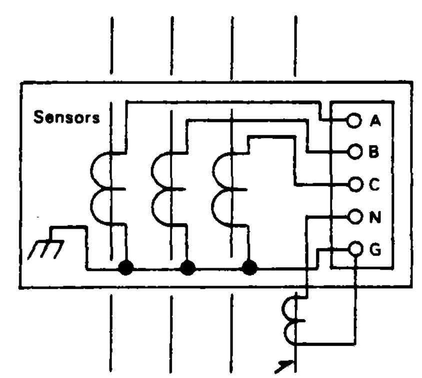
All pick up values subject to ± 10% tolerance.

① Current of this value from the secondary of an external ground transformer will cause the ground element to function.

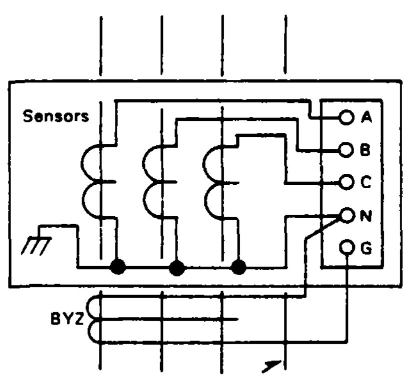
The Following Provides Guideline for Ground Fault Protection.

System	Advantages	Disadvantages	Main Breaker	Tie Breaker	Fdr. Breaker	Notes
			Equipment Available for Protection			
Un-grounded (3 Wire)	Minimum disturbance to service continuity. Currents for the majority of grounds will be limited to capacitance charging current of the system. Can operate with the first ground until it is removed during a regular shutdown.	When ground detector shows that a ground exists corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible. Therefore most ungrounded systems operate with one phase grounded through the first uncleared ground. A ground on another part of the system, due to fault impedance, would probably result in low values of current which would not operate a breaker phase trip, and would produce fire damage.	Lamp type ground detector or ground detecting voltmeters without or with pts. If pts. are used a ground alarm relay can be added for remote or local alarm.			With proper maintenance this system would result in the minimum disturbance to service continuity.
	Ground protection for an ungrounded system		Amptector I-A 'DS' ground 3W protection, minimum pick-up. .50 sec. time delay. See SK No. 1 & No. 6.	Amptector I-A 'DS' ground 3W protection, minimum pick-up. .35 sec. time delay.	Amptector I-A 'DS' ground 3W protection, minimum pick-up. .22 sec. time delay. See SK No. 1 & No. 6.	Ground fault protection on this ungrounded system would trip the breaker when the second ground occurs and current exceeds minimum pick-up setting.
Solid Grounded	Psychologically safer. Practically results in good continuity of service. Isolation of faults automatic through ground protection system; no overvoltages due to ferroresonance or switching.	Probability of very high ground current and extensive damage however, normally these high currents are not obtained. Grounds are automatically isolated and continuity of service is interrupted.	Amptector I-A 'DS' standard residual ground protection in 3W systems and source neutral C.T. feeding into Amptector I in 4 wire systems. Minimum pickup. .50 sec. time delay. See SK No. 1, No. 3 & No. 6.	Amptector I-A 'DS' ground 3W or 4W (as required) fault protection. Minimum pick-up. .35 sec. time delay.	Amptector I-A 'DS' ground 3W or 4W (as required) fault protection. Minimum pick-up. .22 sec. time delay or BYZ current transformer feeding into above Amptector. See SK No. 1, No. 2 & No. 6.	This is the most common system in use today and as long as it is not necessary to coordinate with phase devices down the line it will give very good main bus and feeder protection.
High Resistance Grounded (3 Wire)	Ground fault current is limited. Ungrounding can result in high voltages during switching and this is corrected by high resistance grounding.	Very sensitive detection is required to detect the limited fault current. Since overvoltage due to switching isn't prevalent on ungrounded low voltage systems high resistance grounding is not required.	Same as for ungrounded except if ground alarm relay is used connect relay across grounding resistor.	Same as for ungrounded.	Same as for ungrounded.	This system is very seldom used and is not recommended.

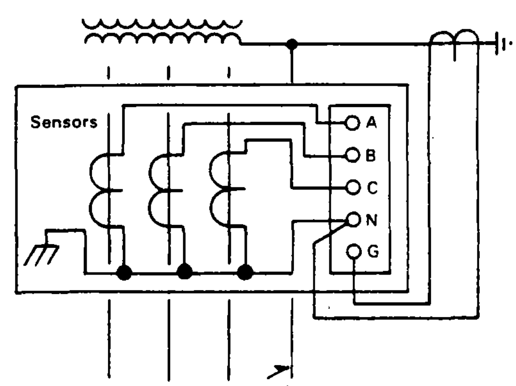
Sketch 1. ②
Residual Main and Feeder Breaker



Sketch 2.
Zero Sequence Feeder Breaker



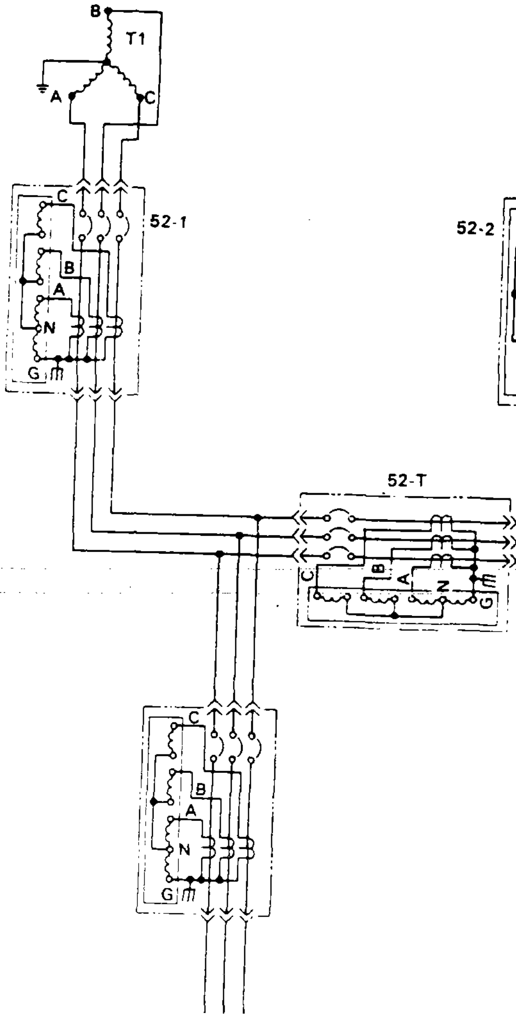
Sketch 3.
Source Neutral Main Breaker



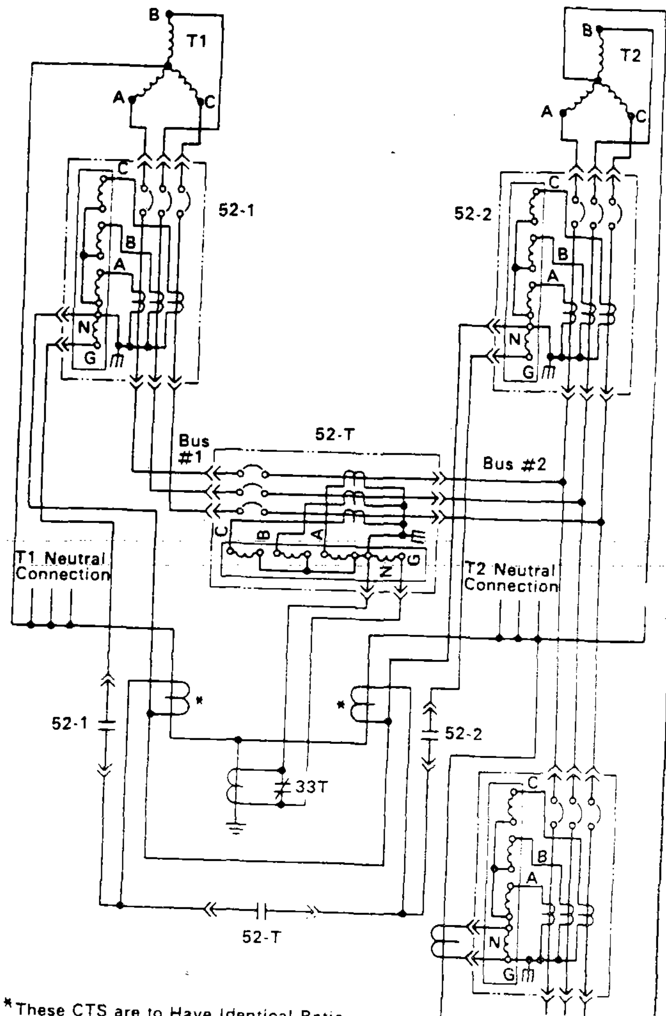
② Apply in 3 Wire Systems for Main Breaker and in 3 or 4 Wire Systems for Feeder Breakers.

Note: For double ended secondary unit substations ground fault protection should be as indicated on sketches No. 4 and No. 5 however for this type application the East Pittsburgh Works Low-Voltage Switchgear Department should be consulted for the actual bill of materials to be used. The application becomes rather complex if single phase to neutral loads are being served.

Sketch 4. 3 Wire Double Ended Unit Substation

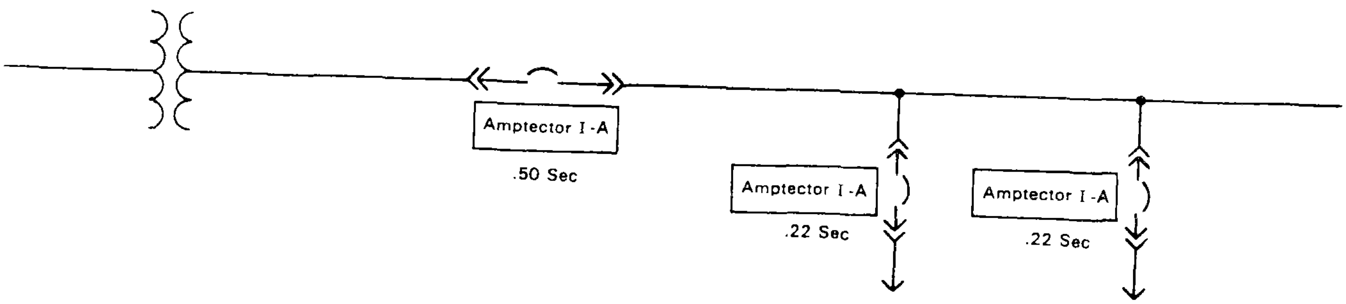


Sketch 5. 4 Wire Double Ended Unit Substation

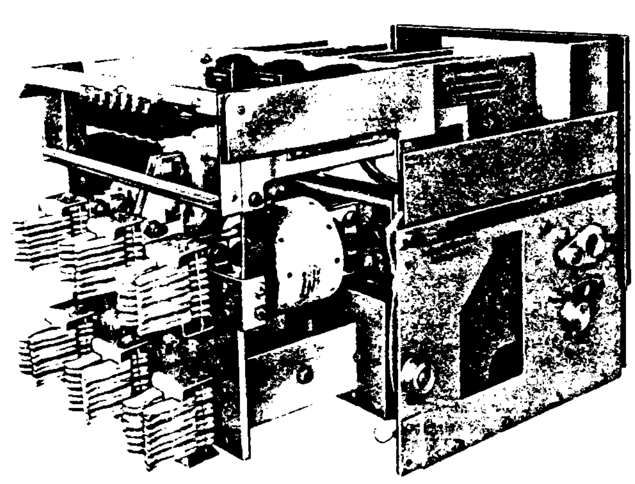


*These CTS are to Have Identical Ratio

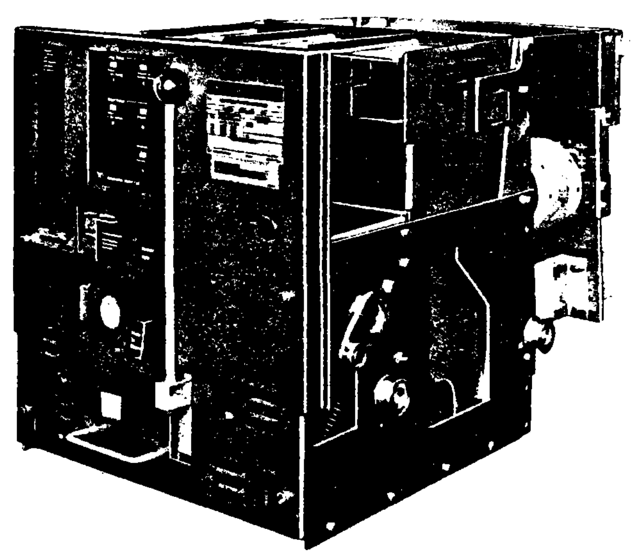
Sketch 6.



Type DSL Limiter Type Air Circuit Breakers



Type DSL-416 Breaker—Rear View



Type DSL-416 Breaker—Front View

Application
Type DSL breakers are coordinated combinations of Type DS breakers and series connected current limiters. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand and interrupting ratings of "downstream" circuit components.

Sizes and Arrangements
Types DSL-206 800 ampere frame and DSL-416 1600 ampere frame breakers include the limiters integrally mounted on the drawout breaker elements, in series with the upper terminals.

Current limiters used in Types DSL-632 and DSL-840 combinations are mounted on separate drawout trucks in additional equal size compartments either directly above the breaker compartment in the same unit or beside it in an adjacent unit.

Scope of Fault Interruption
With properly selected and coordinated limiters, it is expected that the breaker itself will clear overloads and faults within its interrupting rating, leaving the limiters intact and undamaged. The limiters will provide fast interruption of fault currents beyond the breaker rating, up to a maximum of 200,000 amperes symmetrical. Thus, on overloads and faults within the breaker interrupting rating, the breaker protects the limiters; on higher fault currents exceeding the breaker rating the limiters protect the breaker.

Protection Against Single Phasing
Loads are protected against single phase operation by interlock arrangements which trip the circuit breaker whenever any one limiter blows. The breaker cannot be reclosed on a live source until there are three unblown limiters in the circuit.

On the Types DSL-206 and DSL-416 breakers, the primaries of small auxiliary transformers are connected in parallel with the limiters. The voltage between the ends of an unblown limiter is zero, but when any limiter blows, the associated transformer is energized and (1) operates an indicator identifying the fuse and (2) picks up a solenoid which raises the breaker trip bar, holding the breaker trip-free.

The DSL-632 and DSL-840 combinations with separately mounted limiters operate on the same principle except that the solenoid operates a micro-switch which trips the breaker electrically through a shunt trip coil.

Safety Features
The integral fuses on Types DSL-206 and DSL-416 breakers are inaccessible until the breaker is completely withdrawn from its compartment, thereby assuring complete isolation.

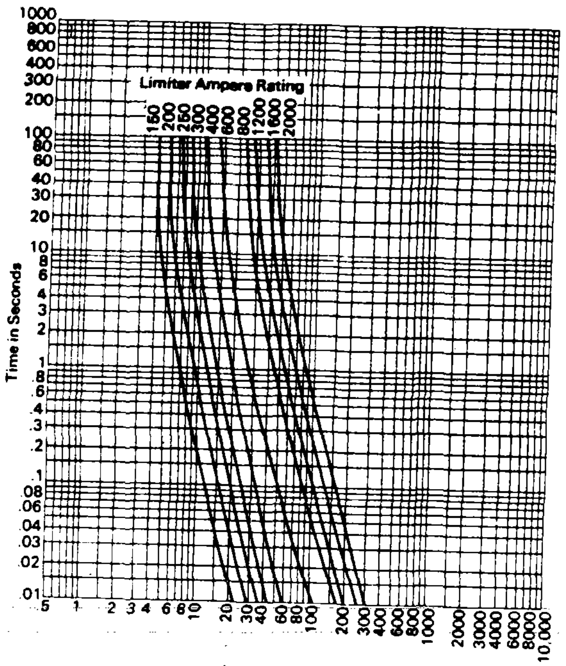
Likewise, the Type DSL-632 and DSL-840 fuses are inaccessible until the separate fuse truck is completely withdrawn and the fuses isolated. The fuse truck is key interlocked with the breaker to prevent withdrawing or insertion unless the breaker is open.

Current Limiting Type Breakers and Combinations

Type	DSL-206	DSL-416	DSL-632	DSL-840
Frame Size, Amperes	800	1600	3200	4000
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000

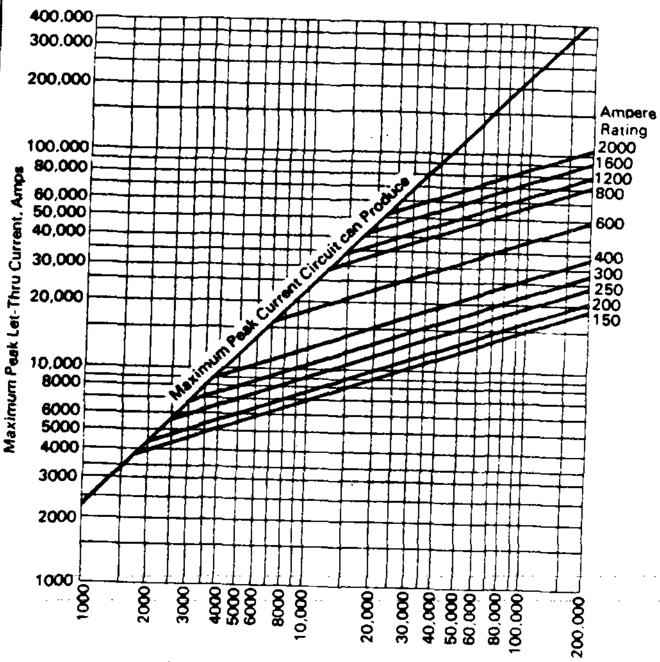
Notes: DSL-206 and DSL-416 include limiters integral with drawout breaker elements.
DSL-632 includes DS-632 breaker and DS-3200 drawout fuse truck, in separate interlocked compartments. Maximum continuous rating limited to 3000A when fuse compartment is above breaker compartment in same unit.
DSL-840 includes DS-840 breaker and DS-4000 drawout fuse truck, in separate interlocked compartments. Maximum interrupting rating limited to 150,000 amperes when 6000A fuses are used.

Limiter Ratings and Characteristics



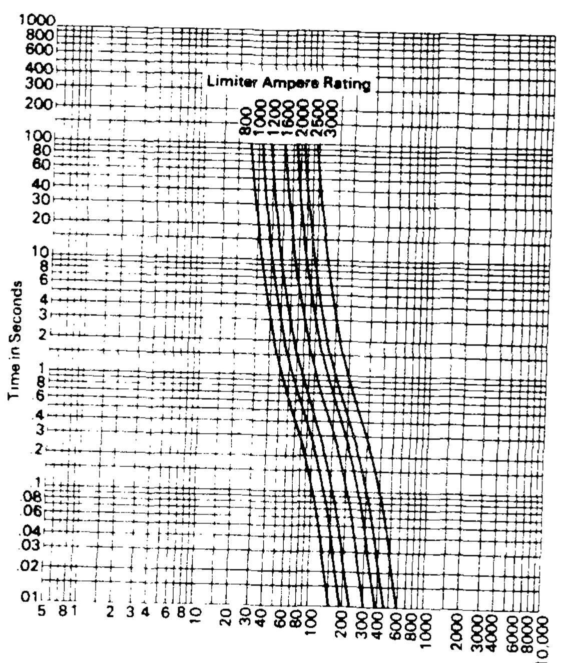
Scale x 100 = Current in Amperes
Limiter Time-Current Characteristic Curves
For DSL-206 Breaker

Curve 1



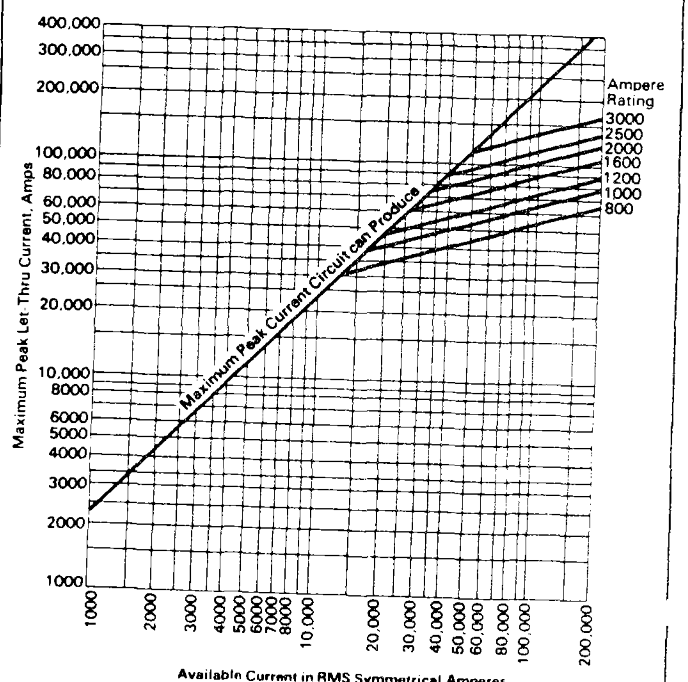
Available Current in RMS Symmetrical Amperes
Maximum Peak Let-Through Current Curves
For DSL-206 Breaker

Curve 2



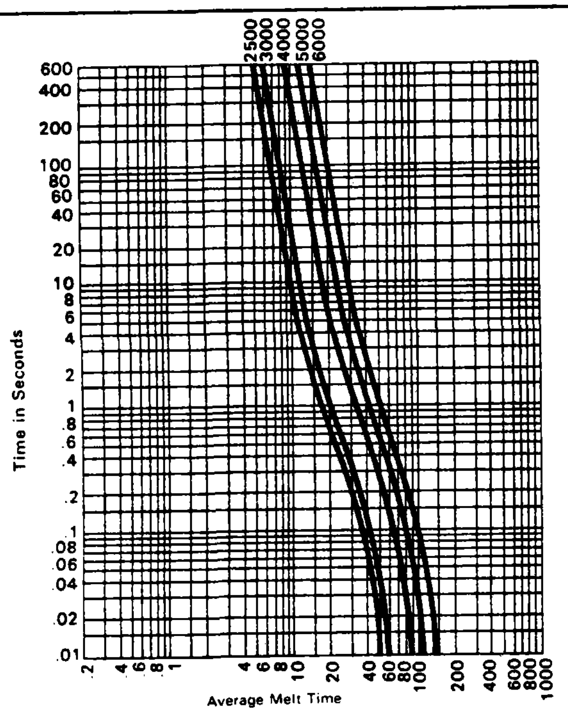
Scale x 100 = Current in Amperes
Limiter Time Current Characteristic Curves
For DSL-416 Breaker

Curve 3



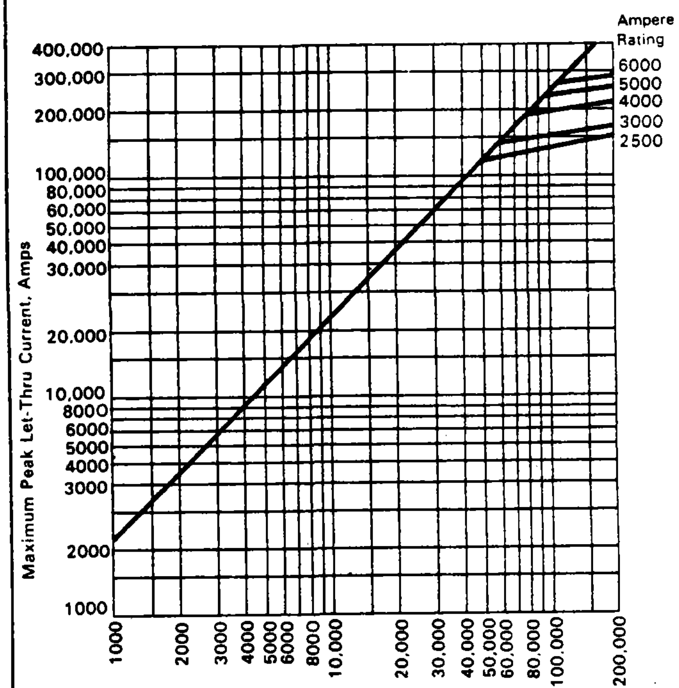
Available Current in RMS Symmetrical Amperes
Maximum Peak Let-Through Current Curves
For DSL 416 Breaker

Curve 4



Curve 5

Fuse Time Current Characteristic Curves
For DSL-632 and DSL-840 Combinations



Curve 6

Maximum Peak Let-Through Current Curves
For Type DSL-632 and DSL-840 Combinations

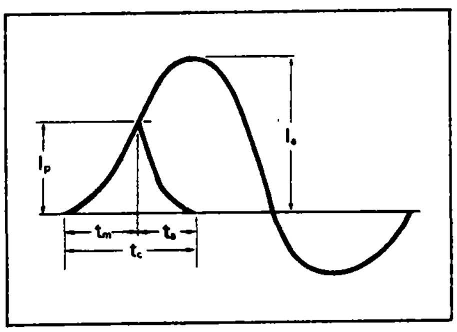
Curves Nos. 1 through 6 illustrate the ratings, melting time-current characteristics and current limiting or let-through characteristics of limiters for Type DSL breakers.

The let-through current for a given limiter application is readily determined from Curve No. 2, No. 4 or No. 6, by extending a vertical line from the applicable maximum available symmetrical fault amperes at the bottom margin to the characteristic line for the particular limiter, and from this intersection extending a horizontal line to the left margin and reading the peak current. The withstand rating of any circuit elements protected by the limiters should be at least equal to this peak current.

It will be noted that the let-through current increases with the limiter size or ampere rating; in other words, the maximum current limiting effect is obtained with the smallest size. This effect is to be expected, since the resistance decreases as the rating increases. If the vertical line from the bottom margin as described in the previous paragraph does not intersect the limiter characteristic line, it is indicated that the available system fault current is below the "threshold" current of that limiter, and it will offer no current limiting effect.

The current limiting principle is illustrated on Curve 7.

Curve 7: Current Limiting Effect of Type DSL Limiters



I_s = The Available Peak Fault Current
t_m = The Melting Time
I_p = The Peak "Let Through" Current
t_a = The Arcing Time
t_c = The Total Interrupting (Clearing) Time

Limiter Selection

The selection of a suitable limiter rating for a given application is generally governed by a choice of the following types of protection:

A. Maximum protection of "downstream" components. Type DSL breakers are often used for this purpose even when the maximum available fault currents are within the interrupting rating of the corresponding Type DS unfused breakers.

B. Protection of the circuit breaker only.

Case A would tend to use the smallest available limiter; Case B the largest. When downstream protection is required, the selection is usually a compromise, since certain small limiters cannot be coordinated with the breaker to avoid nuisance blowing on overloads or small and moderate short circuits.

Minimum, recommended, and maximum limiter sizes for Type DSL-206 and DSL-416 breakers are given in the following table.

Breaker Type	Sensor Rating Amperes	Limiter Rating, Amperes Minimum ①	Recommended ②	Maximum ③
DSL-206	50 or 100	150	1200	2000
DSL-206	150	200	1200	2000
DSL-206	200	250	1200	2000
DSL-206	300	400	1200	2000
DSL-206	400	600	1200	2000
DSL-206	600	800	1200	2000
DSL-206	800	1200	1600	2000
DSL-416	600	800	2000	3000
DSL-416	800	1000	2000	3000
DSL-416	1200	2000	2500	3000
DSL-416	1600	3000	3000	3000

① For use only when protection of downstream equipment is required. Not completely coordinated with breaker to avoid nuisance blowing.
② Lowest rating which can be coordinated with breaker to minimize nuisance blowing.
③ Highest available ratings, for protection of breaker only.

Fuse Time-Current Characteristics Curves are available from the nearest Westinghouse Sales Office or the Switchgear Division.

Application of Type DS Air Circuit Breakers
With Standard 3 Phase Transformers—Liquid Filled, Ventilated Dry, and Gas Filled Sealed Dry Types
Table 3

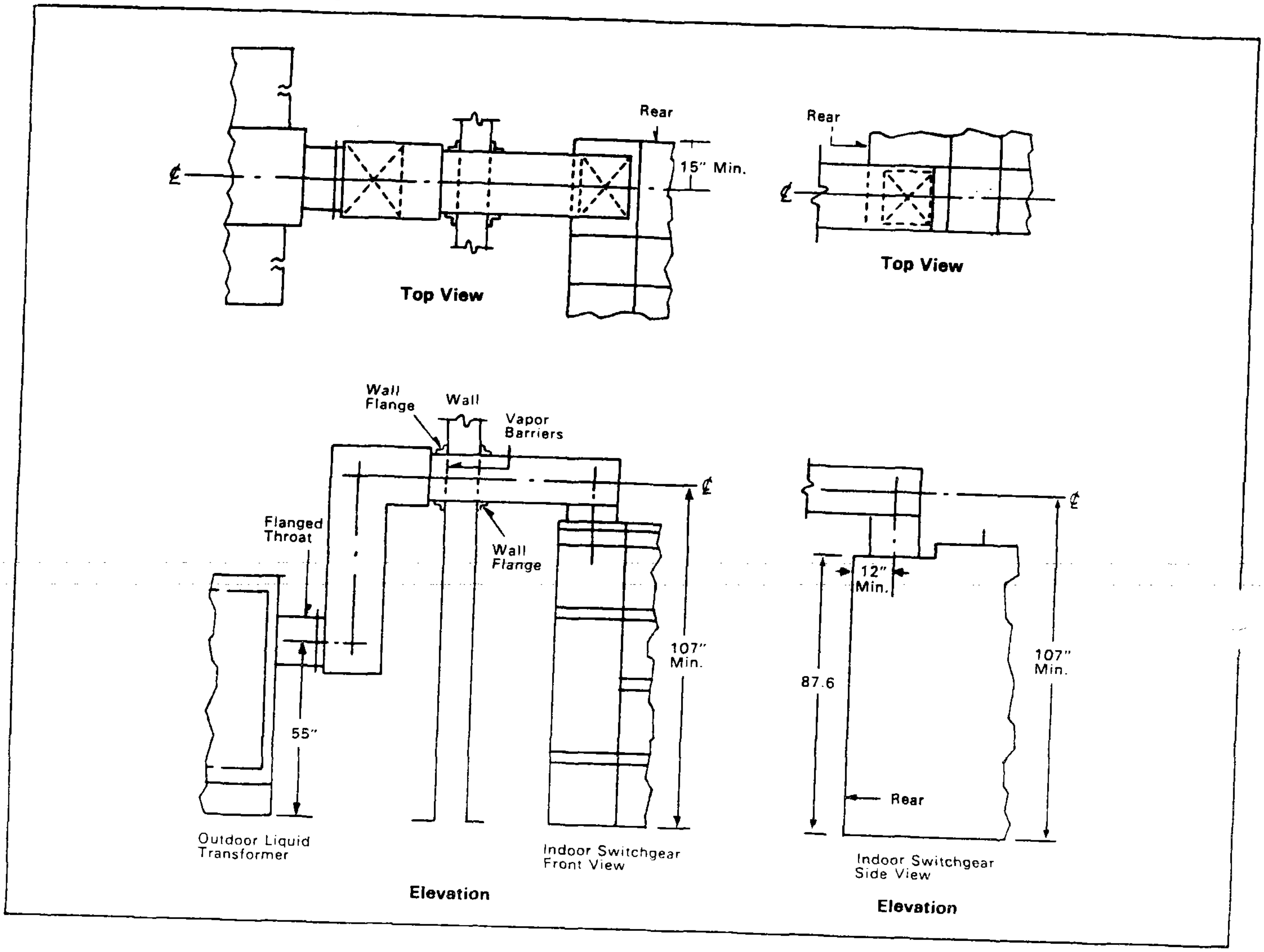
Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Breakers for Selective Trip Systems			Breakers for Non-Selective Trip Systems	
Kva and Percent Impedance	Amperes	Maximum Short Circuit Kva Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip	Main Breaker Instantaneous Trip	Feeder Breaker Instantaneous Trip
Table 3A: 208 Volts 3 Phase—50% Motor Load										
300 5.0%	833	50000	14900	1700	16600	DS-416	DS-206	DS-206	DS-416	DS-206
		100000	15700		17400		DS-206	DS-206		DS-206
		150000	16000		17700		DS-206	DS-206		DS-206
		250000	16300		18000		DS-206	DS-206		DS-206
		500000	16500		18200		DS-206	DS-206		DS-206
		Unlimited	16700		18400		DS-206	DS-206		DS-206
500 5.0%	1389	50000	23100	2800	25900	DS-416②	DS-206	DS-206	DS-416 ②	DS-206
		100000	25200		28000		DS-206	DS-206		DS-206
		150000	26000		28800		DS-206	DS-206		DS-206
		250000	26700		29500		DS-206	DS-206		DS-206
		500000	27200		30000		DS-206	DS-206		DS-206
		Unlimited	27800		30600		DS-206S	DS-206		DS-206
750 5.75%	2083	50000	28700	4200	32900	DS-632	DS-206S	DS-206	DS-632	DS-206
		100000	32000		36200		DS-206S	DS-206		DS-206
		150000	33300		37500		DS-206S	DS-206		DS-206
		250000	34400		38600		DS-206S	DS-206		DS-206
		500000	35200		39400		DS-206S	DS-206		DS-206
		Unlimited	36200		40400		DS-206S	DS-206		DS-206
1000 5.75%	2778	50000	35900	5600	41500	DS-632②	DS-206S	DS-206	DS-632②	DS-206
		100000	41200		46800		DS-416	DS-206S		DS-206S
		150000	43300		48900		DS-416	DS-206S		DS-206S
		250000	45200		50800		DS-416S	DS-416		DS-416
		500000	46700		52300		DS-416S	DS-416		DS-416
		Unlimited	48300		53900		DS-416S	DS-416		DS-416
Table 3B: 240 Volts 3 Phase—100% Motor Load										
300 5.0%	722	50000	12900	2900	15800	DS-206 ②	DS-206	DS-206	DS-206 ②	DS-206
		100000	13600		16500		DS-206	DS-206		DS-206
		150000	13900		16800		DS-206	DS-206		DS-206
		250000	14100		17000		DS-206	DS-206		DS-206
		500000	14300		17200		DS-206	DS-206		DS-206
		Unlimited	14400		17300		DS-206	DS-206		DS-206
500 5.0%	1203	50000	20000	4800	24800	DS-416 ②	DS-206	DS-206	DS-416 ②	DS-206
		100000	21900		26700		DS-206	DS-206		DS-206
		150000	22500		27300		DS-206	DS-206		DS-206
		250000	23100		27900		DS-206	DS-206		DS-206
		500000	23600		28400		DS-206	DS-206		DS-206
		Unlimited	24100		28900		DS-206	DS-206		DS-206
750 5.75%	1804	50000	24900	7200	32100	DS-420 ②	DS-206S	DS-206	DS-420 ②	DS-206
		100000	27800		35000		DS-206S	DS-206		DS-206
		150000	28900		36100		DS-206S	DS-206		DS-206
		250000	29800		37000		DS-206S	DS-206		DS-206
		500000	30600		37800		DS-206S	DS-206		DS-206
		Unlimited	31400		38600		DS-206S	DS-206		DS-206
1000 5.75%	2406	50000	31000	9600	40600	DS-632 ②	DS-206S	DS-206	DS-632 ②	DS-206
		100000	35600		45200		DS-416	DS-206S		DS-206S
		150000	37500		47100		DS-416	DS-206S		DS-206S
		250000	39100		48700		DS-416	DS-206S		DS-206S
		500000	40400		50000		DS-416	DS-206S		DS-206S
		Unlimited	41800		51400		DS-416S	DS-416		DS-416

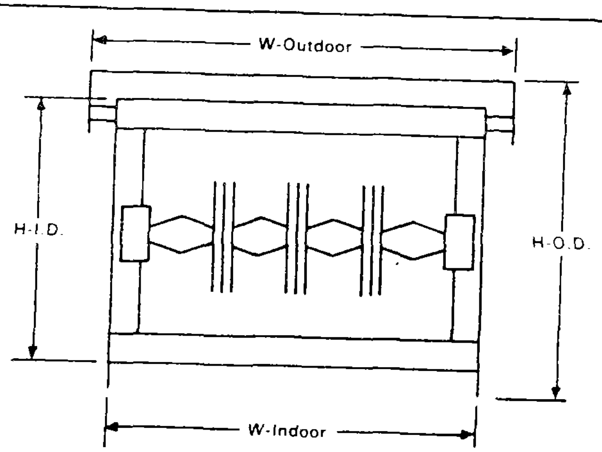
Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Breakers for Selective Trip Systems			Breakers for Non-Selective Trip Systems	
Kva and Percent Impedance	Amperes	Maximum Short Circuit Kva Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip	Main Breaker Instantaneous Trip	Feeder Breaker Instantaneous Trip
Table 3C: 480 Volts 3 Phase—100% Motor Load										
500	601	50000	10000	2400	12400	DS-206 ②	DS-206	DS-206	DS-206 ②	DS-206
5.0%		100000	10900		13300		DS-206	DS-206		DS-206
		150000	11300		13700		DS-206	DS-206		DS-206
		250000	11600		14000		DS-206	DS-206		DS-206
		500000	11800		14200		DS-206	DS-206		DS-206
		Unlimited	12000		14400		DS-206	DS-206		DS-206
750	902	50000	12400	3600	16000	DS-416	DS-206	DS-206	DS-416	DS-206
5.75%		100000	13900		17500		DS-206	DS-206		DS-206
		150000	14400		18000		DS-206	DS-206		DS-206
		250000	14900		18500		DS-206	DS-206		DS-206
		500000	15300		18900		DS-206	DS-206		DS-206
		Unlimited	15700		19300		DS-206	DS-206		DS-206
1000	1203	50000	15500	4800	20300	DS-416 ②	DS-206	DS-206	DS-416 ②	DS-206
5.75%		100000	17800		22600		DS-206	DS-206		DS-206
		150000	18700		23500		DS-206	DS-206		DS-206
		250000	19600		24400		DS-206	DS-206		DS-206
		500000	20200		25000		DS-206	DS-206		DS-206
		Unlimited	20900		25700		DS-206	DS-206		DS-206
1500	1804	50000	20600	7200	27800	DS-420 ②	DS-206	DS-206	DS-420 ②	DS-206
5.75%		100000	24900		32100		DS-206S	DS-206S		DS-206S
		150000	26700		33900		DS-206S	DS-206S		DS-206S
		250000	28400		35600		DS-206S	DS-206S		DS-206S
		500000	29800		37000		DS-206S	DS-206S		DS-206S
		Unlimited	31400		38600		DS-206S	DS-206S		DS-206S
2000	2406	50000	24700	9600	34300	DS-632 ②	DS-206S	DS-206S	DS-632 ②	DS-206S
5.75%		100000	31000		40600		DS-206S	DS-206S		DS-206S
		150000	34000		43600		DS-416	DS-416		DS-416
		250000	36700		46300		DS-416	DS-416		DS-416
		500000	39100		48700		DS-416	DS-416		DS-416
		Unlimited	41800		51400		DS-416S	DS-416S		DS-416S
2500	3008	50000	28000	12000	40000	DS-632 ②	DS-416	DS-416	DS-632 ②	DS-416
5.75%		100000	36500		48500		DS-416	DS-416		DS-416
		150000	40500		52500		DS-416S	DS-416S		DS-416S
		250000	44600		56600		DS-416S	DS-416S		DS-416S
		500000	48100		60100		DS-416S	DS-416S		DS-416S
		Unlimited	52300		64300		DS-416S	DS-416S		DS-416S
Table 3D: 600 Volts 3 Phase—100% Motor Load										
500	481	50000	8000	1900	9900	DS-206	DS-206	DS-206	DS-206	DS-206
5.0%		100000	8700		10600		DS-206	DS-206		DS-206
		150000	9000		10900		DS-206	DS-206		DS-206
		250000	9300		11200		DS-206	DS-206		DS-206
		500000	9400		11300		DS-206	DS-206		DS-206
		Unlimited	9600		11500		DS-206	DS-206		DS-206
750	722	50000	10000	2900	12900	DS-206 ②	DS-206	DS-206	DS-206 ②	DS-206
5.75%		100000	11100		14000		DS-206	DS-206		DS-206
		150000	11600		14500		DS-206	DS-206		DS-206
		250000	11900		14800		DS-206	DS-206		DS-206
		500000	12200		15100		DS-206	DS-206		DS-206
		Unlimited	12600		15500		DS-206	DS-206		DS-206
1000	962	50000	12400	3900	16300	DS-416	DS-206	DS-206	DS-416	DS-206
5.75%		100000	14300		18200		DS-206	DS-206		DS-206
		150000	15000		18900		DS-206	DS-206		DS-206
		250000	15600		19500		DS-206	DS-206		DS-206
		500000	16200		20100		DS-206	DS-206		DS-206
		Unlimited	16700		20600		DS-206	DS-206		DS-206
1500	1443	50000	16500	5800	22300	DS-416 ②	DS-206	DS-206	DS-416 ②	DS-206
5.75%		100000	20000		25800		DS-206	DS-206		DS-206
		150000	21400		27200		DS-206	DS-206		DS-206
		250000	22700		28500		DS-206	DS-206		DS-206
		500000	23900		29700		DS-206	DS-206		DS-206
		Unlimited	25100		30900		DS-206S	DS-206S		DS-206S
2000	1924	50000	19700	7700	27400	DS-420 ②	DS-206	DS-206	DS-420 ②	DS-206
5.75%		100000	24800		32500		DS-206S	DS-206S		DS-206S
		150000	27200		34900		DS-206S	DS-206S		DS-206S
		250000	29400		37100		DS-206S	DS-206S		DS-206S
		500000	31300		39000		DS-206S	DS-206S		DS-206S
		Unlimited	33500		41200		DS-206S	DS-206S		DS-206S
2500	2406	50000	22400	9600	32000	DS-632 ②	DS-206S	DS-206S	DS-632 ②	DS-206S
5.75%		100000	29200		38800		DS-206S	DS-206S		DS-206S
		150000	32400		42000		DS-206S	DS-206S		DS-206S
		250000	35600		45200		DS-416S	DS-416S		DS-416S
		500000	38500		48100		DS-416S	DS-416S		DS-416S
		Unlimited	41800		51400		DS-632 ①	DS-632 ①		DS-632 ①

① Type DSL-416 1600 ampere frame or DSL-206 800 ampere frame fused type breakers may be substituted for Type DS-632 feeder breakers, if adequate for load demands.

② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Table of Transformer Secondary Ampere Ratings on Page 29.

Typical Metal Enclosed Bus Arrangements





Buses 4000 Amp. and Larger Include Interlaced Conductors

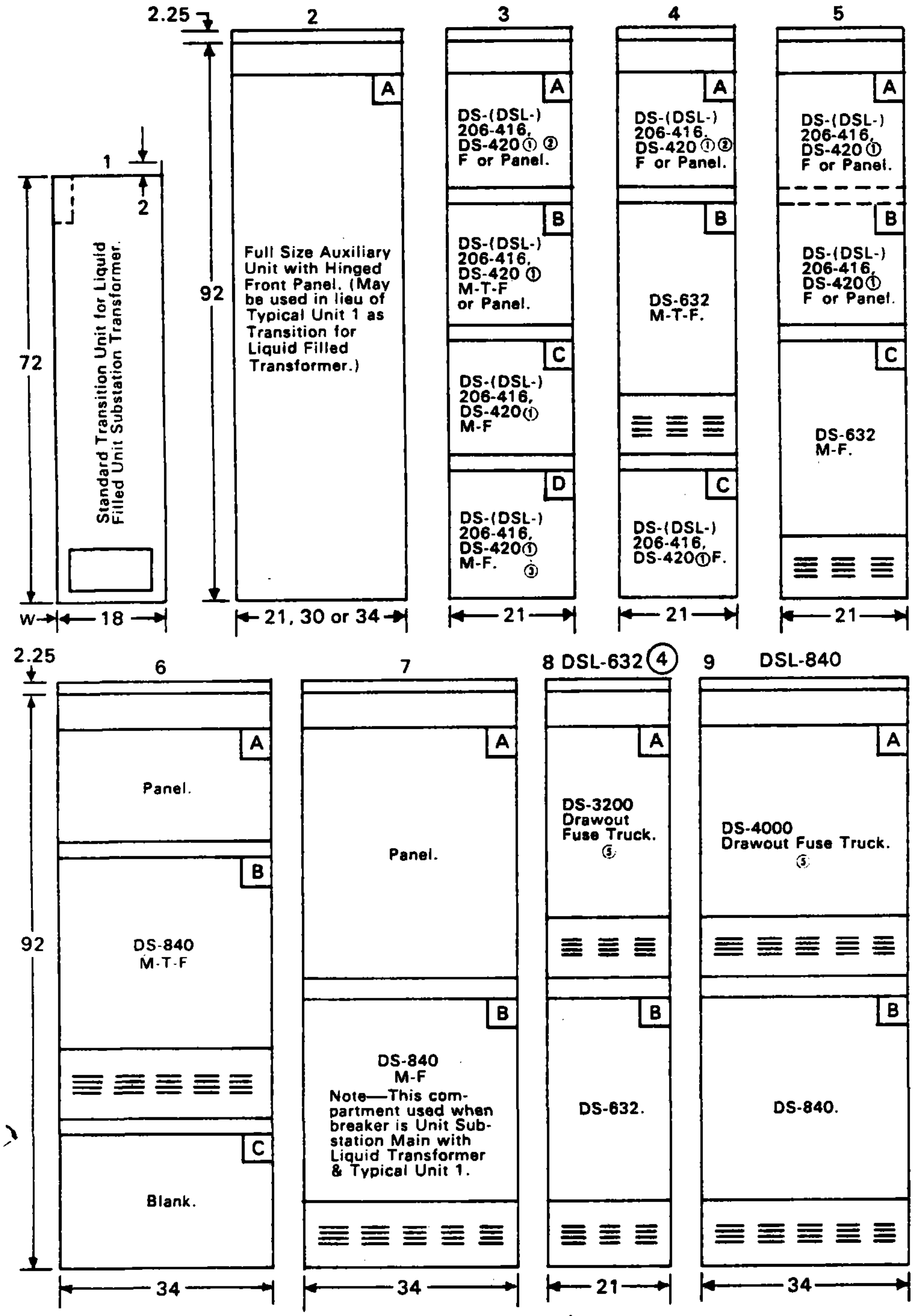
Bus Dimensions, Inches

Cont. Rating, Amp. ①	Copper or Aluminum Conductors, Except as Noted						
	Ventilated				Non-Vent.		
	Indoor		Outdoor		Outdoor		Notes
	W	H	W	H	W	H	
600	18.00	10.00	21.25	13.12	21.25	13.12	3 Wire or 4 Wire
1200	20.00	14.38	23.25	17.50	23.25	17.50	Dimension W Based on 3 Wire; Add 4 In. for 4 Wire.
1600	20.00	14.38	23.25	17.50	23.25	17.50	
2000	20.00	14.38	23.25	17.50	23.25	17.50	
2500 ③	20.00	14.38	23.25	17.50	23.25	17.50	
3000 ②	20.00	14.38	23.25	17.50	N.A.	N.A.	
3500 ②	20.00	14.38	23.25	17.50	N.A.	N.A.	
4000 ②	30.00	22.87	33.25	26.00	N.A.	N.A.	3 Wire Only
4000 ③	34.00	22.87	37.25	26.00	37.25	26.00	3 Wire or 4 Wire
4500 ②	34.00	22.87	37.25	26.00	N.A.	N.A.	
5000 ②	34.00	22.87	37.25	26.00	N.A.	N.A.	

① Continuous ratings are based on Standard 65°C Temperature Rise above ambient air temperature of 40°C maximum outside of bus enclosure.
② Copper conductors only.
③ Copper only when non-ventilated.

Type DS Indoor Switchgear Dimensions—Inches

Front Views of Typical Units



M—Main Breaker
T—Tie Breaker
F—Feeder Breaker

NOTE: For DS-206S and DS-416S space requirements, dimensions and weights use those shown for DS-206 and DS-416 respectively.

① Special Notes on DS-420 Breakers:
1. Only one active DS-420 per unit.
2. If DS-420 in Compt. C or D (Typ. Unit 3) is a close coupled transformer secondary main breaker, no other breakers are permitted in same unit

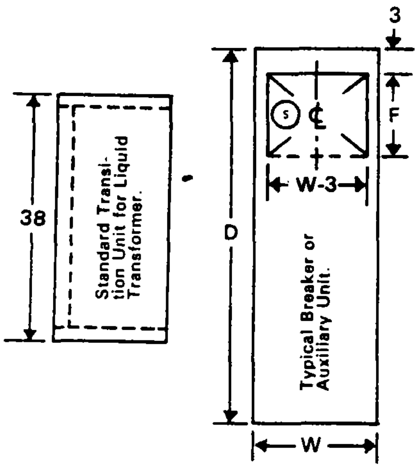
② Must be panel or blank compt. when breaker in Compt. B below is a main breaker.

③ Must be blank compt. when breaker in Compt. C above is a main breaker.

④ Max. continuous rating with this arrangement 3000A.

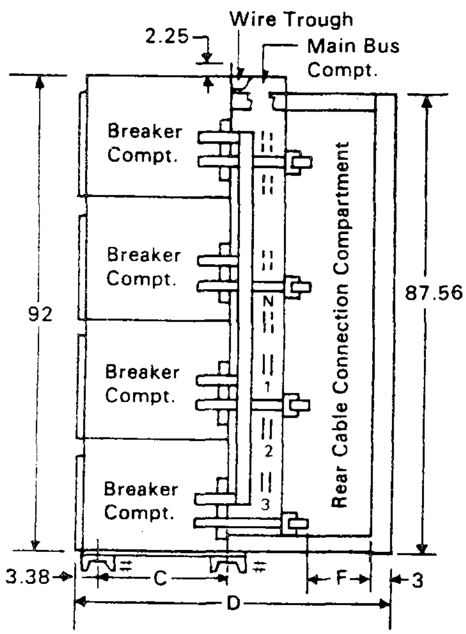
⑤ Fuse truck may also be located in alternate position in compt. beside breaker compt., in adjacent unit. DSL-632 will have 3200A max. cont. rating.

Plans



Ⓢ Space for power and control cables, top and bottom.
Minimum recommended front aisle for breaker removal:
For DS-206-416-420-632—36
For DS-840 or DSL —44
For transfer & lift truck —60
Top-of-gear mounted breaker lifter:
Overall height, approximate—108
Projection front of switchgear—23.5
Maximum height over lift truck—110
Minimum recommended rear aisle—24

Section of Typical Breaker Unit



Depth D	Dim. C	Dim. F
54-60-66-72	23.62	See Table Above
62-68-74-80	31.62	

‡ Floor channels not included.

Main Bus 1600A or 2000A

Unit Depth D ①		Cable Sp. F	
With Bkr. Type DS-206 DS-416 DS-420	With Bkr. Type DSL-206 DSL-416	Bkr. Unit ③	Aux. Unit
54	62	8	14
60②	68②	14	20
66	74	20	26
72	80	26	32

Main Bus 3200A, 4000A or 5000A

Unit Depth D ①		Cable Sp. F	
With Bkr. Type DS-206 DS-416 DS-420 DS-632	With Bkr. Type DSL-206 DSL-416 DSL-632 DSL-840 DS-840	Bkr. Unit ③	Aux. Unit
60	68	9	15
66②	74②	15	21
72	80	21	27

① Maximum depth requirement for any unit determines uniform depth of complete assembly.

② Minimum recommended depth with 3 or 4 DS-206 (DSL-206) or DS-416 (DSL-416) feeder breakers, initial or future, in same unit. Also required for metal enclosed bus termination.
Next deeper unit required for Type BYZ zero sequence current transformers, and/or phase current transformers for relaying.

③ Additional 6 in. available for cables thru floor if bottom compartment is blank.

Type DS Indoor Switchgear Weights—Pounds (Approximate)

Stationary Structures

21 in. wide breaker unit less breakers:	
66 in. maximum depth	—1300
80 in. maximum depth	—1400
34 in. wide breaker unit less breaker	—1500
21 in. wide auxiliary unit:	
66 in. maximum depth	—1000
80 in. maximum depth	—1100
30 in. or 34 in. wide auxiliary unit	
66 in. maximum depth	—1100
80 in. maximum depth	—1200
Std. transition unit (liquid transf.)	— 300

Drawout Elements

DS-206 Breaker #	—175
DS-416 Breaker #	—180
DS-420 Breaker #	—185
DS-632 Breaker #	—300
DS-840 Breaker #	—405
DSL-206 Breaker #	—205
DSL-416 Breaker #	—255
DS-3200 Fuse Truck	—325
DS-4000 Fuse Truck	—430

Manually or elec. operated. For approx. impact weight, add 50% of breaker weight.

Shipping Groups

Each shipping group includes a maximum of five (5) breaker and full size auxiliary units, plus one or two standard transition units (Typical Unit 1).

NOTE: For DS-206S and DS-416S space requirements, dimensions and weights use those shown for DS-206 and DS-416 respectively.

Specification Guide for Power Centers and Type DS Low Voltage Switchgear

General
This specification includes an (Indoor) (Outdoor) secondary unit substation complete from the incoming line terminals to the feeder terminals.

The secondary unit substation shall be designed, assembled and tested in accordance with applicable standards of NEMA, IEEE and ANSI.

The following sections shall be included and arranged (left-to-right) (right-to-left) when facing the control side of the switchgear and the nameplate side of the transformer:
- Incoming Line Section
- Transformer Section
- Outgoing Low Voltage Switchgear Section.

Incoming Line Section

Air Interrupter Switch—The HV switch shall be manually operated and rated at 600 (1200A) continuous, load break with fault closing rating of ________ amperes asymmetrical and a momentary rating of ________ amperes asymmetrical. The switch mechanism shall provide quick closing and opening, independent of the handle speed. When the switch access door is open, a plexiglass or screen barrier shall exist over the area where energized parts may be readily touched.

Switch shall be cable connected to the transformer terminals to prevent transmission of sound to the switch. The switch case shall be made of a minimum of 13 gauge steel.

3-Pole 2-Position—The HV section shall be provided with a gang operated 3 pole, 2 position air-insulated load interrupter switch. The switch compartment shall have a sight window for visual inspection of switch contacts. The switch handle shall be operable from the front of the unit.

Selector Switch—The HV section shall be provided with a gang operated 3 pole, 3 position (open - feeder 1 - feeder 2) selector switch which will consist of a no load selector switch for switching from one feeder to the other on the line side and in series with an air-insulated load interrupter switch. The load interrupter switch must be open before the selector switch can be changed from one feeder to another. The switch compartment shall have a sight window for visual inspection of switch load contacts. The switch handles shall be operable from the front of the unit. The selector switch handle shall visually indicate line 1 and line 2.

Duplex Switch—The HV section shall be provided with a gang operated 3 pole, 2 position duplex switch which will consist of 2 air insulated load interrupter switches connected together on the load side which shall be used for connecting the transformer to one of 2 available feeders. The two switches shall be interlocked to prevent both feeders from being connected to the transformer simultaneously. Each of the 2 switch compartments shall have a sight window for visual inspection of switch contacts. The switch handles shall be operable from the front of the unit.

Fuses—(Three - current limiting ________ E) (three RBA boric acid ________ E) fuses are to be provided on the load side of the HV switch in the HV switch compartment. ______ Kva interrupting capacity required. The hinged access door shall be interlocked with the switch so that the door cannot be opened until the switch is in the open position. Also the switch cannot be closed until the door is closed. The fuses shall have a continuous rating to protect the transformer.

Three spare fusee are to be supplied. (Optional)

Cutouts—The HV section shall consist of 3 - single pole ________ ampere gang operated oil fused cutouts.
Optional equipment available:
1. Provide 3________ spare fuse links for oil fused cutouts.
2. Provide ________ key interlock(s) to interlock with ________.

Terminal Compartment—The HV section shall consist of a terminal compartment for cable entrance. The terminal connectors shall be located so as to give sufficient space for stress cones.

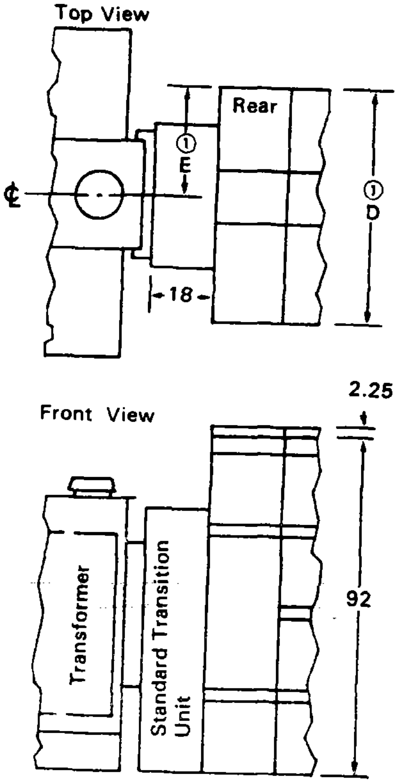
Lightning Arresters—Provide 3________ Kv (station type) (intermediate) (distribution) arresters for ________ Kv (grounded) (ungrounded) service.

Interlocks—Provide ________ key interlock(s) to interlock with ________.

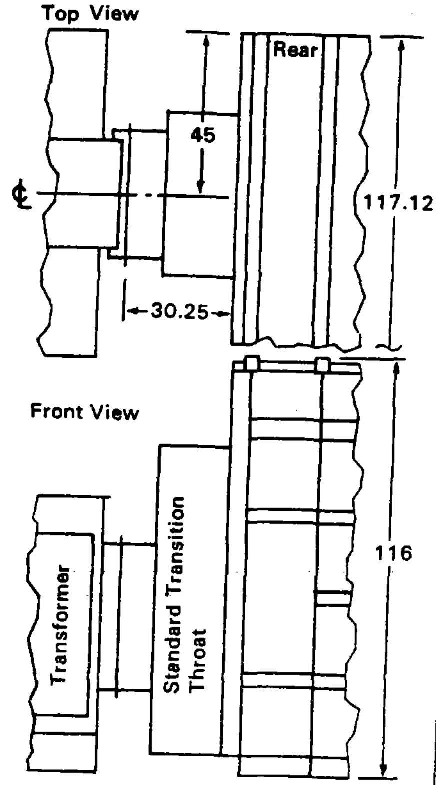
Terminals—Provide (potheads(s)) (clamp terminals) for termination of the (single feed) (loop feed) ________ MCM cables, ________ per phase.

Power Center Coordination—Dimensions in Inches

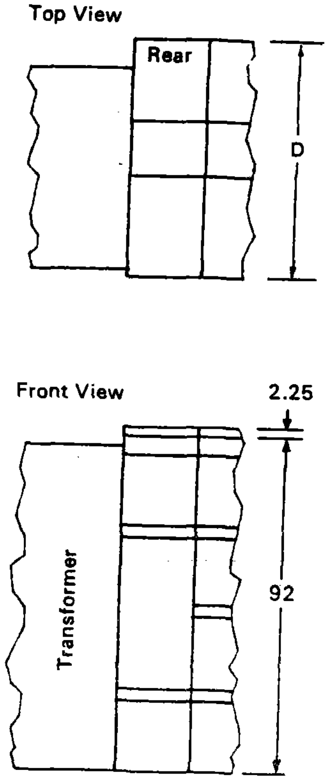
Indoor Power Center with Liquid Filled Transformer



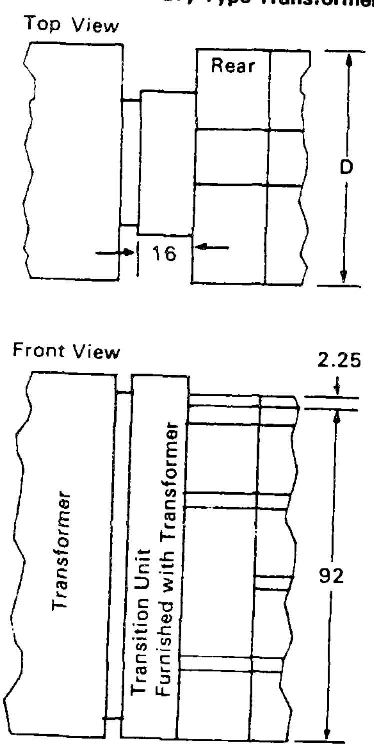
Outdoor Power Center with Liquid Filled Transformer



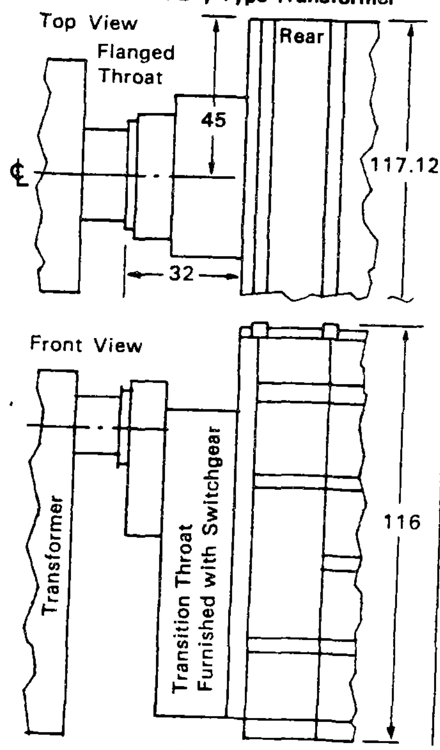
Indoor Power Center with Ventilated Dry Type Transformer



Indoor Power Center with Gas Filled Sealed Dry Type Transformer



Outdoor Power Center with Gas Filled Sealed Dry Type Transformer



Notes

Units are shown with Lv to right. Lv right is standerd and will be supplied unless otherwise specified. Any unit substation may be opposite hand or double ended.

① Depth D	Dim. E
54 or 62	19.25
60 or 68	25.25
66 or 74	31.25
72 or 80	37.25

Insulation
The transformer will be of the non-explosive, fire-resistant, air insulated, dry type construction, cooled by the natural circulation of air through the windings. Solid insulation in the transformer will consist of inorganic materials such as porcelain, glass roving or Nomex in combination with a sufficient quantity of a high temperature binder to impart the necessary mechanical strength to the insulation structure. Such insulation is defined by ANSI Standards as Class H materials.

Case
The knockdown case for ease in fitting through limited openings will be formed of 13 gauge sheet steel construction equipped with removable panels for access to the core and coils on the front and rear with ornamental ventilating grills. A bolted cover section will be supplied for access to the core and coil lifting loops for lifting the complete assembly.

Paint Finish
The case will be phosphatized and finished in manufacturer's standard light gray.

Lightning Arresters (optional)
Three low ratio lightning arresters will be mounted in the transformer case and connected to the high voltage leads. They will be for use on a __________ Kv grounded (ungrounded) system.

Impedance
The impedance of the transformer at normal rating and frequency will be manufacturer's standard ±7½% tolerance.

Gas Filled Sealed Dry Type Transformer Section

The indoor (outdoor) transformer will be rated as follows:
__________ Kva, 3 phase, 60 Hertz, gas filled sealed dry type, 150°C rise, with a 220°C insulation system.
H.V. __________ volts. 3 wire, plus two 2½%, minus two 2½% no load full capacity taps, delta connected.
L.V. __________ volts. 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities
A flange will be provided on the end wall of the tank for attaching the incoming Line Compartment. Flange will be located on the left (right) when facing the front of the transformer.

Cable Entrance
The cables shall enter the terminal compartment from the top (bottom).

Low Voltage Lead Facilities
A flange will be provided on the end wall, opposite high voltage flange, for attaching the low-voltage switchgear.

Accessories will include the following:
- I-beam base for rolling in any direction.
- Cover will be welded to the tank flange.
- Yukon cooler ¼ inch thick.
- Lifting hooks—4 total.
- Jack pads—4 total.
- Vacuum pressure gauge.
- Dial-type gas thermometer with alarm contact.
- ¾ inch filling plug—2 total.
- Diagram nameplate.
- Welded handhole cover for access to high voltage and low voltage bushings.
- De-energized tap changer, externally operated.
- Ground pad.
- Welded-on main tank cover.

Impedance
The impedance of the transformer at normal rating and frequency will be *%±7½% tolerance.

(*5.0% for 500 Kva and below. 5.75% for 750 Kva through 2500 Kva).

Sealed Tank
The transformer will be of sealed tank construction to prevent breathing. Tank will be hermetically sealed with metallic seals throughout and will be tested at 15 psi pressure. It will be provided with welded-on ¼" thick Yukon coolers.

Shot Blast
The case and coolers will be cleaned by shot blast and phosphatized before the paint is applied.

Finish
Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or drak gray ANSI No. 24 (outdoor).

Insulation
The transformer will be of the non-explosive, fire-resistant, fluorocarbon insulated, dry type construction, cooled by the natural circulation of fluorocarbon through the windings. Solid insulation in the trans-

Liquid Type Transformer Section

The Indoor (Outdoor) transformer will be rated as follows:

__________ Kva, 3 phase, 60 hertz, OA/FFA, oil (Silicone) insulated, 65°C rise (55°C rise) (Complete with 230V 1ϕ fans, OA/FA, for increased rating to __________ Kva).
HV __________ volts, 3 wire, plus two 2½%, minus two 2½% no load full capacity taps, delta connected.
LV __________ volts, 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities—A flange will be provided on the end wall of the tank for attaching the Incoming Line Compartment. Flange will be located on the left (right) when facing the front of the transformer.

Cable Entrance—The cables shall enter the terminal compartment from the top (bottom).

Low Voltage Lead Facilities—A flange will be provided on the end wall, opposite high voltage flange, for attaching the low-voltage switchgear.

Accessories will include the following:
- Combination drain and filter valve and sampling device.
- De-energized tap changer, externally operated. Cover mounted operating handle.
- Pressure test connection
- 1-inch filling plug and filter press connection in cover
- Thermometer, dial type, without (with) alarm contacts
- Liquid level gauge, without (with) low level alarm contacts
- Provision for lifting
- Provision for jacking
- Pressure relief device, without (with) alarm contacts. (Silicone only.)
- Instruction nameplate
- Ground pad
- Pressure vacuum gauge
- Welded-on main tank cover

Impedance—The impedance of the transformer at normal rating and frequency will be *% ±7½% tolerance.

(*5.0% for 500 Kva and below, *5.75% for 750 Kva through 2500 Kva.)

Sealed Tank—The transformer will be of sealed tank construction to prevent breathing. Adequate gas space will limit the internal pressure due to normal load cycle operation.

Shot Blast—The case and cooling tubes will be cleaned by shot blast or pickling and phosphatized before the paint is applied.

Finish—Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or dark gray ANSI No. 24 (outdoor).

Future Capacity—Each 750 Kva through 2500 Kva transformer shall be OA/FFA rated, i.e., include all design and construction capacities for future addition of fans.

Ventilated Dry Type Transformer Section

The indoor (outdoor), standard or (tamper-resistant) transformer will be rated as follows:

__________ Kva, 3 phase, 60 hertz, ventilated dry type, 150°C rise, 220°C insulation system. (Complete with fans for increased rating to __________ Kva.)
HV __________volts, 3 wire, with plus two 2½%, and minus two 2½% no load full capacity taps delta connected.
LV __________ volts, 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities
Provisions will be made for connecting the transformer case directly to the high voltage switch housing and the high voltage leads to the high voltage switch.

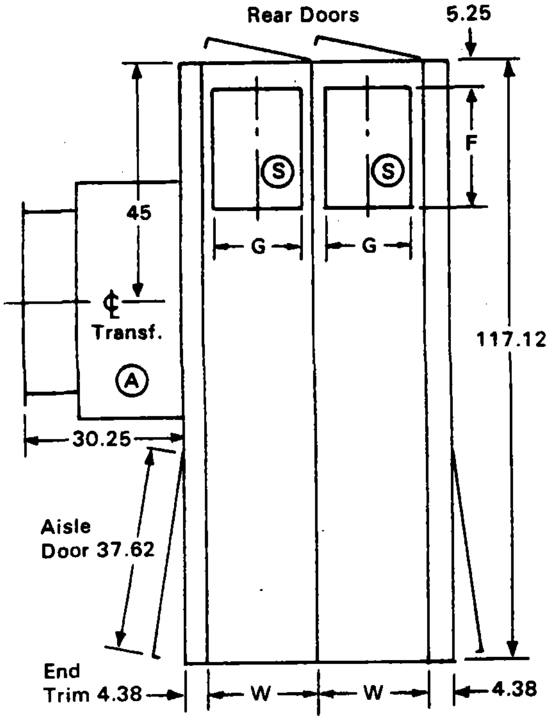
Low Voltage Lead Facilities
Provisions will be made for connecting the transformer directly to the low voltage switchgear housing and low voltage leads to the switchgear bus.

Accessories will include the following:
- Diagram instruction plate
- Provision for lifting and jacking
- Removable case panel for access to high voltage taps
- Drip proof cover
- Ground pad

High Voltage Taps
Tap leads will be terminated at the coils and equipped with provisions for changing taps.

Type DSO Outdoor Switchgear Dimensions — Inches

Plan of Typical Units



(A) Standard Transition Throat for connection to Liquid Filled Unit Substation Transformer. Also available for location on right end of Switchgear, facing front, and on both ends for double ended unit substation.

(S) Cutout in base of Switchgear for power and control cables, with removable bolted cover for drilling by purchaser.

Dimensions F and G

Unit Width W	F	G
21	25.25	17.50
30	25.25	25.25
34	25.25	25.25

Minimum recommended front clearance — 24 in.
Minimum recommended rear aisle for 21 in. wide units — 24 in.
Minimum rear aisle for 30 in. wide unit — 30 in.; for 34 in. wide unit — 34 in.

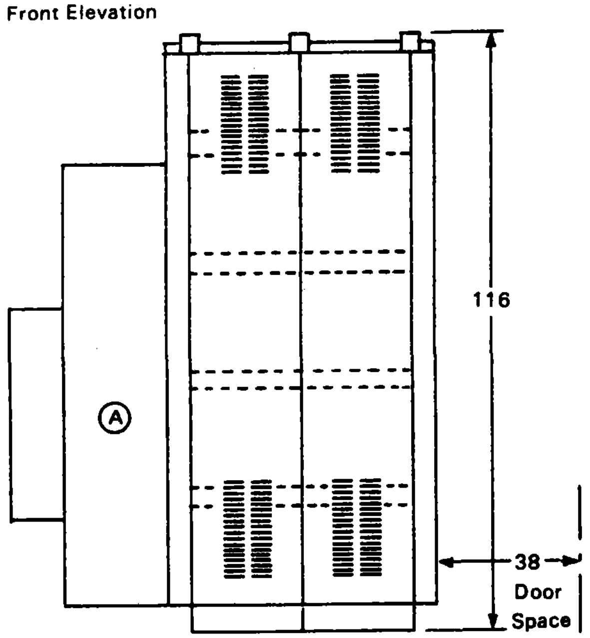
Each shipping group includes a maximum of four (4) breaker and full size auxiliary units, or a maximum combined length of 84 in. exclusive of end trims and transition throats.

Outdoor Switchgear Weights—Pounds (Approximate)
Stationary Structures

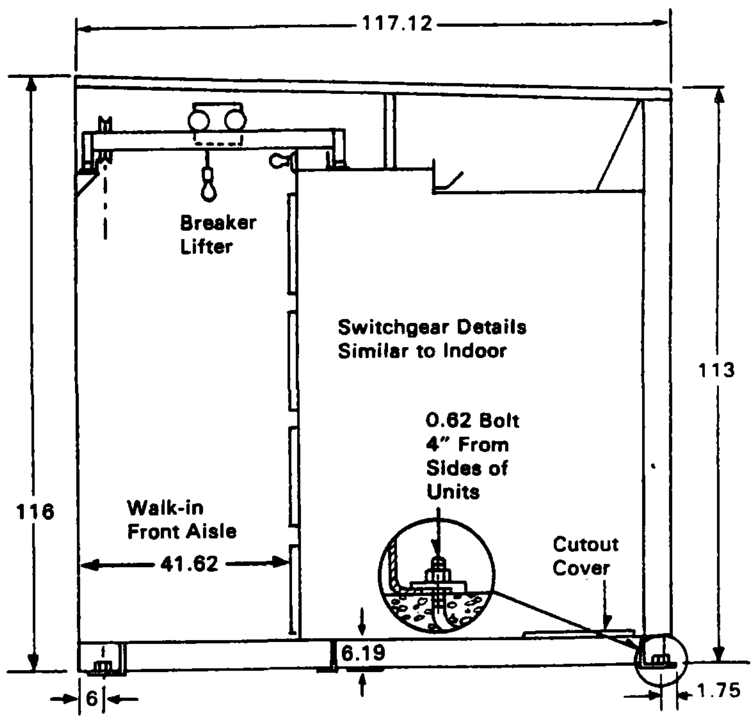
End Trims (One Set per Assembly)	— 1500
21 in. wide breaker unit less breakers	— 2600
34 in. wide breaker unit less breakers	— 2700
21 in. wide auxiliary unit	— 2300
30 in. or 34 in. wide auxiliary unit	— 2400
Standard transition throat	— 800

Drawout Elements
Same as in Indoor Switchgear

Front Elevation



Section of Typical Unit



former will consist of inorganic materials such as porcelain, glass roving or Nomex in combination with a sufficient quantity of a high temperature binder to impart the necessary mechanical strength to the insulation structure. The transformer will be insulated and cooled with C_2F_6 fluorocarbon gas. It will be shipped filled with this C_2F_6 gas to a gauge pressure of approximately 1½ P.S.I. at 25°C ambient.

Bushings
The transformer will be equipped with rolled flange, inert arc welded bushings for the HV and LV connections to insure that the tank is hermetically sealed.

Outgoing Low-Voltage Switchgear Section

General—Type DS indoor (outdoor) low-voltage metal-enclosed switchgear will consist of a stationary structure assembly and one or more removable "De-ion" air circuit breaker units fitted with disconnecting devices and other necessary equipment. The switchgear will be suitable for 600 volts maximum service and will receive a dielectric test for that voltage class in accordance with NEMA standards. It will be designed, manufactured and tested in accordance with the latest standards of IEEE, NEMA, and ANSI.

Stationary Structure—Each steel unit forming part of the stationary assembly will be a self-contained housing having one or more individual breaker or instrument compartments and a rear compartment for the bare buses, and outgoing cable connections. Each circuit breaker compartment will be equipped with primary and secondary contacts, rails, stationary levering mechanism parts, and required instrument current transformers. A blank formed steel door equipped with ventilation openings in the lower flange, an emergency trip buton, and supported on concealed hinges will be provided for each circuit breaker compartment.

The top of the unit will be enclosed with removable steel sheets which include necessary ventilation openings.

The structure will be so designed that future additions may readily be made at any time. The steel structure will be thoroughly cleaned and phosphatized prior to the application of the priming and finishing coats of paint.

A black, anodized aluminum, engraved circuit designation nameplate 1¼ inches high and 3½ inches wide will be provided on each circuit breaker door.

Buses and Connections—Each circuit will include the necessary 3 phase bus and connections between the bus and one set of circuit breaker studs. Solderless type terminals on silver-plated copper extensions for the outgoing cables will be provided on the other set of circuit breaker studs.
The buses and connections will consist of high-conductivity bare aluminum bar mounted on heavy duty glass polyester supports. The main bus joints will be welded. Shipping breaks and provisions for future bus extensions will have silver-plated bolted connections. Moldarta™ terminal blocks with integral-type barriers will be provided for secondary circuits. The terminal blocks will be mounted at the rear of the units, and will be accessible through a removable cover.

Disconnecting Devices—The stationary part of the primary disconnecting devices for each circuit breaker will consist of a set of contacts extending through a glass polyester insulating base. Buses and outgoing cable terminals will be directly connected to them. The corresponding moving contacts will consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "connected" position, these contact fingers will engage the stationary contacts forming a current-carrying bridge. The assembly will provide a multitude of silver-to-silver high-pressure point contacts. High uniform pressure on each finger will be maintained by springs. The entire assembly will be full floating and will provide ample flexibility between the stationary and moving elements. Contact engagement will be maintained only in the "connected" position.

The secondary disconnecting devices will consist of floating fingers mounted on the removable unit and engaging flat contact segments located at the rear of the compartment. The secondary disconnecting devices will be silver-plated to insure permanence of contact. Contact engagement will be maintained in the "connected" and "test" positions.

Removable Element—The removable element will consist of a type DS De-ion air circuit breaker equipped with the necessary disconnecting contacts, wheels, and interlocks for drawout application. The removable element will have four position features and will permit closing the compartment door with the breaker in the "connected", "test", "disconnected", and "remove" positions.

Air Circuit Breakers—The air circuit breakers will be type DS (DSL) operating on the Westinghouse De-ion arc interruption. These breakers will incorporate specially designed circuit-interrupting devices which provide high interrupting efficiency and minimize the formation of arc flame and gases.

The air circuit breakers will have silver-tungsten butt type contacts which operate under high pressure. The arcing contacts will be of arc-resisting silver-tungsten. The breaker will be equipped with "De-ion" arc chutes which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by short-circuit interruption. Each breaker will be equipped with a position indicator, mechanically connected to the circuit breaker mechanism.

Include when DSL breakers specified above. (Circuit breakers shall include current limiters, integrally, or separately mounted coordinated with the breaker trip device so as to avoid unnecessary blowing of the current limiters. Breaker shall include an anti single phase device that will trip the breaker in the event of a blown limiter, indicate from the front of the breaker which limiter is blown, and prevent the breaker from being reclosed on a single phase condition, due to missing or blown limiters.)

Each breaker will be equipped with an Amptector II-A (Amptector I-A) solid-state trip. The adjustments will be Long delay pick-up between 50% and 125% of the trip rating, Long time delay between 4 and 36 seconds at 6 times trip rating, Short delay pick-up between 4 and 10 times trip rating, Short time delay between 0.18 and 0.5 seconds at 2.5 times Short delay pick-up, instantaneous pick-up between 4 and 12 times trip rating, ground fault (Amptector I-A only) pick-up approximately 20% of trip rating and ground fault time between 0.22and 0.5 seconds. Adjustments will be of the continuous type and each will be independent of all the others. All components will be covered with a sealing compound to prevent deterioration in corrosive atmospheres.

It will be possible to test and calibrate the time and current characteristics and trip circuit by means of a portable plug-in test device.

Note: Only those characteristics as required should be specified.

Both electrically operated, and manually operated breakers will have stored energy operating mechanisms. Only one stroke of the operating handle will be necessary to charge the stored energy spring when operating the manual breaker. The release of the energy to close the breaker manually will be by means of a mechanical pushbutton which insures positive control of the closing operation. Electrical close will be initiated by means of a release solenoid.

Factory Assembly and Tests
The switchgear will be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of the equipment.

The main circuits will be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits will be given a dielectric test of 1500 volts for one minute between live parts and ground.

Detail Specification
1—Indoor (Outdoor) low-voltage metal-enclosed switchgear assembly including the following equipment:

a. 1—Set of necessary provisions for throat connection or close coupling to the transformer secondary.

b. 1—Set of necessary bare main bus and ground bus connections. (Including full neutral) (including 50% neutral).

c. __Current transformers_____/5 ampere ratio. (2 for 3 wire, and 3 for 4 wire with neutral bus in switchgear.)

d. __Potential transformers_____/120 volt ratio complete with primary and secondary fuses. (2 for 3 wire, and 3 for 4 wire with neutral bus in switchgear.)

e. 1—Ammeter, 0-_____ ampere range. 2% accuracy class.

f. 1—Ammeter switch for reading each phase current.

g. 1—Voltmeter, 0-_____ volt range, 150 volt coil, 2% accuracy class.

h. 1—Voltmeter switch arranged for reading phase to phase (phase to phase and phase to neutral) voltages.

i. 1—Watthour meter 2 element, 3 wire ($2\frac{1}{2}$ element, or 3 element, 4 wire) 5 ampere, 120 volt coils.

j. ____ Main secondary breaker(s), ____ ampere frame, — Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, short delay (and ___ wire ground) characteristics.

k. ____ Tie breaker(s), ____ ampere frame, ___ Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, short delay (and ___ wire ground) characteristics.

l. ____ Feeder breakers, ____ ampere frame, ___ Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, instantaneous (and ___ wire ground) characteristics (with integrally mounted current limiters for max. 200,000A int. cap.)

m. Control power transformer complete with primary and secondary fuses for space heaters, lights, receptacles and circuit breaker control as required.

n. Sets of clamp type terminals for ____ ____ MCM cables per phase and ____ ____ MCM cables for neutral entering from the bottom (top) of the unit.

o. 1—Set of engraved black anodized aluminum nameplates.

p. 1—Set of necessary small wiring, wiring accessories and terminal blocks.

q. 1—Set of space heaters, light and receptacles as required. (Standard for outdoor).

Caution:

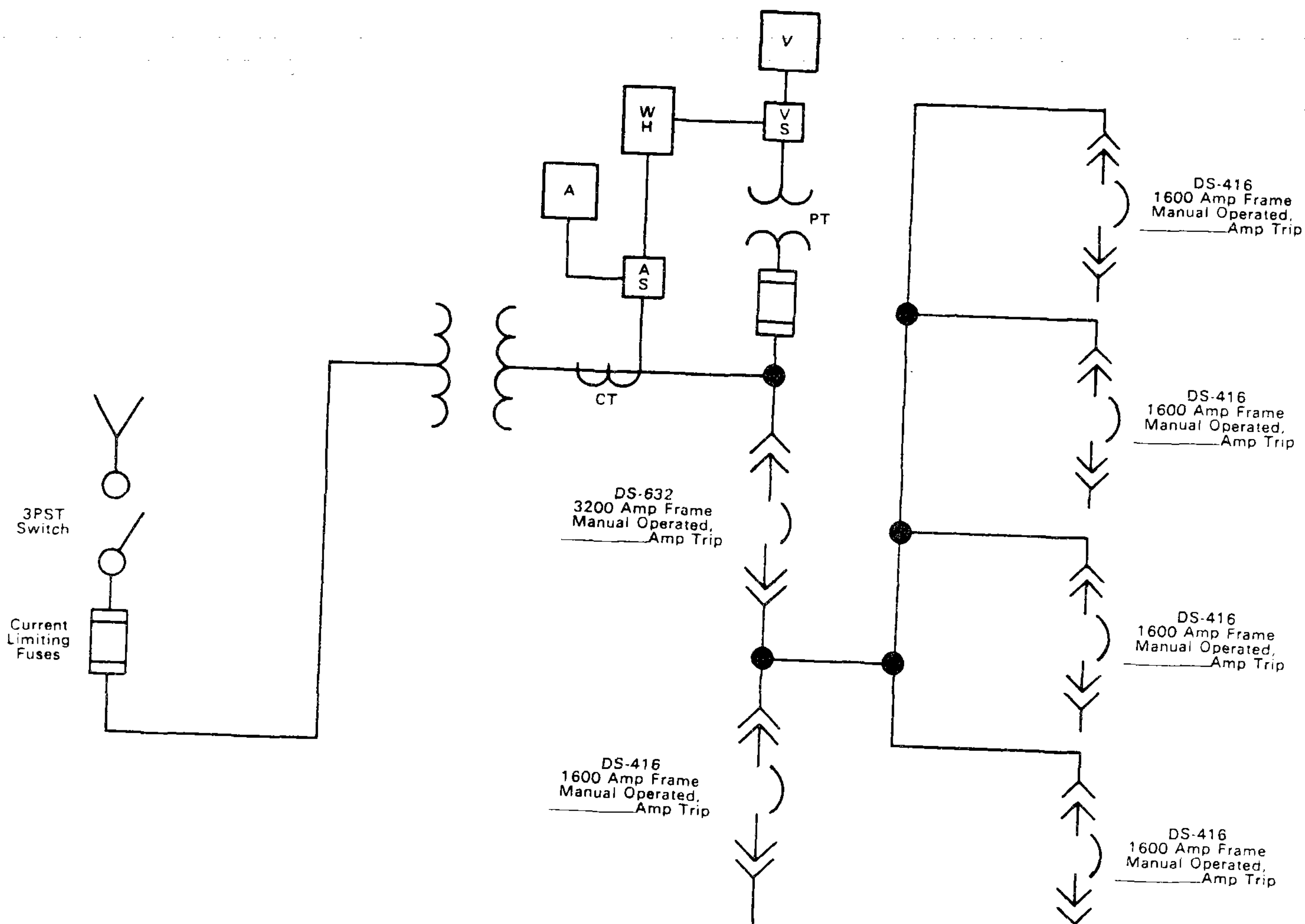
1. (b) Be sure to specify current carrying capacity and arrangement of neutral bus if one is required. Normally 50% capacity will be supplied if full capacity is not specified.
2. (j-k-l) If trip characteristics other than shown are required please be sure to specify them.

Accessories

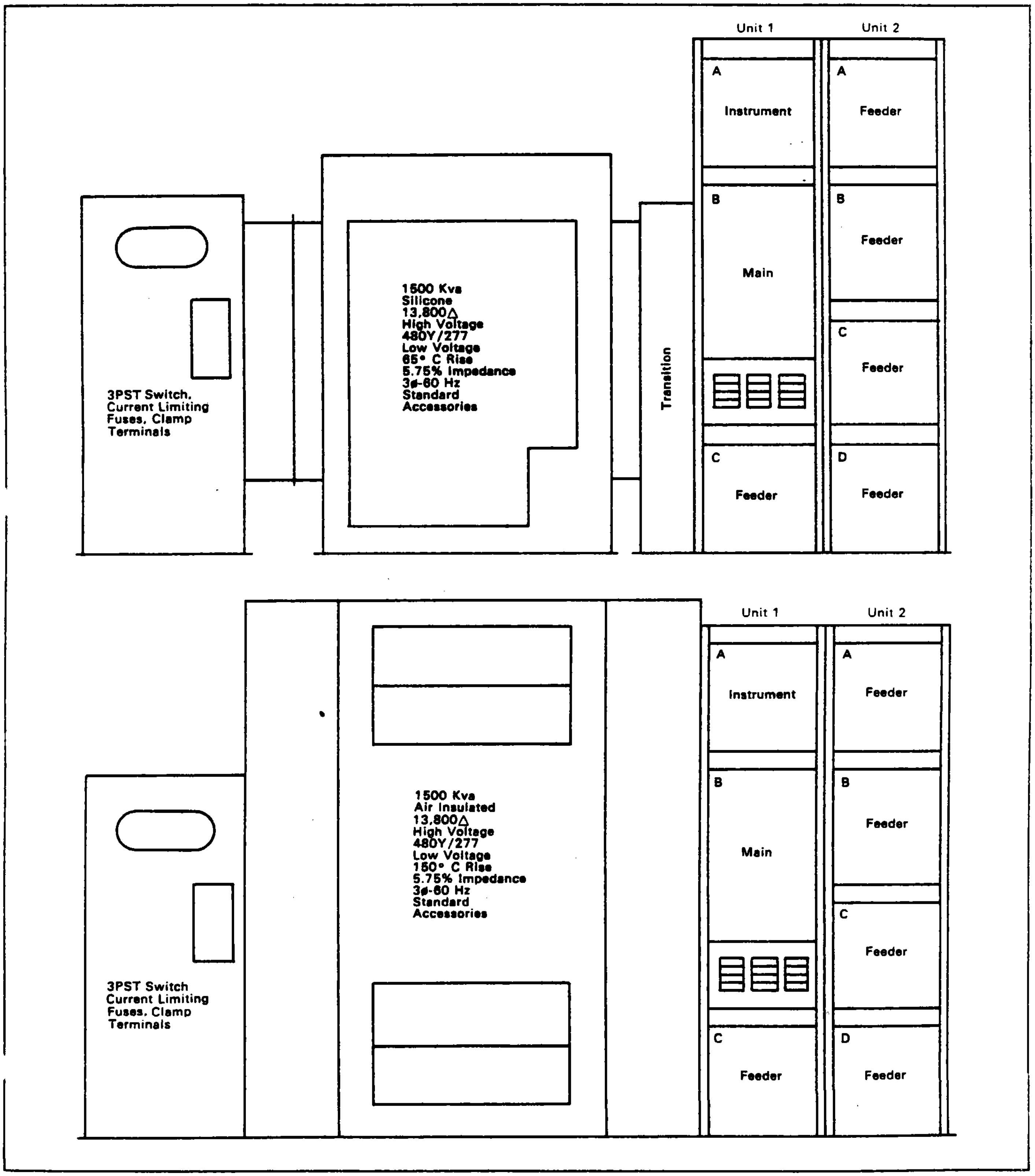
a-1 Top of assembly mounted circuit breaker lifting device (optional)
b-1 Test plug for watthour meter.
c-1 Levering crank.

Single Line Diagram

Note: Arrangement sketch and single line diagram similar to following samples should accompany the written specification.



Indoor Secondary Unit Substations



TYPE DS LOW VOLTAGE POWER CIRCUIT BREAKERS

Ratings and Characteristics

Breaker Type		DS-206	DS-206S	DS-416	DS-416S	DS-420	DS-632	DS-840
Voltage Rating (AC only)		600	600	600	600	600	600	600
Frame Size (Max. Continuous Amp)		800	800	1600	1600	2000	3200	4000

Interrupting Ratings, RMS Symm. Amperes at System Voltages:

		DS-206	DS-206S	DS-416	DS-416S	DS-420	DS-632	DS-840
A. With	0-240V	42,000	50,000	65,000	65,000	65,000	85,000	130,000
Instantaneous	241-480V	30,000	42,000	50,000	65,000	65,000	65,000	85,000
Trip	481-600V	22,000	42,000	42,000	50,000	50,000	65,000	85,000
B. With	0-240V	30,000	42,000	50,000	65,000	65,000	65,000	85,000
Short Delay	241-480V	30,000	42,000	50,000	65,000	65,000	65,000	85,000
Trip	481-600V	22,000	42,000	42,000	50,000	50,000	65,000	85,000

Operating Characteristics-Same for All Types

Control Voltage	24 DC (1)	48 DC	125 DC	250 DC (2)	115 AC	230 AC
Close Current (SR), Amp.	NA	5.0	2.0	1.0	3.0	1.5
Shunt Trip Current, Amp.	6.0	5.0	2.0	1.0	2.0	1.0
Spring Charge Motor, Amp. (3)	NA	7.5	3.0	1.5	3.0	1.5
Close Voltage Range		40-50	90-130	180-260	95-125	190-250
Trip Voltage Range	14-30	28-60	70-140	14--280	95-125	190-250

(1) Not a recommended voltage.
(2) Check Westinghouse for application at this control voltage.
(3) Running current; inrush approximately 400%.

Spring Charge Time - 5 seconds maximum
Time for Spring to Close Breaker, until contacts touch - 4.5 cycles maximum
Opening Time with Shunt Trip - 5 cycles maximum

Interrupting Time, at 200% or more of Inst. Pickup - 3 cycles maximum (4)
Interrupting Time, 100% to 200% of Inst. Pickup - 4 cycles maximum (4)
Arcing Time, Below 50% of Continuous Rating - 6 cycles maximum (4)

(4) Add approximately 2 cycles per shunt trip and approximately 4 cycles for instantaneous undervoltage.

Instructions for Low-Voltage Power Circuit Breakers Types DS and DSL

READ AND UNDERSTAND THESE INSTRUCTIONS
BEFORE ATTEMPTING ANY ASSEMBLY, OPERATION, OR
MAINTENANCE OF THE SWITCH

Westinghouse Electric Corporation

Switchgear Division, East Pittsburgh, Pa. 15112
I.B. 33-790-1E Effective September, 1979 Supersedes Issue Dated April, 1977

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PURPOSE

This instruction book is expressly intended to cover the installation, operation and maintenance of Low Voltage Power Circuit Breakers, Types DS and DSL.

For application information, consult your nearest Westinghouse sales office, see Westinghouse Descriptive Bulletin 32-850, or appropriate ANSI Standards.

SAFETY

All Safety Codes, Safety Standards and/or Regulations as they may be applied to this type of equipment must be strictly adhered to.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

CAUTION

The circuit breakers described in this book were designed and tested to operate within their nameplate ratings. Operation outside of these ratings may cause the equipment to fail, resulting in bodily injury and property damage.

Introduction

These instructions cover the description, operation and maintenance of Westinghouse Type DS and Type DSL Low Voltage AC Power Circuit Breakers and Type DS Drawout Fuse Trucks. These breakers are usually supplied as part of low voltage metal enclosed switchgear of the four-position drawout type. These instructions apply only to the circuit breaker and its auxiliary drawout details which have been designed as a completely integrated drawout unit. Type DS Breakers (not DSL) may also be supplied in a fixed mounted version. In this case the sections of this book referring to the levering device, position interlocks, and spring discharge interlock will not apply.

The DS and DSL Circuit Breakers operate on the magnetic De-ion principle of interruption. In these breakers the arc rises into a series of insulated steel plates. The plates break the rising arc into a series of smaller arcs to cool and extinguish them and funnel the heat to ambient air.

DS and DSL Breakers are available for application at voltages from 208 to 600 Vac; with continuous currents of 50 to 4000 amps; and with interrupting capabilities up to 200,000 amps. Refer to the breaker nameplate for the complete rating information for any given breaker. Breakers conform to NEMA, ANSI and IEEE standards.

TYPE DS AND DSL BREAKERS ARE PROTECTIVE DEVICES. AS SUCH, THEY ARE MAXIMUM CURRENT RATED DEVICES. THEREFORE, THEY SHOULD NOT UNDER ANY CIRCUMSTANCES BE APPLIED OUTSIDE THEIR NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN BODILY INJURY AND PROPERTY DAMAGE.

The available DS and DSL Breakers and their rated performance capabilities are given in Tables 1 and 2.

Table 1 – Type DS Breaker Ratings

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes					
		With Instantaneous Trip			With Short Delay Trip ①②		
		208-240V	480V	600V	208-240V	480V	600V
DS-206	800	42,000	30,000	30,000	30,000	30,000	30,000
DS-206S	800	50,000	42,000	42,000	42,000	42,000	42,000
DS-416	1600	65,000	50,000	42,000	50,000	50,000	42,000
DS-416S	1600	65,000	65,000	50,000	65,000	65,000	50,000
DS-420	2000	65,000	65,000	50,000	65,000	65,000	50,000
DS-632	3200	85,000	65,000	65,000	65,000	65,000	65,000
DS-840	4000	130,000	85,000	85,000	85,000	85,000	85,000

① Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DS-840 which is 65,000.

Maximum voltages at which the interrupting ratings apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

Interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15 second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1/2 second each, with a 15-second interval of zero current between the two periods.

Table 2 – DSL Breakers - Current Limiting Type Breakers and Combinations

Type	DSL-206	DSL-416	DSL-632	DSL-840
Frame Size, Amperes	800	1600	3200	4000
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000

Notes: DSL-206 and DSL-416 include limiters integral with drawout breaker elements. DSL-632 includes DS-632 breaker and DS-3200 drawout fuse truck, in separate interlocked compartments. Maximum continuous rating limited to 3000A when fuse compartment is above breaker compartment in same unit. DSL-840 includes DS-840 breaker and DS-4000 drawout fuse truck, in separate interlocked compartments. Maximum interrupting rating limited to 150,000 amperes when 6000A fuses are used.

GENERAL DESCRIPTION

Westinghouse DS and DSL Circuit Breakers are horizontal drawout magnetic air circuit breakers. They are designed for use in Metal-Clad Switchgear assemblies having maximum voltages of 635 volts AC for DS Circuit Breakers and 600 volts for DSL. They are equipped with spring-stored, energy-closing mechanisms. All primary insulation to ground is glass polyester. These breakers have many common features, but they will vary in size and detail depending on the specific breaker type number and ratings. Figure 1 shows Type DS Low Voltage Power Circuit Breaker shipped inside its own compartment. Figures 78 and 79 show Types DSL-206 and DSL-416 Circuit Breakers.

Each DS and DSL Circuit Breaker consists of a basic breaker assembly, three interrupter assemblies (arc chutes), barriers, and an Amptector solid-state trip unit. DSL breakers have added current limiters to extend their interrupting range to 200,000 amps. Various accessories are also provided.

Basic Breaker Assembly

The basic breaker assembly includes a chassis, a control panel, an operating mechanism, a levering-in device, various interlocks, and three insulated pole unit assemblies mounted on a base.

On the front of the breaker are the control items needed for proper operation of the circuit breaker. They are: breaker position indicator, breaker open/closed indicator, levering device shutter and shaft, breaker trip plate, closing spring charged/discharged indicator, Amptector trip test terminal access, Amptector trip controls, closing spring charge handle, close bar and padlock plate.

Arc Chutes

Each arc chute contains vertical steel splitter plates, insulating spacers and plates. These are all assembled in an insulating arc chute jacket. The arc chutes mount on top of the pole units and are vented to atmosphere.

Optional Components

Optional components provided upon order are: undervoltage trip attachment, overcurrent trip switch, high-load trip switch, latch check switch, auxiliary switches.

Accessories

Levering crank and Amptector Test Kit are supplied as required.

Since the major components and the accessories depend on the particular type and rating of circuit breaker, packing lists provided with each shipment and more detailed sections of this instruction book should be referred to for special information. Any questions about the circuit breakers may be referred to the nearest Westinghouse Electric Corp. Sales Office. When making inquiries about type DS (DSL) circuit breakers always provide the specific type number, continuous current rating, mechanism type, applicable order numbers, breaker shop orders or style numbers, date of manufacture and other pertinent information as shown on the circuit breaker nameplate. Inquiries can be handled faster when complete information is provided with the initial inquiry.

Special Circuit Breakers: DS-206S and DS-416S

Table 1 gives the interrupting rating of DS-206S as 42,000 amperes at 600 volts AC. It is an improved model of DS-206, which has an interrupting capacity of 30,000 amperes at 600 volts AC. Yet, the maximum continuous current rating of 800 amperes is the same for both types.

Also, their parts are similar except for these differences:

1. DS-206S uses the three piece base of the DS-416 type, instead of the one piece molded base of the DS-206.

2. DS-206S uses the DS-416 arc chute.

3. DS-206S main disconnects have 50% more fingers than the DS-206.

4. DS-206S has twice as many main contacts and arms as the DS-206.

5. The pole unit hinge joint of DS-206S is a forked construction or a miniature version of the DS-416 hinge.

6. Fifty ampere sensors cannot be installed on DS-206S; but they can be put on DS-206.

Similarly, the parts of DS-416S are almost identical to those of DS-420. Their interrupting ratings are the same: 65,000 amperes at 480 volts AC and 50,000 amperes at 600 volts AC. But, the maximum continuous current rating of DS-420 is 2,000 amperes and for DS-416S it is 1600 amperes.

Compared to Type DS-416, DS-416S has higher interrupting ratings, giving it improved operating flexibility. See Table 1.

Safety Features

Type DS (DSL) Breakers are manufactured with several built-in interlocks and safety features to reduce hazards and provide proper operating sequences. **UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE AS THIS MAY RESULT IN BODILY INJURY OR PROPERTY DAMAGE.**

1. Positive mechanical indicators on front panel show whether the breaker is open or closed, and whether the closing spring is charged or discharged.

2. Closing Spring Automatic Discharge - Mechanical interlocking automatically discharges the closing springs when the breaker is removed from its compartment.

3. Mechanical interlocking prevents levering of breaker unless its contacts are open. Contacts cannot be closed until the breaker is levered into TEST or CONNECT positions.

4. Mechanical interlocking prevents closing of breaker contacts while it is being levered into or out of its cell, or while it is standing in any intermediate location between the TEST and the CONNECT positions or the DISCONNECT position.

5. Provisions for Padlocking-Breakers can be padlocked open to prevent electrical or manual closing. This padlocking can also secure the breaker in the connected, test, or disconnected position by preventing levering.

6. In the CONNECT position automatic mechanical interlocking prevents the disconnecting or withdrawal of a closed breaker. This avoids drawing dangerous, destructive arcs on the disconnecting contacts when the circuit is energized.

7. In the REMOVE position mechanical interlock system prevents the closing springs from being charged or remaining charged.

8. The integral fuses on Types DSL-206 and DSL-416 breakers are inaccessible until the breaker is completely withdrawn from its compartment, thereby assuring complete isolation.

Likewise, the Type DSL-632 and DSL-840 fuses are inaccessible until the separate fuse truck is completely withdrawn and the fuses isolated. The fuse truck is key interlocked with the breaker to prevent withdrawing or insertion unless the breaker is open.

Recommended Safety Practices

Type DS circuit breakers are complex electrical devices containing high speed, high energy, operating mechanisms. They are designed to operate within the current and voltage limitations on the breaker nameplate. Do not apply these breakers to systems with currents and/or voltages exceeding these limits.

1. To perform work on Type DS Circuit Breakers requires personnel with training and experience in high voltage circuits. Only qualified electrical workers, familiar with the construction and operation of such equipment and the hazards involved, should be permitted to work on these circuit breakers.

2. Only Qualified Persons as defined in the National Electric Safety Code should be permitted to assemble, operate or maintain these breakers.

3. The breakers are equipped with various interlocks. **DO NOT MAKE ANY OF THE INTERLOCKS INOPERATIVE AS THIS MAY RESULT IN BODILY INJURY OR PROPERTY DAMAGE.**

4. Never put a breaker into a cell without barriers and arc chutes.

5. Always be sure that all switch hardware is in place and bolted tightly before inserting breaker into cell.

6. Do not lift breaker with ordinary crane hooks, ropes, chains, etc., to avoid possible damage to parts or dropping the unit. Use breaker lifting adapter.

7. Use handle on front panel of circuit breaker to move it into or out of cell. Keep fingers and hands off top, bottom or sides of breaker when moving it into or out of cell to prevent bodily injury.

8. When operating breaker without arc chutes and barriers, keep hands, arms, head and tools out of area where contacts travel. Severe bodily injury could result from being struck by the moving contacts either as they open or close.

9. Be sure circuit breaker contacts are open and closing springs are discharged before doing maintenance work.

10. Be sure circuit breaker contacts are open and closing springs are discharged after completing maintenance work.

11. Never leave breaker in an intermediate position in a cell. Always have the breaker either in the disconnect, test or connected position because control circuits may be either improperly connected (or disconnected) and may cause electrical failures.

12. Avoid trip-free type operation because it causes more shock on some parts of breaker than normal closing operations. Refer to last paragraph in Item 4.1.

13. Before operating breaker in test position, be sure that closing the breaker will not cause another electrically interlocked breaker to inadvertently trip.

Section 1 - Receiving, Handling and Storing

1.0 RECEIVING AND HANDLING

The circuit breakers may be shipped completely assembled and inside their respective compartments.

Receiving and handling of this equipment is covered in Westinghouse Instruction Book 32-690 for Low-Voltage Metal-Enclosed Switchgear, Types DS and DSO.

If the circuit breakers are not shipped in the switchgear assembly, they will be packed separately in individual cartons or crates. These packages must be handled with care to avoid hidden damage to the circuit breakers.

If the circuit breakers have been shipped in the switchgear assembly, proceed as described in Section 2. If the breakers have been shipped in separate packages, remove them from the crate or carton carefully so as not to cause damage. Place the breakers on the switchgear extension rails. (See Section 2.3 before attempting to lift breakers.) Remove the insulating barriers and arc chutes. Inspect the contact structures to be sure no damage has occurred during shipment. Replace the arc chutes and insulating barriers and proceed as described in Section 3.

1.1 STORING

If it is necessary to store the equipment before installation, keep it in a clean dry place, protected from dirt and water and with ample air circulation and heat, if necessary, to prevent condensation. Like all electrical apparatus, these units contain insulation. Although it is of highest quality, it, like all other insulation, must be protected against dirt and moisture. Refer to Instruction Book 32-690-C for details.

NOTE

Breakers that have been stored or have infrequent operations shall be operated a minimum of five times before being placed in service.

1.2 WEIGHTS: CIRCUIT BREAKERS AND FUSE TRUCKS

Table 3 gives the approximate weights of DS and DSL circuit breakers. They will vary slightly due to the differences in functional components of the individual DS Breaker, and the size of the current limiters supplied on DSL Breakers. Fuse truck weights will vary due to differences of fuse sizes.

Table 3 – Approximate Weights

Drawout Elements	Pounds
DS-206 Circuit Breaker.	150
DS-206S Circuit Breaker.	160
DS-416 Circuit Breaker.	195
DS-416S Circuit Breaker.	200
DS-420 Circuit Breaker.	200
DS-632 Circuit Breaker.	300
DS-840 Circuit Breaker.	400
DSL-206 Circuit Breaker.	200
DSL-416 Circuit Breaker.	260
DS-3200 Fuse Truck	325
DS-4000 Fuse Truck	430

Section 2 - First Removal of Breaker from Compartment

2.0 GENERAL

To examine and become familiar with the construction and operation of the breaker, it first must be withdrawn from the compartment. There are rails provided which permit the breaker to be rolled out of the compartment so that it can be examined on all sides and operated. First unlatch and open the compartment door.

2.1 SETTING THE RAILS IN FRONT OF THE COMPARTMENT

Refer to Figures 1 and 2. There are two rails for each breaker compartment which, when not in use, are stored on the inside of the compartment in a back-sloping position. Withdraw each rail completely and let it down into a horizontal position, as shown in Figure 2.

The first movement of the breaker toward the front of the compartment must be done with the levering device.

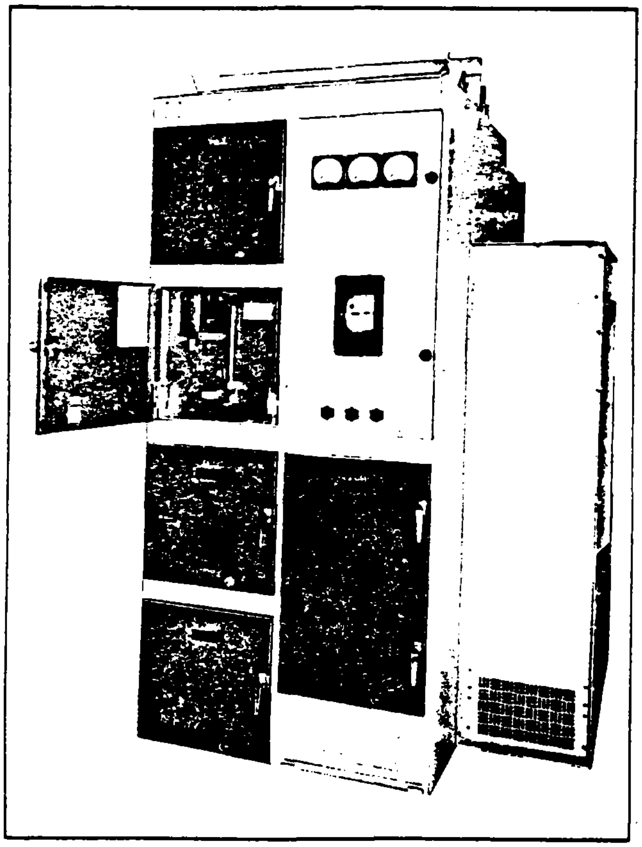


Fig. 1 *The Type DS Low Voltage Power Circuit Breaker is Shipped Inside Its Own Compartment (388880*)*
*PHOTO NUMBER

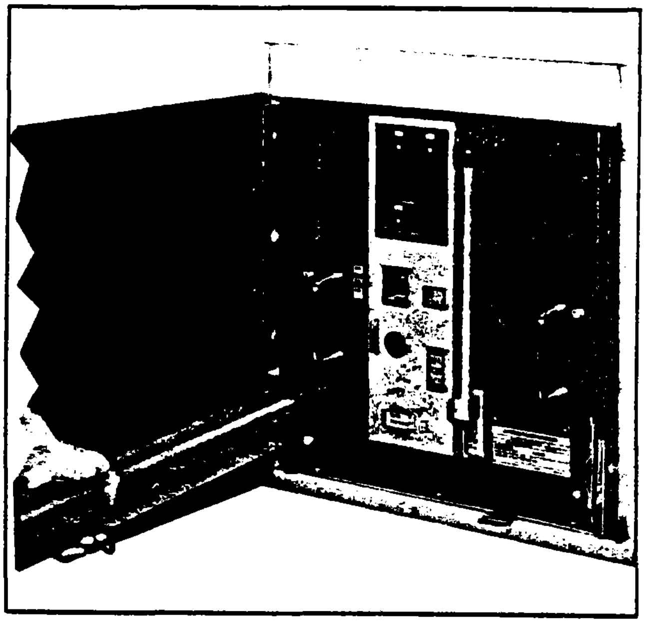


Fig. 2 *Rails are Stowed away in the Compartment. Withdraw as Shown (383027)*

2.2 REMOVING SHIPPING BRACE

Before the circuit breaker element can be withdrawn from its compartment for the first time, two shipping braces must be removed from the lower part of the breaker front panel. These braces are small steel angles bolted to the front of the circuit breaker and to the bottom cradle of the circuit breaker compartment.

During shipment, the front wheels of the breaker are lifted approximately 1/16 inch above the compartment rails, and the unit is held part way between DISCONNECT and TEST positions by means of its levering device and the shipping angle.

1. With a screwdriver, remove the two (2) outside .25-20 panhead screws with captive washers from the bottom leg of the two angles. Do not discard, as later they will be returned to their tapped holes. Do not remove the center screw from the bottom cradle.

2. The levering device is now used to release the breaker from the shipping position. When the breaker is part way between DISCONNECT and TEST positions as described above the breaker levering device interlock will hold the shutter down and the trip plate depressed. The hex shaft of the levering device will be exposed and ready to receive the levering crank handle. See Figure 3. Insert the crank

Fig. 3 *Levering Device Crank Handle Installed. Read Section 2.2 on this Operation (391177)*

and turn in a counter-clockwise direction and observe the action of the drawout position indicator. The indicator will move down to the REMOVE position at which time the load on the crank handle increases because a stop has been reached.

NOTE

DO NOT APPLY FORCE ON THE CRANK HANDLE AFTER THE STOP HAS BEEN REACHED AS THE BREAKER IS NOW FREE.

3. When the position indicator shows the levering device to be in the REMOVE position, remove the hand crank. Pull the breaker out onto the extended rails. This will require more effort than normal as the rear wheels are jammed into the cradle hold-down hooks by two lengths of plastic tubing. Refer to illustrations in the stationary structure Instruction Book 32-690 covering shipping braces.

4. Remove the two (2) .25-20 panhead screws holding the two shipping angles to the front panel of the breaker. Care must be exercised to prevent marring the front panel. Two or more flat washers are used between the angle and front panel for shipping. Discard the angles.

5. Immediately replace the two panhead screws discarding all washers.

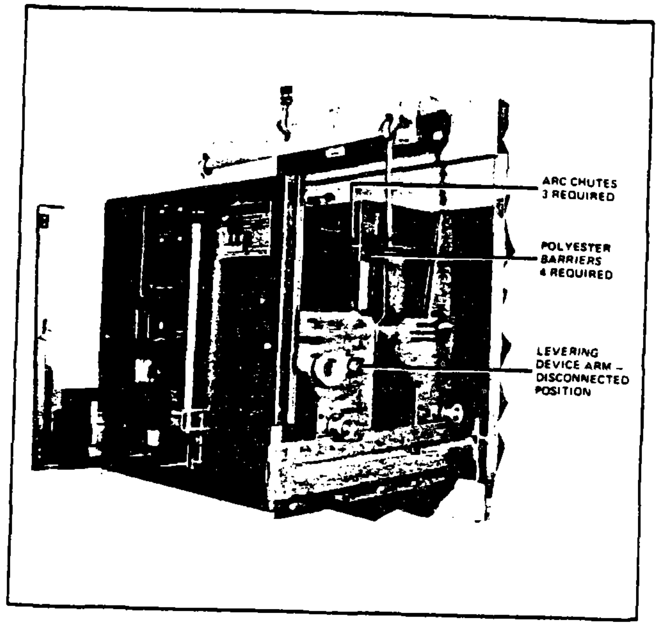


Fig. 4 *Use of Breaker Lifting Adapter (391187)*

6. With the breaker pulled completely to the end of the rails, remove the two (2) six inch long pieces of split plastic tubing that are on the rear of the stationary rails immediately below the hold-down hooks. This tubing is for shipping purposes only and is to be discarded.

7. The stationary secondary disconnecting contacts are covered by a sheet of insulating material during shipment. This must be removed and discarded before the breaker is moved to the TEST or CONNECTED position.

8. Push the breaker back into its compartment, and replace the two (2) panhead .25-20 screws at the front edge of the cradle.

2.3 LIFTING THE BREAKER

When it is necessary to lift the breaker off the rails, all lifting should be done only with the accessory lifting adapter. DO NOT ATTEMPT TO LIFT BREAKER WITH ORDINARY CRANE HOOKS, ROPES, CHAINS ETC., AS VITAL PARTS SUCH AS WIRING, BARRIERS AND ARC CHUTE PARTS MIGHT BE DAMAGED. Figure 4 shows a view of the breaker with the lifting adapter in place. The lifter consists essentially of two sheet steel hooks specially shaped to hook under the top edges of the large openings on each circuit breaker side sheet, or in the specially provided lifting lugs on some breakers, and a spreader. Actual lifting may be with a crane, chain block or with the optional lifting mechanism which can be supplied for the switchgear. The breaker must be pulled completely to the end of the rails.

Section 3 - Preliminary Examination of Circuit Breaker

3.0 GENERAL

Read these instructions carefully and look at the breaker as it stands out of the compartment before trying to operate it. Refer to Figures 5, 6, 7 and 8.

The complete drawout element includes the circuit breaker itself and its auxiliaries. The circuit breaker consists of four major components:

1. The operating mechanism.

2. The contacts, operated by the mechanism.

3. The arc chutes, which interrupt the arc which always results from opening the breaker under load or short circuit conditions.

4. The Amptector® solid-state overcurrent tripping system.

The remainder of the drawout element includes the following auxiliary components:

1. Interphase insulating barriers which isolate the arc chutes from each other and from ground.

2. Drawout element frame and rollers.

3. The levering device, for placing the element into its various positions inside the compartment.

4. The main disconnecting contacts, for connecting the breaker to power source and load.

5. The secondary contacts, for connecting the control circuits to the electrical operating parts of the element.

6. The interlocks, which increase the safety of operation.

7. Drawout element position indicator.

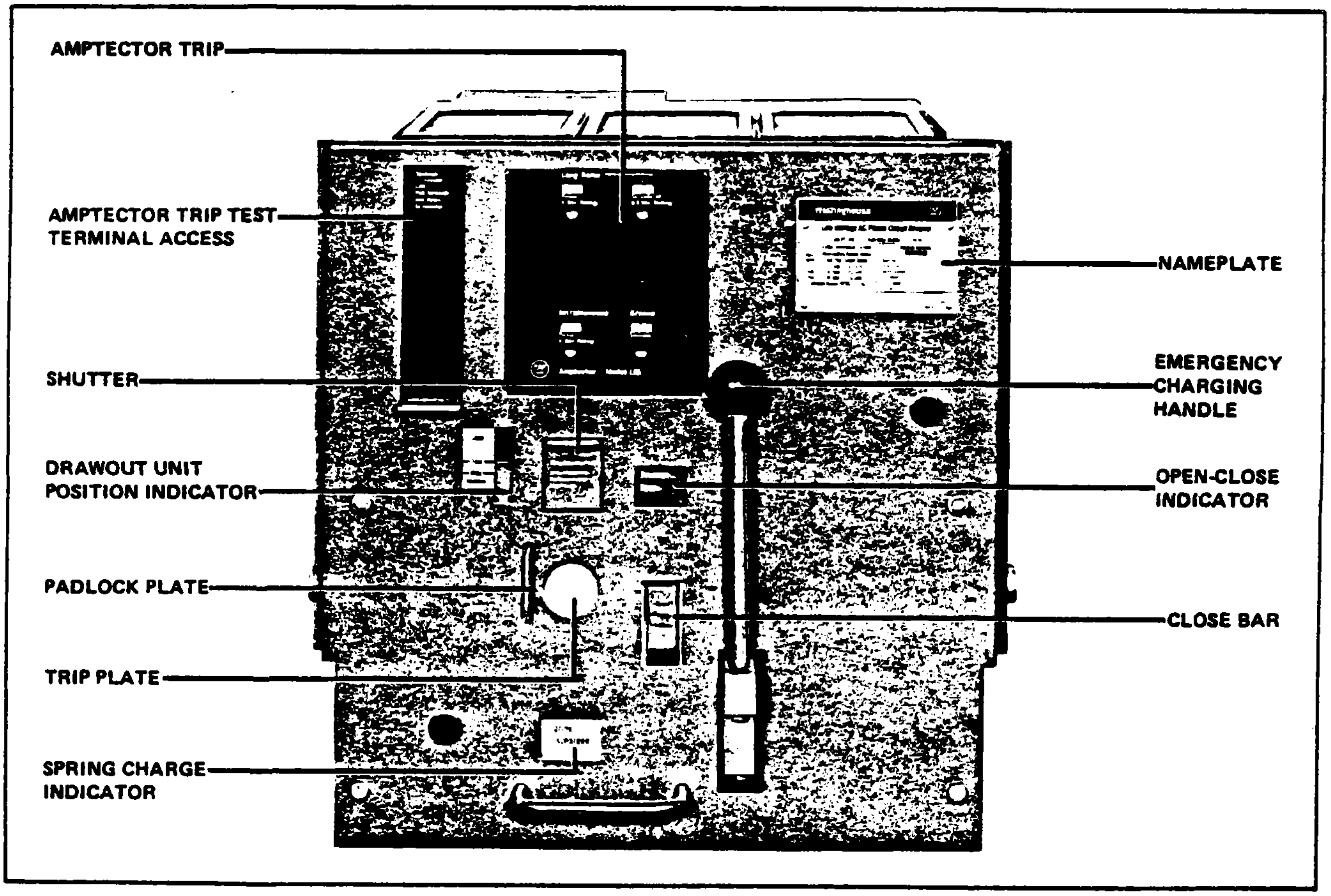


Fig. 5 *View Showing Controls on the Panel (391066)*

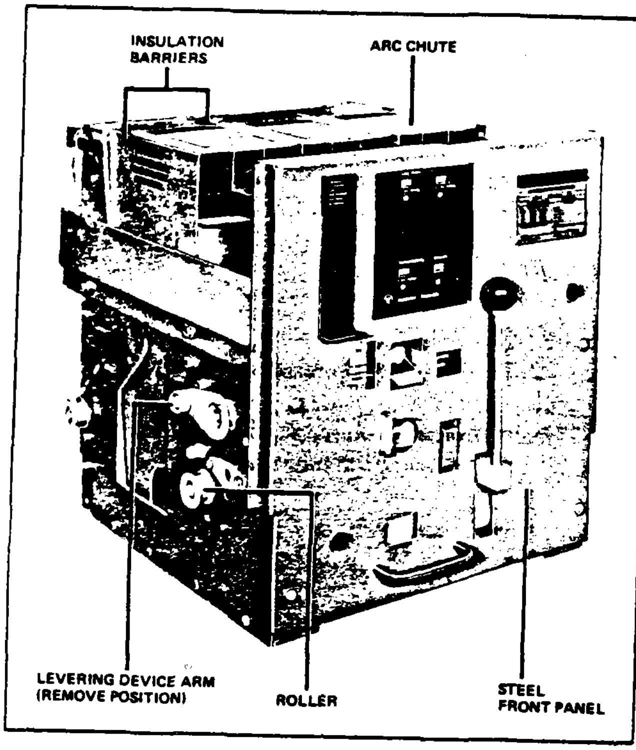


Fig. 6a *Left Side of Breaker with Levering Device Arm in REMOVE Position (391065)*

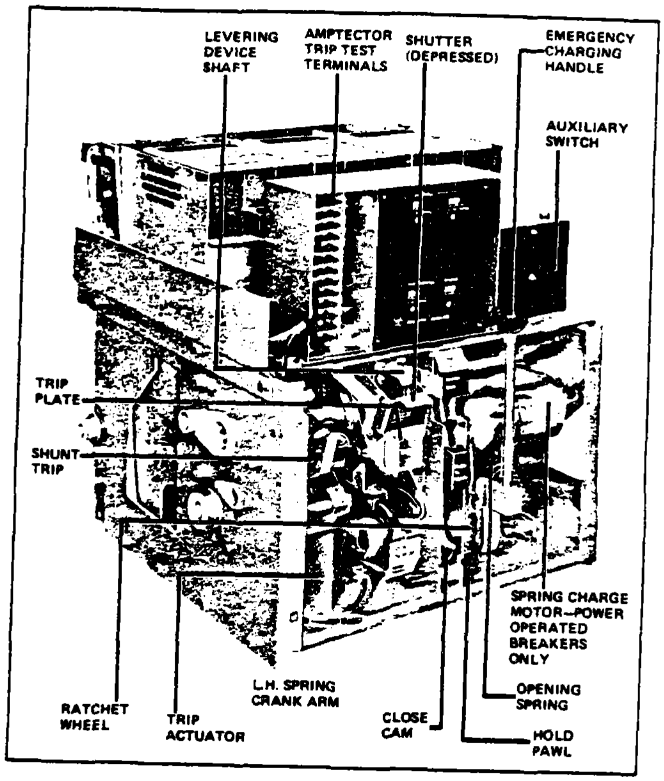


Fig. 6b *DS 416 Breaker with Front Panel Removed (391070)*

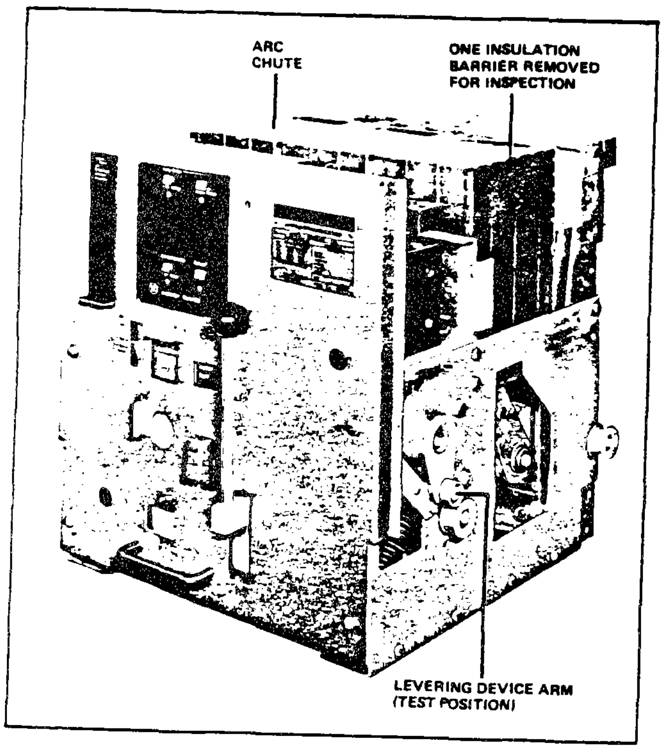


Fig. 7 *Right Side Showing Levering Device Arm in TEST Position (391068)*

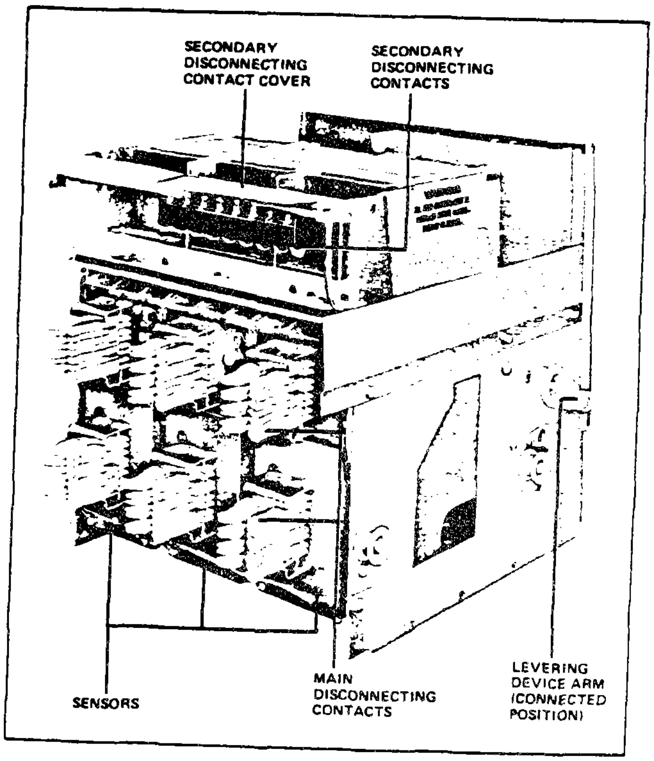


Fig. 8 *Rear View Showing Levering Device Arm in CONNECT Position (391067)*

8. Open-Close indicator.

9. Spring charge indicator.

10. The close bar and trip plate.

11. Steel front cover.

12. Nameplate with complete rating information.

The Type DSL-206 and DSL-416 drawout elements also include the following components:

1. Current limiters.

2. Isolating transformers, connected in parallel with the limiters.

3. Combination "Blown Limiter Indicator" and anti-single phase device, connected to the isolating transformers, actuated by blowing of one or more of the current limiters. This device has individual phase indicators and a common "RESET" button extending through the front cover.

Each breaker is equipped with a spring-type stored energy closing mechanism. This mechanism closes the circuit breaker contacts with the necessary speed and force, independently of the operator. Basically, the closing springs must first be charged or cocked before the breaker can be closed. The springs are then released by releasing the spring release latch. The breaker is opened by releasing the tripping latch.

3.1 INDEPENDENT MANUAL AND POWER-OPERATED BREAKERS

3.1.1 Closing Facilities

On manually operated breakers, the closing springs can be charged only by hand, by means of the spring-charge handle. The actual closing of the breaker is done only by hand-push on the close bar. As optional equipment, the electrical spring release attachment normally supplied only on power-operated breakers can be supplied on manually operated breakers.

On power-operated breakers, the springs are normally charged by an electric motor. Closing may be done electrically by an electro-magnet which lifts the closing spring release latch. Both of these operations can be done by hand if the control power source fails.

3.1.2 Tripping Facilities

The breaker can be tripped open by hand by pushing with the finger on the trip plate on the breaker panel or the trip plate on the breaker compartment door (the latter is operative only when the breaker is in the connected position).

The breaker can also be tripped electrically by the following devices:

1. Shunt trip device, optional equipment on manually operated breakers.

2. Trip Actuator, energized from the Amptector trip unit.

3. Undervoltage Trip Device (Optional on all breakers)

4. Blown Limiter Indicator (for DSL breakers)

3.2 LEVERING DEVICE

The drawout element has four normal positions in its compartment, determined by the levering device:

1. The REMOVE position, Figure 6.

2. The DISCONNECT position.

3. The TEST position, Figure 7.

4. The CONNECT position, Figure 8.

The REMOVE position is the first position in the compartment as the element is pushed directly by hand as far as it will go. The DISCONNECT, TEST, and the CONNECT positions are reached only by means of the levering device. This is hand operated with a removable crank handle. This handle is placed on the levering device worm shaft, which is exposed by depressing the shutter.

Section 4 - Basic Operating Instructions

4.0 GENERAL

The breaker is now ready for trial mechanical operation. Keep the breaker standing on the compartment rails, out in front of the compartment. Examine it externally for any signs of obvious damage or foreign material. When everything appears to be in order, perform the following operations as "dry run" practice. If any malfunctioning is found during these operations, see that it is corrected before further operations or before placing the breaker in service.

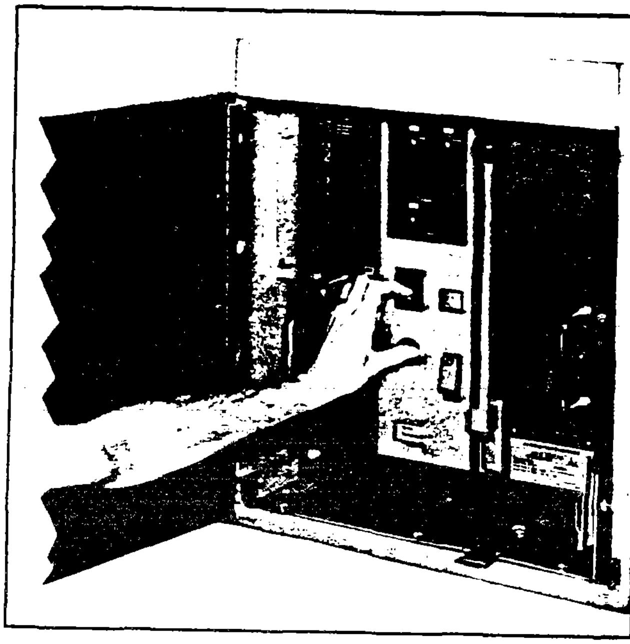


Fig. 9 *Method Used to Press Trip Plate and Lower Shutter with One Hand, Preparatory to Inserting Crank (383028)*

4.1 LEVERING DEVICE

If the circuit breaker was shipped in a separate package, the levering device was probably left in the REMOVE position. If not it will be necessary to return it to this position. Push in the TRIP plate and depress the shutter over the levering shaft, using one hand. as shown in Figure 9, and insert the levering crank as shown in Figure 3. Turn the crank counterclockwise until the position indicator is in the REMOVE position, at which time the load on the crank handle increases because a stop has been reached. Now rotate the crank clockwise to simulate levering the breaker inward toward the CONNECT POSITION. Watch the movement of the levering device arms. At the start of cranking the arms are horizontal, with rollers toward the rear, Figure 6. As the crank is turned clockwise the levering device arms rotate downward. When they have moved approximately 40° from the horizontal, the shutter will rise until it touches the crank socket. The position indicator will be opposite "DISC" which is the DISCONNECT position wherein the breaker is held in its compartment with both main and secondary contacts disengaged. If the crank is withdrawn, the shutter will close completely, and the breaker may be locked in this position as later described in Section 5.1.8.5 of this instruction book. There is very little movement of the breaker into its compartment between the REMOVE and DISCONNECT positions.

Continued rotation of the crank in the clockwise direction moves the arms downward to the vertical position, and the indicator will show "TEST" as in Figure 7. The shutter will rise.

Further clockwise rotation of the crank handle rotates the arms to the CONNECT position. This is about 65 degrees from the test position, as shown in Figure 8. When this position is reached, the crank suddenly becomes hard to turn. At this point, stop turning the crank, as the worm shaft bottoms in the tapped hole of the stop nut.

NOTE

Further turning effort is useless. The breaker will be secure, even if the stop is only lightly touched. Remember this when actually levering the breaker into the connect position.

Rotation of the crank counterclockwise will turn the levering device arms to withdraw the unit from the CONNECT position to the TEST position and then to the DISCONNECT and REMOVE positions. Then, when the crank is removed from the worm shaft, the shutter will remain down and the trip plate will remain trapped by the shutter.

NOTE

If the breaker is levered out from the TEST position to the REMOVE position with the closing springs charged, a trip-free "closing" operation automatically will be performed but the breaker contacts will not close. When a power-operated breaker is removed from cell, it must go through a trip-free operation.

4.2 CHARGE THE CLOSING SPRINGS

The closing springs must be charged before the breaker can be closed. To manually charge the closing springs, the levering device arms must be rotated away from the REMOVE position to the TEST position. If charging is attempted in the REMOVE position, the closing cam will rotate past the charged position and go through a trip-free "closing" operation, i.e., the springs will discharge without moving the breaker contacts. Do not attempt to charge the springs in the DISCONNECT position as the same action may occur. After turning the levering device to TEST position, manually charge the springs. On manually operated breakers, the springs are charged by a single stroke downward on the spring-charge handle, rotating it about 90° toward you until it suddenly becomes very easy to move and then tends to run away from your hand. At the same time, you will hear a metallic "click!" as the over center closing spring stop is reached. Note that the spring charge indicator now shows "Spring Charged."

CAUTION

Do not release the handle before the charging operation is completed. To release handle before charging completion will return handle upwards with such velocity that it may break the handle knob or cause bodily injury.

CAUTION

Hold breaker to prevent tilting forward when hand charging closing springs with the breaker on the extended rails. Otherwise, it may topple to the floor and cause bodily injury or equipment damage.

On power operated breakers, a short spring-charge handle is included for emergency operation. This works on a ratchet principle, and requires 10 to 12 pumping operations to completely charge the springs. At this point, the same metallic "click" will be heard; and the spring charge indicator will show "Spring Charged." The handle must not be forced beyond this point.

NOTE

Power-operated breakers, when being levered into the compartment, will have the spring-charge motor run and charge the spring automatically as the TEST position is reached.

4.3 CLOSE THE BREAKER

The breaker can be closed only when the following conditions are met:

1. The closing springs are charged.

2. The levering arms are in either the TEST position, as in Figure 7 or in the CONNECT position, Figure 8.

3. The levering device crank handle has been removed and the shutter is closed.

4. Undervoltage trip device (if included) has been energized.

5. Blown limiter indicator (for DSL breakers only) is reset.

Having met these conditions, close the breaker by pushing on the close bar. Note that the breaker position indicator shows "Breaker Closed", against a red background. Also that the spring-charge indicator now shows "Spring Discharged."

Some power-operated breakers are interlocked to prevent manual closing from the close bar on the front panel when in the CONNECT position. In this case crank the levering device to the TEST position to operate. This interlock is covered by Section 5.1.8.2.

It is possible to recharge the springs immediately after closing the breaker. This results in increased strain on the mechanism, and it is recommended that this be done only if the operating procedure requires this condition.

NOTE

If closing is attempted with the levering arms in other than the TEST or CONNECT positions, with or without the levering crank in place, a trip-free "closing" operation is performed but the breaker contacts do not close. This trip free type of operation results in more shock on some parts of the mechanism than normal closing operations. Therefore, this type of operation should be avoided if possible.

4.4 OPEN THE BREAKER

The breaker can be opened in the following ways:

1. By hand operation of the trip plate (on the breaker or on the compartment door.)

2. Automatically by overload, short circuit or undervoltage condition.

3. Breakers equipped for power operation can be tripped electrically by a shunt trip device energized by hand switch or relay.

For the present purpose of getting acquainted with the breaker, open it by pushing on the trip plate. Note that the breaker position indicator now shows "Breaker-open", against a green background.

NOTE

On breakers equipped for power operation, when they are in the compartment and in either the TEST or CONNECT position, the spring-charge motor normally runs automatically and charges the closing springs as soon as the breaker opens. The closing springs normally remain discharged while the breaker stands in the closed position. Also see Section 5.1.2.1.

Now to become better acquainted with the breaker, charge the closing springs, close and open the breaker several times. Also, place the levering crank handle on the levering device work shaft and rotate the levering arms to their various positions by turning the levering crank handle. **Leave the levering arms horizontal, with rollers toward rear of breaker, i.e. in the remove position.**

The breaker is now ready to be put into its various operating positions in the compartment.

4.5 PLACE THE BREAKER IN THE TEST POSITION

Push the breaker into the REMOVE position.

Note that the compartment door can now be closed and fastened. With the compartment door closed, the breaker cannot be operated in any manner. **HOWEVER YOU WILL NOTE THAT, WITH THE COMPARTMENT DOOR OPEN, THE FRONT PANEL ASSEMBLY OF THE BREAKER FORMS A STEEL PROTECTIVE SHIELD.**

Place crank on the levering device worm shaft. Turn crank clockwise until drawout unit position indicator shows "TEST." Remove the levering device crank. The shutter will close over the hex shaft. All manual operations can now be performed. On power operated breakers the spring is charged automatically as the breaker arrives in the TEST position. The breaker can also be opened with it shunt trip device, and it can be electrically closed with the spring release device.

4.6 PLACE THE BREAKER IN THE CONNECT POSITION

Press the trip plate and lower the shutter. Place the crank handle on the levering device worm shaft and turn the crank clockwise until the CONNECT position stop is reached, as indicated by sudden increase in load on the crank, as previously described in paragraph 4.1.

Note however, that before the stop is reached, an increase in load on the crank will be felt after the breaker has moved about an inch. This is caused by the making up on the main disconnecting contacts. The load on the crank will decrease after reaching a peak. The next increase in load is when the stop is reached.

NOTE

Do not try to crank after the stop is reached. Further tightening of the crank does not help keep the breaker in position. When the crank handle is removed, the shutter and the trip plate should snap into normal position.

4.7 REMOVE THE BREAKER FOR FINAL INSPECTION

Withdraw the breaker from the CONNECT position in the compartment to the end of the extended rails following the reverse procedure described above. Inspect it thoroughly to see that no foreign objects have lodged within it. If any defects were found during these preliminary operations, complete their corrections at once.

4.8 FINAL INSPECTION

MAKE SURE THE THREE (3) ARC CHUTES ARE PROPERLY INSTALLED. MAKE SURE ALL FOUR (4) INSULATING BARRIERS ARE PROPERLY INSTALLED.

1. With the breaker withdrawn, rotate levering device to connected position before attempting to charge the spring.

2. Close and trip the breaker several times as previously described.

3. Return the levering device to the remove position; i.e., with the roller arms pointing toward the rear as shown in Figure 6.

4. This completes the "dry run."

4.9 AMPTECTOR TRIP SETTINGS

When the breaker is shipped, the calibrating dials of the Amptector trip unit are at the nominal settings. For specific overload tripping characteristics to coordinate with the load or the system, refer to Section 8 and Curves found later in this instruction book.

4.10 PLACE THE BREAKER IN SERVICE

Lever the breaker into the connected position as previously described, and latch the compartment door.

Section 5 - Description and Explanation of Operation

5.0 GENERAL

The following paragraphs give a general description and explanation of the operation of the breaker.

5.1 THE OPERATING MECHANISM AND HOW IT WORKS

The operating mechanism is of the spring charged stored energy type. This means that it consists of two major parts:

(1) The stored energy or spring-charging mechanism.

(2) The mechanism for closing and opening the breaker.

The basic parts of these are combined into one sub-assembly illustrated in Figures 10, 11, 12, and 13. There are two varieties of mechanisms for the complete line of DS and DSL breakers:

Power-Operated

Manually Operated

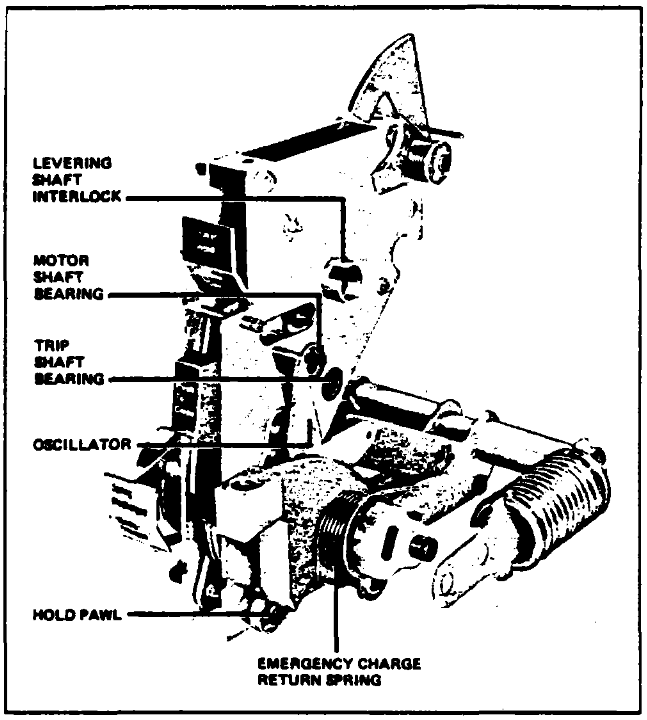


Fig. 11 *Front View of Mechanism (Power-Operated Spring Charge) (385301)*

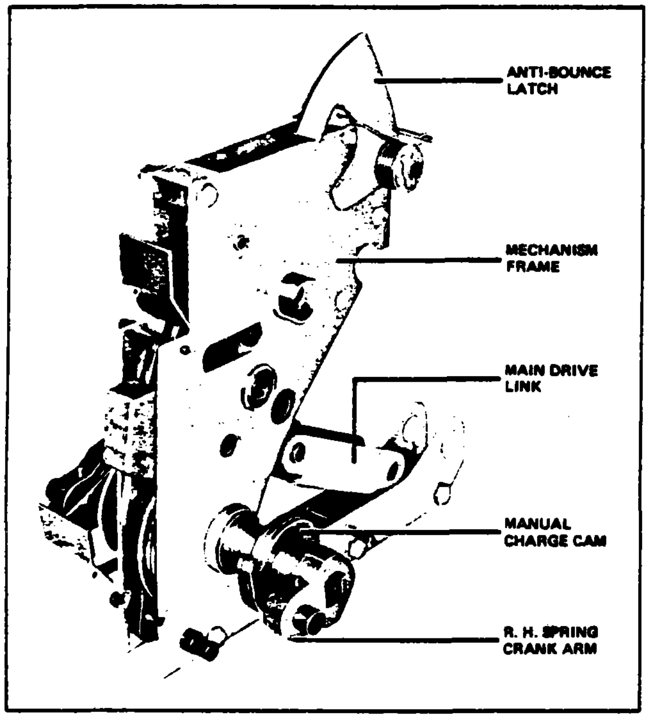


Fig. 10 *Front View of Mechanism (Manual Spring Charge Except for DS-632/840) (383035)*

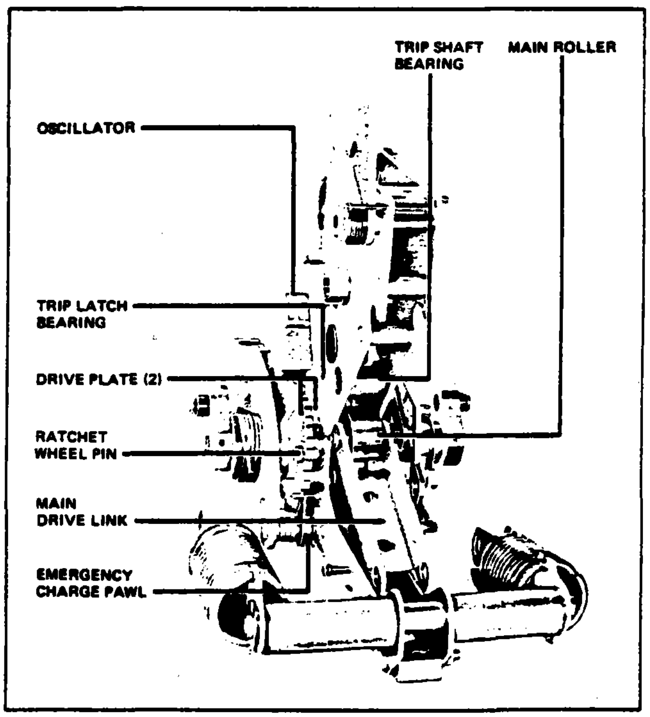


Fig. 12 *Rear of Power-Operated Mechanism (385303)*

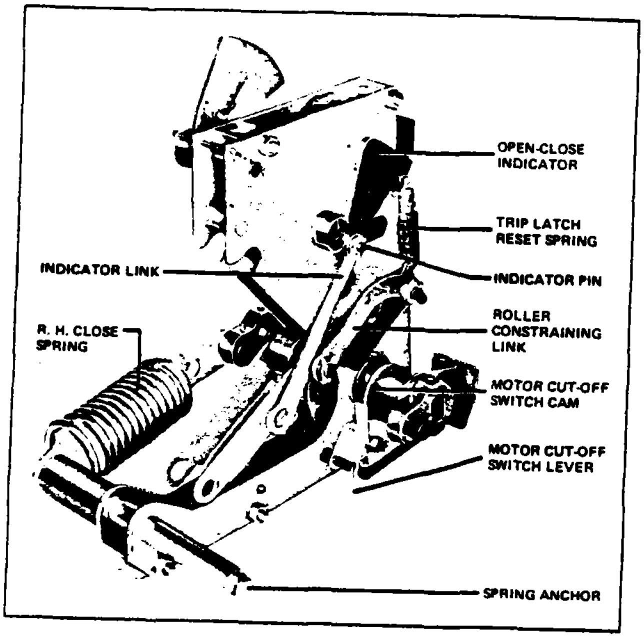


Fig. 13 *Rear View of Mechanism (Left Close Spring Removed) (383034)*

5.1.1 Power-Operated Mechanism

In the power-operated version, the mechanism is equipped with a universal-type motor for automatic charging of the closing springs. It is equipped with a spring release device for electrically closing through a control switch push-button, or other circuit-making device. A shunt trip device is supplied for remote tripping through a control switch, relay, etc. In the absence of control voltage, or whenever desirable, the closing spring can be charged by hand with the emergency charging handle. Hand closing of the breaker can be done by means of the close bar. Hand opening of the breaker can be done by means of the trip plate.

5.1.2 Explanation of Spring-Charging Mechanism for Power-Operated Breakers

Figure 14 is an isometric diagram of the principal parts of a completely power-operated mechanism.

Figure 15 is a front view drawing showing the principal parts of the spring-charging portion of this mechanism. Other parts are omitted for clarity. Figures 16a and 16b show in greater detail the major parts of the spring-charging mechanism in the two basic positions:

Closing springs charged (16a).

Closing springs discharged (16b).

Referring to Figure 15, the basic elements are mounted on the crank shaft (8). This is a straight shaft with four flats machined on it, and a crank arm (11) attached to each end. Each crank arm connects to its closing spring (9) by a formed spring end (10) Figure 16b. The rear of the springs anchor to the rear of the mechanism frame. The crank arms (11), motor cutoff switch cam (7), close cam (6) and two drive plates (25) have matching flats; and are thus anchored to the crank shaft. The spring charge indicator (12) ratchet wheel (17), oscillator (30), and emergency charge device (26) do not have internal flats but are mounted on separate bushings and are free to rotate on the crank shaft.

Figure 17 is an exploded view of the crankshaft parts.

Figure 16a is a view looking into the right end of the crankshaft, and shows the position of the components when the springs are charged.

Figure 16b is a partial view with the springs discharged.

The motor crank shaft assembly (29), carrying a roller for driving the oscillator, is pivoted in the right hand mechanism side frame. The hold pawl (18) is mounted by means of a pin on the mechanism side frame as shown.

In operation, rotation of the motor crank pushes the oscillator arm counterclockwise to make the oscillator pawl (28) push a tooth in the ratchet wheel (17) and rotate the ratchet wheel slightly more than one tooth in the counterclockwise direction. The holding pawl snaps behind the corresponding advanced tooth, and holds it against the torque of the closing springs while the oscillator arm rotates back clockwise to catch another ratchet tooth. Thus the ratchet wheel is rotated counter-clockwise until the ratchet wheel pin (21) engages the two drive plates (25) which in turn rotate the crank shaft and the crank arms in the same direction until the arms are slightly past horizontal dead center. Since the close cam (6) is rigidly mounted on the crank shaft, the same as the drive plates, it has rotated the same amount as the plates. The close cam carries a stop roller as shown in Figure 22b. Just after horizontal dead center of the crank arms is reached, the torque of the closing springs starts to rotate the crank, independently of the driving motor. However, the stop roller on the close cam quickly stops the movement of the crank at only a few degrees over center and holds it there by coming against the spring release latch. This is the "spring charged" position. The motor cut-off switch cam (7) operates the switch (15) through a lever (13) at this time, and the motor stops.

At the instant that the springs snap over dead center, the lobes of the drive plates raise the pawl lifters (27), and prevent the oscillator pawl (28) from engaging the next tooth in the ratchet wheel. Thus the oscillator is free and renders the exact stopping point of the motor not critical.

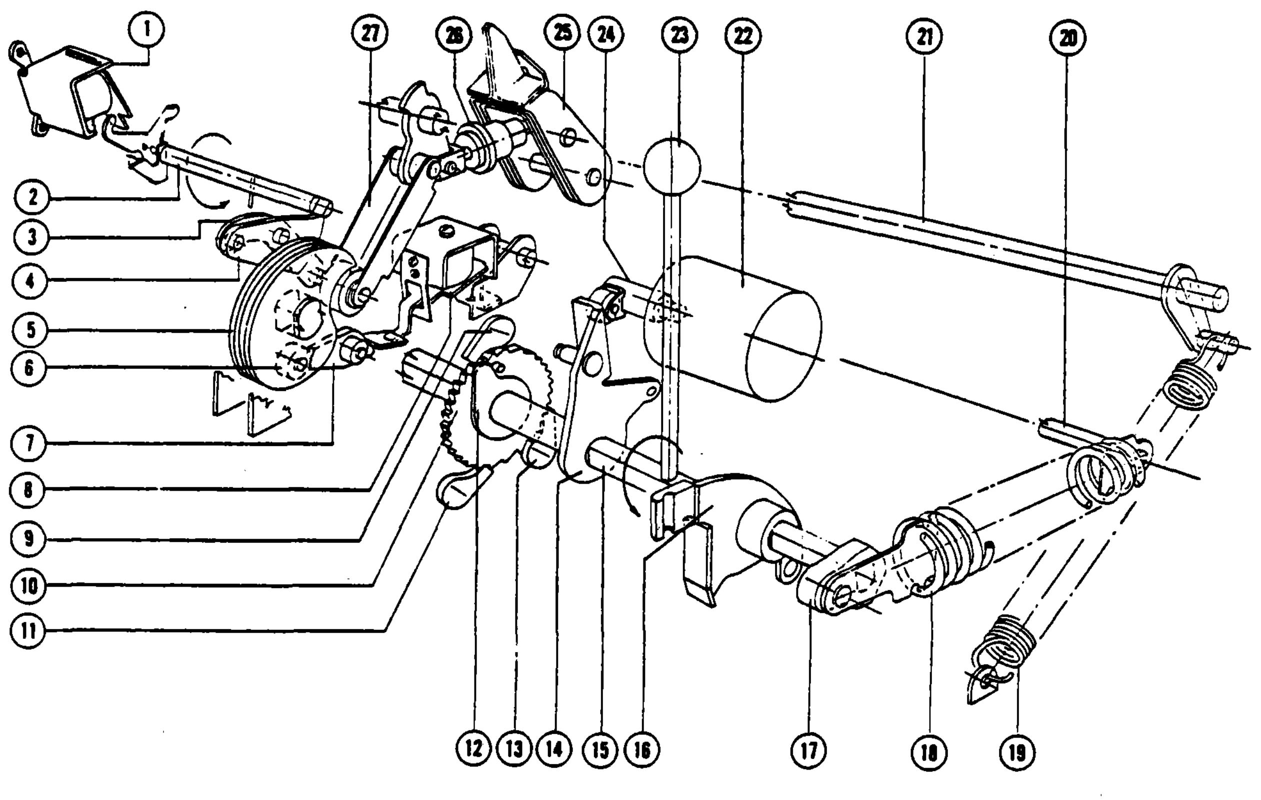
When the spring release latch is moved below the level of the stop roller, as later described, the close cam is free to rotate; and the two closing springs rotate the crank-shaft counterclockwise to close the breaker contacts. They assume the position shown in Figure 16b and the cam as in 22c. During rotation, the drive plates move away from the ratchet wheel pin. The ratchet wheel does not rotate during the closing operation thus preventing excessive wear on the teeth and pawls.

Power-operated breakers are also equipped for emergency hand charging the closing springs. Refer to Figure 21. This operation is similar to that of the motor and oscillator except a separate emergency charge pawl (33) is used to advance the ratchet wheel (17) several teeth on each stroke of the charge handle (34). This device (26) also pivots on the crank shaft.

5.1.2.1 Power Operation

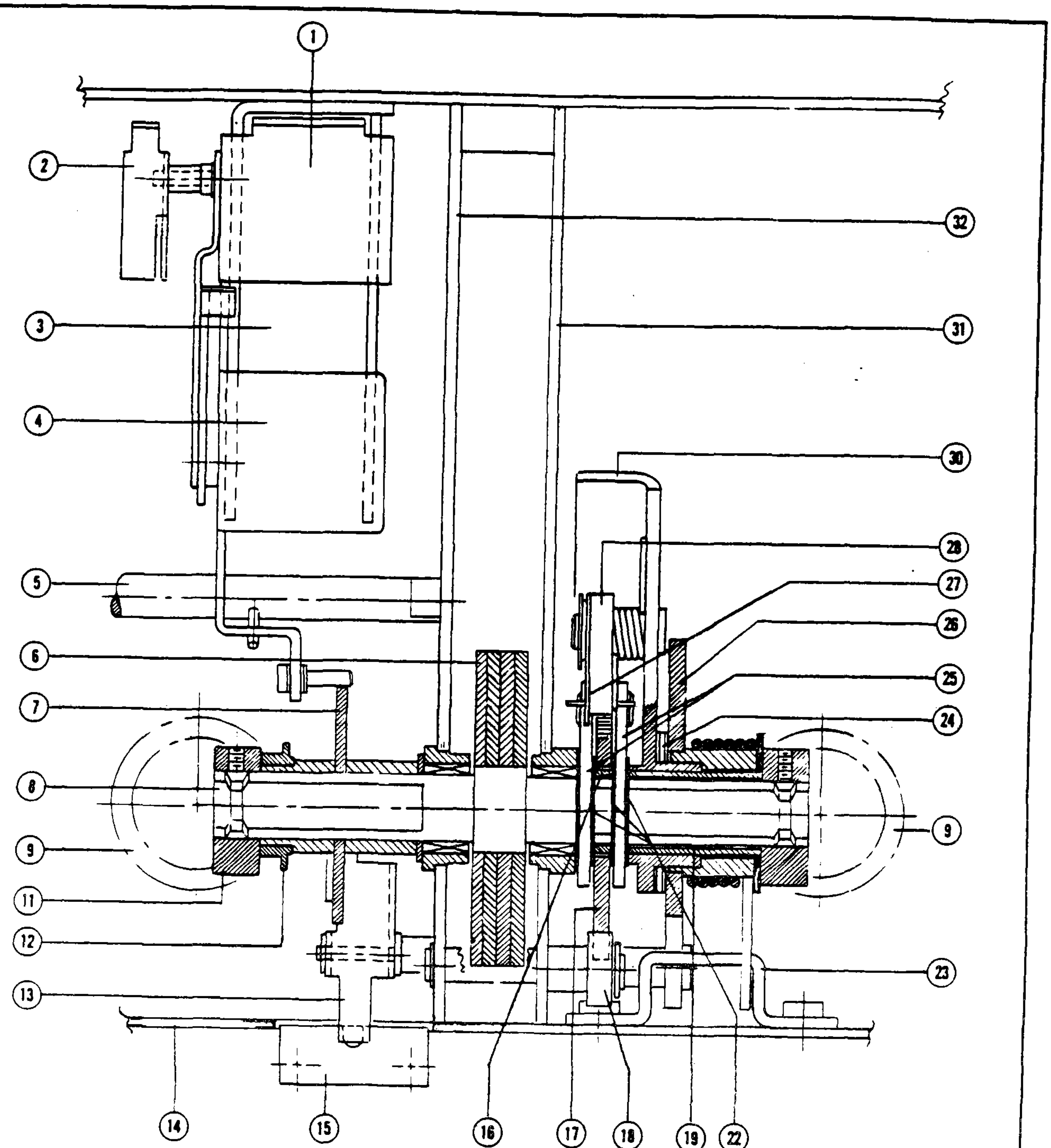
The electrical operation of the spring-charging motor circuit is as follows:

The standard basic schematic and connection diagrams are shown in Figure 19a and b. Device Y is the anti-pump relay.



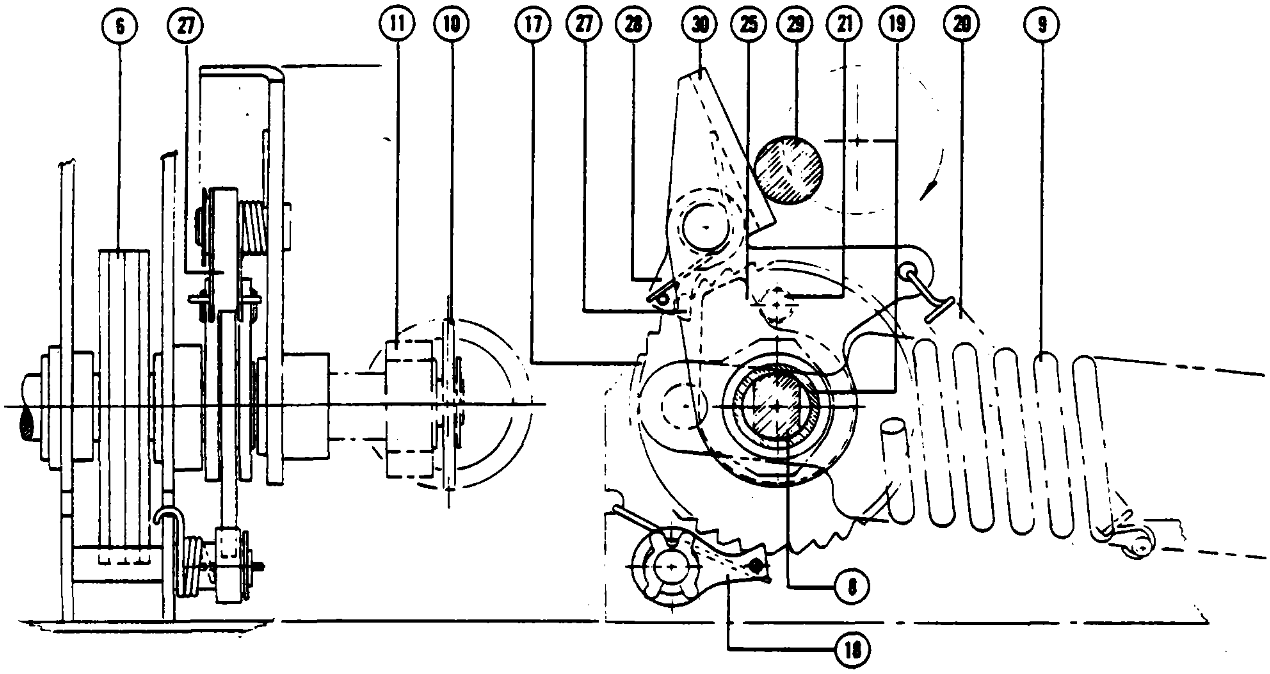
1. Shunt Trip Device
2. Trip Shaft
3. Roller Constraining Link
4. Trip Latch
5. Close Cam
6. Stop Roller
7. Spring Release Latch
8. Spring Release Device
9. Oscillator Pawl
10. Ratchet Wheel
11. Hold Pawl
12. Drive Plate
13. Emergency Charge Pawl
14. Oscillator
15. Crank Shaft
16. Emergency Charge Device
17. Crank Arm
18. Closing Spring
19. Reset Spring
20. Closing Spring Anchor
21. Pole Shaft
22. Motor
23. Emergency Charge Handle
24. Motor Crank and Handle
25. Moving Contact Assembly
26. Insulating Link
27. Main Drive Link

Fig. 14 *Arrangement of the Principal Parts of a Power Operated Mechanism. The Close Spring is Shown in the Charged Position*



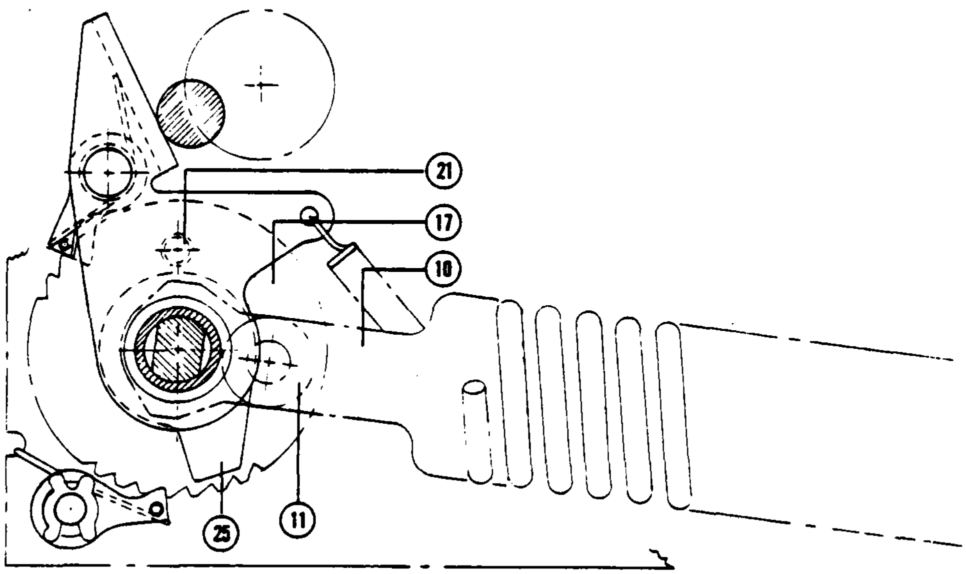
1. Shutter
2. Levering Device Indicator
3. Levering Mechanism
4. Trip Plate
5. Trip Shaft
6. Close Cam
7. Motor Cut-Off Switch Cam
8. Crank Shaft
9. Closing Spring
11. Crank Arm
12. Spring Charge Indicator
13. Motor Cut-Off Switch Lever
14. Draw Out Unit Base
15. Motor Cut-Off Switch
16. Ratchet Bushing
17. Ratchet Wheel
18. Hold Pawl
19. Oscillator Bushing
22. Spacers (3)
23. Stop Bracket
24. Thrust Bearing and Races
25. Drive Plates (2)
26. Emergency Charge Device
27. Pawl Lifter
28. Oscillator Pawl
30. Oscillator
31. Mechanism Side Frame, Right Hand
32. Mechanism Side Frame, Left Hand

Fig. 15 *Front View Showing Major Parts of the Crank Shaft Assembly. Some Parts are Omitted for Clarity*



a) Spring Charged

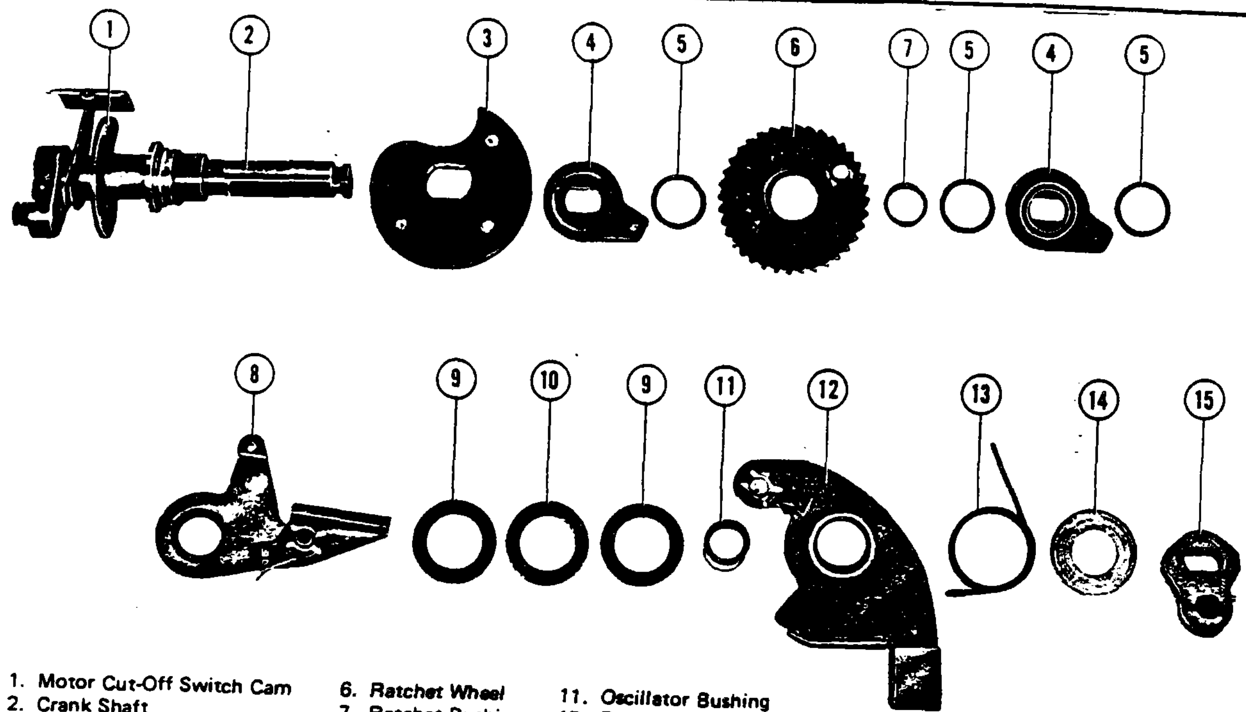
Note: Main cam position for this crank shaft position is shown in Fig. 22a



b) Spring Discharged

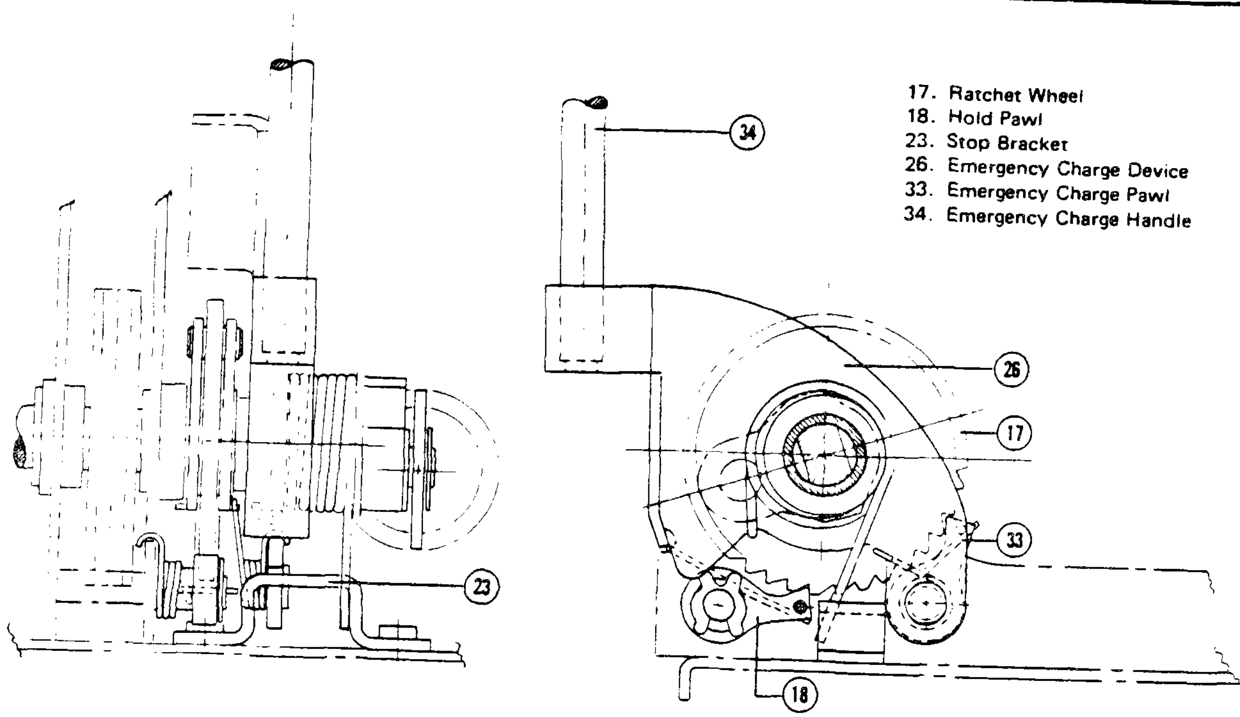
6. Close Cam
8. Crank Shaft
9. Closing Spring
10. Spring End
11. Crank Arm
17. Ratchet Wheel
18. Hold Pawl
19. Oscillator Bushing
20. Oscillator Spring
21. Ratchet Wheel Pin
25. Drive Plate
27. Pawl Lifter
28. Oscillator Pawl
29. Motor Crank Roller
30. Oscillator

Fig. 16 *Power-Operated Spring-Charge Details*



1. Motor Cut-Off Switch Cam
2. Crank Shaft
3. Close Cam
4. Drive Plate
5. Precision Spacer
6. Ratchet Wheel
7. Ratchet Bushing
8. Oscillator
9. Bearing Race
10. Thrust Bearing
11. Oscillator Bushing
12. Emergency Charge Device
13. Charge Device Return Spring
14. Spring Retainer
15. Crank Arm

Fig. 17 *Crank Shaft Assembly of Power-Operated Mechanism (385304)*



17. Ratchet Wheel
18. Hold Pawl
23. Stop Bracket
26. Emergency Charge Device
33. Emergency Charge Pawl
34. Emergency Charge Handle

Fig. 18 *Emergency Spring-Charge on Power Operated Mechanism*

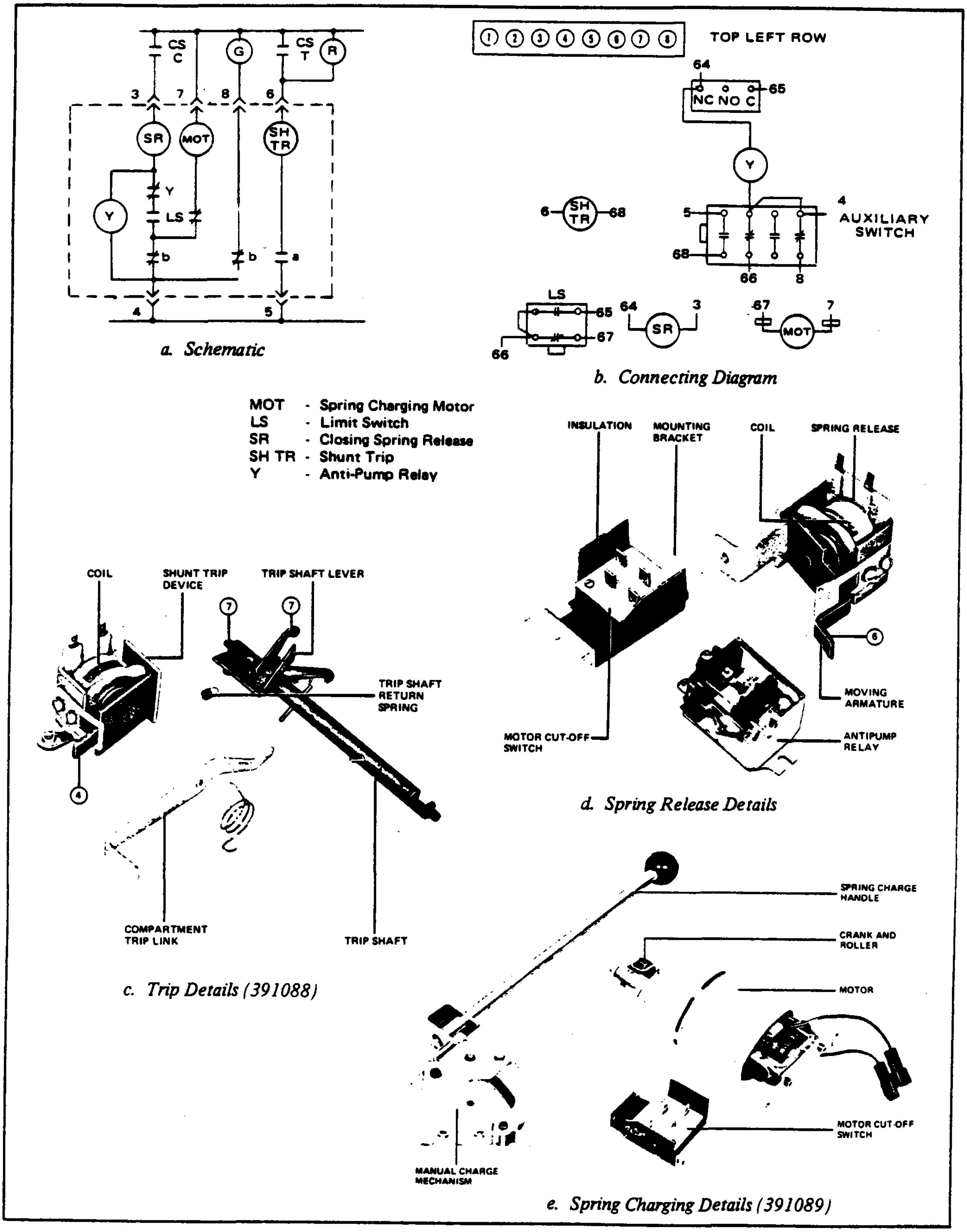


Fig. 19 *Standard Schematic and Connection Diagrams for Power-Operated Breakers and Trip, Spring Release, Spring Charging Details*

With the breaker open and springs discharged, the motor is energized through the limit switch (LS) and the "b" contact. The green indicating lamp (G) is controlled by a separate "b" contact, and when lit indicates that the breaker is open.

Motor runs and charges the closing springs.

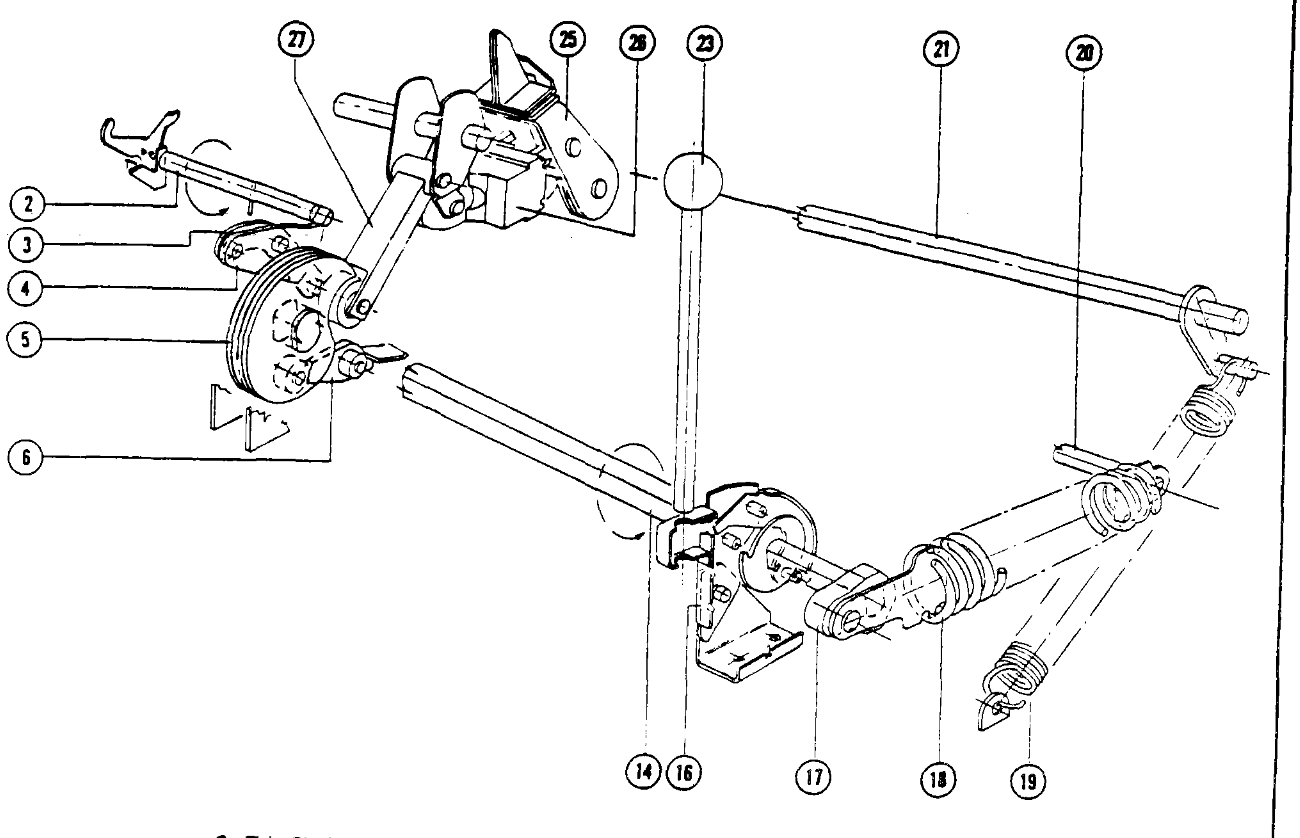
When the springs are fully charged, limit switch (LS) opens in the motor circuit and closes in the spring release coil (SR) circuit.

When the close contact (CS-C) makes, the spring release coil (SR) is energized through the normally closed "Y" contact, the limit switch (LS), and breaker "b" contacts. This releases the latch holding the stop roller on the close cam.

Springs are released to close the breaker. When the breaker closes, the "b" contact opens to cut off spring release coil and motor, and limit switch (LS) contacts reset.

If the close contact (CS-C) is maintained, the "Y" relay will be picked up by the current through the SR coil, and will open its "Y" contact in the SR circuit. This allows only one close operation until the close contact (CS-C) has been reset. The "Y" coil has a very low drop-out voltage.

On some circuit breakers a special closing circuit may be provided which permits the closing springs to be automatically recharged immediately after the breaker is closed instead of only after the breaker is opened. This is accomplished by separating the motor and limit switch



2. Trip Shaft
3. Roller Constraining Link
4. Trip Shaft
5. Close Cam
6. Spring Release Latch
14. Crank Shaft
16. Manual Charge Device
17. Crank Arm
18. Closing Spring
19. Opening Spring
20. Closing Spring Anchor
21. Pole Shaft
23. Manual Charge Handle
25. Moving Contact Assembly
26. Insulating Link
27. Main Drive Link

Fig. 20 *Principal Parts in a Manually Charged Spring Operated Mechanism.*

from the "b" contact so the motor operation is independent of the position of the breaker contacts. This arrangement makes the breaker suitable for use with instantaneous reclosing relays or in special operating sequences.

The standard control utilizes AC or DC control power. For 240 or 120 volt AC equipment, the control power may be taken direct from the source through fuses. For 480 and 600 volt operation, a suitable control power transformer is used. The transformer is optional for 240 volt systems. DC control voltages are 48, 125 or 250.

When the breaker closed, the "a" contact in the shunt trip (SH-TR) coil circuit also closed to complete this trip circuit. The red indicating lamp (R) supervises the shunt trip circuit to show that it is in working order, and indicates that the breaker is closed.

When control power is turned on, any power-operated breaker in the test or connected position with its springs discharged will have its motor energized until the closing springs are charged.

5.1.3 Manual-Operated Mechanisms

On manually operated breakers, the closing spring can be charged only by hand, as described in Section 4.2. As usually equipped, the breaker can be closed only by hand, with the close bar. As an optional extra, a closing spring release device can be supplied on these breakers.

Hand opening of the breaker can be done only by means of the trip plate; however a shunt trip device can be supplied as an optional extra.

5.1.4 Explanation of Spring-Charging Mechanism for Manually-Operated Breakers

Figure 20 is another isometric diagram to illustrate the mechanism in a manually operated breaker. For sake of clarity, the actuator has been omitted.

Figure 21 gives the details of this spring-charging device which is located between the mechanism right hand side frame and the right crank arm. A part of this assembly is the manual charge cam which is rigidly fixed to the crank shaft, the same as the main close cam and crank arms.

The other parts are the front crank assembly which is pivoted to a bracket fastened to the main frame base, and has a socket for the manual charge handle. The rear crank is pivoted to the front portion and has a cross-wise pin on the end. A spring forces this pin against the cam. Another spring holds the front crank assembly in a clockwise direction against a stop, so that the manual spring-charge handle socket is normally upright in the unused position.

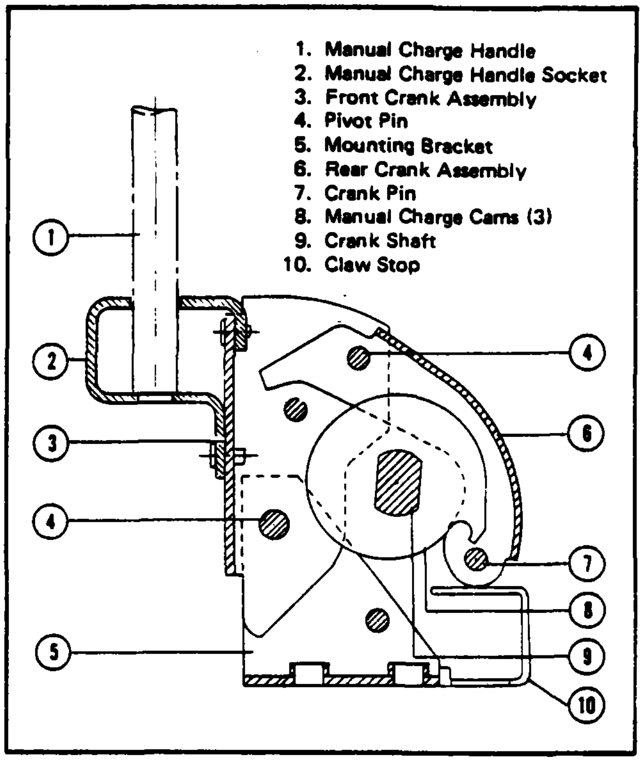


Fig. 21 *Spring-Charging Mechanism on Manual Operated Breakers*

The manual charge cam is mounted on the crank shaft so that the crank pin hooks behind the hook-shaped surface of the manual charge cam as shown, when the handle is upright and the springs discharged. The springs are fully charged by a 90 degree counterclockwise rotation of the handle. The crank spring then returns the assembly to the handle-upright position. In operation this means a single downward stroke from vertical to approximately the horizontal position. As the "Spring charged" position is reached, the handle becomes effortless to turn and the closing spring crank arms snap over center.

It is possible to manually recharge the closing springs immediately after closing the breaker and before it has been tripped open. This results in the springs loading the associated bearings and latches for long periods. Also an extra close operation, or trip-free operation, will be necessary on levering the breaker to the disconnect and remove positions. Therefore, it is recommended that the springs be charged just prior to the closing of the breaker.

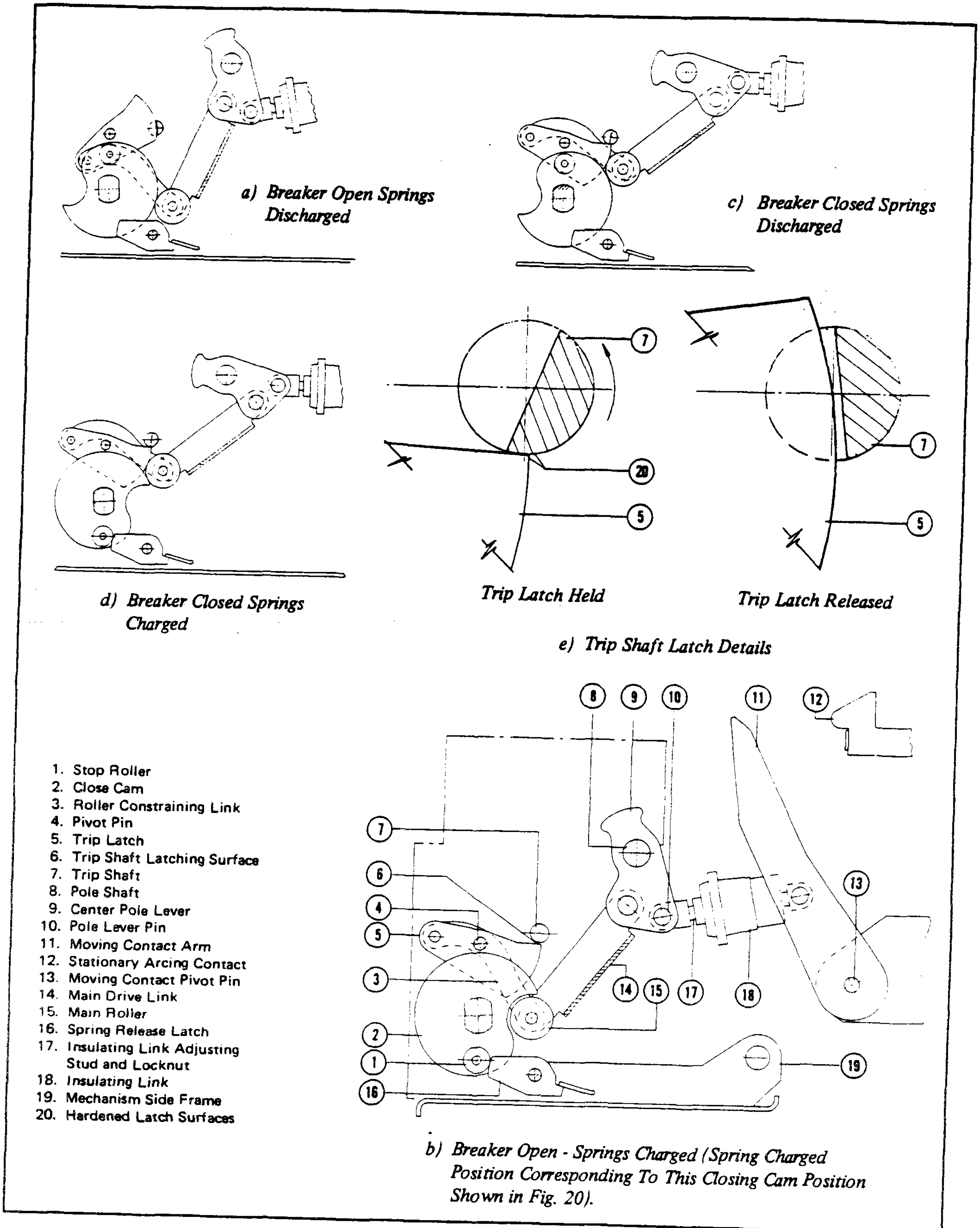


Fig. 22 *These Sketches Show the Four Basic Positions of Breaker and Linkage with Enlarged View of Trip Shaft and Latch*

5.1.5 Circuit Breaker Closing Mechanism

This mechanism is of the general variety of mechanically trip-free mechanisms. This means that the breaker can be opened or tripped free from the closing mechanism at any point in its closing stroke. It also means that if the trip latch is held in the "trip" position while the spring release latch is released, the closing springs will make a trip-free operation but the breaker contacts will not close or move appreciably toward the closed position.

Based on this construction, the breaker close and trip linkage can have four steady state conditions. The arrangements of the basic close and trip linkage for these four conditions are shown in Figures 22a, 22b, 22c, and 22d as follows:

Figure 22a Breaker Open, Springs Discharged, Trip Latch Not Reset.

Figure 22b Breaker Open, Springs Charged, Trip Latch Reset.

Figure 22c Breaker Closed, Springs Discharged.

Figure 22d Breaker Closed, Springs Charged.

The angular position of the close cam in Figure 22a corresponds to the angular position of the drive plates and closing spring crank arms shown in Figure 16b. The trip latch is in the tripped position and it will reset to the latched position at the end of the spring charging stroke. The closing springs are charged by counterclockwise rotation of the ratchet and drive plates until the close cam stop roller meets the spring release latch, as shown in Figure 22b.

Note in Figure 22b also that the lower end of the main drive link, with the main roller, has swung upward and toward the left, pushing the trip latch constraining link so as to rotate the trip latch back to the reset position. This occurs at the same time that the spring charge is complete and just before the close cam stop roller strikes the spring release latch. The position of the cam in Figure 22b corresponds to the position of the drive plates in Figure 16a spring charged, breaker open.

The breaker is now ready to be closed. Closing is started by counterclockwise rotation of the spring release latch. Refer again to Figure 22b. This removes the hold on the close cam stop roller, and allows the force of the closing springs to rotate the close cam counterclockwise

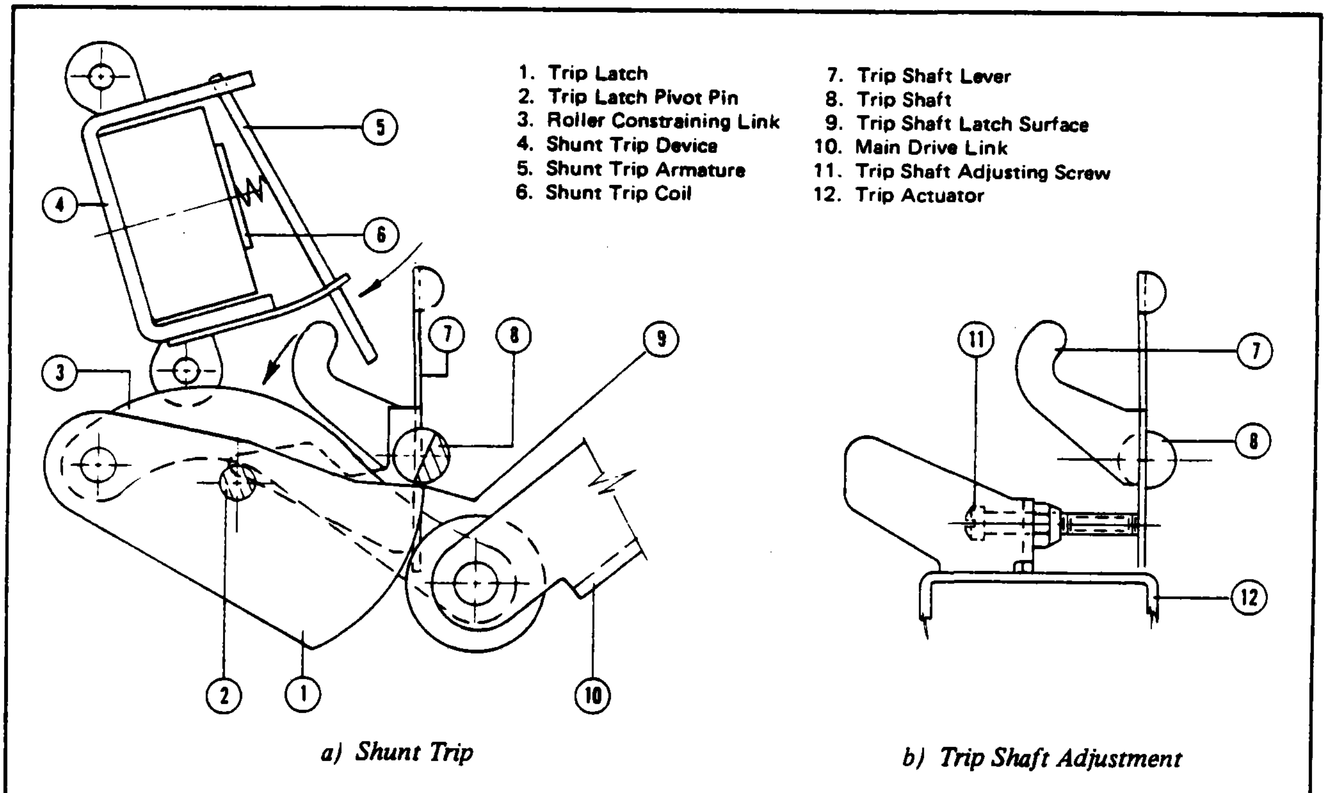


Fig. 23 *Shunt Trip Details Showing Trip Shaft Adjustment*

and close the breaker. The linkage is then in the position shown in Figure 22c. The close cam has rotated about 180 degrees.

The spring release latch can be rotated by two methods:

1. By the spring release device on power-operated breakers, as shown in Figures 14 and 31b.

2. By the close bar, through the linkage shown in Figure 31b.

5.1.6 Circuit Breaker Tripping or Opening Mechanism

Referring to Figure 22c showing the breaker in the closed position, the breaker is tripped open by counterclockwise rotation of the trip shaft. The trip shaft extends across the left hand part of the breaker, from the left hand mechanism side sheet to the left hand breaker side sheet; and can be rotated by several devices as later described.

Rotation of the trip shaft accomplishes breaker opening as follows: Staying with Figure 22c, the main contacts (not shown) produce a clockwise twisting force or torque on the pole shaft. This is transmitted by the center pole lever downward through the main drive link to the main roller. The main drive link at the main roller is connected to the trip latch by the roller constraining link. The downward force on the main drive link results in a pulling force on the roller constraining link. This force tends to rotate the trip latch counterclockwise, but the trip latch is kept from rotating by overlap of the latch surface of the trip shaft. A very small rotation of the trip shaft thus releases the trip latch to rotate counterclockwise to the position shown in Figure 22a. The enlarged views of the trip shaft and trip latch tip in Figure 22e show in detail the rotation of the trip shaft for release of the trip latch. Thus the entire linkage collapses under the force of the main contacts and comes to rest with the breaker open, as in Figure 22a. Note that the trip latch is still in the released position, i.e., not reset.

If the breaker stands open with springs charged as in Figure 22b, and if the trip shaft is held in the rotated or trip position, an attempt to close will result in a trip-free operation. This is so because, with the trip shaft in the trip position, there is no restraint on the trip latch, so no force is applied to the main link to close the breaker.

Although certain interlocking operations may or will result in this trip-free type of operation, it causes some

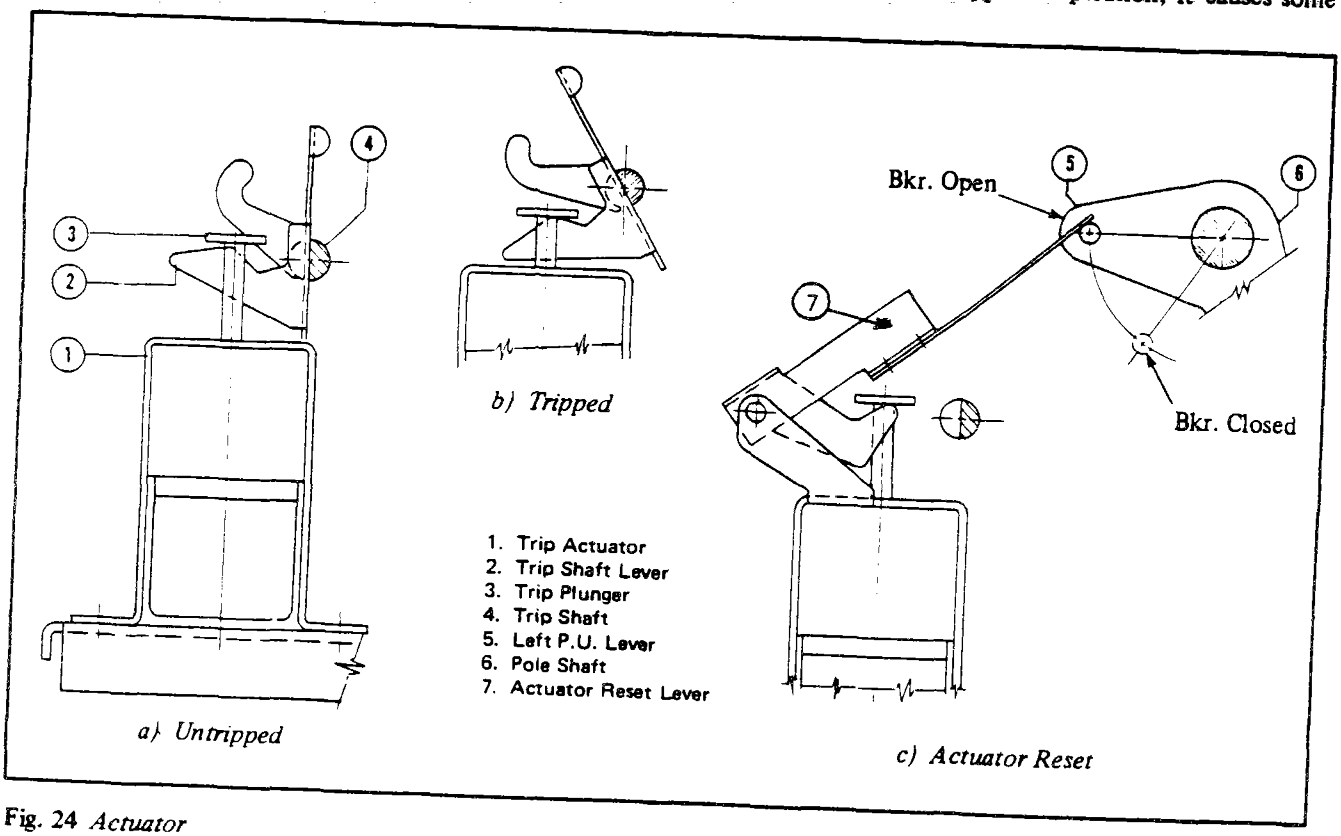


Fig. 24 *Actuator*

extra shock on the mechanism parts. Therefore trip-free operations should be avoided.

The trip shaft can be rotated to trip the breaker in the following ways:

1. By hand push on the trip plate. As shown in Figure 27, this item has a tab which pushes against a pin on the trip shaft which applies a direct rotating force on the shaft in the tripping direction.

2. By shunt trip device, as shown in Figure 23a. The armature of the clapper-type electro magnet pushes on a lever on the trip shaft to rotate it in the tripping direction.

3. By action of the actuator, as shown in Figure 24b. A downward pull by the trip plunger pulls on a lever from the trip shaft to rotate it in the tripping direction.

4. By action of the trip plate on the front of the breaker compartment door (providing the breaker is in the connected position.) A flap on the breaker compartment hinged door, operating through a sliding link and lever fastened to the cradle move the compartment trip lever extending from the bottom of the drawout unit. Refer to Figures 25 and 26.

5. An undervoltage trip device is available as an accessory, and will directly operate the trip shaft. This is shown in Figures 67 & 68, and its operation is covered in Section 8.7.1.

6. Blown Limiter Indicator. See Fig. 80.

5.1.6.1 Miscellaneous Details

Figure 26 shows a bottom view of the breaker drawout unit. Visible in this picture are details as follows:

1. The Interference Interlocks

These are Z-shaped brackets which prevent circuit breakers with insufficient interrupting ratings (or mis-matching disconnects) from being inserted into wrong compartments.

This compartment	Will accept these breakers
DS-206	DS-206
DS-206S	DS-206S, DS-416, DS-416S, DS-420
DS-416	DS-416, DS-416S, DS-420
DS-416S	DS-416S, DS-420
DS-420	DS-416S, DS-420
DSL-206	DSL-206
DSL-416	DSL-416

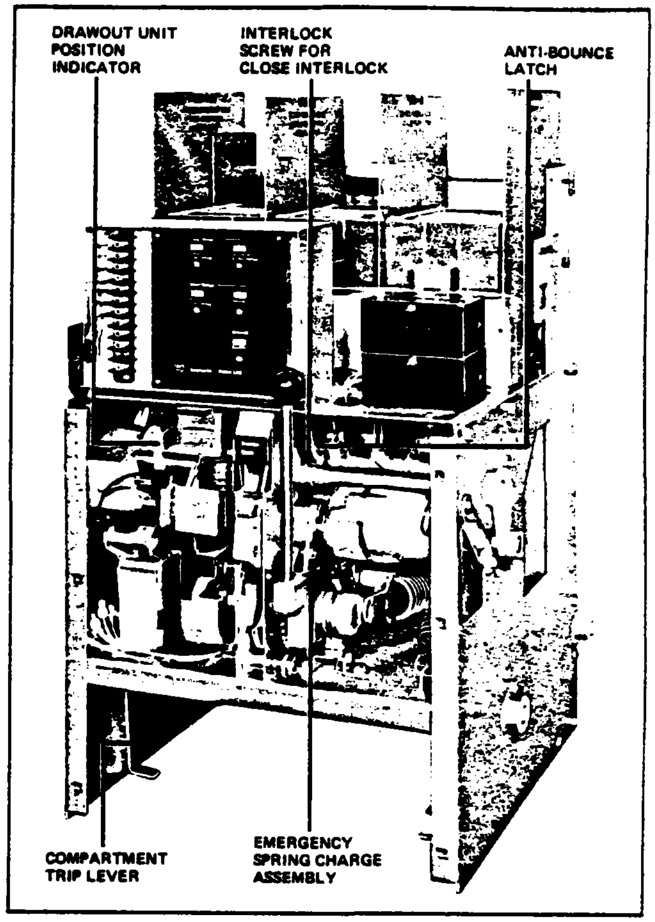


Fig. 25 *DS-632 Breaker with Front Panel Removed (391063)*

2. Ground Contact

This contact engages a corresponding contact on the compartment floor and provides positive grounding of the breaker frame.

3. Motor Cut-Off Switch

On power-operated breakers this switch disconnects the motor when the charging of the closing springs is com-plete. It is operated by motor cut-off switch lever shown in Figures 13 and 15, which also operates the spring charge indicator.

4. Seismic Positioner

Seismic Positioner increases the rigidity of the breaker to withstand sideways forces due to vibrations on earthquake condition. As shown in Figure 26b, it is mounted on the top rear of the breaker pole unit frame and engages with a spring loaded counterpart in the enclosure.

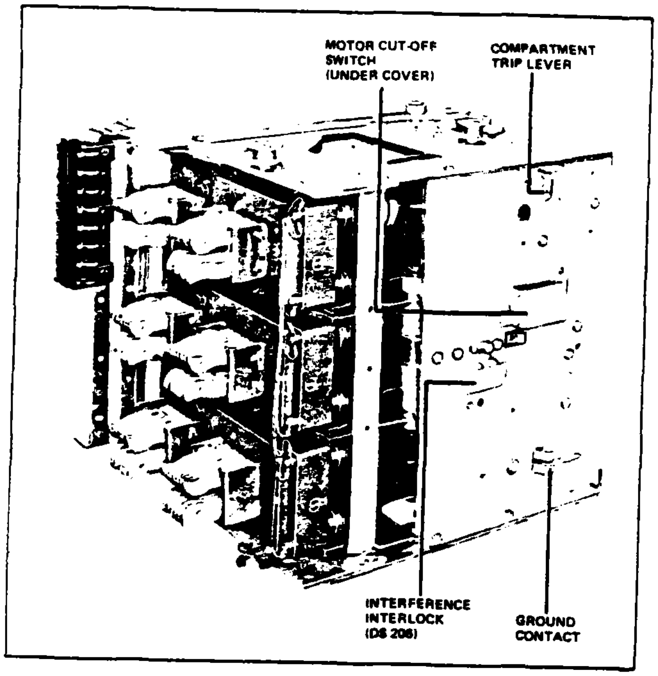


Fig. 26a *Bottom View of Breaker Unit Showing Interference Interlock, Motor Cut-off Switch and Other Details not Visible from Above*

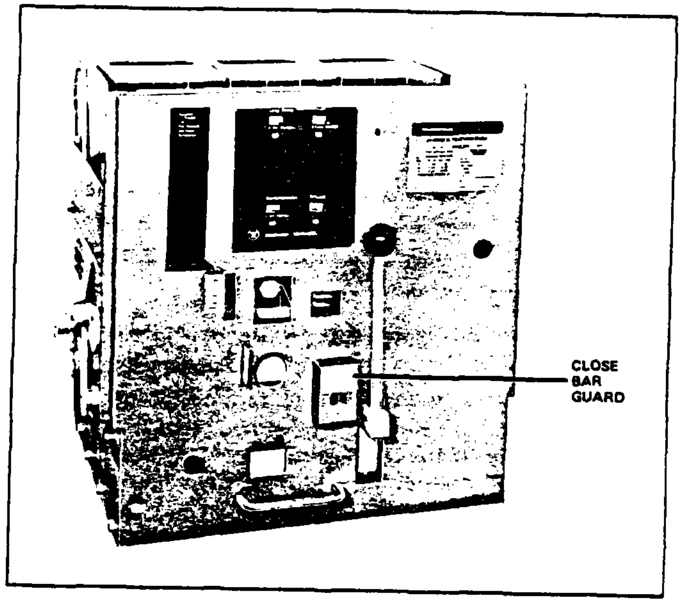


Fig. 26c *Front View Showing Close Bar Guard (391071)*

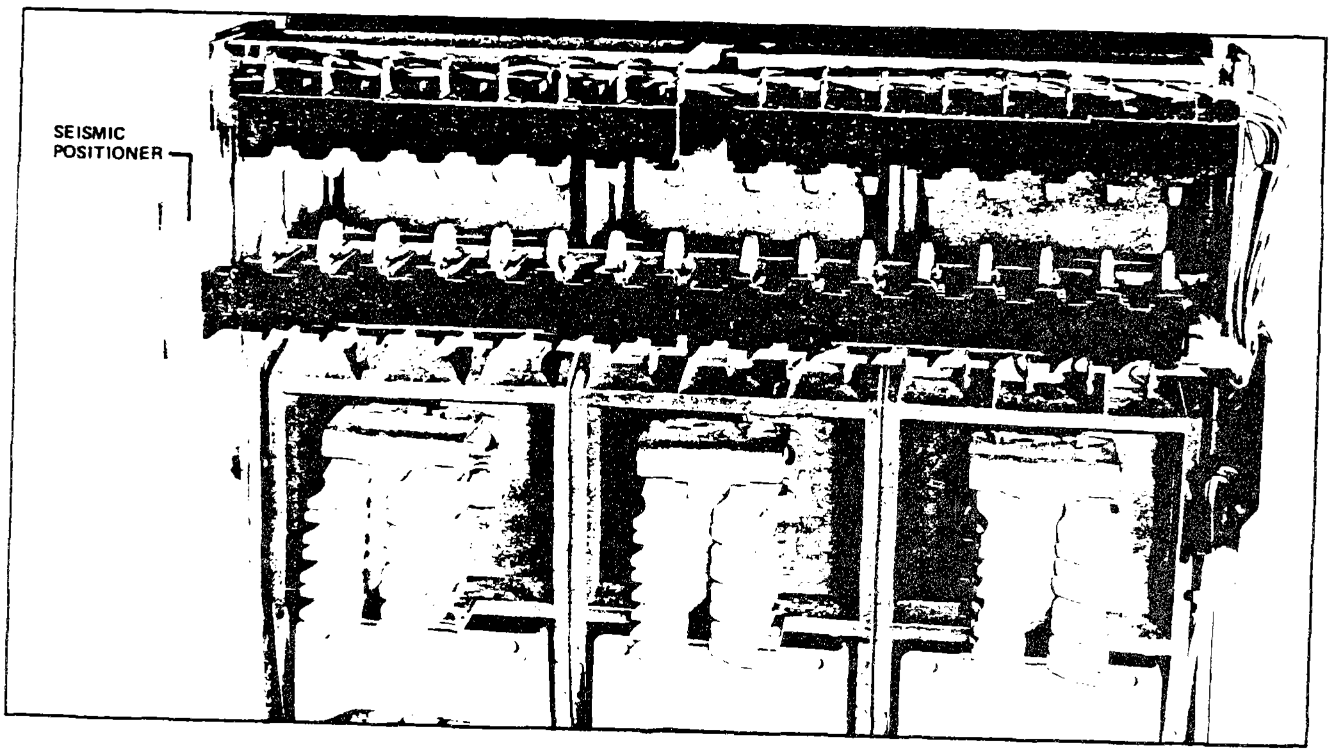


Fig. 26b *Rear View Showing the Seismic Positioner (75010-2)*

5. Close Bar Guard

This covers the close bar to prevent unintentional manual closing of the breaker. It is mounted on the front panel to cover the close bar. In case of emergency, the breaker may be closed by pushing the close bar through a small hole in the cover. See Figure 26c.

6. Operation Counter

Mechanical counter mounted under the top plate below the auxiliary switch provides the record of the number of breaker operations. The counter is connected through linkage to the pole shaft.

5.1.7 Mechanical Interlocking, Description and Explanation of Operation

To increase safety to personnel and the circuits to which the breaker is connected, the complete unit is equipped with automatic mechanical interlocking. This interlocking is effective in various ways in the four breaker positions (Figure 27):

WARNING

DO NOT TAMPER WITH INTERLOCKING, AND IF IS NOT FUNCTIONING, HAVE IT CORRECTED. INTERLOCKING THAT IS FUNCTIONING IMPROPERLY CAN RESULT IN MECHANICAL AND ELECTRICAL DAMAGE TO EQUIPMENT AND BODILY INJURY TO PERSONNEL.

a. The REMOVE position.

b. The DISCONNECT position.

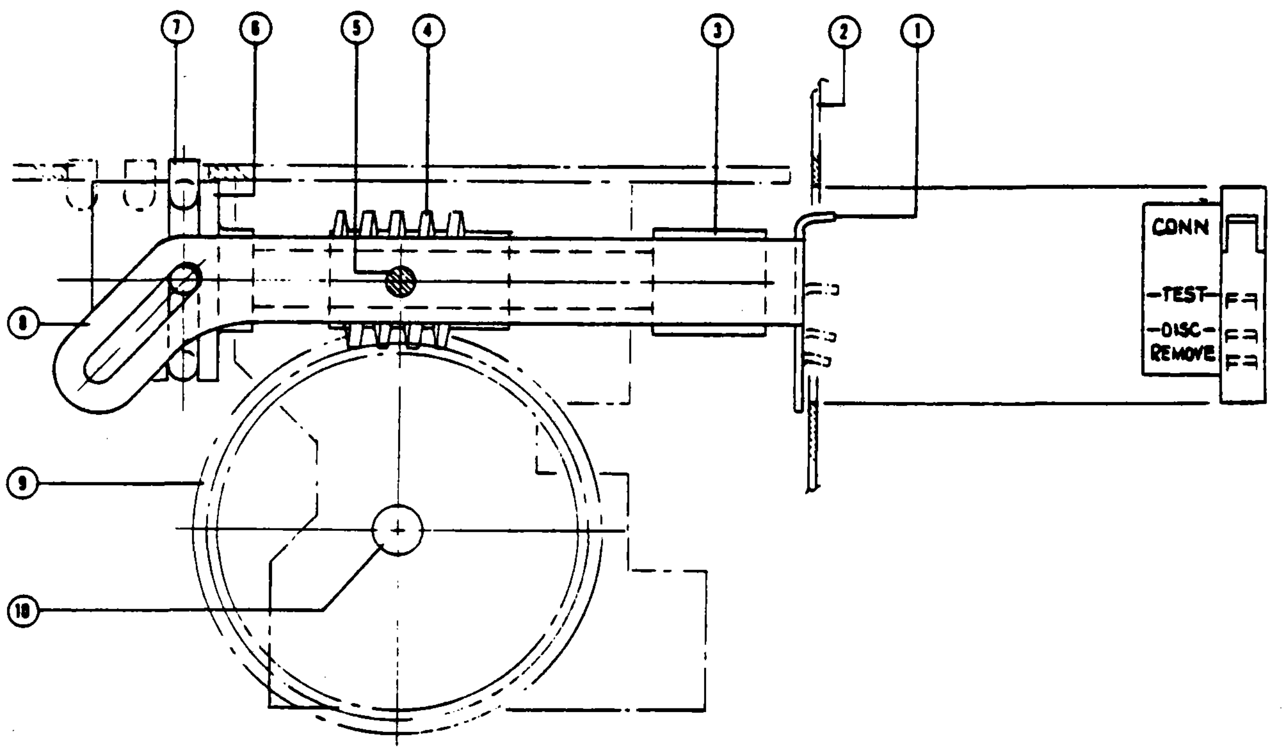
c. The TEST position.

d. The CONNECT position.

In addition there is an interference interlock described in Section 5.1.6.1.

This mechanical interlock system serves basic purposes as follows:

1. In the REMOVE position it prevents the breaker from being closed and prevents the closing springs from being



1. Indicator Index Tab
2. Front Panel
3. Levering Worm Shaft
4. Levering Worm
5. Indicator Pivot Pin
6. Traveling Stop Nut
7. Traveling Stop Nut Clamp
8. Indicator Lever
9. Levering Worm Gear
10. Levering Shaft

Fig. 27 *Drawout Unit Position Indicator* charged or remaining charged. The levering device shutter is held open.

2. In the DISCONNECT position it prevents the breaker from being withdrawn from its compartment.

3. In the TEST position it permits all normal no-load operations of the breaker with the primary disconnect contacts separated.

4. In the CONNECT position it prevents the disconnecting or withdrawal of a closed breaker. This prevents the drawing of dangerous, destructive arcs on the disconnecting contacts if the circuit is loaded.

5. While moving the breaker in either direction between the TEST position and the CONNECT position or the DISCONNECT position; or while standing in any intermediate position, it prevents the closing of the breaker. Therefore it prevents the connecting of the closed breaker to the power circuits. This prevents arcing on the disconnecting contacts as would occur in going into contact with a load on the circuit.

Here are the detailed interlocking conditions which exist in each of the four breaker positions:

5.1.7.1 The REMOVE Position

This is the position of the breaker when nearest the front of its compartment, and is where the breaker must be placed when it is installed after having been completely outside of the compartment. It is the farthest point in the compartment to which the breaker can be withdrawn and still permit the compartment door to be reclosed.

In this position, the following conditions exist:

A. The breaker is open.

B. The closing springs are discharged. If an attempt is made to charge the springs, a trip-free operation will result.

C. The breaker cannot be closed either electrically or by hand.

D. The breaker can be withdrawn from the compartment by direct pull. (The levering device is not engaged with the cradle.)

E. The levering device arms are in a horizontal position with their rollers pointing toward the rear. See Figure 6.

5.1.7.2 The DISCONNECT Position

In this position the breaker has moved only a fraction of an inch into its compartment and will be shown by the position indicator.

In this position the following conditions exist:

A. The breaker will be held in its compartment as the levering rollers have lowered into the slots in the cradle arms.

B. The shutter will close over the levering device hex shaft.

C. The shutter may be locked closed and the breaker held trip-free by a padlock as described in Section 5.1.8.5, thus locking it in the compartment.

D. Both primary and secondary disconnecting contacts are separated.

E. The breaker is open.

5.1.7.3 The TEST Position

This is the position of the breaker when at a point in between the DISCONNECT position and the CONNECT position, as shown by the draw-out position indicator. In this position the main disconnecting contacts are separated enough to permit safe operation of the breaker. However, the secondary contacts are made up.

In this position the following conditions exist:

A. The breaker must arrive in this position-from either direction with its contacts open. Its closing springs may be either charged or discharged when coming from the connected position.

B. When the levering crank handle is removed, it is possible to close and trip the breaker by hand or electrically.

C. Just before the breaker arrives in the TEST position from the DISCONNECT position, the secondary contacts make up and the spring-charge motor automatically runs and charges the closing springs on power-operated breakers.

D. The breaker can be closed by hand, or electrically, after the springs are charged as in paragraph C above.

E. The breaker can be tripped open by hand, or electrically through the shunt trip device.

F. The trip plate on the hinged compartment door will not trip the breaker.

G. The breaker must be open before further levering can be done.

H. The overload tripping characteristics can be visually checked or changed. Amptector trip devices can be electrically checked and calibrated with a portable test kit. (Accessory equipment)

5.1.7.4 The CONNECT Position

This is the position in which both primary and secondary disconnecting contacts on the breaker are engaged with their stationary counterparts in the compartment.

It is the farthest position from the front of the compartment into which the breaker can be levered, as (1) shown by the drawout position indicator, and (2) when the mechanical stop is felt as a sudden increase in load on the levering crank handle.

NOTE

When levering in from the TEST position, an increase in load on the crank handle will be felt as the main disconnecting contacts are engaged. As cranking is continued, the load will decrease some and then suddenly increase as the final connected position stop is reached.

In this position all of the conditions listed for TEST position also exist, except

IN THIS POSITION, DO NOT ATTEMPT TO ELECTRICALLY CHECK THE AMPTECTOR TRIP DEVICE WITH THE TEST KIT OR BY ANOTHER METHOD BECAUSE BREAKER WILL BE TRIPPED AND CAUSE DISRUPTION OF SERVICE.

The trip plate on the hinged compartment door will be operative, and can be used to trip the breaker when this door is closed.

In addition to the above interlocks, the interference interlock described in Section 5.1.6.1 prevents a breaker of the wrong frame size from being placed in a compartment.

5.1.8 Detailed Explanation of Mechanical Interlock System

That part of the interlock system which prevents closing of the breaker while being driven in either direction by the levering device, or while it is standing in any intermediate position between "TEST" and "CONNECT" or "DISCONNECT", is shown in Figure 28a and b. Figure 28a shows the shutter and trip plate for normal operation, such as in DISCONNECT, TEST, or CONNECT positions. The breaker can be closed and tripped open by all available devices in the latter two positions except the trip plate on the hinged compartment door.

In Figure 28a, the shutter prevents pushing the levering device crank handle onto the worm shaft. If the shutter alone is pushed downward, it will rotate slightly about its pivot pin and its lower projection (See Figure 28a) strikes the hook on the trip plate, and the worm shaft will not be cleared. So it is necessary to push the trip plate in, which moves the hook back out of the way of the shutter lower projection. This permits the shutter to be pushed downward to clear the worm shaft for the levering device crank handle, as shown in Figure 28b.

Note that pushing the trip plate in also pushes the trip shaft pin so as to rotate the trip shaft counterclockwise, thus tripping the breaker open. If closing is attempted with the linkage as in Figure 28b, a trip free operation will be made.

Movement of the shutter also is controlled by the interlock cam, mounted on the levering device shaft to the left of the worm gear. The interlock cam has a fixed relation to the levering device arms. Figure 29a, b, c, and d show the relation between the shutter, interlock cam and levering device arms for the four basic positions of the drawout unit in the compartment.

Figure 29a shows the CONNECT position. The cam is in a position to allow free travel of the shutter interlock pin.

Therefore the shutter can be pushed downward, but only after pushing in the trip plate as in Figure 28. This trips the breaker and therefore prevents levering out with the breaker closed.

Figure 29b shows the TEST position. Note that between CONNECT and TEST positions the cam will rotate so as to block the shutter interlock pin. This prevents the shutter returning to its closed position and releasing the trip plate if the levering device crank handle is removed. Thus, if a closing operation is tried during this part of the travel, a trip-free operation occurs and the breaker contacts do not close. Note that this is true for either direction of breaker travel so that no load is made or broken at the disconnecting contacts.

When the breaker gets to the TEST position, a slot in the interlock cam allows free movement of the shutter interlock pin, and the shutter returns to closed position when the crank is removed. The levering device arms are almost vertically downward.

Figure 29c shows the DISCONNECT position. Here also the cam rotates so as to block the shutter interlock pin while the breaker is between positions thus holding the shutter open. When the exact position, as shown on the indicator, is reached, the shutter will close when the

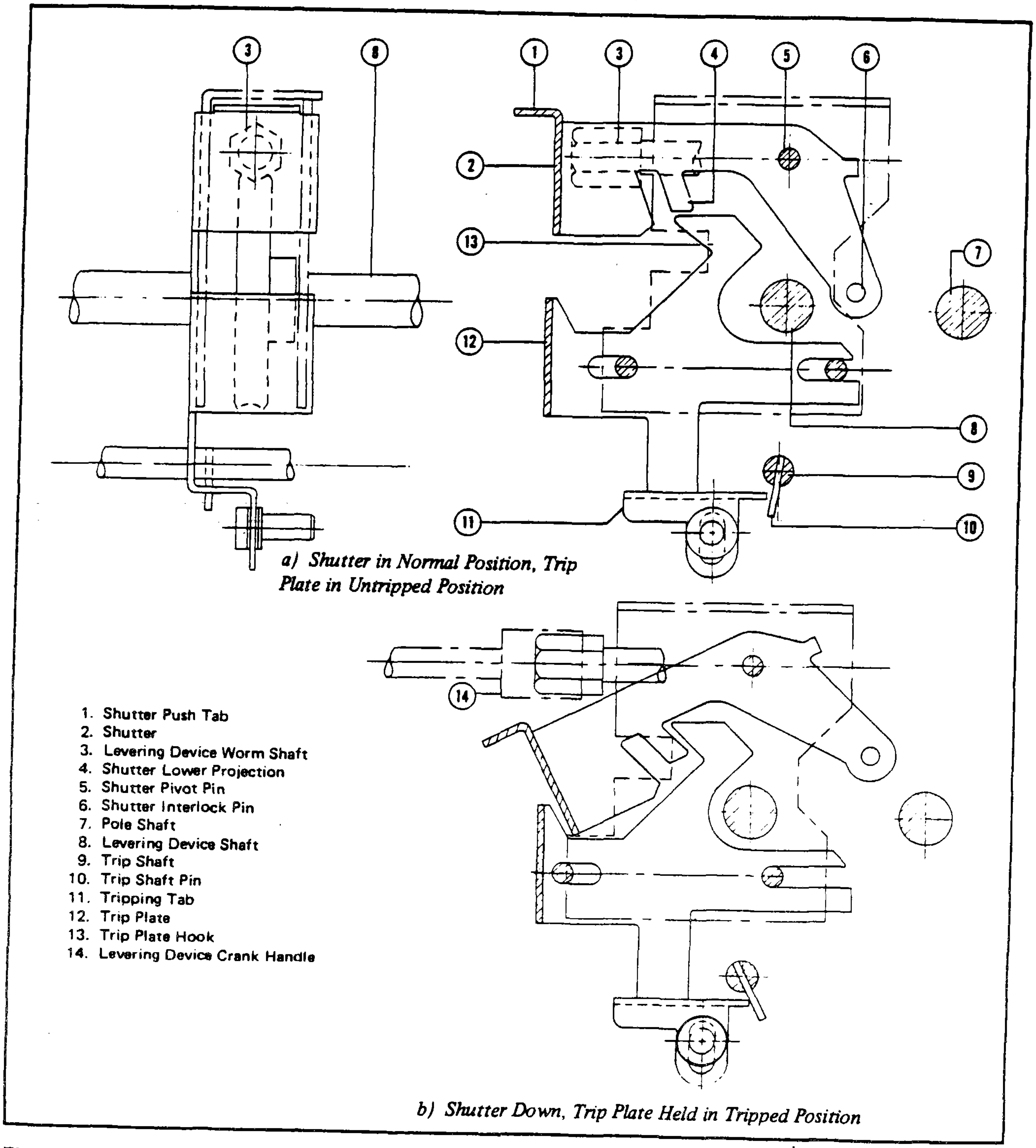


Fig. 28 *Relation of Shutter, Trip Plate, and Trip Shaft*

crank is removed. The levering arms will be approximately 40° below the horizontal.

Figure 29d shows the REMOVE position. Here the interlock cam stops with the shutter interlock pin blocked. Thus the shutter stays down and the breaker stays tripped when the crank handle is removed. The breaker is held trip-free, so it cannot be closed. Also, by another interlock described later, the close-release latch cannot be released.

5.1.8.1 Spring Discharge Interlock

1. The purpose of this interlock is to operate the close-release latch as the breaker is moved out beyond TEST position. This causes a trip-free operation of the closing mechanism because it occurs while the levering device crank handle is necessarily still on the worm shaft, and the closing springs are charged if the breaker is electrically operated. This is because the crank handle is still being used to move the breaker in the final part of its travel to the DISCONNECT position. Thus, the trip plate is still pushed in and consequently the breaker is trip free.

2. Figure 30a, b, c and d shows the essential parts of the spring discharge interlock. a and b show the levering device in the REMOVE position. The Interlock Plate has two horizontal pins 7 and 8 extending from it, as shown in a, b, c and d. The upper one is designated arbitrarily as Pin A and is darkened to distinguish it from Pin B. In

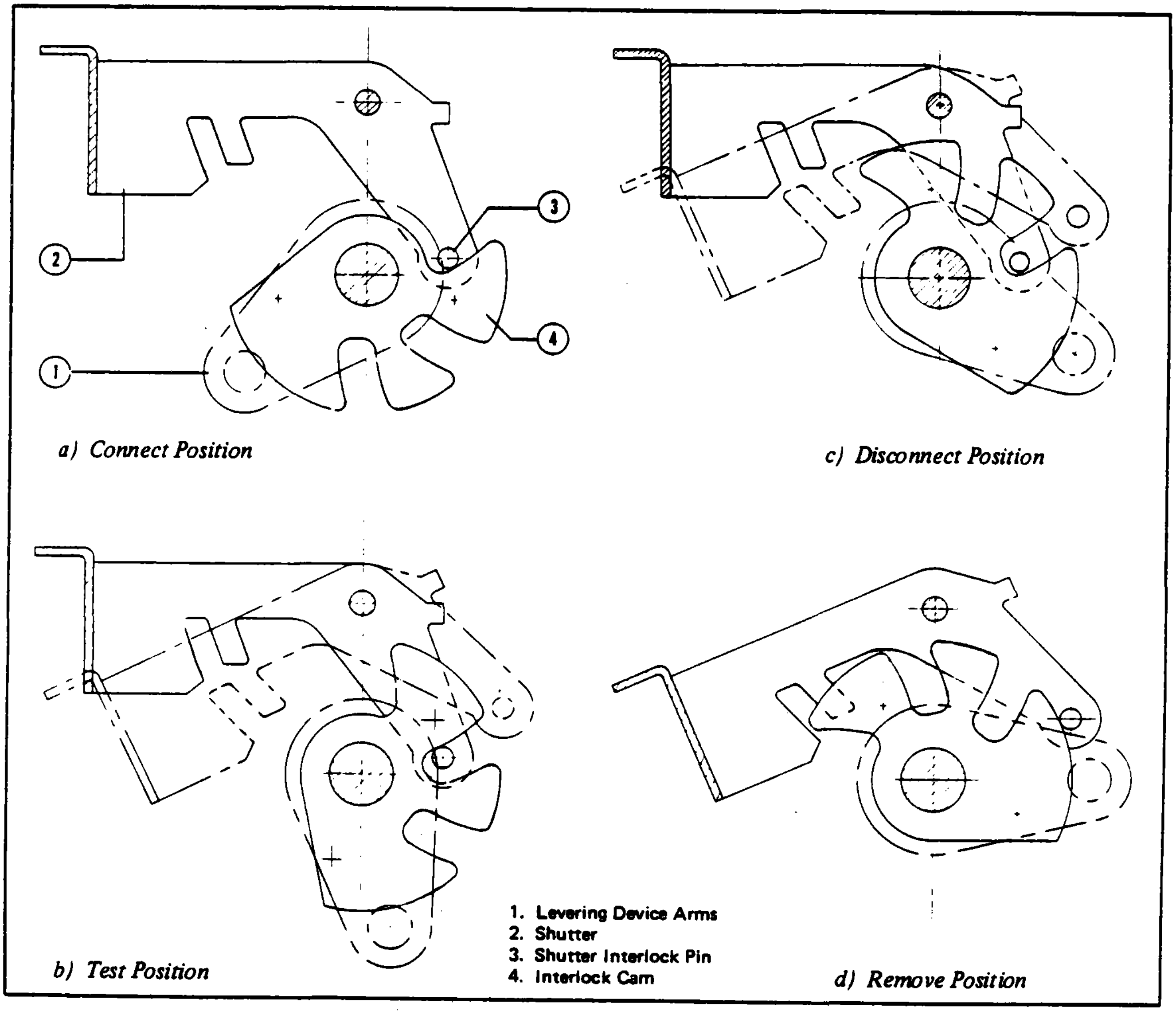
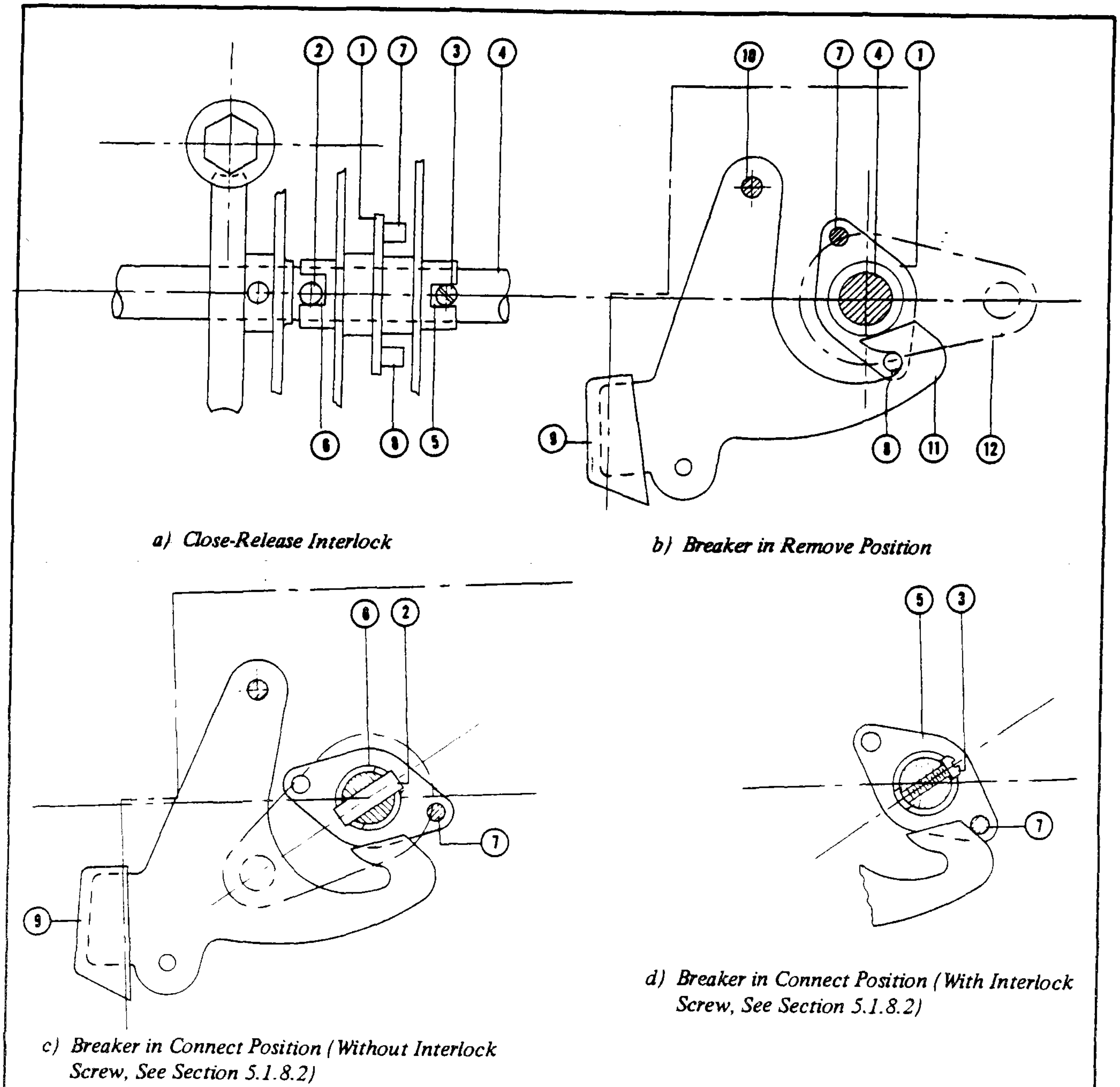


Fig. 29 *Relation of Shutter, Interlock Cam and Levering Device Arms*

levering the breaker out to the REMOVE position as shown in a and b the levering shaft has turned counter-clockwise until the levering device arms are horizontal to the rear. As it rotates, the close bar cam has been rotated counterclockwise by Pin B, to the CLOSE position. This releases the spring release latch through the linkage shown in Figure 30, which results in a trip-free operation of the breaker if the closing springs are charged. This happens



a) Close-Release Interlock

b) Breaker in Remove Position

c) Breaker in Connect Position (Without Interlock Screw, See Section 5.1.8.2)

d) Breaker in Connect Position (With Interlock Screw, See Section 5.1.8.2)

1. Interlock Plate Assembly
2. Drive Pin
3. Interlock Screw
4. Levering Device Shaft
5. Narrow Slot
6. Wide Slot
7. Pin "A"
8. Pin "B"
9. Close Bar
10. Close Bar Pivot
11. Close Bar Cam
12. Levering Device Arm

Fig. 30 *Close-Release Interlock to Discharge Springs on Levering Out of Compartment and Conn. Position no Manual Close Interlock* because the levering device crank has the Trip plate held in the Trip Position. If the breaker is manually operated, levering out can be stopped at the TEST position. Remove the levering device crank handle and (1) Close the breaker and (2) Trip the breaker. This will discharge the springs so that, when the REMOVE position is reached, there will not be a trip-free operation. The Close bar will merely be pulled into the "CLOSE" position.

5.1.8.2 Connected Breaker Manual Close Interlock

The purpose of this Interlock is to make possible a choice between being able to close the breaker by hand-push on the Close bar and not being able to, with the breaker in the CONNECT position. Some consider it undesirable to do so. Referring to Figure 30a, the Interlock Plate Assembly is keyed loosely to the levering device shaft by a drive pin as shown. If the interlock screw is omitted, the interlock plate can be rotated freely on the shaft about 10 degrees. This is because the "wide" slot is considerably wider than the drive pin. If the interlock screw is in place in the "narrow" slot, the Interlock Plate has practically no play and is forced to rotate exactly as much as the levering device shaft rotates.

Figure 30c shows the standard arrangement, without the interlock screw, with the levering device arms in the CONNECT position. Note that there is a clearance between the back of the hook and Pin A. This permits the close bar to be pushed to the "close" position and close the breaker.

In Figure 30d, all parts are in the same position as in Figure 30c, except that the interlock screw has been placed in the "narrow slot". This arrangement is shown in Figure 25. This forces the interlock plate to rotate about

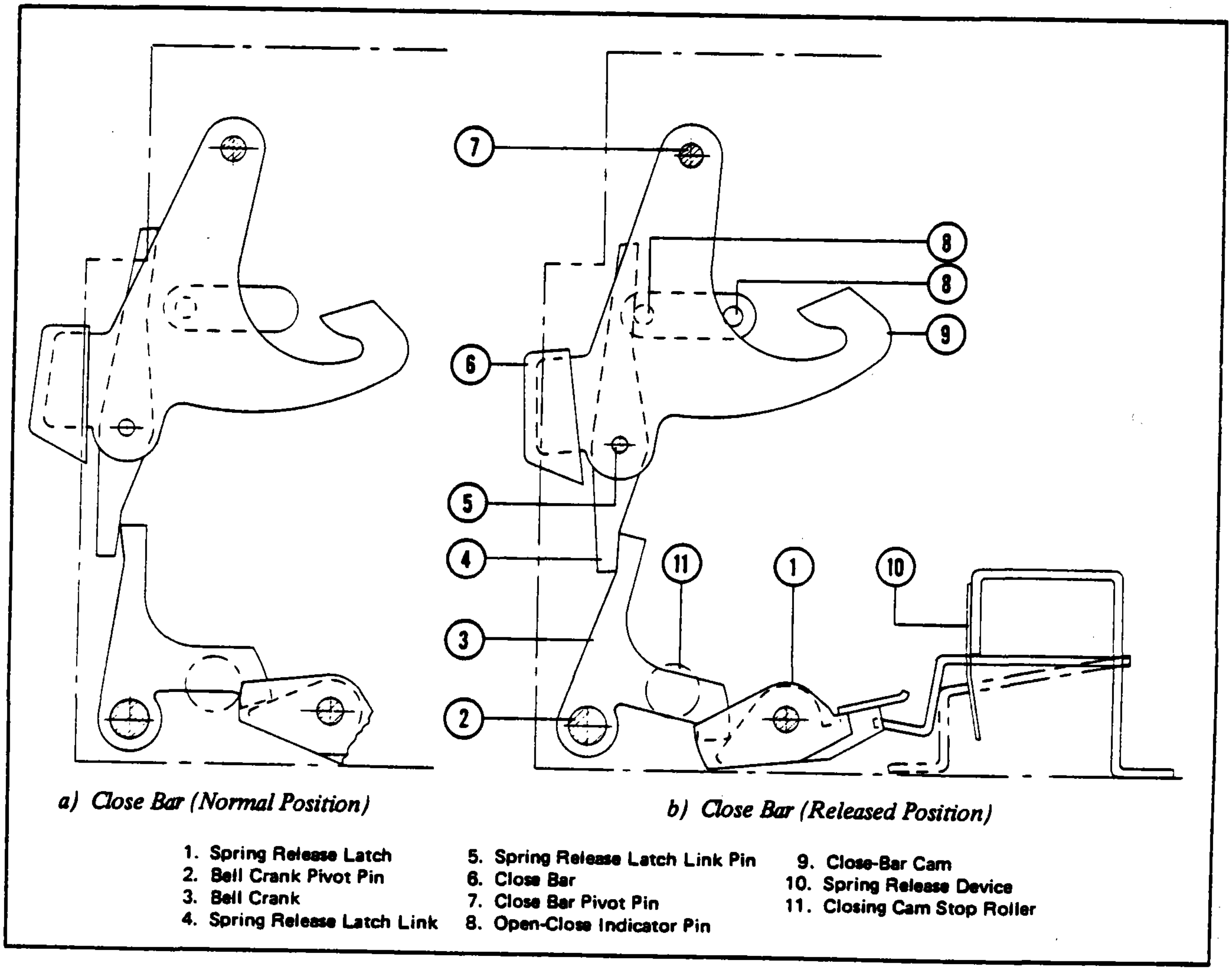


Fig. 31 *Close Interlock to Prevent Efforts to Close a Breaker that is Already Closed*

10 degrees further than in Figure 30c, so that there is almost no clearance between Pin A and the back of the hook. Consequently the Close bar cannot be pushed to the "Close" position. However, the breaker can be remote-closed by applying control voltage to the spring release coil through a control switch or other circuit-making device.

5.1.8.3 Breaker Equipped for Electric Lockout

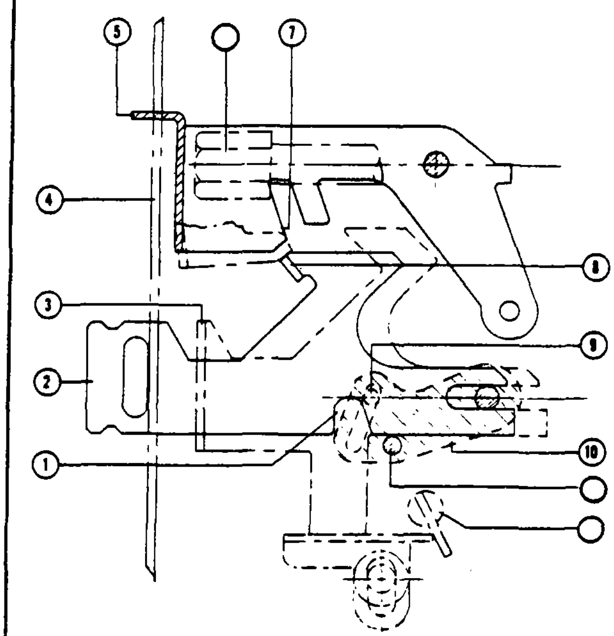
Power operated breakers may be equipped for electric lockout, meaning that closing an unenergized circuit is prevented. This may be the main circuit or any other desired circuit. This is accomplished by making it impossible to release the spring release latch by the spring release device unless the monitored circuit is energized. The spring release coil (SR) is wired through the contact on the motor cut-off switch that closes as the closing springs become fully charged. The remainder of the circuit is through a front panel closing pushbutton switch and to the terminals of the circuit being monitored. Thus, when the monitored circuit is energized properly, the breaker may be closed through the panel pushbutton switch, provided in addition that the closing springs are charged.

As an additional safeguard against undesired closing under this electric lockout condition, all such breakers will be equipped with the interlock screw as described in Section 5.1.8.2 above. This prevents hand closing of the breaker in the CONNECT position.

Manually operated breakers may also be furnished with this feature if they are equipped with optional electrical spring release devices.

5.1.8.4 Closed Breaker Interlock

Figure 31 shows how operation of the spring release latch is prevented when the breaker already is in the closed position. The Close Bar is connected to the spring release latch by a link and bell crank. The link is pivoted on the lower end of the close bar cam by a pin as shown. As the Close Bar is pushed, the pin and latch link will move to the right, along with the lower end of the cam. The lower end of the link is facing a knife edge pivot on the vertical arm of the bell crank. The upper end of the link is facing the Open-Close Indicator Pin. This pin is at the left end of its slot in the mechanism side frame with the breaker open and at the right end with the breaker closed. As the Close Bar is pushed, the link therefore has two possible end pivots. If the breaker is open the upper end of the link will swing to the right until it touches the indicator pin. The lower end of the link will then swing to the right and



1. Padlock Plate Notch
2. Padlock Plate
3. Trip Plate
4. Front Panel
5. Shutter
6. Levering Device Worm Shaft
7. Projection on Shutter
8. Bent Tab on Padlock Plate
9. Projection on Trip Plate
10. Padlock Interlock Lever
11. Pin on Padlock Interlock Lever
12. Trip Shaft

Fig. 32 *Padlock Device - Locked Trip Free and Shutter Raised*

push the vertical arm of the bell crank to the right. The horizontal arm of the bell crank moves downward and presses directly on the spring release latch, allowing the breaker to close.

If the breaker already is closed and the Close Bar is pushed, the upper end of the spring release latch link will swing free to the right because the indicator pin is not there to stop it. Consequently, no force is applied to the vertical arm of the bell crank, and nothing else happens.

5.1.8.5 Padlocking Provision

Figure 32 shows the essential parts of the padlock interlock. The breaker is padlocked in the trip-free condition in which the breaker cannot be closed and the breaker cannot be moved with the levering device. This figure shows the relation of parts for padlocking in the trip-free, shutter up condition. There are three major parts involved, which are interleaved and assembled on the left hand side of the levering device assembly:

1. The Shutter

2. The Trip Plate

3. The Padlock Interlock Lever

The Padlock Interlock lever is located between the Trip Plate and the Padlock Plate, and is pivoted on a fixed center toward the rear of the breaker. The front part of this lever has a sloping slot into which a projection from the trip plate extends. Horizontal movement of the trip plate by cam action of the projection against the walls of the slot, causes the front of the interlock lever to move up or down. The interlock lever is pushed upward by a spring. This lever also has a short pin extending outward normally into a curved notch in the bottom edge of the padlock plate.

To padlock the breaker, with shutter closed, push the trip plate in. Pull the padlock plate forward. This exposes the padlock slot in the padlock plate. Insert the padlock and lock.

Movement of the trip plate pushes the front end of the padlock interlock lever down, moving its pin downward and out of the notch in the padlock plate. Forward movement of the padlock plate and backward movement of the trip plate places the pin in the padlock interlock lever behind the notch in the padlock plate. With the padlock plate held forward, the padlock interlock lever cannot move. The projection from the trip plate is consequently held in the slot in the padlock interlock lever, so the breaker remains locked in the trip-free condition until the padlock is removed and the members are returned to their normal positions by their return springs. While so locked, the shutter is prevented from downward travel by a horizontal projection striking a bent-over tab on the padlock plate.

Section 6 - Circuit Breaker Pole Units, Description and Operation

6.0 GENERAL

Figures 33, 34, 35, and 36 show detailed three pole assemblies of all of the type DS circuit breakers.

DS206 has the three poles mounted on a single molded base of high strength insulating material, with the contact parts and sensors mounted on it. Figures 37 and 38 show front and rear views of the assembly.

The DS416, DS420, DS632 and DS840 differ in that each of the three poles are mounted on individual insulating bases, and all three poles held in accurate alignment by a welded steel frame. Front and rear views of each are shown in Figures 39 and 40 for the DS416, Figures 41 and 42 for the DS420, Figures 43 and 44 for the DS632, Figures 45 and 46 for the DS840.

6.1 MOVING CONTACT SUB-ASSEMBLIES

The moving contact members of all ratings consist of blades hinged at the bottom to the lower main terminal

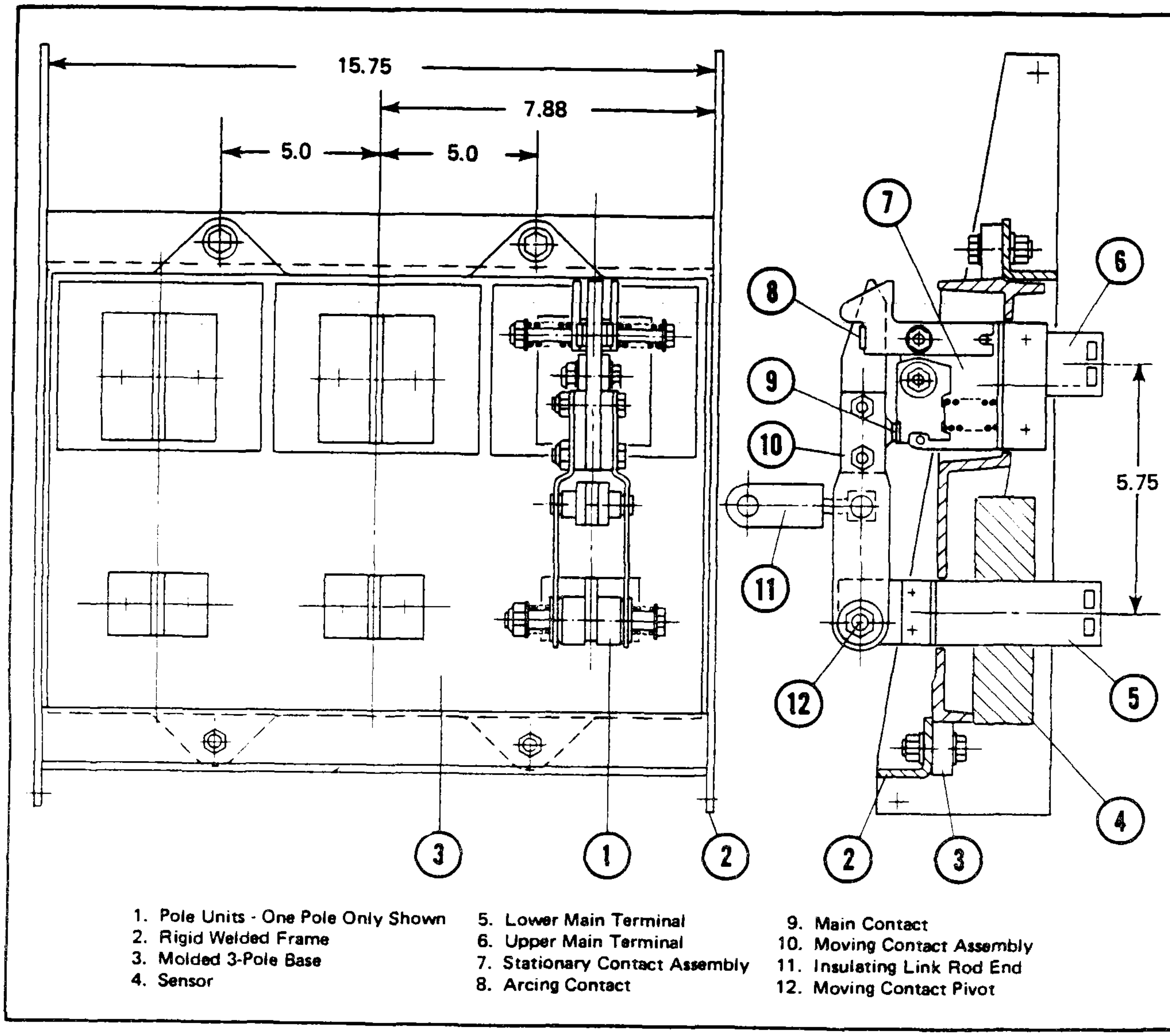


Fig. 33 *Three-Pole Assembly of DS-206 Pole Units on Frame*

through controlled pressure rotating contacts and with main and arcing contacts at the upper end. The arcing contacts of all of the five ratings shown are essentially the same design. The number of blades, the size of the main terminals and the number of fingers in the main disconnecting contacts vary with the rating. The DS206 has two moving blades, the DS416 and DS420, four moving blades, and the DS632 and DS840, eight moving blades. On the DS206, two butt type main contacts and a knife blade arcing contact are located between the two hinged blades. On the DS416 and DS420 the main contact member, i.e. which makes actual contact with the stationary contacts, is a horizontal member to which all blades are connected. On the DS632 and DS840 there are two sets of contacting surfaces, one vertically above the other, for making contact with two corresponding rows of stationary contact fingers. The arcing contact assembly is bolted to the top of the main moving contact blade

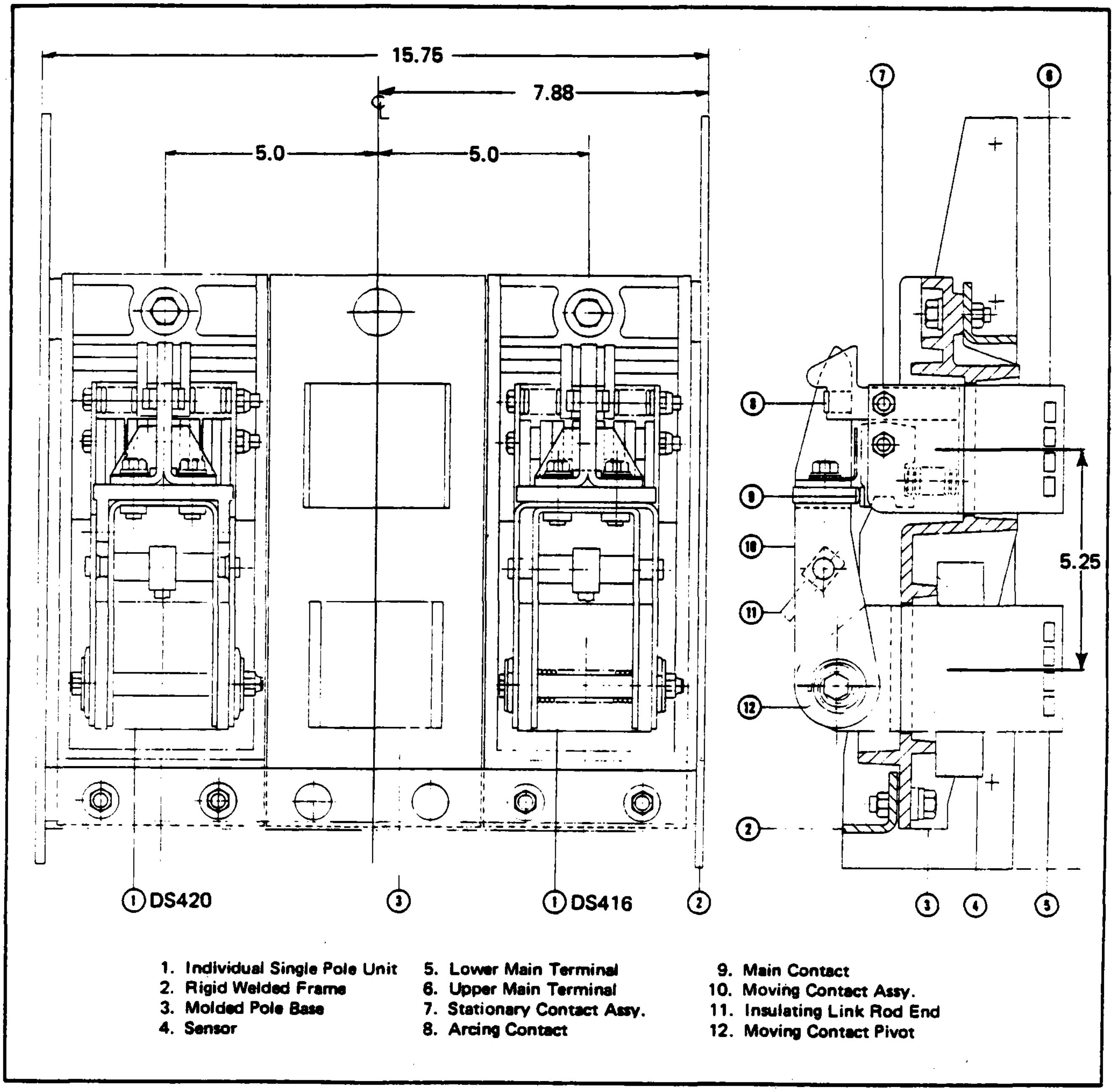


Fig. 34 *Three-Pole Assembly of DS-416 and DS-420 Pole Units on Frame*

assembly. This has the arcing contact tips, of arc resisting metallic composition, permanently fastened near the upper end of the assembly. The moving contact blade assembly is operated by a strong and rigid insulating link.

6.2 STATIONARY CONTACT SUB-ASSEMBLIES

The stationary contact sub-assemblies may be seen in Figures 47, 48, 49, 51 and 53. All main contacts, i.e.

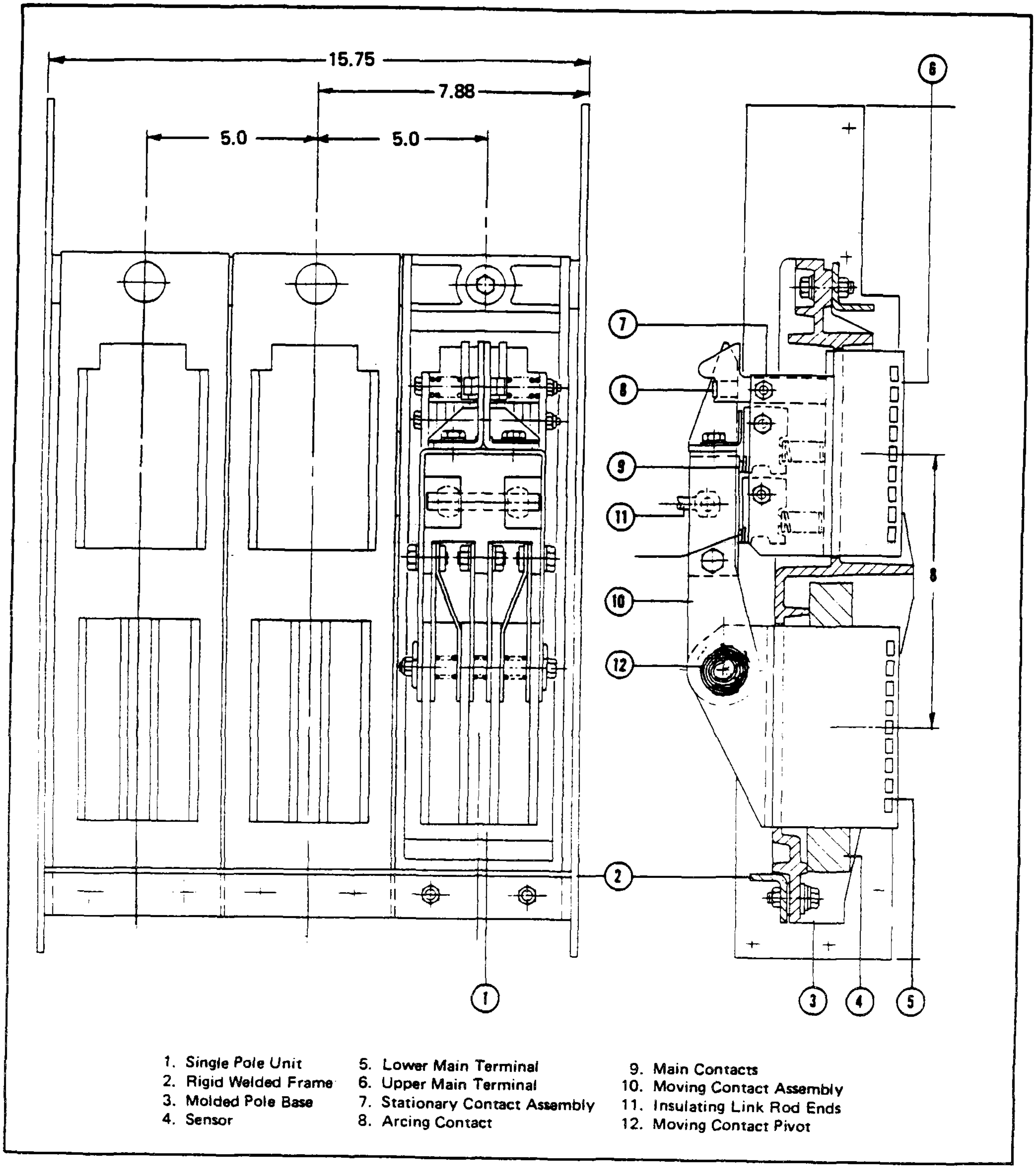
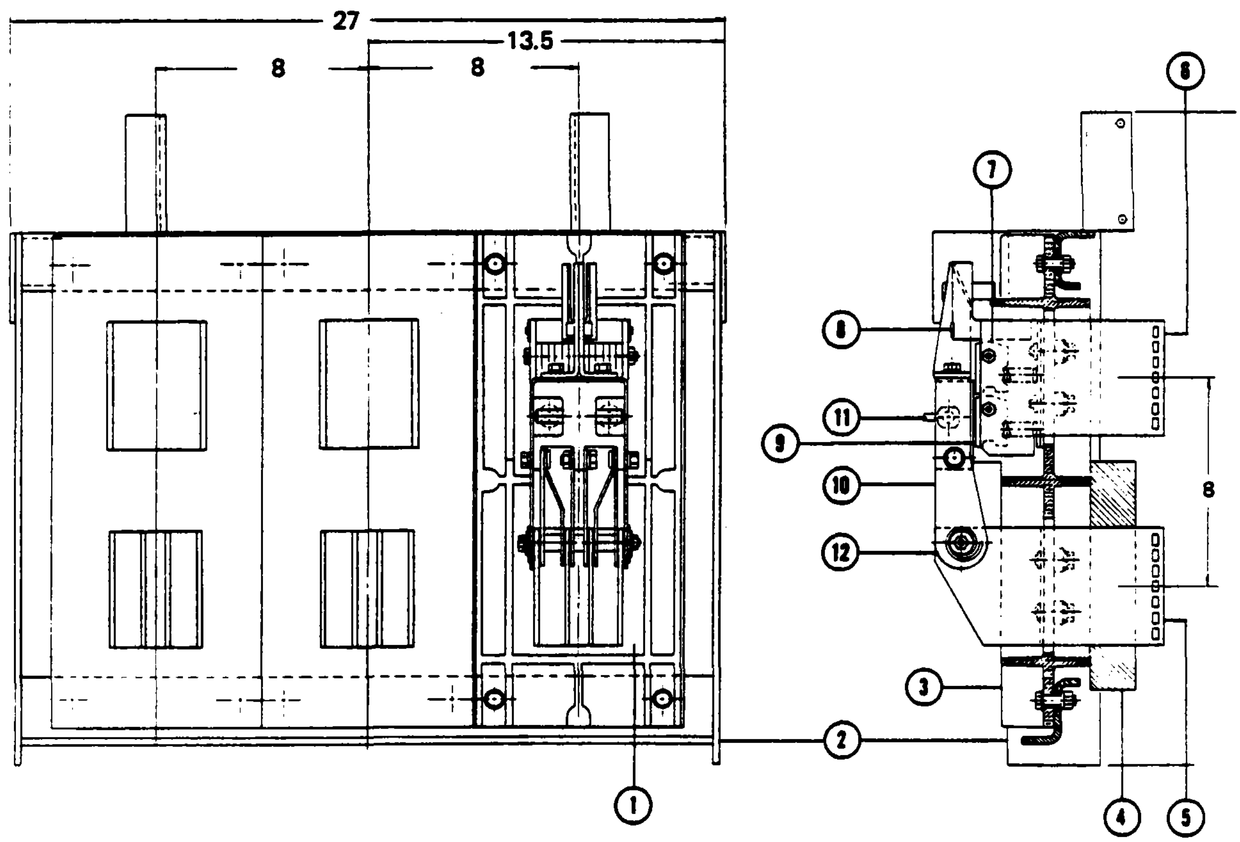


Fig. 35 *Three-Pole Assembly of DS-632 Pole Units on Frame*

those which carry the main continuous load current, are of the butt type composed of a multiplicity of fingers. Each finger is hinged at the upper end under controlled pressure. Compression springs at the lower end apply predetermined pressure against the moving main contact in closing, and standing in the closed position. These springs are visible in the photograph of the DS206 only. With this construction, the pressure on the main contact surfaces is increased during the carrying and opening of high short circuit currents because the magnetic field of the current pushes the lower end of the finger toward the moving contact. Hinging the finger at the top thus results in what is sometimes called "blow-on" action. This greatly increases the capability of the entire contact assembly to withstand the high fault currents associated with these breaker ratings.

The stationary arcing contacts are similar for all ratings and consist of two parallel fingers, one on each side of the stationary terminal member. They are pushed toward each other by compression springs and have arc resisting tips.



1. Single Pole Unit
2. Rigid Welded Frame
3. Molded Pole Base
4. Sensor
5. Lower Main Terminal
6. Upper Main Terminal
7. Stationary Contact Assembly
8. Arcing Contact
9. Main Contacts
10. Moving Contact Assembly
11. Insulating Link Rod Ends
12. Moving Contact Pivot

Fig. 36 *Three Pole Assembly of DS-840 Pole Units on Frame*

The moving arcing contact thus wedges the stationary contact fingers apart as the breaker closes.

The parallel action of the magnetic fields of the currents in each arcing contact finger causes the fingers to be attracted toward each other when closing against fault currents. This results in a "blow-on" action on the arcing contacts.

Figures 37 thru 46 show the combined moving and stationary contact sub-assemblies of the various breakers. This shows the proper relationships, clearances and contact deflections of the various parts.

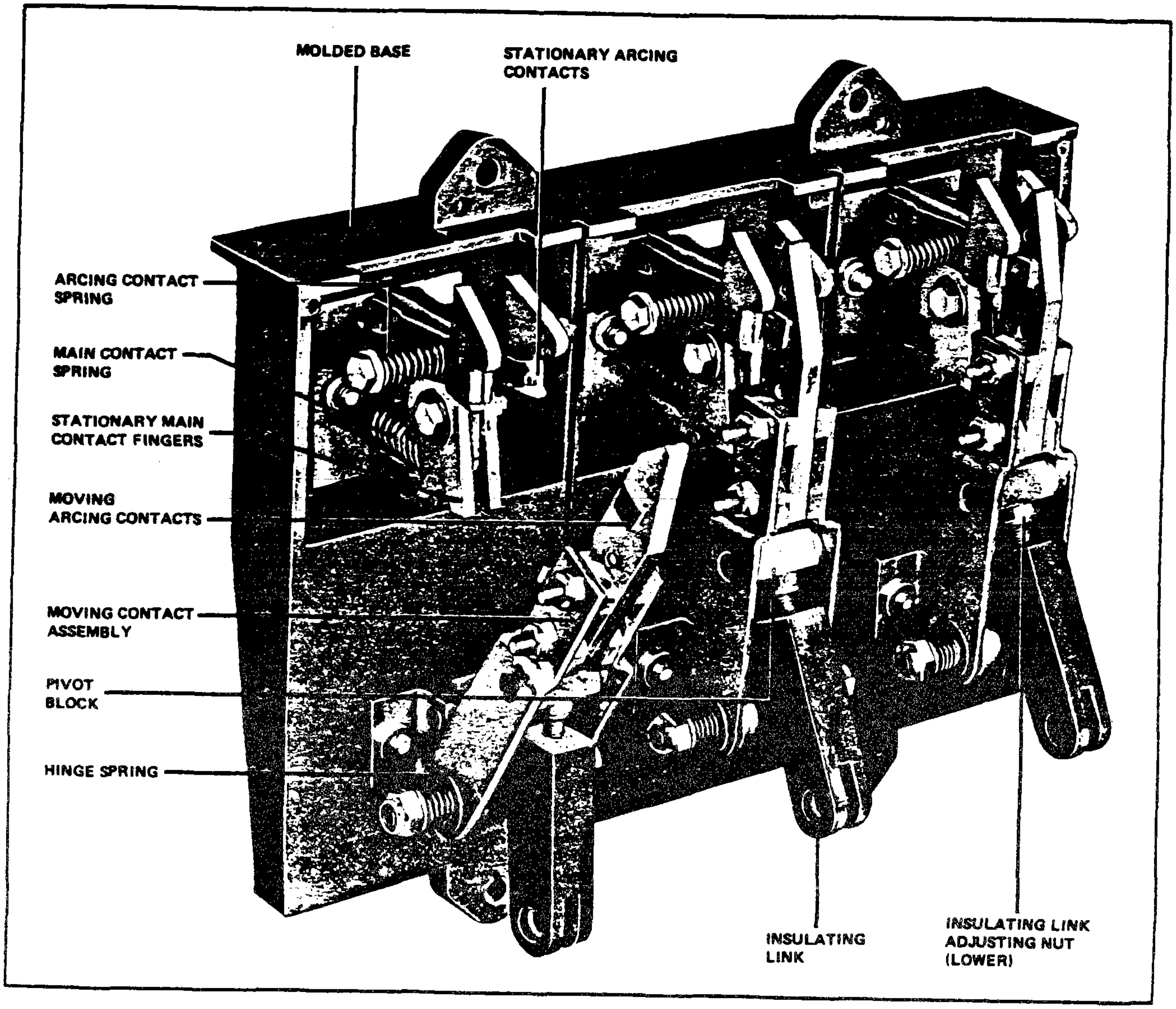


Fig. 37 *Type DS-206 Pole Unit Assembly - Front View (384502)*

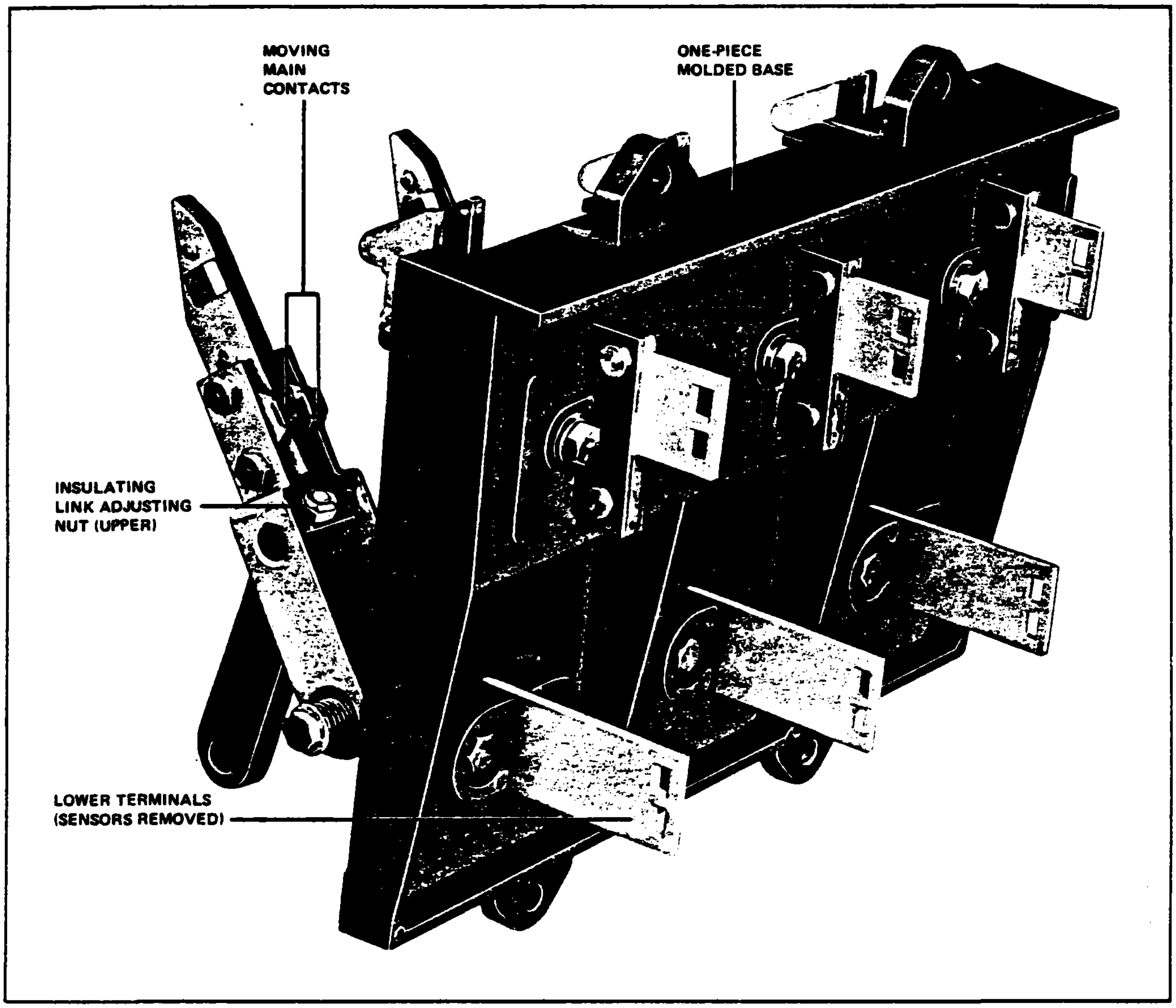


Fig. 38 *Type DS-206 Pole Unit Assembly - Rear View (384499)*

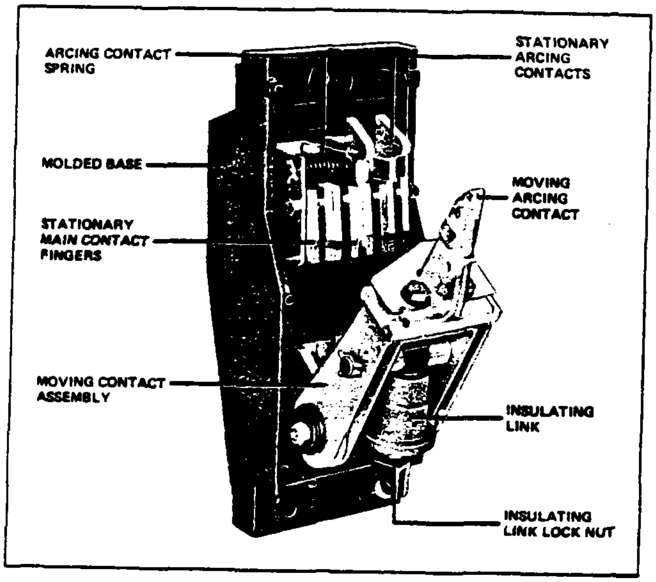


Fig. 39 *Type DS-416 Pole Unit Assembly - Front View (383420)*

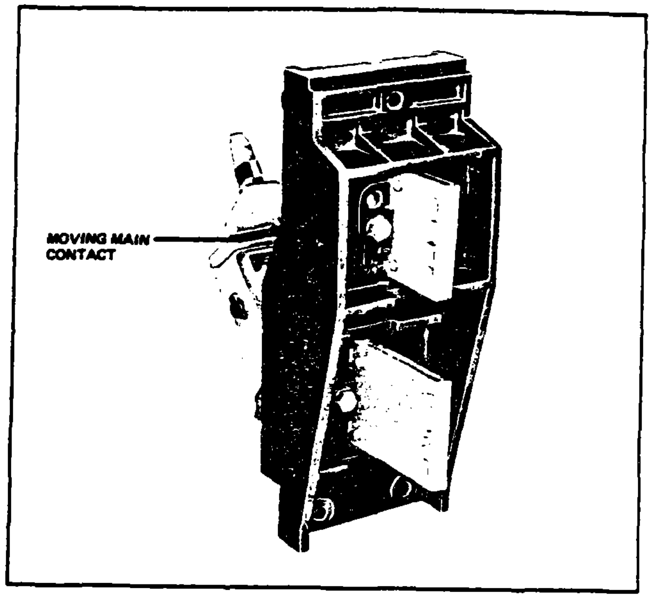


Fig. 40 *Type DS-416 Pole Unit Assembly - Rear View (391098)*

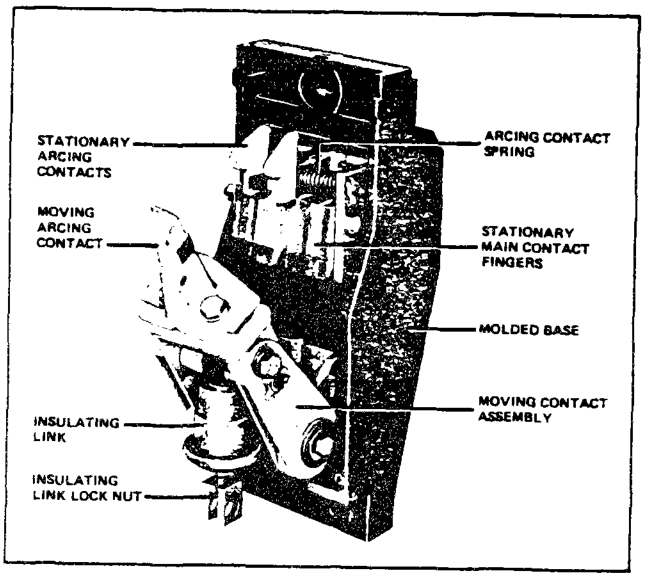


Fig. 41 *Type DS-420 Pole Unit Assembly - Front View (391101)*

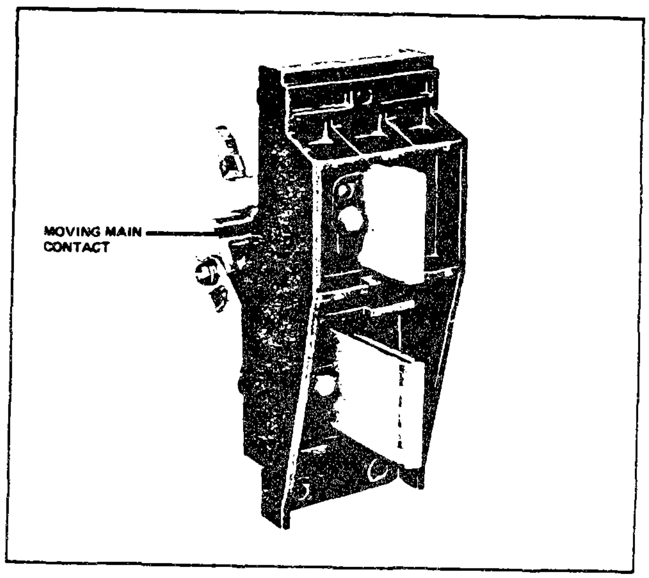


Fig. 42 *Type DS-420 Pole Unit Assembly - Rear View (391099)*

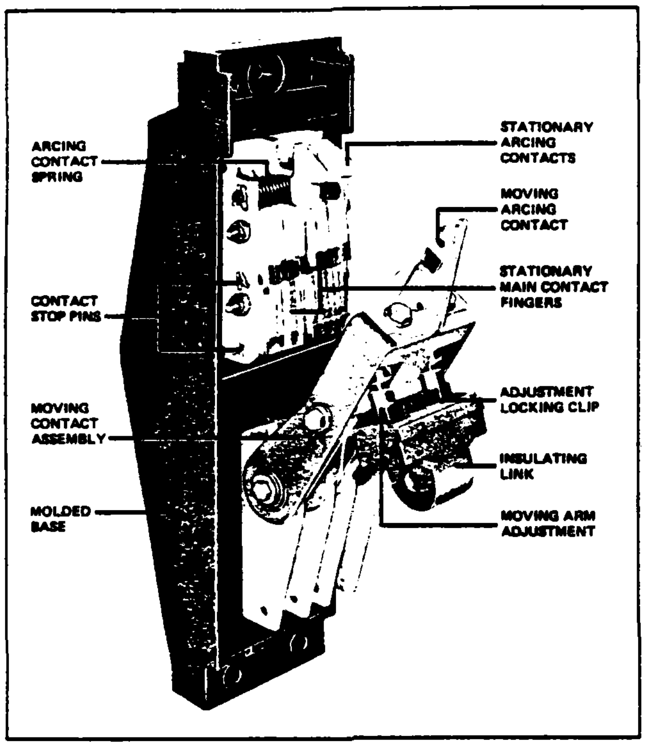


Fig. 43 *Type DS-632 Pole Unit Assembly - Front View (383418)*

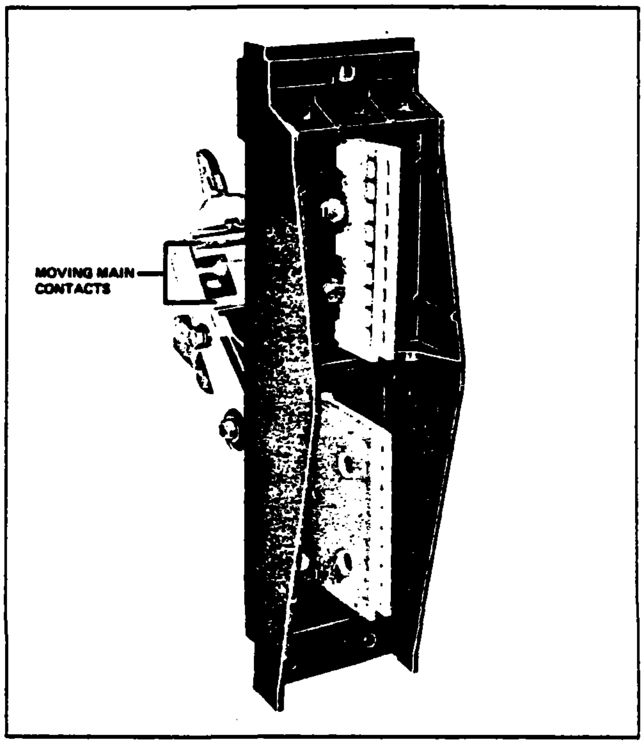


Fig. 44 *Type DS-632 Pole Unit Assembly - Rear View (391095)*

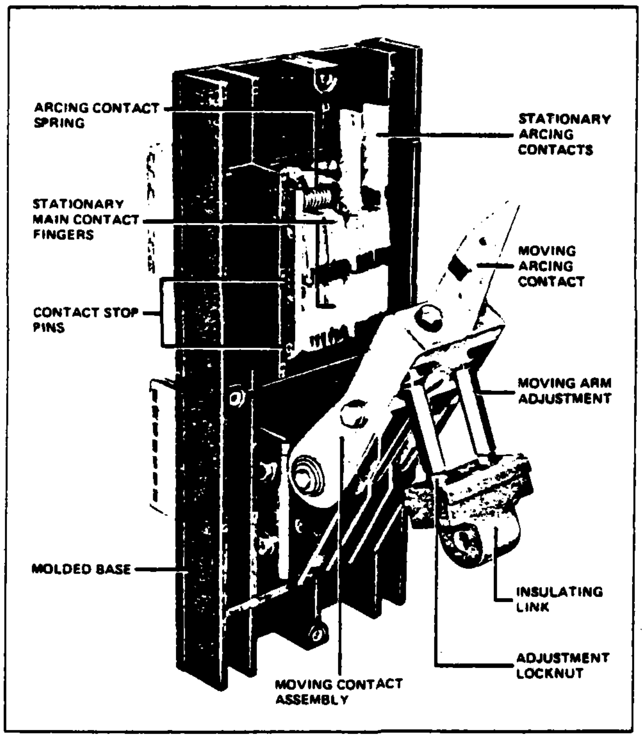


Fig. 45 *Type DS-840 Pole Unit Assembly - Front View (391094)*

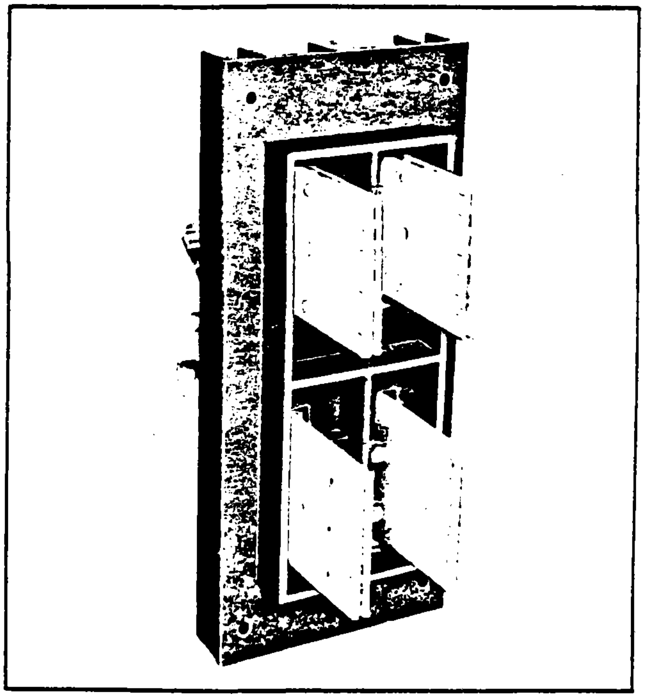
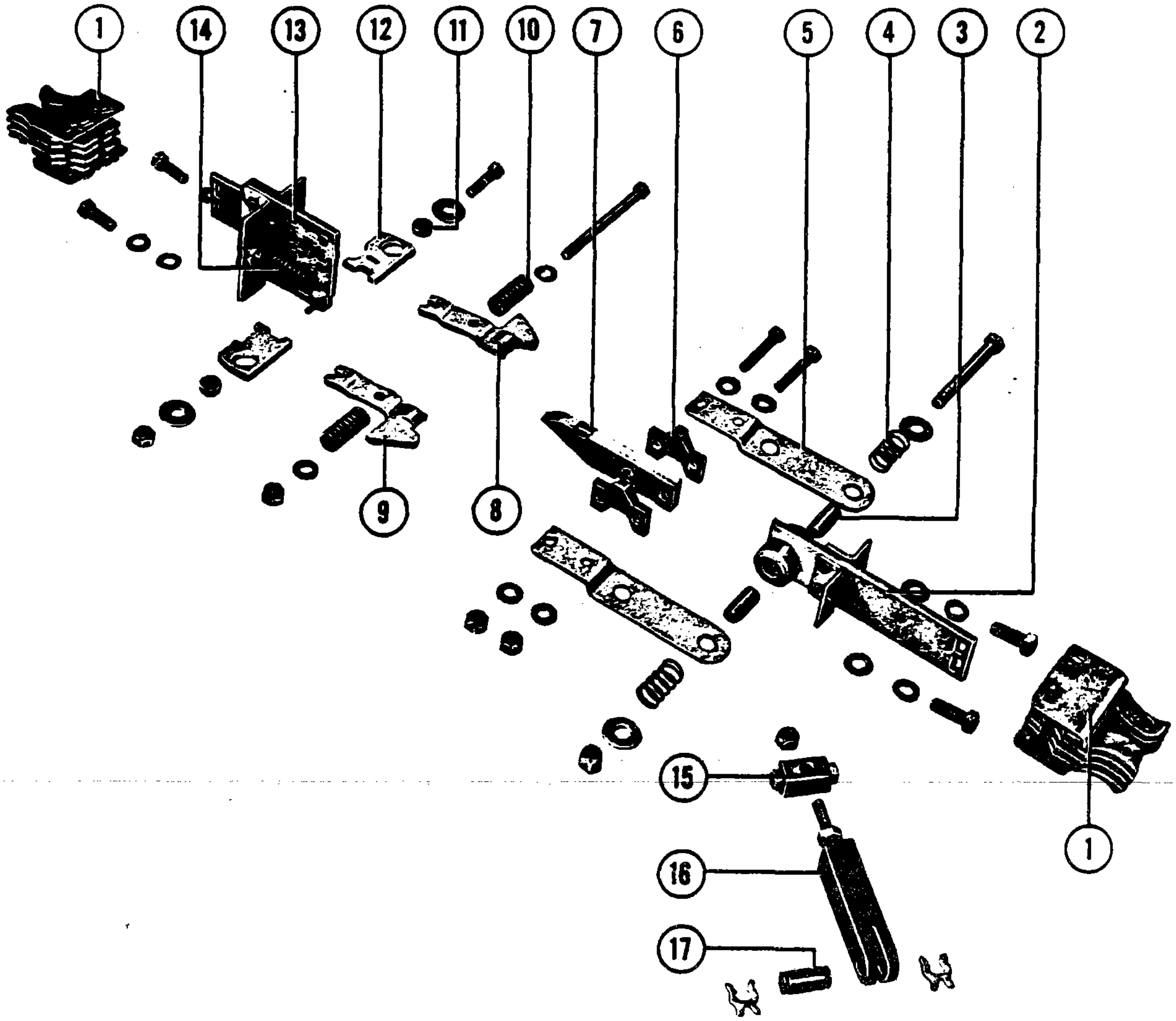
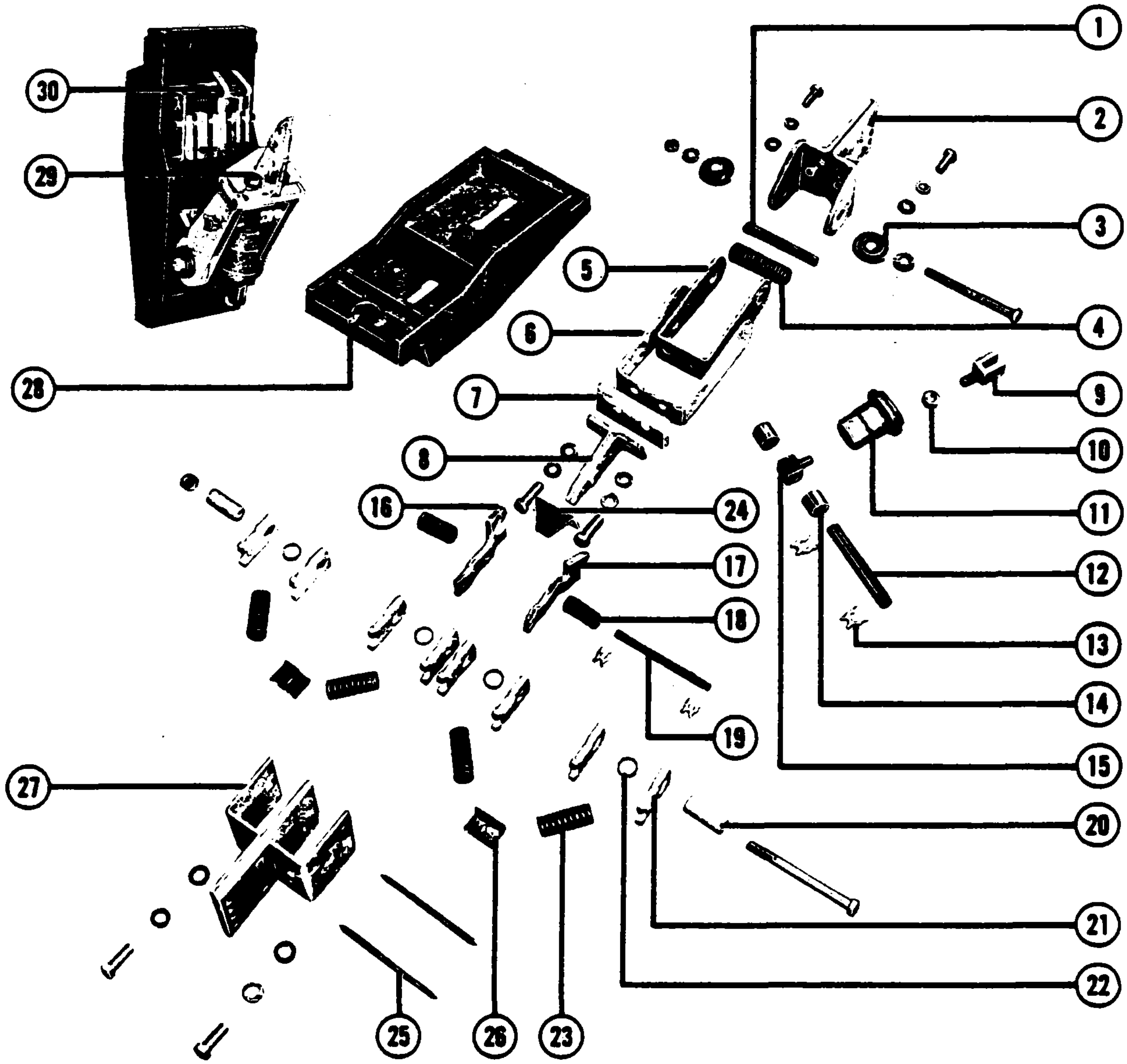


Fig. 46 *Type DS-840 Pole Unit Assembly - Rear View (391097)*



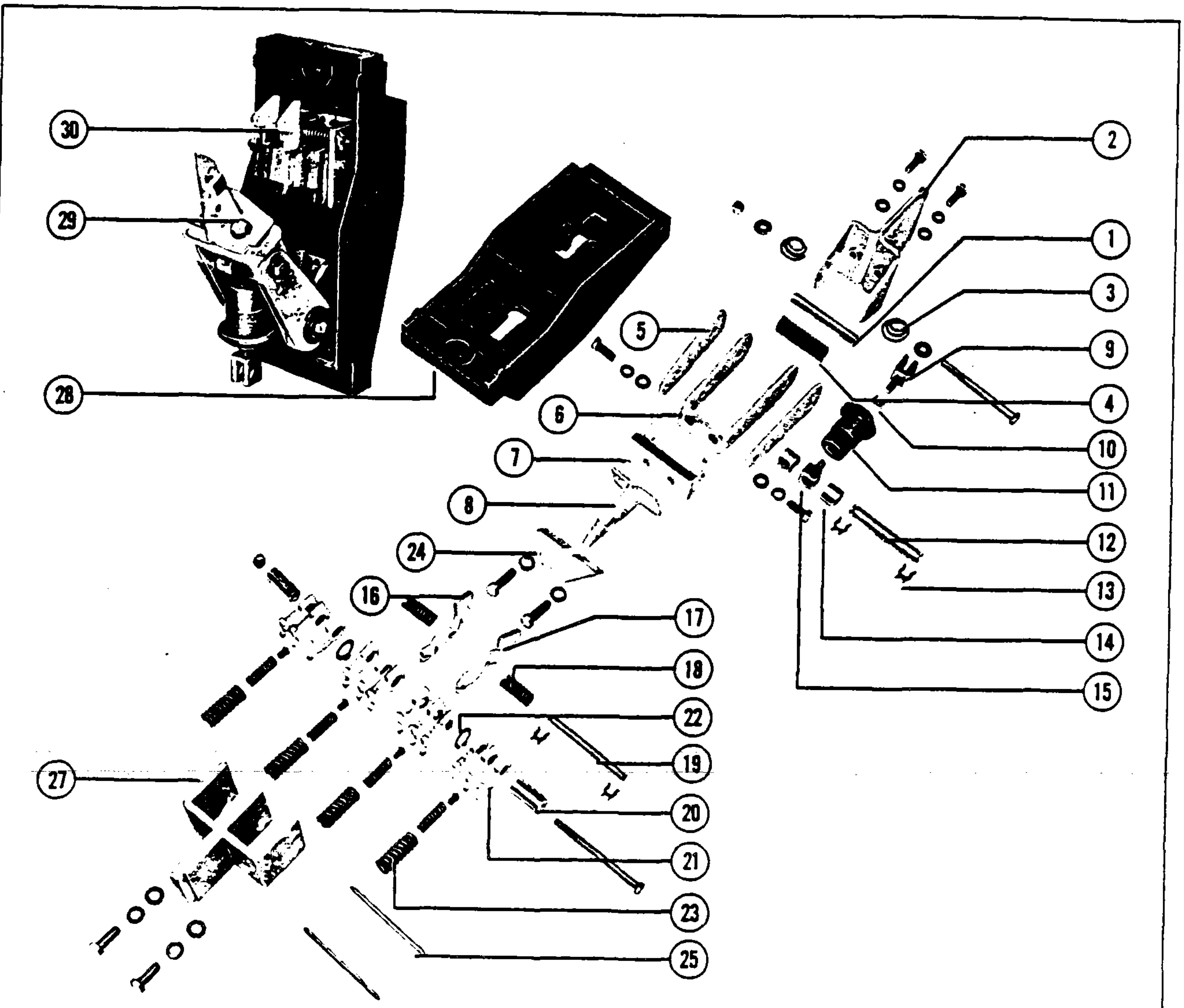
1. Main Disconnecting Contact Cluster
2. Hing Contact
3. Hinge Bearing Tube
4. Hinge Spring
5. Moving Arm
6. Moving Main Contact
7. Moving Arcing Contact
8. Stationary Arcing Contact - Right Hand
9. Stationary Arcing Contact - Left Hand
10. Stationary Arcing Contact Spring
11. Contact Spacer
12. Stationary Arcing Contact Spring
13. Stationary Contact Assembly
14. Main Contact Spring
15. Link Pivot Block
16. Insulating Link
17. Pole Lever Pin

Fig. 47 *Moving and Stationary Contact Details DS-206 (383979)*



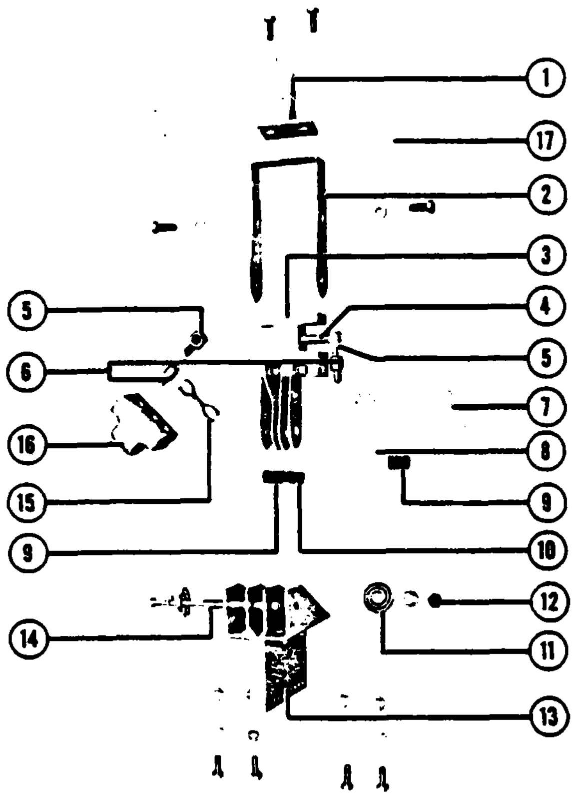
1. Hinge Bearing Tube
2. Hinge Assembly
3. Spring
4. Hinge Spring
5. Moving Arm - Inner
6. Moving Arm - Outer
7. Moving Main Contact
8. Moving Arcing Contact
9. Clevis
10. Insulating Link Lock Nut
11. Insulating Link
12. Operating Link Upper Pin
13. Retainer
14. Spacer
15. Rod End
16. Stationary Arcing Contact - Right Hand
17. Stationary Arcing Contact - Left Hand
18. Stationary Arcing Contact Spring
19. Arcing Contact Retaining Pin
20. Bearing Tube
21. Main Contact Fingers
22. Contact Spacer
23. Contact Spring
24. Arc Runner
25. Pin
26. Spring Seat
27. Stationary Contact Cage
28. Base Mold
29. Moving Contact Assembly
30. Stationary Contact Assembly

Fig. 48 *Moving and Stationary Contact Details DS-416 (391100) (383416)*



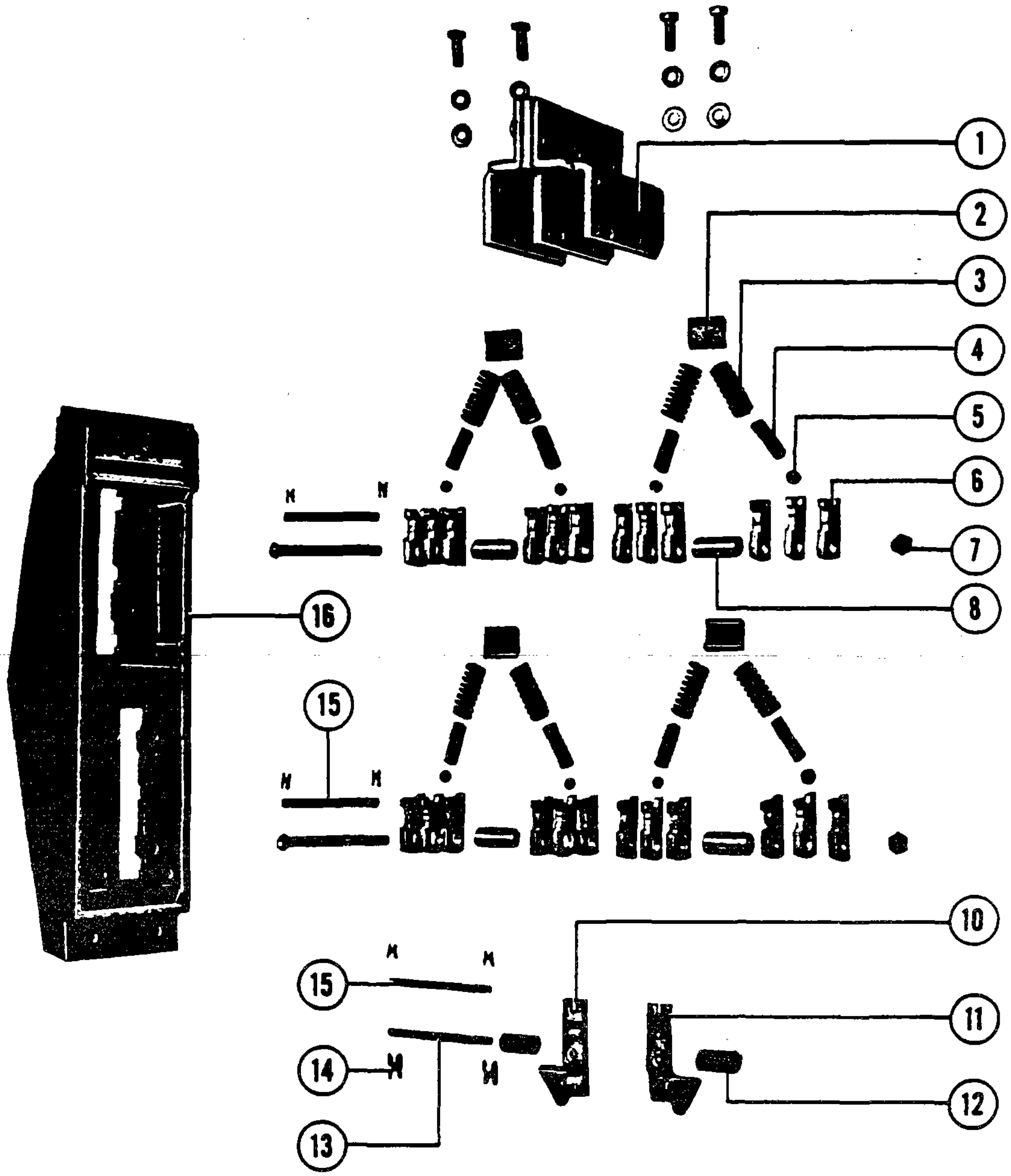
1. Hinge Bearing Tube
2. Hinge Assembly
3. Spring
4. Hinge Spring
5. Moving Arm - Inner
6. Moving Arm - Outer
7. Moving Main Contact
8. Moving Arcing Contact
9. Clevis
10. Insulating Link Lock Nut
11. Insulating Link
12. Operating Link Upper Pin
13. Retainer
14. Spacer
15. Rod End
16. Stationary Arcing Contact - Right Hand
17. Stationary Arcing Contact - Left Hand
18. Stationary Arcing Contact Spring
19. Arcing Contact Retaining Pin
20. Bearing Tube
21. Main Contact Fingers
22. Contact Spacer
23. Contact Spring
24. Arc Runner
25. Pin
27. Stationary Contact Cage
28. Base Mold
29. Moving Contact Assembly
30. Stationary Contact Assembly

Fig. 49 *Moving and Stationary Contact Details DS-420 (391086)*



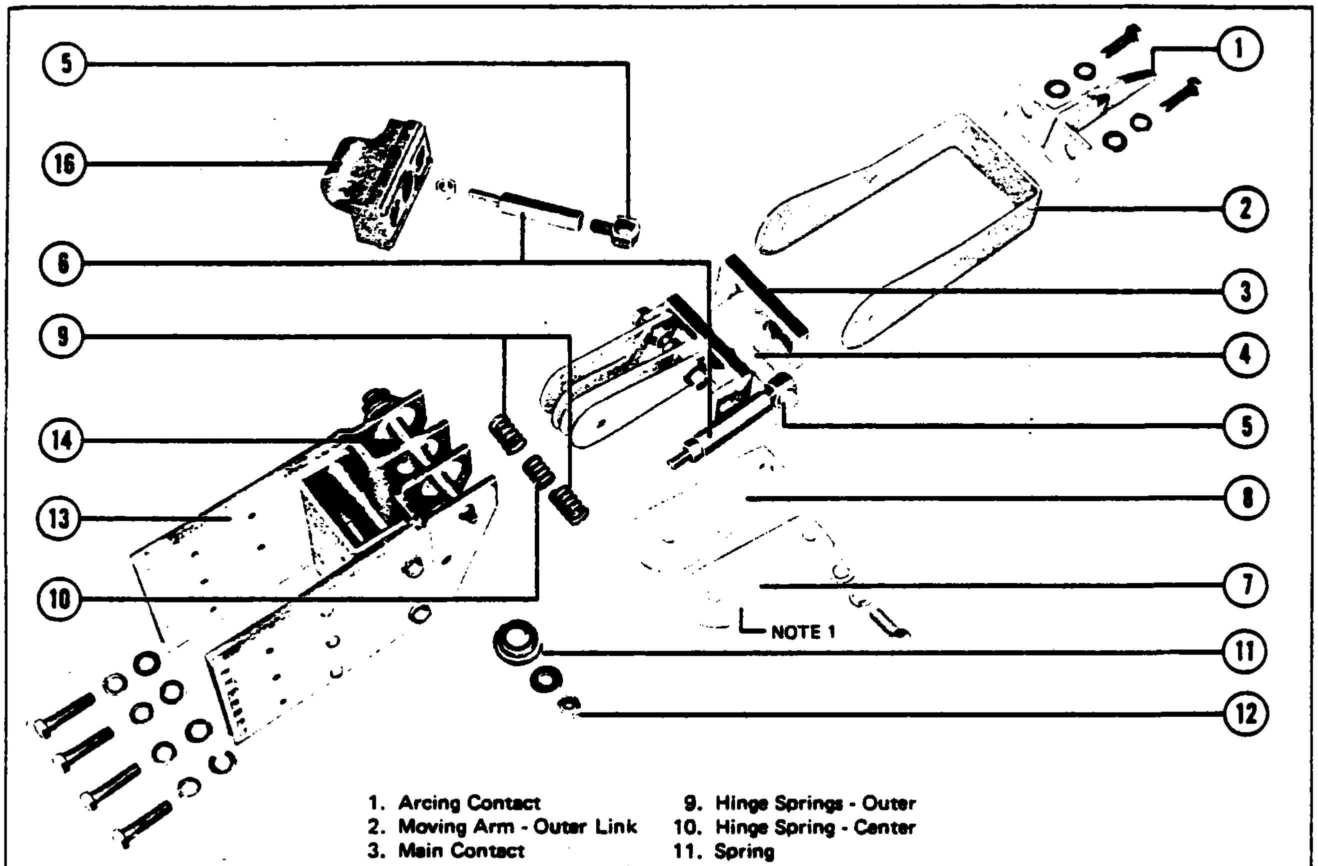
1. Arcing Contact
2. Moving Arm - Outer Link
3. Main Contact
4. Operating Link - Upper Pin
5. Rod End
6. Adjusting Nut
7. Moving Arm - Inner Links - Straight
8. Moving Arm - Inner Links - Offset
9. Hinge Springs - Outer
10. Hinge Spring - Center
11. Spring
12. Locking Nut
13. Hinge Assembly
14. Hinge Bearing Tube
15. Adjustment Locking Clip
16. Insulating Link
17. Arc Runner

Fig. 50 *Moving Contact Details DS-632 (383415)*



1. Stationary Contact Cage
2. Spring Seat
3. Contact Spring - Outer
4. Contact Spring - Inner
5. Spring Button
6. Main Contact Fingers
7. Locking Nut
8. Bearing Tube
10. Arcing Contact - Left Hand
11. Arcing Contact - Right Hand
12. Arcing Contact Spring
13. Arcing Contact Retaining Pin
14. Retainer
15. Pin
16. Base Mold

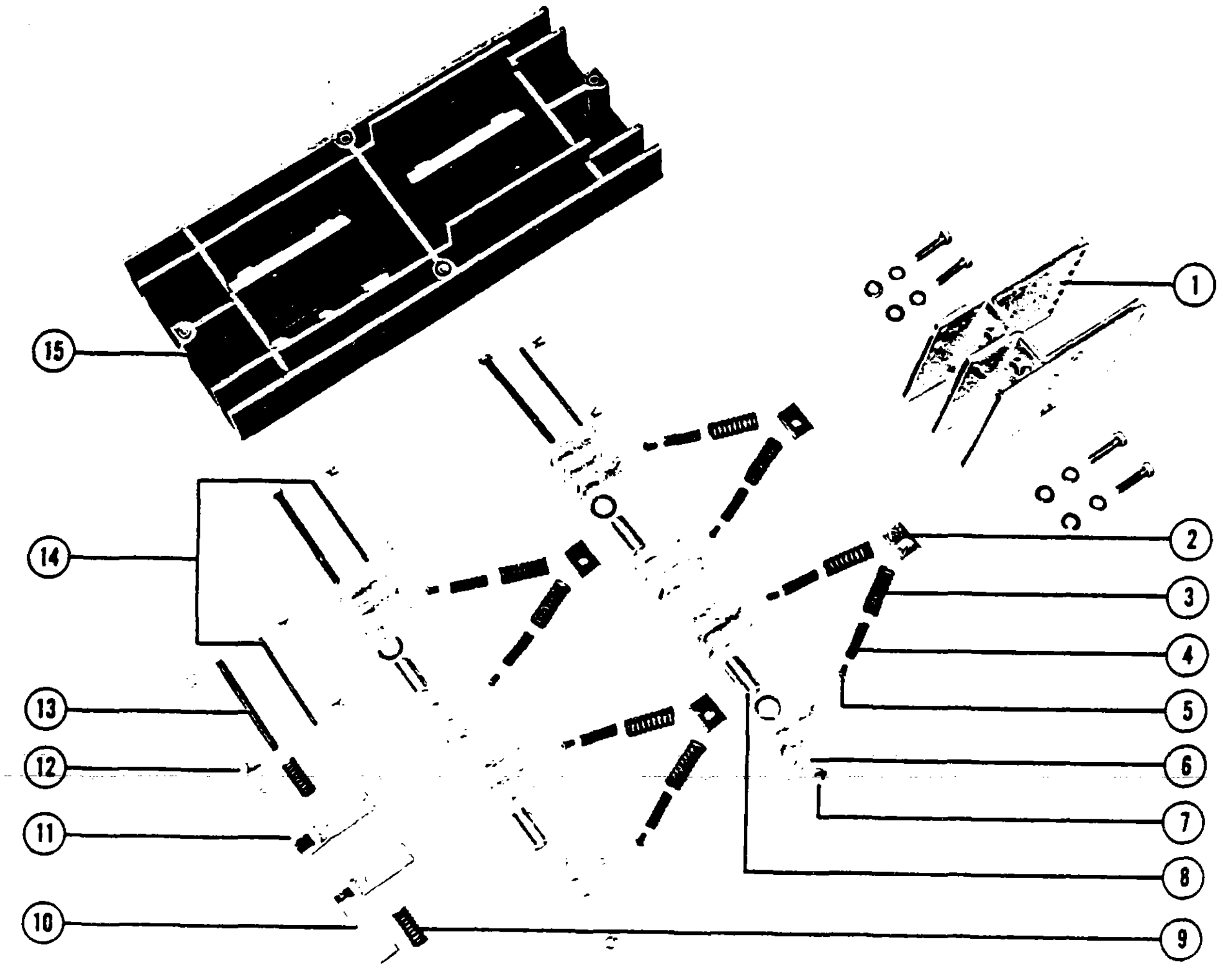
Fig. 51 *Stationary Contact Details DS-632 (383414)*



1. Arcing Contact
2. Moving Arm - Outer Link
3. Main Contact
4. Operating Link - Upper Pin
5. Rod End
6. Adjusting Nut
7. Moving Arm - Inner Links - Straight
8. Moving Arm - Inner Links - Offset
9. Hinge Springs - Outer
10. Hinge Spring - Center
11. Spring
12. Locking Nut
13. Hinge Assembly
14. Hinge Bearing Tube
15. Adjustment Locking Clip
16. Insulating Link

NOTE 1 - Raised bearing surface on each arm must be in contact with stationary hinge surface.

Fig. 52 *Moving Contact Details DS-840 (391084)*



1. Stationary Contact Cage
2. Spring Seat
3. Contact Spring - Outer
4. Contact Spring - Inner
5. Spring Button
6. Main Contact Fingers
7. Locking Nut
8. Bearing Tube
9. Arcing Contact Spring
10. Arcing Contact - Right Hand
11. Arcing Contact - Left Hand
12. Retainer
13. Arcing Contact Retaining Pin
14. Pin
15. Base Mold

Fig. 53 *Stationary Contact Details DS-840 (391271)*

Section 7 - Arc Chute

7.0 GENERAL

Figure 54 is a close-up view of a breaker with one insulating barrier removed to show the arc chute in place on the pole unit. Similar designs of arc chutes are used on the DS416, DS420 and DS632 assemblies with a smaller one on the DS206 and a slightly larger one on the DS840.

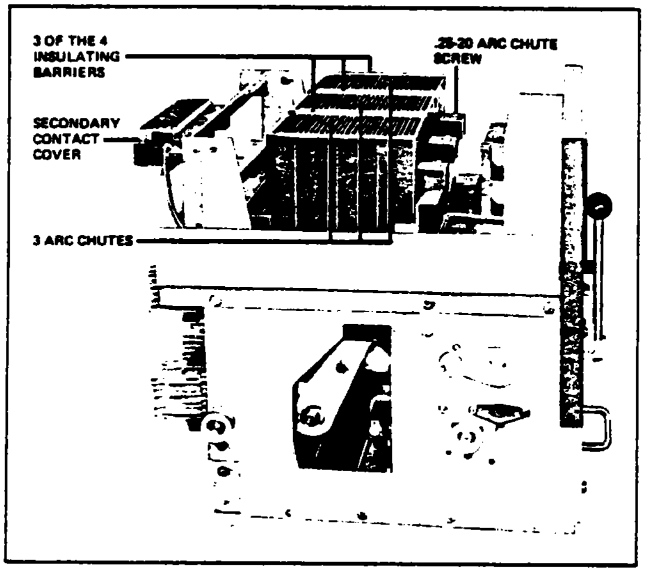


Fig. 54 *Breaker with Barrier Removed to Show Mounting of Arc Chutes (391072)*

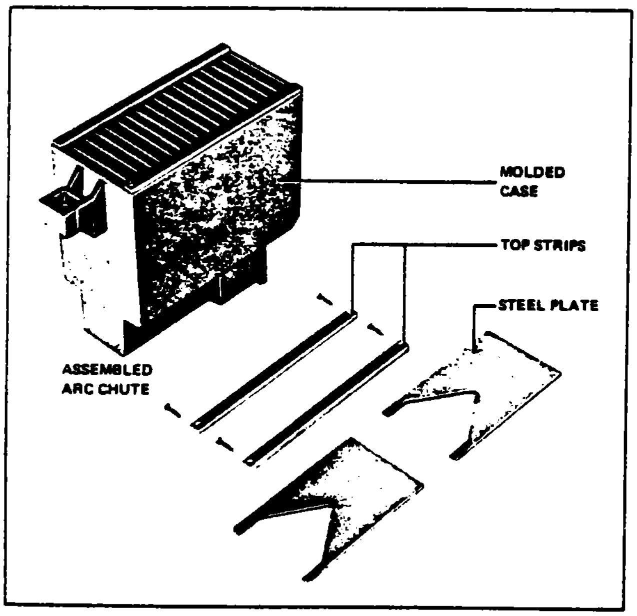


Fig. 55 *DS-206 Arc Chute with Details (383973)*

The arc chute fits well down over the arcing contacts so that the arc is confined inside the chute at all times and for all values of current. In the arc chute, immediately above the arcing contacts, are spaced crosswise vertical

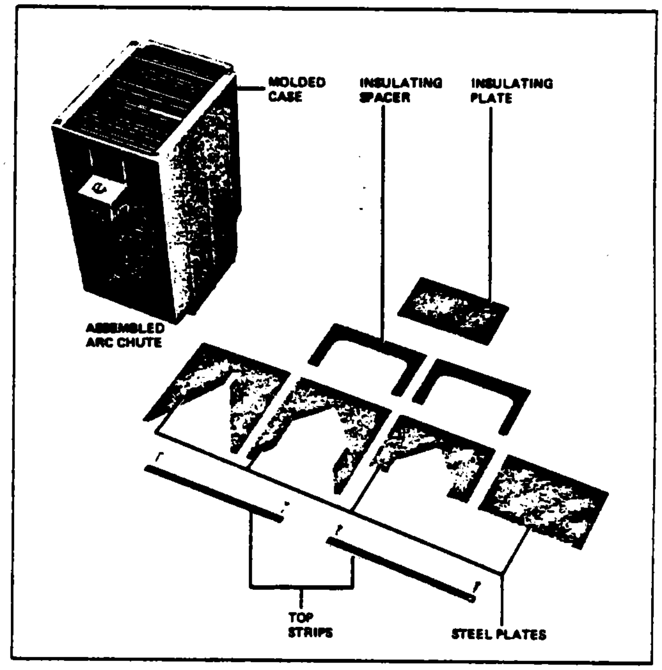


Fig. 56 *DS-416/420 Arc Chute with Details (391270)*

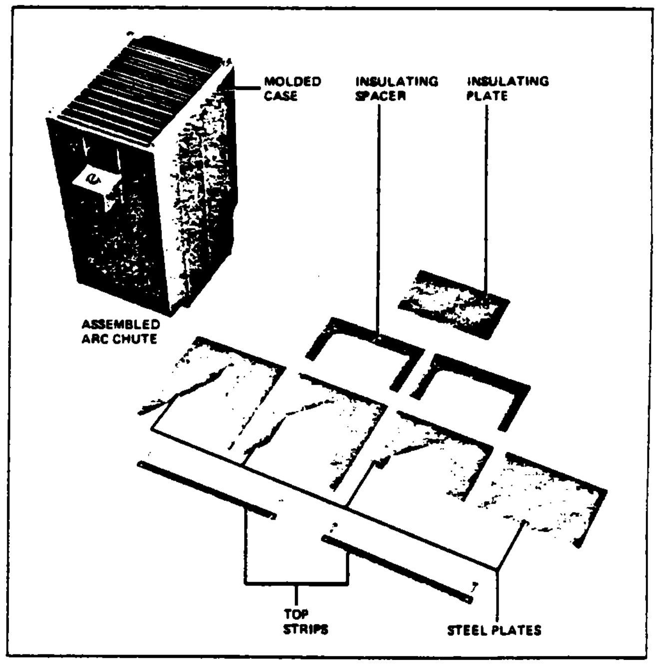


Fig. 57 *DS-632 Arc Chute with Details (391269)*

steel splitter plates having an inverted "V" notch to attract the arc and interrupt it essentially the cooling and stretching the arc.

The DS206 arc chute is shown in Figure 55. The larger arc chute for the DS416 and DS420 is shown in Figure 56, the DS632 arc chute is shown in Figure 57 and the DS840 arc chute is shown in Figure 58.

In addition to the steel plates, the larger arc chutes include hard arc-resisting glass polyester plates. These plates produce turbulence in the exhaust gases above the steel plates and prevent electrical breakdown over the top of the arc chute or to ground.

WARNING

ALL ARC CHUTES AND BARRIERS MUST BE IN PLACE BEFORE RETURNING BREAKER TO COMPARTMENT. IF BREAKER IS ENERGIZED WITHOUT CHUTES AND BARRIERS BEING INSTALLED, IT COULD CAUSE A DISASTROUS SHORT-CIRCUIT FAULT WITHIN THE SYSTEM; AND IT MAY RESULT IN BODILY INJURY AND EQUIPMENT DAMAGE.

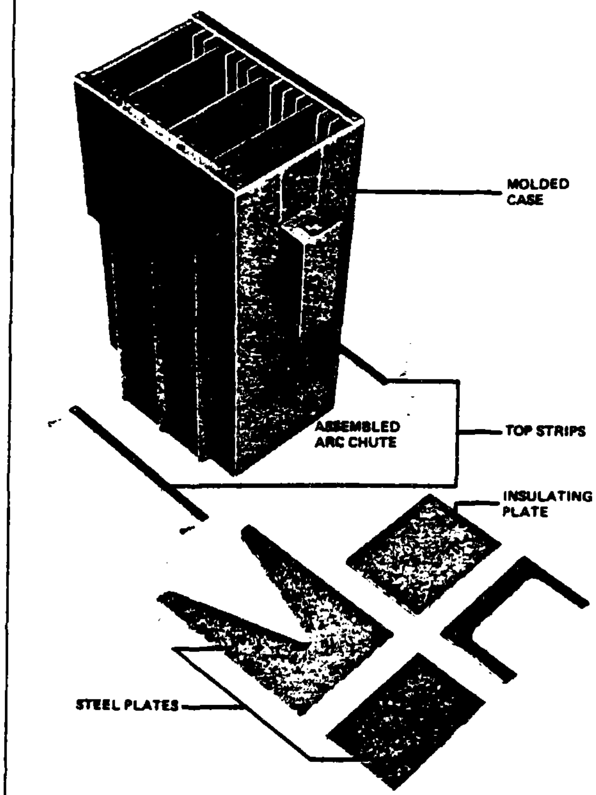


Fig. 58 *DS-840 Arc Chute with Details (391092)*

Section 8 - Circuit Breaker Automatic Tripping System

8.0 GENERAL

The circuit breaker is tripped on overload and short circuit conditions by combined action of three components:

1. The sensors which determine the current level.

2. The Amptector solid-state trip unit which provides a tripping signal when pre-determined current levels are reached.

3. The Actuator which actually trips the circuit breaker.

Schematically this may be represented as shown in Figure 59. This provides a very flexible system covering a wide range of tripping characteristics. Not only is the Amptector trip unit adjustable but the sensors are available over a wide range of current ratings.

The automatic overload and short circuit tripping characteristics for a specific breaker rating, as determined by the sensor rating, are determined by the settings of the Amptector solid-state trip unit. This unit also supplies a pulse of tripping current to the actuator. Thus all tripping functions are performed by secondary control circuitry, with no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the breaker.

The Amptector solid-state trip units are available in two basic versions; the Amptector II-A and the Amptector I-A.

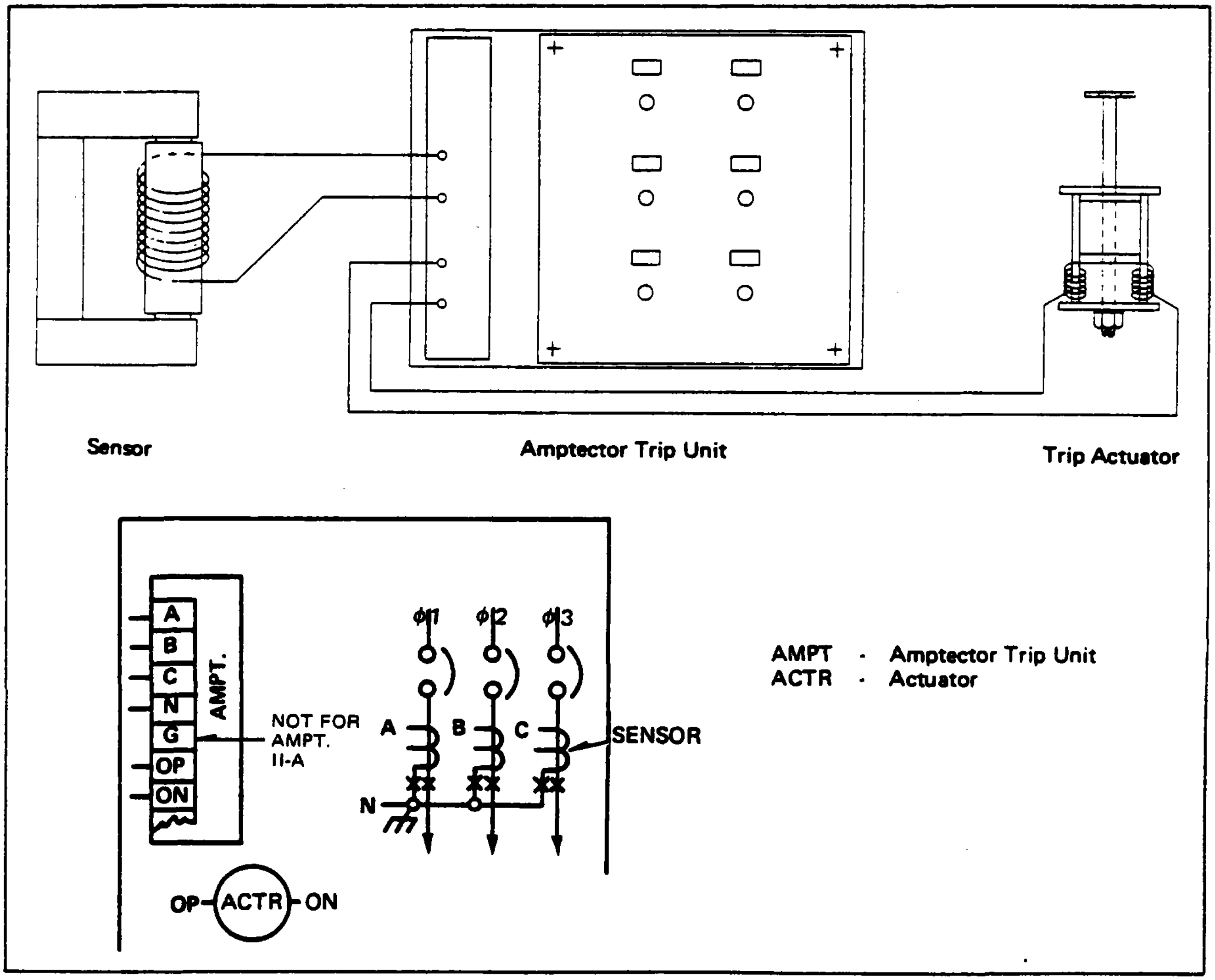


Fig. 59 *Schematic Illustration of Tripping System*

8.1 THE AMPTECTOR II-A TRIP UNIT

Improvements have been made to the Westinghouse Amptector and the standard model is now Amptector II-A. Wiring and terminal changes were made to provide method of testing with a tester. Refer to Section 8.7.6 for testing with Amptector Test Kit.

Another change was to modify the long delay curve to nearly an I^2T function. The revised curve shows this change. See Curve No. 1.

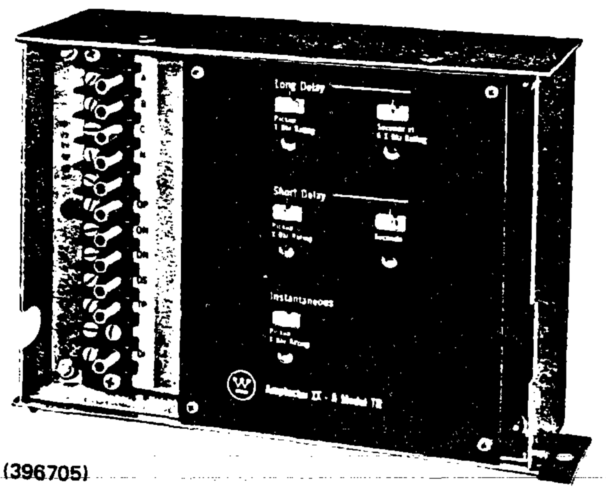
The Amptector II-A is standard equipment on all DS and DSL circuit breakers. It provides approximately equivalent functions as the electro-mechanical trip devices provided on some circuit breakers but with the superior operating capability of solid-state devices. The Amptector I-A is an optional (extra cost) tripping system which can be provided when ground fault protection or trip indicators are required. Both trip units have the same reliability and repeatability inherent in solid-state design.

As shown in Figure 5 the Amptector trip unit is at the top front of the breaker. Figure 60 shows a close-up of the front of the Amptector II-A trip unit. There can be a total of five adjustable controls, with screwdriver adjustment. These are for setting the following characteristics:

1. Long-delay current pick-up.
2. Long-delay time.
3. Short-delay current pick-up.
4. Short-delay time.
5. Instantaneous current pick-up.

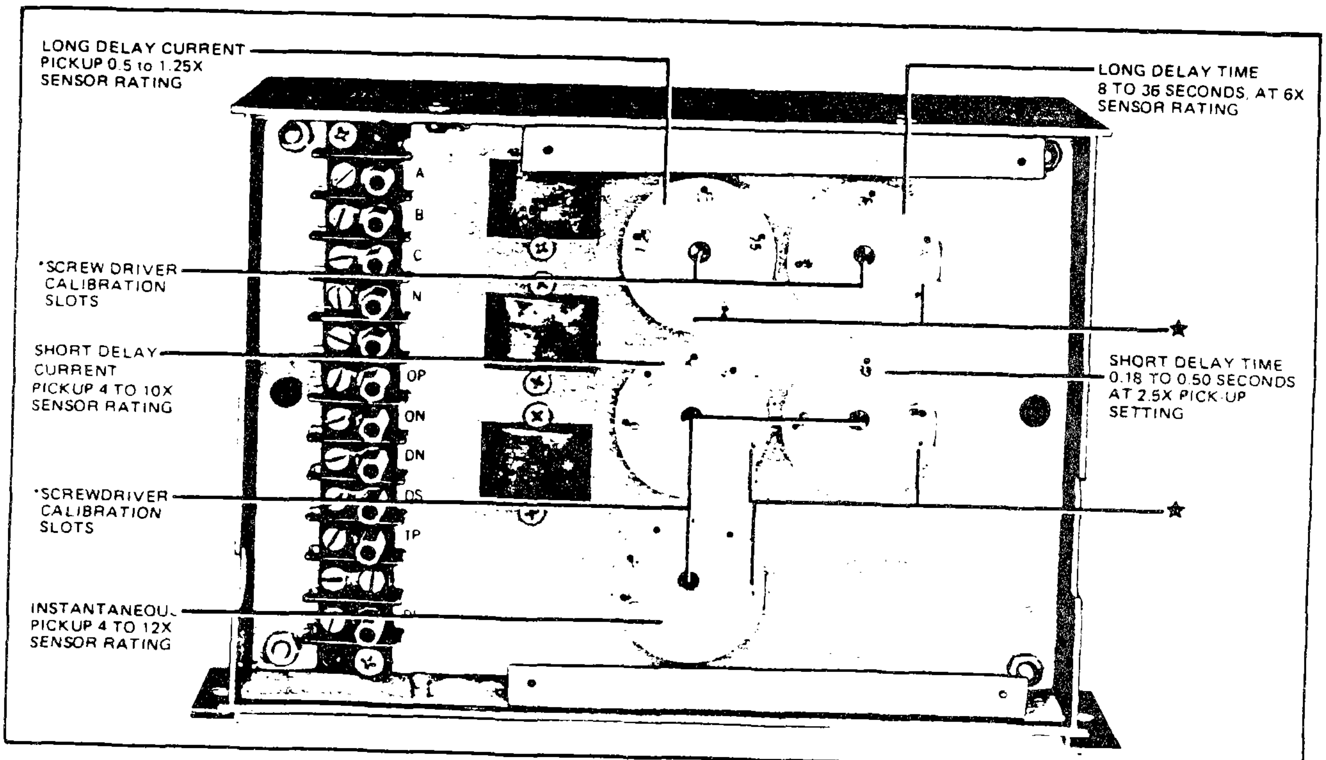
NOTE

The term "pick-up" as used here means the rms value of current at which the Amptector trip unit timing function begins or instantaneous tripping is intiated.



(396705)

Fig. 60 *Standard Amptector II-A Solid-State Trip Unit*



* See Section 8.4 of Text for Explanation

Fig. 61 *Amptector II-A Trip Unit with Front Cover Removed (396704)*

Figure 61 is the Amptector II-A trip unit with front cover removed, showing all of the calibration marks on the dials. The ranges of current settings in multiples of sensor rating and time delay are as follows:

1. Long-delay pick-up	.5 to 1.25 X sensor rating
2. Long-delay	8 to 36 seconds, at 6 X sensor rating

Over these ranges tripping will always occur within the time band shown on Curve No. 1, page 59. The bottom of the band is called the resettable delay. If the overload subsides in less than the resettable delay time, resetting of the trip unit will occur within a few cycles after the load drops to less than 90% of the pick-up setting.

3. Short-delay pick-up	4 to 10 X sensor rating
4. Short delay	.18 seconds to .50 seconds or 11 to 30 cycles at 60 Hz, at 2.5 X pick-up setting.

Over these ranges tripping will always occur within the time band shown on Curve No. 1, page 59. Although the time adjustment is continuous, three time bands are calibrated as shown on the curve.

5. Instantaneous Pick-up	4 to 12 X sensor rating

Three different combinations of trip elements are provided. Those combinations with the corresponding Amptector II-A model designations as follows:

1. Long Delay Instantaneous	DU (DUAL)
2. Long Delay Short Delay	SE (SELECTIVE)
3. Long Delay Short Delay Instantaneous	TR (TRIPLE)

Each Amptector II-A trip unit has a terminal block accessible on the front of the circuit breaker front panel.

Figure 59 shows a typical standard wiring diagram, which includes the Amptector II-A trip unit terminal block. The following table explains the markings of the terminals:

A Sensor phase A	ON Output negative*
B Sensor phase B	DN Test point (internal neutral)**
C Sensor phase C	DS Test point**
N Sensor neutral	TP Test point**
OP Output positive*	DI Test point**

*To Actuator Coil. THIS COIL HAS A POLARITY MARKING ON THE POSITIVE LEAD WHICH MUST BE OBSERVED. OTHERWISE THE BREAKER WILL NOT HAVE OVERLOAD OR FAULT PROTECTION WHICH COULD RESULT IN BODILY INJURY AND/OR SERIOUS EQUIPMENT DAMAGE.

**Terminals marked "test point" are intended to provide connections for operation of the optional test kit.

8.2 THE AMPTECTOR I-A TRIP UNIT

Amptector I-A trip units perform all of the functions described above for Amptector II-A trip units and in addition provide the following:

1. Optional adjustable ground fault protection with resettable operation indicator.

2. All Amptectors I-A have a trip indicator that will indicate on overload tripping and another that indicates on short circuit tripping. (All indicators are reset manually.)

Figure 62 shows the front of the Amptector I-A trip unit. A maximum of seven adjustable controls with screwdriver adjustments may be provided for setting the following characteristics:

1. Long-delay current pick-up
2. Long-delay time
3. Short-delay current pick-up
4. Short-delay time
5. Instantaneous current pick-up
6. Ground current pick-up
7. Ground delay time

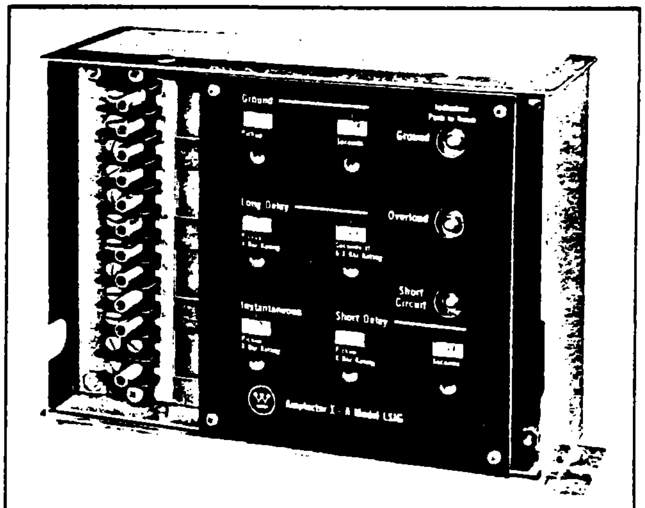


Fig. 62 *Optional Amptector I-A Solid-State Trip Unit (396707)*

Figure 63 is the Amptector trip unit with front cover removed, showing all of the calibration marks on the dials and trip indicators. The ranges of current settings in multiples of sensor rating and time delay are as follows:

1. Long-delay pick-up	.5 to 1.25 X sensor rating
2. Long-delay	4 to 36 seconds, at 6 X sensor rating

Over these ranges tripping will always occur within the time band shown on Curve No. 2, page 60. The bottom of the band is called the resettable delay. If the overload subsides in less than the resettable delay time, resetting of the Amptector trip unit will occur within a few cycles after the load drops to less than 90% of the pick-up setting.

3. Short-delay pick-up	4 to 10 X sensor rating
4. Short delay	.18 seconds to .50 seconds or 11 to 30 cycles at 60 Hz, at 2.5 X pick-up setting.

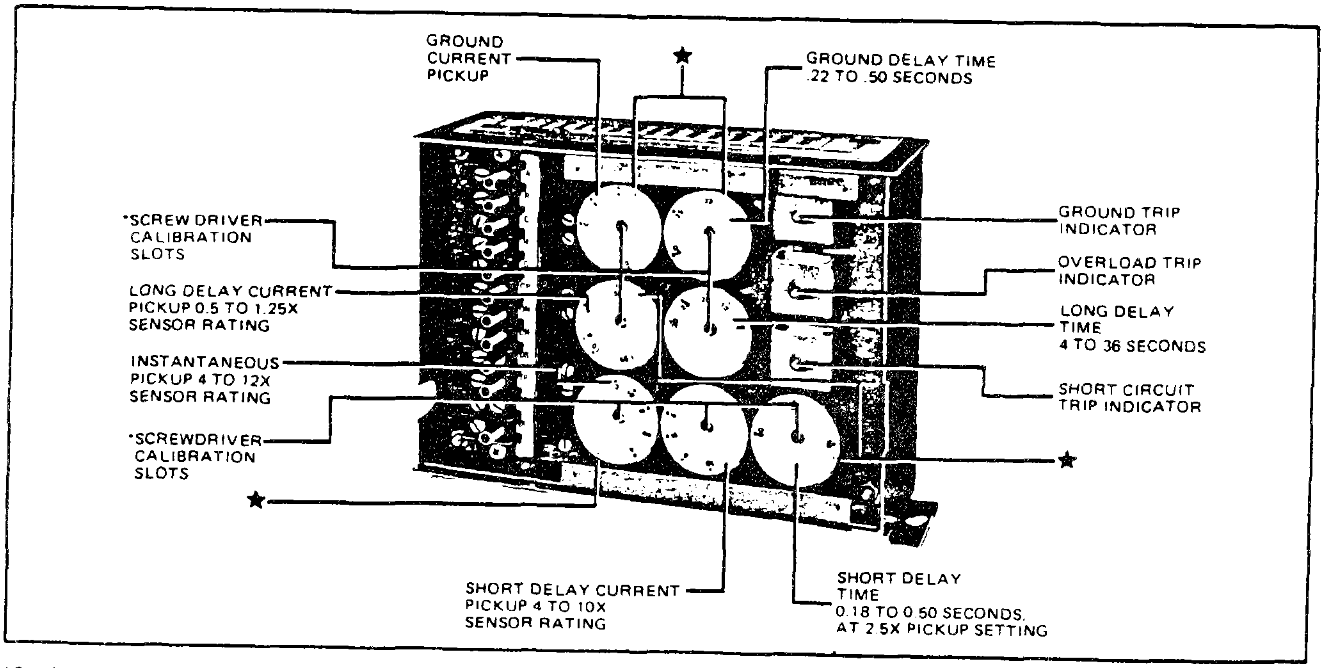
Over these ranges tripping will always occur within the time band shown on Curve No. 2, page 60. Although the time adjustment is continuous, three time bands are calibrated as shown on the curve.

5. Instantaneous pick-up	4 to 12 X sensor rating
6. Ground current pick-up	See table on top of trip unit or on Curve No. 2.
7. Ground delay time	.22 to .50 seconds 13 to 30 cycles at 60 Hz

Six different combinations of the above trip elements are provided. These combinations with the corresponding Amptector I-A model designations are as follows:

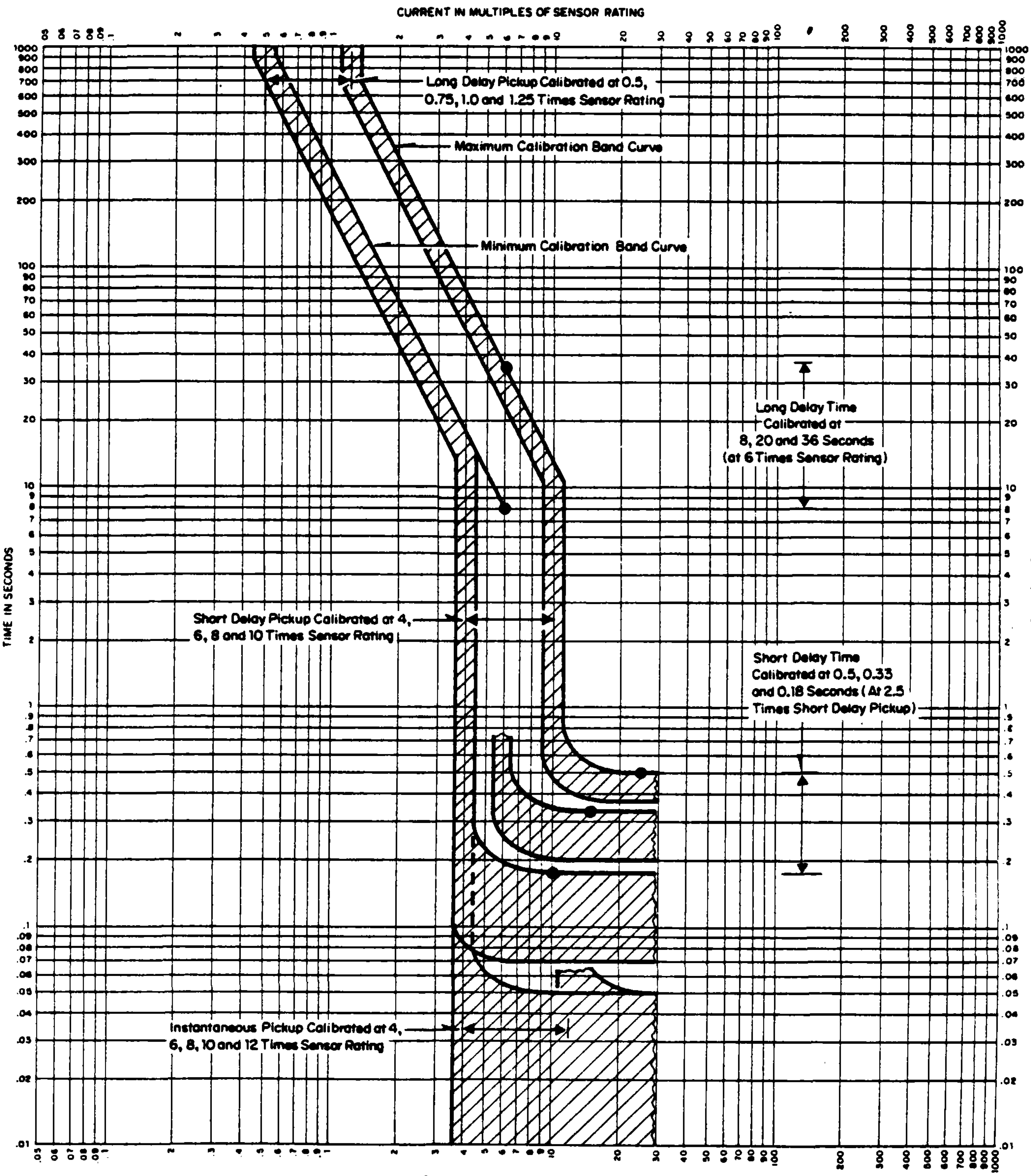
1. Long Delay Instantaneous	LI
2. Long Delay Instantaneous Ground	LIG
3. Long Delay Short Delay	LS
4. Long Delay Short Delay Ground	LSG
5. Long Delay Short Delay Instantaneous Ground	LSIG
6. Long Delay Short Delay Instantaneous	LSI

Each Amptector I-A trip unit has a terminal block equipped with test plug terminals accessible on the front of the circuit breaker front panel. This permits convenient field checking of calibrations and operation with an ex-



*See Section 8.4 of Text for Explanation

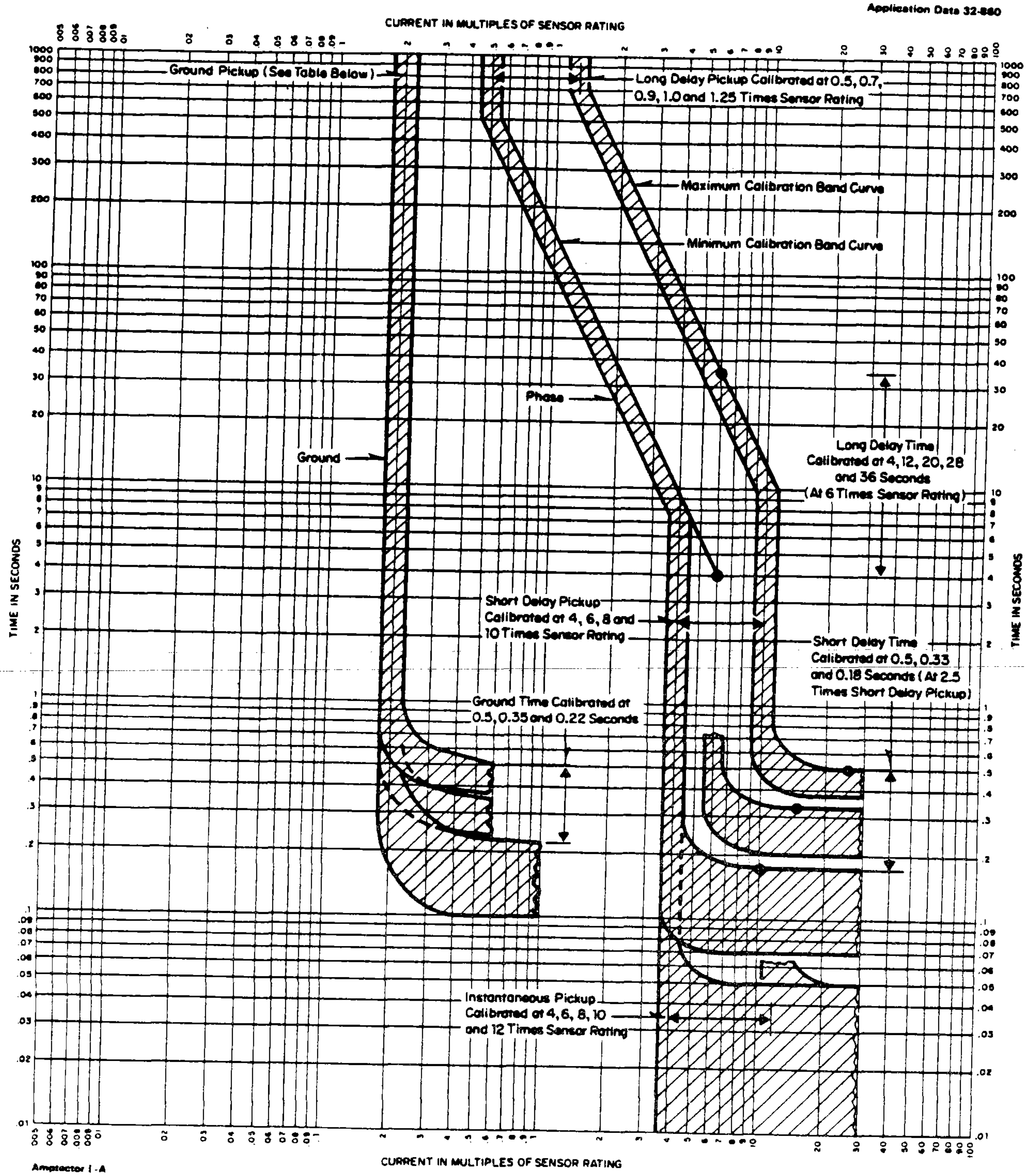
Fig. 63 *Amptector I-A Trip Unit with Front Cover Removed (396706)*



Amptector II-A
Time - Current Characteristics

Curve No. 705502
New Information
November, 1978

Curve No. 1



Amptector I-A

Ground Pick Up Value—Amperes

Dial Setting	50	100	150	200	300	400	600	Sensor Rating 800	1200	1800	2000	2400	3200	4000	Secondary Current ¹
A	13	57	60	65	80	110	145	180	260	330	400	530	640	800	1.0
B	18	67	75	85	110	150	205	280	385	505	600	770	1000	1200	1.5
C	22	75	85	100	130	185	250	325	480	625	760	960	1200	N A	1.9
D	33	100	120	145	200	270	385	500	730	970	1200	N A	N A	N A	3.0

All pick up values may vary ± 10%

¹ Current of this value from the secondary of an external ground transformer will cause the ground element to function. Ground element pick up can also be tested using this value. All sensors must be disconnected during test

Amptector I-A

Time - Current Characteristics

Curve No. 2

Curve No. 705501

New Information
November, 1978

:ernal power supply. A specially designed power supply test kit, with plugs to match the Amptector trip unit test plug terminals is available; and its operation is described in Section 8.7.6 of this instruction book.

Figure 59 shows a typical standard wiring diagram, which includes the Amptector trip unit terminal block. The following table explains the markings of the terminals:

A Sensor phase A

B Sensor phase B

C Sensor phase C

N Sensor neutral

G Ground

OP Output positive*

ON Output negative*

DN Test point (internal neutral)**

DS Test point**

TP Test point**

OSS High load switch signal to accessory unit

DI Test point**

*To Actuator Coil. THIS COIL HAS A POLARITY MARKING ON THE POSITIVE LEAD WHICH MUST BE OBSERVED. OTHERWISE THE BREAKER WILL NOT HAVE OVERLOAD OR FAULT PROTECTION WHICH COULD RESULT IN BODILY INJURY AND/ OR SERIOUS EQUIPMENT DAMAGE.

**Terminals marked "test point" are intended to provide connections for operation of the optional test kit.

8.2.1 Ground Fault Protection

When the Amptector I-A trip unit includes ground current protection, the type of connection to the circuit must be considered. If the system neutral is grounded but the neutral is not carried with the phase conductors, the Amptector trip unit has all of the equipment necessary for sensitive ground protection.

If the system neutral is grounded and a neutral conductor is carried with the phase conductors, it is necessary to order an additional sensor, for the purpose of cancelling out any residual current in the phase conductors. This sensor must be mounted separately and must be located on the neutral conductor at the point where the neutral conductor connects to the neutral bus. These sensors are duplicate of those supplied on the breaker except for the 2400A and 3200A ratings where a modified neutral sensor is required.

The Amptector trip unit ground element may be energized from an external ground current source rather than from internally developed ground current. Such an external source could be a ring-type transformer through which all the load current conductors would have to pass. In the case of a three-phase four-wire circuit all three phase conductors and the neutral conductors would have to pass through the transformer. The sensitivity of the ground element for this kind of arrangement would depend on the ratio of the transformer used.

The ground current pick-up dial on the Amptector I-A trip unit has alphabetic calibration markings. The actual ground current corresponding to these calibrated points varies with the rating of the sensor being used. These pick-up values are printed on the top of the trip unit box.

The "Ground Trip Indicator" is a metal plunger located at the upper right corner of the trip unit. If the trip unit has functioned due to a ground fault, this plunger will protrude through the faceplate of the unit. The indicator is reset by pushing in on the plunger. If it is not reset before placing the breaker back in service, the trip unit will function normally but there will remain a false indication.

Overload Trip Indicator – Functions due to overload currents less than short delay or instantaneous pick-up.

Short Circuit Trip Indicator – Functions due to fault current in excess of short delay or instantaneous pick-up.

8.3 MAKING CURRENT RELEASE (DISCRIMINATOR)

All Amptector trip units which do not have instantaneous trip elements (Amptector II-A model SE and Amptector I-A models LS and LSG) are provided with a "making current release" which is referred to as a "Discriminator". This is a circuit in the trip unit which determines at the time of a fault whether or not there has been any current flow in the primary circuit previous to the fault. If there has been no measurable current flow previous to the fault, indicating that the circuit breaker is just being closed (or possibly that a switching device ahead of the breaker has just been closed) and if the primary current flow exceeds approximately twelve times the sensor rating, the trip unit will function instantaneously. If the "Discriminator" circuit determines that there has been a measurable current flow prior to the fault, the instantaneous operation will not occur and the normal short time delay element will take over to delay tripping. The purpose of this unique tripping concept is that selectivity and continuity of service in un-faulted sections of the system can be maintained if there is any need, but if there is no previously operating load on the circuit, the instantaneous function takes over to limit extensive damage which might occur due to a delayed tripping operation.

8.4 SERVICING OF AMPTECTOR TRIP UNIT

The Amptector trip unit is the intelligence of the overcurrent protection provided by the breaker. It is a device that has many solid-state components. Since the only moving parts are the adjustments, the Amptector trip unit will give long, trouble-free service. All components and connections, including the printed circuit board itself, are coated to give effective environmental protection.

In changing the Amptector trip unit settings, *the dials should be moved only by means of a small screw driver inserted through the round hole in the faceplate directly below the calibration window.* The shafts must never be rotated by applying torque directly to the dial as it has only a friction fit on the shaft.

If it is suspected that the dial has moved on its shaft, it may be checked by means of rotating the shaft counterclockwise to the limit of travel. A dot at the end of the calibration should lineup with the index mark on the faceplate. See asterisk (*) on Figures 61 and 63.

If there is any reason to suspect that the Amptector trip unit is not operating correctly IT SHOULD NOT BE TAMPERED WITH; SINCE TAMPERING COULD RESULT IN LOSS OF VITAL OVERCURRENT PROTECTION.

NOTE

Warranty on the Amptector trip unit will be void if there is any evidence of tampering.

A specially designed tester is available for checking Amptector trip unit operation without using primary current. The tester can be plugged into any convenience outlet; and will pass enough current to check any pickup calibration. Time delay calibrations can also be checked. Place drawout breakers in DISCONNECT position before performing Amptector trip unit check.

Special handling and test equipment are required to service solid-state devices. If use of the tester shows that an Amptector trip unit is not operating correctly, it is strongly recommended that a spare Amptector trip unit be used; and the questionable unit be returned to the factory for service.

8.5 ACTUATOR

The actuator receives a tripping pulse from the Amptector trip unit, and produces a mechanical force to trip the breaker. Refer to Figures 64, 65 and 24 for location and details. The actuator is made up of a permanent magnet, a disc held by the magnet, a rod acted on by a spring, a lever for tripping the breaker, and a lever for mechanically resetting the actuator. The magnet cannot pull and reset the disc against the force of the spring acting on the rod, but can overcome the spring force when the disc is in contact with the magnet pole piece. A tripping pulse from the Amptector trip unit counteracts the effect of the permanent magnet, allowing the spring to separate the disc from the magnet pole piece and move the rod to actuate the trip shaft lever. The trip shaft lever then rotates the trip shaft and trips the breaker. As the breaker opens, the left pole unit lever pin strikes the spring finger attached to the reset lever; this furnishes the assistance required to move the disc so as to close the air gap between it and the permanent magnet against the spring force. The device is reset when the disc is in contact with the magnet. If the disc is not fully reset, the trip shaft lever will hold the breaker mechanism in the trip-free condition; and the breaker cannot be reclosed.

The actuator must be replaced if it will not stay reset when the plunger has been moved to the top of its travel.

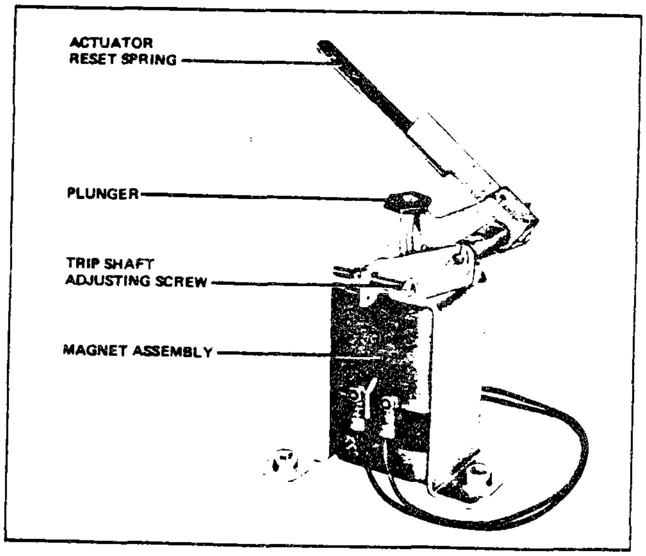


Fig. 64 *Trip Actuator (391093)*

8.6 SENSORS

The three sensors are located at the rear of the breaker on the lower studs, and directly behind the main disconnecting contacts. Refer to Figure 66. They produce an output proportional to the load current and furnish the Amptector trip unit with the intelligence and energy to trip the breaker when preselected conditions of current magnitude and duration are exceeded.

The continuous current rating for any frame size breaker can be changed simply by changing the sensors. The wide range of long-delay current pick-up available on the Amptector trip unit makes one set of sensors suitable for a number of current ratings. The Amptector trip unit setting controls are standard, and are usable with any standard sensors. If sensors are changed because of changing load conditions, etc., it is only necessary to readjust the Amptector trip unit controls to the new desired values. Available sensor ratings are listed in Table 4.

Table 4. Frame Size and Sensor Ratings

Breaker Type	Frame Size Amperes*	Sensor Ratings, Amperes**
DS-206 or DSL-206	800	50-100-150-200-300-400-400-600-800
DS-206S	800	100-150-200-300-400-600-800
DS-416, DSL-416 or DS-416S	1600	100-150-200-300-400-600-800-1200-1600
DS-420	2000	100-150-200-300-400-600-800-1200-1600-2000
DS-632	3200	2400-3200
DS-840	4000	4000

*Maximum continuous current rating for breaker.

**Amptector trip unit Long Delay Pick-up is adjustable from 50% to 125% of the sensor rating, but should not be set above 100% when using sensor rating equal to frame size.

8.7 OPTIONAL ACCESSORIES

In addition to the Amptector trip unit to provide overload protection, the following optional accessories are provided as required.

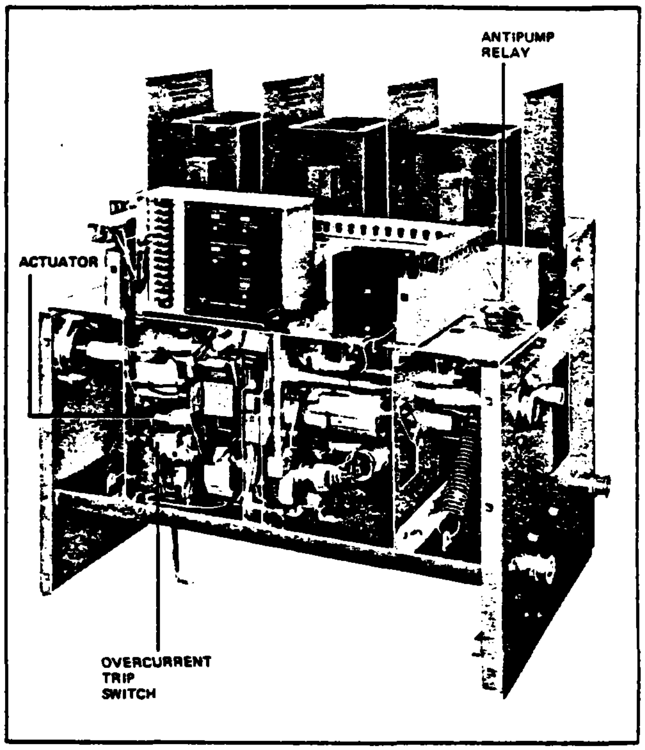


Fig. 65 *DS-840 Breaker with Front Panel Removed (391076)*

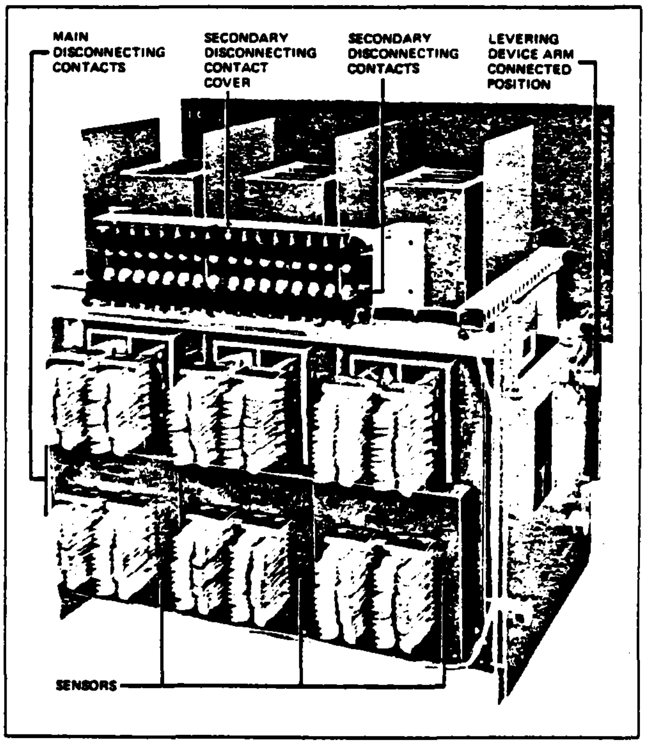


Fig. 66 *DS-840 Breaker Rear View Showing Sensors (391074)*

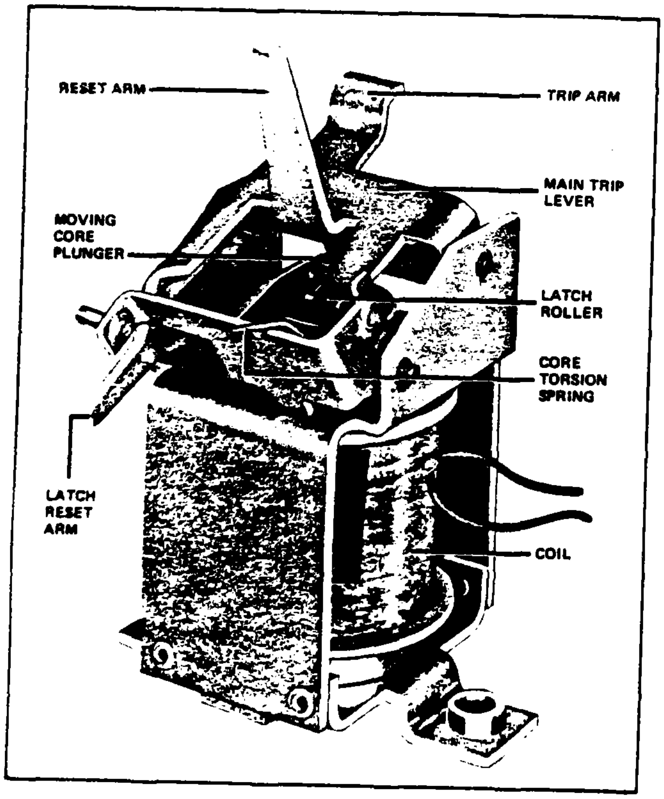


Fig. 67 *Undervoltage Trip Device (390244)*

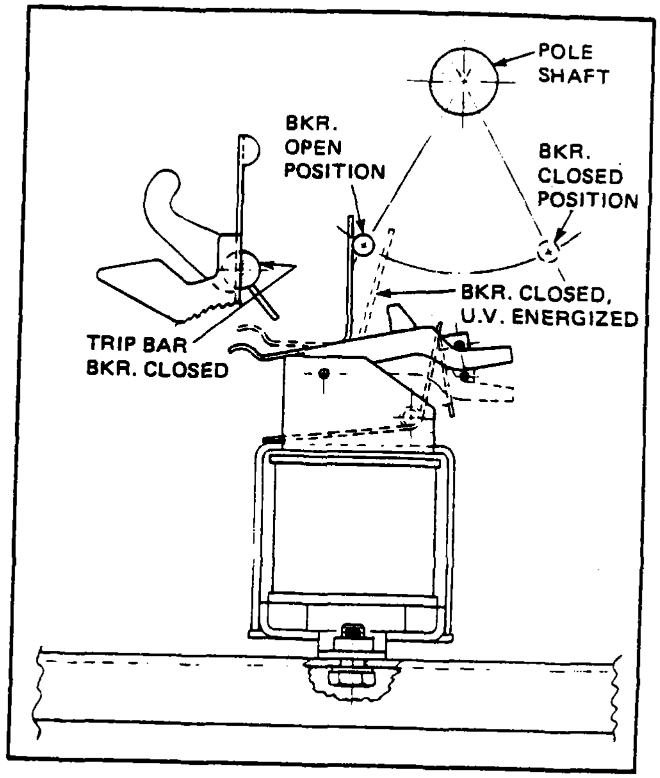


Fig. 68 *Undervoltage Trip Device Operation*

8.7.1 Undervoltage Trip Attachment

The undervoltage trip shown in Figure 67 is an electromechanical device that trips the circuit breaker when the voltage on its coil falls to between 30 and 60 percent of normal. The standard unit trips instantaneously. A similar device is also available with non-adjustable time delay intended to ride through momentary fluctuations of system voltage.

In operation, a moving core is normally held magnetically against a stationary core and a spring. This is linked to a latch carrying a roller which restrains the main tripping lever of this assembly.

When the coil voltage is reduced sufficiently, the torsion spring overcomes the magnetic attraction between the two cores. The moving core travels upward, and rotates the latch in a counterclockwise direction so that the roller moves from beneath the tail of the main tripping lever. A torsion spring (not visible in Figure 67) around the pivot pin of the tripping lever then rotates it in a counterclockwise direction, causing a projection on the right side of this lever to strike a pin in the breaker mechanism trip shaft, and rotate the latter in a clockwise direction to trip the breaker.

As the breaker opens, a pin on the left pole unit shaft strikes a vertical leg (Reset arm) of the undervoltage tripping lever and rotates it counterclockwise against its torsion spring. Another arm on the tripping lever resets the roller latch and the moving core. A slight amount of overtravel on the trip latch insures positive resetting under all conditions. Set Figure 68 for the relationship of the undervoltage trip device, pole shaft and trip shaft.

Always connect the undervoltage coil on the line side of the breaker unless the attachment is equipped with a time delay device. In this case, the time delay will delay tripping of the breaker long enough to permit energization of the undervoltage coil from the load side. Do not use an auxiliary switch contact in this circuit.

8.7.2 Overcurrent Trip Switch

This device is available as an optional accessory on either manually operated or power-operated breakers of all ratings. Its function is to provide a signal to indicate that the breaker has tripped open by action of the Amptector trip unit due to phase or ground overcurrent. Normal tripping by the trip plate, shunt trip device, undervoltage trip device, etc. does not cause it to operate. It is mounted on and operates from the trip actuator of the breaker.

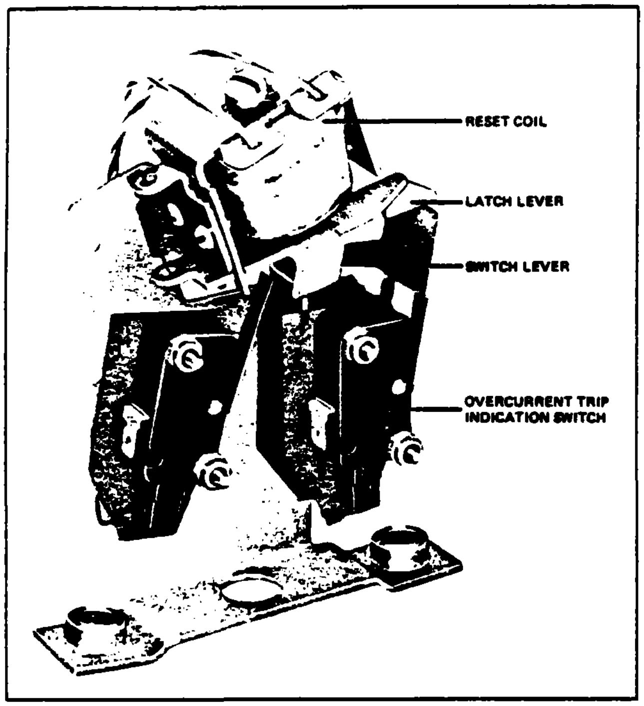


Fig. 69 *Overcurrent Trip Switch (390239)*

Three contact arrangements are available as standard: (1) two normally open, (2) two normally closed, or (3) one normally open and one normally closed contact. These are independently wired to secondary disconnect contacts at the rear of the breaker unit. Some special units may have one or two additional contacts.

The device is latch-type and must be manually reset by means of a pushbutton on the breaker front panel. Also available is an electric reset for remote operation. Figures 69 and 70 illustrate an electric reset device.

8.7.3 High Load Switch (available with Amptector I-A only)

This is a self-resetting solid-state device which picks up on an overload condition at a lower pick-up value than the breaker overload trip setting of the Amptector trip unit. Its function is to give advance notice of an overload condition before the breaker trips. See Figure 71.

The pick-up point is adjustable from 60% to 100% of the Amptector trip long delay pick-up setting. The non-adjustable time delay of 60 seconds requires that the pick-up current be maintained for that interval to cause the relay contact to operate. If the load current falls below the pick-up point, the timing resets in about a second. The relay has one normally open and one

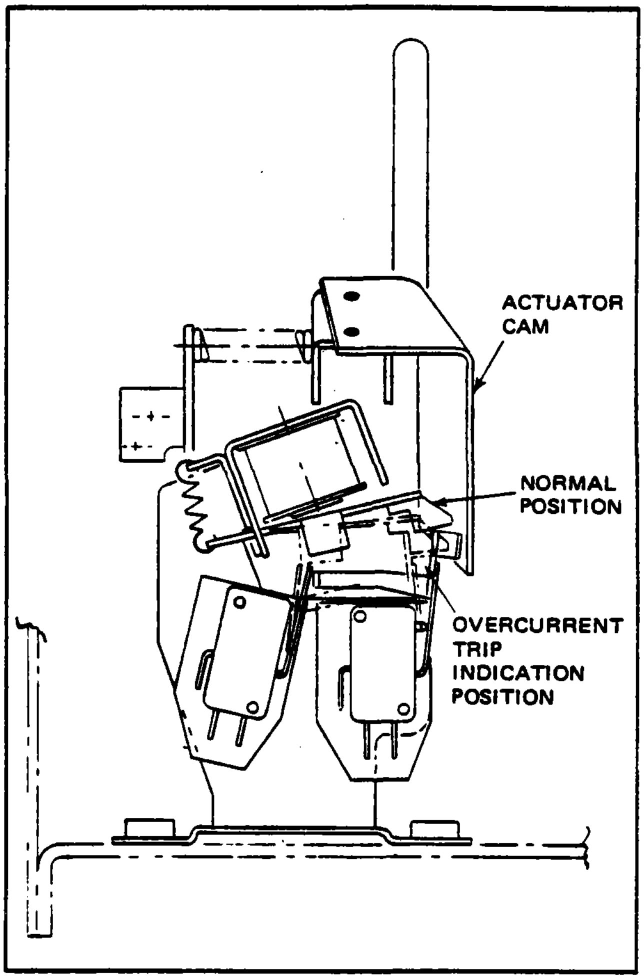


Fig. 70 *Overcurrent Trip Switch Operation*

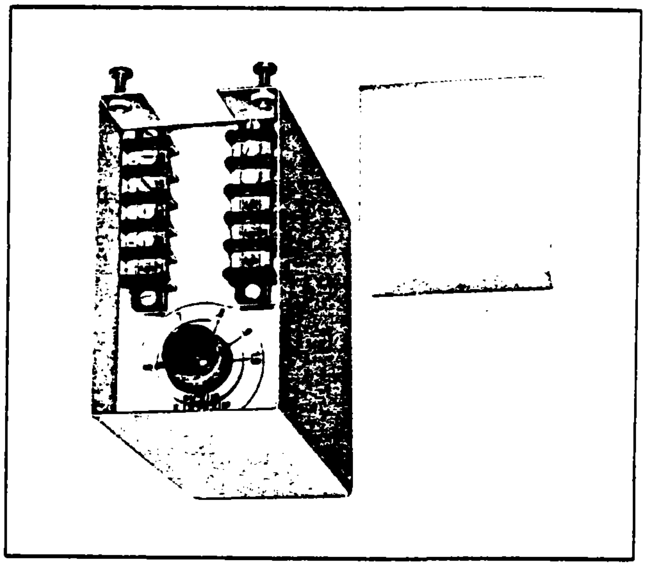


Fig. 71 *High Load Switch (391087)*

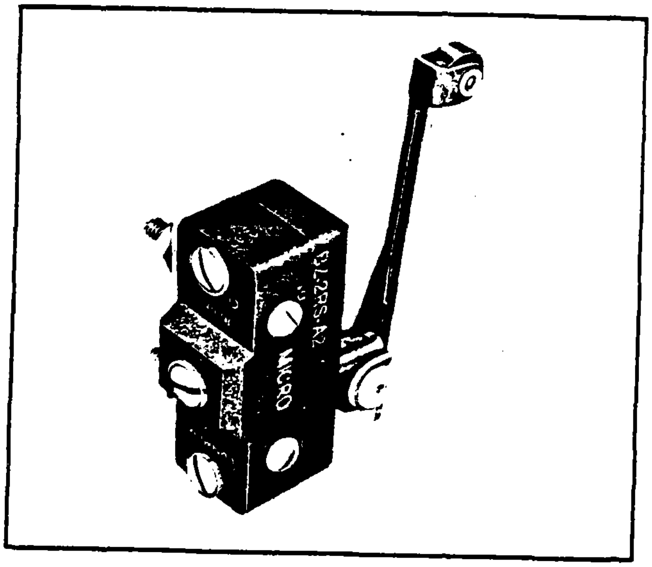


Fig. 72 *Latch Check Switch (392298)*

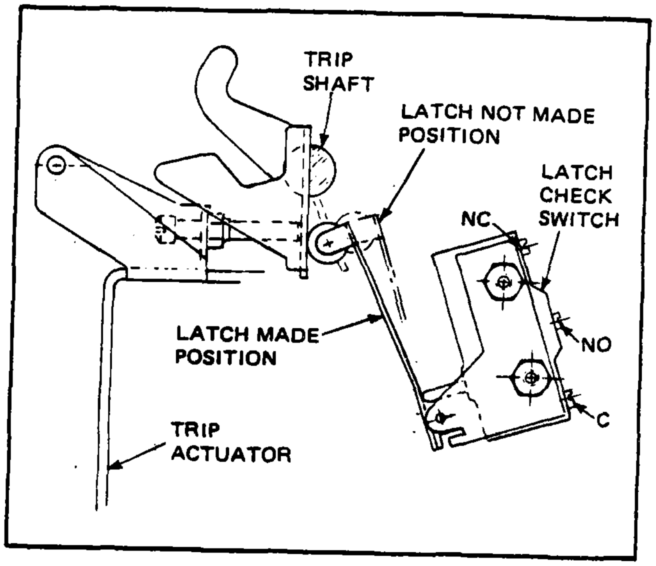


Fig. 73 *Latch Check Switch Operation*

normally closed contact with a common connection. Its built-in power supply requires a reliable sinusoidal source of either 120 or 240 volts AC.

Since this is a solid-state device, no maintenance will be required; and the same cautions apply as previously stated for the Amptector trip unit. Warranty will be void if there is any evidence of tampering.

8.7.4 Latch Check Switch

The Latch Check Switch consists of a switch mounted on the inside at the left hand side sheet of the circuit breaker. The switch is located so that when the breaker trip shaft is in the "reset" position a normally closed contact of the switch is closed. See Figures 72 and 73. When this switch is supplied, the contact is usually connected in the closing circuit of the circuit breaker to insure that the tripping system is reset before the circuit can be energized to close the breaker.

8.7.5 Auxiliary Switches

As shown in Figure 65, there may be from one to three auxiliary switches located to the right of the Amptector trip unit. Each switch has four contacts, which may be either normally open or normally closed. See Figure 74 for construction. Auxiliary switch contacts are rated 10 amperes at 120/240 volts AC, 10 amperes at 125 volts DC, and 2 amperes at 250 volts DC. The AC ratings may

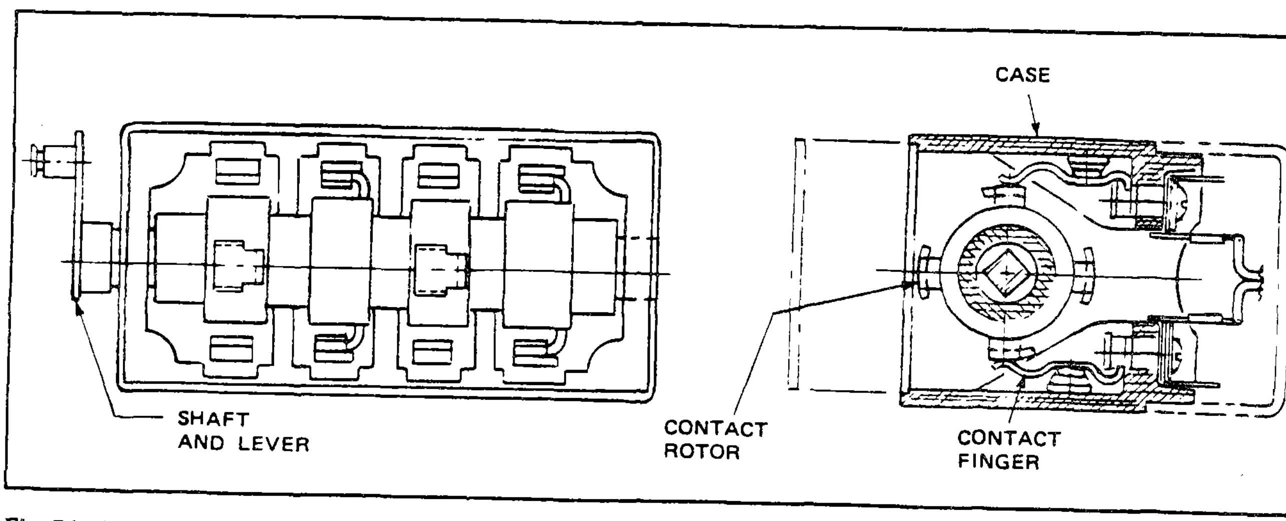


Fig. 74 *Auxiliary Switch Construction Details*

be increased to 15 amperes if the circuit breaker wiring is increased to No. 14 on these circuits.

8.7.6 Amptector Trip Unit Test Kit

8.7.6.1 General

The Amptector Trip Unit Test Kit consists of an external power supply, current measuring device, and a precision timer for field checking the operation of the unit. These three functions have been combined into a single portable device housed in a convenient carrying case. It is powered from a standard 120 volt, single phase, 60 Hz outlet; and will furnish the high secondary currents to the input of the Amptector unit to simulate primary fault conditions on the circuit breaker.

8.7.6.2 Description

A long flexible cable terminated by an 11 prong polarized plug connects to the test terminals of the Amptector trip unit. A second cable connects to the source of input power. Figures 75 and 76 show the tester and operating controls. The ammeter is dual range and controlled by the "Hi-Lo" switch. In the low range it reads 0-8 amps, while the high range covers 0-80 amps. The timer reads in seconds with the right hand digit (white) in tenths of seconds. An external ammeter may be connected in the output circuit through the terminals designated for this purpose and the shorting link removed.

CAUTION

When using the Test Kit, the breaker MUST NOT be in the connected position because breaker will be tripped and cause disruption of service. It may be in either the test or disconnected position, or removed from its compartment.

8.7.6.3 Operation

The complete testing and calibration of the Amptector trip unit by means of the Test Kit is covered by the instruction sheet (I.L. 33-791) included with the Test Kit.

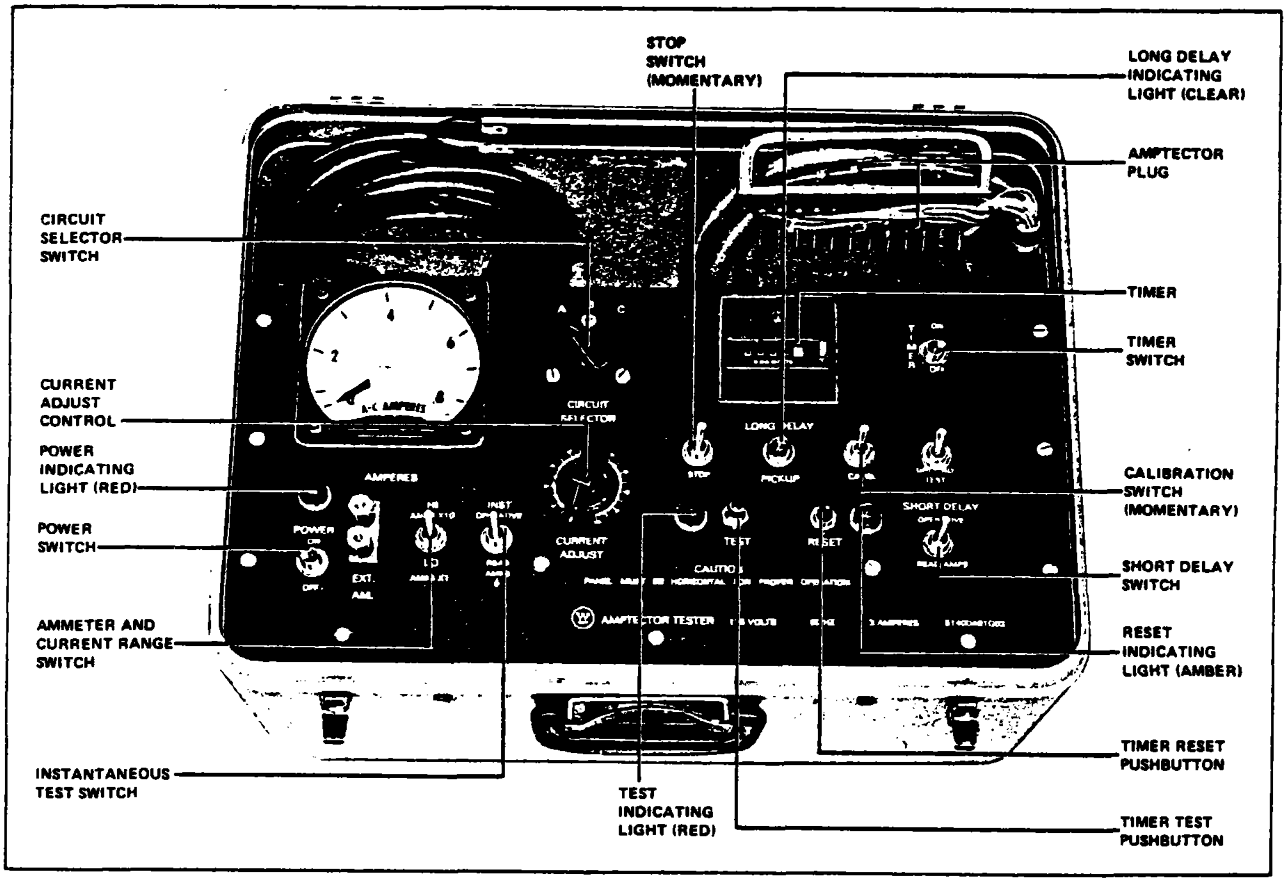


Fig. 75 *Amptector Trip Unit Test Kit (For Amptector I-A and II-A) (391672)*

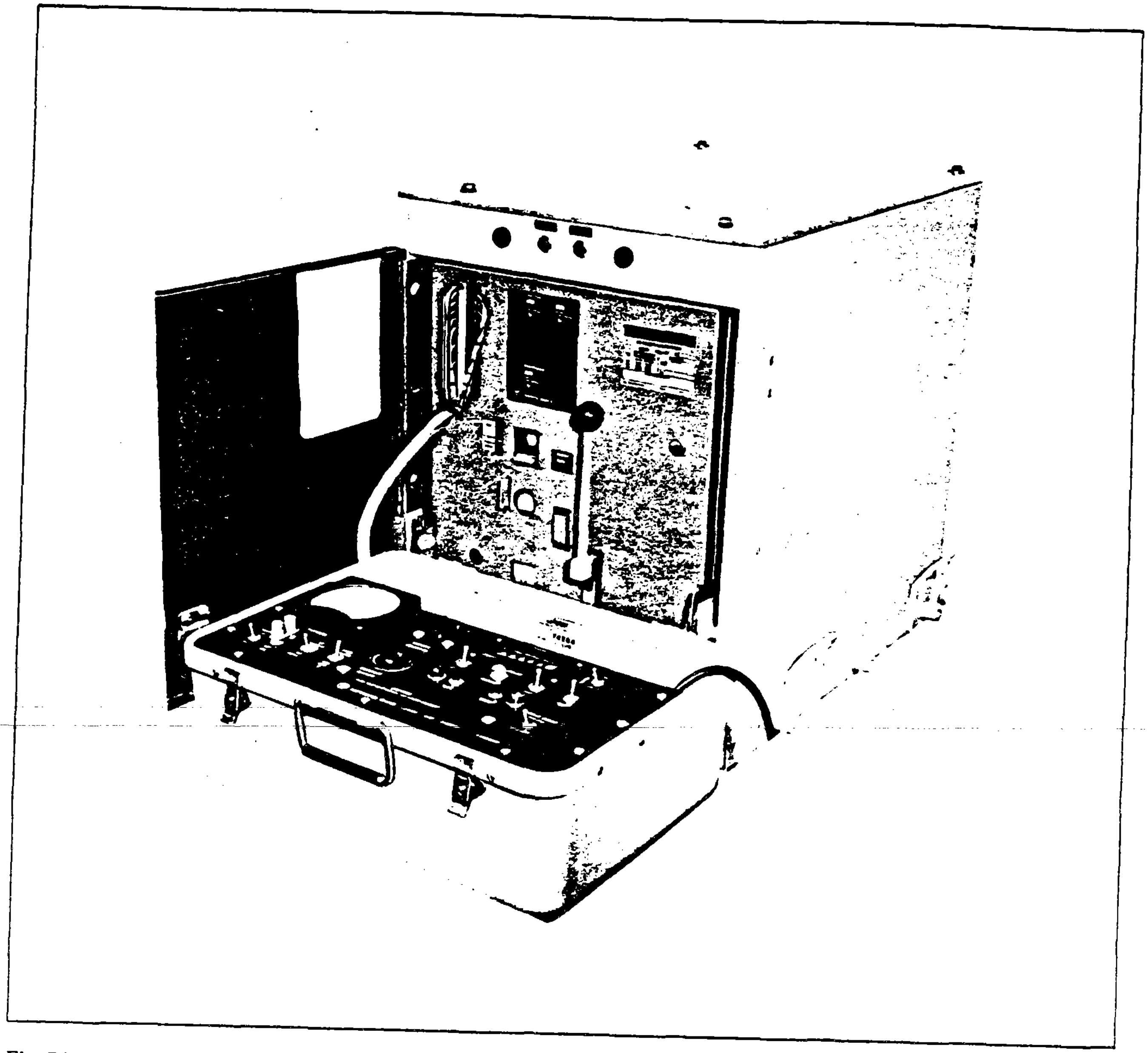


Fig. 76 *Test Kit in Operation (384826)*

Section 9 - DSL Circuit Breakers and Fuse Trucks

9.0 GENERAL

DSL circuit breakers are coordinated combinations of standard DS circuit breakers and integrally mounted series connected current limiters. They are available in two frame sizes, DSL-206 and DSL-416. The primary purpose of the current limiters is to extend the interrupting rating of the DS circuit breaker up to 200,000 amperes RMS symmetrical current. If the current limiters are sized per Table 5, the circuit breaker will function and interrupt the routine fault currents. Infrequent high faults will be cleared by the limiter. The limiters protect the circuit breaker on faults above the rating of the breaker. The limiters will blow below the circuit breaker short-time rating if the fault currents equal the system maximum capacity.

In some applications the current limiters will be sized smaller than necessary for protection of the DSL circuit breaker in order to provide protection for downstream equipment. When this is done, the current limiters will blow on fault currents which could have been satisfactorily interrupted by the basic circuit breaker.

Type DS-3200 and DS-4000 fuse trucks provide for separate mounting of Class L current limiting fuses on drawout trucks for use in series with DS-632 and DS-840 circuit breakers respectively. This separate mounting is made necessary by the size of the Class L fuses and their high temperature characteristics.

9.1 DSL CURRENT LIMITERS

Available current limiter ratings and their recommended applications are listed in Table 5. Do not replace limiters with sizes other than permitted by the table. Westinghouse DSL current limiters have been tested and approved by Underwriters Laboratories, Inc. for use in DSL circuit breakers when applied according to Table 5. They are not electrically or physically interchangeable with current limiting fuses of any other design.

The current limiters are held in place in an extension provided on the back of the circuit breaker. This extension makes the DSL circuit breakers eight inches deeper than the corresponding DS circuit breakers. See Figures 77, 78 and 79. The current limiters can only be removed from the circuit breaker and replaced when the circuit breaker is removed from its associated compartment. For this reason there is no fixed mounted version of the DSL circuit breakers.

Table 5 - Sensor and Limiter Ratings

Breaker Type	Sensor Rating	Limiter Ratings ϕ Recommended	*Minimum	**Maximum
DSL-206 DSL-206	800A 600A	1600A 1200A	1200A 800A	2000A 2000A
DSL-206	Less than 600A	1200A	125% or more of sensor rating	2000A
DSL-416	1600A	3000A	3000A	3000A
DSL-416	1200A	2500A	2000A	3000A
DSL-416	Less than 1200A	2000A	125% or more of sensor rating	3000A

ϕMinimizes nuisance blowing of limiters
*Use only when current limiting is required for downstream equipment. If long delay pick-up is set above 100%, minimum limiter ratings should not be used.
**Highest rating that will protect breaker.

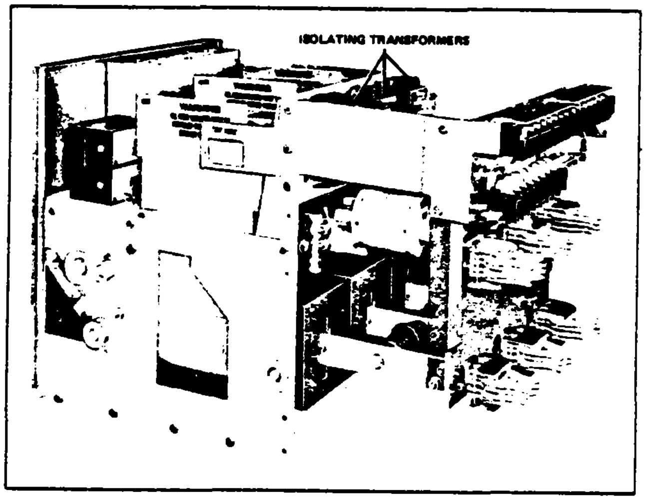


Fig. 77 *DSL-206 Breaker Side View (388138)*

9.2 BLOWN LIMITER INDICATOR

The Blown Limiter Indicator provides a visual indication on the front of DSL circuit breakers when a current limiter in any phase has interrupted a short circuit. It also insures that the circuit breaker will be tripped when any current limiter has blown, to prevent single phase power being applied to a three-phase load. See Figure 80.

This device consists of three solenoids, each connected in parallel with one of the limiters. When a limiter is blown, the resulting voltage across the open limiter causes

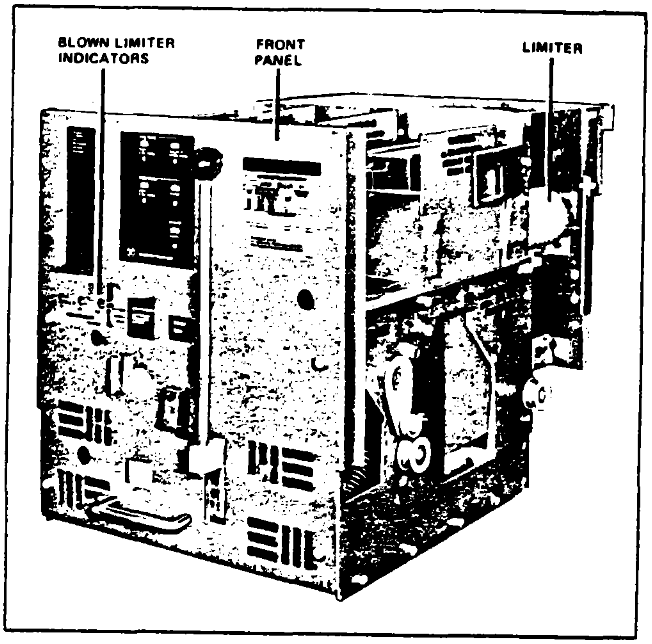


Fig. 78 *DSL-206 Breaker Front View (DSL-416 Similar) (388445)*

the associated solenoid to operate, tripping the circuit breaker mechanically and extending an indicator through the front cover of the circuit breaker. See Figure 78. The indicator will remain extended and the breaker will be held trip-free until the reset button is pushed. If the device is reset and the breaker reclosed on an energized circuit before the blown limiter is replaced, the breaker will be immediately reopened and held trip-free. The solenoids are isolated from the primary circuit voltage by three transformers located above the limiters. See Figures 77 and 79.

9.3 FUSE TRUCKS

DS-3200 and DS-4000 Fuse Trucks provide drawout mounting for Class L current limiting fuses when installed in type DS switchgear. These drawout trucks physically fit in the same compartments as the DS-632 and DS-840 circuit breakers respectively. They are moved in and out of the compartment using a similar levering mechanism as provided on the DS circuit breakers. See Figures 81 and 82.

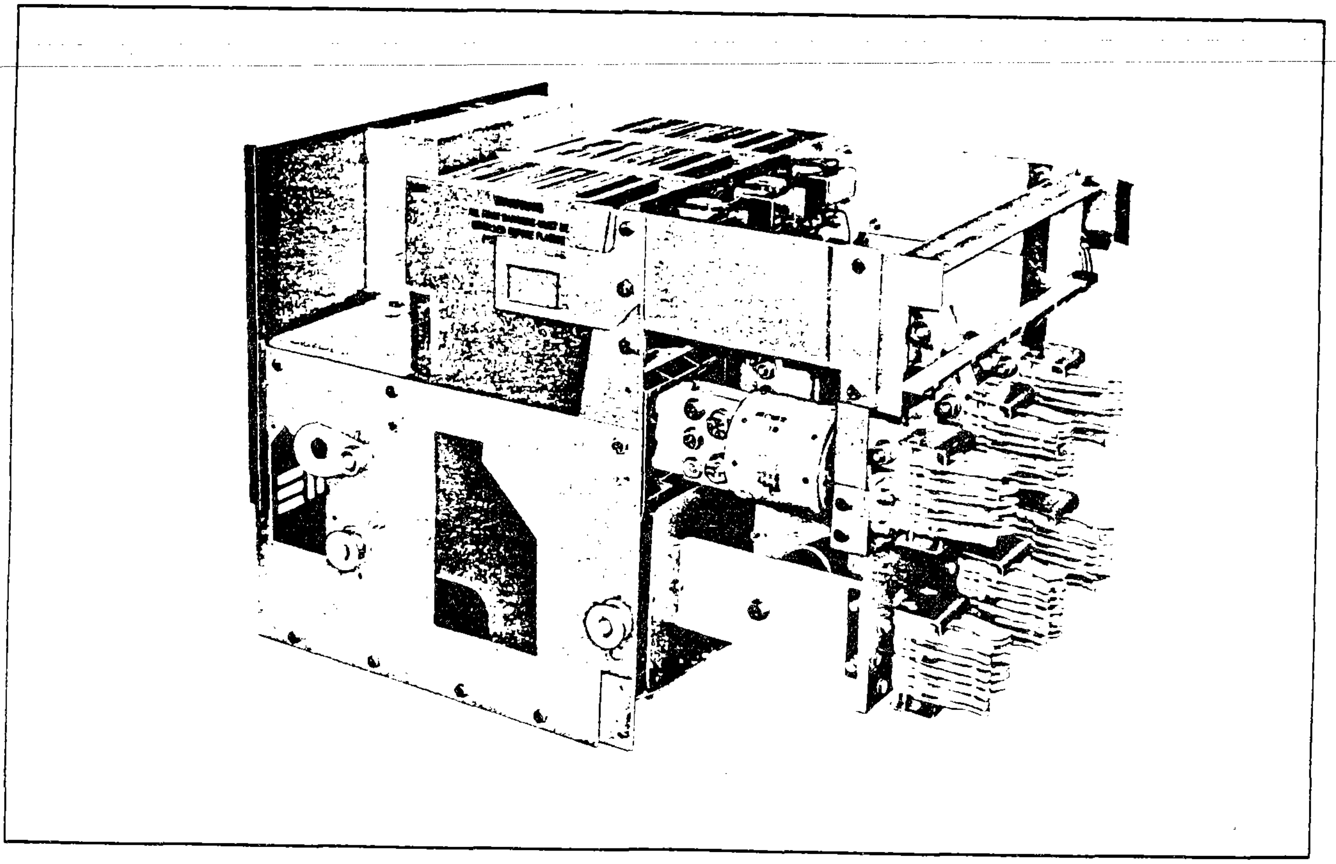


Fig. 79 *DSL-416 Breaker Side View (391073)*

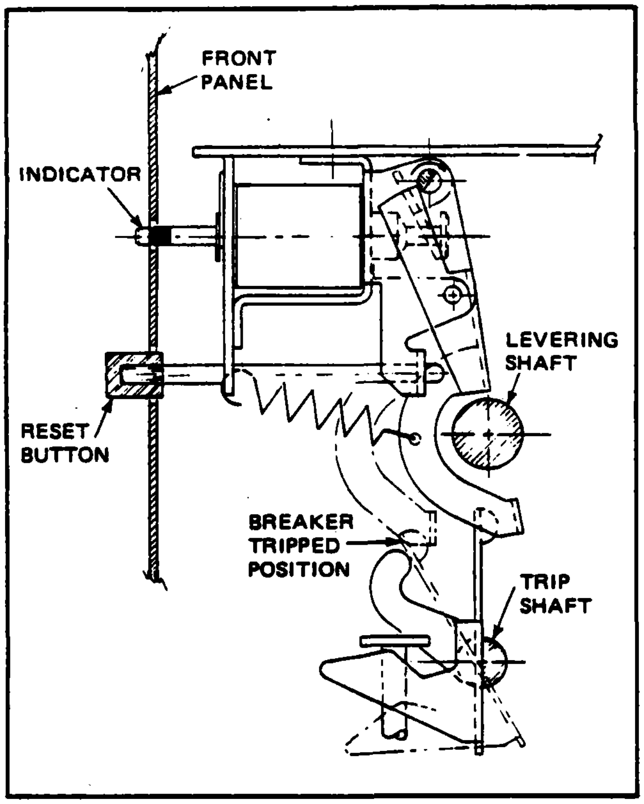


Fig. 80 *Blown Limiter Indicator*

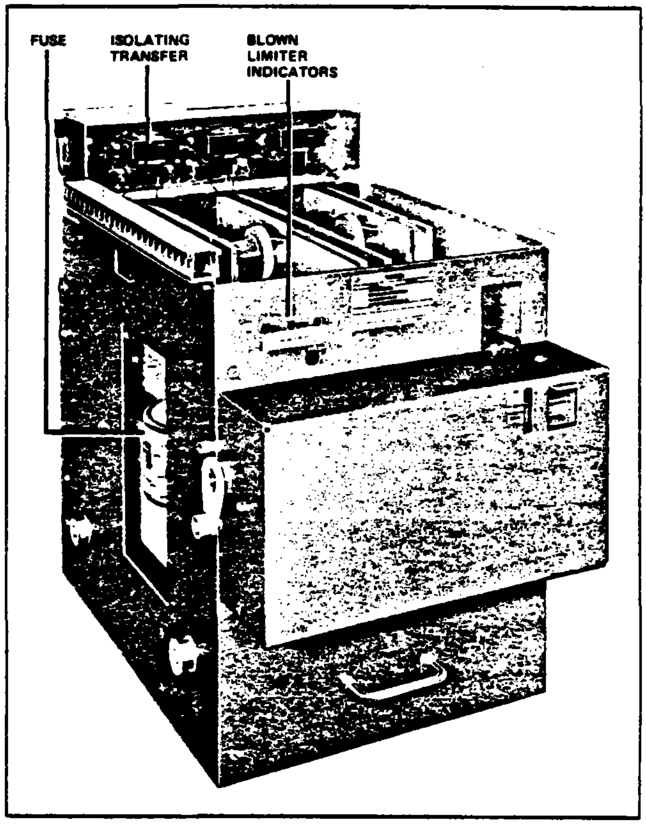


Fig. 81 *DS-3200 Fuse Truck Front View (391081)*

9.3.1 Installing Fuse Trucks

The fuse truck is normally installed in series with a circuit breaker of the same current rating. When this is done the fuse truck should be in the circuit ahead of the circuit breaker in order to provide maximum protection of the equipment. The fuse truck must never be permitted to close the current circuit or to open it when levering the truck in or out of the cell, because the primary disconnect contacts are not designed for this service. For this reason a key interlocking system is always provided which prevents opening of the fuse truck door unless the associated circuit breaker has been opened, pulled out and held in essential disconnected position. This key interlock is installed on the door of the fuse truck compartment, not on the fuse truck itself.

9.3.2 Replacing Fuses

Westinghouse type NCL fuses are normally provided when the fuse truck is built unless otherwise specified. However, any Class L current limiting fuse of the proper current rating can be used as a replacement.

After the fuse truck has been withdrawn from the compartment, the fuses can be removed by unbolting them from the conductors on the fuse truck. This is a relatively uncomplicated procedure on the DS-4000 fuse truck because there is sufficient working space within the truck. However, because the DS-3200 fuse truck is more restricted in space it will facilitate the operation if the front cover and levering mechanism is first removed from the truck. See Figure 83.

After replacing fuses, be sure that all connection bolts are tight and that any truck parts removed in the process have been replaced.

9.3.3 Blown Fuse Indicator

The same Blown Fuse Indicator is provided on fuse trucks as on DSL circuit breakers. However, since there is no opening mechanism on fuse trucks, it cannot serve directly as an anti-single phase device. In order to perform this function, the Blown Fuse Indicator is arranged to mechanically operate a switch, which is wired to secondary contacts on the fuse truck. The switchgear assembly wiring must be arranged to connect this switch into the tripping circuit of the associated circuit breaker. See Figure 83. Again, the indicator must be reset after being operated to reset the switch; or its contact will prevent the breaker from being closed.

WARNING

FOR PROTECTION AGAINST SINGLE-PHASING, THE CONTROL POWER FOR TRIPPING THE CIRCUIT BREAKER MUST BE FROM A RELIABLE SOURCE.

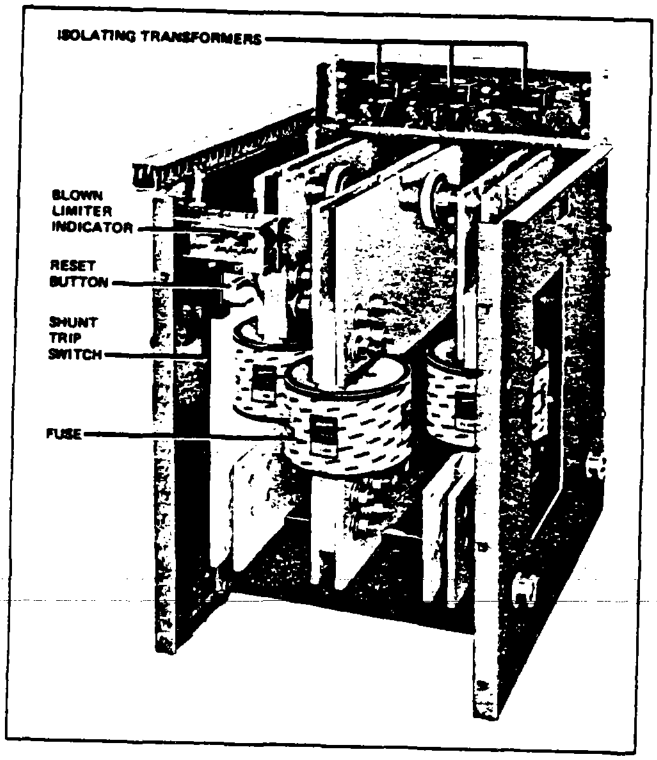


Fig. 82 *DS-3200 Fuse Truck with Front Cover Removed (391078)*

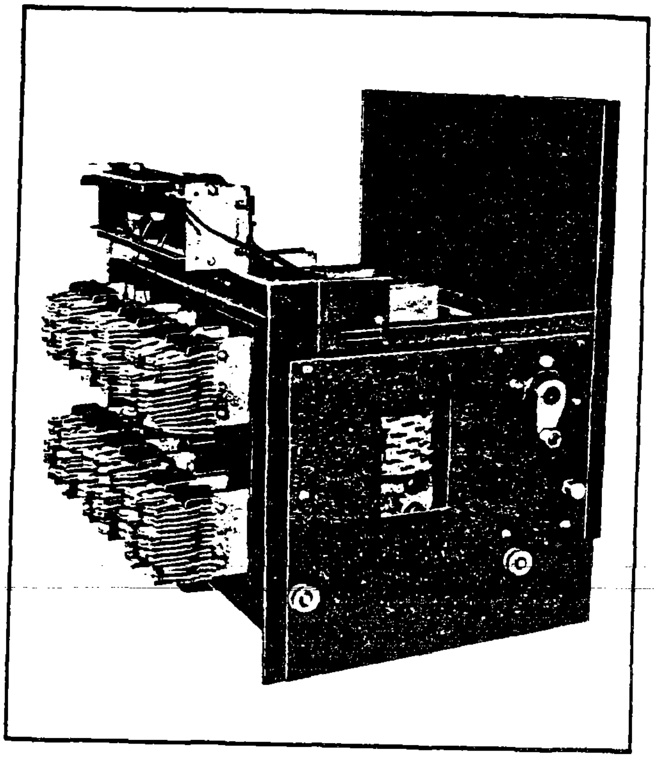


Fig. 83 *DS-4000 Fuse Truck Side View (391677)*

Section 10 - Fixed Breakers

10.0 GENERAL

Fixed Breakers differ from the drawout version in that they do not have levering device, primary disconnects and secondary disconnects. They do have padlock feature to hold the breaker in "trip-free" position. Key interlock mounted in the location of levering device may also be supplied to insure proper sequence of operation between two or more breakers. This insures that before the interlock key can be removed to be used in another location the circuit breaker must be opened and held in trip-free position. The breaker stabs have holes for bolting to the bus connections. Terminal blocks mounted at the back of the breaker are used as secondary contacts. The frame is modified so that the breaker can be mounted on the panel.

Section 11 - Drawout Dummy Elements

11.0 GENERAL

A dummy element consists of a drawout frame or truck with disconnecting contacts and with connecting links between the upper and lower terminals on each pole. When inserted into a compartment it bridges the upper and lower stationary disconnecting contacts in each phase, and is thus equivalent to an isolating disconnecting switch.

It must be emphasized that a dummy is not a breaker, and has no current breaking ability whatsoever; therefore, it is almost invariably key interlocked with a breaker or other load interrupting device, to insure that it will be isolated or at least carrying NO current before it can be levered out to the disconnected positions.

Dummy element requires the same size compartments as those of equivalent type DS breakers of the same frame sizes. The key interlock is of the same type and operates in the same manner as that described in Section 9 for type DS-3200 and DS-4000 drawout fuse trucks.

Section 12 - Inspection and Maintenance

12.0 GENERAL

Type DS circuit breakers are "top of the line" equipment. This means they are manufactured under a high degree of quality control, of the best available materials and with a high degree of tooling for accuracy and interchangeability of parts. Design tests show them to have durability considerably beyond minimum standards requirements. All of these factors give the DS line of breakers high reliability. However, because of the variability of application conditions and the great dependence placed upon these breakers for protection and the assurance of service continuity, inspection and maintenance checks on them should be made on regular schedules.

Since maintenance of these breakers will consist mainly in keeping them clean, the frequency of maintenance will depend to some extent on the cleanliness of the surroundings. If there is much dust, lint or other foreign matter present obviously more frequent maintenance will be required.

WARNING

BE SURE CIRCUIT BREAKER CONTACTS ARE OPEN AND SPRINGS DISCHARGED BEFORE DOING MAINTENANCE WORK. FAILURE TO DO SO COULD CAUSE BODILY INJURY.

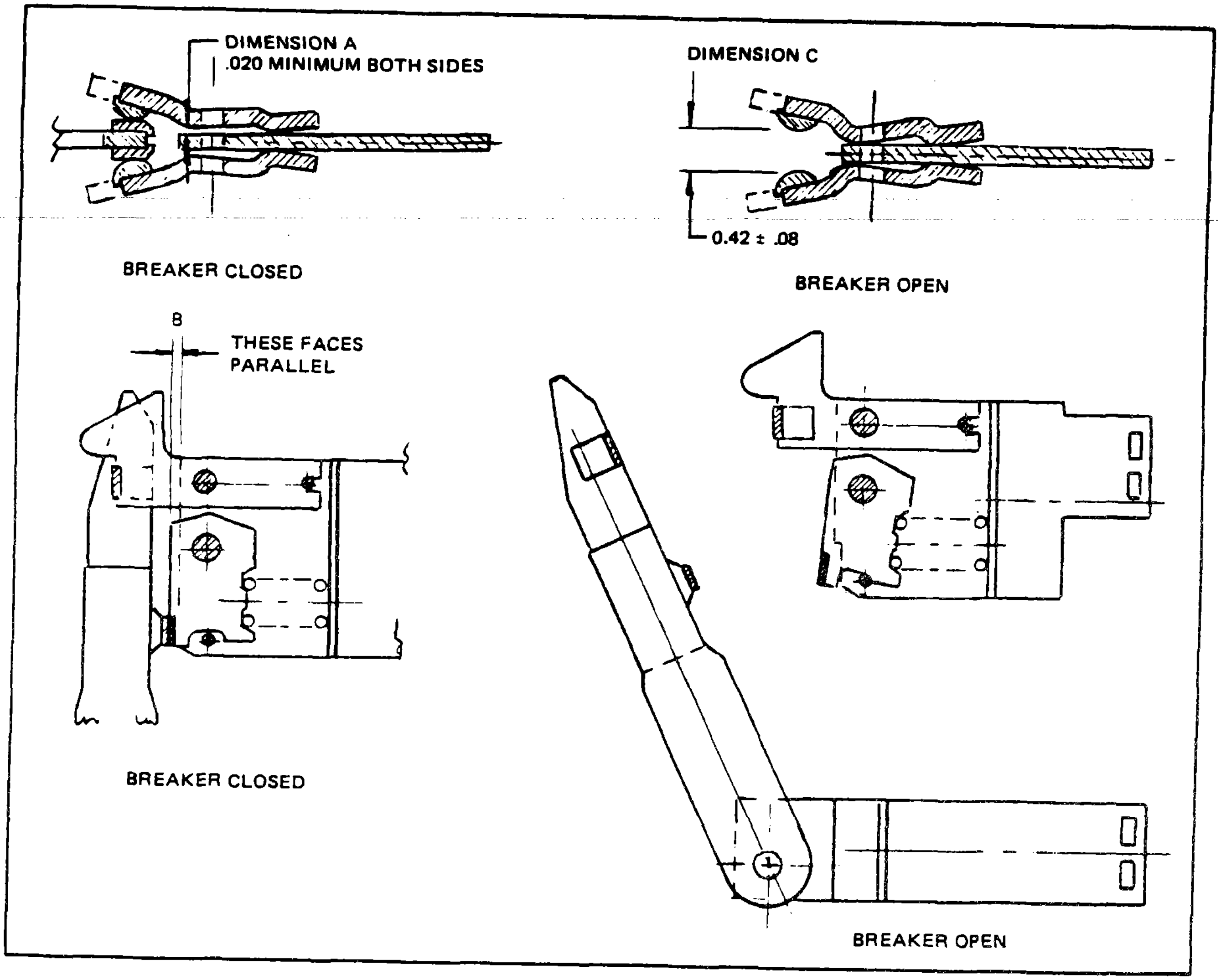


Fig. 84 *Contacts and their Adjustment, DS-206 Breaker*

12.1.1 When to Inspect

Industry standards for this type of equipment recommend a general inspection and lubrication after the number of operations listed in Section 12.3.1 of this instruction book. This should also be conducted at the end of the first six months of service if the number of operations has not been reached.

After the first inspection, inspect at least once a year. If these recommended inspections show no maintenance requirements, the period may be extended to a more economical point. Conversely, if the recommended inspection shows, for instance, heavy accumulations of dirt or other foreign matter that might cause mechanical, insulation or other electrical damage, the inspection and maintenance interval should be decreased.

When a breaker opens a heavy fault, at or near its rating, give it a visual inspection withdrawn from the compartment and with insulating barriers and arc chutes removed.

12.1.2 What to Inspect

First withdraw the breaker from the compartment. Remove barriers. Remove arc chutes. If there is a deposit

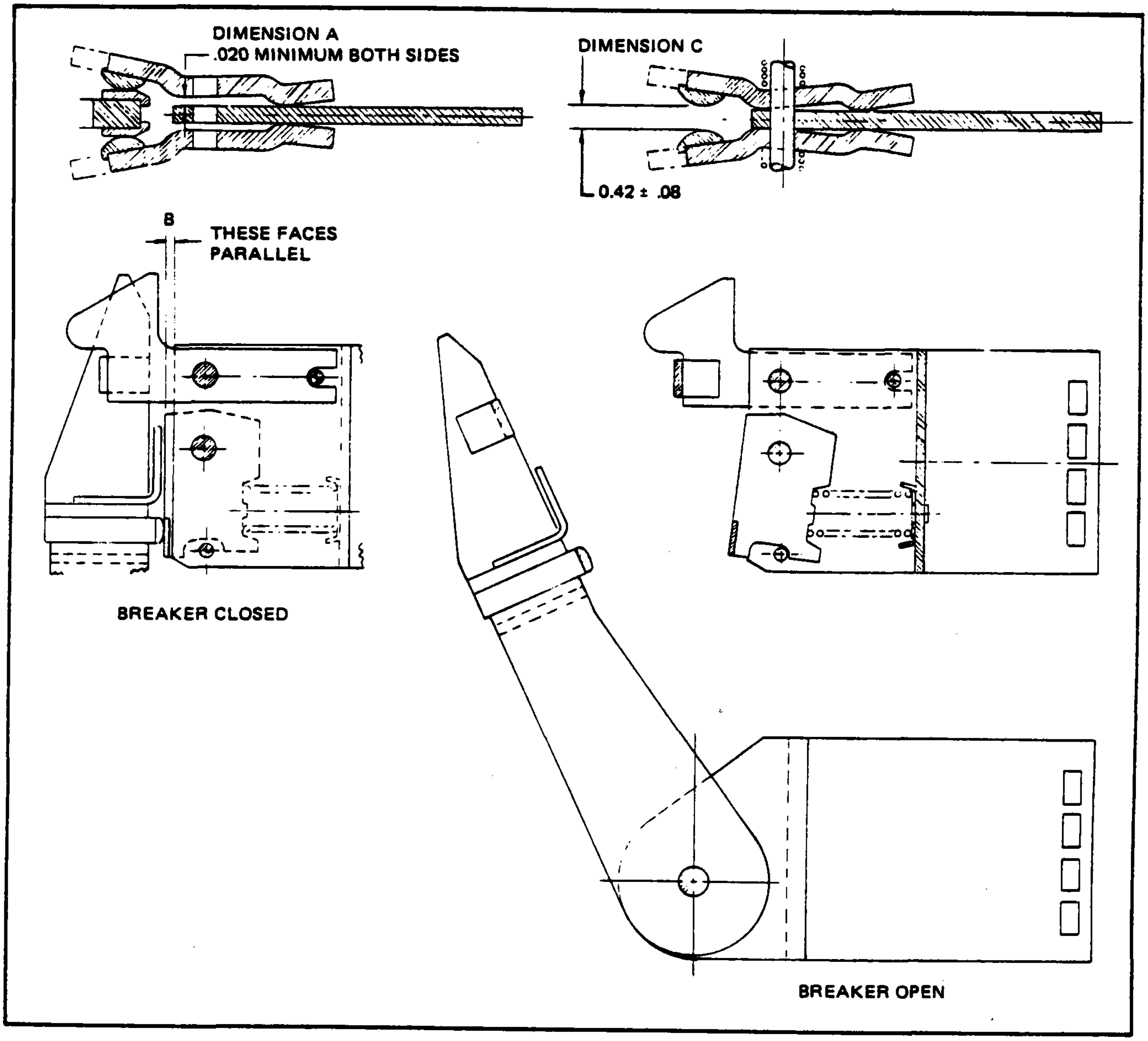


Fig. 85 *Contacts and their Adjustment, DS-416/420 Breaker*

of dust, blow clean with compressed air, if available. Wipe accessible areas with a clean dry cloth. Inspect contacts.

NOTE

Switching and fault interruptions and the making of motor inrush currents will cause some pitting of the breaker contact parts. A large accumulation of operations will give the contacts, especially the arcing contacts, a mottled, dirty, eroded appearance. This appearance is the normal result of arc burning and in itself is no cause for concern.

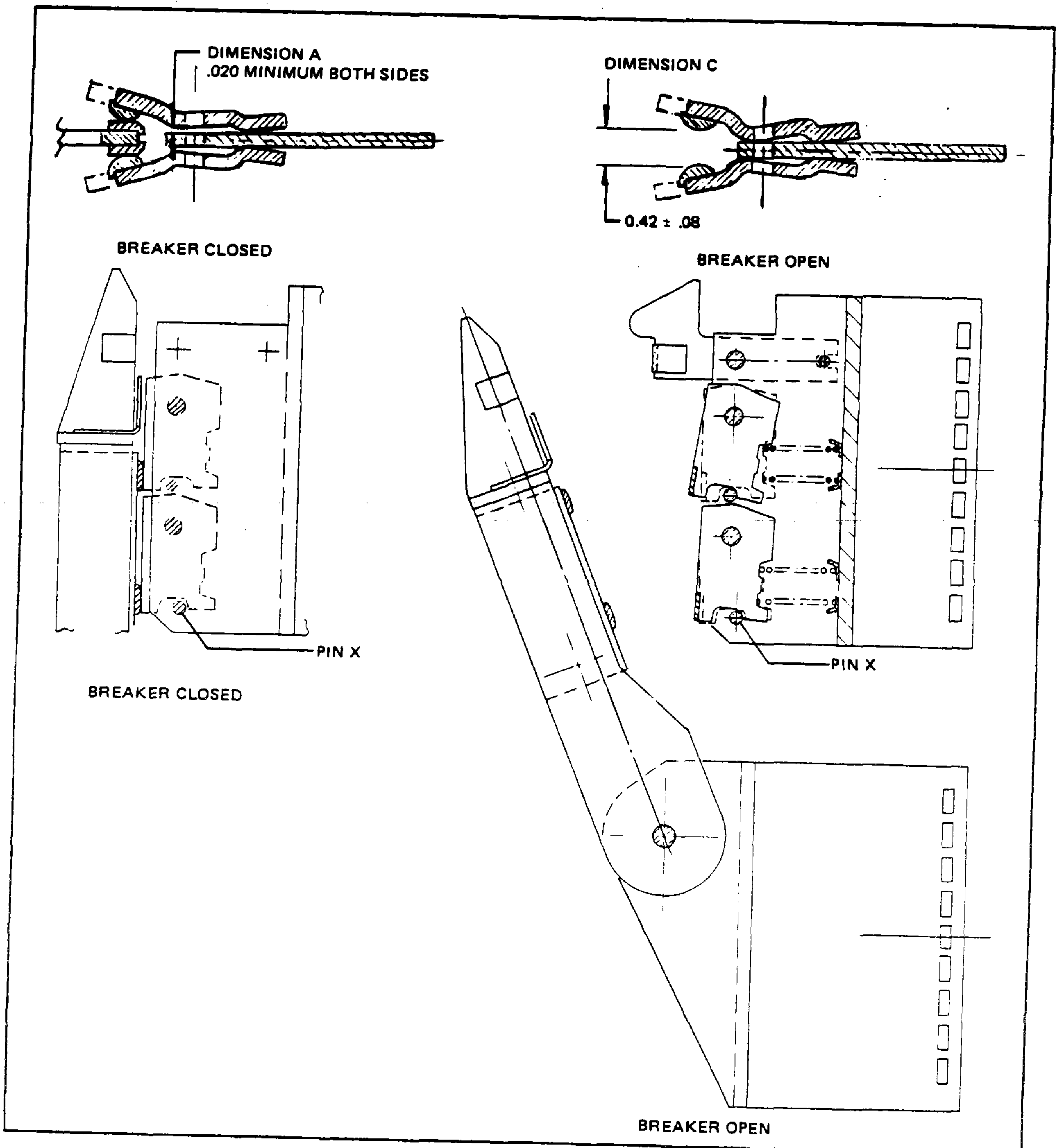


Fig. 86 *Contacts and their Adjustment, DS-632 Breaker*

12.1.2.1 DS-206, DS-206S, DS-416, DS-416S and DS-420

Remove the barriers and the arc chutes to expose the contacts:

With the breaker open, examine the contact tips of moving and stationary arcing and main contacts. If the tips are burned or worn more than .030", the contacts must be replaced. Also check the dimension (C) between the stationary arcing contacts (Figures 84 and 85). It should be .42 ± .08. If this dimension is not maintained, the stationary arcing contacts must be replaced.

Close the breaker and check the contact engagement according to Figures 84 and 85. The main stationary contact fingers should be parallel (B) to the fixed contact cage. If not, adjust the contacts according to 12.2.3. Also check the dimension (A) between the stationary arcing contacts and the center section of the cage. If this dimension is not .02 inches or greater, the stationary arcing contacts should be replaced.

Replace the barrier and the arc chutes after inspection is completed.

NOTE

The DS-206 adjustments and maintenance apply completely to the DS-206S. Also, the DS-420 instructions cover the DS-416S.

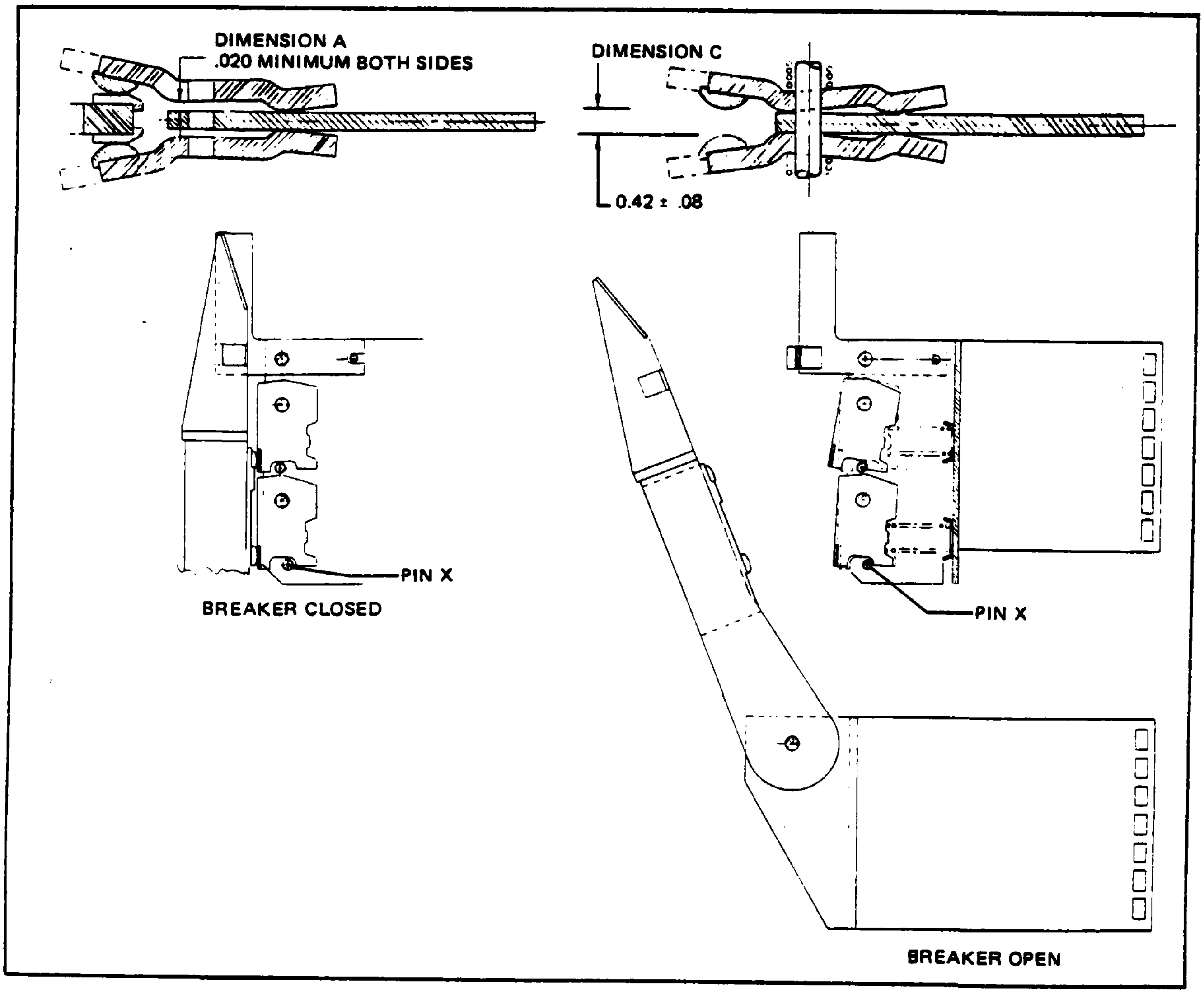


Fig. 87 *Contacts and their Adjustment, DS-840 Breaker*

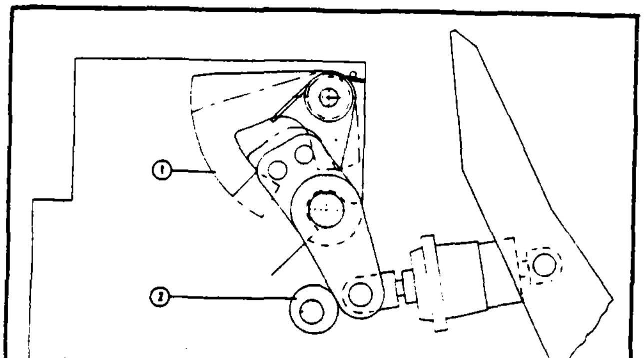


Fig. 88 *Open Position Stop and Anti-Rebound Latch*

To replace the stationary contacts, the disconnect fingers on the rear are removed and then the two bolts holding the upper contact assembly to the molded base. Withdraw the contact assembly from the front. This should be replaced with a new contact assembly. Make sure that all bolts are securely tightened. Close the circuit breaker and check all contact dimensions as described in Section 12.1.2.

12.1.2.2 DS-632 and DS-840

In addition to the requirements for the DS-206, DS-206S, DS-416, DS-416S and DS-420 above:

The lower main fixed contacts should be inspected to ensure that they have adequate contact pressure. This is determined by pin "X" being free to slide in the contact cage (See Figures 86 and 87). Unlike DS-206/DS-416/DS-420 breakers, the top row of fixed main contacts are compressed beyond parallel position to assure adequate contact pressure for lower row of fixed main contacts.

12.1.3 Replacement of Contacts

12.1.3.1 DS-206

Both moving main and arcing contacts are held between the two moving arms by two bolts with self-locking nuts. Removal of the two bolts permits the replacement of the moving contacts. These bolts must be securely tightened after replacement.

The fixed arcing contacts are held by a single bolt passing through the contacts and their pressure springs. On reassembly the self-locking nut is tightened so that a dimension of 3.12 inches is obtained between the inside surfaces of the flat washers on the spring ends.

12.1.3.2 DS-416, DS-416S, DS-420, DS-632 and DS-840

The moving arcing and main contacts are secured to the moving contact assembly by two bolts. Removal of these bolts permits the replacement of the moving contacts.

To change the fixed arcing and main contacts, the fixed contact assembly must first be removed from the pole unit. Remove the disconnect fingers, remove the screws holding the contact assembly to the pole unit base and withdraw the contact assembly.

Obtain a new or reconditioned assembly and reassemble in the pole unit, with the holding screws finger tight. Close circuit breaker and check the dimensions A (Figures 85, 86 and 87); they should be approximately equal. If not, trip breaker and adjust fixed contact system until alignment is obtained. Tighten screws and contacts as described in 12.2.3.

12.1.4 Arc Chutes

The V-shaped slots in the arc chutes will undergo slow erosion with arc interruptions. Switching operations will give them a pitted, mottled and sooty appearance. This is normal. Heavy fault interruptions will cause greater arc erosion.

If the steel splitter plates have more than 1/4 inch of material eroded away at the top of the V-shaped slots, arc chutes should be replaced. This can be determined by comparing a plate near the center with a plate near the end.

12.1.5 General Inspection

Look over all visible parts possible for missing pin retainers, loose nuts, bolts or screws, bent, worn or damaged parts. Make appropriate corrections to anything found out of order.

After any inspection make sure all parts are properly installed on the breaker, especially arc chutes and all four barriers.

12.2 FACTORY ADJUSTMENTS (Required for Major Overhaul Only)

The type DS circuit breakers are designed and built with very few adjustable parts. The operating parts and frame mounting parts are accurately tool made for automatically accurate assembly relationships. The parts are made of material that are affected to the minimum by repeated operations and normally encountered atmospheric temperature and dirt conditions.

There are a few adjustments, made at the factory and subjected to quality control inspection and test. These factory settings normally can be expected to hold for the life of the breaker.

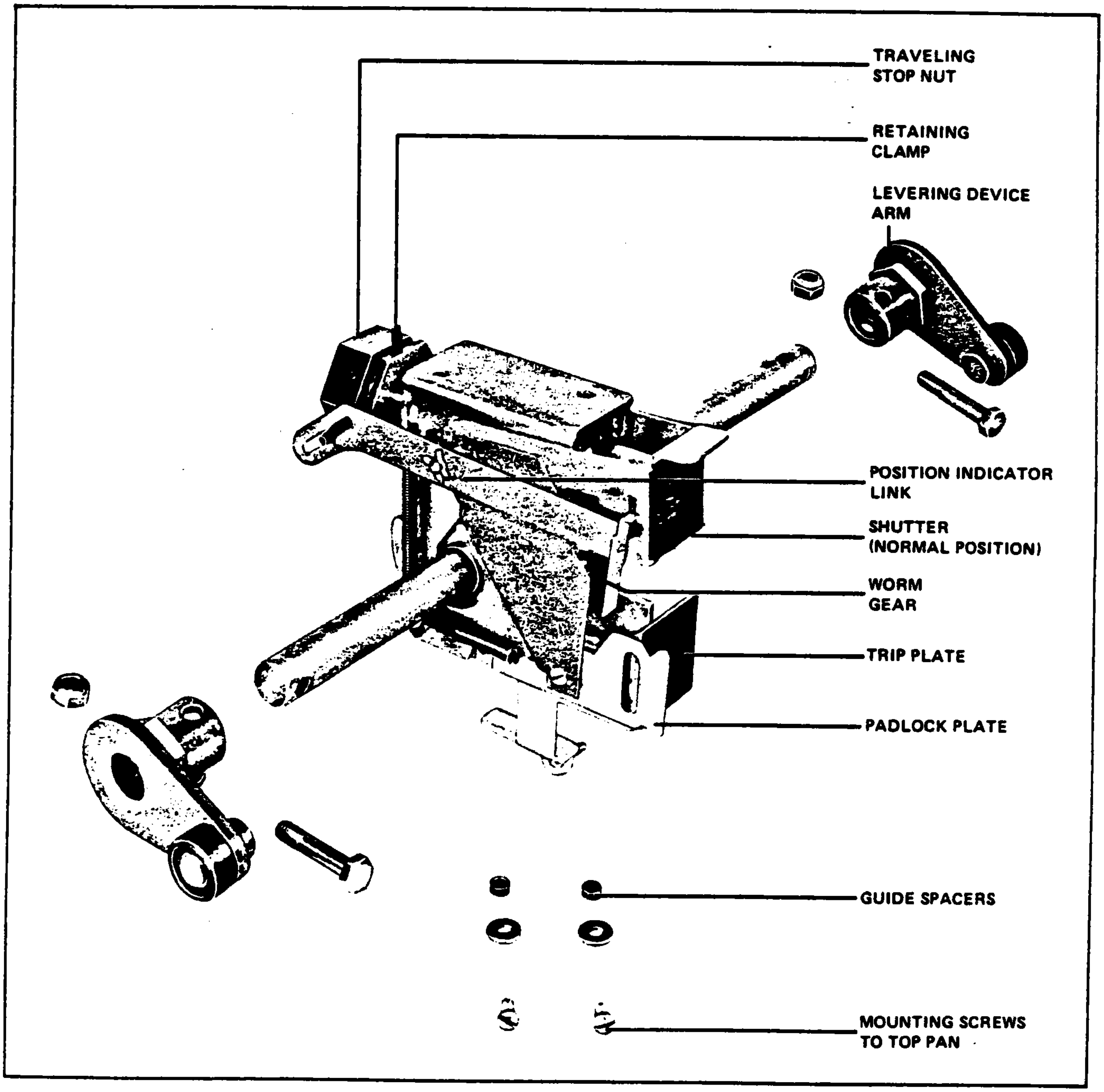


Fig. 89 *Levering Mechanism (384021)*

Factory settings are adjustments which should only be necessary when parts are reassembled after dismantling. These are described in Sections 12.2.1 and 12.2.2.

Maintenance adjustments should be made as indicated on maintenance inspections and are described in Section 12.2.3.

12.2.1 Trip Latch Overlap

Figure 23a shows a composite view of the shunt trip lever and the trip latch, as described in Section 5.1.6. The angular position of the trip shaft latch surface is adjustable in relation to the trip latch surface by means of a screw located in the top of the actuator frame. (Figure 23b).

Proper adjustment procedure is as follows:

Close the breaker

Slowly rotate adjusting screw clockwise until the breaker trips. This is "no overlap" position.

Rotate adjusting screw 4 turns in a counterclockwise direction.

12.2.2 Breaker Open Position Stop (DS-632 Only)

Proper Adjustment Procedure is as follows:

Refer to Figure 88

With the breaker open, loosen the open position stop bolt nuts so that the eccentric cylinders can be turned by hand but will stay put.

Rotate the cylinders to obtain a clearance of approximately .005 in. between the cylinders and the stop levers. Tighten nuts on bolts.

12.2.3 Moving Contact Adjustment

The contact assemblies are adjustable for the amount of engagement only. The lead of the arcing contacts over the main contacts is fixed. The correct engagement of the contacts is achieved when the vertical faces of the main fixed contacts and the fixed contact cage are parallel.

For the DS-206 this is obtained by the adjusting nuts located on the insulating link stud above and below the pivot block. Refer to Figures 37 and 38. These nuts are self-locking, and must be tight when the adjustment is complete.

The moving pole of the DS-416/420 is adjusted by rotating the insulating link after the lock nut has been loosened. Refer to Figure 39. Tighten the locknut securely after the adjustment has been completed.

The DS-632 and DS-840 have two adjusting studs on each pole, and both must be moved together to retain the parallelism. Refer to Figures 43 and 45. A spring type locking clip holds the adjustment for DS-632. For DS-840 locking nuts similar to DS-416/420 hold the adjustments.

Check contact system as described in Section 12.1.2.

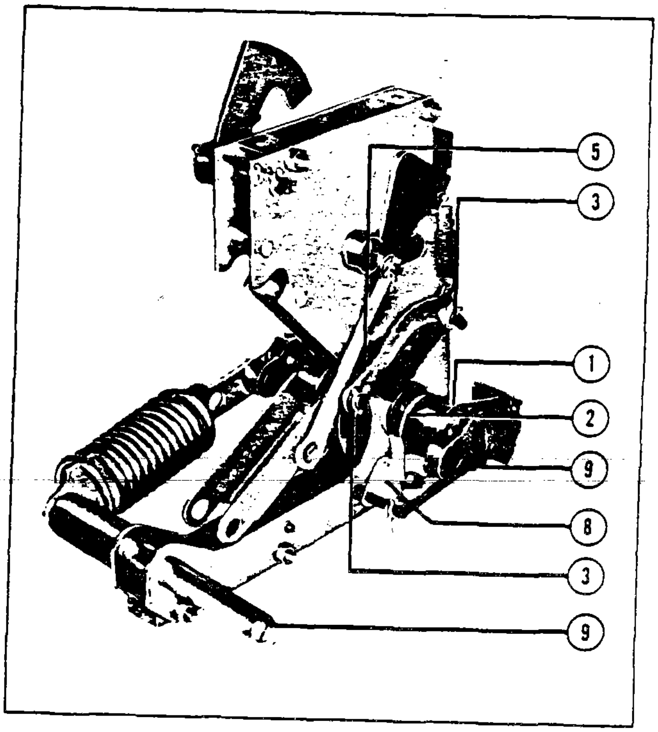


Fig. 90 *Lubrication Points on Left Side of Mechanism (383034)*

12.2.4 Levering Mechanism

The complete levering mechanism is shown in detail in Figure 89. If the traveling stop nut on the rear of the worm shaft has been removed, it must be replaced in the exact position with respect to the worm gear position for proper interlock operation. This is achieved when the threaded worm shaft bottoms in the stop nut and the interlock cam is in the connected position shown in Figure 29a. The shutter interlock pin will then drop to its normal position beneath the lobe of the cam. The retaining clamp ring also operates the position indicator and may be slipped in its groove in the stop nut. The stop nut is prevented from rotating by having a "flat" against the bottom of the breaker horizontal top pan.

When reassembling, care must be exercised to insure that the two guide spacers are located in the slots of the top pan. This allows this mechanism to float. Screws should be tightened and then backed off 1/2 turn to allow mechanism to float.

12.3 LUBRICATION

In general, the circuit breaker requires only moderate lubrication at regular intervals. The use of a special lubricant is required in a few places, and must be applied with care. Only small quantities are needed. All excess must be removed with a clean cloth to prevent any accumulation of dust or dirt. Avoid any lubricant on insulation or other electrical parts. Care must be taken to prevent any of the molybdenum lubricant reaching any current carrying contact surface.

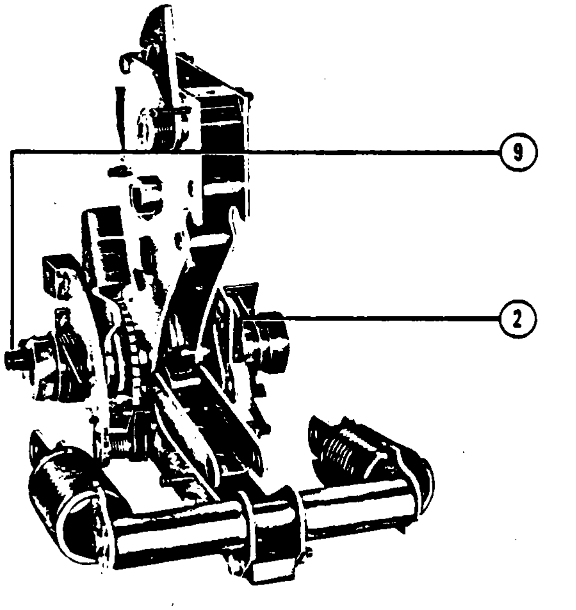


Fig. 91 *Lubrication Points on Right Side of Mechanism (385303)*

12.3.1 Frequency

Type DS-206/DS-206S breaker after 1750 operations.
Type DS-416/DS-416S/DS-420 breakers after 500 operations.
Type DS-632 and DS-840 breaker after 250 operations.

NOTE

Breakers that have been stored or have infrequent operations shall be operated a minimum of five times before being placed in service.

WARNING

FAILURE TO INSPECT, CLEAN, LUBRICATE AND MAINTAIN CIRCUIT BREAKER AT RECOMMENDED FREQUENCIES COULD RESULT IN FAILURE OF EQUIPMENT TO OPERATE PROPERLY UNDER FAULT CONDITIONS, WHICH COULD CAUSE EQUIPMENT DAMAGE AND/OR BODILY INJURY.

12.3.2 Location and Lubricant

Refer to Figures 90 and 91. The numbered references below correspond to those on the above figures.

Molykote M-30 dispersion by Dow Corning or mixture of molybdenum disulphide and alcohol or equivalent should be placed on the following surfaces. Oil base lubricants are generally avoided to prevent the accumulation of dust and dirt which will cause wear and binding in the mechanism.

1. The spring-charge indicator surface engaging with the cut off switch link.
2. The cam surface operating the cut-off switch link.
3. The pins on both ends of the constraining link.
4. Shunt trip moving armature surface, Fig. 19c.
5. The curved surface of the trip latch.
6. Spring release moving armature surface, Fig. 19d.
7. The trip shaft, Fig. 19c.
8. The surface of the cut off switch link.
9. The main spring pins on each end of the crankshaft and fixed ends.

NOTE

All parts of the levering mechanism, Figure 89 have sufficient lubrication, and should not require any further attention.

WARNING

BE SURE CIRCUIT BREAKER CONTACTS ARE OPEN AND CLOSING SPRINGS ARE DISCHARGED AFTER COMPLETING MAINTENANCE WORK. FAILURE TO DO SO COULD CAUSE BODILY INJURY.

Section 13 - Renewal Parts

13.0 GENERAL

Renewal Parts Data, listing by name and style number the recommended renewal parts to be kept in stock, are supplied separate from this book. When ordering parts, always specify the part name and style number, if known, from the Renewal Parts Data, RP33-790-1E. If the style number is not known, refer to the Figure number, name and item number as shown in this book, along with the breaker type and shop order number or style number as shown on the nameplate on the front cover of the circuit breaker.

Some of the detail parts shown in the figures in this book will be available only as part of a sub-assembly. The detail parts in the figures are illustrated to show their function and location in the assembly; but certain parts, due to manufacturing procedures or installation procedures, are recommended and furnished as part of a sub-assembly. The renewal parts data indicates which parts are available as individual items or in a sub-assembly. When inquiring about or ordering parts, refer to the figures in this book and the renewal parts data for identification of the part or sub-assembly in question.

13.1 IDENTIFYING PARTS FOR DS-416S and DS-206S

13.1.1 DS-416S Parts

The parts of a DS-416S are almost identical to those of a DS-420. The parts shown in a proper DS-420 figure (or drawing) are used for the same purpose in Type DS-416S. Description of these parts are the same too, but they are identified as parts for DS-416S (or shop order number).

13.1.2 DS-206S Parts

The parts of Type DS-206S are very similar to those of DS-206. By reference to the proper DS-206 figure (or drawing) identification of their common parts can be made. When they are ordered for the DS-206S, it is so specified. The major differences are:

1. DS-206S uses the three piece base of the DS-416, instead of the one piece molded base of the DS-206.

2. DS-206S uses the DS-416 arc chute.

3. DS-206S main disconnects have 50% more fingers than the DS-206.

4. DS-206S has twice as many contacts and arms as the DS-206.

5. The pole unit hinge of DS-206S is a forked construction or a miniature version of the DS-416 hinge.

Memorandum

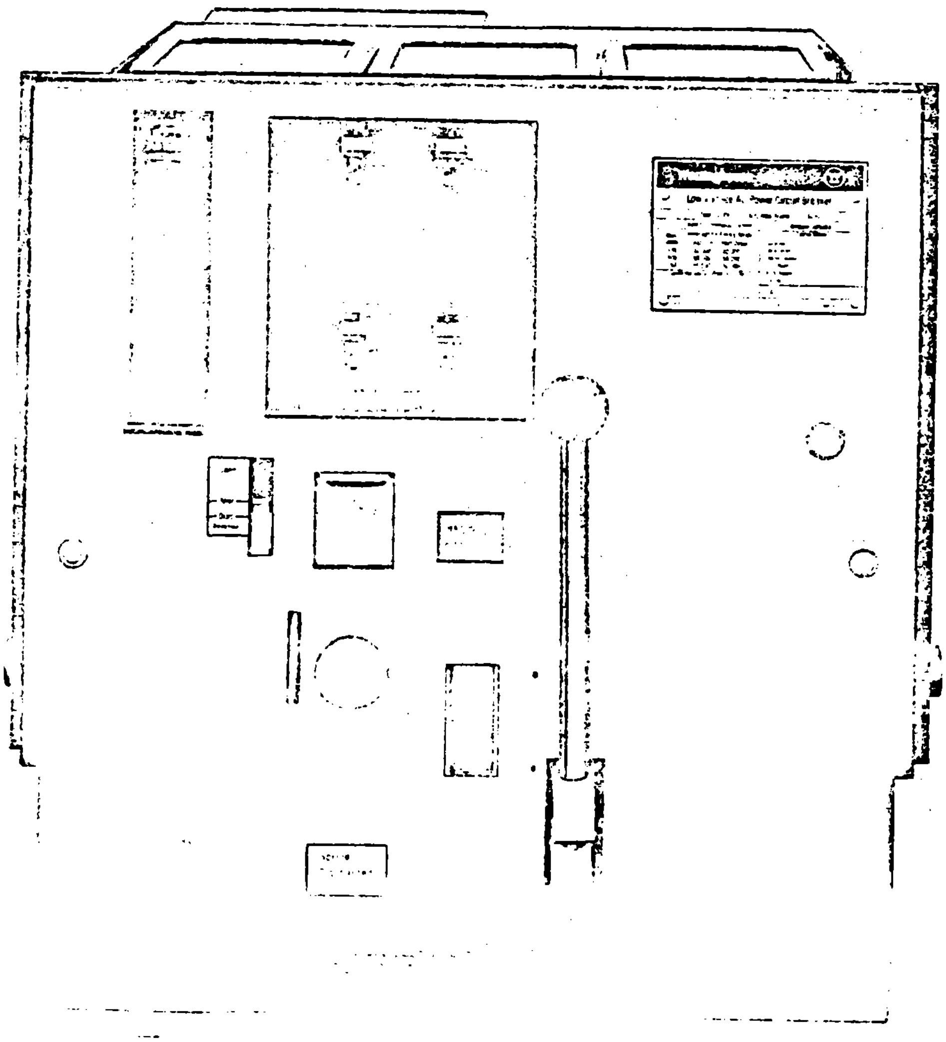
Memorandum

Memorandum

Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, Pa. 15112 U.S.A.

May 1980
New Information and
Supplements I.B. 33-790-1E

Low-Voltage Power Circuit Breakers Types DS and DSL



The following breakers are included in R.P.D. 33-790-1E *

Breaker Type	Frame Size Amperes
DS-206	800
DSL-206	800
DS-206S	800
DS-416	1600
DSL-416	1600
DS-416S	1600
DS-420	2000
DS-632	3200
DS-840	4000

*Data applies to Drawout Breakers only.

INDEX

Parts Identification

Renewal Parts Data 33-790-1E is supplementary information to Instruction Book 33-790-1E, *Instructions for Low Voltage Power Circuit Breakers Types DS and DSL*. The illustrations in this Renewal Parts Data show parts and sub-assemblies which are identified by name and style number in the associated tabulations. Additional information and illustrations are shown in the figures in I.B. 33-790-1E, which show many sub-assemblies and detail parts in order to illustrate their function and location in the assembly. Some of the detail parts shown in the instruction book are recommended only as part of a sub-assembly to facilitate their replacement or installation in the field. The availability of parts and sub-assemblies is indicated by style number in the following data.

If the item in question cannot be identified by style number, refer to the Figure number, name and item number as shown in this RPD (or I.B. 33-790-1E) along with the breaker type and its shop order number or style number as shown on the nameplate on the front cover of the circuit breaker.

The above nameplate information will also be required when adding components, which are not direct replacements, to a circuit breaker.

RECOMMENDED SPARE PARTS

Spare parts recommended for stocking are indicated in the following data by the symbol ®. An adequate stock of spare parts will help minimize emergency situations and can substantially reduce production down time.

The amount of investment to be made in spare parts stock can be dependent on a number of individual factors. The items recommended and the quantities specified below are intended as a guide.

For 1 to 5 Breakers—Items marked ® in sufficient quantity for one breaker.

For 5 to 10 Breakers—Items marked ® in sufficient quantity for two breakers.

Over 10 Breakers—One spare complete breaker, plus recommended spare parts for one breaker.

ORDERING INFORMATION

1. Name item and give its style number. Specify quantity desired.
2. *State method of shipment desired.*
3. Send all orders or correspondence to nearest Westinghouse Sales Office.

PRICING INFORMATION

Many of the style numbers in this data are listed in Price and Entry Guide 120 and PL 121.

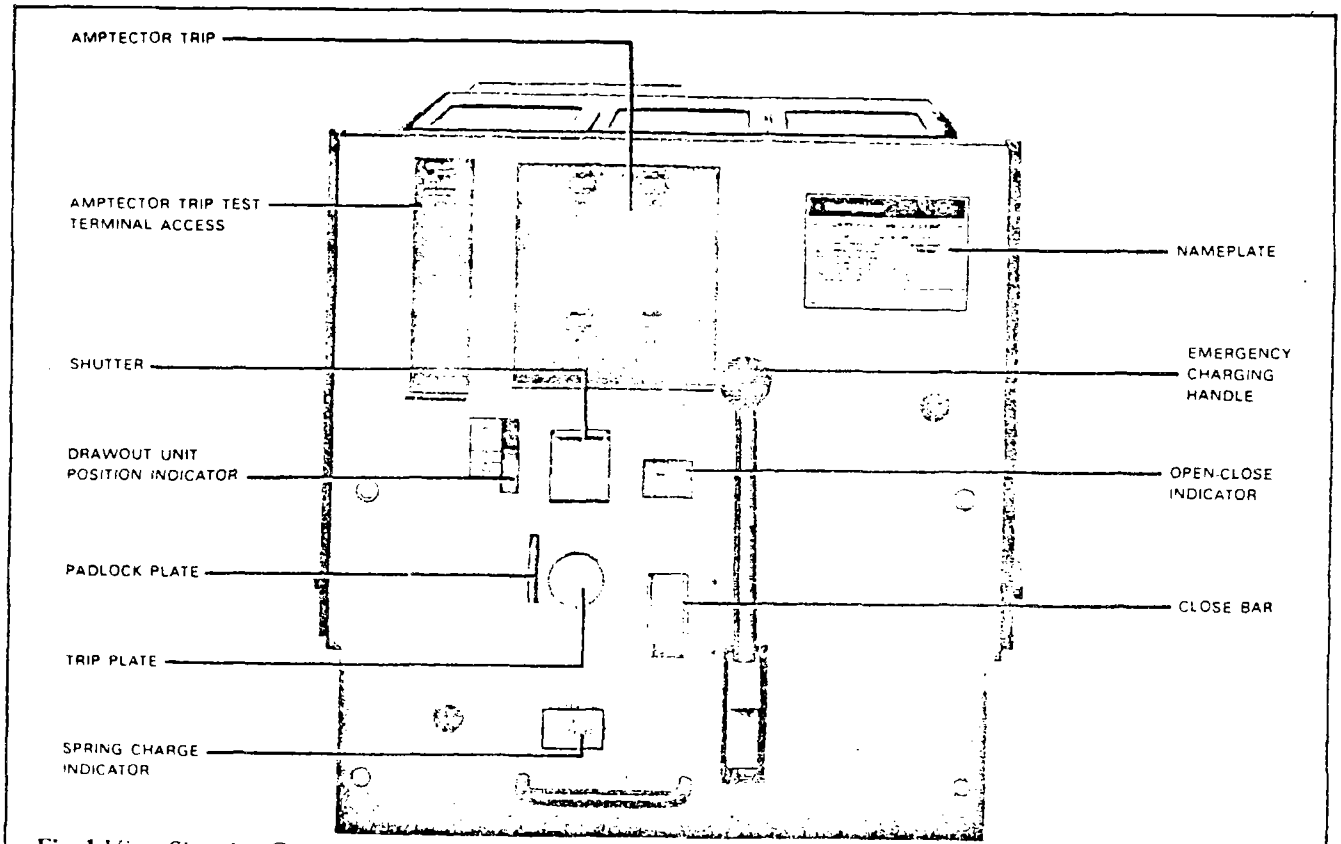


Fig. 1 *View Showing Controls on the Panel*

Items Common to All Breaker Types

AUXILIARY SWITCHES—FIGURE NO. 2

When replacing an existing auxiliary switch, order basic switch assembly style 449D622A01 which includes 2 "a" and 2 "b" contacts. Style 449D622A01 is suitable as a replacement on all breakers except those equipped with mechanical interlocks, and those wired per diagram figures 10D, 10E, 10F and 10G.

When adding auxiliary switches to an existing breaker, specify the number of switches required together with the nameplate information as itemized on page 2.

SECONDARY DISCONNECTING CONTACTS—FIGURE NO. 3

When replacing an existing disconnecting contact, order style 591C498G06 which includes an 8 point block plus mounting hardware.

When replacing an existing disconnecting contact cover, order style 588C729G02.

When adding secondary disconnecting contacts to an existing breaker, specify the number of upper contacts and the number of lower contacts together with the nameplate information as itemized on page 2.

TYPE DS CIRCUIT BREAKER FASTENER KIT

Includes an assortment of retaining rings, truarc rings, "E" rings and "X" washers in a plastic bag.

Style 3586A86G01
Recommended spares:
1 for one breaker
2 for two to five breakers
3 for six to twenty breakers
4 for over twenty breakers

STANDARD HARDWARE

Standard hardware such as bolts, nuts, washers, etc. are not listed in this data. Such items should be purchased locally. **Note:** Bolts holding copper details together in the pole unit, and bolts holding levering in cranks should be SAE Grade 5.

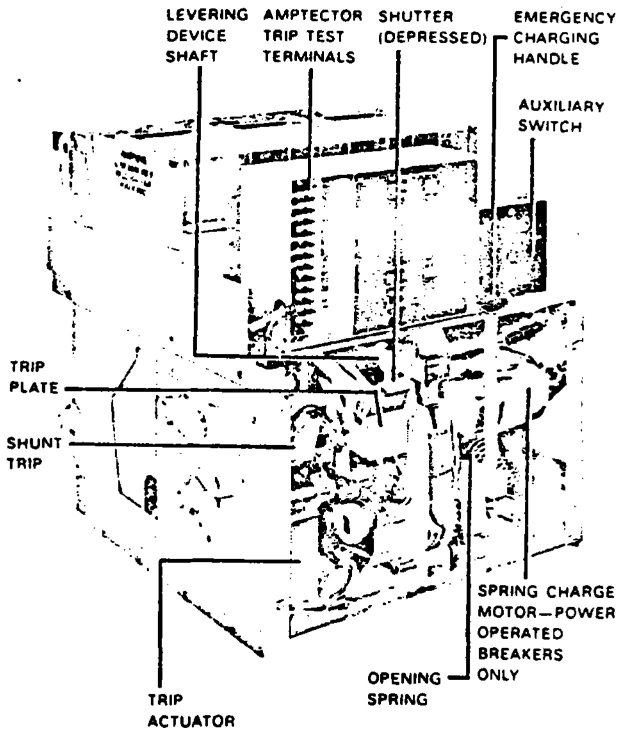


Fig. 2 *DS 416 Breaker with Front Panel Removed*

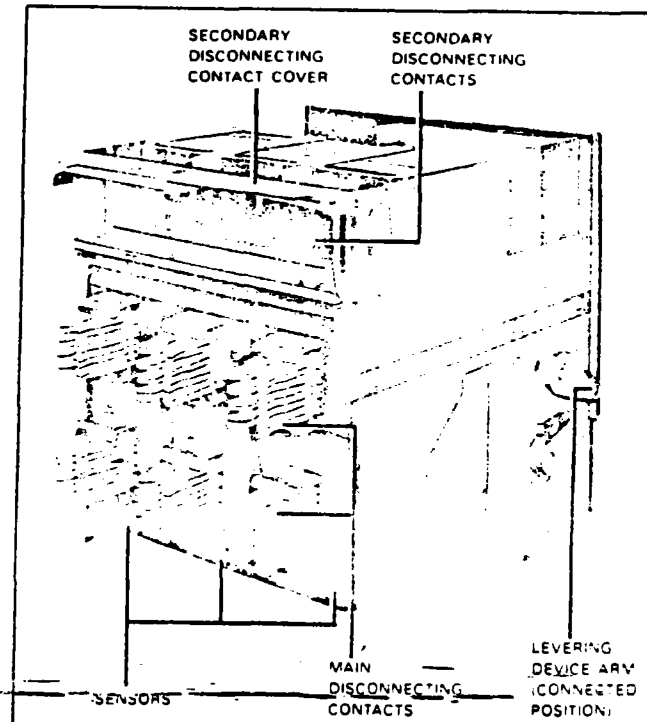


Fig. 3 *Rear View Showing Levering Device Arm in CONNECT Position*

Type DS-206. DSL-206 and DS-206S Pole Unit

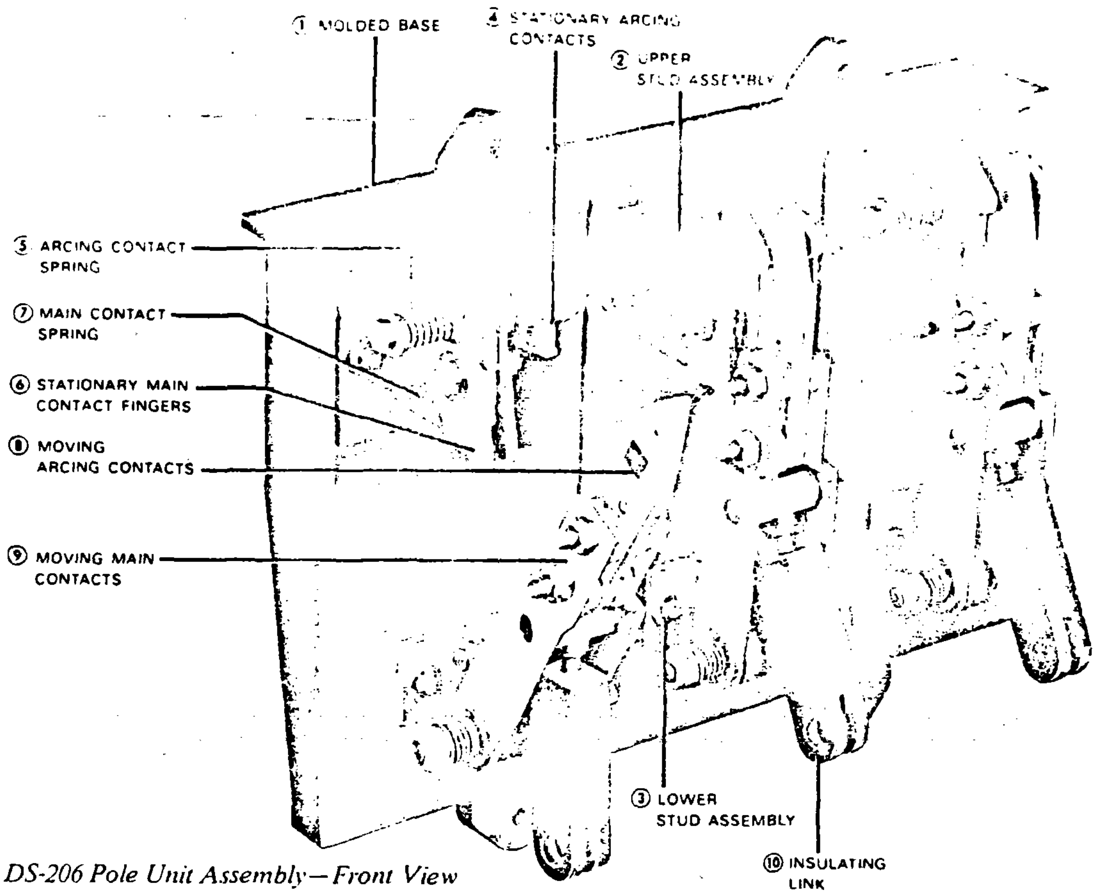


Fig. 4
Type DS-206 Pole Unit Assembly—Front View

			DS-206		DSL-206(1)		DS-206S(2)	
Description	Fig. No.	Item No.	No. Req. Per Bkr.	Style Number	No. Req. Per Bkr.	Style Number	No. Req. Per Bkr.	Style Number
Three Pole Unit Assembly Complete	4	—	1	140D152G01	1	140D152G03	1	9145D41G01
Following are included in Three Pole Unit Assembly:								
Molded Base	4	1	1	140D150H01	1	140D150H01	3	553F204H01
Upper Stud Assembly	4	2	3	591C653G01	3	591C653G03	3	592C928G01
Lower Stud Assembly	4	3	3	591C652G01	3	591C652G03	3	592C927G01
Following are included in Upper Stud Assembly:								
Stationary Arcing Contact—R.H.	4	4	3 ®	503B025G01	3 ®	503B025G01	3 ®	503B025G01
Stationary Arcing Contact—L.H.	4	4	3 ®	503B025G02	3 ®	503B025G02	3 ®	503B025G02
Stationary Arcing Contact Spring	4	5	6 ®	503B027H01	6 ®	503B027H01	6 ®	503B027H01
Stationary Main Contact Finger	4	6	6 ®	809A263G01	6 ®	809A263G01	12 ®	809A263G01
Stationary Main Contact Spring	4	7	3 ®	503B027H08	3 ®	503B027H08	6 ®	503B027H08
Following are included in Lower Stud Assembly:								
Moving Arcing Contact	4	8	3 ®	591C651G02	3 ®	591C651G02	3 ®	591C651G02
Moving Main Contact	4	9	6 ®	591C651G01	6 ®	591C651G01	12 ®	591C651G01
Insulating Link Assembly	4	10	3	788A588G01	3	788A588G01	3	788A588G03
Main Disconnecting Contact Assembly (not included in Pole Unit Assembly)	3	—	6	591C655G02	6	591C655G02	6	591C655G03

® Recommended Spare—See page 2.

(1) See page 16 figure 32 for illustration of the DSL-206.

(2) The DS-206S pole unit is not illustrated. The DS 206S pole unit assembly is similar to the DS-416 with the upper and lower stud assemblies mounted on a separate molded base for each pole rather than a common base for the three poles.

Type DS-416, DSL-416, DS-416S and DS-420 Pole Unit

DS-416 Pole Unit is illustrated. DS-416S and DS-420 Pole Unit Assemblies are similar

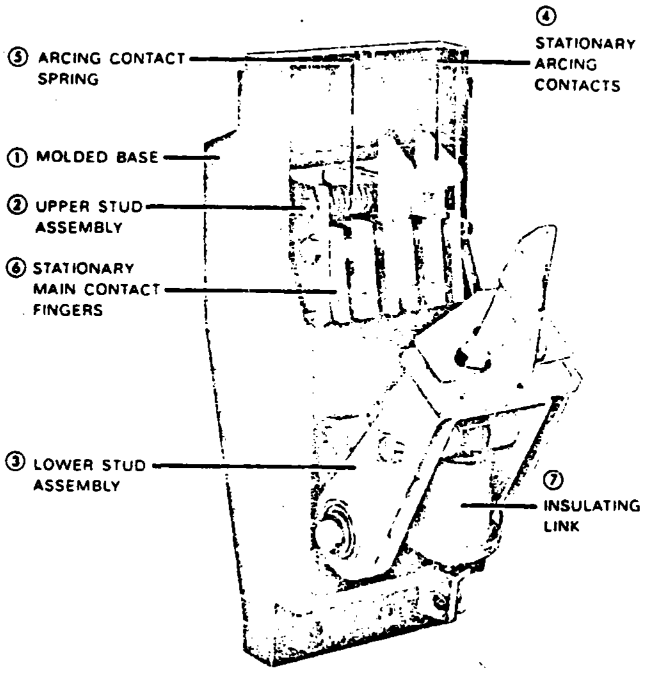


Fig. 5
Type DS-416 Pole Unit Assembly—Front View

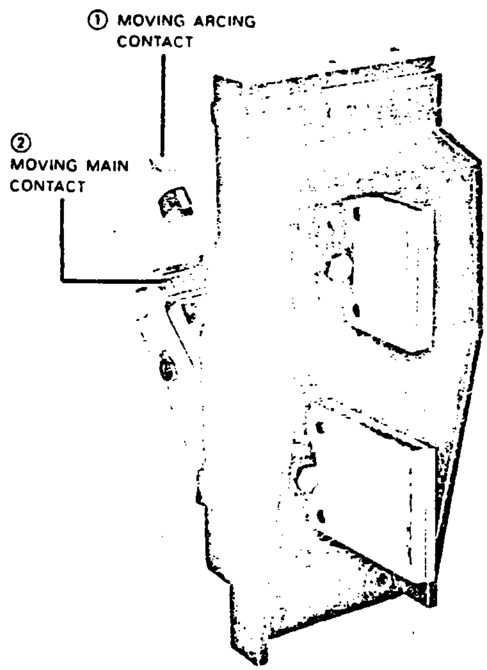


Fig. 6
Type DS-416 Pole Unit Assembly—Rear View

			DS-416		DSL-416(1)		DS-416S and DS-420	
Description	Fig. No.	Item No.	No. Req. Per Bkr.	Style Number	No. Req. Per Bkr.	Style Number	No. Req. Per Bkr.	Style Number
Single Pole Unit Assembly Complete	5-6	—	3	151D064G01	3	151D065G01	3	151D065G02
Following are included in Single Pole Unit Assembly:								
Molded Base	5	1	3	553F204H01	3	553F204H01	3	553F204H01
Upper Stud Assembly	5	2	3	591C750G02	3 ®	139D635G01	3 ®	139D635G02
Lower Stud Assembly	5	3	3	126D298G06	3	139D633G04	3 ®	139D633G05
Following are included in Upper Stud Assembly:								
Stationary Arcing Contact—R.H.	5	4	3 ®	503B025G01	3 ®	503B025G01	3 ®	503B025G01
Stationary Arcing Contact—L.H.	5	4	3 ®	503B025G02	3 ®	503B025G02	3 ®	503B025G02
Stationary Arcing Contact Spring	5	5	6 ®	503B027H01	6 ®	503B027H01	6 ®	503B027H01
Stationary Main Contact Finger	5	6	24 ®	809A263G01	36 (2)	809A263G01	36 (2)	809A263G01
Stationary Main Contact Spring—Outer			12 ®	503B027H05	12 (2)	503B027H05	12 (2)	503B027H05
Stationary Main Contact Spring—Inner			—		12 (2)	503B027H10	12 (2)	503B027H10
Following are included in Lower Stud Assembly:								
Moving Arcing Contact	6	1	3 ®	503B022G01	3 ®	503B022G01	3 ®	503B022G01
Moving Main Contact	6	2	3 ®	665A321G01	3 ®	795A769G01	3 (3)	795A769G01
Insulating Link Assembly	5	7	3	436B450G02	3	436B450G02	3	436B450G02
Main Disconnecting Contact Assembly (not included in Pole Unit Assembly)	3	—	6	682C347G01	6	682C347G01	6	590C804G01

® Recommended Spare—See page 2.

(1) See page 16 figure 33 for illustration of the DSL-416.

(2) Assembly of the stationary main contact fingers and inner and outer springs is difficult. The Upper Stud Assembly is recommended for the DSL-416, DS-416S and DS-420.

(3) Changing the moving main contact is complicated because of a drilling and pinning operation. The Lower Stud Assembly is recommended for the DS-416S and DS-420.

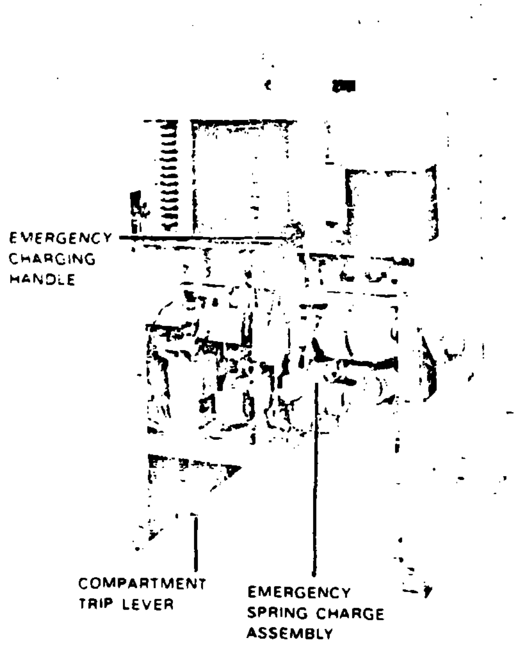


Fig. 7 *DS-632 Breaker with Front Panel Removed*

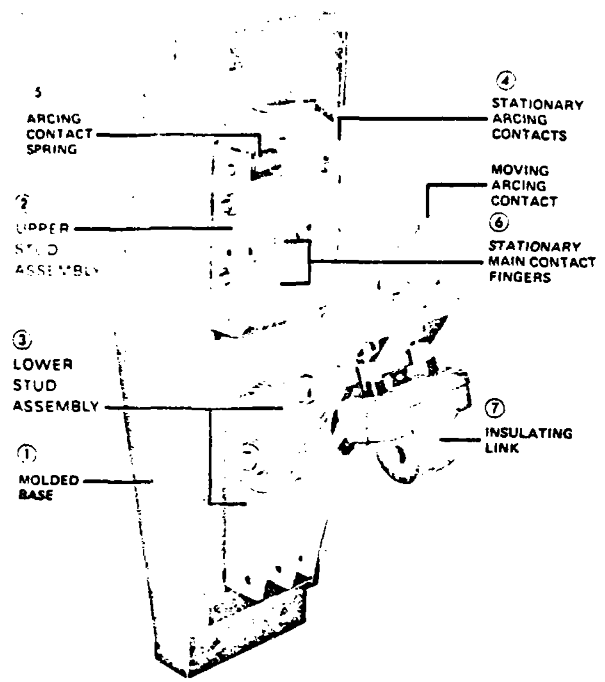


Fig. 8 *Type DS-632 Pole Unit Assembly— Front View*

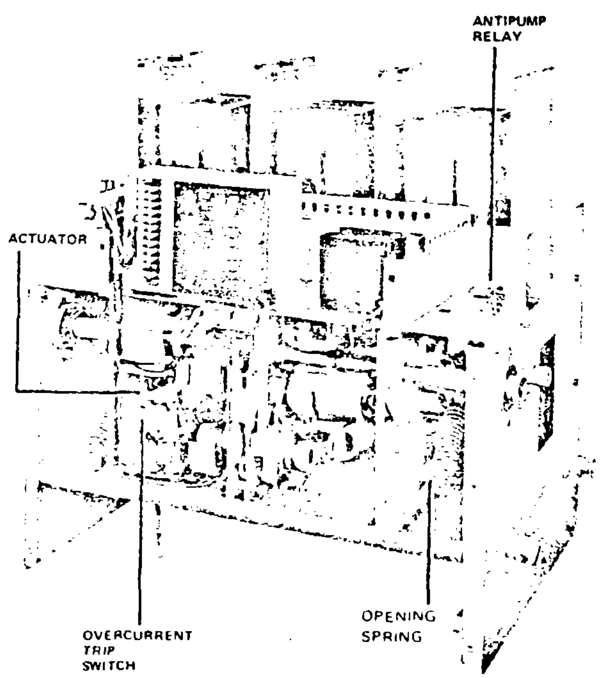


Fig. 10 *DS-840 Breaker with Front Panel Removed*

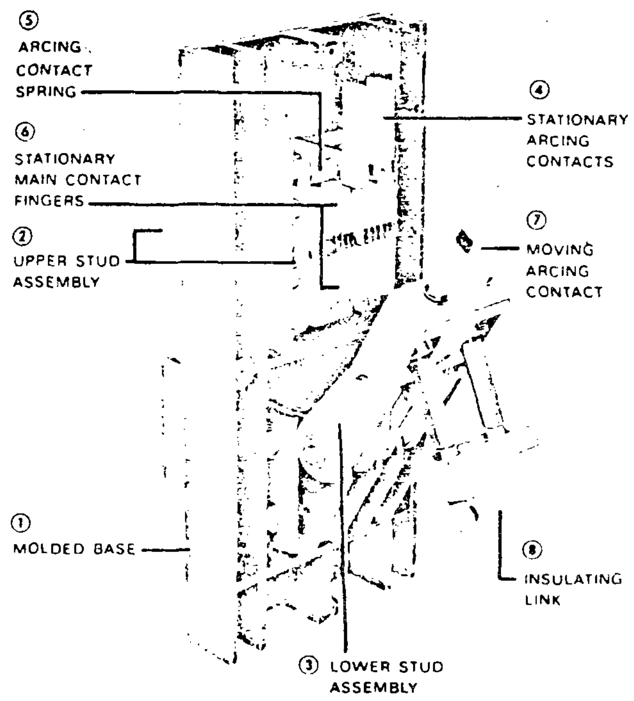


Fig. 11 *Type DS-840 Pole Unit Assembly—Front View*

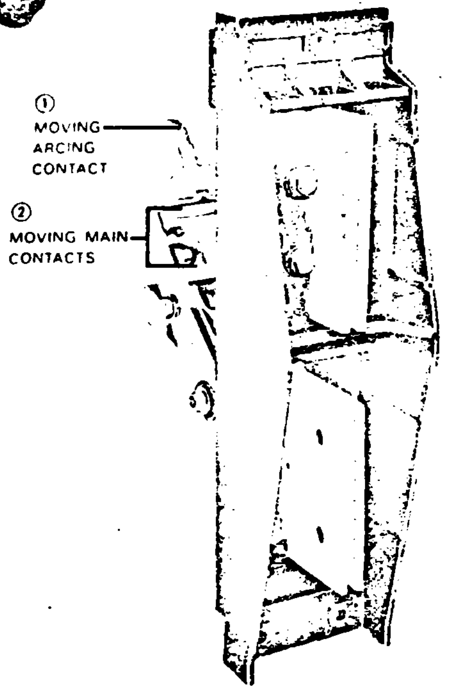


Fig. 9 *Type DS-632 Pole Unit Assembly—Rear View*

Type DS-632 Pole Unit

Description	Figure Number	Item No.	Number Required Per Bkr.	Style Number
Single Pole Unit Assembly Complete	8-9	—	3	567F962G01
Following are included in •Single Pole Unit Assembly:				
Molded Base	8	1	3	553F205H01
Upper Stud Assembly	8	2	3 ®	126D299G02
Lower Stud Assembly	8	3	3 ®	140D091G05
Following are included in Upper Stud Assembly:				
Stationary Arcing Contact—R.H.	8	4	3 ®	588C736G01
Stationary Arcing Contact—L.H.	8	4	3 ®	588C736G02
Stationary Arcing Contact Spring	8	5	6 ®	503B027H01
Stationary Main Contact Finger	8	6	72 (1)	809A263G01
Stationary Main Contact Spring—Outer			24 (1)	503B027H05
Stationary Main Contact Spring—Inner			24 (1)	503B027H10
Following are included in Lower Stud Assembly:				
Moving Arcing Contact	9	1	3 ®	588C735G01
Moving Main Contact	9	2	3 (2)	794A105G01
Insulating Link Assembly	8	7	3	680C792G03
Main Disconnecting Contact Assembly (not included in Pole Unit assembly)	3	—	6	682C347G02

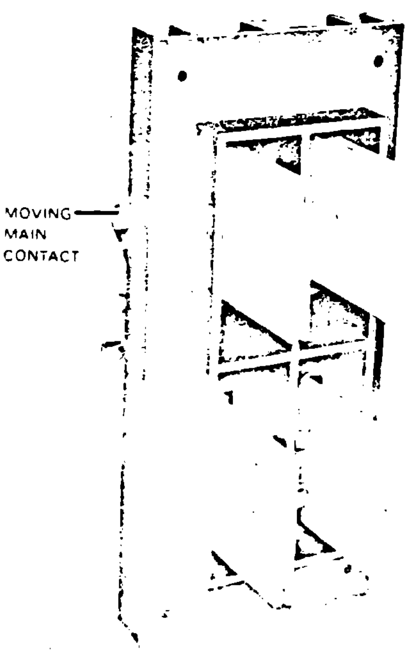


Fig. 12 *Type DS-840 Pole Unit Assembly—Rear View*

Type DS-840 Pole Unit

Description	Figure Number	Item No.	Number Required Per Bkr.	Style Number
Single Pole Unit Assembly Complete	11-12	—	3	567F991G03
Following are included in Single Pole Unit Assembly:				
Molded Base	11	1	3	567F501G01
Upper Stud Assembly	11	2	3 ®	140D779G01
Lower Stud Assembly	11	3	3 ®	140D778G01
Following are included in Upper Stud Assembly:				
Stationary Arcing Contact—R.H.	11	4	3 ®	588C736G01
Stationary Arcing Contact—L.H.	11	4	3 ®	588C736G02
Stationary Arcing Contact Spring	11	5	6 ®	503B027H01
Stationary Main Contact Finger	11	6	72 (1)	809A263G01
Stationary Main Contact Spring—Outer			24 (1)	503B027H05
Stationary Main Contact Spring—Inner			24 (1)	503B027H10
Following are included in Lower Stud Assembly:				
Moving Arcing Contact	11	7	3 ®	588C735G01
Moving Main Contact	12	—	3 (2)	794A105G01
Insulating Link Assembly	11	8	3	680C792G04
Main Disconnecting Contact Assembly (not included in Pole Unit assembly).	3	—	12	591C100G01

® Recommended Spare – See page 2.

(1) Assembly of the stationary main contact fingers and inner and outer springs is difficult. The Upper Stud Assembly is recommended.

(2) Assembly of the moving main contact is difficult. The Lower Stud Assembly is recommended.

Arc Chutes and Barriers

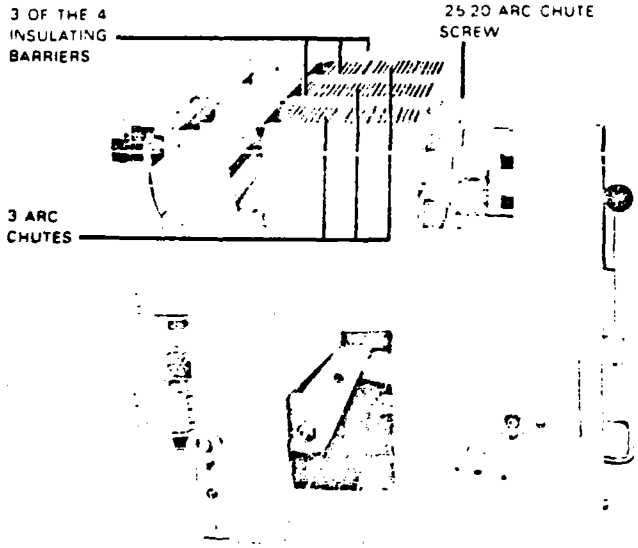


Fig. 13 *Breaker with Barrier Removed to Show Mounting of Arc Chutes*

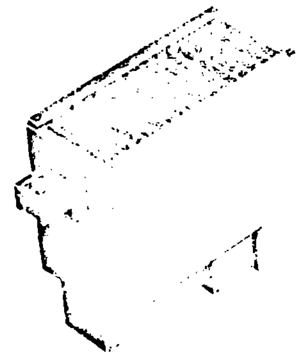


Fig. 14 *DS-206 Arc Chute*

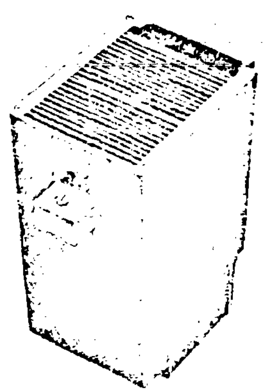


Fig. 15 *DS-206S, DS-416 DS-416S, DS-420 Arc Chute*

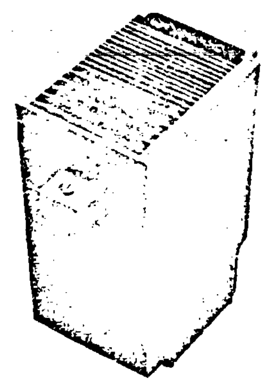


Fig. 16 *DS-632 Arc Chute*

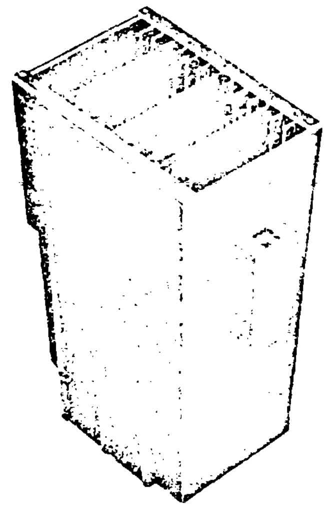


Fig. 17 *DS-840 Arc Chute*

	Assembled Arc Chute and Mounting Screw			Removable Insulating Barriers — Fig. 13			
				Outer		Inner	
Breaker Type	Figure Number	Number Required Per Breaker	Style Number	Number Required Per Breaker	Style Number	Number Required Per Breaker	Style Number
DS-206 DSL-206	14	3	449D508G01	2	349A578H01	2	788A586H01
DS-206S DS-416 DSL-416 DS-416S DS-420	15	3	151D018G01	2	349A578H01	2	349A578H01
DS-632	16	3	151D018G02	2	436B108H02	2	436B108H01
DS-840	17	3	140D164G01	2	803A735H01	2	803A735H01

Levering Mechanism

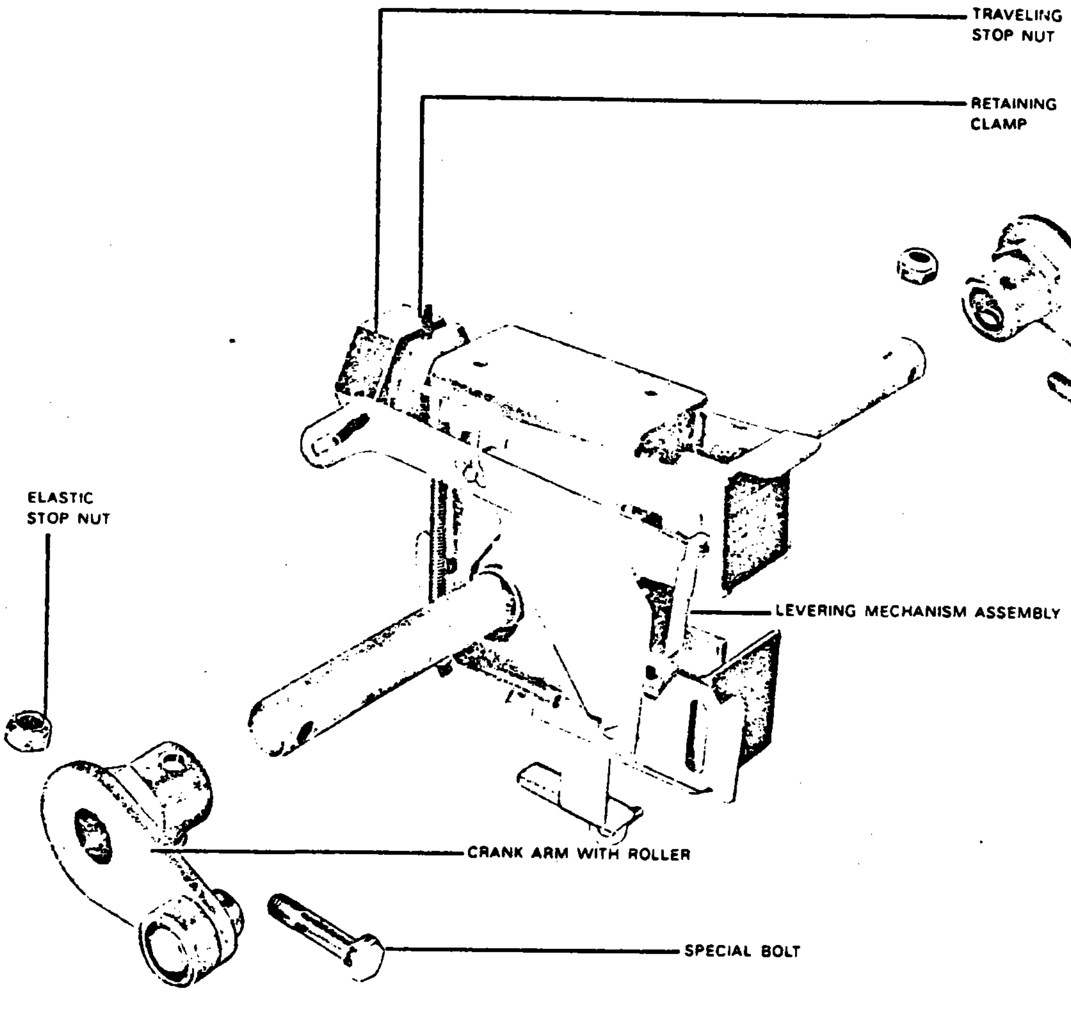


Fig. 18 *Levering Mechanism*

Levering Mechanism — Fig. 18

Description	Number Required per Breaker	All Type DS/DSL except DS-840 Style Number	DS-840 Style Number
Levering Mechanism Assembly	1	449D224G04	449D224G05
Following are included in Assembly:			
Traveling Stop Nut	1	791A674H01	791A674H01
Retaining Clamp	1	791A679H01	791A679H01
Following are not included in Assembly:			
Crank Arm with Roller	2	786A586G01	567F993G02
Special Bolt	2 (1)	794A024H01	794A024H01 (1)
Elastic Stop Nut	2 (1)	70220ERN18	70220ERN18 (1)

(1) For DS-840 four are required per breaker.

Mechanism and Related Parts

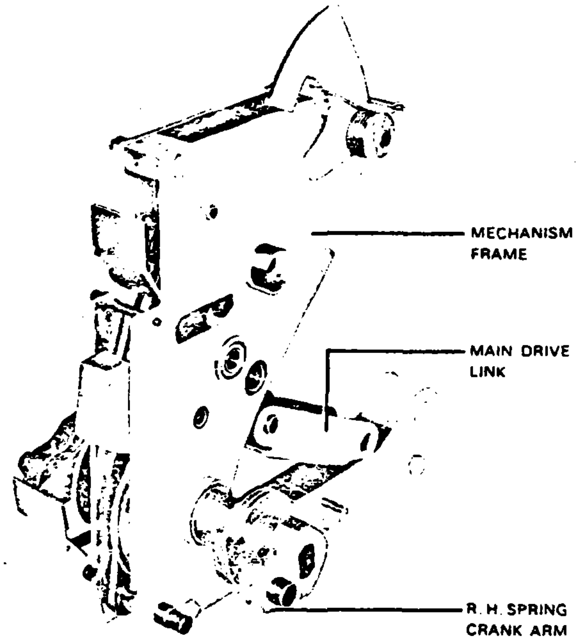


Fig. 19 *Front View of Mechanism (Manual Spring Charge)*

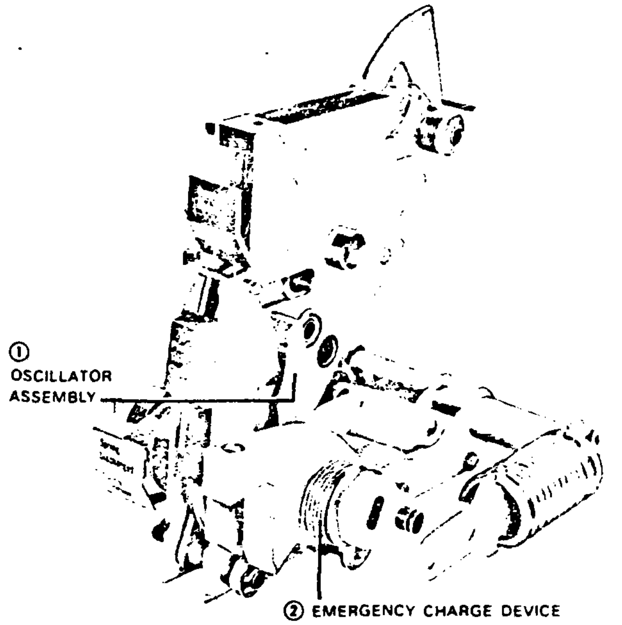


Fig. 20 *Front View of Mechanism (Power-Operated Spring Charge)*

All DS/DSL except DS-632 and DS-840

	Power Operated				Manual Operated		
Description	Number Required per Breaker	Fig. No.	Item No.	Style Number	Fig. No.	Item No.	Style Number
Mechanism Assembly (Without Closing Spring)	1	20	—	567F759G02	19	—	567F759G01
Following are included in Mechanism Assembly:							
Main Drive Link Ass'y. (With Roller)	1	21	1-2	437B146G03	21	1-2	437B146G03
Oscillator Ass'y.	1	20	1	436B923G01			•
Oscillator Reset Spring (Not Illustrated)	1	—	—	® 503B601H11			•
Emergency Charge Device	1	20	2	436B925G01			•
Spring Release Latch (With Bearings)	1	22	1	795A855G01	22	1	795A855G01
Trip Latch	1	22	2	3755A19G01	22	2	3755A19G01
Lever (for motor cut-off switch)	1	22	3	791A516H01	22	3	791A516H01
Trip Latch Reset Spring	1	22	4	® 795A077H01	22	4	® 795A077H01
Following are not included in Mechanism Assembly:							
Manual Charge Ass'y. (Without Handle)	1			•	23	8	591C385G01
Manual Charge Handle	1			•	23	9	349A669G02
Emergency Charge Handle	1	2	—	349A669G04			•
Trip Shaft	1	23	2	788A502H01	23	2	788A502H01
Trip Shaft Lever	1	23	3	437B381H01	23	3	437B381H01
Trip Shaft Return Spring	1	23	4	® 436B621H05	23	4	® 436B621H05
Opening Spring	1	2	—	® 503B601H04	2	—	® 503B601H04
Motor, incl. Crank & Connectors	1	23	10	® See Page 12			•
Closing Spring Ass'y.	2	21	3-4		21	3-4	
DS-206 DS-206S				349A521G01			349A521G01
DS-416 DS-416S				791A671G02			791A671G02
DS-420				791A671G01			791A671G01

® Recommended Spare—See page 2. •Not Required

Mechanism and Related Parts

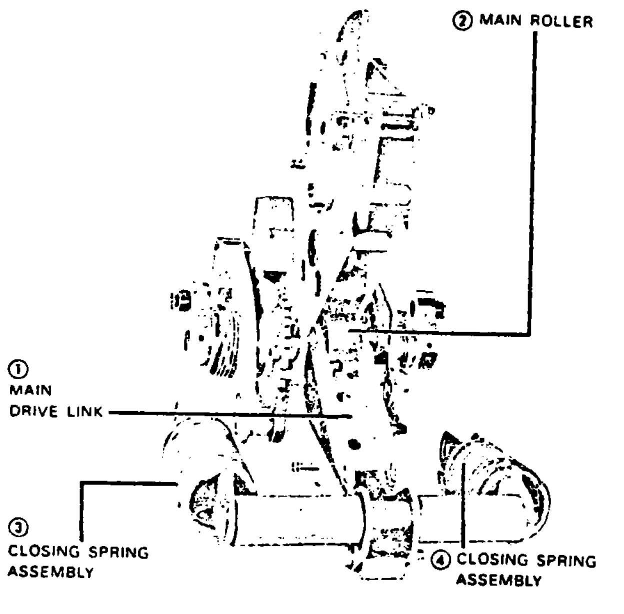


Fig. 21 *Rear of Power-Operated Mechanism*

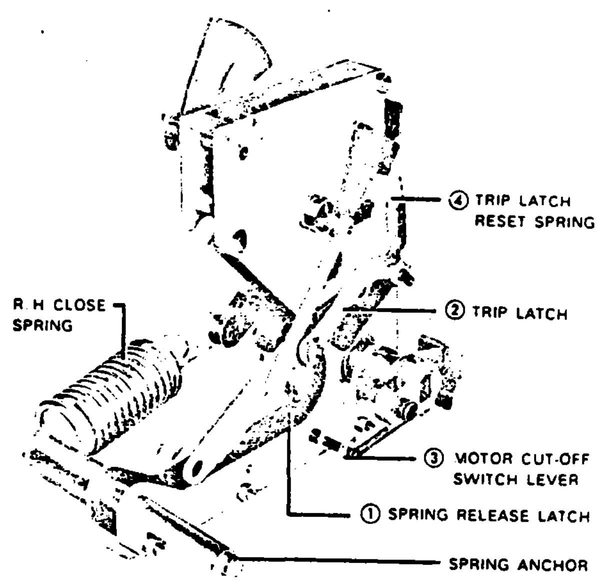


Fig. 22 *Rear View of Power-Operated Mechanism (Left Close Spring Removed)*

DS-632 and DS-840

Description	Number Required per Breaker	Power Operated (1) Fig. No.	Power Operated Item No.	Power Operated Style Number	Manual Operated (1) Fig. No.	Manual Operated Item No.	Manual Operated Style Number
Mechanism Assembly (Without Closing Spring)	1	20	—	567F759G04	19	—	567F759G07
Following are included in Mechanism Assembly:							
Main Drive Link Ass'y. (With Roller)	1	21	1-2	437B146G04	21	1-2	437B146G04
Oscillator Ass'y.	1	20	1	436B923G01			•
Oscillator Reset Spring (Not Illustrated)	1		—	® 503B601H11			•
Emergency Charge Device	1	20	2	436B925G01			•
Spring Release Latch (With Bearings)	1	22	1	795A855G01	22	1	795A855G01
Trip Latch	1	22	2	3755A19G01	22	2	3755A19G01
Lever (for motor cut-off switch)	1	22	3	791A516H01	22	3	791A516H01
Trip Latch Reset Spring	1	22	4	® 795A077H01	22	4	® 795A077H01
Following are not included in Mechanism Assembly:							
Manual Charge Ass'y. (Without Handle)	1			•	23	8	591C385G01
Manual Charge Handle	1			•	23	9	349A669G02
Emergency Charge Handle	1	7	—	349A669G04			•
Trip Shaft	1	23	2	788A502H01	23	2	788A502H01
Trip Shaft Lever	1	23	3	437B381H01	23	3	437B381H01
Trip Shaft Return Spring	1	23	4	® 436B621H05	23	4	® 436B621H05
Opening Spring	1 (2)	8	—	® 503B601H04	8	—	® 503B601H04
Motor, incl. Crank & Connectors	1	23	10	® See Page 12			•
...osing Spring Ass'y.	2	21	3-4	791A671G03	21	3-4	791A671G03

® Recommended Spare—See page 2.

•Not Required.

(1) Figures 19 thru 22 illustrate mechanism for all DS/DSL breakers except DS-632 and DS-840. DS-632 and DS-840 mechanisms are similar.

(2) Two opening springs are required for DS-840.

Mechanism and Related Parts

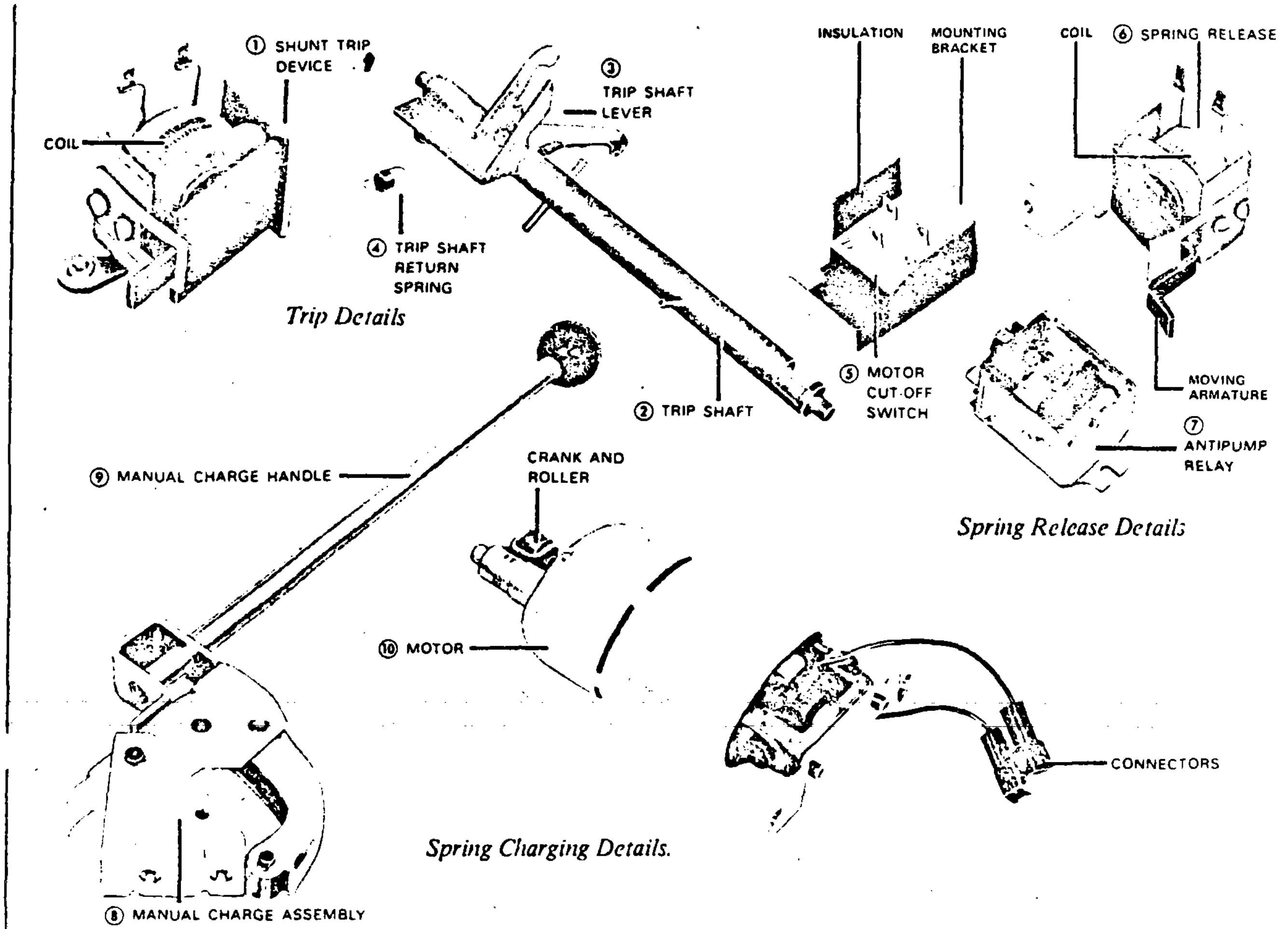


Fig. 23 *Trip, Spring Release, and Spring Charging Details*

Voltage	Shunt Trip (1) Fig. No. 23 Item No. 1: Complete Assembly DS/DSL except DS-840 (2)	Shunt Trip: Coil ® Only	Spring Release (1) Fig. No. 23 Item No. 6: Complete Assembly DS/DSL except DS-840 (3)	Spring Release: Coil ® Only	® Anti-Pump Relay Fig. No. 23 Item No. 7	® Motor Kit (4) Fig. No. 23 Item No. 10
24 DC	3752A02G01	151D786G01	—	—	—	—
32 DC	3752A02G02	151D786G03	—	—	—	—
48 DC	3752A02G03	151D786G04	3752A03G01	151D786G04	140D930H03	449D431G03
125 DC	3752A02G04	151D786G08	3752A03G02	151D786G08	140D930H04	449D431G01
250 DC	3752A02G05	151D786G11	3752A03G03	151D786G11	140D930G05	449D431G02
120 60 HZ	3752A02G06	151D786G04	3752A03G04	151D786G02	140D930H01	449D431G01
240 60 HZ	3752A02G07	151D786G08	3752A03G05	151D786G05	140D930H02	449D431G02
For Use with Capacitor Trip	3752A02G08	151D786G08	—	—	—	—

® Motor Cut-off Switch—All breakers—Style 450D818G02 Fig. 23—Item 5.

® Recommended Spare—See page 2.

(1) Shunt Trip and Spring Release complete assembly includes mounting hardware and wire leads for field replacement. When adding shunt trip or spring release to manual breakers, an auxiliary switch, secondary contacts, and possibly other components will be required.

(2) For DS-840 use corresponding groups of 3752A22

(3) For DS-840 use corresponding groups of 3752A23.

(4) Motor Kit includes crank and roller and connectors for field replacement.

Type DS Circuit Breaker Automatic Tripping System

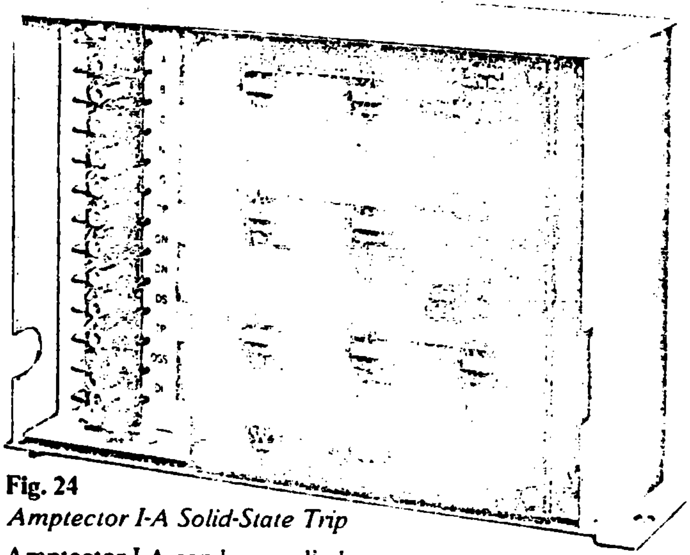


Fig. 24
Amptector I-A Solid-State Trip

Amptector I-A can be supplied in various combinations of four independent continuously adjustable overcurrent tripping functions:

Long delay (L), Short delay (S), Instantaneous (I), Ground (G)

The following combinations are available:
LI, LIG, LS, LSG, LSI, LSIG

Model	Style Number —60 HZ
LI	6998D02G01
LIG	6998D02G02 (1)
LS	6998D02G03
LSG	6998D02G04 (1)
LSIG	6998D02G05 (1)
LSI	6998D02G06

(1) For DS-632 and DS-840 use Groups 62, 64, 65 and 82, 84, 85 respectively.

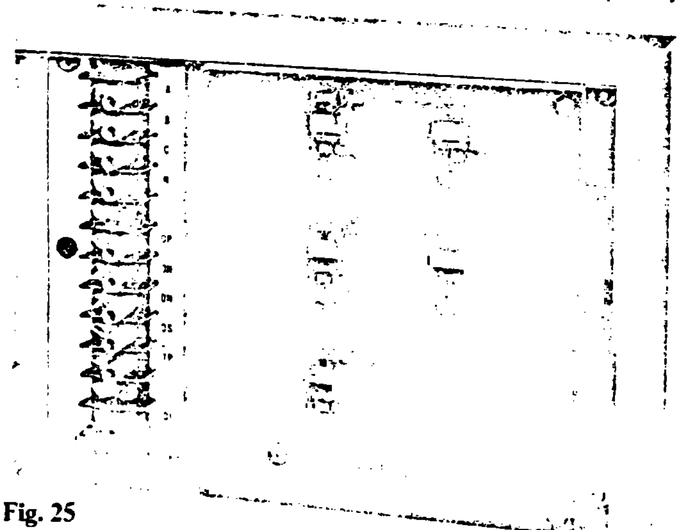


Fig. 25
Amptector II-A Solid-State Trip

Amptector II-A can be supplied in three models or combinations of three independent continuously adjustable overcurrent tripping functions: long delay, short delay and instantaneous. These models are:

DU(Dual—Long delay and instantaneous

SE(Selective)—Long delay and short delay

TR(Triple)—Long delay, short delay and instantaneous

Model	Style Number —60 HZ
DU	6997D20G41
SE	6997D20G42
TR	6997D20G43

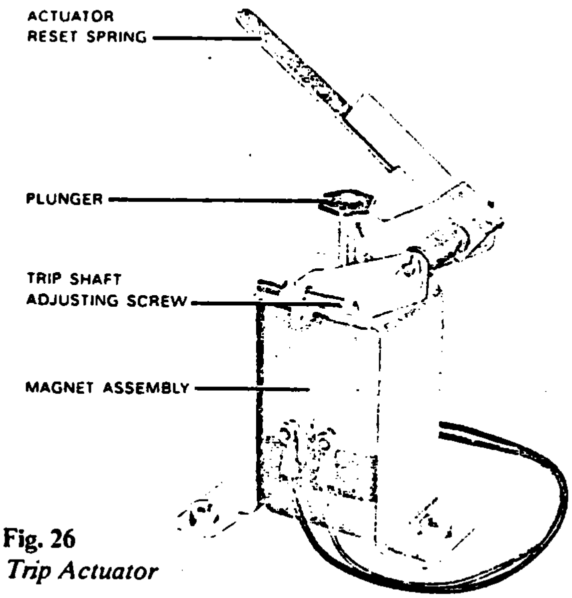


Fig. 26
Trip Actuator

DIRECT TRIP ACTUATOR FIGURE NO. 26

All type DS Breakers use Style Number 592C114G03 (with Black Magnet Ass'y)

Exception: If a breaker is equipped with an earlier Amptector II Style 151D792G series, use actuator style 592C114G01 (with Red Magnet Ass'y).

SENSORS

See Figure 3 for Typical Sensors

Refer to I.B. 33-790-1E. Table 4. for application of sensors.

Sensor Rating Amperes	Sensor Style Number
50	794A170G01
100	151D995G01
150	151D995G15
200	151D995G02
300	151D995G03
400	151D995G04
600	151D995G06
800	151D995G08
1200	151D995G12
1600	151D995G16
2000	151D995G20
2400	151D995G24
3200	151D995G32
4000	588C734G01

NOTE:

For information on application and operation of the automatic tripping system refer to Section 8 of Instruction Book 33-790-1E.

Optional Accessories

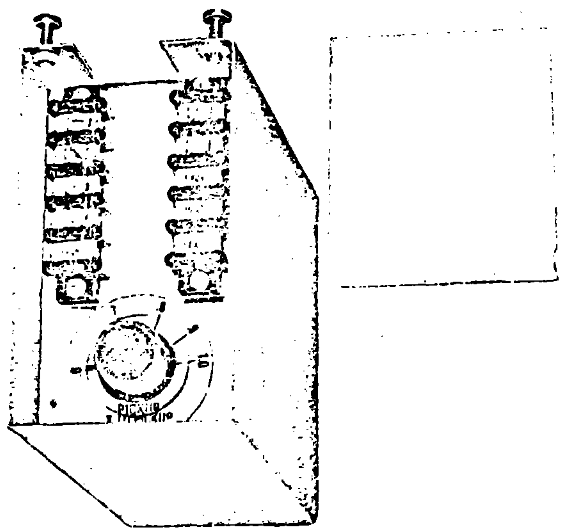


Fig. 27 *High Load Switch—Style 151D006G04*

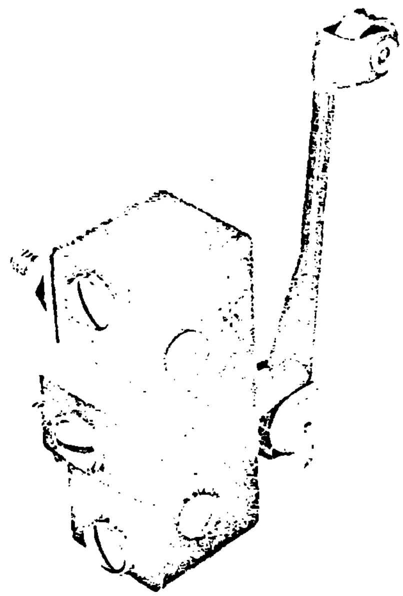


Fig. 28 *Latch Check Switch—Style 140D161G01*

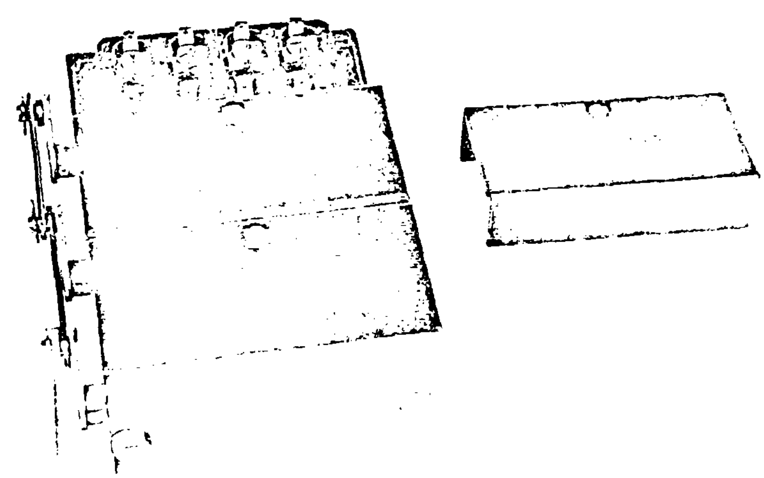


Fig. 29 *Auxiliary Switches—See page 3 for identification of auxiliary switches.*

Optional Accessories

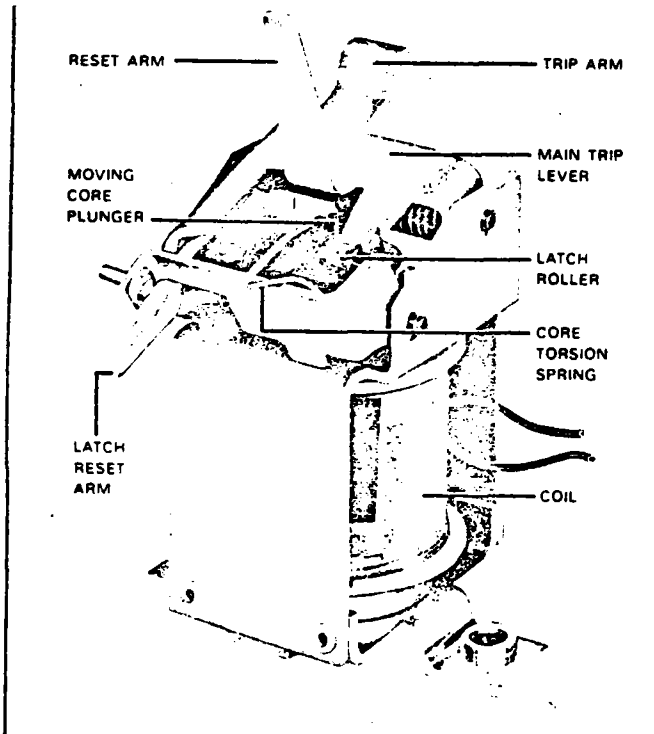


Fig. 30 *Underwattage Trip Device*

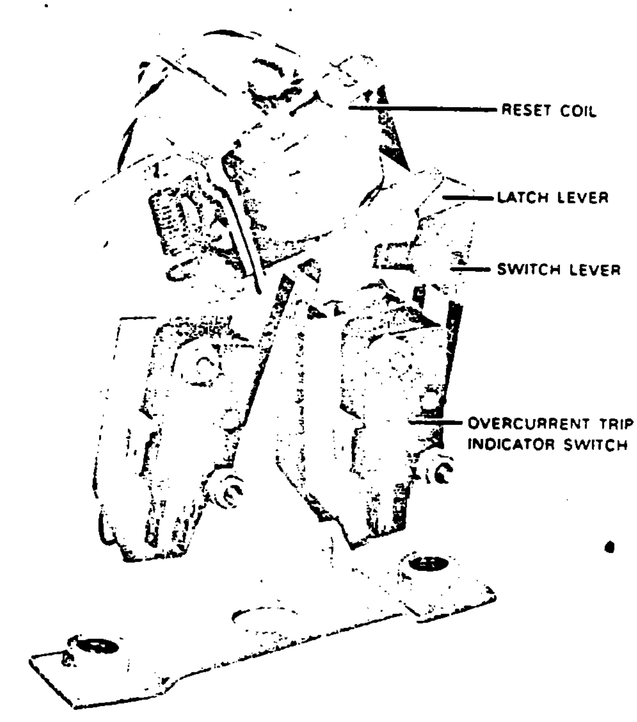


Fig. 31 *Overcurrent Trip Switch*

UNDERVOLTAGE TRIP DEVICE—FIGURE NO. 30

Voltage	Undervoltage-Instantaneous All DS/DSL Except DS-840 (1)	Undervoltage-Time Delay All DS/DSL Except DS-840 (2)
120 60 HZ	3752A05G01	3752A06G01
208 60 HZ	3752A05G02	3752A06G02
240 60 HZ	3752A05G03	3752A06G03
460 60 HZ	3752A05G04	3752A06G04
48 DC	3752A05G05	3752A06G05
125 DC	3752A05G06	3752A06G06
250 DC	3752A05G07	3752A06G07

(1) For DS-840 use corresponding groups of 3752A25

(2) For DS-840 use corresponding groups of 3752A26

Special Voltage	All DS/DSL including DS-840	All DS/DSL including DS-840
24 DC	3752A45G01	3752A46G01
115 50 HZ	3752A45G02	3752A46G02
208 50 HZ	3752A45G03	3752A46G03
230 50 HZ	3752A45G04	3752A46G04
400/415/50 HZ	3752A45G05	3752A46G05
460 50 HZ	3752A45G06	3752A46G06

NOTES
* " styles include mounting hardware and wire leads for field replacement. n adding to existing breakers. secondary contacts will be required.

The undervoltage trip device is available as a complete assembly. The coil ıly is not recommended as it is riveted into the assembly.

OVERCURRENT TRIP SWITCH—FIGURE NO. 31
For all type DS/DSL except DS-840 (1).

Manual Reset

2 Contact	3 Contact	4 Contact
3752A04G01	3752A04G02	3752A04G03

Electrical Reset

Voltage	2 Contact	3 Contact
48 DC	3752A04G04	3752A04G09
115 AC	3752A04G05	3752A04G10
125 DC	3752A04G06	3752A04G11
230 AC	3752A04G07	3752A04G12
250 DC	3752A04G08	3752A04G13

(1) For DS-840 use corresponding groups of 3752A24.

All styles include mounting hardware and wire leads for field replacement. When adding to existing breakers other components may be needed.

For replacement of switches only order style 6898D52A01 which consists of two switches, a switch bracket and rivets.

DSL-206 and DSL-416 Breakers

Parts for pole units, arc chutes, mechanisms, etc.
for DSL breakers are identified on preceeding pages of this R.P.D.

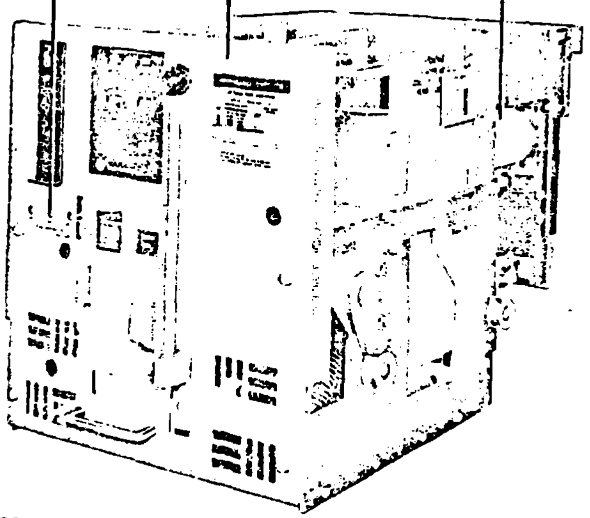


Fig. 32 *DSL-206 Breaker—Front View*

Description	Fig. No.	Number Required per Breaker	DSL-206 and DSL-416 Style Number
Blown Limiter Indicator Ass'y.	32	1	140D777G01
Isolating Transformer Ass'y. (includes 3 transformers)	33	1	591C755G01
Transformer Only:	33	3	795A823H01

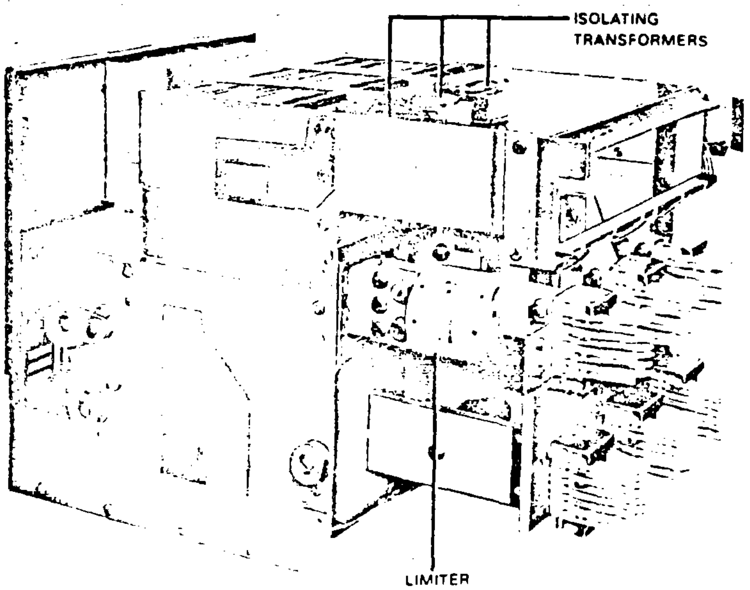


Fig. 33 *DSL-416 Breaker—Side View*

® LIMITERS—FIGURES 32-33

Refer to I.B. 33-790-1E, Table 5, for application of limiters.

Breaker Type	Number Required per Breaker	Rating Amps	Style Number
DSL-206	3	150	140D316G01
	3	200	140D316G02
	3	250	140D316G03
	3	300	140D316G04
	3	400	140D316G05
	3	600	140D316G06
	3	800	140D316G07
	3	1200	140D316G10
	3	1600	140D316G11
	3	2000	140D316G12
DSL-416	3	800	151D932G01
	3	1000	151D932G02
	3	1200	151D932G03
	3	1600	151D932G04
	3	2000	151D932G05
	3	2500	151D932G09
	3	3000	151D932G10

® Recommend 3 spare limiters of each current rating.

Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, Pa. 15112 U.S.A.

Printed in U.S.A.

Assembled Switchgear

TYPE DS-420 AIR CIRCUIT BREAKER
Motor or Manual Operated - 2000 Ampere

Renewal Parts Data

32-250
Type DS-420

Recommendations for Stock

Refer to I.B. 33-790-IB for Maintenance and Parts Identification

Ref. No.	Unit Quantity	Style Number	Description
Fig. 56			**POLE UNIT PARTS**
It. 7	3*	795A769G01	Moving Main Contact
It. 8	3*	503B022G01	Moving Arcing Contact
It. 16	3*	503B025G01	Stationary Arcing Contact - L.H.
It. 17	3*	503B025G02	Stationary Arcing Contact - R.H.
It. 18	6*	503B027H01	Stationary Arcing Contact Spring
It. 21	36*	809A263G01	Stationary Main Contact Finger
It. 23	12*	503B027H05	Main Contact Spring - Outer
It. 23	12*	503B027H10	Main Contact Spring - Inner
			DS - SWITCHGEAR COMMON PARTS
			MECHANISM SPRINGS
	1	436B621H05	Trip Bar Reset
	1	795A077H01	Trip Latch Reset
	1+	503B601H11	Oscillator Reset
	1	503B601H04	Opening
			SWITCHES
	1	449D622G21	Auxiliary
	1	450D818G02	Motor Cut-Off

Volts	Cycles	Spring Release Coils	Shunt Trip Coils	U.V. Trip Coils	Complete-Anti Pump Relay	Motor Kit
24	D-C	——	151D786G01	——	——	——
32	D-C	——	151D786G03	——	——	——
48	D-C	151D786G04	151D786G04	300P896G01	140D930H03	449D431G03
125	D-C	151D786G08	151D786G08	300P897G01	140D930H04	449D431G01
250	D-C	151D786G11	151D786G11	794A214G01	140D930G05	449D431G02
120	A-C	151D786G02	151D786G04	300P044G01	140D930H01	449D431G01
208	A-C	——	——	1491 404	——	——
240	A-C	151D786G05	151D786G08	300P896G01	140D930H02	449D431G02
480	A-C	——	——	1491 405	——	——

+ - For Power Breakers only.
* - The quantities specified are those required to replace both arcing and main contacts of one breaker.
Parts indented are included in the part under which they are indented. Order part by name and identification number—give complete nameplate reading.

November, 1976

Assembled Switchgear

TYPE DS-416 AIR CIRCUIT BREAKER
Motor or Manual Operated - 600 Ampere

Recommendations for Stock

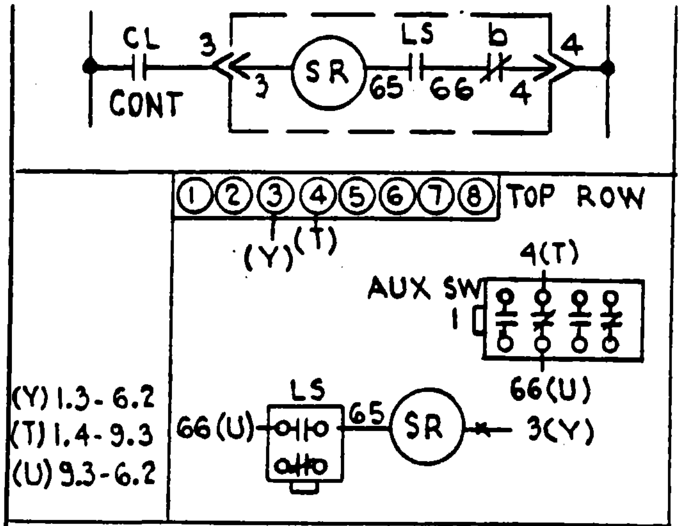
Refer to I.B. 33-790-IB for Maintenance and Parts Identification

Ref. No.	Unit Quantity	Style Number	Description
Fig. 56			POLE UNIT PARTS
It. 7	3*	665A321G01	Moving Main Contact
It. 8	3*	503B022G01	Moving Arcing Contact
It. 16	3*	503B025G01	Stationary Arcing Contact - L.H.
It. 17	3*	503B025G02	Stationary Arcing Contact - R.H.
It. 18	6*	503B027H01	Arcing Contact Spring
It. 21	24*	809A263G01ϕ	Stationary Main Contact Finger
It. 23	12*	503B027H05	Main Contact Spring
			DS - SWITCHGEAR COMMON PARTS
			MECHANISM SPRINGS
	1	436B621H05	Trip Bar Reset
	1	795A077H01	Trip Latch Reset
	1+	503B601H11	Oscillator Reset
	1	503B601H04	Opening
			SWITCHES
	1	449D622G21	Auxiliary
	1	450D818G02	Motor Cut-Off

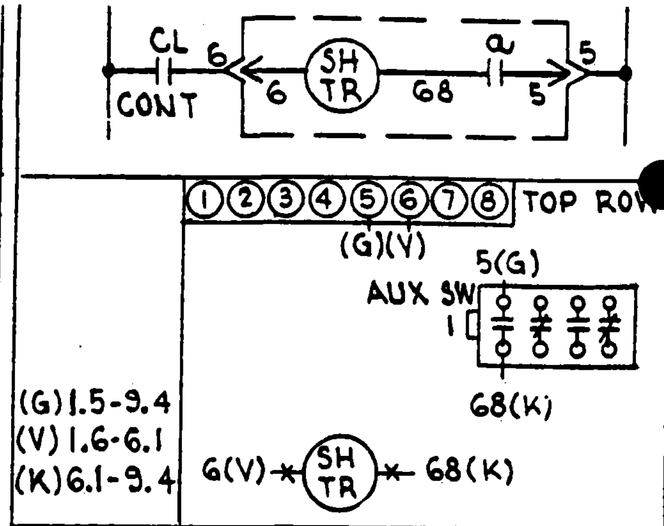
Volts	Cycles	Spring Release Coils	Shunt Trip Coils	U.V. Trip Coils	Complete-Anti Pump Relay	Motor Kit
24	D-C	---- ---	151D786G01	---- ---	---- ---	---- ---
32	D-C	---- ---	151D786G03	---- ---	---- ---	---- ---
48	D-C	151D786G04	151D786G04	300P896G01	140D930H03	449D431G03
125	D-C	151D786G08	151D786G08	300P897G01	140D930H04	449D431G01
250	D-C	151D786G11	151D786G11	794A214G01	140D930G05	449D431G02
120	A-C	151D786G02	151D786G04	300P044G01	140D930H01	449D431G01
208	A-C	---- ---	---- ---	1491 404	---- ---	---- ---
240	A-C	151D786G08	151D786G08	300P896G01	140D930H02	449D431G02
480	A-C	---- ---	---- ---	1491 405	---- ---	---- ---

ϕ - Use after June, 1971.
+ - For Power Breakers only.
* - The quantities specified are those required to replace both arcing and main contacts of one breaker.
Parts indented are included in the part under which they are indented. Order part by name and identification number—give complete nameplate reading.

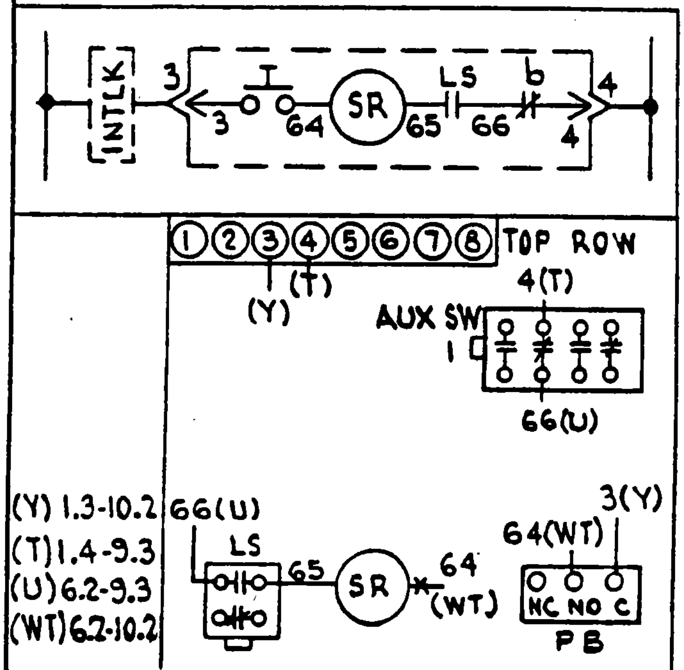
November, 1976



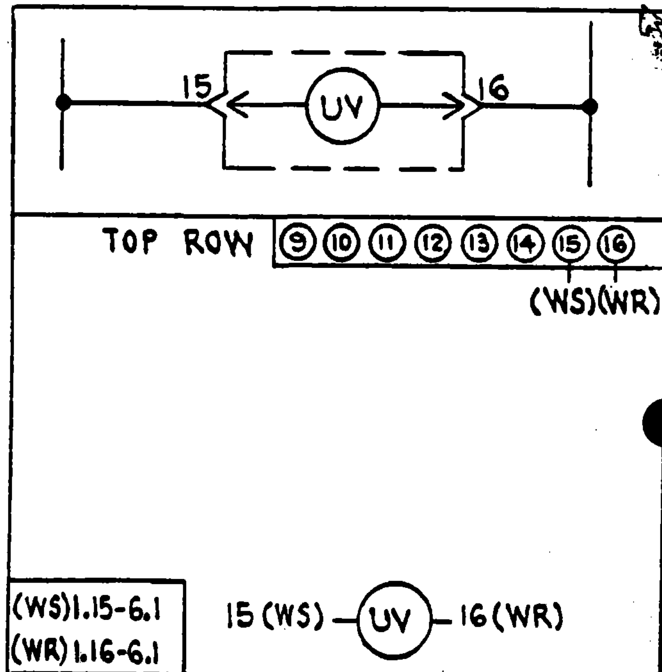
ELEC SPRING REL(MAN.BKR) 3A



SHUNT TRIP (MAN. BKR) 3B



ELEC LOCKOUT (MAN. BKR) 3C



UNDERVOLTAGE 3D

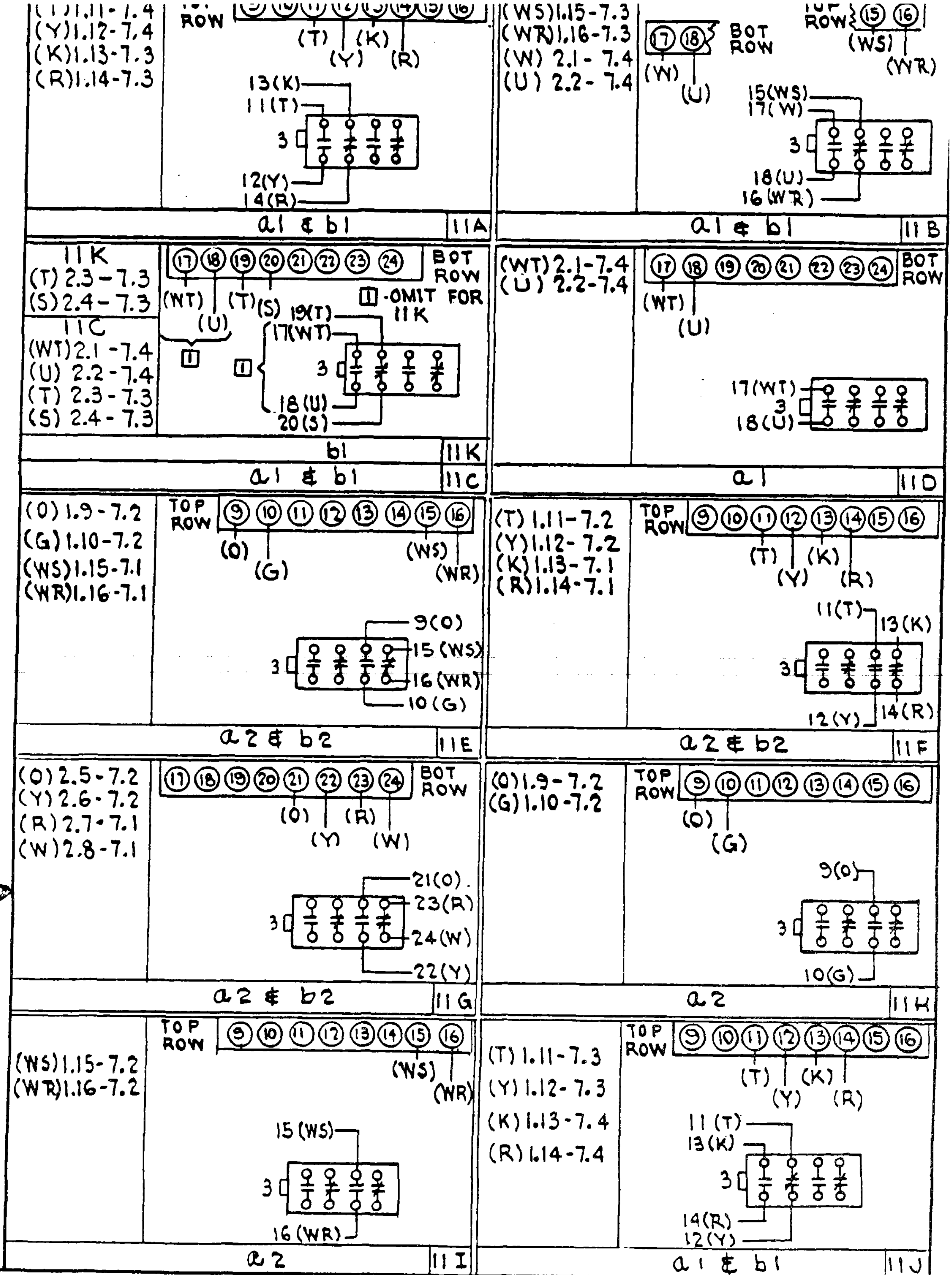
WESTINGHOUSE ELECTRIC CORPORATION

TITLE BASIC ACCESSORIES

800A600

DIVISION

3.1.1-310 PLANT LOCATION E. PGH PA SH 3



WESTINGHOUSE ELECTRIC CORPORATION

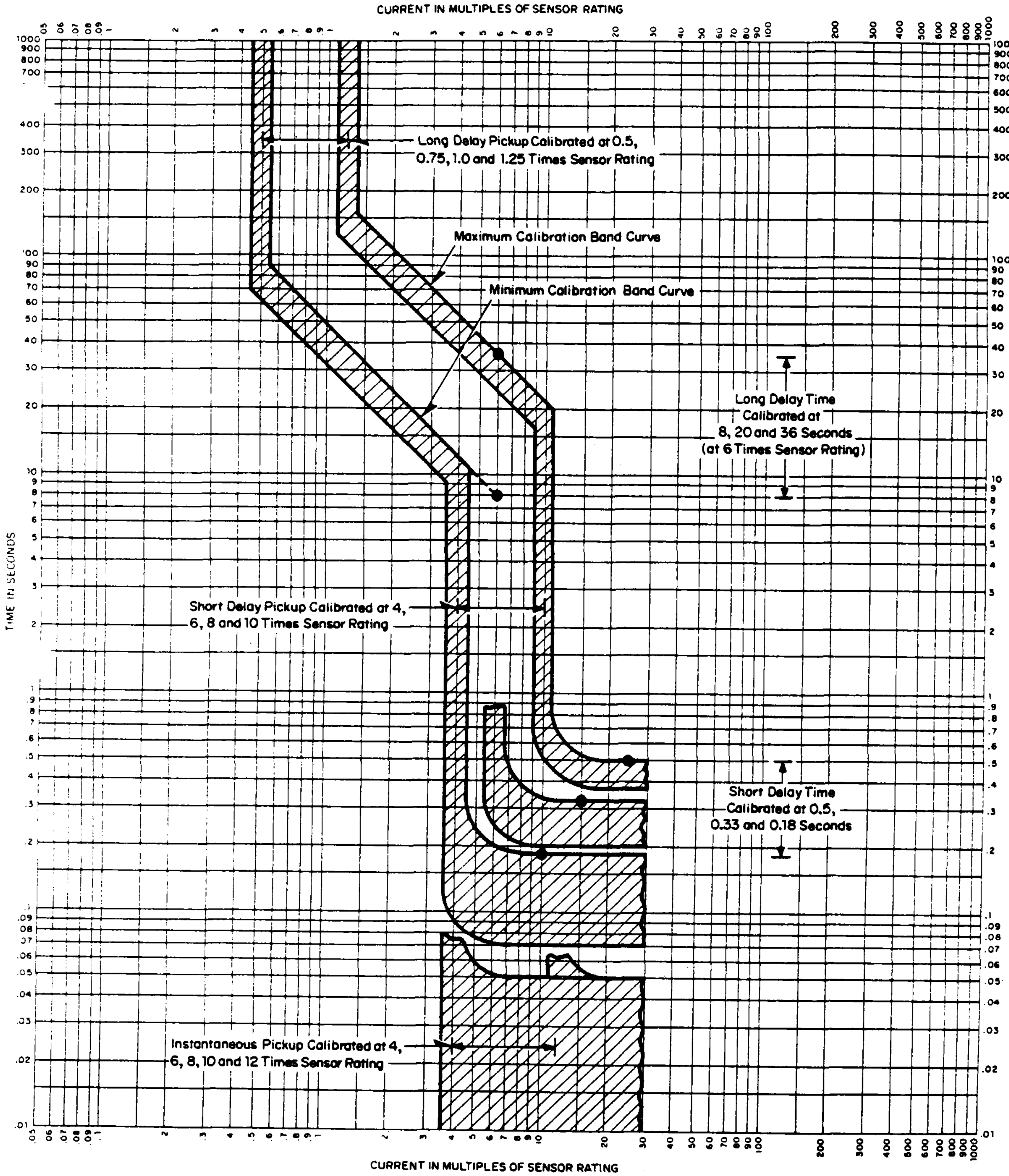
TITLE AUXILIARY SWITCH 3

800A600

DIVISION SWGR

3.1.1-311

PLANT LOCATION E.PGH PA SH11



mptector II

e - Current Characteristics

Westinghouse Electric Corporation
Switchgear Division, East Pittsburgh, Pa 15112
Printed in USA

Curve No. 666600
New Information
April, 1976

Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, PA 15112

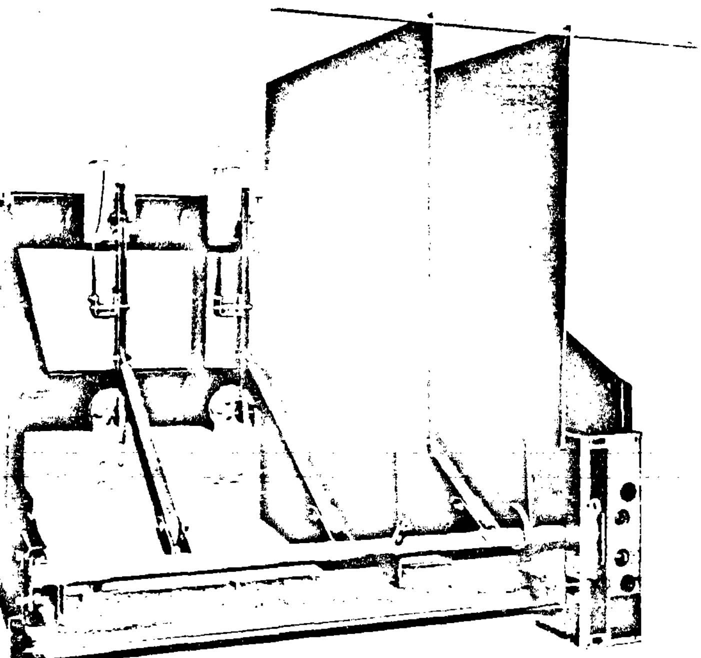
November, 1977
Supersedes Descriptive Bulletin 36-553 dated January, 1972 and 36-553A D WE A, dated September, 1975
Mailed to: E, D, C/1968/DB

Indoor frame mounted 2.4 kV to 34.5 kV.

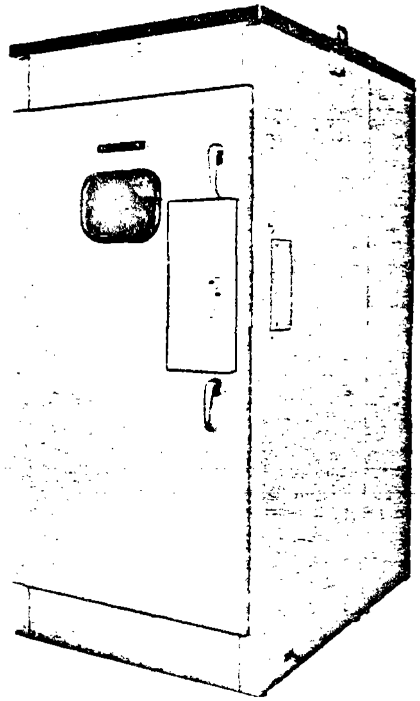
Indoor and outdoor enclosed non-fused 2.4 kV to 15 kV.

Indoor and outdoor enclosed fused 2.4 kV to 15 kV.

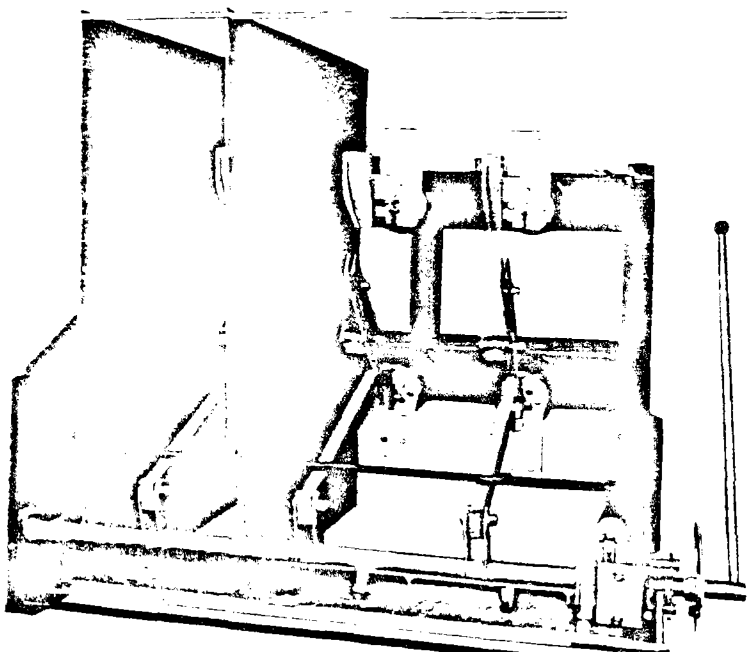
Type AWP Load Interrupter Switch



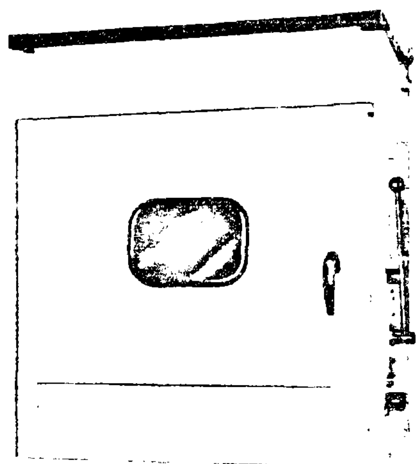
Front Operated Frame Mounted Switch



Front Operated Enclosed, Fused Switch



Side Operated Frame Mounted Switch



Side Operated Enclosed Wall Mounted Switch

Desc ion
The load interrupter switch, frame mounted, is a full rated quick make-quick break spring stored energy operated switch which provides fast and reliable protection for high voltage circuits 2.4 kV through 34.5 kV.

Application
AWP interrupter switches are available in unitized three pole, frame mounted construction for mounting in enclosures or assemblies. These units can be applied separately or in conjunction with fuses. They provide non-automatic switching for sectionalizing primary feeders, and isolation for transformer banks, capacitors, voltage regulators and similar applications. When used in series with expulsion or current limiting fuses, the combination provides a higher interrupting rating against faults, within the capability of the fuse rating.

Front Operated
The front operated type AWP switch is available in open frame mounted design from 5 kV through 34.5 kV, and is available in both right or left hand operation. In this design the operating handle is removable and is intended to be stored within the access door of its enclosure.

Side Operated
This switch design is available in open frame mounting from 5 kV through 34.5 kV, and is avai in both right or left hand operation. The o ating handle is fixed and requires no storage facility. On side operated units operating handles are available for either (1) hand operation or (2) hookstick operation. Fig. 23.

Frame mounted AWP switches, 5kV to 15 kV can be supplied with a 600 or 1200 ampere continuous current and load break feature. At 23.0 and 34.5 kV the continuous current rating can be 1200 amperes, but only with a 600 ampere load break feature.

Fault close of 20,000, 40,000 and 61,000 amperes is available in the voltage range from 5 kV to 23.0 kV, and only 20,000 and 30,000 amperes at 34.5 kV.

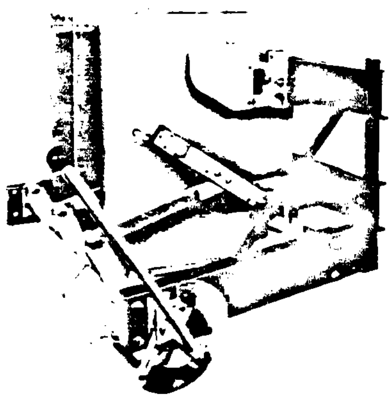
The open frame mounted AWP switches are designed for indoor applications and must be mounted in a suitable metal enclosure of adequate strength to withstand the short circuit forces.

Refer to Component Sales East Pittsburgh for frame mounted motor operated AWP switches.

Ratings

Max. Volt	Nom. Volt	BIL kV.	Continuous Amps	Interrupting Current	Momentary 10 Hz. Asym. kA	Momentary 4 SEC. Sym. kA	Fault Close ① kA
Table A: 5 kV							
5.0	4.8	60	600	600	40	25	20
5.0	4.8	60	600	600	40	25	40
5.0	4.8	60	1200	600	80	38	61
5.0	4.8	60	1200	1200	80	38	61
Table B: 8.25 kV							
8.25	7.2	75	600	600	40	25	20
8.25	7.2	75	600	600	40	25	40
8.25	7.2	75	1200	600	80	38	61
8.25	7.2	75	1200	1200	80	38	61
Table C: 15 kV							
15.0	13.2	95	600	600	40	25	20
15.0	13.2	95	600	600	40	25	40
15.0	13.2	95	1200	600	80	38	40
15.0	13.2	95	1200	600	80	38	61
15.0	13.2	95	1200	1200	80	38	40
15.0	13.2	95	1200	1200	80	38	61
Table D: 25.8 kV							
25.8	23.0	150	600	600	40	25	20
25.8	23.0	150	600	600	40	25	40
25.8	23.0	150	1200	600	40	25	40
25.8	23.0	150	1200	600	61	38	61
Table E: 38 kV							
38.0	34.5	150	600	600	40	25	20
38.0	34.5	150	600	600	40	25	30
38.0	34.5	150	1200	600	40	25	30
38.0	34.5	150	1200	600	61	38	30

① All fault closing tests are done at maximum voltage rating and without any protective fusing.



Special side operated AWP switches are specifically designed for mounting within 30 inch mine rectifiers but can be applied where limited space is required

Design Features

Stored energy nechanism:
The AWP quick make-quick break stored energy mechanism provides constant high-speed opening and closing and is capable of closing and holding on its rated fault current. The speed and force of opening and closing the contacts are both independent of the handle operation stroke.

The energy for the operation of the switch is provided by a spring that is compressed and released through a mechanical linkage.

Operation
Closing the front operated switch is accomplished by inserting the handle into the handle casting, Figure 1. An upward motion of the handle starts the rotation of the handle casting assembly. Through a mechanical linkage this operates a spring lever, Figure 2, 3 and 4, which compresses the spring. When the spring lever reaches the over toggle position, the spring releases its energy and closes the main contacts.

The opening cycle is initiated by a downward motion of the handle with the mechanical sequence repeated.

In the case of the side operated switch the handle is "fixed" and travels vertically in an arc of 120 degrees, approximately 60 degrees on each side of the operating shaft center line.

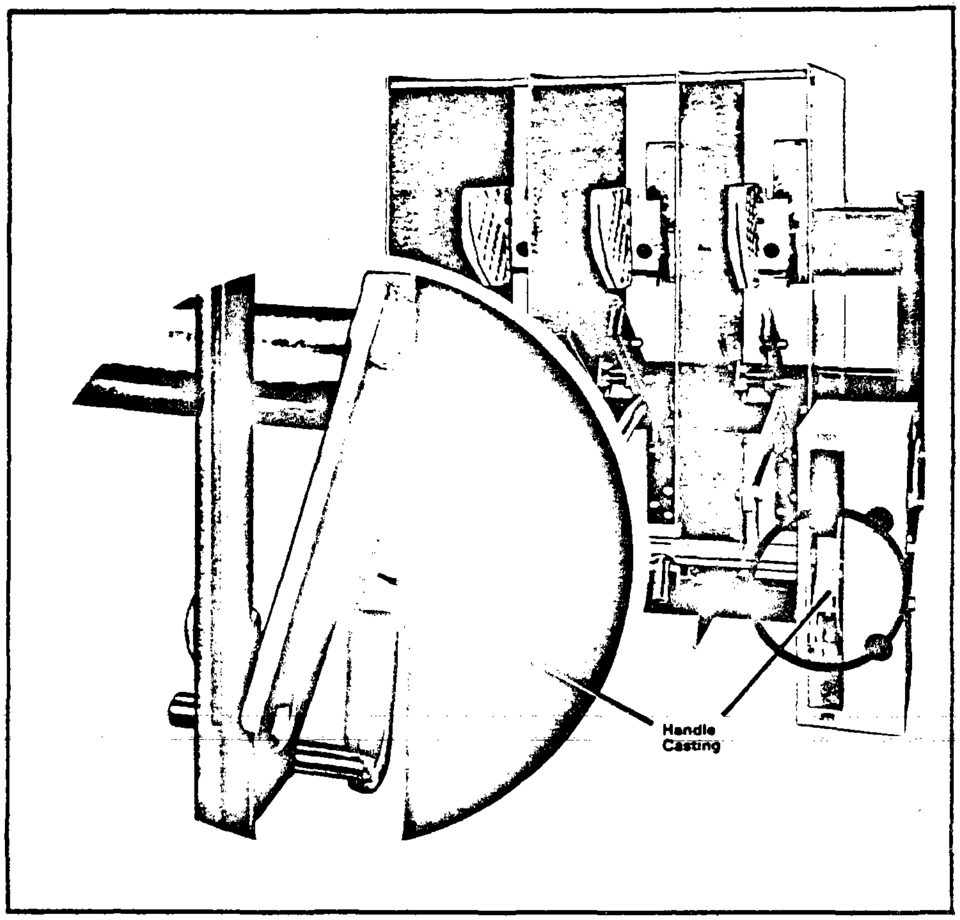


Figure 1

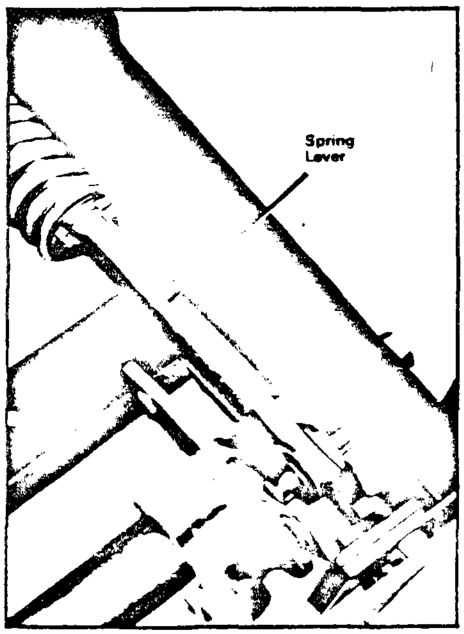


Figure 2

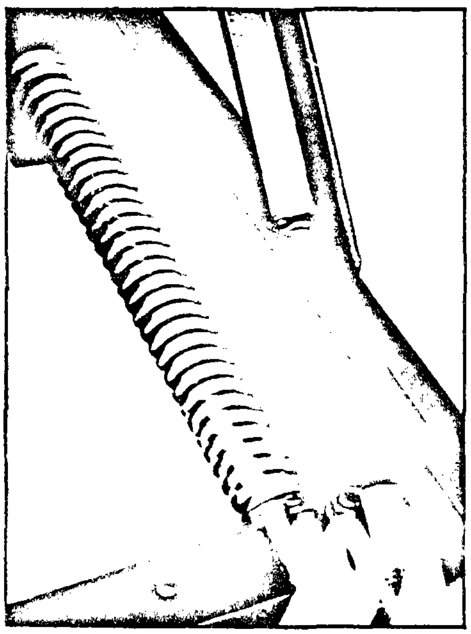


Figure 3

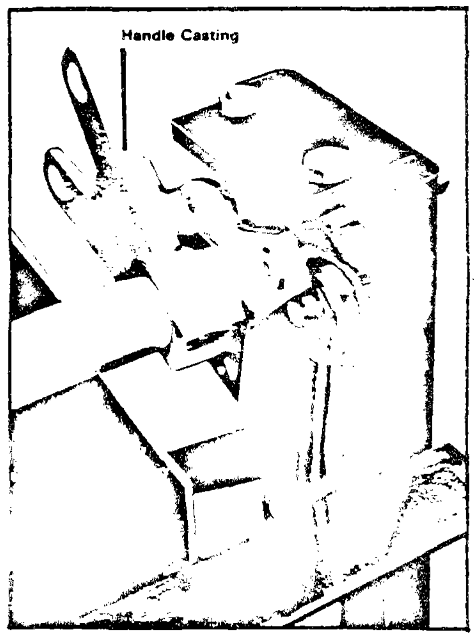


Figure 4

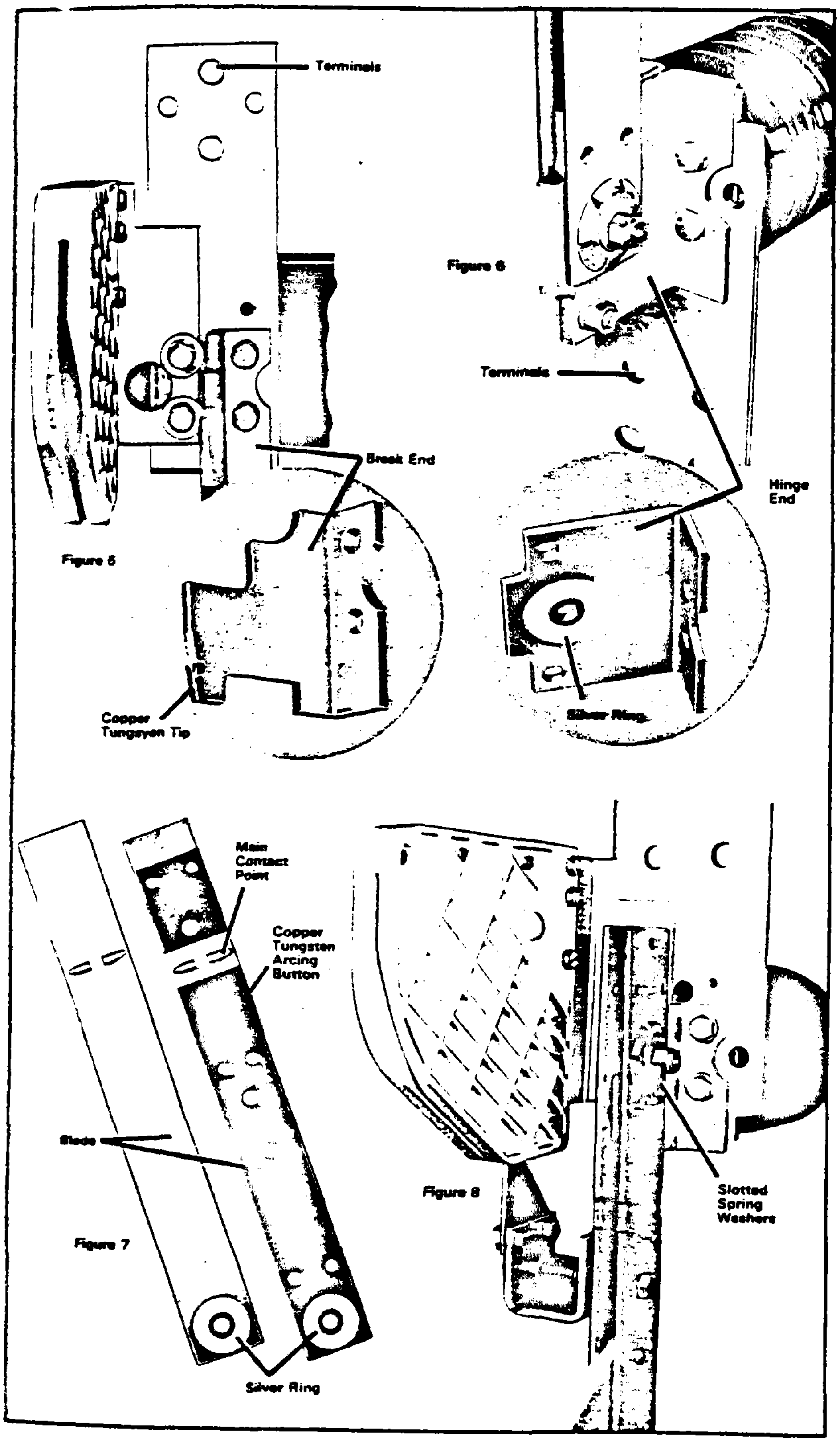


Figure 5

Figure 6

Figure 7

Figure 8

Design Features (Continued)

Main Contact

The main contacts, break and hinge end, are made of high conductivity hard drawn copper. For 40,000 and 61,000 ampere fault closing, the break end is provided with a copper tungsten alloy arcing tip, Figure 5.

The hinge end consists of two pieces of copper fastened together. Proper electrical contact is maintained when the blade is attached to the hinge contact with a bolt and spring washer. To further assure good electrical contact at 1200 amperes, the hinge end is also provided with silver rings at the moving point, Figure 6.

The blade consists of two high conductivity hard drawn copper bars in parallel, Figure 7. Since the electrical contact point for 600 amperes is silver to copper, the blades are provided with a silver ring at the hinge end and a copper embossed silver plated main contact point. On 40,000 and 61,000 ampere fault close ratings, copper tungsten alloy arcing buttons are provided to prevent damage to main break contact.

The two bars are fastened together to form the single blade at the hinge and break end. To assure permanent high contact pressure, self-adjusting slotted spring washers of phosphorus bronze are drawn tight over machined spacers. This provides flexibility in meeting stresses from distortion due to load or from uneven mounting, Figures 6 and 8.

Arc Chute

The arc chutes consist of two pieces of UREA formaldehyde fastened together to produce gas under high current conditions to extinguish the arc. Contacts within the arc chute restrain the flicker blade assembly until the spring is charged prior to opening, Figures 5 and 8.

Insulators

Glass polyester insulators are standard equipment on switches rated 5.0 kV and 15 kV. Porcelain insulators can be furnished as an optional feature. Porcelain insulators are standard on 7.2, 23.0 and 34.5 kV.

Design Features (Continued)

Flicker Blade
The flicker blade is connected to the side and parallel to the main blade. It is constructed of hard drawn copper with an arc resisting silver tungsten alloy tip, Figure 9. In the opening sequence as the main blade separates from the main break contact, the current is transferred to the flicker blade which is being restrained by the high pressure contacts within the arc chute. Once the maximum angular movement between the flicker blade and main blade has been reached, the flicker blade starts to move out of the arc chute contacts. The additional pull of the torsional spring on the flicker blade assembly snaps the blade into an open position at high speed.

The heat of the arc releases a blast of deionizing gas from the arc chamber. This combination of the quick break and De-ion action quickly extinguishes the arc de-energizing the ciruit.

For maintenance purposes or replacement, only the flicker blade portion need be removed.

Terminals
The terminal pads for both the 600 and 1200 ampere switches are high conductivity hard drawn copper bar with standard NEMA drilling, Figures 5, 6 and 9. For the mine application AWP switch the terminal pads are shortened to provide for insulated cable connections. (See page 2).

Blade Alignment
Blade and contact alignment for maintenance purposes can be checked with ease. The AWP Switch is supplied with slow close feature. Inserting the operating lever into the hub located on the shaft and using an upward motion, Figure 10, the switch blades can be readily moved for alignment check with main contacts. The switch cannot be fully latched with this slow close feature and once the lever is released the switch will always revert to the open position.

Barriers and Drive Rods
The barriers and drive rods are made of flame retardant glass polyester. The drive rods are also track resistant, Figure 11.

Standardization
The AWP was designed to be as flexible and simple as possible. Parts may be readily added or removed for changing applications.

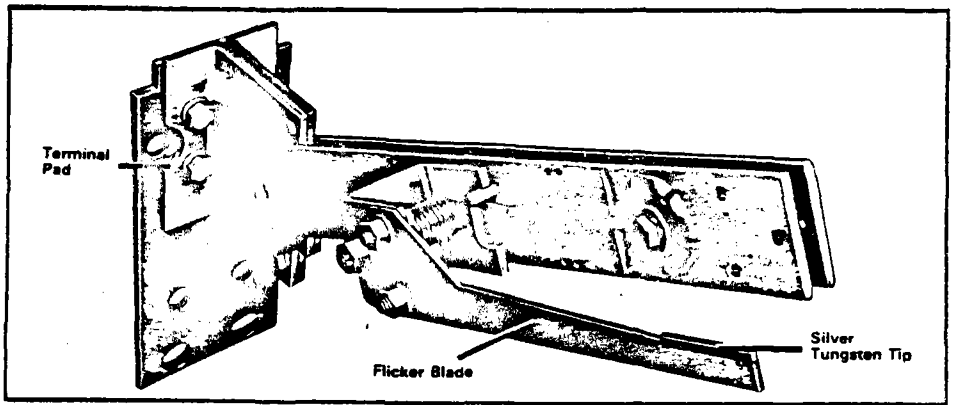


Figure 9

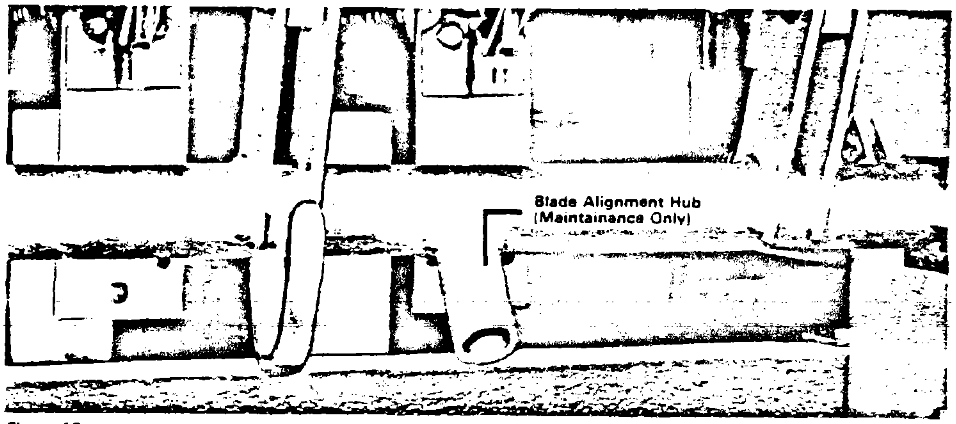


Figure 10

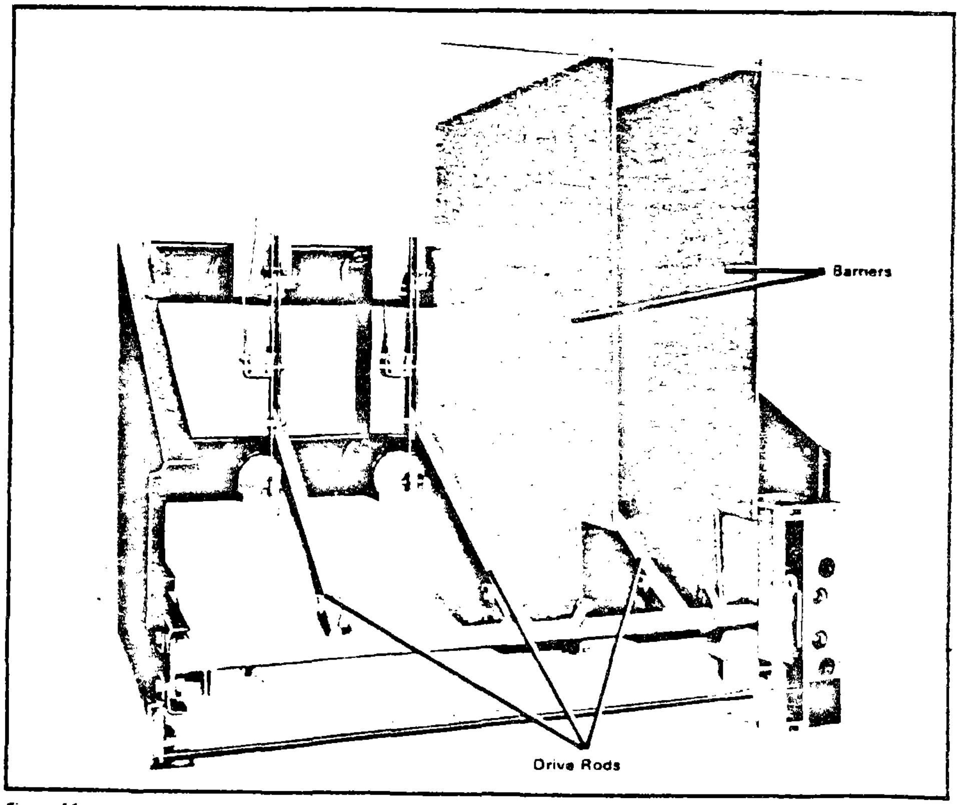


Figure 11

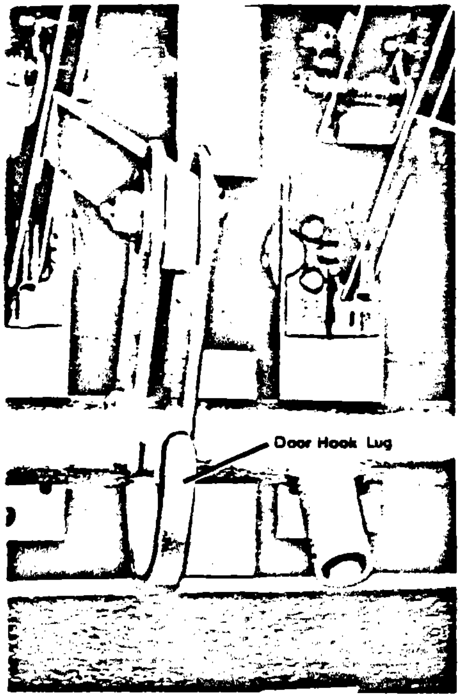


Figure 12

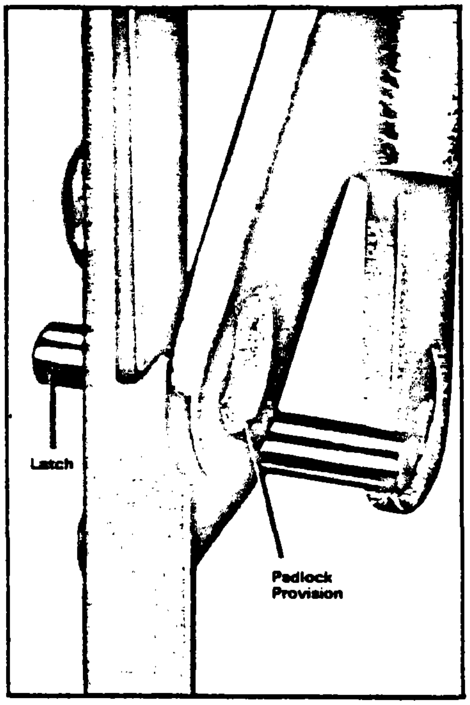


Figure 13

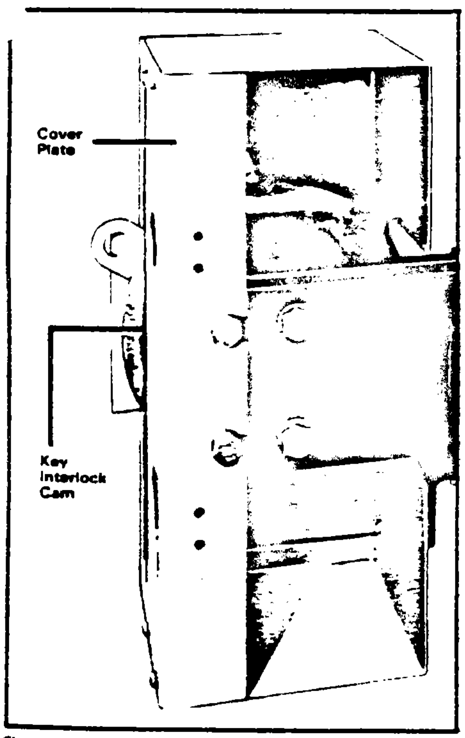


Figure 14

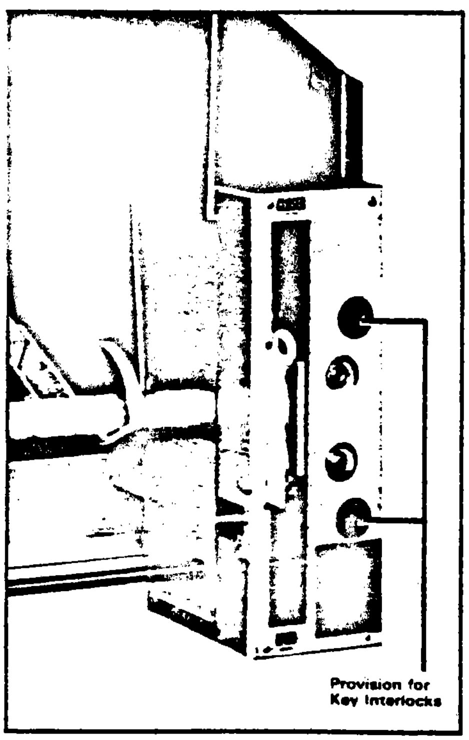


Figure 15

Door Interlocks and Special Features

Since the speed and force of closing the main contacts are independent of the lever closing operation, the AWP has an inherent built-in anti-tease mechanism. Each switch has two mechanical interlocks. The door interlock is a hook lug arrangement on the shaft which engages a ring mounted on the enclosure door, Figure 12. This prevents the door from being opened while the switch is in the closed position. The other interlock prevents the switch from being closed while the door is opened. The latch, Figure 13, must be pushed forward by a latch lug mounted on the enclosure door to close switch. For maintenance purposes only, this latch may be disengaged. **Prior to such maintenance all sources of power to the switch must be de-energized.**

To prevent contact with live parts through the mechanism cover plate, a barrier surrounds the operating mechanism, isolating it from the main current carrying parts of the switch, Figure 14.

In addition to the built-in interlocks, on front operated switches there are provisions for two kirk key interlocks, Figure 15, which will allow the switch to be locked in open or closed positions, plus provision for one padlock, Figure 13. Similar provisions are available on side operated switches when mounted in an enclosure.

When a key interlock (s) is required, on front operated switches holes are provided (Figure 15) for lock mounting. Additional material is required to complete the lock installation. Refer to "Accessories" in price list.

Padlock provision, Figure 13 & 23, will accommodate one padlock. An adapter is available to accommodate additional pad-locks if required.

Operation of Electrical/Manual Stored Energy Mechanism

The electrical/manual stored energy mechanism portion of the AWP Switch is located on the right side of the switch just above the operating shaft and handle casting assembly, Figure 16.

The unit is a mechanical linkage consisting of a teeter bar, double toggle assembly and a shunt trip coil. Closing of this switch is accomplished by inserting the handle into the handle casting. An upward motion of the handle starts the rotation of the casting assembly. Through a mechanical linkage, this operates a spring lever which compresses the spring. When the spring lever reaches the over toggle position, the spring tends to release its energy and tries to move the operating shaft. The movement is restrained by a linkage which transfers the energy into the double toggle assembly.

The switch can now be closed by tripping the double toggle assembly using a manual release located in front of the switch or remotely by the shunt trip coil.

Once the switch is closed, the opening cycle is made ready by a downward motion of the handle; the double toggle assembly is reset after each open or close cycle allowing the mechanical sequence to repeat. Again the switch can now be opened manually or electrically. Shunt trip coil voltages can be 48 volts dc, 125 volts dc, 250 volts dc, 115 volts ac and 230 volts ac. Shunt trip attachment is available on 2.4 through 15 kV units only.

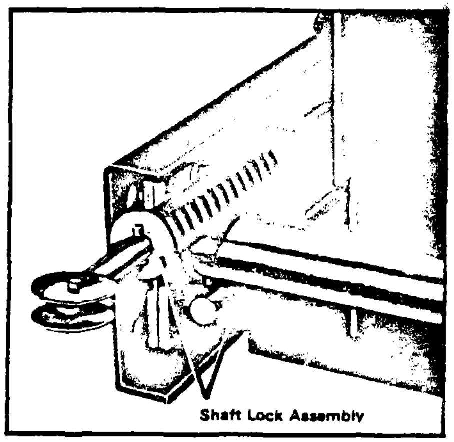


Figure 17

Special Features
Indicators located at the operating end are provided to show if the spring is charged or if the switch is opened or closed, Figure 19.

A shaft lock assembly is provided on the left side of the switch to prevent the switch from operating when the door is opened and the switch charged for operation, Figure 17. For maintenance purposes only, this latch may be disengaged. Prior to such **maintenance all sources of power to the switch must be de-energized.**

On this type of operating mechanism, Kirk Key Interlocks cannot be provided; however, there is provision for padlocks on the handle casting, Figure 16.

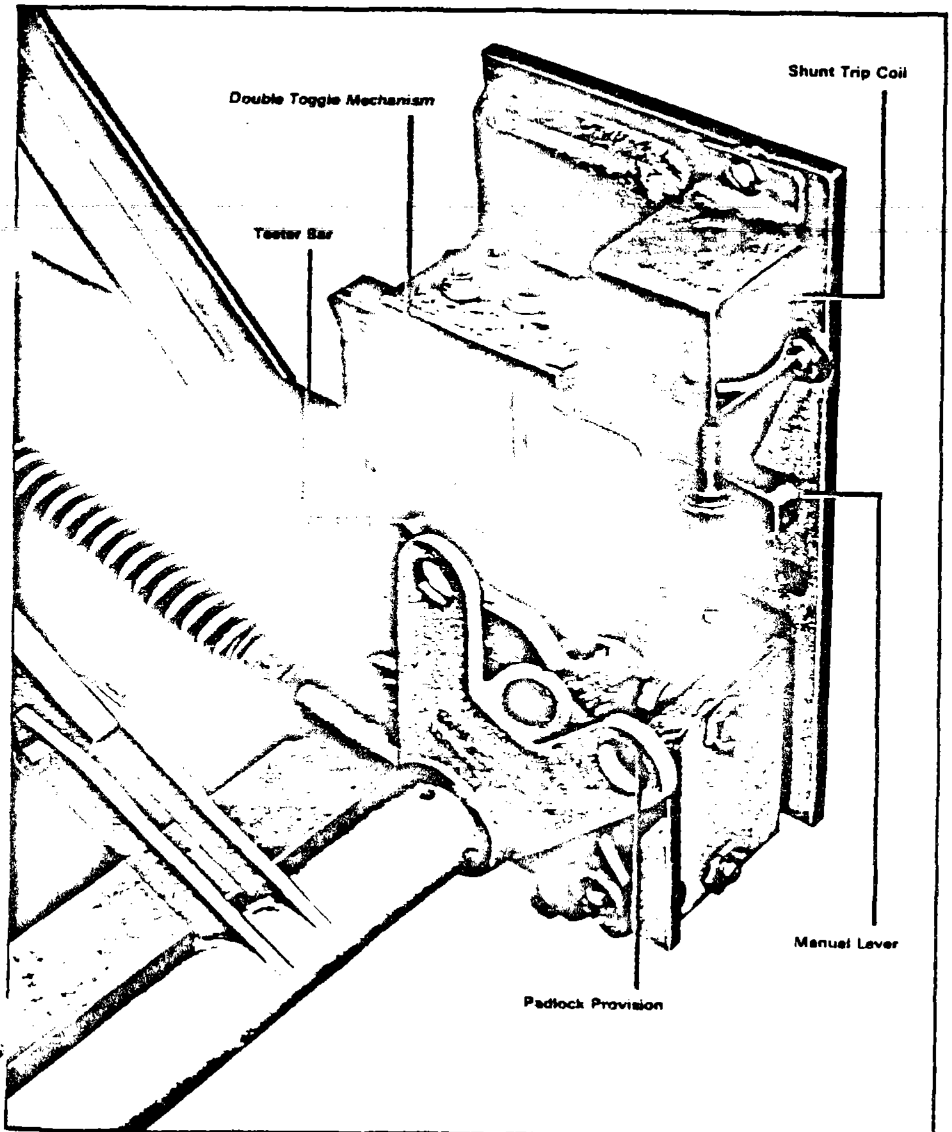


Figure 16

Access Door
An access door Fig. 18 to the switch operating mechanism can be provided for mounting on cabinet door. This door assembly can be used for either indoor or outdoor application. Drawing pertaining to cutout requirements for mounting may be found on page 5 of Technical Certification Section 36-573.

Test Data
Tests were performed on 5.0 kV through 34.5 kV 600 and 1200 ampere switches in accordance with NEMA STD SG6, ANSI C37-32 and Canadian Standard C105-1960. These certified tests are available upon request.

Pertinent data, such as interrupting capabilities, fault closing and momentary, are listed in Table on page 2. To further highlight the design features of the AWP, it is capable of interrupting magnetizing currents of transformer at low power factor, and at 23.0 kV, cable charging currents. This data is also available upon request.

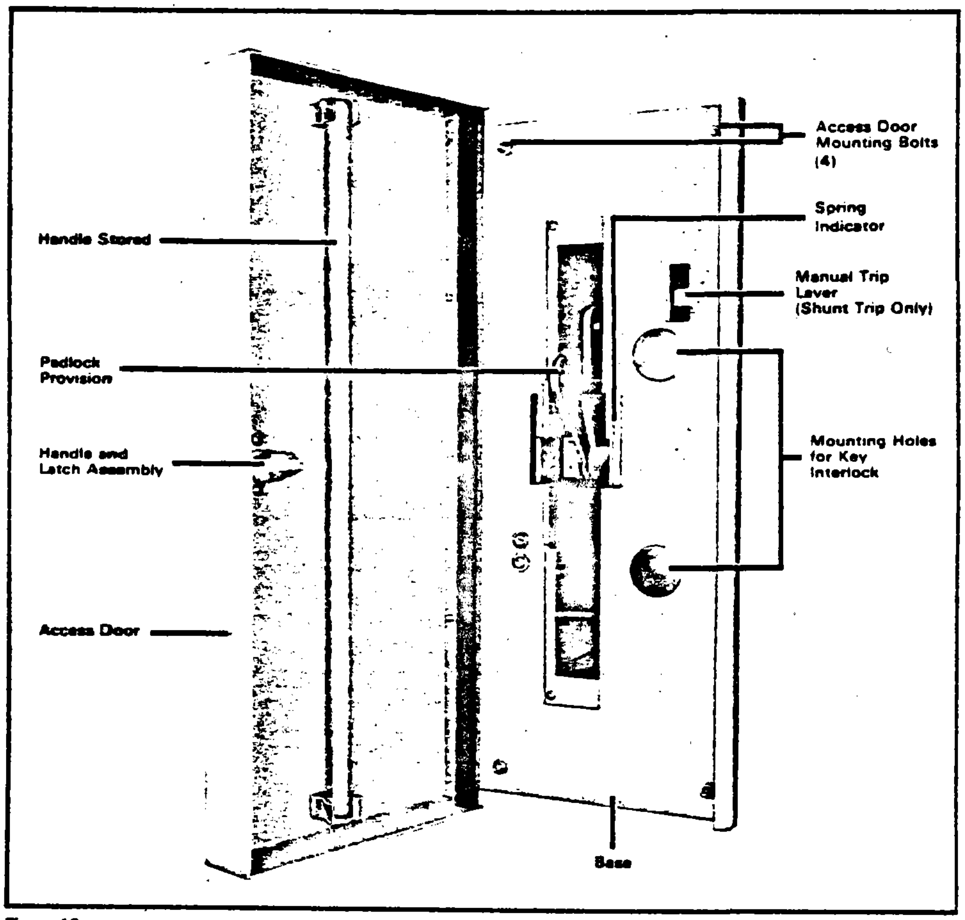


Figure 18

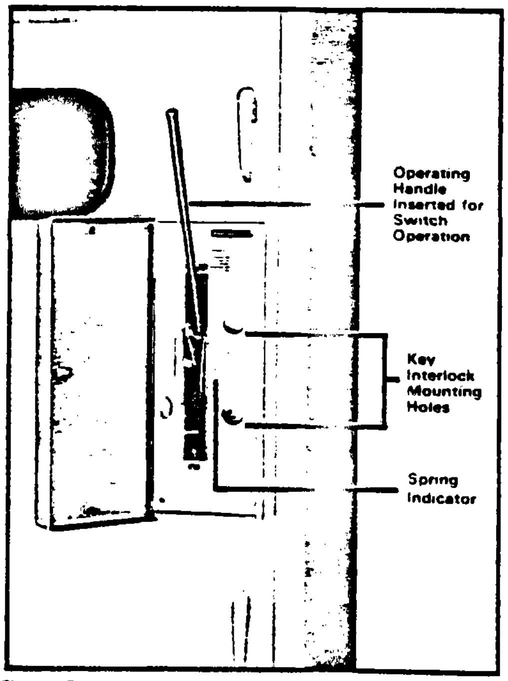


Figure 19

Enclosures

Enclosures for the type AWP switch are available for side operated, wall mounted, unfused units, Figure 19A, as well as the fused units which can be side or front operated, 5 kV through 15 kV. These enclosures are made of 11 gauge steel and are of bolted construction, Figure 20. All steel used in the enclosure is cleaned and phosphatized in preparation for painting. The paint used in standard production is light gray ANSI-61 for indoor applications and ANSI-70 for outdoor applications.

Each enclosure door contains a window through which the switch unit can be observed. The window is tempered reinforced glass which meets all applicable standards and is free floating in a rubber molding. (See Figure 20) The door of each enclosure is mounted on three (3) hinges and latches at three (3) points with two (2) handles, Figure 21.

Each enclosure door of the front operated unit is equipped with an access door through which the switch may be operated, Figure 20. Each enclosure door is equipped with a door interlock which prevents opening the enclosure door when the switch contacts are closed, Figure 21, and utilizes the open door interlock as described on page 6 under door interlock features.

All fuse mountings designed for use within the enclosed AWP switch are of the non-disconnect type.

Fuse units used in conjunction with these mountings can be either the RBA-200, 400, 800, CLE, CLE-1-2-3, CLT or CX, dependent upon the proper application.

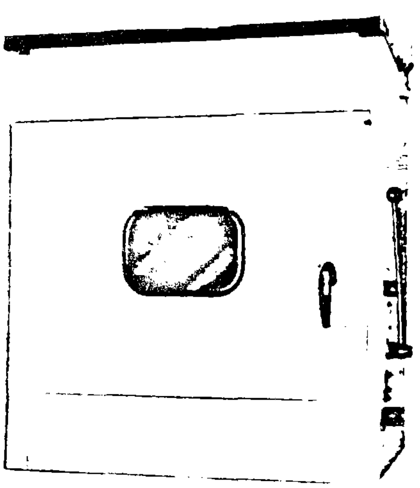


Figure 19A
Non-Fused Side Operated Enclosed Wall Mounted Switch

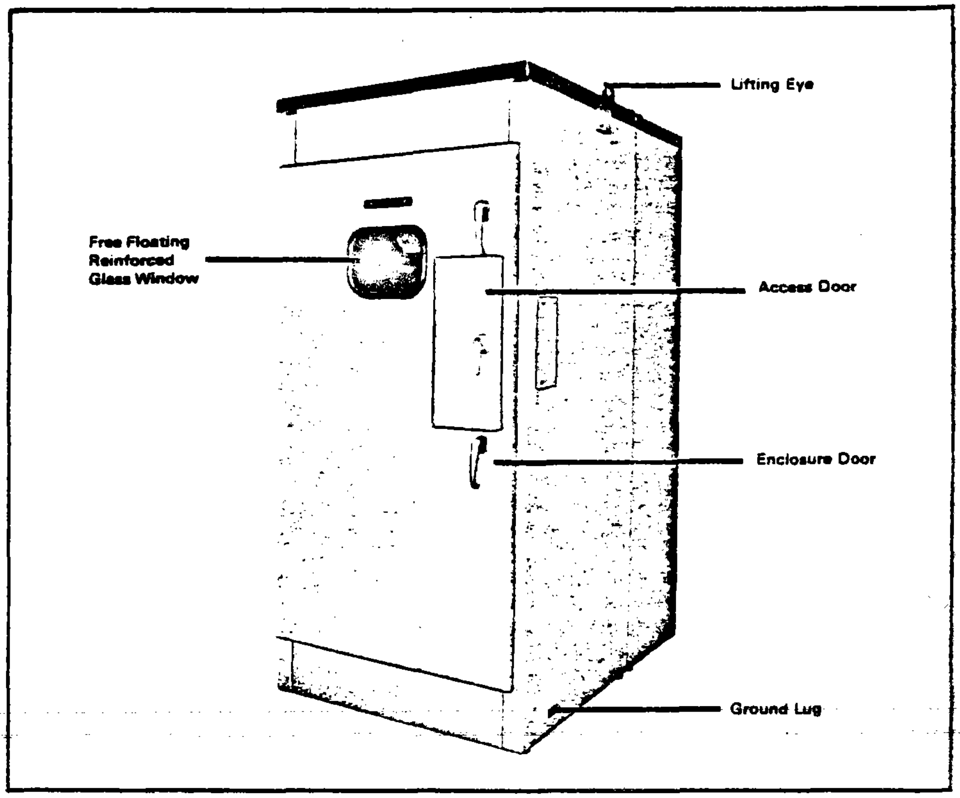


Figure 20

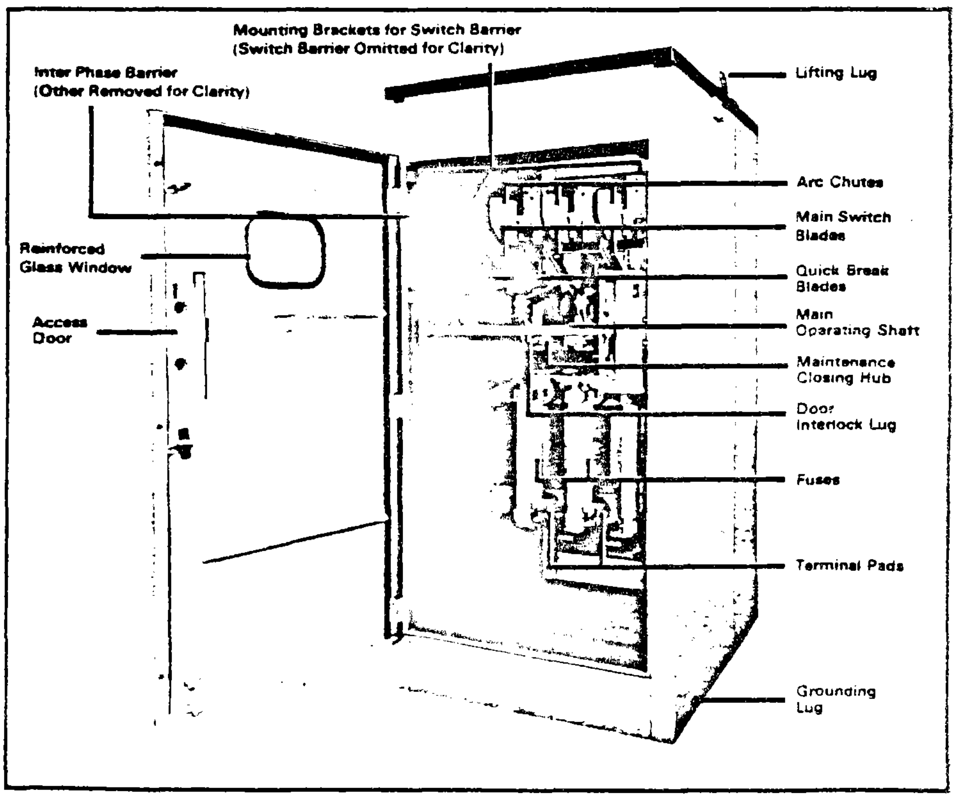


Figure 21

All enclosures which incorporate fuses have in their design a hinged shield over the switch compartment to prevent contact with the live parts while working in the fuse compartment. Figure 22.

Standard enclosures provide for cable entrance in the top and out the bottom. Conduit locations are identified for drilling purposes. When the requirement arises to have the cables in and out either the top or the bottom a module is added to the back of the switch. Figure 24, to provide space for rear connections. When the rear compartment is added, the rear panel of the standard enclosure is omitted to provide access to the rear compartment. These two compartments are shipped bolted together and may be separated, if desired for ease of installation of cable. Figure 24. Each compartment is equipped with lifting lugs bolted into place and which may be removed after installation.

AWP Switches 5.0 kV to 15.0 kV can be obtained in weatherproof and dust tight enclosures. The standard outdoor enclosure is supplied with a conduit adapter but roof bushings are available. Other equipment which can be mounted in the enclosure includes auxiliary switches and potheads. All enclosures are furnished with grounding lugs. Figure 21.

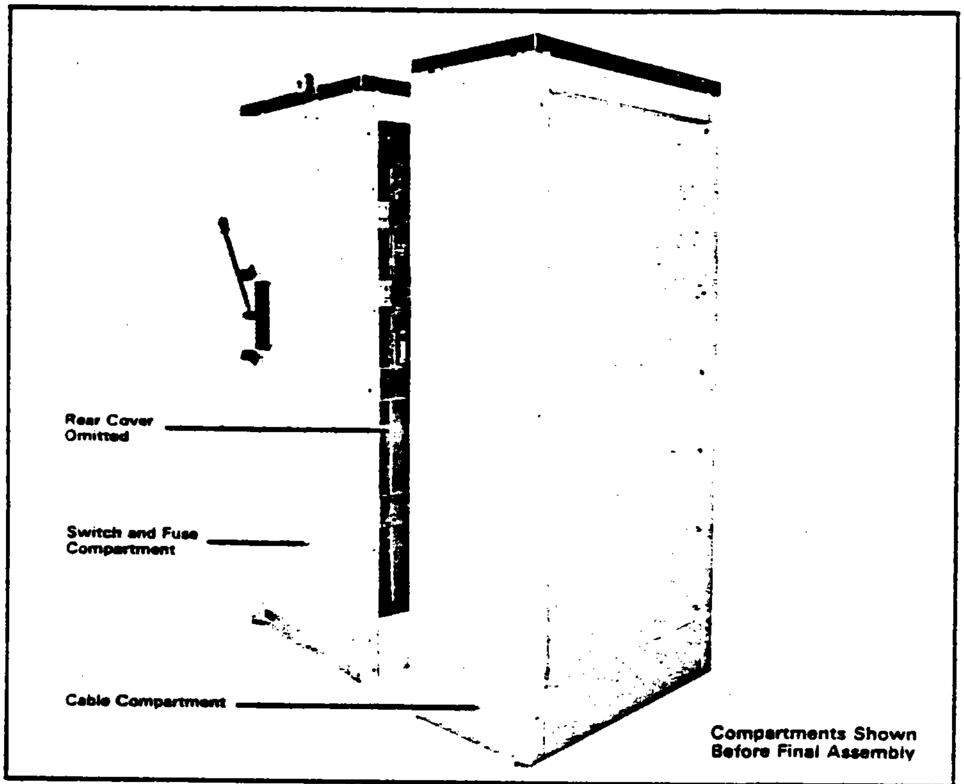


Figure 24

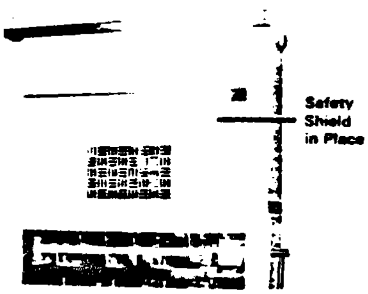


Figure 22

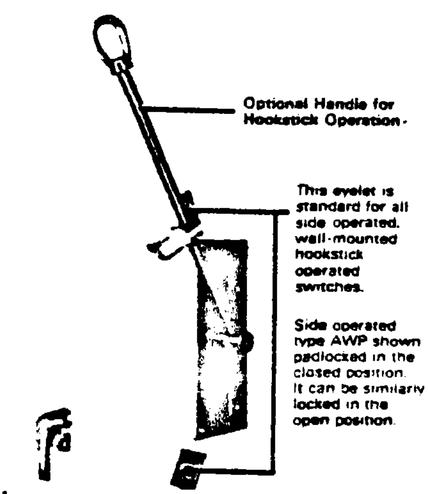


Figure 23

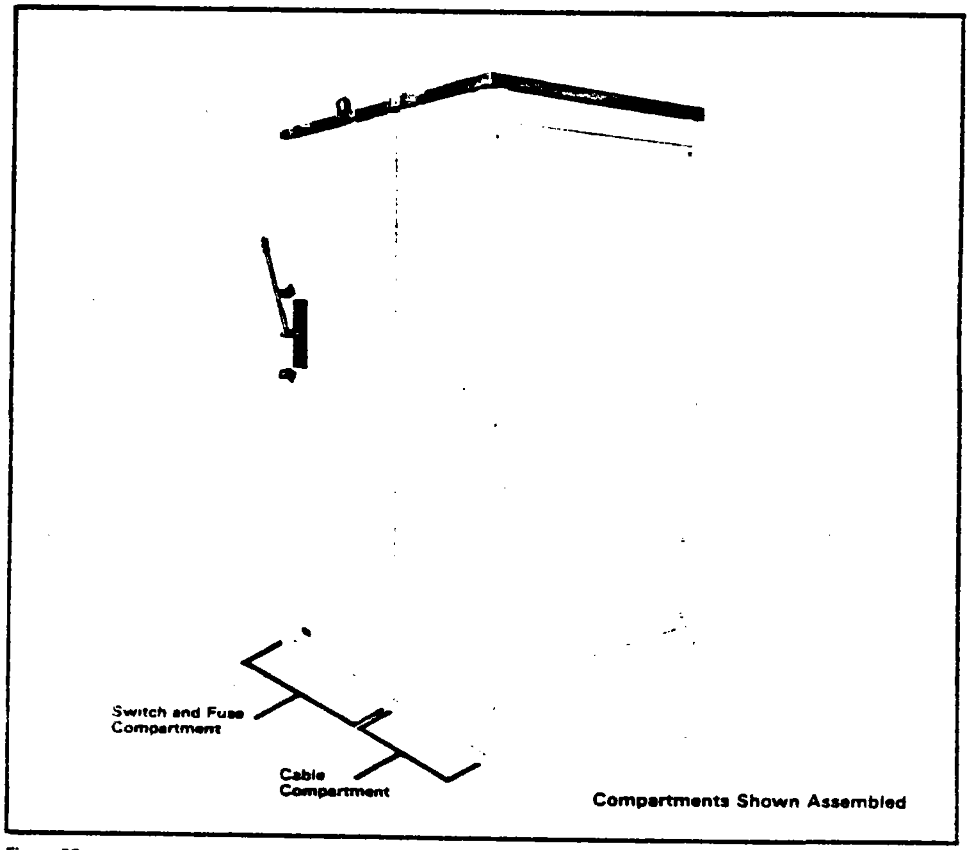


Figure 25

Outline Dimensions 5-15 kV Enclosures

UNFUSED — Side Operated Only

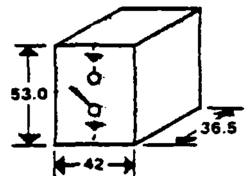


Figure 26
Cable In Top-Out Bottom

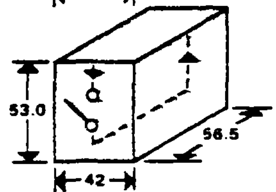


Figure 27
Cable In Top-Out Top

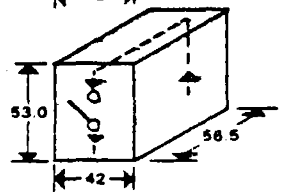


Figure 28
Cable In Bottom-Out Bottom

FUSED — Side or Front Operated

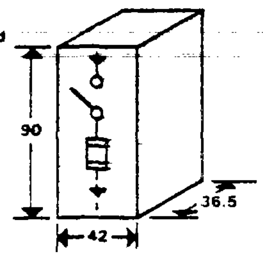


Figure 29
Cable In Top-Out Bottom

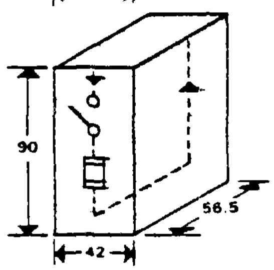


Figure 30
Cable In Top-Out Top

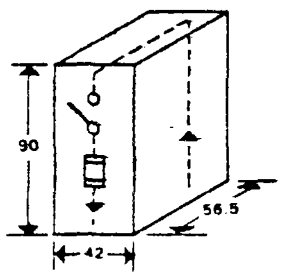


Figure 31
Cable In Bottom-Out Bottom

Front View

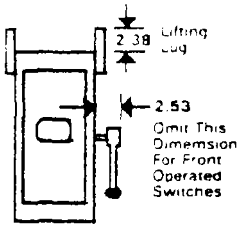
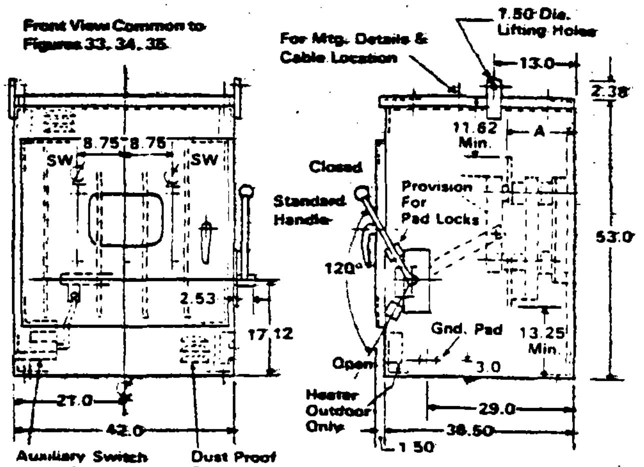
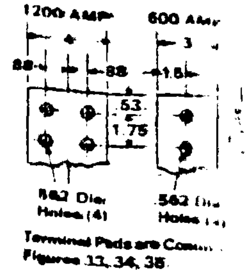


Figure 32

Indoor, Outdoor or Dust Proof Enclosure with Side Operated Mechanism

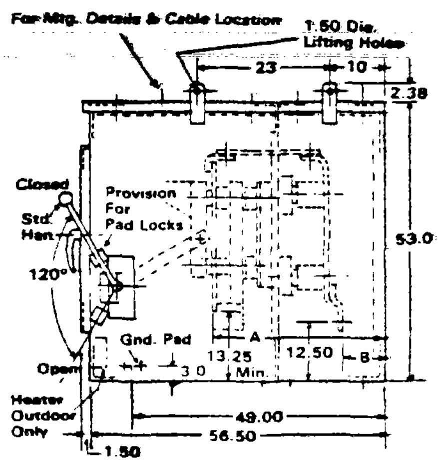
Figure 33 - Cable In Top - Out Bottom

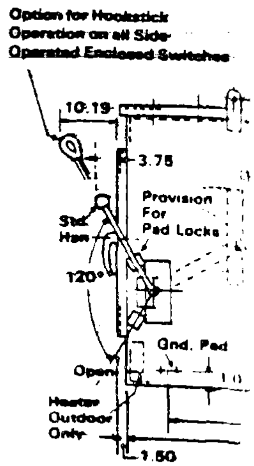




kV	A
5.0	9.75
7.5	12.25
15.0	12.25

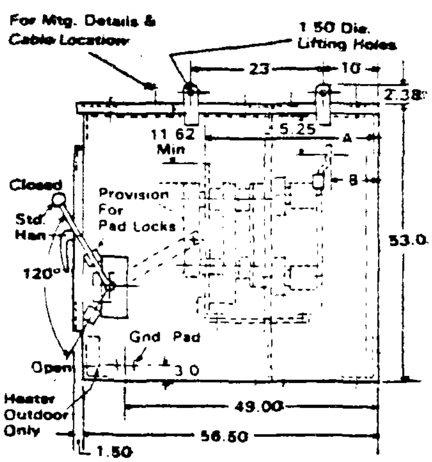
Figure 34 - Cable in Bottom—Out Bottom

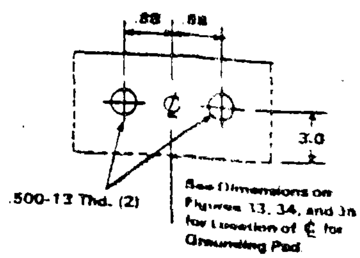




kV	A
5.0	29.75
7.5	32.28
15.0	32.28

Figure 35 - Cable in Top—Out Top





kV	A	B
5.0	29.75	12.12
7.5	32.28	8.62
15.0	32.28	8.62

Mounting Hole, Conduit Hole and Cable Hole Locations

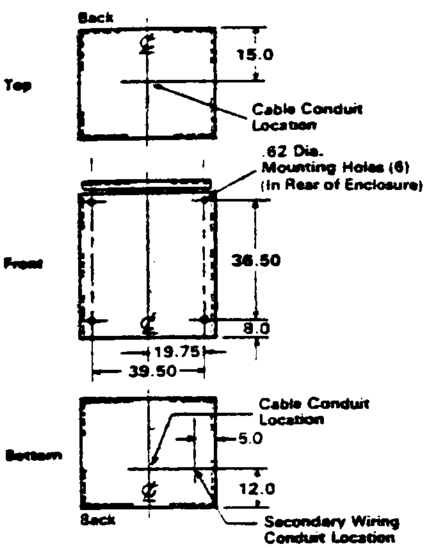


Figure 36
Wall Mounted - Unfused - Cable In Top - Out Bottom

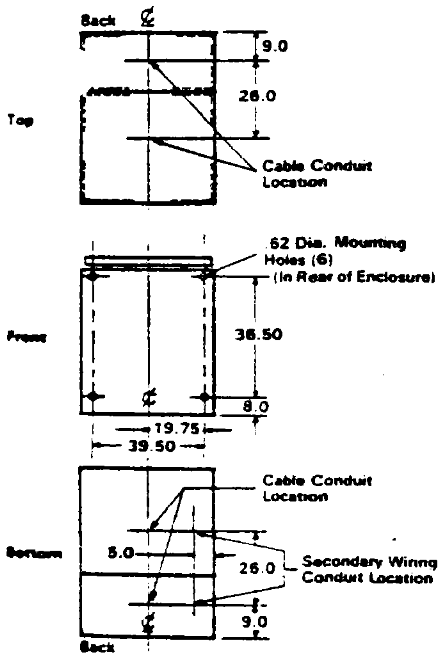


Figure 37
Wall Mounted - Unfused - With Rear Enclosure Cable In Top - Out Top or In Bottom - Out Bottom

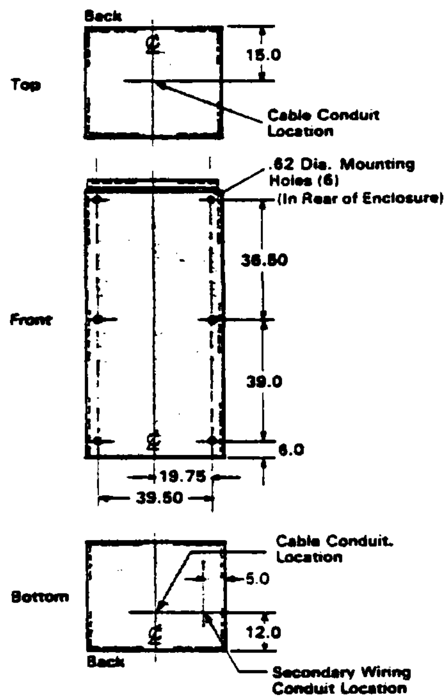


Figure 38
Wall Mounted - Fused - Without Rear Compartment Cable In Top - Out Bottom

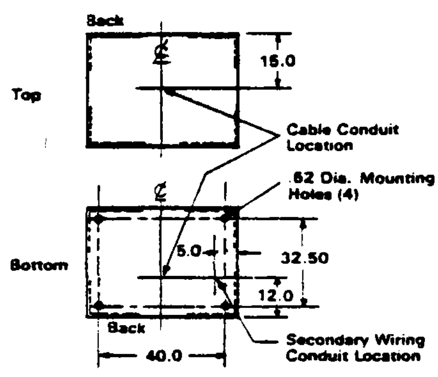


Figure 39
Floor Mounted - Fused - Without Rear Compartment Cable In Top - Out Bottom

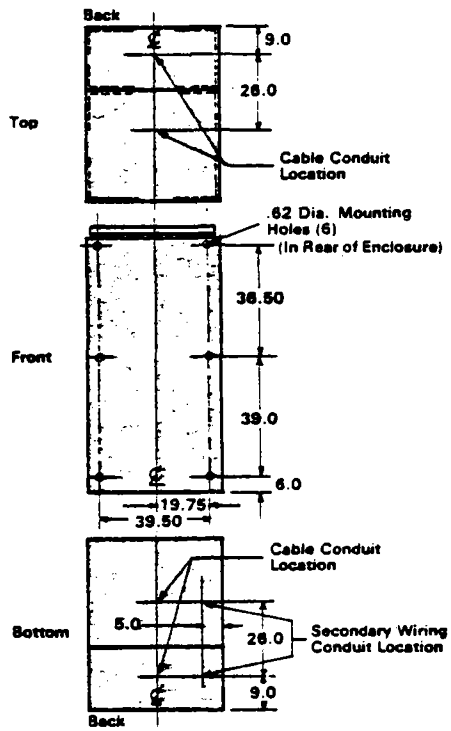


Figure 40
Wall Mounted - Fused - With Rear Compartment Cable In and Out Top or In and Out Bottom

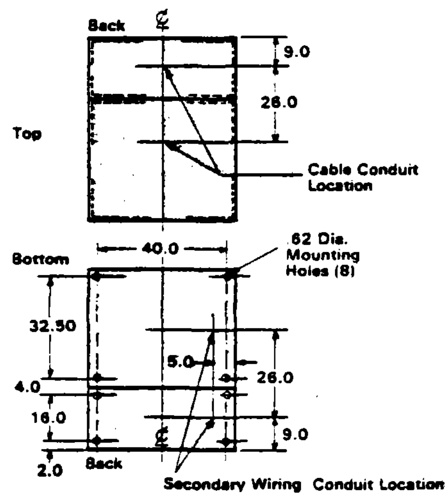


Figure 41
Floor Mounted - Fused - With Rear Compartment Cable In and Out Top or In and Out Bottom

Further Information
Price List 36-523, 36-524
[illegible] -573

Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, PA 15112

Standard AWP Load Interrupter Switch (Front and Side Operated)

Indoor, 2.4 Kv Through 13.8 Kv

Maximum Design Voltage	Nominal Voltage	BIL KV	Continuous Amps	Interrupting Current	Momentary 10Hz. Asym. Ka	Momentary 4 Sec. Sym. Ka	Fault Close Ka	Porcelain Insulators Style Number	Porcelain Insulators RAMAD	Porcelain Insulators List Price	Glass Polyester Insulators Style Number	Glass Polyester Insulators RAMAD	Glass Polyester Insulators List Price
Right Hand Front-Operated													
5.0	4.8	60	600	600	40	25	20	140D719G01	[illegible]950		6910D78G01	48293	
5.0	4.8	60	600	600	40	25	40	140D719G04	81990		6910D78G04	48303	
5.0	4.8	60	1200	600	80	38	61	140D720G01	81992		6910D79G01	48314	
5.0	4.8	60	1200	1200	80	38	61	140D721G01	42981		6910D80G01	48327	
Right Hand Side-Operated													
5.0	4.8	60	600	600	40	25	20	628F011G01	70093		568F556G01	70098	
5.0	4.8	60	600	600	40	25	40	628F011G04	70094		568F556G04	70099	
5.0	4.8	60	1200	600	80	38	61	628F012G01	70096		568F557G01	70105	
5.0	4.8	60	1200	1200	80	38	61	628F013G01	70097		568F558G01	70110	
Right Hand Front-Operated													
8.25	7.2	75	600	600	40	25	20	140D719G02	42982		NOT AVAILABLE		
8.25	7.2	75	600	600	40	25	40	140D719G05	42983				
8.25	7.2	75	1200	600	80	38	61	140D720G02	42984				
8.25	7.2	75	1200	1200	80	38	61	140D721G02	42985				
Right Hand Side-Operated													
8.25	7.2	75	600	600	40	25	20	628F011G02	70112		NOT AVAILABLE		
8.25	7.2	75	600	600	40	25	40	628F011G05	70116				
8.25	7.2	75	1200	600	80	38	61	628F012G02	70117				
8.25	7.2	75	1200	1200	80	38	61	628F013G02	70120				
Right Hand Front-Operated													
[illegible]	13.2	95	600	600	40	25	20	140D719G03	42986		6910D78G03	48340	
[illegible]	13.2	95	600	600	40	25	40	140D719G06	81991		6910D78G06	48362	
[illegible]	13.2	95	1200	600	80	38	40	140D720G03	42987		6910D79G03	48366	
[illegible]	13.2	95	1200	600	80	38	61	140D720G04	81993		6910D79G04	48394	
[illegible]	13.2	95	1200	1200	80	38	40	140D721G03	42988		6910D80G03	48395	
[illegible]	13.2	95	1200	1200	80	38	61	140D721G04	43326		6910D80G04	48401	
Right Hand Side-Operated													
[illegible]	13.2	95	600	600	40	25	20	628F011G03	70121		568F556G03	70139	
[illegible]	13.2	95	600	600	40	25	40	628F011G06	70122		568F556G06	70142	
[illegible]	13.2	95	1200	600	80	38	40	628F012G03	70123		568F557G03	70145	
[illegible]	13.2	95	1200	600	80	38	61	628F012G04	70124		568F557G04	70161	
[illegible]	13.2	95	1200	1200	80	38	40	628F013G03	70125		568F558G03	70162	
[illegible]	13.2	95	1200	1200	80	38	61	628F013G04	70135		568F558G04	70163	

Accessories For Front Operated Switches

- Shunt Trip Mechanism (Check East Pittsburgh for Availability) ④ ......
- Auxiliary Switch ④ ......
- Operation Counter ④ ......
- Inverted Switch Operation ④ ......
- Provision for Kirk Key Interlock (Order Style 140D441G04) ③ ......
- Access Door Assembly
- Standard Door (Order Style 140D884G01) ③ ......
- Door with Handle Lock (Order Style 140D884G02) ③ ......

① Fault closing tests done at maximum voltage rating and without any protective fusing.
② Stocked (order on W-39).
③ Not stocked (order on W-13).
④ Order by description on Y3.
⑤ This price addition for the stored energy switch includes the special electrical manual stored energy mechanism with shunt trip and two auxiliary switches. (See TCS 36-73, pages 3-5.)
⑥ Suitable for lock-type FNOE.
⑦ Switch provided with provisions for Kirk Key Lock Type B with 1" projection.
⑧ Switch provided with hasps for padlocking handle.

Prices Include:
Three pole, single throw, front connected, group-operated AWP switch with pole units, barriers and manual operating mechanism on a common frame. Prices do not include terminal connectors. Terminal connectors can be ordered by referring to DB 34-350 and Price List 34-320.

Ordering Information
When ordering switch that is carried in W-39 stock, order by style number. Switches not carried in stock order on W-19 by Style Number – 6 to 8 weeks delivery.

Shipment
Obtain shipment quotation on all non-stock items from Switchgear Division, Component Sales, East Pittsburgh, Pa.

Instructions for Type AWP Load Interrupter Switch

1. GENERAL

The Type AWP Interrupter Switch is a coordinated 3-pole assembly which combines the function of a disconnect switch with the ability to interrupt load and magnetizing currents. It also has a fault closing capacity which enables it to be closed against a short circuit without sustaining significant damage, after the fault has been cleared by suitable protective equipment, the switch can subsequently remain in service. Its performance satisfies all requirements of ANSI Standard Specification C37.32. The Type AWP Switch differs from a circuit breaker in that it does not have a fault breaking capacity and that its operation is not automatic. The Type AWP Switch is designed for operation in a proper metal enclosure with or without fuses.

Caution: **It is NOT SAFE to operate the switch outside an enclosure unless equivalent protection has been provided for the operating personnel.**

2. DESCRIPTION

The Type AWP Switch is comprised of the following basic components:

2.1 Frame

A frame for 3 blade assemblies and operating mechanism.

2.2 Main Blades and Jaws

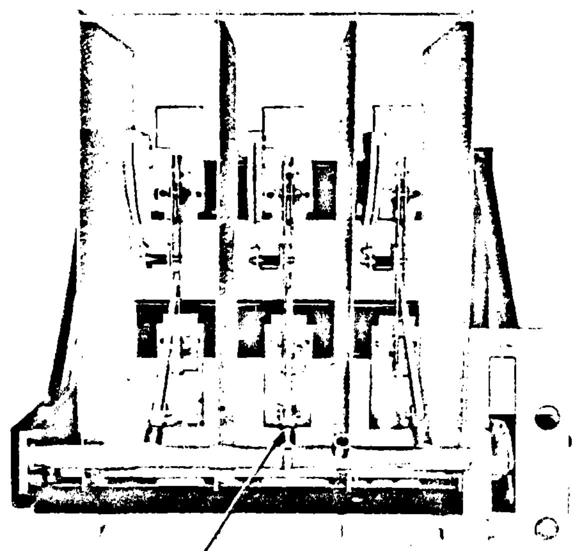
The main contacts, break and hinge end, are hard drawn copper. For 40 KA and 61 KA fault closing, the break jaw is provided with a copper tungsten arcing tip. The blades are also hard drawn copper and copper tungsten arc buttons are provided for the 40 KA and 61 KA ratings.

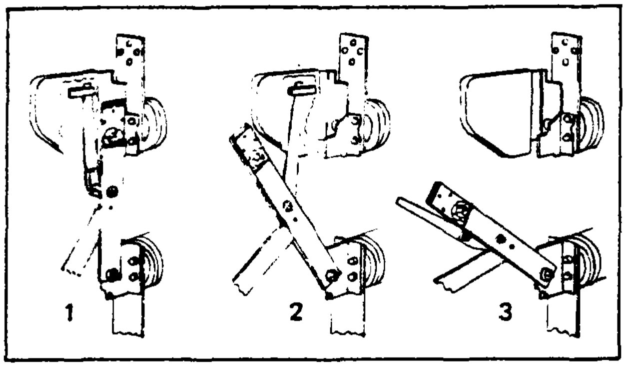
2.3 Load Interrupter

It consists of a Flicker Blade and engaging contact fingers located inside a De-ion® arc chute. On opening of the switch the main blades open first which shunts the current through the spring loaded flicker blades. Further travel of the main blades causes the flicker blades to snap out of their contact fingers and arcs are drawn within the De-ion arc chutes. Positive arc interruption is accomplished by the de-ionizing action of the arc chutes in combination with the high opening speed of the spring loaded flicker blades.

2.4 Operating Mechanism

The main blade quick-make, quick-break mechanism is a compression spring operated by a rod connected to the spring lever which in turn is attached to the switch shaft. To close the switch, a removable handle is inserted into the handle casting which is then rotated through an angle of 120°. This charges the compression spring and as the spring lever goes over toggle the stored energy of the spring is transferred to the shaft which snaps the switch closed. The mechanism is operated similarly for opening of the switch. This quick make mechanism provides the power to overcome blow-out forces which occur when the switch is closed against a fault. However, these forces are not transmitted to the operating handle since it is not rigidly connected with the blades. Therefore it is SAFE to close the switch under short circuit conditions within its rating.





De-ion Quick-break Operation

1. Switch closed . . . When the switch is closed, practically all the current flows through the main blade.

2. Main blade opens . . . As the main contacts separate, current is transferred momentarily through the flicker blade, which is held in the arc chute by high pressure contact fingers.

The main blade opens until the stop on the flicker blade hinge prevents further angular movement between the main and flicker blades. This starts the flicker blade out of the high pressure contacts in the arc chamber.

3. Switch opened . . . The combined pull of the torsional spring in the flicker blade and the main blade operating mechanism snaps the flicker blade into the open position at high speed. The heat of the arc, meanwhile, releases a blast of de-ionizing gas from the gas-generating material of the arc chamber. This combination of quick-break and De-ion action quickly extinguishes the arc and the circuit is safely de-energized.

2.5 Ratings - ANSI - Approved

KV Rating		Amp Rating				
			Interrupting		Asym. Rating	
Max.	B.I.L.	Continuous	Load	Mag.	Fault Closing	10 Cycle Momentary
4.76	60	600	600	60	20 KA	40,000
4.76	60	600	600	60	40 KA	40,000
4.76	60	1200	600	60	61 KA	80,000
4.76	60	1200	1200	60	61 KA	80,000
8.25	75	600	600	60	20 KA	40,000
8.25	75	600	600	60	40 KA	40,000
8.25	75	1200	600	60	61 KA	80,000
8.25	75	1200	1200	60	61 KA	80,000
15.0	95	600	600	60	20 KA	40,000
15.0	95	600	600	60	40 KA	40,000
15.0	95	1200	600	60	40 KA	80,000
15.0	95	1200	1200	60	40 KA	80,000
15.0	95	1200	600	60	61 KA	80,000
15.0	95	1200	1200	60	61 KA	80,000

3. INSTALLATION

3.1 Storage and Handling

These units should remain in their packing cases until ready to install. They should be completely protected from weather, building dirt, cement dust and the like. Reasonable care is necessary when unpacking to prevent damage. All dust and packing material should be cleaned from the interrupting chambers, contacts, and insulators.

When welding, sanding, drilling, filing or sawing operations are performed nearby, the contacts, interrupting chambers, insulators and mechanism parts should be covered and kept clean.

3.2 Mounting

Four holes 9/16" diameter for 1/2" bolts are provided in the base of the frame for mounting of the switch in the enclosure. This enclosure must have a slot in its front door as shown on the template drawing of Fig. 4, to clear the mechanism cam when it is rotated with the removable handle. The recommended distance between the front door and the front of the switch frame is .125 to .250 inches.

3.3 Power Connections

The hinge and jaw terminal pads, with standard NEMA drilling, are suitable for connection to flat bus bar runs.

3.4 Interlocks (See Fig. 15)

Each switch is equipped with two automatic interlocks as follows:

A. Door Interlock

The switch shaft is equipped with a hook which engages a hasp supplied by the enclosure manufacturer and welded to the back of the enclosure door so that the door cannot be opened when the switch is closed.

B. Door Operated Interlock

When the enclosure door is opened, a spring biased interlock link is moved into position, blocking rotation of the mechanism cam and preventing the switch from being inadvertently closed while the enclosure door is open.

Each switch is also equipped with the following facilities for non-automatic interlocking:

C. Padlocking

The mechanism cam has lugs permitting the switch to be padlocked in the open and/or closed positions. See Fig. 13.

D. Key Interlocks See Figure 15

a. A key interlock can be bolted to the mechanism cover plate. The switch can be locked in the open and/or closed positions.

b. Another lock can also be provided on the mechanism cover plate to lock the switch in its open position.

3.5 Adjustment

Each switch is completely factory adjusted and operated 25 times before shipment. No further adjustment should be necessary. However, in order to ensure that the adjustment has not been affected in transit or during installation, it is recommended that each switch be inspected after installation in the enclosure and before it is put into service as follows:

(a) Main and flicker blades should be in proper alignment with jaws and arc chute openings, respectively. See Fig. 8.

(b) Closed and open stops should be as follows:

Closed - The shaft rod ends should be slightly over toggle.

Open - The distance between the edge of the main blade and the break jaw should be 6-5/8" ± 1/8".

(c) Upper spacers of main blades should rest approximately 3/16" above the bottom in the depressions of the angular switch jaws.

(d) Hardware must not be loose.

(e) Automatic and non-automatic interlocks should operate correctly.

(f) Arc chute and insulating surfaces should be free from dust.

If the inspection revealed some defects in adjustment, this should be corrected as outlined in paragraph 4.2.

Caution Note: **After the switch adjustment has been found (or made) satisfactory, the switch should be closed and opened at least three times with the quick-make, quick-break mechanism before it is energized.**

4. MAINTENANCE

Note: **The switch must be de-energized before any maintenance is attempted.**

4.1 Inspection Schedule

It is recommended that each switch be inspected after 24 months of service or after approximately 100 rated current interruptions, whichever occurs first. When the current interrupted is smaller than rated, the duty is proportionally lighter and more operations may be allowed before inspection. After the switch has been closed against a fault current, it should be inspected at the first opportunity at which it can be de-energized. Inspections should be conducted as listed in paragraphs 3.5(a) to 3.5(g). In addition, it is desirable to check the following: See 4.2(h) Regarding Safety Latch.

(a) Check main blade contact pieces and the leading edges of the flicker blades for arc erosion.

(b) Check the engagement of the flicker blades by inserting the handle in the handle casting and closing the switch. Now, insert the handle in the blade alignment hub on the shaft and slowly open the switch. The flicker blade should remain engaged in their contact fingers while the main blades open. When the main blades clear the break jaws, they will hit the stop on the flicker blade brackets and start the flicker blades out of their contact fingers. The flicker blades will then snap open from the forces in their charged torsional coil springs.

(c) Check barriers for carbon or metallic deposits. Replace the barriers if deposits appear excessive.

(d) Inspect arc chute sides and replace them if they are damaged.

(e) Replace worn or damaged parts of the flicker blade assembly. Arc chute must be dismantled in order to examine condition.

(f) After a fault closing operation it may be necessary to clean up the arcing contacts. This may be done with a few light strokes of a fine file. It is only necessary to remove sharp and high points; no attempts should be made to file out the pit marks. DO NOT USE abrasive material for cleaning.

(g) Close and open the de-energized switch at least three times to check the performance of the operating mechanism.

Note: **The main current carrying contacts should not be filed. Opening and closing of the switch will clean the contacts. However, if there is evidence of excessive burning, the main blade and hinge assembly together with the break jaw should be replaced.**

4.2 Alignment Procedure

Note: **The switch must be completely DE-ENERGIZED before any attempt to align the switch is made. See paragraph (h) for procedure to override the safety latch.**

(a) Closed-open Stop Alignment

Remove the operating mechanism safety barrier by lossening the two front bolts on the right side, slide the barrier forward to clear the handle casting, then push it to the left until the stop bolts are exposed. The top bolt and nut adjusts the open position and the bottom bolt and nut adjusts the close position. In the closed position, the shaft rod ends should be slightly over toggle (5^{o}). In the open position the clearance between the edge of the main blade and the break jaw should be 6-5/8 ± 1/8 inch.

(b) Main Blade Alignment

Loosen the four hinge terminal bolts on top of the insulator. Loosen the two break jaw terminal bolts on top of the insulator. Insert the removable handle in the blade alignment hub on the shaft and close the switch. For safety purposes, the switch will not fully close and will revert to the open position if the pressure on the handle is released. Hold the switch in the closed position with the handle and tighten up the bolts on both the hinge and jaw terminals. An alternative to this method is to remove the drive rod from the rod end as described in paragraph (d) and align each pole separately by closing and opening the pole with the drive rod.

(c) Flicker Blade and Arc Chute Alignment

Loosen the two arc chute mounting bolts. Adjust the arc chute so that the arc chute opening is parallel to the main blade. Lightly tighten the arc chute mounting bolts. Using the procedure described in (b) slowly close the switch and check that the flicker blade is in line with the arc chute opening. If necessary, move the arc chute left or right until the flicker blade and arc chute line up. Tighten the arc chute mounting bolts and re-check the alignment.

(d) Over or Under Travel of Main Blades

Close the switch by inserting the removal handle in the handle casting and push in an upward motion until the stored energy spring lever goes over toggle and the switch slams closed. Check that the upper spacers of the main blades are approximately 3/16" above the bottom of the break jaw blade stop. If it is not, remove the pin holding the drive rod to the shaft rod end. Loosen the pal nut on the rod end and turn the rod end clockwise into the shaft assembly to decrease the travel or counter-clockwise to increase the travel. Insert the pin thru the rod end and drive rod and check for proper setting. When proper setting is obtained, tighten the nut on the rod end, insert the cotter pin and spread the cotter pin.

(e) Flicker Blade Replacement

To change a flicker blade, remove the two bolts holding the flicker blade to the flicker blade bracket. The switch must be in the open position. Remove the worn blade and replace with a new blade. Replace the two bolts and tighten the nuts.

To change a complete flicker blade assembly, remove the elastic stop nut from the bolt holding the assembly to the main blade. Using a box wrench or similar tool, hook the hole in the wrench over the torsion spring end and pull slightly forward and to the left until the spring end clears the stop post. Remove the wrench and pull out the bolt. The flicker blade assembly is now free. To install a new assembly, reverse the procedure. Be sure the spacer between the two copper bars making up the main blade is still there. Tighten the stop nut only enough to eliminate any wobbling of the assembly. Before the torsion spring is placed behind the stop post, a sideward movement of a 1/16" should be present. Too much tightening will decrease this movement and cause friction which will slow down the action of the flicker blade. Using the same procedure for releasing the torsion spring end, put the spring end on the other side of the stop post.

(f) Stored Energy Spring

To dis-engage the stored energy spring, remove the safety barrier as instructed in (a). Take a 5/16-18 threaded rod 4" long and screw it into the rear end of the spring rod. Make a spacer 1.5" long from a pipe or tube with a 1.0" I.D. Put this over the 5/16" rod. Take a washer with an O.D. as large or larger as the O.D. of the spacer and with a clearance hole for the 5/16" rod and place this on the rod.

Run a 5/16-18 nut down the rod and center the spacer. Now tighten the nut until the tension on the pin at the front of the spring rod is released. Remove the washers holding the pin in and remove the pin. The spring assembly is now free from the shaft. To completely remove the spring assembly, remove the two bolts holding the L-shaped bracket to the side of the frame. To re-install the assembly, or to re-engage the spring rod, reverse the procedure.

(g) Shaft Bearings

To replace the shaft bearings, dis-engage the stored energy spring rod as instructed in paragraph (f). Remove the drive rods from the rod ends as instructed in paragraph (d). Remove the operating mechanism safety barrier as instructed in paragraph (a). Remove the four bolts on right side (front) and the two bolts on the left side (front). Loosen the two bolts holding the L-shaped bar to the bottom and sides of the frame. Slide the shaft and end brackets forward and out. The bearings can now be removed and replaced. To replace the shaft, slide the shaft and end brackets back into the frame. Install the four bolts on the right side and the two bolts on the left side. Tighten the bolts. (Don't forget to slide the operating mechanism safety barrier under the right two front bolts). Take a large clamp and put across the sides of the frame, preferably in line with the shaft and tighten the clamp. Now tighten the two bolts holding the L-shaped bar to the bottom and sides of the frame. Remove the clamp. Replace the drive rods and stored energy spring-rod.

(h) Safety Latch

To close the switch with the door open, the safety latch must be dis-engaged. To do this, install the handle in the handle casting and push the handle upward and at the same time, push the latch on the left side of the safety barrier downward until the butterfly on the handle casting clears the locking pin. The same procedure should be used in opening the switch except the handle would by pushed downward. This procedure must be used any time the quick-make, quick-break feature is used with the door open. It is *not* necessary to use this procedure when using the blade alignment hub for slow close or slow open.

(i) Completing Alignment

After completing any alignment, the switch should be operated thru at least three "close-open" operations to insure proper performance of the operating mechanism.

(j) Main Blade, Jaw and Hinge Assembly

Disconnect the drive rod from the shaft rod end as instructed in paragraph (d). Remove the four bolts holding the Hinge Assembly and terminal pad to the top of the insulator. The hinge, main blade and flicker blade are now free. Remove the two bolts holding the jaw to the insulator. Remove the jaw and replace with a new jaw. Replace and finger tighten the two bolts. If the new hinge and blade assembly is equipped with a flicker blade assembly, mount the hinge on top of the terminal pad and install the four bolts finger tight. If the new hinge and blade assembly does not have the flicker blade assembly, remove from the old assembly and install on the new assembly per paragraph (e.). Tighten the lock nut on the spring washer on the jaw end of the blade. When it is as tight as possible (using standard tools) back the nut off 1/4 turn. Set the main blade to an open position of approximately 45°. The weight of the blade should let the blade fall slowly open. If the blade fails to fall open, loosen the lock nut on the hinge spring washer until the blade slowly falls open. If the blade falls too fast, tighten the lock nut. Now align the blade per paragraph (b). Tighten the jaw and hinge mounting bolts. Align the flicker blade and arc chute per paragraph (c). Re-check alignments, if satisfactory, connect drive rod to shaft rod end. Check the switch for over or under travel per paragraph (d). Perform operations per paragraph (i).

SWITCH PUSH ROD ADJUSTMENT FEATURE

Refer to Illustration on page 11.

The main shaft was redesigned to provide a simpler means of achieving the necessary switch push rod adjustment (as described in 4.2 (d)). The screw type rod end has been replaced by two fixed arms (1) which are welded to the main shaft. These arms have suitable slots (2) to provide the necessary length adjustment to the push rod (3) with the switch in the closed position. Disposed between these arms is the push rod which is free to pivot on a special pivot pin (4), the ends of which have a hardened contour to provide a sharp knife edge, so that when the clamping hardware (5) is tightened the pin is securely fixed to the shaft arms. The push rod, however, is still free to rotate about the axis of the pivot pin.

Therefore, the switch blade can be adjusted to its correct setting with the clamping hardware (5) loose, thus allowing the special pivot pin (4) to move in the arm slots. When the correct blade setting is obtained the clamping hardware is tightened (35-40 ft. lbs.) and locked. If found necessary, further adjustment can be made by loosening and moving the special pivot pin and retightening.

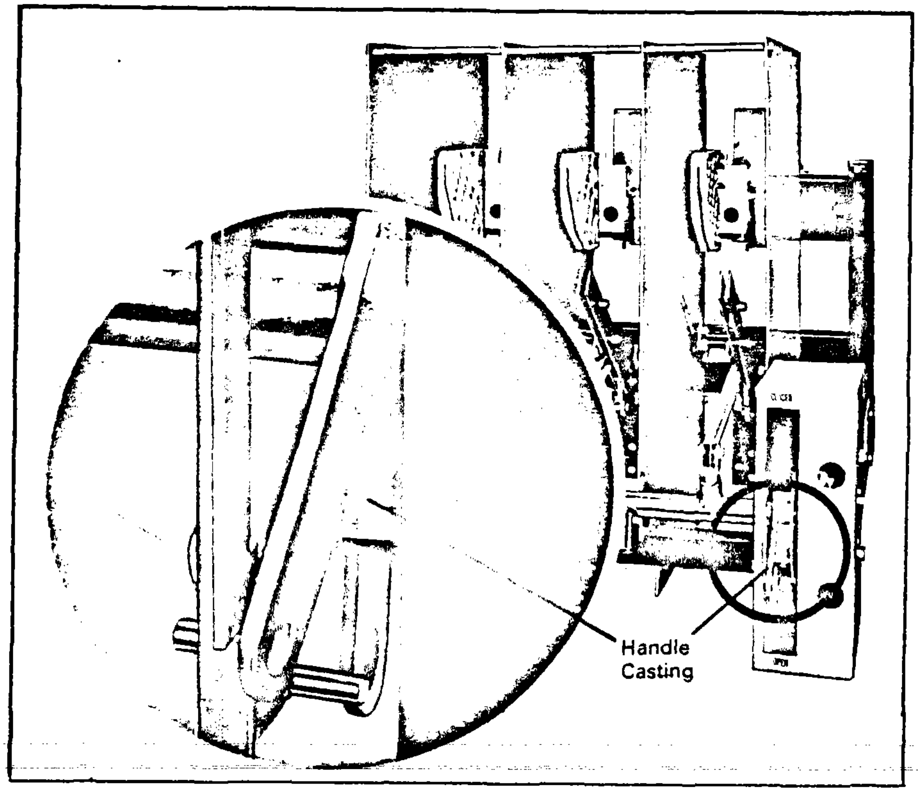


Fig. 1

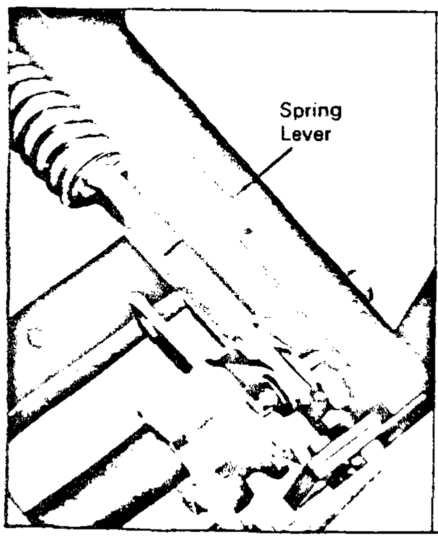


Fig. 2

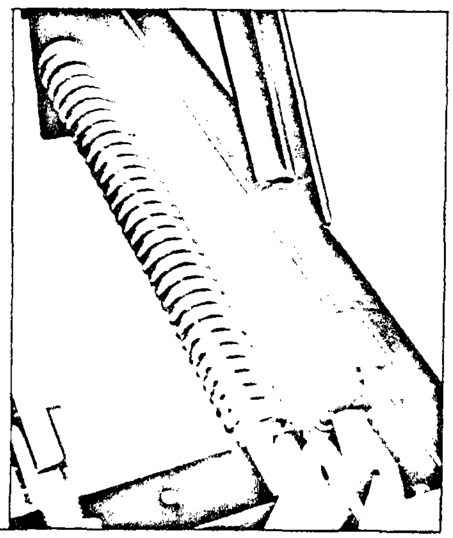


Fig. 3

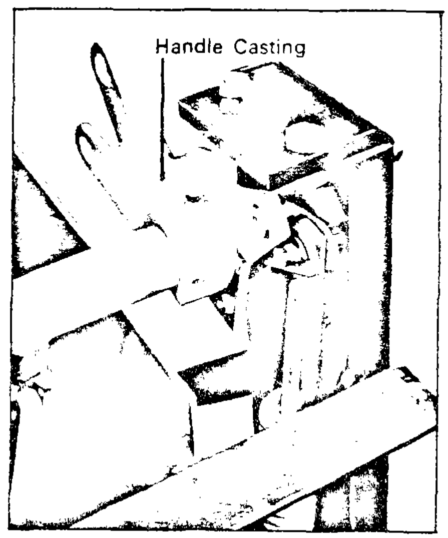


Fig. 4

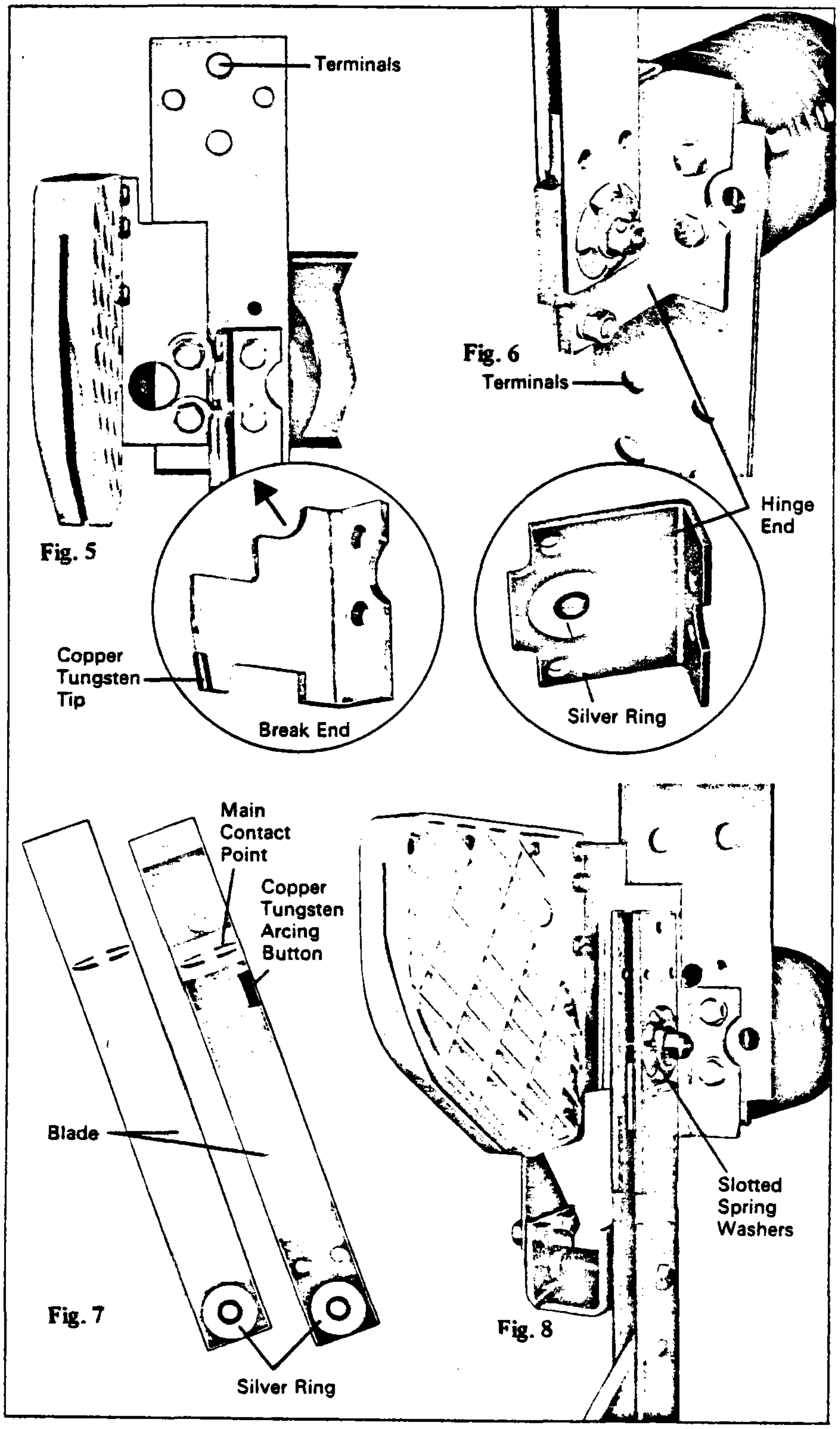


Fig. 5

Fig. 6

Fig. 7

Fig. 8

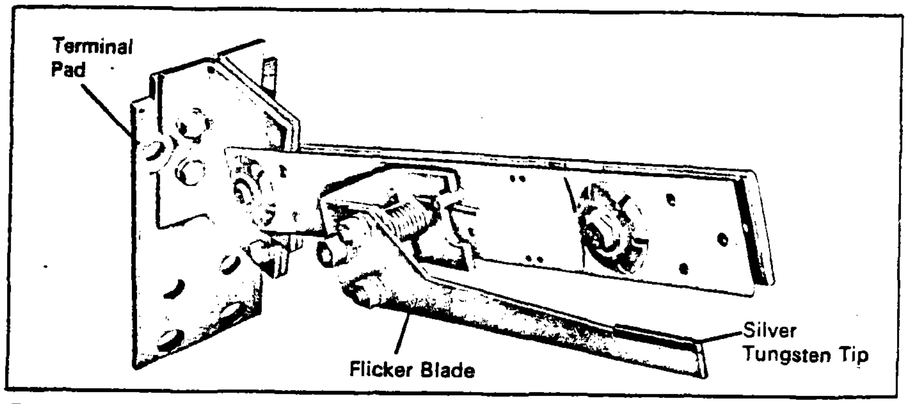


Fig. 9

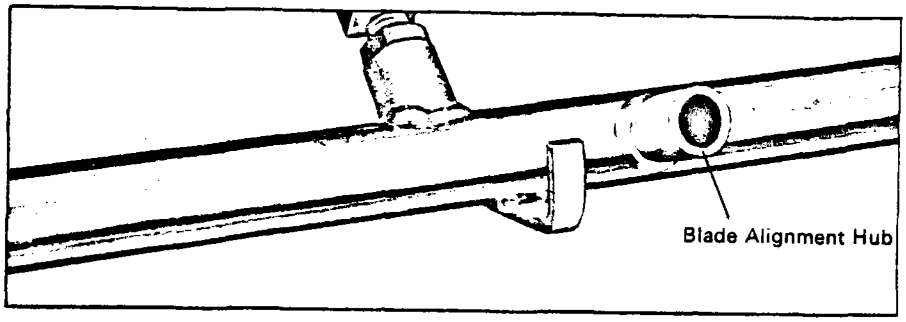


Fig. 10

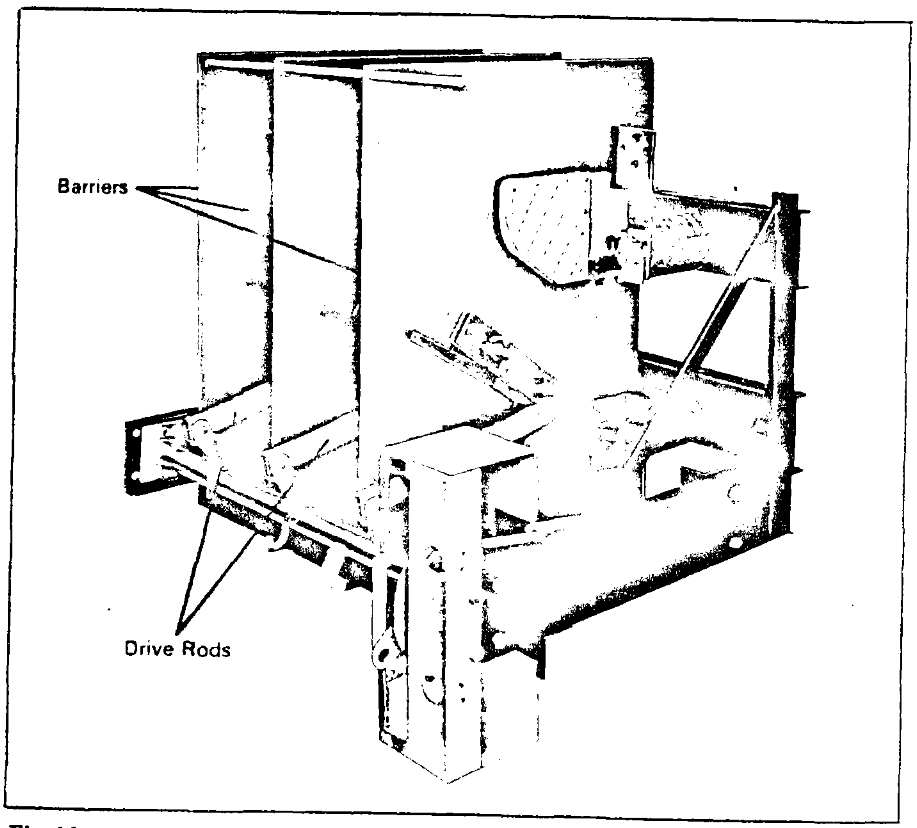


Fig. 11

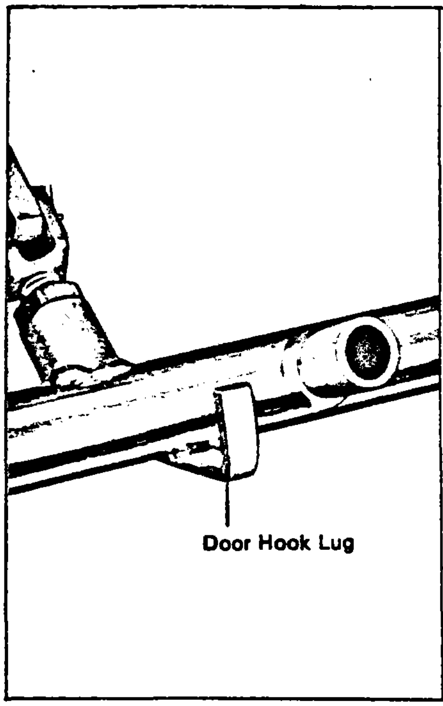


Fig. 12

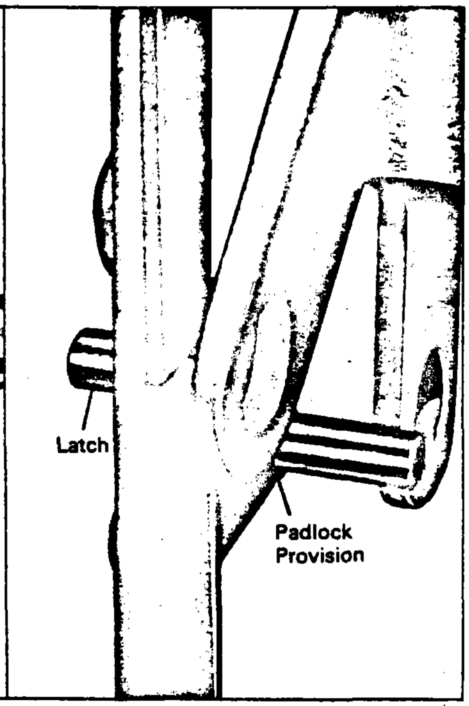


Fig. 13

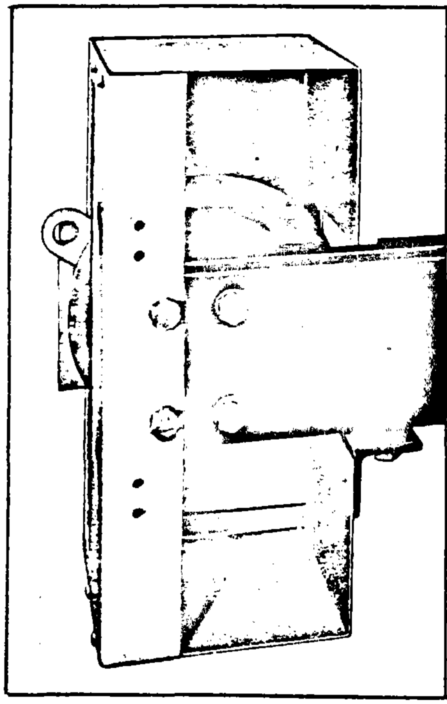


Fig. 14

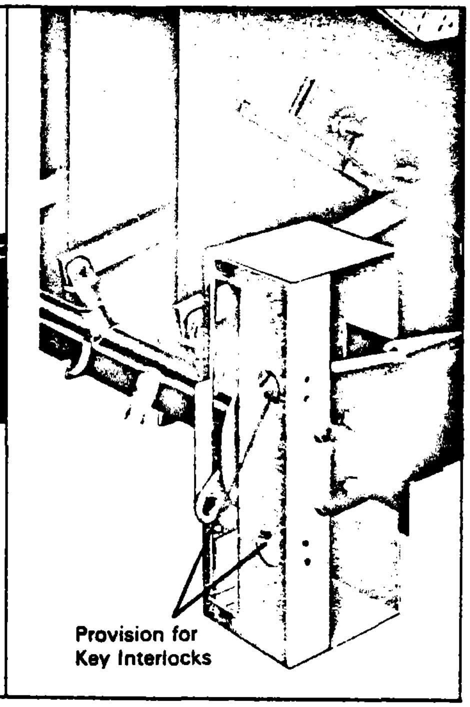


Fig. 15

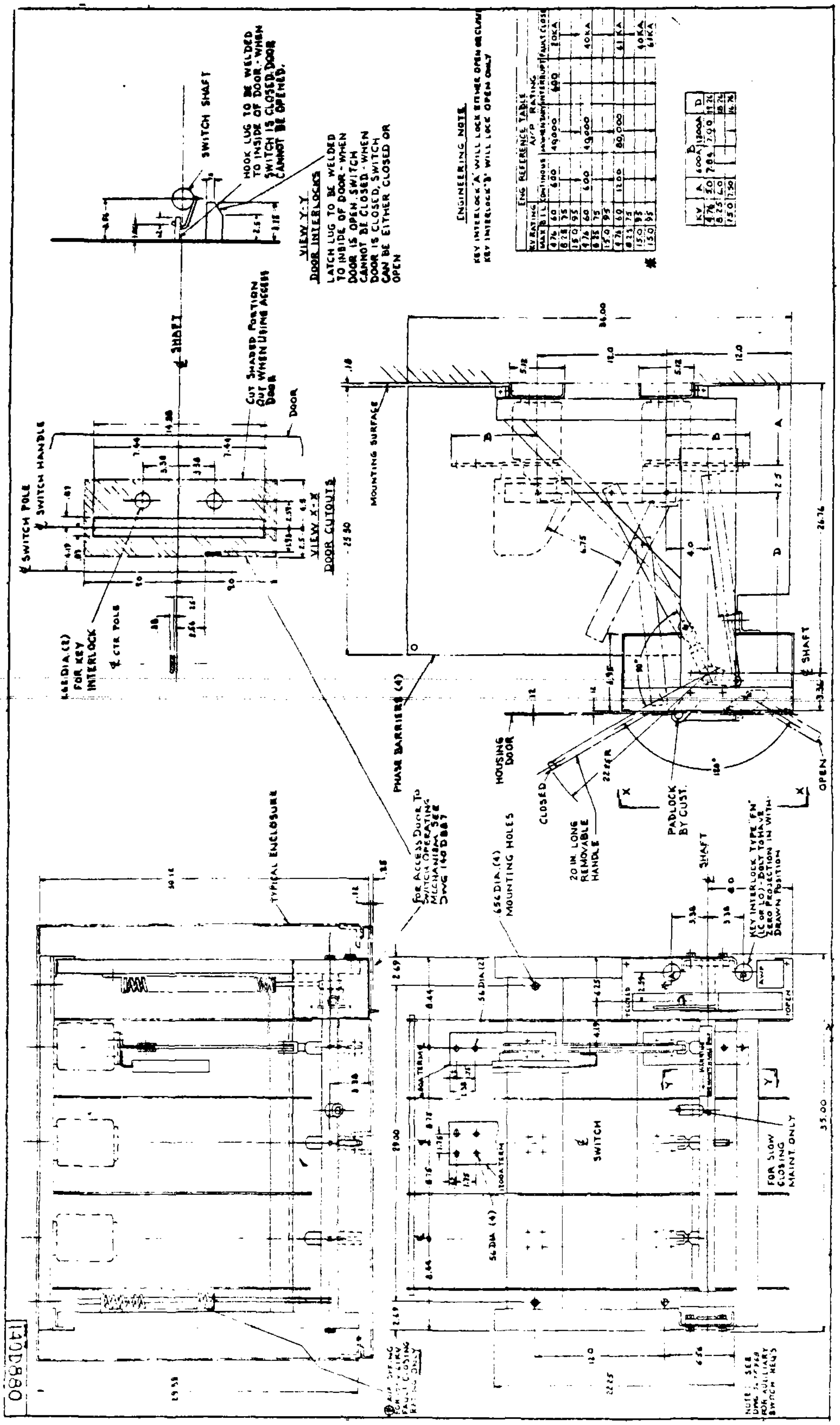

140D880
TYPICAL ENCLOSURE
PHASE BARRIERS (4)
MOUNTING SURFACE
HOUSING DOOR
CLOSED
OPEN
PADLOCK BY CUST.
20 IN. LONG REMOVABLE HANDLE
SWITCH SHAFT
VIEW Y-Y
DOOR INTERLOCKS
VIEW X-X
DOOR CUTOUTS
ENGINEERING NOTE
FOR SLOW CLOSING MAINT ONLY

Fig. 16

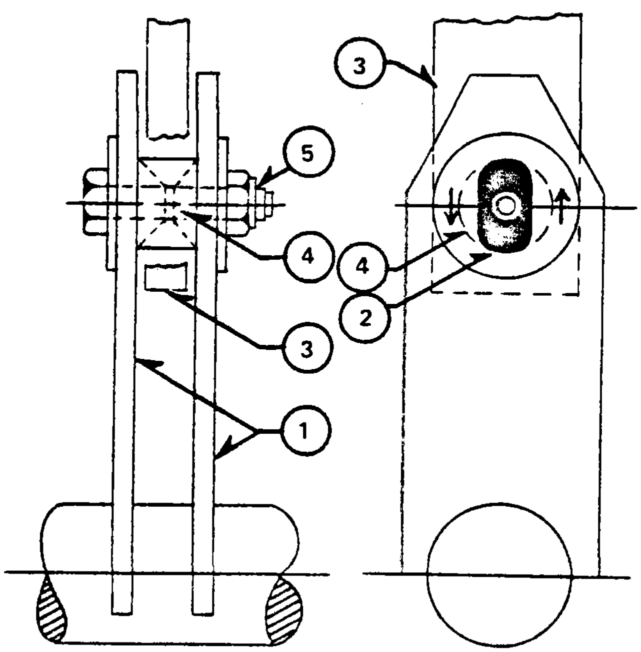
Part's List

Main Blade-Hinge and Jaw Assy. Switch Style No.	Switch Rating	Part No.	No. Reqd. Per Pole	Per Switch
140D719G01	4.76KV - 600A - 20KA Fault	140D875G03	1	3
140D719G02	8.25KV - 600A - 20KA Fault	140D875G03	1	3
140D719G03	15KV - 600A - 20KA Fault	140D875G03	1	3
140D719G04	4.76KV - 600A - 40KA Fault	140D875G04	1	3
140D719G05	8.25KV - 600A - 40KA Fault	140D875G04	1	3
140D719G06	15KV - 600A - 40KA Fault	140D875G04	1	3
140D720G01	4.76KV - 1200A - 61KA Fault	140D875G05	1	3
140D720G02	8.25KV - 1200A - 61KA Fault	140D875G05	1	3
140D720G03	15KV - 1200A - 40KA Fault	140D875G05	1	3
140D720G04	15KV - 1200A - 61KA Fault	140D875G05	1	3

Parts Common To All Quick Make - Quick Break Switches

Description	Part Style Number	No. Reqd. Per Pole	Per Switch
Flicker Blade Assembly	437B349G01	1	3
Flicker Blade and Bracket Assembly	449D726G03	1	3
Arc Chute Assembly	140D883G01	1	3
Barriers	591C620G01	-	4‡
Main Shaft Bearings	496A760H07	-	2
Handle - Removable	795A839H01	-	1
Barriers	591C620H01	-	4

‡For Bolt-On Design



Insulators and Drive Rods

Description	Part Style Number	KV	No. Reqd. Per Pole	Per Switch	
Insulator	548D224G01	5	2	6	
Insulator	548D229G01	7.5	2	6	
Insulator	548D235G01	15	2	6	
Drive Rod	436B828H01	5	1	3	*
Drive Rod	436B828H02	7.5	1	3	*
Drive Rod	436B828H03	15	1	3	*
Drive Rod	590C911H03	5	1	3	†
Drive Rod	590C911H02	7.5	1	3	†
Drive Rod	590C911H01	15	1	3	†
Special Pivot Pin	795A458H01	–	1	3	†
.375-16 x 1.75 Hex Stl. Bolt	70100EG07N	–	1	3	†
.375 x Wide Stl. Washer	70500BD32B	–	2	6	†
.375-16 Stl. Elastic Stop Nut	1650412	–	1	3	†

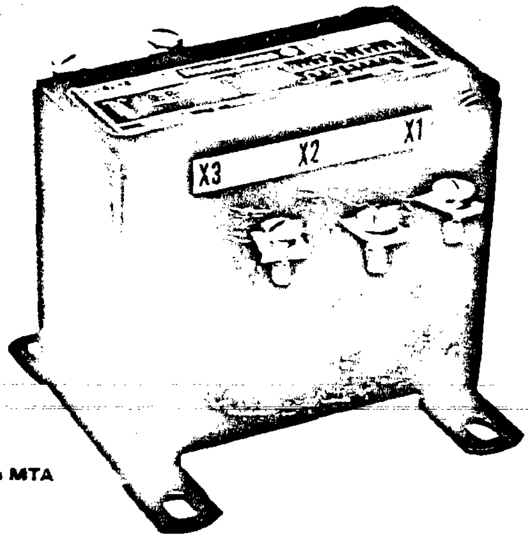
*For screw type drive rod adjustment.
†Fixed arm drive rod adjustment feature.

Westinghouse Electric Corporation
Dry Type Distribution Transformer Division
Greenville, Pa. U.S.A. 16125

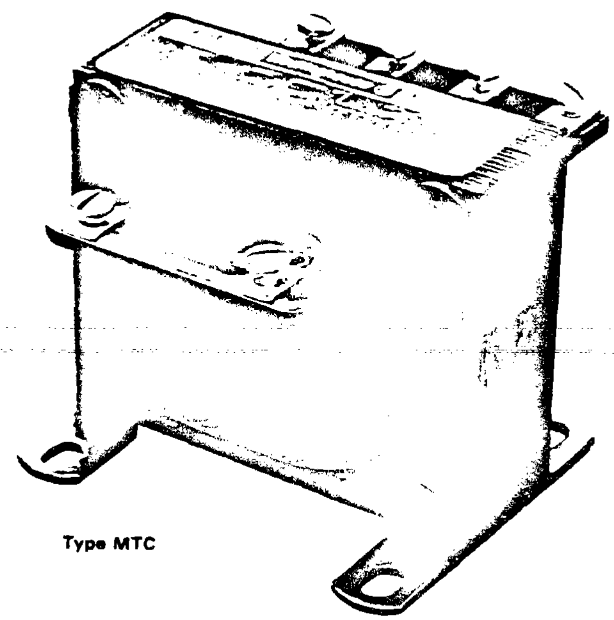
November, 1977
New Information
Mailed to: E. D. C/2071, 2072/DB

MTA and MTC Control Transformers
AP Machine Tool Transformers
SW Transformers
Network Power Filter

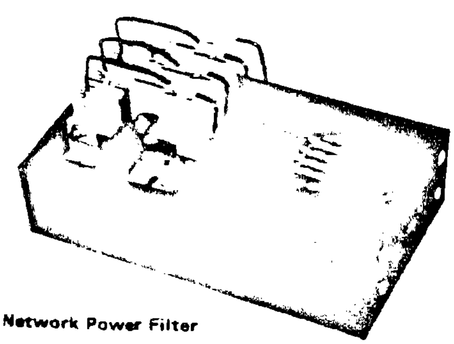
Control Transformers For Machine Tools and Panel Boards



Type MTA

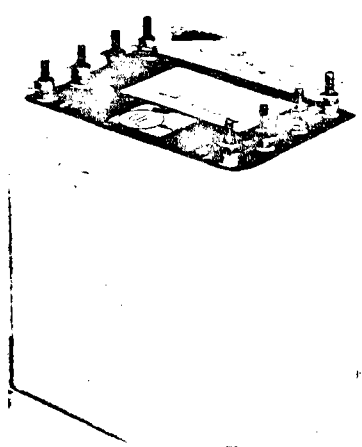


Type MTC

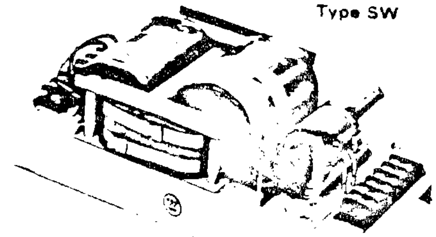


Network Power Filter

Side/Wall Mount
AP



Type SW



All MTA and MTC transformers 1000 va and below on this page are a recognized component by Underwriters Laboratory, Inc.

Standard Voltages Type MTA

Volt-Amperes	Catalog Number	②Frame Number	②Wiring Diagram
230/460 Volts to 115 Volts 60 Hertz			
50①	1F0890	1310	1
75①	1F0927	1510	1
100①	1F0906	1512	1
150①	1F0907	1520	1
200①	1F0908	1714	1
250①	1F0909	1717	1
300①	1F0910	1723	1
350①	1F0911	1727	1
500①	1F0912	1923	1
750①	1F0913	1931	1
1000①	1F0914	C613	1
1500①	1F0965	C614	1
2000①	1F0966	C827	1
3000①	1F0967	C828	1
5000①	1F0968	C829	1
230/460/575 Volts to 115/95 Volts 50/60 Hertz			
50①	1F0987	1314	2A
75①	1F0988	1512	2A
100①	1F0989	1517	2A
150①	1F0990	1714	2A
200①	1F0991	1717	2A
250①	1F0992	1723	2A
300①	1F0993	1730	2A
350①	1F0994	1923	2A
500①	1F0995	1931	2A
750①	1F0996	1943	2A
1000①	1F0997	C614	2A
1500①	1F0998	C827	2A
208/380/416 Volts to 115/95 Volts 50/60 Hertz			
50①	1F1025	1314	2B
100	1F1027	1516	2B
150①	1F1028	1714	2B
200①	1F1029	1717	2B
250①	1F1030	1723	2B
300①	1F1031	1730	2B
500①	1F1033	1931	2B
750①	1F1034	1943	2B
1000①	1F1035	C614	2B
1500①	1F1036	C827	2B
115 Volts to 12 Volts 50/60 Hertz			
50①	1F3050	1310	4A
100	1F3051	1513	4A
115 Volts to 24 Volts 50/60 Hertz			
50①	1F3052	1310	4B
100①	1F3053	1513	4B
200①	1F3054	1714	4B

① TOPS stock.
② For detailed dimensions by Frame Number and Wiring Diagrams, refer to TCS 46-870 and TCS 46-871 respectively.
③ Accessory for MTA and MTC only.

Volt-Amperes	Catalog Number	②Frame Number	②Wiring Diagram
230/460 Volts to 115/230 Volts 60 Hertz			
50①	1F2198	1310	3
75①	1F2185	1510	3
100①	1F2186	1512	3
150①	1F2189	1520	3
200①	1F2191	1714	3
250①	1F2034	1717	3
300	1F1113	1727	3
350	1F2187	1727	3
500①	1F2190	1930	3
750①	1F2188	C613	3
1000①	1F1687	C613	3
1500①	1F1688	C614	3
2000①	1F1696	C827	3
3000①	1F1690	C828	3
5000①	1F1701	C829	3

Standard Voltages Type MTC
240/480-120 Volts, 60 Hertz
230/460-115 Volts, 50/60 Hertz
220/440-110 Volts, 50/60 Hertz

Volt-Amperes	Catalog Number	②Frame Number	②Wiring Diagram
50①	1F0890	1310	1
75①	1F0891	1314	1
100①	1F0892	1413	1
150①	1F0893	1517	1
200①	1F0894	1714	1
250①	1F0895	1717	1
300①	1F0896	1722	1
350①	1F0897	1726	1
500①	1F0898	1931	1
750①	1F0899	1943	1
1000①	1F0900	2236	1
1500①	1F0901	C822	1
2000①	1F0902	C823	1
3000①	1F0903	C824	1
5000①	1F0904	C825	1

Add-A-Part Fuse Holders③

50 through 750 va,
Style No. 257A574G01

1000 through 3000 va,
Style No. 257A564G01

For non-standard Type MTA transformers and modifications refer to Price List 46-820, page 2.

Network Power Filter

For use on Transformer Secondary 208Y/120

Catalog Number①	Transformer Name Plate KVA
1N20	15
1N21	30
1N22	45
1N23	75
1N24	112½
1N25	150
1N26	225
1N27	300
1N28	500
1N29	750
1N30	1000

① Network Power Filter Only.

Type AP – Machine Tool Transformers

240/480 Volt Primary No Taps to 120/240 Secondary Single Phase, 60 Hertz

Kva	Catalog Number	②Frame Number	②Wiring Diagram
Bottom Mount			
3	6F495	133	6
5	6F201	99	5
7½	6F202	100	5
10	6F203	101	5
15	6F496	134	6
Side/Wall Mount			
3	6F320	283	6
5	6F321	256	6
7½	6F322	257	6
10	6F323	258	6
15	6F324	259	6

Type SW Transformers
Input 105-125 Volts, Output 120 Volts (±1%) Single Phase 60 Hertz

Catalog Number	Rating
1M21①	120 Va
1M22①	250 Va
1M23①	500 Va
1M24①	1000 Va

Regulation Data—Type MTC

Continuous Nominal Volt-Amperes	Inrush Volt-Ampere at 20% Power Factor — Secondary Voltage 100%	95%	90%	85%
50	146	207	379	456
75	211	318	419	518
100	254	405	547	686
150	408	795	1,079	1,394
200	682	1,208	1,680	2,128
250	1,020	1,623	2,275	2,898
300	1,212	2,193	3,075	3,912
350	1,750	3,171	4,449	5,683
500	3,315	6,018	8,465	10,820
750	4,580	8,595	12,345	15,975
1000	7,410	13,888	19,860	25,640
1500	9,195	17,788	25,800	33,510
2000	10,780	20,428	29,580	38,520
3000	19,350	36,158	52,950	69,810
5000	27,150	54,400	83,350	114,200

Printed in USA

Dry Type Transformers
Control Type

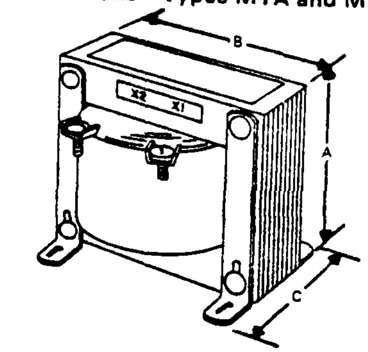
MTA, MTC, AP, Machine Tool

Type MTC①

Volt-Amperes	Catalog Number	Frame Number
240/480-120 Volts, 60 Hertz		
230/460-115 Volts, 50/60 Hertz		
220/440-110 Volts, 50/60 Hertz		
50	1F0890Ⓢ	1310
75	1F0891Ⓢ	1314
100	1F0892Ⓢ	1413
150	1F0893Ⓢ	1517
200	1F0894Ⓢ	1714
250	1F0895Ⓢ	1717
300	1F0896Ⓢ	1722
350	1F0897Ⓢ	1726
500	1F0898Ⓢ	1931
750	1F0899Ⓢ	1943
1000	1F0900Ⓢ	2236
1500	1F0901Ⓢ	C822
2000	1F0902Ⓢ	C823
3000	1F0903Ⓢ	C824
5000	1F0904Ⓢ	C825

① 1000 Va and below are listed as a recognized component by Underwriters' Laboratory, Inc.

Dimensions – Types MTA and MTC



Frame Number	Dimensions in Inches A	B	C (Max.)	Approx. Wt. Lbs.
1310	2 19/32	3	3 1/4	2
1314	2 19/32	3	3 3/4	3
1413	2 7/8	3 3/8	4	3
1510	3 3/16	3 3/4	3 3/4	3
1512	3 3/16	3 3/4	4	4
1513	3 3/16	3 3/4	4 1/8	4
1516	3 3/16	3 3/4	4 3/4	5

Frame Number	Dimensions in Inches A	B	C (Max.)	Approx. Wt. Lbs.
1517	3 3/16	3 3/4	4 3/4	6
1520	3 3/16	3 3/4	4 3/4	6
1714	3 13/16	4 1/2	4 1/2	7
1717	3 13/16	4 1/2	5	8
1722	3 13/16	4 1/2	5 3/8	10
1723	3 13/16	4 1/2	5 1/2	10
1726	3 13/16	4 1/2	6	11
1727	3 13/16	4 1/2	6	12
1730	3 13/16	4 1/2	6	13
1923	4 3/8	5 1/4	5 5/8	15
1930	4 3/8	5 1/4	6 1/4	15
1931	4 3/8	5 1/4	6 7/8	20
1943	4 3/8	5 1/4	7 3/4	28
2236	5 7/16	6 3/8	7 1/2	34
C613	5 1/4	6 1/8	6 3/4	19
C614	6	6 7/8	7 1/2	27
C822	6 1/8	6 7/8	8 3/8	35
C823	6	6 3/4	8 1/2	38
C824	7 3/8	8 7/16	8 3/4	53
C825	7 7/8	8 11/16	11	82
C827	5 7/8	6 7/8	8 1/2	36
C828	6 1/2	8 3/16	8 3/4	52
C829	7 5/8	8 15/16	10 1/4	79

Type AP, Single Phase, 60 Hertz – Class 155, 80°C Rise, 3 Through 10 Kva-Class 185, 115°C Rise, 15 Kva

All Type AP transformers on this page are Underwriters' Laboratories, Inc. listed and labeled.

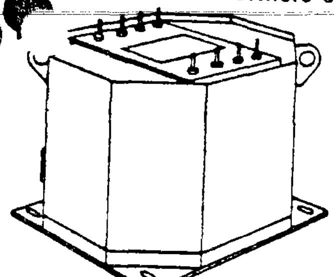


Fig. 1

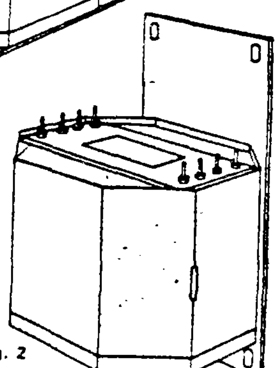


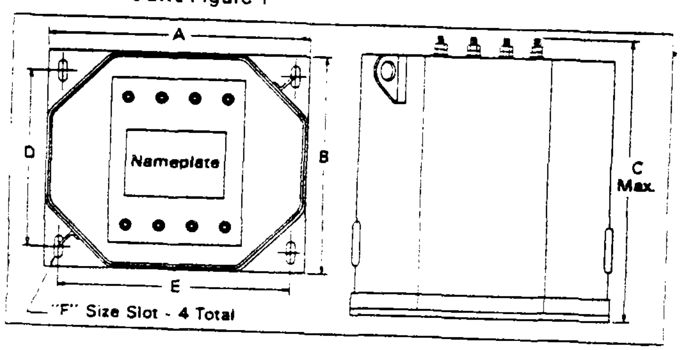
Fig. 2

Kva	Catalog Number	Figure Number	Net Wt., Lbs.
240/480 Volt Primary, No Taps to 120/240 Volt Secondary			
3	6F495	1	52
5	6F201	1	80
7½	6F202	1	122
10	6F203	1	133
15	6F496	1	160
3	6F320Ⓢ	2	52
5	6F321Ⓢ	2	80
7½	6F322Ⓢ	2	122
10	6F323Ⓢ	2	133
15	6F324Ⓢ	2	160

Ⓢ Normal inventory item, order through TOPS.

Dimensions In Inches

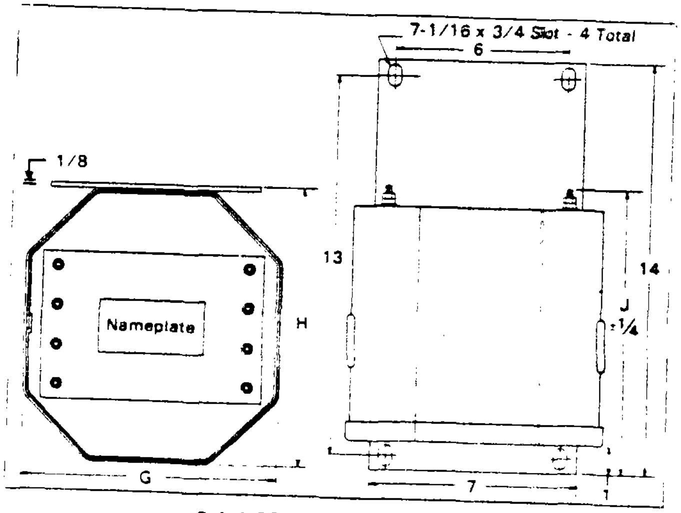
Bottom Mount Figure 1



Kva	Approximate Dimension A	B	C
3	7 17/32	7 17/32	8 9/16
5	9 13/32	8 25/32	9 3/16
7½	12 1/32	10 13/32	9 7/8
10	12 1/32	10 13/32	11 1/4
15	11 9/32	11 9/32	12 1/2

Kva	D	E	F
3	6 1/2	6 1/2	9/32 x 17/32
5	7	8	7/16 x 3/4
7½	8 1/2	10 1/2	7/16 x 3/4
10	8 1/2	10 1/2	7/16 x 3/4
15	9 1/2	10	7/16 x 3/4

Side/Wall Mount Figure 2

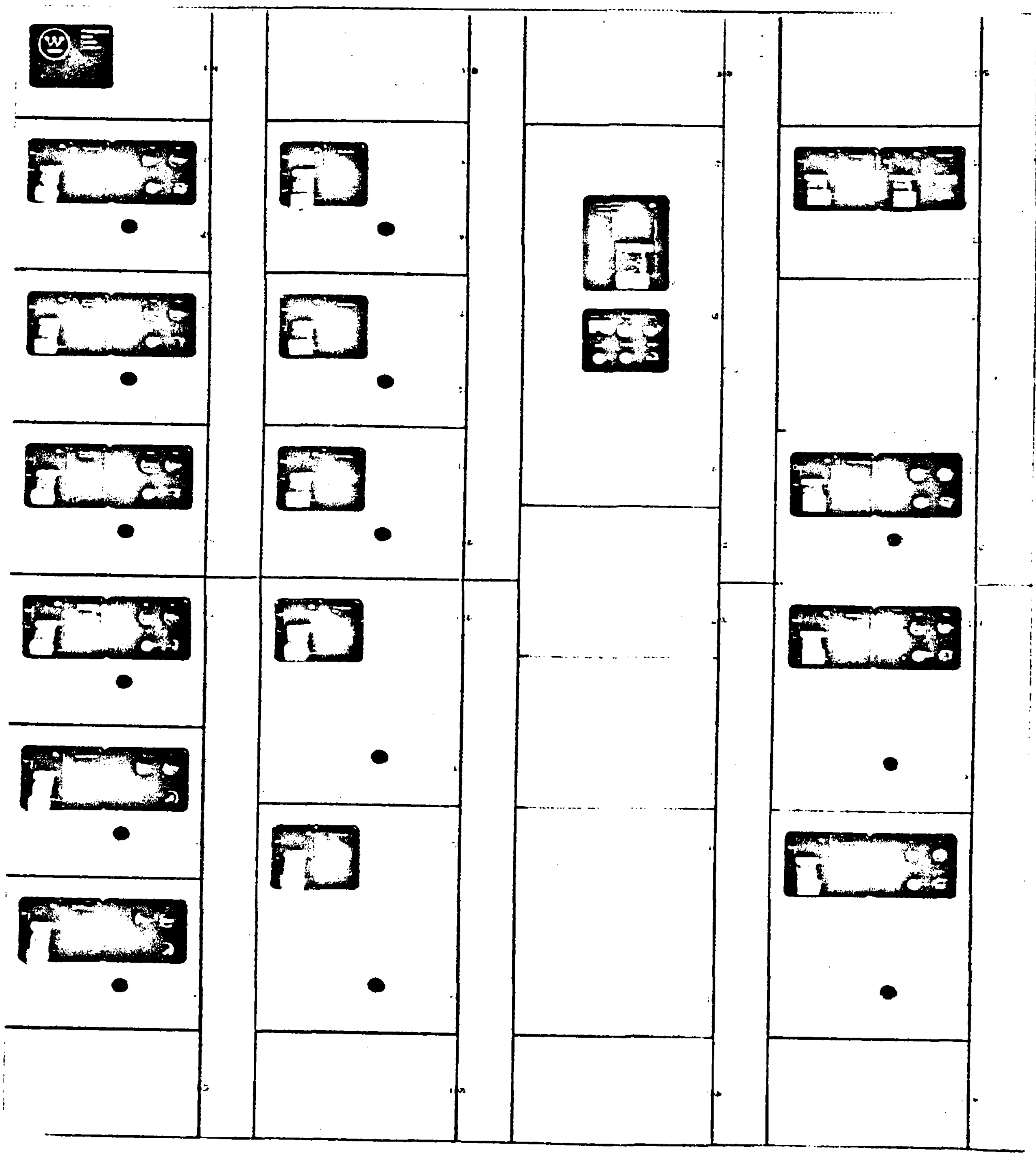


Kva	Approximate Dimension G	H	J
3	7 1/2	7 5/8	8 7/8
5	8 3/4	9 5/16	9 3/4
7½	8 5/8	10 3/4	11 5/8
10	10 1/8	10 3/4	11 5/8
15	10 7/16	12 3/16	12 3/8

September, 1975
New Information
Mailed to: E, D, C/1926/DB

Standardized Units Classes I and II
3 Phase: To 450 Horsepower, 230 Volts
To 900 Horsepower, 600 Volts

Motor Control Centers Five Star

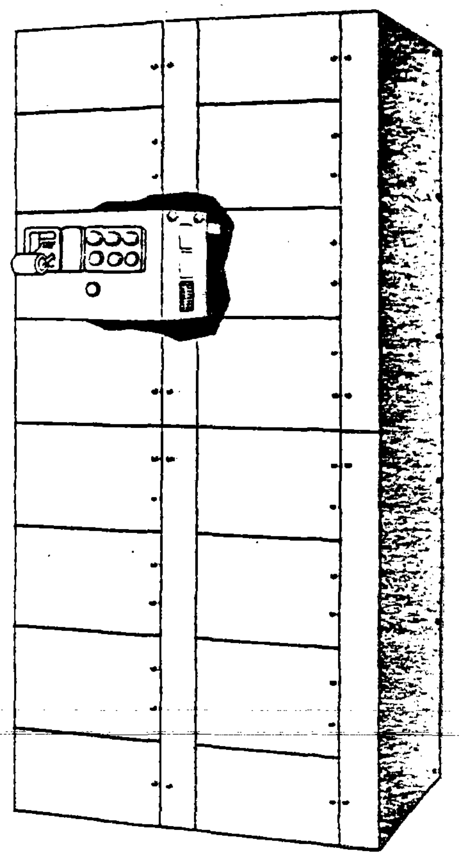


Many processes and commercial buildings benefit from the grouping of electrical controls. Industries such as primary metals, paper, petroleum and chemicals typically install electrical controls in centralized locations so that supervision and operation can be performed by a minimum of personnel. To meet this need Westinghouse introduced the Motor Control Center Concept in 1937. This provided a means to mount various motor starter units, feeder tap units and auxiliary controls in a flexible structure arrangement. Since that time the Motor Control Center Concept has been refined to permit greater flexibility, safety and convenience. Westinghouse now has available the ultimate in Motor Control Center design – Five Star.

The Five Star design begins with components of proven electrical and mechanical integrity; assembles them with strict adherence to the highest engineering practices and with special emphasis on personnel safety and ease of maintenance. The assembly is then wrapped in an enclosure which prevents accidental contact with the enclosed electrical parts and provides an exterior of exceptionally modern appearance, featuring a coordinated control area to provide easy recognition of functions in each starter unit.

The Five Star Motor Control Center has been designed and tested to comply with the general standards for industrial controls and the specific standards for motor control centers as set forth by NEMA, UL, IEEE and ANSI. The various state and city codes are generally met by the standard design. However, in those instances where more specific requirements must be met, the Five Star has the design flexibility to meet them.

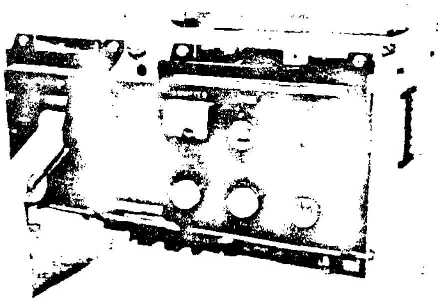
Contents Pages



I. Units

Starter Units

Motor starter units are combination type employing a contactor or contactors and a disconnect device of proven capability. The disconnect device can be either a circuit breaker or fusible switch. The Westinghouse Type MCP motor circuit protector breaker is furnished as standard.



The MCP and starter combination has a 22,000 RMS symmetrical ampere interrupting capacity. With the addition of a current limiter the interrupting capacity is increased to 200,000 amperes. Optional circuit breakers for starter units are the Mark 75 and the TriPac with interrupting ratings of 22,000 amperes and 200,000 amperes respectively.

The fusible switch disconnect device is the Type DS. It is a quick-make, quick-break, visible blade switch with fusing facilities for use with current-limiting or dual element, rejection type, NEMA Class "J" or "R" fuses. Facilities for NEMA Class "H" fuses are available.

Both breaker and fuse selection should take into consideration the total short circuit capacity of the system to which the control center is connected.

The starter units are equipped with A200 Contactors for NEMA Sizes one through four and GCA Contactors for NEMA Sizes five and six. These contactors have been successfully applied in thousands of the most demanding industrial applications. Overload protection is provided by a three pole thermal overload relay as standard with ambient compensated also available. The overload relay has adjustable hand or automatic resetting. The hand reset button extends through the unit door. All relays have a "no" stop feature as standard. The location of all control elements contained in each unit has been designed to provide a coordinated control area for easy recognition of functions and maximum operator efficiency.

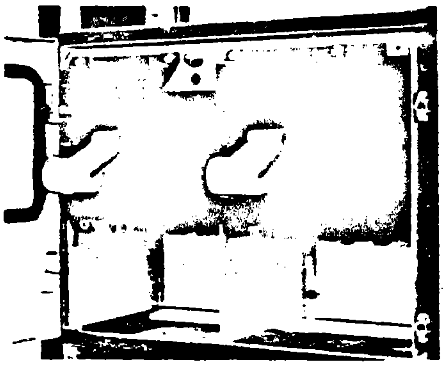
Typical starter units available include the following:

Full Voltage, Non-Reversing
Full Voltage, Reversing
Full Voltage, Non-Reversing, Two Speed, Single Winding
Full Voltage, Non-Reversing, Two Speed, Two Winding

Reduced Voltage, Autotransformer, Closed Transition
Reduced Voltage, Part Winding
Reduced Voltage, Wye-Delta, Closed Transition

All starters through NEMA Size 5 are a drawout design except Size 5 reduced voltage.

Feeder Tap Units

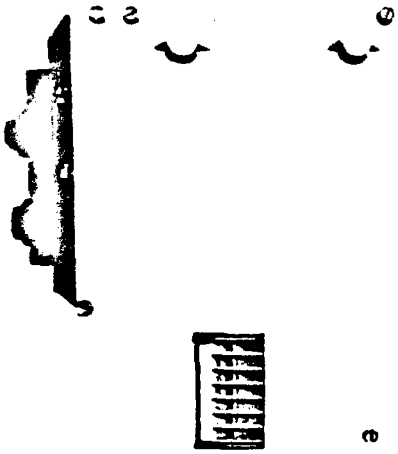


Feeder tap units may contain either circuit breakers or fusible switches. Draw-out breaker units include the fixed trip Type FB, single or dual mounted in ratings through 150 amperes and the interchangeable trip Types KB and LB single mounted through 250 amperes and 400 amperes respectively. Larger circuit breakers are non-draw-out fixed mounted. Adjustable seltronic breaker is standard. Ratings to 2000 amperes are available.

Fusible feeder tap units utilize the Type DS Switch through 200 amperes. Non-auto breakers and fuses are furnished for 400 amperes and above. These switches are mounted in draw-out units through 400 amperes with the 30 ampere and 60 ampere ratings available in dual mounting. Ratings from 600 amperes through 1200 amperes are fixed mounted.

The DS switches are supplied with fusing facilities for use with current-limiting or dual element rejection type, NEMA Class "J" or "R" fuses. Facilities for NEMA Class "H" fuses can also be supplied.

Terminal Blocks



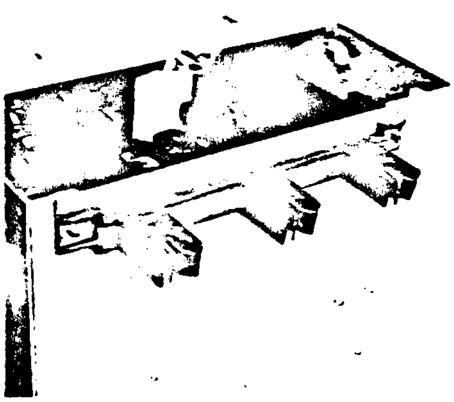
A new side mounted terminal block is standard on units with NEMA Type B or C wiring. These terminal blocks are mounted in knockouts on the wireway side of the unit wrapper. This placement provides greater access to other components within the unit.

The terminal block is available in three types; Standard Pressure Connector, Pressure Pull-Apart, and Pull-Apart for ring or spade type crimp terminations. The smallest starter unit (2X or 12 inches high) can accommodate up to three of the new side mounted terminal blocks providing a maximum of 21 circuits in the standard pressure types and up to 18 circuits in the spade or ring type. Larger starter units can accommodate additional terminal blocks.

As an alternate, terminal blocks may be mounted across the bottom front of the unit.

Standard track mounted terminal blocks include the following types: Standard Pressure Connector, Standard Pressure Pull-Apart, Straight Ring or Spade type for crimp terminations, and Pull-Apart Ring or Spade type for crimp terminations. When mounted in this fashion, a maximum of 30 circuits can be provided by the Standard Westinghouse Pressure types and the Ring and Spade types. Wiring within each unit and to the terminal blocks is made with 16 AWG stranded thermoplastic-insulated wire rated 105°C. Power wiring is black and sized to carry the maximum full load current of the unit. AC control wiring is red and DC control wiring is blue. Plug-in type terminal blocks can be supplied for all control wiring and load wiring through size 2 when specified.

Stab Assembly

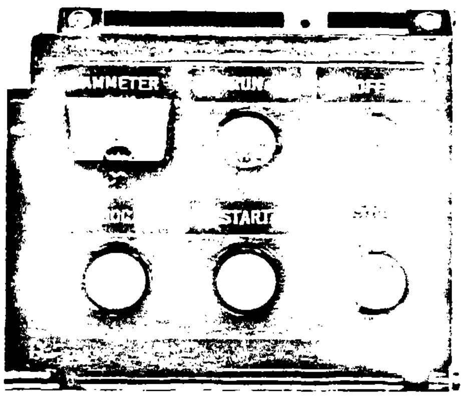


A newly designed two component copper alloy stab incorporates the ultimate in mechanical simplicity to provide precise control of contact pressure on the bus. This assures a positive connection yet permits easy unit insertion and withdrawal. Self aligning Magna-Grip® stabs are mounted in a glass reinforced plastic insulation block which totally shrouds each stab and absolutely ensures positive alignment of the stabs with the vertical bus. The insulation block is also an integral part of the phase to phase isolation system. Power wiring is firmly welded to the stabs and is totally contained within the unit enclosure. This means the vertical bus compartment is completely free of wiring for maximum safety and reliability.

Four stab assembly sizes are used; 60, 150, 300 and 400 amperes to accurately match the electrical requirement of each unit.

I Units, Continued

Device Panel

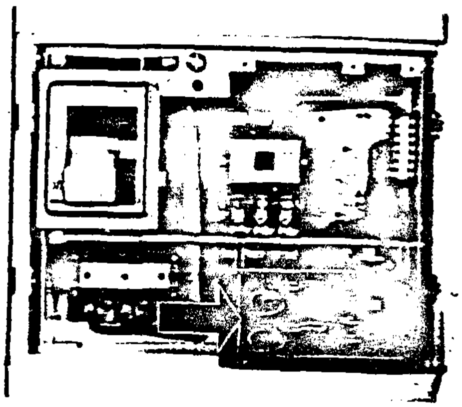


The new device panel can accommodate up to six pilot devices such as oil-tite pushbuttons, indicating lights, selector switches and a new line of miniature meters.

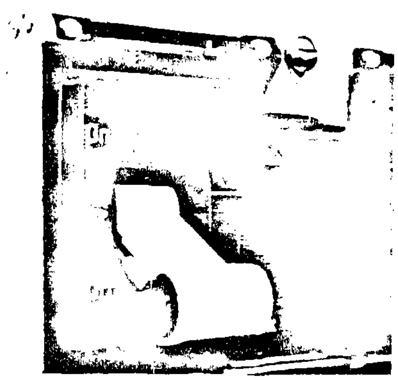
The device panel is hinged on a horizontal rod extending across the front of the unit. With the unit door open and after removing two captive retaining screws at the top of the panel, it may be swung down. This provides ready access to the rear of the panel and increased accessibility to the unit interior.

Molded into the panel is a knock-out for each device location. This facilitates the future addition of devices to the panel.

The panel is molded of a durable, chemically stable plastic material which eliminates corrosion. The textured surface of the panel prevents smearing and fingerprinting to preserve the pleasing appearance of the unit under operating conditions.



ndle Mechanism



The new handle mechanism is designed to provide a high mechanical advantage so that little effort is required to operate any device. Two sizes are used; the smaller mechanism for devices through 400 amperes, and the larger mechanism for devices through 1200 amperes.

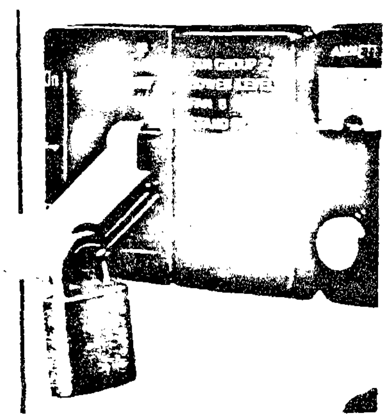
The handle mechanism is a vertical motion type device with three positions; ON, OFF and TRIPPED. It is mounted securely by the wrapper, breaker or fusible switch to eliminate alignment problems and to provide a sitive indication of the breaker or switch sition, even with the door open.

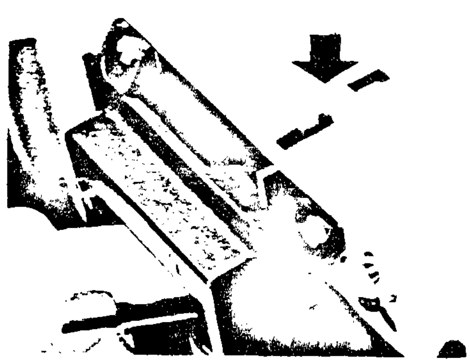
The handle mechanism provides several safety features.

In the "ON" or "TRIPPED" position an interlock prevents the unit door from being opened. However, to enable authorized maintenance personnel to gain access to the units when required, a door interlock defeater screw is located above the handle.

With the unit door open and the operating handle in the "ON" or "TRIPPED" position, an interlock slides into a slot in the divider pan above and prevents removal of the unit. This same interlock prevents insertion of the unit (as shown below) unless the handle mechanism is in the "OFF" position.

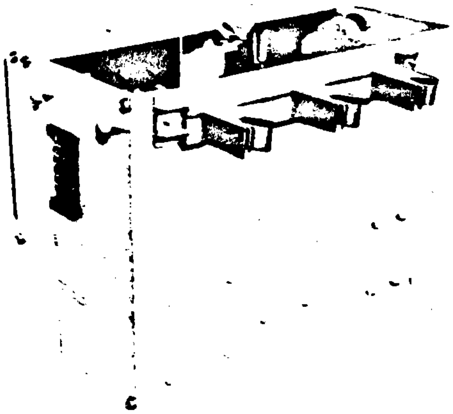
To insure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the "OFF" position. Sufficient space is available for a minimum of three padlocks. Where critical processes are involved and to prevent unauthorized shutdown, the handle mechanism can be modified to enable padlocking in the "ON" position.





The handle and exterior mounting panel are molded from the same plastic material as the device panel. The mounting panel has a textured surface to preserve appearance. The "ON", "OFF", "TRIP" and "RESET" positions of the mechanism are molded into the panel and are highly visible. The operating handle is designed for rugged duty and good operator feel. Its color contrasts with the device and mounting panels for easy recognition.

Unit Wrapper

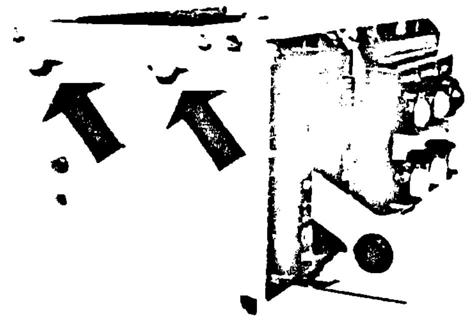


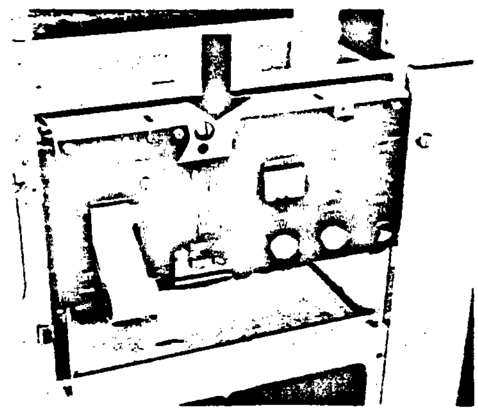
The unit wrapper is fabricated of 16 gauge steel. After fabrication, it is cleaned and given a rust inhibiting phosphatizing treatment. The finish on the unit wrapper is a baked on enamel ASA 70. This is a highly durable enamel, off white in color to increase visibility within the unit and facilitate wiring and maintenance procedures.

The unit wrapper provides three sides of a rugged steel shell and the mounting base for the unit components. The smallest unit measures 13¾ inches wide, 8 inches deep and 12 inches high. Units increase in size in 6 inch increments to a maximum height of 72 inches.

The unit wrapper is designed to provide ample space for cable entry from the wireway to the unit.

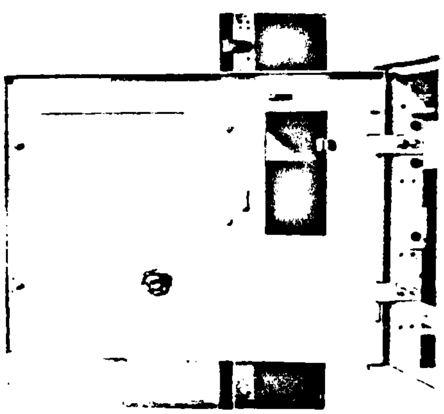
The unit wrapper has four mounting points, two on each side, which support the unit in the structure. They engage guide rails located near the top of each unit space. This mounting point guide rail system produces minimum friction and allows units to be inserted and withdrawn easily. The guide rails also give precise alignment to the unit for accurate stabbing on the vertical bus.





At the top center of the unit wrapper is a quarter turn latch which securely holds the unit in the compartment. The latch can only be engaged when the stabs are fully mated with the vertical bus. Upon release of the latch the unit can be partially withdrawn (as shown above) such that the stabs disengage from the vertical bus. In this position the latch can be re-engaged to prevent the unit from being returned to the fully stabbed position or from being removed from the structure. The latch can be padlocked in this position to ensure the stabs remain disengaged during maintenance.

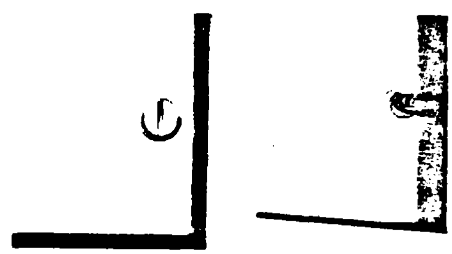
Unit Doors



Unit doors are formed of 14 gauge steel with a ½ inch flange on all four sides. The flange adds rigidity to the door and provides a surface to contain door gasketing when applied. Cutouts are made in the door as required to accommodate the operating handle and device panel. The doors are cleaned, phosphatized and given a finish of off-white, baked on enamel ASA 70.

The doors will open approximately 110° and opposite to wireway doors permitting optimum access to the unit compartment. The doors are mounted on removable pin hinges. This permits quick removal of any door in a vertical structure without disturbing adjacent doors.

Each door is provided with a minimum of two quarter turn indicating type fasteners. They securely hold the door in the closed position, yet allow quick and easy access to the unit when required. The fasteners provide a visual indication of the latched position.



I Units, Continued

Nameplates
Unit nameplates are of durable anodized aluminum with ⅛ inch high white lettering on a black background. They are heat and crack resistant to eliminate the need for replacement. Nameplates are mounted with a pressure sensitive adhesive. Rivets or screws can be used if specified.

Modifications
Starter and feeder tap units can be modified to meet a variety of specification requirements. Some typical components which can be added include; control circuit transformers – fused or unfused; control relays, MOR (modular overload) relays, groundgard relays, current transformers, extra electrical interlocks, pushbuttons, selector switches, indicating lights, circuit breaker shunt trip or undervoltage release and auxiliary switches. In most cases, these modifications do not increase starter unit size.

Additional Equipment
In addition to motor starter and feeder units additional equipment can be supplied including the following:

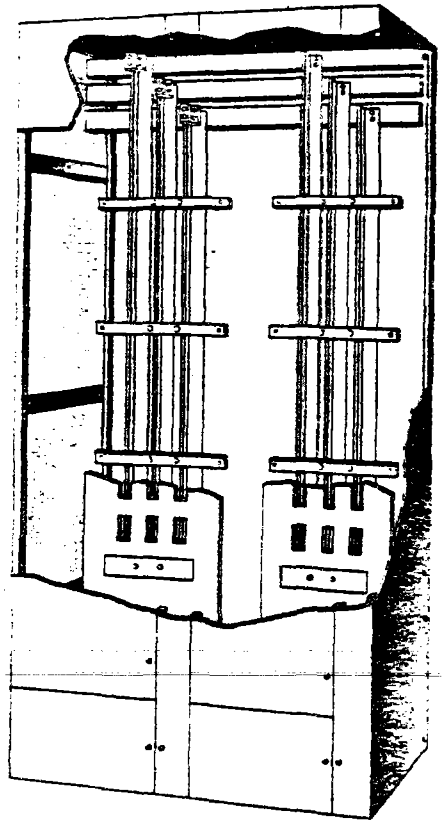
Single phase dry type distribution transformers in ratings of 3, 5, 7.5, 10 and 15 KVA.

Three phase dry type distribution transformers in ratings of 9, 15, 22.5, 30 and 45 KVA.

Lighting panelboards with 12, 18, 24, 30, 36, or 46 circuits with either plug-in branch breakers or bolt-on branch breakers.

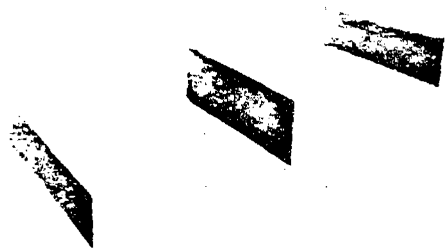
Current limiting reactors with ohmic values of .01, .015, .02 and .025 and amperage ratings of 600, 800, 1000 and 1200.

Metering equipment such as voltmeters, ammeters, wattmeters and power factor meters.



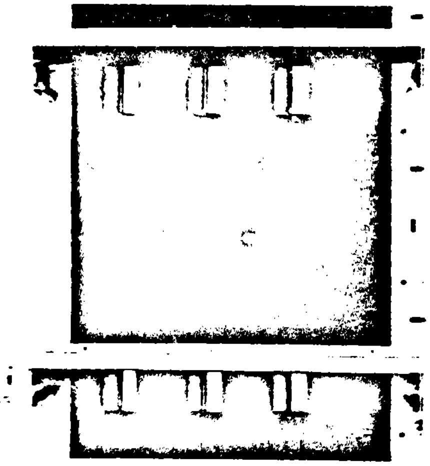
II. Bus System

Vertical Bus
The vertical bus provides three phase power distribution from the main horizontal bus to the vertical compartments. The bus is a unique angular configuration with an "L" shape for front mounted only structures and a "Z" shape for back to back mounted structures. These shapes have the inherent mechanical strength to withstand fault stresses. They also provide a smooth stabbing surface for unit connection.



Due to the high strength capability of the bus bars, bus bracing at 42,000 RMS symmetrical amperes is standard. Bracing at 100,000 RMS is available as an option. Bus braces are molded from a glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

Vertical Bus, Continued

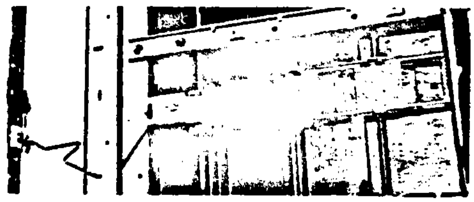


The vertical bus is available in ratings of 300, 600 and 1200 amperes for front mounted only, and 600 and 800 amperes for back to back mounted. Standard vertical bus bars through 600 amperes are tin plated aluminum with the special POLYTET-50 process. Copper bus is available as an option in 300 and 600 amperes and is standard in 800 and 1200 ampere ratings.

The exclusive POLYTET-50 process further improves the corrosion resistant qualities of tin plated aluminum when used in severe environments. It also provides a lubricating effect which prevents stabs from galling and facilitates easy removal and insertion of units.

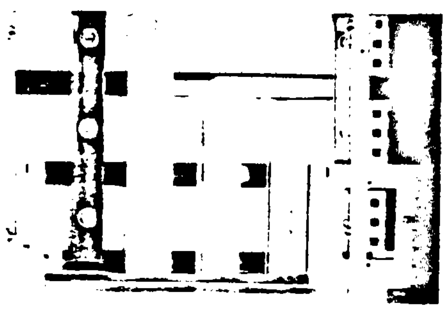
Isolation of the vertical bus compartment from the unit compartments is accomplished by a full height barrier which is provided as standard. This is a single sheet of glass-reinforced polyester with cut-outs to allow the unit stabs to engage the vertical bus. Snap in covers are available for the cutout openings to provide total isolation during maintenance procedures.

When insulation and isolation of the vertical bus is required, a labyrinth design barrier is available. This barrier is molded glass reinforced polyester and forms a labyrinth around the bus bars to restrict fault propagation. This design provides maximum protection against phase to phase insulation breakdown. Thermal efficiency is maintained by a close tolerance fit between the bus bars and the barrier which minimizes air pockets. This insures compliance with NEMA and UL heat rise standards. When bus bracing of 100,000 RMS amperes is supplied, the labyrinth barrier is provided as standard.



An automatic shutter mechanism is included with the labyrinth barrier to provide complete isolation of the vertical bus. The shutter moves automatically to cover the stab openings when a unit is removed. This provides maintenance personnel with maximum protection since the vertical bus is never exposed. As the unit is reinserted in the compartment, the shutter moves sideways to uncover the stab openings in the barrier.

Horizontal Bus



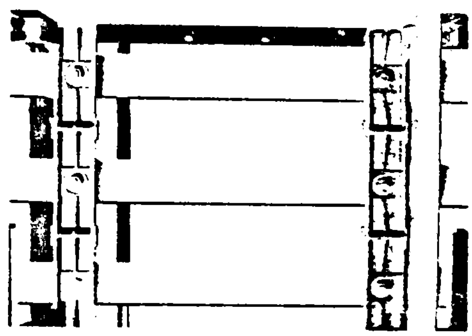
The main horizontal bus provides three phase power distribution from the incoming line or primary disconnect device to each vertical structure in an assembly. The bus bars are mounted in a vertical plane, edge to edge. This mounting produces an exceptionally strong assembly able to withstand high fault current stresses.

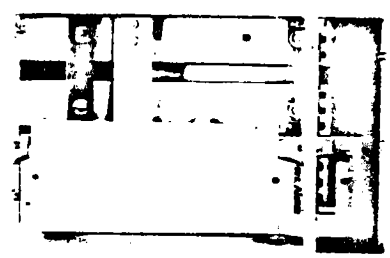
Standard horizontal bus bracing is 42,000 RMS symmetrical amperes. Additional bracing to 100,000 amperes is available. Bus braces are molded from a glass reinforced polyester material with high strength which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

The main horizontal bus is rated at 600 amperes as standard with ratings of 800, 1000, 1200, 1400, 1600, 2000 and 2500 amperes optionally available. Tin-plated aluminum bus bars are supplied as standard. Tin-plated aluminum or copper is available for ratings up through 1200 amperes. Above 1200 amperes only copper bus is supplied. The exclusive POLYTET-50 process is applied to all tin-plated aluminum horizontal bus to further improve its corrosion resistant properties in severe environments.

The horizontal bus is rated at 65°C temperature rise in compliance with NEMA standards. A rating of 50°C temperature rise to comply with UL Standards is available as an option.

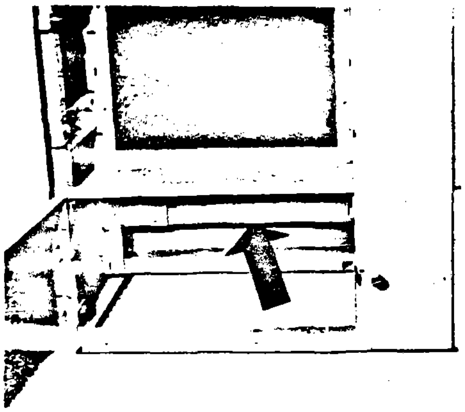
The horizontal main bus is isolated from the top horizontal wireway compartment by an isolation barrier. This two piece steel barrier extends to the full width of each vertical structure. The two piece design allows access to bus connections without the removal of the entire barrier, for added maintenance convenience. The bus bar layout permits front access to all bus connections. This allows maintenance personnel to make splices and check splice bolt torques from the front of the structure.





II Bus System, Continued

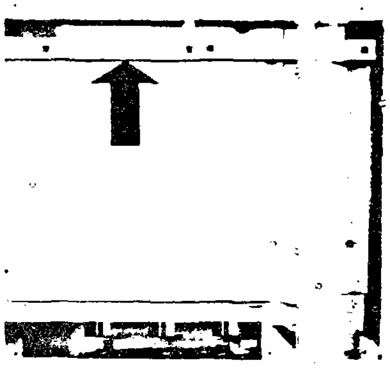
Neutral Bus



Neutral bus can be supplied one half or full rated. The bus bar is mounted on stand-off insulators across the bottom of each vertical compartment.

Tin-plated aluminum or copper bus is available. One half rated tin-plated aluminum with special POLYTET-50 process is standard.

Ground Bus



Ground bus is available in ¼ inch by 1 inch tin-plated aluminum or copper. Tin-plated aluminum with the special POLYTET-50 process is standard. Mounting is across the top of each vertical structure in the horizontal wireway. The bus can also be mounted across the bottom when the bottom 9 inches are not occupied by units or master terminal blocks.

Control, Load and Incoming Line Terminations

For NEMA Type A wiring each unit is assembled and devices interwired. Terminal blocks are not supplied and control and load wiring is internal to the unit.

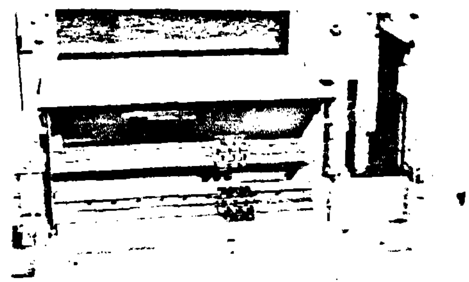
For NEMA Type B wiring, control wires are terminated at blocks within the unit. Refer to the discussion of units for types of terminal blocks available.

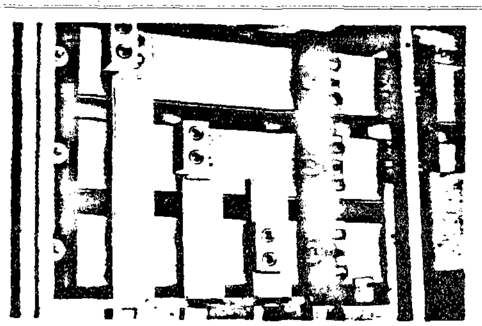
For NEMA Type C wiring, control and load wires are extended from the unit terminal blocks to master terminal blocks located at the top or bottom of any vertical structure. The mounting location of the master terminal block in front mounted only structures is in the existing horizontal wireway space at the top or bottom. When mounting is made in an incoming line section, twelve inches of unit space must be used. When mounting is made in the rear of back to back mounted structures, 6 inches of unit space must be used at the bottom and 12 inches at the top.

Master terminal blocks can be either fixed or draw-out mounted with draw-out provided as standard. In the draw-out design the terminal blocks are rack mounted to permit removal of the entire assembly for ease of wiring during installation and maintenance.

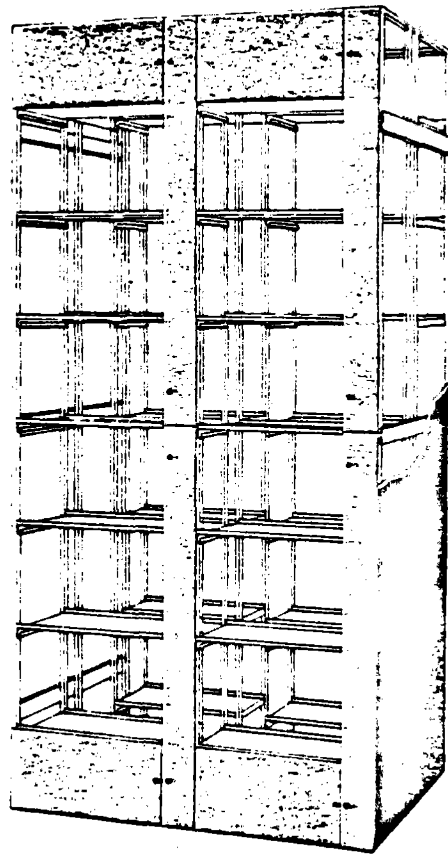
Incoming line cables entering from the top of the control center can be easily terminated on the main horizontal bus or connected to a main breaker. Incoming line (more than one per phase) entering from the bottom of the structure can be easily terminated at the bottom of the vertical bus in that section at ratings through 1200 amperes. Adapters can be provided for up to four cables per phase and for crimp-on lugs. Terminals are suitable for both copper and aluminum cable.

Copper or aluminum cables of #6-350 MCM, two per phase, can be terminated in the incoming line structure utilizing 6 inches of additional space. Copper or aluminum cables of 4/0-600 MCM, two per phase, can be terminated with the addition of 6 inches for top entry and the addition of 18 inches for bottom entry.





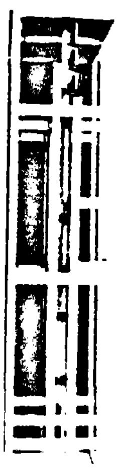
III Structure



III. Structure

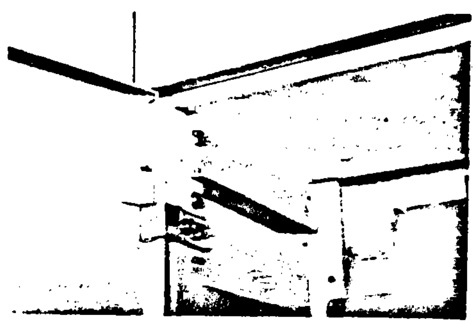
Construction

The standard vertical structure is 90 inches high and 20 inches wide. Front mounted only structures can be either 16 inches or 21 inches deep. Back to back mounted structures are 21 inches deep.



The structure framework is made of 12 gauge formed steel channels. The sub-frames for the front and rear of each structure are welded. These sub-frames are then bolted to longitudinal members to form the complete frame which is rigid and self-supporting. Side, back and roof sheets of 14 gauge steel are mounted with screw fasteners for quick and easy removal when desired. All doors are 14 gauge steel with a ½ inch flange to provide a rigid, secure closure for all openings. Doors mounted on removable pin hinges are provided on all unit compartments, vertical wireways, top horizontal wireways, and bottom horizontal wireways.

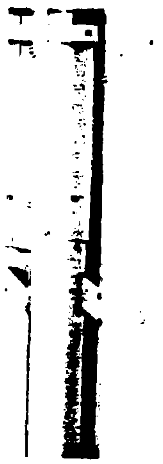
The unit pan forms the top barrier of each unit space. In conjunction with the unit wrapper this provides isolation between adjacent units and wireways. The guide rails are an integral part of this pan and provide precise alignment of the unit stabs on the vertical bus.



All structure elements are thoroughly cleaned after fabrication and given a phosphatizing treatment to inhibit rust and prime the metal for the finish coating. A baked enamel ASA 70 off-white is applied to the structure framework, back sheets, doors and units. ASA 24 charcoal grey is applied to the roof and side sheets.

III. Structure, Continued

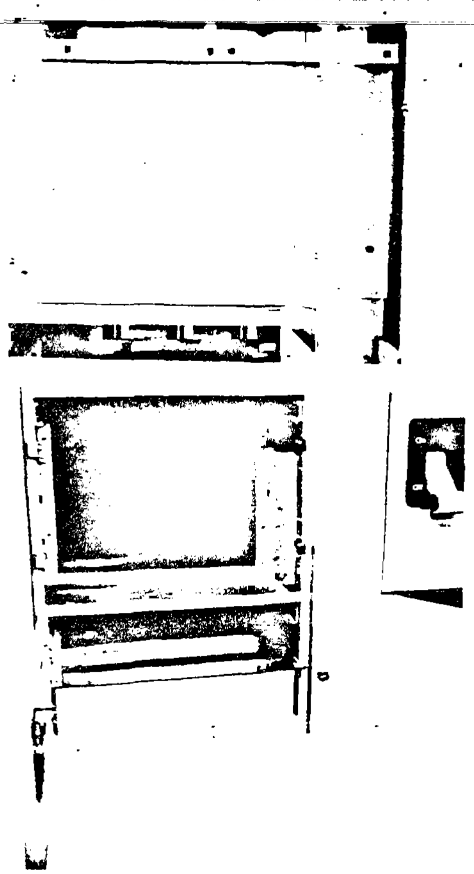
Vertical Wireway



A vertical wireway is provided in each vertical structure. Located on the right side, it extends *the full 90 inch height of the structure.* The width of the wireway is 4⅝ inches at the rear of the vertical frame members. Overall depth of the wireway is 8 inches providing a cross-sectional area of nearly 35 square inches to easily accommodate control and load wiring. Supports are provided at suitable intervals to secure all wiring and cables.

The wireway opening is covered by two doors, top and bottom, so that the entire wireway need not be exposed to gain access to one section. The doors swing open 110° and opposite to the unit doors for maximum accessibility. The doors are mounted on removable pin hinges for quick detachment and are secured in the closed position by two quarter-turn indicating type fasteners.

Horizontal Wireways



The top horizontal wireway is 9 inches high and 7 inches deep in front mounted only structures and in the front of back to back mounted structures. It extends the full width of each structure and is barriered from the main horizontal bus. The bottom horizontal wireway is 9 inches high and extends the full depth of the structure. This provides unlimited wiring space. The entire floor area under the control center is open for unrestricted conduit entry. For top entry, the top wireway can be increased to 15 inches high, as shown at left, reducing the bottom wireway height to 3 inches.

For back to back mounted structures, the top horizontal wireway at the rear is 15 inches high and 6 inches deep. The bottom wireway is limited to 3 inches high for a depth of 11 inches.

All horizontal wireway openings are covered by doors for increased accessibility. Each door is mounted with removable pin hinges to allow quick detachment and securely closed with a quarter turn indicating type fastener.

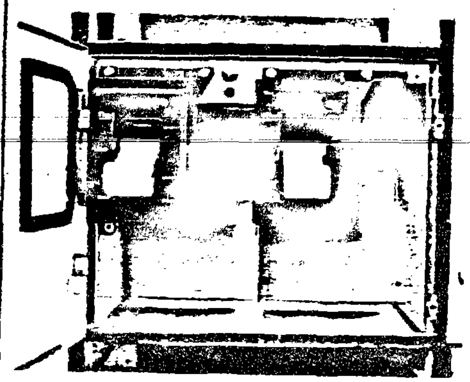
Special Structures

In addition to the standard 20 inch wide structure, extra wide structures are available in 4 inch increments up to 32 inches wide. These structures can be supplied with or without 4⅝ inch wide vertical wireways. They are used for mounting transfer switches, SPCB and DS breakers and other special equipment.

Another special structure is a transition section between Type W and the Five Star. This structure is 10 inches wide to provide for horizontal bus splicing.

Enclosures

The standard enclosure type is the NEMA 1 General Purpose – Indoor. This enclosure is appropriate for installations with normal atmospheric conditions.



The NEMA 1 Gasketed Enclosure has gasketing material around the perimeter of all doors and door cut-outs. It is used to prevent airborne matter from entering the control center.

The NEMA 2 Dripproof – Indoor employs a special roof panel with a drip shield and water channels. This prevents liquid from dripping into the control center.

The NEMA 3R Rainproof and Sleet Resistant – Outdoor consists of a NEMA 1 enclosure mounted on a special base with an outdoor house erected around and over it. Both walk-in, non-walk-in aisle and tunnel types are available.

The NEMA 12 *Dusttight and Driptight – Indoor* has gasketing material around all doors, door cut-outs, cover plates, side, top and back sheets. A gasketed bottom plate is available with this enclosure. This construction provides maximum protection against airborne matter and dripping liquids.

Typical Specification
Motor Control Centers

1. General

Motor Control Centers shall be built and tested in accordance with:

a. NEMA Standards
b. ANSI
c. Underwriters Laboratories, Inc.
d. Other (specify)

2. Service

a. Suitable for operation on _______ volts _______ phase _______ wire _______ hz.

b. Suitable for connection to an available fault of (42,000) (100,00) RMS symmetrical amperes.

3. Incoming Line

a. The incoming line shall enter the _______ section at the (top) (bottom) (other) and will be (cable) (bus) connected.

b. The cable will consist of (Number _______) (Size _______). (If bus specify details _______).

c. A main disconnect (is) (is not) required. (Provide details if required)

4. Wiring

a. The motor control center shall be wired NEMA Class (I) (II), Type (A) (B) (C).

b. If Type C, master terminal blocks shall be located at the (top) (bottom) of each section.

5. Structure

a. Structures shall be totally enclosed, dead-front, free standing assemblies, 90 inches high and not less than 16" deep for front mounted units (21" deep for back to back mounted units). Working height shall be 72" to accommodate starter units in multiples of 6" increments with a minimum of 12". Removable lifting angles will be provided.

b. Structures shall contain a horizontal wireway at the top, isolated from horizontal bus and readily accessible. Each structure shall contain an isolated vertical wireway with cable supports, accessible through hinged doors.

c. All structure doors to be mounted on removable pin hinges and secured with quarter turn indicating type fasteners.

6. Bus System

a. Bus shall be braced to withstand a fault of (42,000) (100,000) RMS symmetrical amperes.

b. Main horizontal bus rating to be (600) (800) (1000) (1200) (1400) (1600) (2000) (2500) amperes and be effectively isolated from all wireways and working areas.

c. Vertical bus rating to be (300) (600) (800) (1200) amperes.

d. Full height of vertical bus bars to be protected against accidental contact by (a single sheet of glass reinforced polyester with cutouts for stab openings) (a labyrinth barrier to provide insulation and isolation with shutters which automatically cover stab openings when units are withdrawn).

7. Unit Compartments

a. Each unit compartment shall be provided with an individual front door. Starter and feeder tap unit doors shall be interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while the door is open. An interlock between the unit disconnect device and the structure will prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions. Means shall be provided for releasing the interlock for intentional access and/or application of power.

b. Padlocking arrangements shall permit locking the disconnect device OFF with at least three padlocks with the door closed or open.

c. Means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

d. All full voltage starter units through NEMA size 5 shall be of the draw out type. Draw out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Power wiring to stabs shall be contained within the draw out unit. Overload relays shall be reset from outside the enclosure by means of an insulated button.

e. All draw out units shall be secured by a spring loaded quarter turn indicating type fastening device, located at the top front of the unit.

f. Combination motor controller and feeder tap units shall employ (molded case circuit breakers) (fusible switch with clips for _______ type fuses) for branch circuit protection, and shall be equipped with: (Select 1, 2, 3, 4 or 5)

1. MCP (Motor Circuit Protector)
2. MCP with current limiter
3. Thermal magnetic breaker
4. TriPac circuit breaker
5. Fusible switch

g. Control power shall be provided as follows: (Select 1, 2 or 3)

1. Individual control power transformers with one secondary control fuse. The other secondary lead shall be grounded.

2. Line voltage control circuits. Line-voltage control circuits on all circuit breaker combination controllers and fusible combination controllers larger than Size 2 shall be provided with NEMA Class J current-limiting fuses mounted in the unit in both legs of the control circuit.

3. Terminals for a separate source of control power. A control power fuse shall be provided in the unit, and the main disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.

h. Starter units shall contain: (Specify as required)

1. Number of auxiliary contacts.

2. Unit-mounted pilot devices and indicating lights.

3. Control relays and other devices.

i. Other units to be included in the motor control center: (List as required)

1. Lighting and power transformers.
2. Lighting distribution panelboards.
3. Metering panels and instrument transformers.
4. Operating panels.
5. Power-factor correction capacitors.
6. Other _______________

Dimensions
Overall Height .... 90"
Width .... 20"
Depth: Front Mounted Only
Standard .... 16"
Optional .... 21"
Back to Back Mounted .... 21"

Vertical Wireway Height .... 90"
Width .... 4⅝"
Depth .... 8"
Cross Section .... 35 sq. in.

Top Horizontal Wireway
Front Mounted Only and Front of Back to Back Mounted
Height:
Standard .... 9"
Optional .... 15"
Depth .... 8"
Rear of Back to Back Mounted
Height .... 15"
Depth .... 6"

Bottom Horizontal Wireway
Front Mounted Only and Front of Back to Back Mounted
Height:
Standard .... 9"
Optional .... 3"
Depth .... 16"
Rear of Back to Back Mounted
Height .... 3"
Depth .... 21"

Material
Frame .... 12 ga. Formed Steel Channel
Side, back & roof sheets, doors .... 14 ga.
Unit wrapper .... 16 ga. Steel Sheet

Finish
Frame, back sheets, doors and units .... Off White ASA 70
Roof & Side sheets .... Charcoal ASA 24

Horizontal Bus
Ampere Ratings
Standard:
600 ampere, Tin Plated Aluminum with POLYTET-50
Optional:
600 ampere, Copper
800 ampere, Tin Plated Aluminum with POLYTET-50 or Copper
1000 ampere, Tin Plated Aluminum with POLYTET-50 or Copper
1200 ampere, Tin Plated Aluminum with POLYTET-50 or Copper
1400 ampere, Copper
1600 ampere, Copper
2000 ampere, Copper
2500 ampere, Copper

Horizontal Bus, Continued
Bus Bracing
Standard, 42,000 amperes symmetrical
Optional, 100,000 amperes symmetrical

Incoming Line Terminations
From Top or Bottom
To Bus or Disconnect Device
Sizes: #6-350 MCM, 2 per phase in bus compartment
4/0-600 MCM, 2 per phase
Top entrance 12" additional
Bottom entrance 18" additional

Vertical Bus
Ampere Ratings
Standard:
Front Mounted Only
300 Ampere, Tin Plated Aluminum with POLYTET-50
Back to Back Mounted
600 Ampere, Tin Plated Aluminum with POLYTET-50
Optional:
Front Mounted Only
300 Ampere, Copper
600 Ampere, Copper
1200 Ampere, Copper
Back to Back Mounted
600 Ampere, Copper
800 Ampere, Copper

Bus Bracing
Standard, 42,000 Amperes symmetrical
Optional, 100,000 Amperes symmetrical

Barriers
Standard
Isolation Barrier: Glass polyester cover sheet with stab cut-outs.
Optional
Labyrinth Barrier:
Glass polyester molding for insulation and isolation, including a shutter mechanism to automatically cover stab openings.

Neutral Bus (Bottom Mounted)
Standard .... ½ neutral tin-plated aluminum with POLYTET-50
Optional .... ½ neutral copper, Full neutral aluminum with POLYTET-50 or copper
Ratings .... 300 to 2500 amperes

Ground Bus (Top Mounted)
Standard .... ¼" x 1" Tin-plated aluminum with POLYTET-50
Optional .... ¼" x 1" Copper
Ratings .... 300 Amperes

Units
Dimensions:
Width .... 13⅜"
Depth .... 8"
Height .... 12" to 72" in 6" Increments

Stab Ratings: 60 Amperes
150 Amperes
300 Amperes
400 Amperes

Interrupting Capacity
Circuit Breaker Units:
MCP with combination starter .... 22,000 Amperes
MCP with Current Limiter and combination starter .... 200,000 Amperes
TriPac .... 200,000 Amperes
Fusible Switch Units .... 200,000 Amperes

Further Information
Price List 12-125 P WE A

Westinghouse Electric Corporation
General Control Division
Chicago, Illinois, U.S.A. 60632

Installation and Maintenance Manual
FIVE STAR MOTOR CONTROL CENTERS

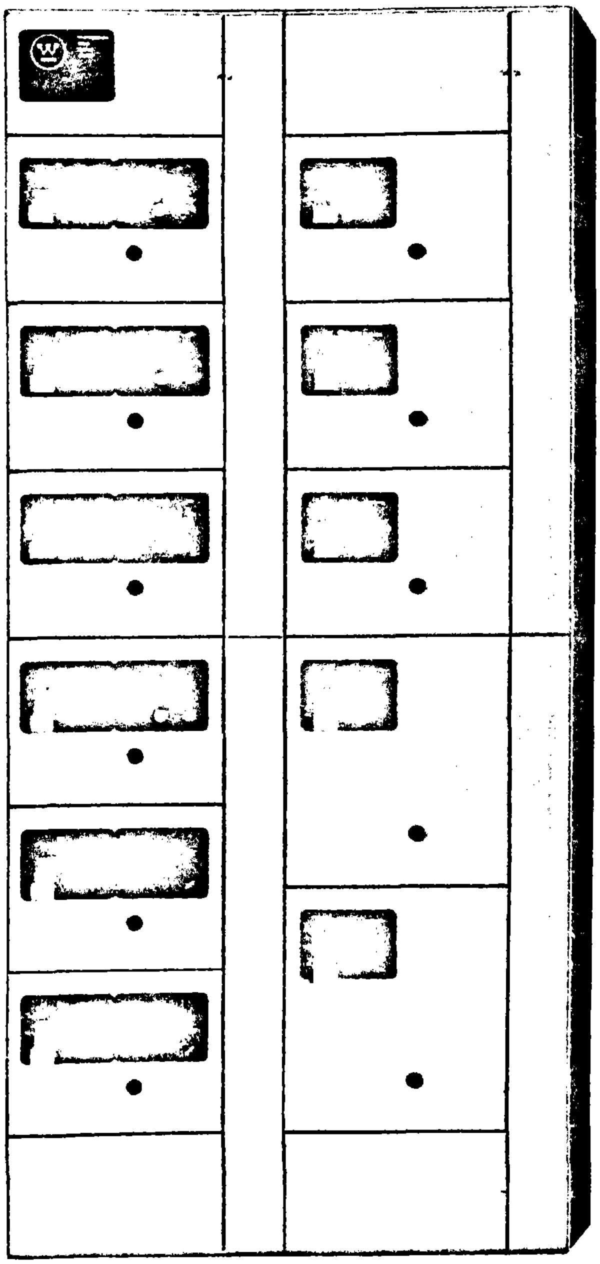


TABLE OF CONTENTS

This electrical control equipment is designed to be installed, operated, and maintained by adequately trained workmen. These instructions do not cover all details, variations, or combinations of the equipment, its storage, delivery, installation, check-out, safe operation, or maintenance. Care must be exercised to comply with local, state, and national regulations, as well as safety practices, for this class of equipment. The maximum short circuit capability of the equipment should not be exceeded by connection to a source with higher capacity.

If maintenance or troubleshooting assistance is required, contact your nearest Westinghouse Engineering Service Division or Sales Office.

Westinghouse Electric Corporation
Control Center Division
Chicago, Illinois 60632

3.1.1-352

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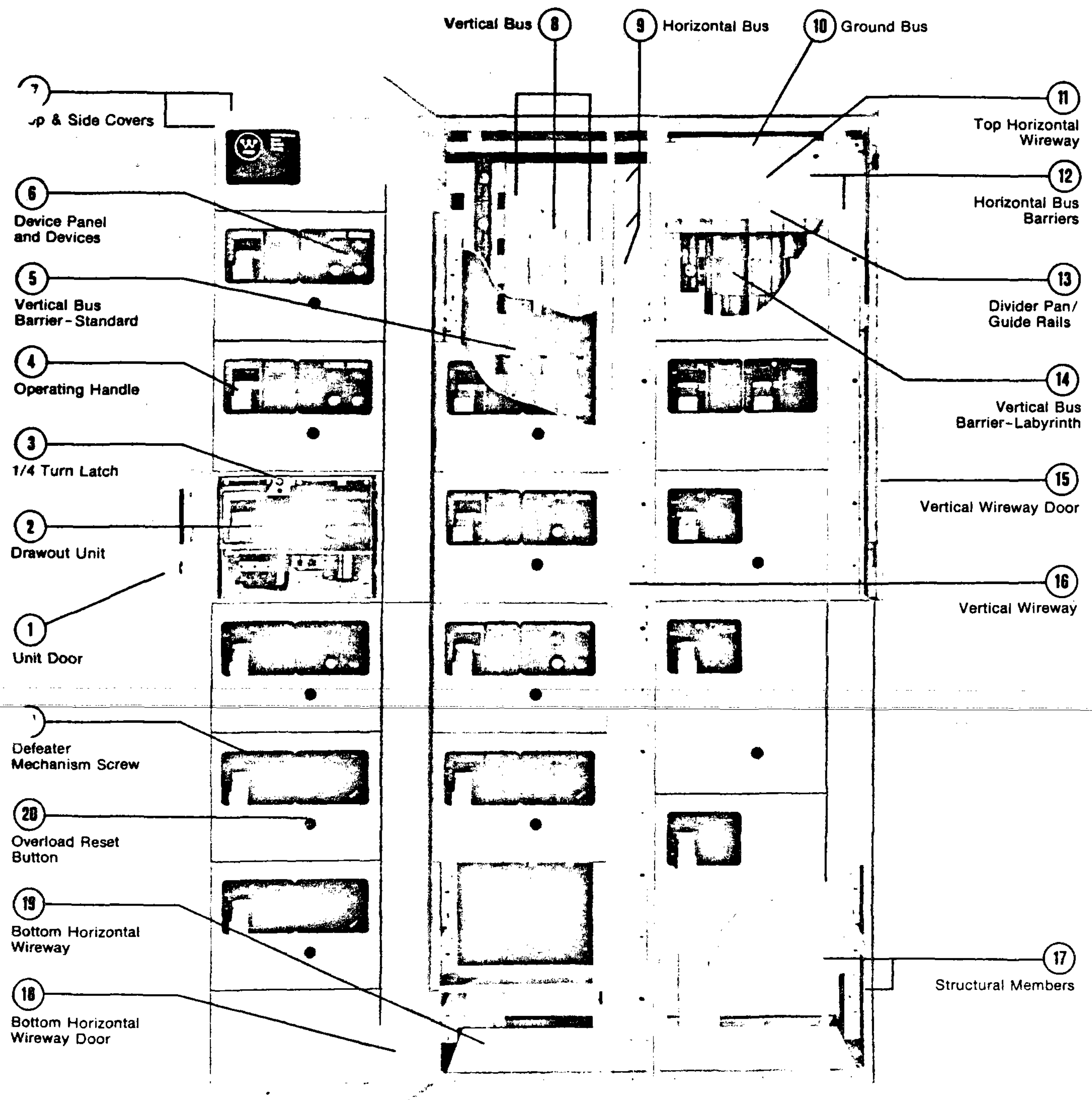
May, 1979



1.0 GENERAL DESCRIPTION

The Westinghouse FIVE STAR Motor Control Center consists of one or more totally enclosed, dead front, free standing structural assemblies (17) 90 inches high which are compartmentalized to house in-ividual control units. (2) With control units mounted in the front side only, the structure may be 16 or 21 inches deep. For mounting units back-to-back, the structure is 21 inches deep. Steel covers (7) enclose the structure at the top, sides and at the rear of front mounted only, structures.

Each control center contains a main horizontal bus system (9) mounted at the top and extending across the length of the control center.

A vertical bus system (8) installed in each vertical structure, is connected to the horizontal bus to feed the individual control units. The vertical bus is isolated by a full height barrier. (5) An optional labyrinth barrier provides both isolation and insulation. (14) An automatic shutter is included with the labyrinth barrier system to cover the stab openings for each control unit.

At the top of each structure, a door provides ready access to the top horizontal wireway (11) and ground bus (10) (if provided). The horizontal wireway is isolated from the bus systems by steel barriers (12) which can be removed for installation and maintenance operations. Adequate space is provided for control wiring and top cable entry.

At the bottom of each structure, a door (18) provides ready access to the bottom horizontal wireway, (19) and neutral bus (if provided). The bottom of each structure is completely open to provide unrestricted bottom entry of cable and conduit. Channel sills may be installed across the bottom of the control center if specified and an optional bottom plate may also be specified.

A vertical wireway 8 inches deep, (16) extending the full 90 inch height of the control center is located to the right of each vertical compartment. This wireway is covered by two hinged doors (15) and contains rugged cable supports to secure wire bundles and cables. The vertical wireway joins the horizontal wireway at top and bottom to provide unobstructed space for interwiring.

Each vertical structure provides space to mount up to six control units (2) with a minimum height of 12 inches, in increments of six inches for a total of 72 inches of usable space. Control units through NEMA Size 5 are drawout type (except Reduced Voltage Starters). These drawout unit assemblies are a completely self-contained package consisting of a steel enclosure, operating handle and electrical components. The drawout assembly slides into its compartment on guide rails (13) to provide easy withdrawal and reinsertion and to ensure precise alignment of the unit stabs with the vertical bus. Each drawout unit is held in place by a single quarter turn latch (3) which can only be engaged when the unit stabs are fully mated with the vertical bus. Each unit has a separate door, (1) held closed by a minimum of two quarter turn, indicating type fasteners.

The operating handle on the control unit (4) moves vertically. In the "on" or "tripped" positions, the handle interlocks with the unit door to prevent its opening. In this position, authorized personnel can open the door by turning the defeater mechanism screw. (21) With the unit door open and the operating handle in the "on" or "tripped" positions, another interlock to the divider pan prevents removal of the unit. This same interlock prevents insertion of the unit unless the handle mechanism is in the "off" position. To ensure units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the "off" position. Space is provided for a minimum of three padlocks.

The device panel (6) is mounted on the drawout unit. It will accommodate up to six pilot devices. The overload reset button (20) is mounted on the unit door.

2.0 HANDLING

Lifting angles for handling by overhead crane are bolted to the top of each shipping assembly. Handling by overhead crane is preferable but when crane facilities are not available, the control center can be positioned by using rollers under the shipping skid or with a fork lift truck. The shipping skids should be left in place until the center is in its final location. After removal of the top lifting angles, the mounting hardware should be replaced to prevent the entrance of dirt, etc.

2.1 RECEIVING

After unloading the control center, a thorough inspection should be made to detect any damage which might have been incurred during shipment. If there is evidence that the control center has been mishandled or shipped on its back or sides, the drawout units should be removed and a complete inspection made of the internal structure, vertical bus and units for possible hidden damage. Any damage should be reported at once to the carrier.

2.2 STORAGE

When the control center cannot be placed in service reasonably soon after its receipt, it should be stored in a clean, dry, ventilated building. The storage area should be free from condensation or other injurious environmental conditions. Freedom from condensation is essential and may be accomplished by the use of auxiliary heaters if necessary. The equipment must also be protected from excessive dust. Outdoor storage, even when protected by a tarpaulin, is inadequate.

3.0 INSTALLATION

CAUTION — If work is involved in connecting the ontrol center with existing equipment, ensure that coming power is disconnected before work is begun. Complete the work described in this section and Sections 4, 5 and 6 before incoming power is applied.

Before any installation work is begun, consult all drawings furnished by Westinghouse as well as all applicable contract drawings for the installation. Particular attention should be given to the physical location of units in the Control Center and their relation to existing or planned conduits, busways, etc.

Care should be taken to plan for any future conduit entrance in advance of Control Center installation.

Control Centers are assembled at the factory on smooth and level surfaces to assure correct alignment of all parts. The foundation furnished by the purchaser must be true and level, or the bottom frames must be shimmed to support the entire base in a true plane. An uneven foundation can cause misalignment of shipping sections, units and doors. It is recommended that leveled channel sills under both the front and rear of the Control Center be used provide this level base. They should be drilled and tapped for mounting bolts in accordance with the applicable floor plan drawing and then either installed level with, or on top of, the finished floor. If sills are grouted in concrete, the mounting bolts should be screwed in place and remain until the concrete has hardened.

Refer to pages 14 and 15 for floor plan dimensions. The shaded area represents the open space available for conduit entry through the bottom of each section. This area may be restricted if large control or auto-transformers are mounted in the bottom of these sections. If optional bottom plates are supplied, the plates may be removed and drilled for conduit entry.

If two or more shipping sections are to be joined into an integral assembly or a shipping section is to be joined to an existing section, refer to Sections 3.1 and 3.2 before proceeding with the installation. If joining is not involved, remove the bottom horizontal wireway doors to provide access, move the section into place and secure it to the floor sills or mounting bolts.

3.1 JOINING FIVE STAR SECTIONS

If two or more shipping sections are to be joined into an integral assembly, or a section added to an existing installation, splicing of horizontal bus, ground bus, neutral bus and joining of the adjacent vertical structures must be planned with the installation.

(1) Side sheets must be removed from adjacent vertical structures to be joined. (These sheets will have been removed from factory assembled sections.)

(2) The horizontal bus splice plates and connection hardware will be packed in the top horizontal wireway. These splice plates should preferably be attached first to the bus in the structure on the left side of the right hand section, whether existing or to be installed. Refer to Figure 1. This method provides the most convenient access to the bolts, and eliminates need for removal of the horizontal bus barriers in that structure. Should the existing bus be oxidized, sand lightly with a fine aluminum oxide paper. CAUTION — do not use emery cloth or any abrasive containing metal.

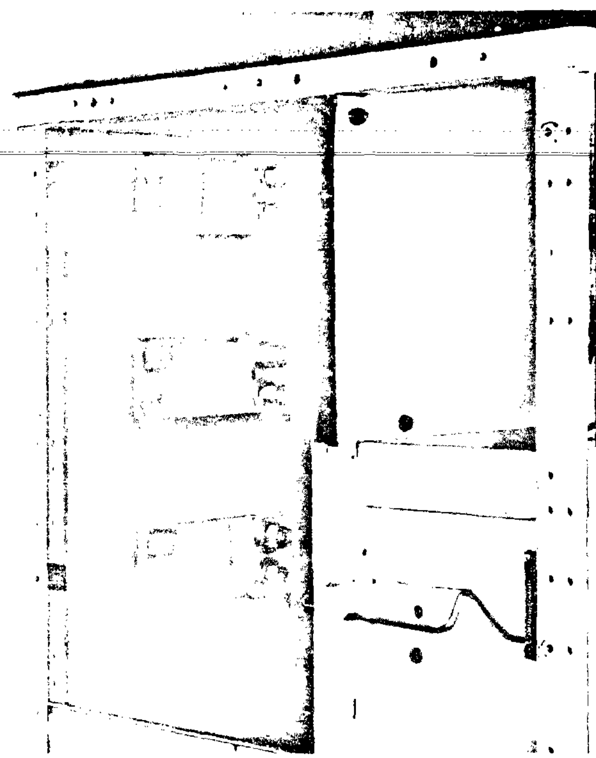


Figure 1 (76-0891)

(3) Remove the upper horizontal wireway door from the structure on the right side of the left hand section and remove the two piece wireway barrier to provide access to the ends of the bus in that section. If master terminal blocks for Type C wiring are installed in this wireway, refer to Section 5.3.

(4) Move the section in place, aligning the upright

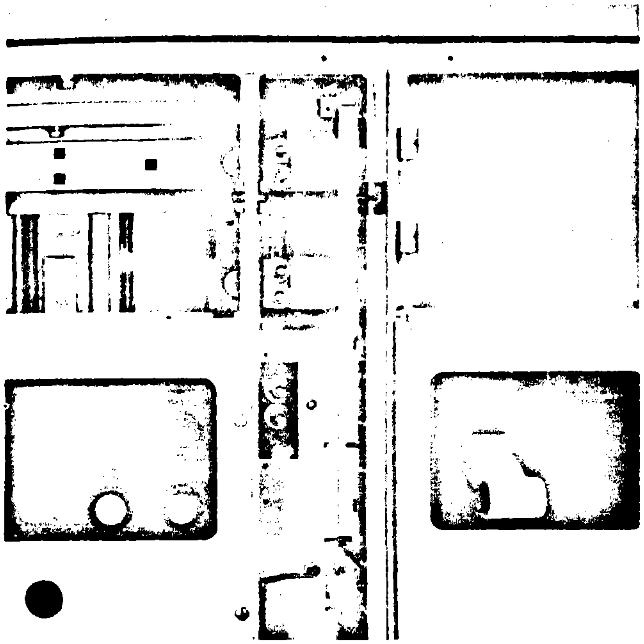


Figure 2 (76-0894/5)

structural channels and bottom channels. Alignment of the section with floor sills and foundation provisions will be facilitated by removal of the bottom horizontal wireway doors. Using the "U" type frame clamps provided, clamp adjacent front upright channels together at the top, bottom and approximate center of the vertical structure. This operation will be facilitated by removal of the vertical wireway doors from the left hand structure and one or more drawout units from the right hand structure. See Sections 7.1 and 7.2.

(5) If rear access is available, "U" clamps should also be used to clamp the rear upright channels together. In front only structures, this will require removal of the adjacent back sheets. In a back to back mounted structure, remove the vertical wireway doors and one or more drawout units as above.

(6) Secure the sections to the floor sills or mounting bolts as provided for the installation.

(7) Bolt the horizontal bus links to the bus in the left hand structure, torquing all bus splice bolts to 23 foot Lbs. See Figure 2.

(8) Replace all bus barriers and doors.

3.2 JOINING FIVE STAR TO OTHER EQUIPMENT

Joining a Five Star Control Center to other equipment such as Type W and 11-300 Control Centers will usually involve a transition section, installed between the two varieties of equipment. This transition section will be detailed on drawings provided by Westinghouse and the applicable contract drawings. If provided separately, it should be installed first. The overall installation task should be reviewed to determine whether the transition section should be attached to the existing equipment or to the Five Star section, before it is moved into place, and to select the sequence which will provide best access to bus splicing and joining of the structures.

4.0 INCOMING LINE CONNECTIONS

CAUTION: All incoming line compartments present an obvious hazard when the door is opened or covers are removed with power on. When working in this area, the incoming feeder should be de-energized.

Main cables normally terminate at the line side of the main motor Control Center disconnect or at an incoming line lug compartment. The design of the Five Star Motor Control Center provides a wide variety of choices in the selection of incoming line arrangements. Typical incoming line arrangements are shown in Figure 3. Before beginning work on incoming line connections, refer to all drawings furnished by Westinghouse as well as all applicable contract drawings for the particular installation.

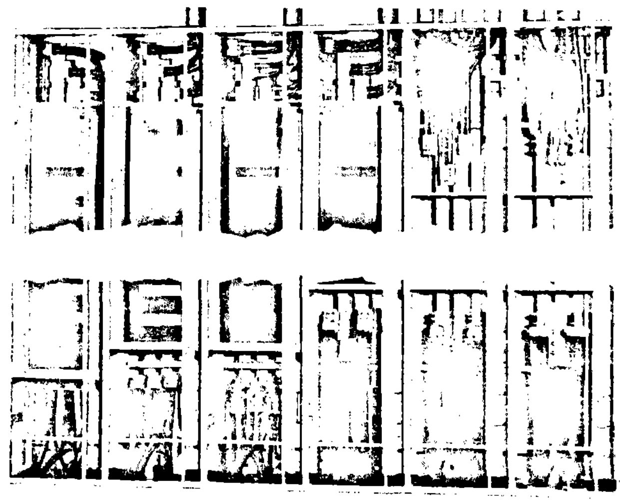


Figure 3 (76-0156)

Depending on the location, size and type of the incoming arrangement, removal of one or more horizontal and vertical wireway doors, horizontal bus barriers, side sheets and units will provide complete access.

For top entry, the top cover plates are easily removed to facilitate drilling or punching operations.

Provisions should be made to locate cables in the motor control centers so that they will be free from physical damage and also to avoid overheating. The cables should be supported in order to withstand available short circuit currents.

5.0 MOTOR & CONTROL CONNECTIONS

All field wiring to control units should be made in accordance with the wiring drawings which are urnished with the control center. Load and control wiring can be brought in through the upper and/or lower horizontal wireways. Determine the type of wiring installed in the control center (NEMA Type A, B or C) and proceed per the appropriate section below.

5.1 NEMA TYPE A WIRING (terminal blocks not provided)

Each control unit is factory assembled with devices interwired within the unit. Terminal blocks are not provided. All field wiring must be brought into the unit for connection. All field wiring should be brought from a horizontal wireway into the vertical wireway on the right hand side of the applicable control unit. From the vertical wireway, the wires should be carried under the bottom right hand side of the unit and terminations made within the unit.

5.2 NEMA TYPE B WIRING (unit terminal blocks provided)

Each control unit is factory assembled with devices nterwired within the unit. In addition, all control wiring is carried to unit terminal blocks mounted on the right hand side of the unit. Field wiring of control wires should be brought from a horizontal wireway into the vertical wireway on the right hand side of the applicable control unit and terminated at the unit terminal blocks. Load wiring should be carried from the vertical wireway, under the bottom right hand side of the unit and terminations made within the unit.

5.3 NEMA TYPE C WIRING (unit and master terminal blocks provided)

Each control unit is factory assembled with devices interwired within the unit. In addition, all control wiring is carried to unit terminal blocks on the side of the unit and from these unit blocks and load wiring through Size 2 to master terminal blocks located at the top or bottom of the structure. See Figure 4. Master terminal blocks can be either fixed or drawout mounted with drawout provided as standard. In the drawout design the terminal blocks are rack mounted to permit withdrawal of the entire assembly for ease of wiring during installation and maintenance. Field wiring should be brought from the horizontal wireway and terminated at the master terminal blocks except for load wiring above Size 2. These load wires should be carried into the vertical wireway and under the bottom right hand side of the unit and terminations made within the unit.

5.4

After completion of field wiring, utilize the cable supports in the vertical wireways to secure wire bundles and cables.

5.5 INSTALLATION OF MOTOR CIRCUIT PROTECTIVE DEVICES

Motor Circuit Protectors must be adjusted and fuses and overload relay heaters must be installed by the purchaser after installation of the Control Center. This adjustment and installation at the job site, when actual motor full load currents are known, assures maximum protection for equipment and safety for personnel.

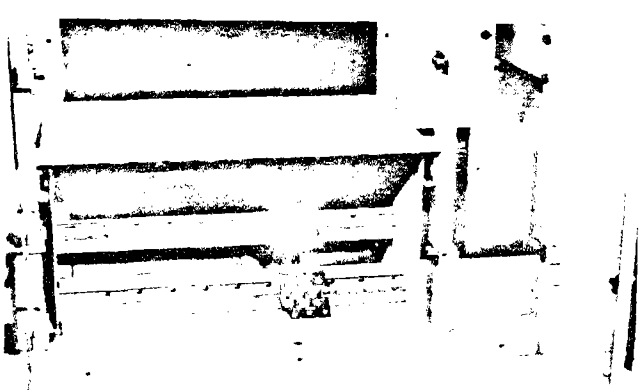


Figure 4 (DB-8B)

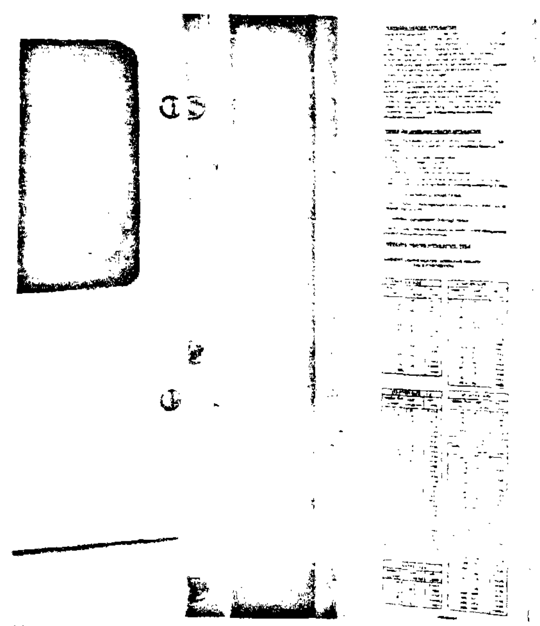


Figure 5 (76-0814)

WARNING: The opening of a branch circuit protective device may be an indication that a fault current has been interrupted. To provide continued protection against fire or shock hazard, current carrying parts and other components of the combination controller should be examined and replaced if damaged.

Following sections provide complete instructions for adjustment of MCP's and installation of heaters. In addition, ready reference to overload heater application is provided by a table attached to the inside of the upper vertical wireway door. See Figure 5.

In fusible units, factory installed fuse clips are sized in accordance with order specifications. Fuse selection and verification of fuse clip ratings should be made on the basis of the characteristics of installed motors, order specifications and national and local codes.

5.6 MOTOR CIRCUIT PROTECTION (MCP)

AFTER INSTALLATION OF THE CONTROL CENTER, EACH MCP MUST BE ADJUSTED TO ACTUAL MOTOR FULL LOAD AMPS (FLA) SO THAT IT WILL TRIP AT ANY CURRENT WHICH EXCEEDS STARTING INRUSH. This provides low level fault protection. The first half-cycle inrush will vary with the motor characteristics. Motors with locked rotor currents of six times motor full load amperes will usually require an instantaneous magnetic setting of 7 to 11 times motor full load amperes to prevent tripping when starting.

A screwdriver adjustment is near the lower left corner around which are seven circled adjustment points calibrated in trip amperes. See Figure 6. A pin is provided loose for insertion at the point of correct adjustment. Adjustment should never exceed 13 times FLA which is in accordance with N.E.C. requirements for magnetic only breakers.

Adjustment should be made as follows:

1. Obtain FLA from motor nameplate.
2. Multiply FLA by 13.
3. Find the nearest trip setting to the calculated figure in Item 2. This is the maximum pin location.
4. Depress and turn the screwdriver adjustment counterclockwise until the breaker trips in starting and then adjust upward one setting position. This will insure that the circuit will open instantly on any current above the motor inrush — usually 7-11 times FLA.
5. Push the pin through the Decal at the location in Item 4. This should always be at no higher point than the maximum location per Item 3. This acts as a stop for adjustment nearest the tripping point to provide maximum overcurrent protection and to prevent unauthorized increase from this adjustment without change in motor characteristics.

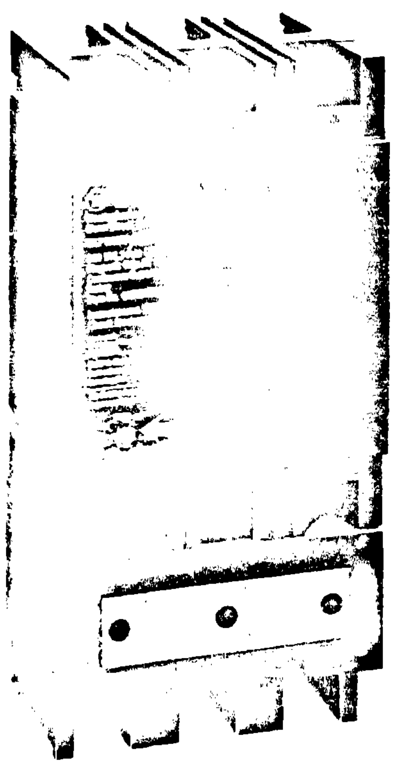


Figure 6 (2555-2)

5.7 CURRENT LIMITERS FOR USE WITH MCP and FB BREAKERS

The addition of the current limiter provides interrupting capacity above the range handled by the MCP in motor starters or by FB Thermal Magnetic feeder breakers.

Each MCP or FB breaker rating up to 150 amps has its own current limiter to provide co-ordinated protection against faults up to 200,000A RMS.

Built-in trip indicators in each phase immediately show when a fault has blown the current limiter and tripped the circuit breaker. This provides protection against single phasing. **After interrupting a fault, the current limiter will require replacement.** After the fault has been cleared, the current limiter is replaced by the removal of three screws. The breaker can then be reset to provide for subsequent high current protection.

5.8 OVERLOAD HEATER APPLICATION

HEATERS MUST BE INSTALLED IN THE STARTER OVERLOAD RELAY ASSEMBLIES BEFORE THE STARTER IS ENERGIZED.

Heaters should be selected on the basis of the actual full load current and service factor as shown on the motor nameplate or in the manufacturer's published literature.

FOR NON-AMBIENT COMPENSATED RELAYS (RED RESET ROD) When the motor and overload relay are in the same ambient and the service factor of the motor is 1.15 to 1.25, select heaters from the heater application table on page 13, right hand column. If the service factor of the motor is 1.0, or there is no service factor shown, or a maximum of 115% protection is desired, select one size smaller heater than indicated.

FOR TEMPERATURE COMPENSATED OVERLOAD RELAYS, (BLACK RESET ROD) select the heaters according to the left hand column on page 13 and selection information above regardless of ambient.

Figure 7 (76-0968)

Figure 7 shows a Type A overload relay with one of the heaters being installed. Heaters must be installed with the diagonal cut corners matching the relay contact area and securing screws must be drawn down tight. Do not rely on the code marking on the heater to indicate current rating.

WARNING: To provide continued protection against fire and shock hazard, the complete overload relay must be replaced if burnout of the current element occurs.

WARNING: Do not ever remove heaters from Size 5 and larger starters to check unit operation. These starters use current transformers to drop the current to the size one overload relay and operation with heaters removed will not interrupt voltage to the motor and will generate dangerous voltages in the open secondary of the current transformer.

6.0 INSPECTION BEFORE ENERGIZING

Before energizing the Control Center, conduct a thorough inspection to make certain that all foreign materials such as tools, scraps of wire and other debris are removed from all units and the structure. Any accumulation of dust and dirt should be removed with a vacuum cleaner if available, otherwise this material can be blown out with an air hose or manually cleaned.

All circuit connections are tightened at time of assembly by power driven tools with controlled torque. However, the vibrations experienced in transit may loosen some of these connections. It is recommended that at least 10% of the total connections be checked for a tight connection. (See page 9 for Torque Values.) **Should this spot check reveal some loose connections, it will be necessary to check all connection points.** The connections include bus hardware, circuit breaker and switch terminals, contactor and relay terminals and terminal blocks. A necessary check in any event should include the incoming line connections.

All relays should be inspected to ensure that any blocking for shipment is removed and that the armature moves freely. Power circuit fuses and overload relay heaters are normally furnished by the purchaser and must be installed in the field. Each fuse and heater should be checked for correct rating in accordance with National Electric Code application requirements.

Finally, all mechanical latches, operating mechanisms and door assemblies should be checked for proper alignment and operation. Mishandling in transit can cause misalignment. The disconnect operating mechanism should operate without mechanical interference in both the "ON" and "OFF" positions. When the mechanism is in the "ON" position, the door should not open.

Refer to Sections 7.3 and 7.4 for adjustments of the door interlock and operating mechanism.

If the Control Center contains a labyrinth vertical bus barrier system, operation of the automatic shutters should be verified. See Section 7.5 for adjustments of this mechanism.

7.0 MAINTENANCE

This control equipment is designed to be installed, operated, and maintained by adequately trained workmen. These instructions do not cover all details, variations, or combinations of the equipment, its storage, delivery, installation, check-out, safe operation, or maintenance. Care must be exercised to comply with local, state, and national regulations, as well as safety practices, for this class of equipment.

When servicing and adjusting the electrical equipment, refer to the applicable drawings covering the specific Control Center and any other related interconnection drawings. Follow any instructions which may be given for each device. A list of instruction leaflets covering standard components is shown on page 12 of this manual. Any of these leaflets may be obtained by contacting your nearest Westinghouse Representative.

In addition, the following items should be noted when servicing equipment.

1. **WARNING:** Line side of disconnect is energized. Do **not** work on drawout units unless in the lockout position or removed from the structure. Do **not** work on fixed units until the main disconnect is in the "OFF" position.

2. The equipment should be kept clean at all times. Any accumulation of dust and dirt should be removed by an industrial vacuum cleaner if available, or by manual cleaning.

3. Periodic inspection should be made of all devices to insure that the apparatus is functioning in proper order.

4. Badly worn or pitted contacts should be replaced as soon as possible for safety reasons and as a part of preventive maintenance.

5. Lubrication should **not** be applied to any part of any electrical device, especially the contact point of unit stabs and vertical bus.

6. It is **not** recommended that emery paper, sandpaper, or a file be used to clean or dress up any portion of the electrical equipment. For copper bus applications requiring a sanding operation use Aluminum Oxide Paper. This will not leave sand or metal particles on contact surface areas. Do not sand aluminum bus under any circumstances.

7. The silver cadmium contact points of linestarters must **not** be sanded. In the event of wear, replace all contacts as a group to avoid misalignment problems.

8. Keep connections tight per the following table of Torque Values. Special attention should be given to the overload relay thermal element (heater) connections to assure proper functioning.

CONNECTION		TORQUE VALUES
Bus (Horizontal & Vertical)		23 Foot Lbs.
Bus Insulator		20 Inch Lbs.
MCP Bkr. or DS Switch		60 Inch Lbs.
A-200 Starter (Contactor	Size 1	25 Inch Lbs.
& Overload Relay)	Size 2	60 Inch Lbs.
	Size 3 & 4	90 Inch Lbs.
Type GCA Starter/ Contactor	Size 5	25 Foot Lbs.
Overload Relay		25 Inch Lbs.
Terminal Blocks (Control)		18 Inch Lbs.
Fuse Block Terminals		100 Inch Lbs.

Figure 8 (76-0812)

9. Authorized personnel may open the door while the starter unit is energized. This is accomplished by defeating the mechanical interlock between the operating mechanism and the unit door. A clockwise quarter turn of the slotted head screw located above operating handle will allow the door to open. See Figure 8.

10. To positively lock the operating mechanism in the "OFF" position and to prevent the door opening, a metal locking bar recessed in the handle may be extended and padlocked with from one to three padlocks. See Figure 9.

11. With the door open and the disconnect device "OFF" it is mechanically interlocked to prevent inadvertently being pushed "ON". To defeat this interlock, the bar on the top of the mechanism should be pushed in slightly, allowing the handle to move upward to

the "ON" position. Padlocking to prevent this handle movement may be accomplished by the same method as described above.

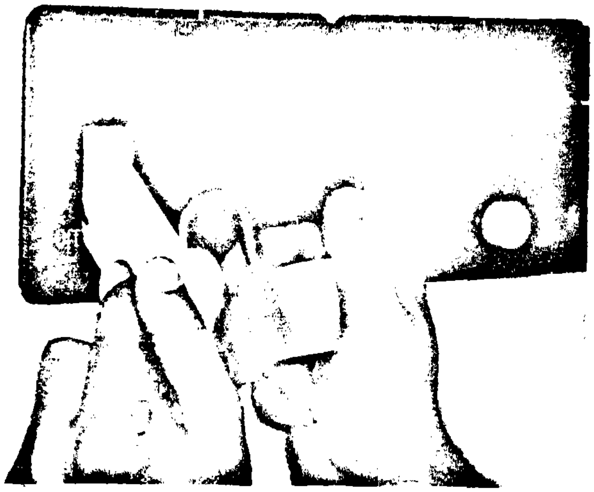


Figure 9 (76-0811)

7.1 DOOR REMOVAL AND RE-INSTALLATION

All doors on the Control Center are mounted on pin hinges to facilitate removal for installation and maintenance operations. With the operating handle in the "OFF" position, turn the quarter turn indicating latches, open the door, remove the hinge pins as shown in Figure 10, partially close the door and lift it from the structure. Reverse this procedure for installation.

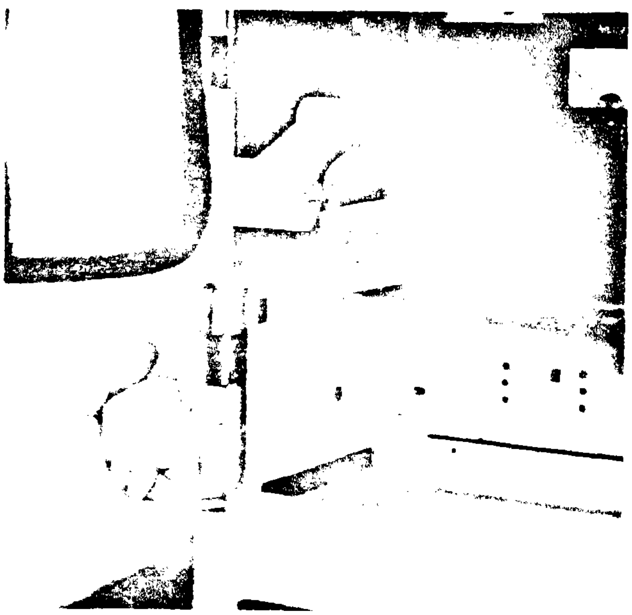


Figure 10 (76-0608)

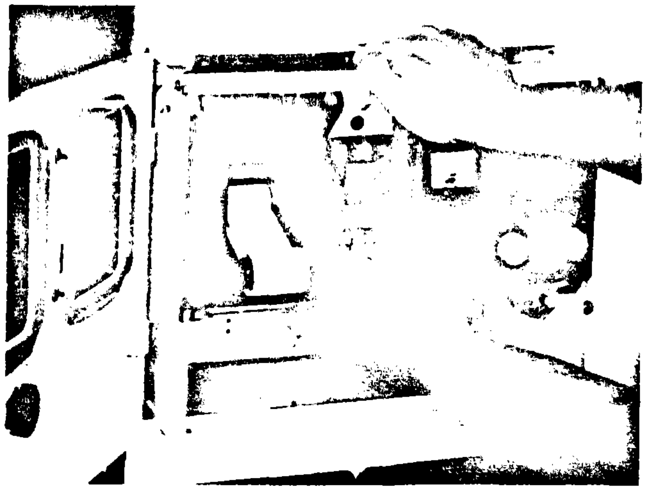


Figure 11 (76-0813)

7.2 UNIT REMOVAL AND RE-INSTALLATION

After opening and/or removing the unit door, the control unit is exposed. With a screwdriver, push in on the latch at the top center of the unit and rotate 1/4 turn counterclockwise. **CAUTION** — wiring from the unit to other units, to master terminal blocks or to load devices must be disconnected before the unit is removed. Grasp the unit as shown in Figure 11 and pull it outward. The first inch of travel pulls the stabs free from the vertical bus.

To replace a control unit, position the mounting points on the wrapper with the mating guide rails. Slide the unit inward until all four mounting points are engaged, then move it inward with a quick push. This movement easily overcomes the compression of the stabs as they engage the vertical bus. With the unit in its correct position, the 1/4 turn latch is easily engaged by pushing inward and rotating 1/4 turn clockwise.

Figure 12 (76-0609)

For maintenance and test purposes, the unit can be partially withdrawn (approximately 1½ inches) until the stabs are free of the bus. In this position, the 1/4 turn latch can be rotated clockwise to engage the detent position slot, this will secure the unit to ensure the stabs remain disengaged during maintenance. See Figure 12. The latch can be padlocked in this position.

7.3 UNIT DOOR INTERLOCK ADJUSTMENT

Each unit door has an interlock with the operating mechanism to prevent inadvertent opening of the door with the operating handle in the "ON" position. When the door is closed and the operating handle is in the "OFF" position, the door interlock depresses the vertical bar in the operating mechanism, permitting the operating handle to move freely into the "ON" position. In the event the unit door can be opened with the handle in the "ON" position, or the handle does not move freely into the "ON" position with the door closed, the door interlock should be adjusted as shown in Figure 13.

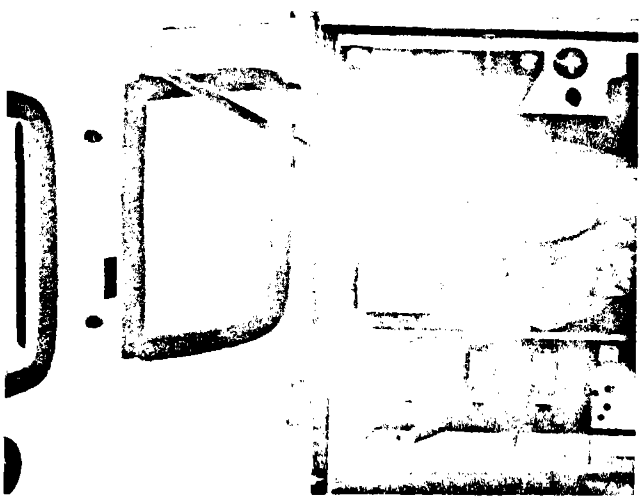


Figure 13 (76-0610)

7.4 OPERATING HANDLE LINKAGE ADJUSTMENT

Movement of the operating handle in the vertical plane should not be restricted by the handle cavity at either the top or bottom of its travel. Should restriction occur, it can be eliminated by adjusting the length of the operating linkage as shown in Figure 14. Depending on the type of primary disconnect device contained in the control unit, it may be necessary to lengthen or shorten the linkage.

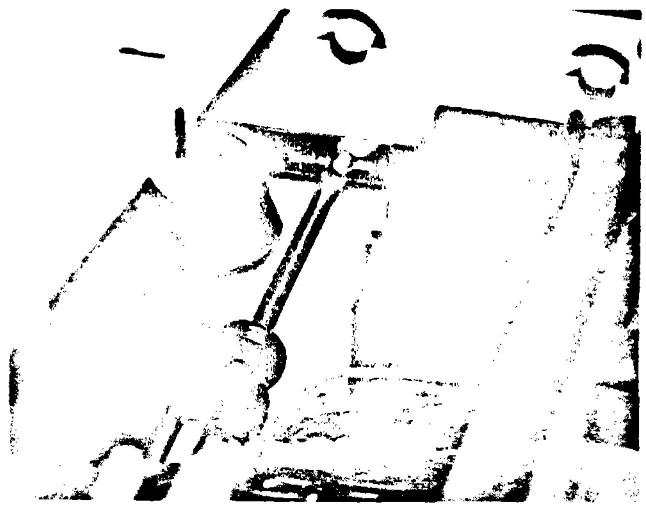


Figure 14 (76-0606)

7.5 AUTOMATIC SHUTTER TRAVEL ADJUSTMENT

When the optional labyrinth vertical bus barrier is installed in the control center, a shutter is provided to automatically cover the stab openings when a control unit is withdrawn. The shutter is opened by engagement of the left hand side of the control unit with the shutter arm linkage attached to the left hand vertical structural members. When the unit is withdrawn free of the linkage, a spring automatically moves the shutter to its closed position. See Figure 15, and Figure 1.

With the control unit removed, the shutter should completely cover the stab openings. If it does not cover the openings, use an adjustable wrench to bend the link arm to the right until the shutter covers the stab openings.

If, on re-insertion of the control unit, interference is felt between the stab assembly at the rear of the unit and the shutter, the engagement of the control unit

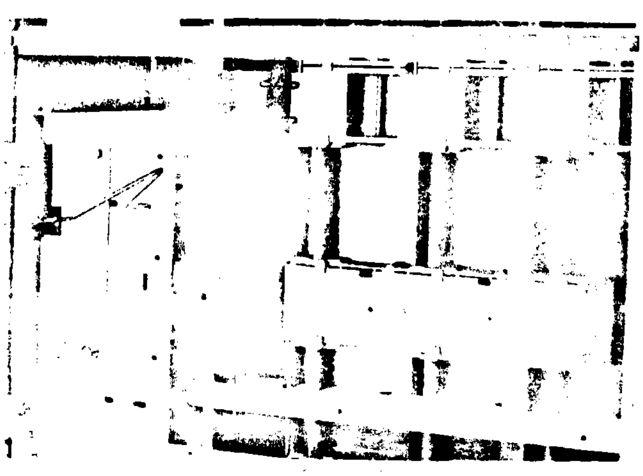


Figure 15 (DB-7B)

with the shutter arm linkage is insufficient to fully open the shutter. Use an adjustable wrench to bend the linkage arm inward toward the unit to increase its engagement with the unit. An inward bend of approximately 1/4 inch will provide sufficient additional shutter travel.

7.6 INSTALLING ADDITIONAL PILOT DEVICES

The device panel can accommodate up to six pilot devices such as oil tight pushbuttons, indicating lights, selector switches and miniature meters. If unused space is available and the addition of other devices is desired, observe the following procedure.

After opening the unit door, loosen the two screws at the top of the device panel. Sliding the panel 1/2 inch left will permit it to swing down for access. See Figure 16. With the peen end of a ball peen hammer or with a drift or chisel, remove the desired knockout. **CAUTION** — Brace the panel solidly to avoid breaking the hinge points. A knife or small file can be used to remove remaining plastic burrs. Install and wire the new device and re-attach the top of the device panel to the unit.

Figure 16 (76-0890)

8.0 INSTALLING A NEW UNIT

It is recommended that a new unit be installed in a space at the top of a vertical compartment or directly below an existing unit. Material provided with the new unit by the factory includes; a divider pan with integral guide rails, a unit door, hinges, catches and hardware. Observe the following sequence of operations for installation.

1. Remove the existing blank door.
2. Position the new unit door over the open space to ensure the hinges and latches are aligned. If the spaces differ, the hinges and latches on the structure must be re-located to match the door hinges and latches. Mount the door, using the hinge pins provided.
3. Install the new divider pan in the notches provided in the rear barrier so that it is aligned with the bottom of the new door. Attach the pan to the vertical structure channels with one thread forming screw on each side.
4. Remove from the vertical bus barrier the flat plate which covers the stab holes that will align with the stabs on the new unit. If an optional labyrinth vertical bus barrier is installed, an automatic shutter must be installed over the stab cutouts. Follow the instruction sheet provided with the shutter kit.

RELATED INSTRUCTION LEAFLETS

and reference material for devices commonly used in Five Star Control Centers.

DEVICE	INSTRUCTION BOOKLET OR OTHER REFERENCE
LINESTARTERS	
Size 1 Non-Reversing	IL 13633
Size 2 Non-Reversing	IL 13678
Size 3 & 4 Non-Reversing	IL 13240
Size 1 Reversing	IL 13194
Size 2 Reversing	IL 13197
Size 1 & 2 Reversing	IL 13243
CONTACTORS	
Size 1 Non-Reversing	IL 13144
Size 2 Non-Reversing	IL 13158
Size 3 & 4 Non-Reversing	IL 13238
Size 1 & 2 Reversing	IL 13187
Size 3 & 4 Reversing	IL 13241
GCA Size 5	IL 15825-14
GCA Size 6	IL 15825-15
OVERLOAD RELAYS	
Size 1 and 2	IL 14568
Size 3 and 4	IL 14570
GCA Size 5	IL 15827-20
GCA Size 6	IL 15827-21
Modular Overload	IL 14973
DS SWITCHES	
30A through 100A	IL 14441
200A	IL 13701
ELECTRICAL INTERLOCKS TYPE L56, Sizes 1-4	IL 13134
MECHANICAL INTERLOCKS	
Sizes 1, 2, 3 and 4	IL 14597
GCA Size 5 and 6	CS 16-121
CIRCUIT BREAKERS	AD 29-160
CONTROL RELAYS	CS 16-300

HEATER TABLES — BLOCK TYPE OVERLOAD USING 3 HEATERS

These Heater Application Tables indicate the range of full load motor current to which a given heater may be applied. The tables represent a 100% setting of the adjustment knob on the bottom of the relay. Turning the knob towards the 85% setting will result in the relay tripping in shorter time. Turning the knob towards the 115% setting will result in the relay tripping at a longer time.

Heaters should be selected on the basis of 40° C rise open motors with the actual full load current and service factor as shown on the motor nameplate or in the manufacturer's published literature.

For non-ambient compensated relays, (red reset rod) when the motor and overload relay are in the same ambient and the service factor of the motor is 1.15 to 1.25, select heaters from the right hand column of the Heater Application Table. **If the service factor of the motor is 1.0, or there is no service factor shown, or a maximum of 115% protection is desired, select one size smaller heater than indicated.**

When motor and overload relay are in different ambients and when using non-compensated overload relays, select heaters from the table using adjusted motor currents as follows: decrease rated motor current 1% for each °C motor ambient exceeds controller ambient. Increase rated motor current 1% for each °C controller ambient exceeds motor ambient.

For temperature compensated overload relays, (black reset rod) select heaters according to the left hand column of the table, and selection information above regardless of ambient.

WARNING: To provide continued protection against fire and shock hazard, the complete overload relay must be replaced if burnout of the current element occurs.

FOR STARTER SIZE 1

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
.51 — .55	.48 — .51	FH10
.56 — .62	.52 — .57	FH11
.63 — .68	.58 — .63	FH12
.69 — .75	.64 — .70	FH13
.76 — .83	.71 — .77	FH14
.84 — .91	.78 — .85	FH15
.92 — 1.00	.86 — .93	FH16
1.01 — 1.11	.94 — 1.03	FH17
1.12 — 1.22	1.04 — 1.13	FH18
1.23 — 1.34	1.14 — 1.25	FH19
1.35 — 1.47	1.26 — 1.37	FH20
1.48 — 1.62	1.38 — 1.51	FH21
1.63 — 1.78	1.52 — 1.65	FH22
1.79 — 1.95	1.66 — 1.81	FH23
1.96 — 2.15	1.82 — 1.99	FH24

FOR STARTER SIZES 1 & 2

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
2.16 — 2.35	2.00 — 2.19	FH25
2.36 — 2.58	2.20 — 2.39	FH26
2.59 — 2.83	2.40 — 2.63	FH27
2.84 — 3.11	2.64 — 2.89	FH28
3.12 — 3.42	2.90 — 3.17	FH29
3.43 — 3.73	3.18 — 3.47	FH30
3.74 — 4.07	3.48 — 3.79	FH31
4.08 — 4.39	3.80 — 4.11	FH32
4.40 — 4.87	4.12 — 4.55	FH33
4.88 — 5.3	4.56 — 5.0	FH34
5.4 — 5.9	5.1 — 5.5	FH35
6.0 — 6.4	5.6 — 5.9	FH36
6.5 — 7.1	6.0 — 6.6	FH37
7.2 — 7.8	6.7 — 7.2	FH38
7.9 — 8.5	7.3 — 7.9	FH39
8.6 — 9.4	8.0 — 8.7	FH40
9.5 — 10.3	8.8 — 9.5	FH41
10.4 — 11.3	9.6 — 10.5	FH42
11.4 — 12.4	10.6 — 11.5	FH43
12.5 — 13.5	11.6 — 12.6	FH44
13.6 — 14.9	12.7 — 13.8	FH45
15.0 — 16.3	13.9 — 15.1	FH46
16.4 — 18.0	15.2 — 16.7	FH47
18.1 — 19.1	16.8 — 18.3	FH48
19.9 — 21.7	18.4 — 20.2	FH49
21.8 — 23.9	20.3 — 22.2	FH50
24.0 — 26.2	22.3 — 24.3	FH51
26.3 — 28.7	24.4 — 26.6	FH52

FOR STARTER SIZE 2

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
28.8 — 31.4	26.7 — 29.1	FH53
31.5 — 34.5	29.2 — 32.0	FH54
34.6 — 37.9	32.1 — 35.2	FH55
38.0 — 41.5	35.3 — 38.5	FH56
41.6 — 45.0	38.6 — 42.3	FH57

FOR STARTER SIZES 3 & 4

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
19.0 — 20.8	17.5 — 19.1	FH72
20.9 — 22.9	19.2 — 21.1	FH73
23.0 — 25.2	21.2 — 23.2	FH74
25.3 — 27.8	23.3 — 25.6	FH75
27.9 — 30.6	25.7 — 28.1	FH76
30.7 — 33.5	28.2 — 30.8	FH77
33.6 — 37.5	30.9 — 34.5	FH78
37.6 — 41.5	34.6 — 38.2	FH79
41.6 — 46.3	38.3 — 42.6	FH80
46.4 — 50	42.7 — 46	FH81
51 — 55	47 — 51	FH82
56 — 61	52 — 56	FH83
62 — 66	57 — 61	FH84
67 — 73	62 — 67	FH85
74 — 79	68 — 73	FH86
80 — 87	74 — 80	FH87
88 — 90	81 — 87	FH88

FOR STARTER SIZE 4

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
88 — 95		FH88
96 — 105	88 — 95	FH89
106 — 116	96 — 105	FH90
117 — 128	106 — 116	FH91

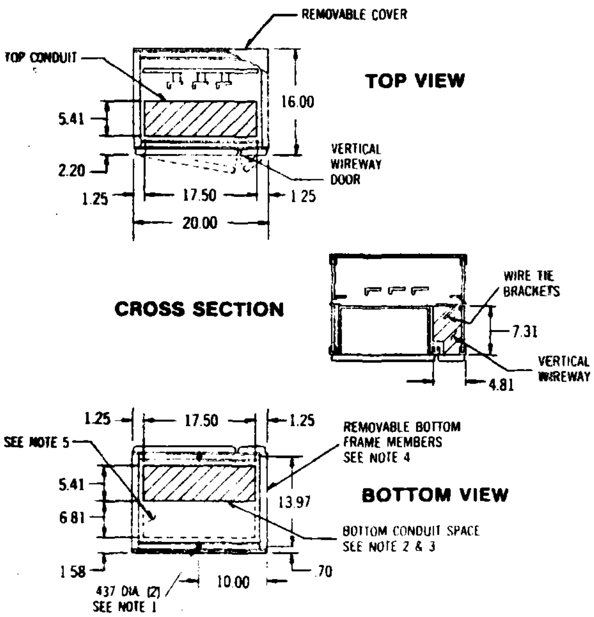
FOR STARTER SIZE GCA 5 (300/5 CT ratio)

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
118 — 129	110 — 119	FH24
130 — 141	120 — 131	FH25
142 — 155	132 — 143	FH26
156 — 170	144 — 158	FH27
171 — 187	159 — 173	FH28
188 — 205	174 — 190	FH29
206 — 224	191 — 208	FH30
225 — 244	209 — 227	FH31
245 — 263	228 — 247	FH32
264 — 270	248 — 270	FH33

FOR STARTER SIZE GCA 6 (600/5 CT ratio)

Compensated Ambient (Black reset rod)	Non Compensated (Red reset rod)	Heater Code Marking
236 — 259	219 — 239	FH24
260 — 283	240 — 263	FH25
284 — 310	264 — 287	FH26
311 — 340	288 — 316	FH27
341 — 374	317 — 347	FH28
375 — 411	348 — 381	FH29
412 — 448	382 — 417	FH30
449 — 489	418 — 455	FH31
490 — 527	456 — 494	FH32
528 — 540	495 — 540	FH33

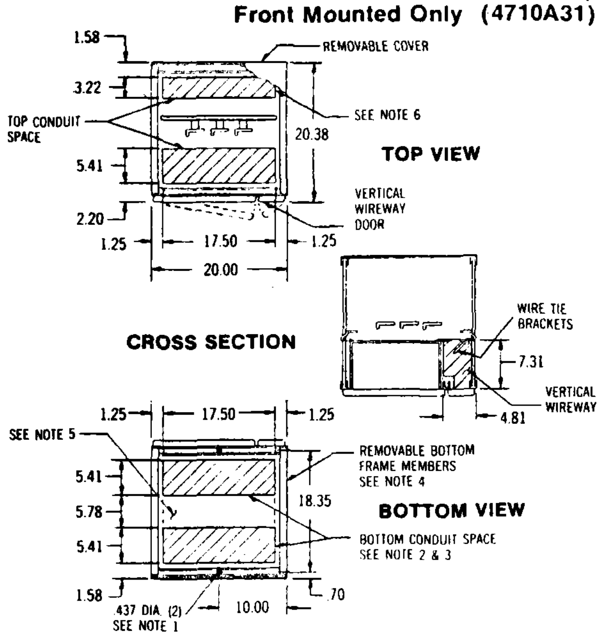
20 Inches Wide, 16 Inches Deep Front Mounted Only (4710A30)



1. Minimum length of anchor bolt 2 inches (.36-16 recommended.)
2. Recommended maximum conduit height above floor line 3.50 inches.
3. Maximum conduit space with channel sills 17.5 x 9.73 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.

See side View A, far right for vertical dimensions.

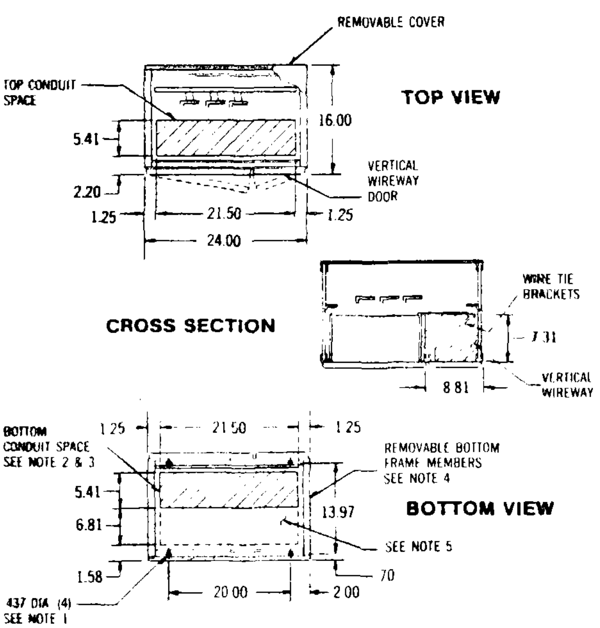
20 Inches Wide, 21 Inches Deep Front Mounted Only (4710A31)



1. Minimum length of anchor bolt 2 inches (.36-16 recommended.)
2. Recommended maximum conduit height above floor line 3.50 inches.
3. Maximum conduit space with channel sills 17.5 x 14.11 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.
6. Top rear conduit space not recommended for conduit entry in FMO structure.

See side View A, far right for vertical dimensions.

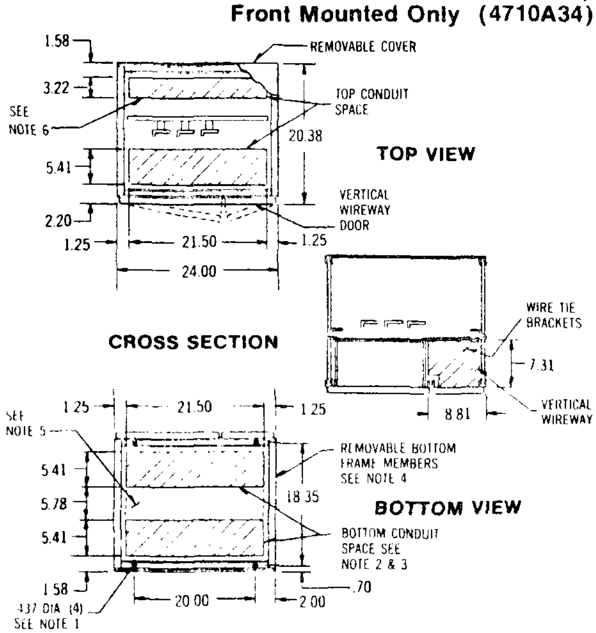
24 Inches Wide, 16 Inches Deep Front Mounted Only (4710A33)



Minimum length of anchor bolt 2 inches (.36-16 recommended.)
Recommended maximum conduit height above floor line 3.50 inches.
Maximum conduit space with channel sills 21.5 x 9.73 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.

See side View A, far right for vertical dimensions.

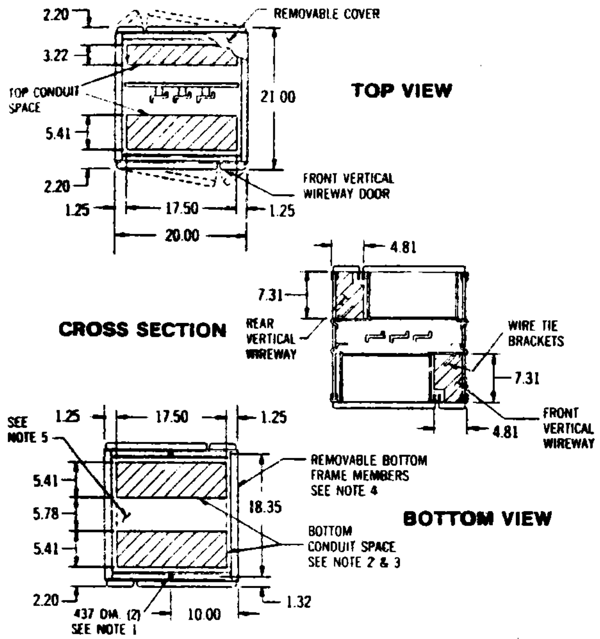
24 Inches Wide, 21 Inches Deep Front Mounted Only (4710A34)



1. Minimum length of anchor bolt 2 inches (.36-16 recommended.)
2. Recommended maximum conduit height above floor line 3.50 inches.
3. Maximum conduit space with channel sills 21.5 x 14.11 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.
6. Top rear conduit space not recommended for conduit entry in FMO structure.

See side View A, far right for vertical dimensions.

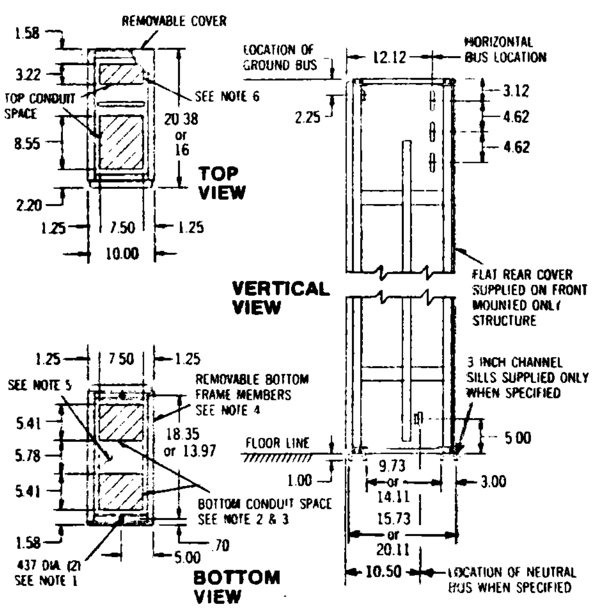
20 Inches Wide, 21 Inches Deep Front and Rear Mounted (4710A32)



1. Minimum length of anchor bolt 2 inches (.36-16 recommended.)
2. Recommended maximum conduit height above floor line 3.50 inches.
3. Maximum conduit space with channel sills 17.5 x 14.11 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.

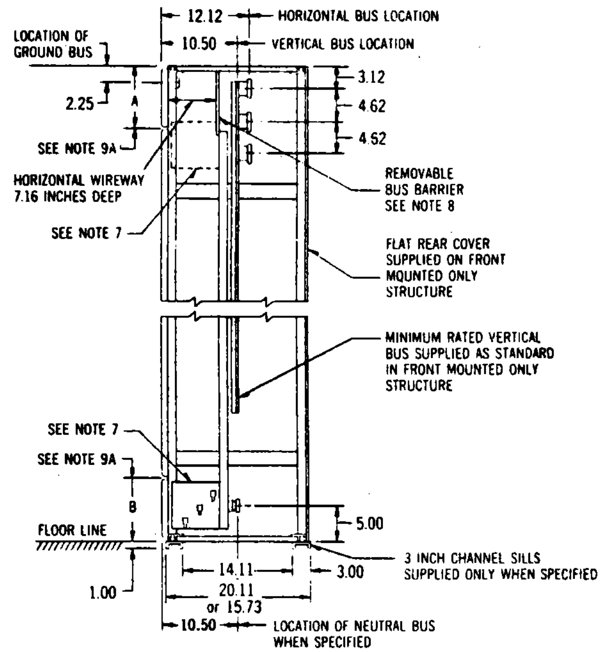
See side View B, far right for vertical dimensions.

10 Inches Wide, 16 or 21 Inches Deep Transition Structures (4710A35/6)



1. Minimum length of anchor bolt 2 inches (.36-16 recommended.)
2. Recommended maximum conduit height above floor line 3.50 inches.
3. Maximum conduit space with channel sills 7.5 x 14.11 inches in 21" deep structure, 7.5 x 9.73 inches in 16" deep structure.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum un-restricted conduit space at bottom.
5. This conduit space not recommended when neutral bus required. Otherwise available.
6. Top rear conduit space not recommended for conduit entry in 21" deep FMO structure. Space not available in 16" deep structure.

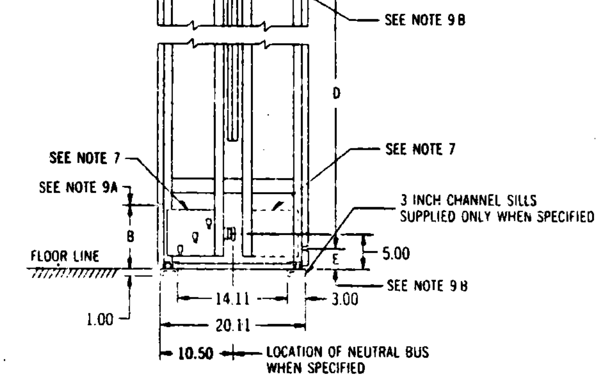
SIDE VIEWS



SIDE VIEW A

Common Notes

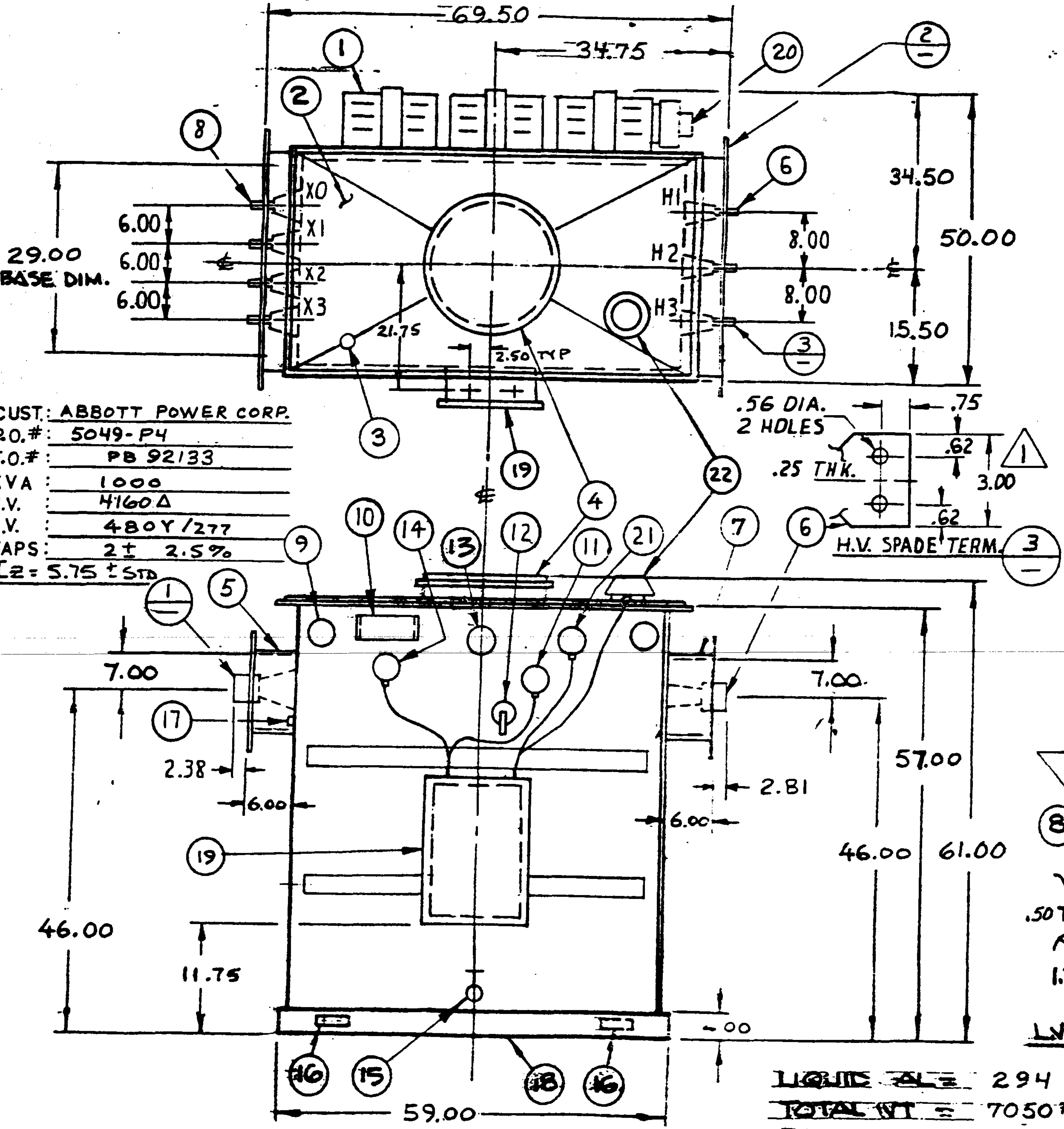
7. Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.
8. Rear horizontal bus barrier not supplied with front mounted only structure.
9. Standard structure arrangement
   (a) In Front
   Without MTB; A & B = 9"
   With MTB at bottom; A & B = 9"
   With MTB at top; A = 15", B = 3"
   (b) In Rear
   Without MTB; C = 0, D = 72", E = 3"
   With MTB at bottom; C = 0, D = 66", E = 9"
   With MTB at top; C = 12", D = 60", E = 3"

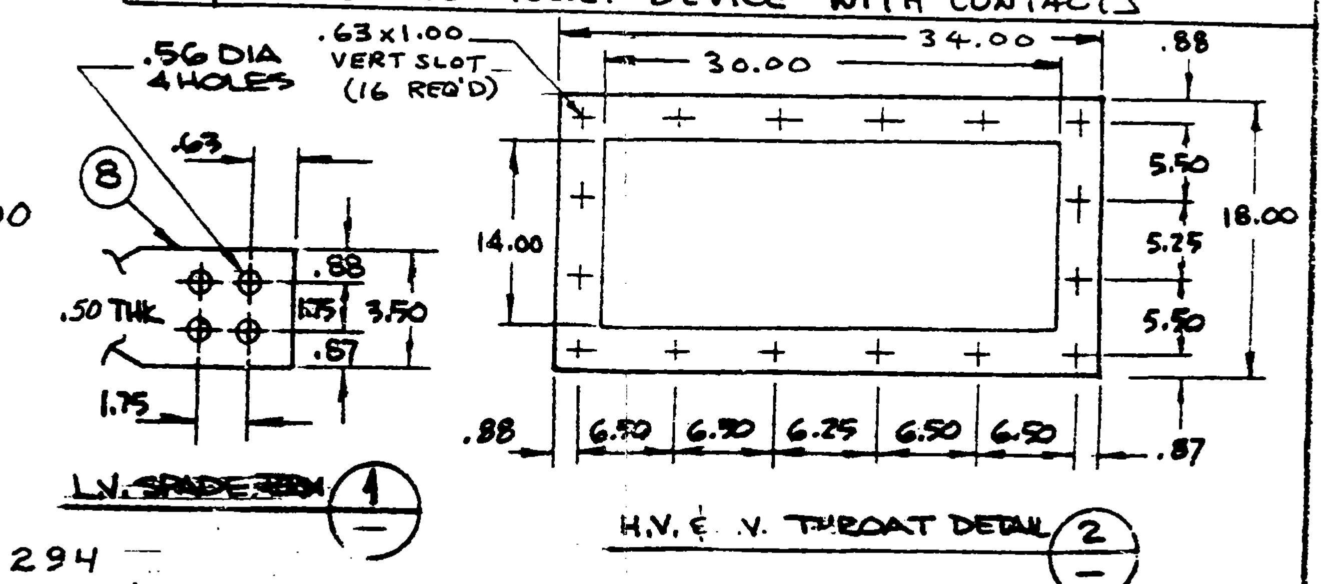


SIDE VIEW B

ITEM	DESCRIPTION
1	COOLING PANELS
2	WELDED-ON COVER W/PROVISION FOR LIFTING
3	1" UPPER FILTER PRESS CONN. & FILL PIPE
4	16" DIA HANDHOLE WITH BOLTED COVER
5	H.V. THROAT - SEE DETAIL 2
6	H.V. BUSHING WITH 2 HOLE SPADE - SEE DETAIL
7	L.V. THROAT - SEE DETAIL 2
8	L.V. BUSHING WITH SPADE TERMINAL. SEE DETAIL
9	LIFT LUGS
10	STAINLESS STEEL NAMEPLATE & CONNECTION DIAGRAM
11	LIQUID LEVEL GAUGE WITH CONTACTS
12	NO-LOAD TAP CHANGER WITH PROVISION FOR PADLOCK
13	PRESSURE VACUUM GAUGE
14	DIAL-TYPE THERMOMETER WITH CONTACTS
15	1" DRAIN VALVE-FILTER PRESSURE CONNECTION & SAMPLER
16	GROUND PAD WITH (2) 1/2-13 TAPPED HOLES
17	1/2-13 TAPPED GROUND PAD BELOW X_0
18	FORMED BASE SUITABLE FOR JACKING, SKIDDING & PULLG
19	AUX. WIRING CABINET
20	COOLING FAN
21	RAPID RISE PRESSURE RELAY WITH CONTACTS
22	PRESSURE RELIEF DEVICE WITH CONTACTS

CUST: ABBOTT POWER CORP.
P.O.#: 5049-P4
F.O.#: PB 92133
KVA: 1000
H.V.: 4160 Δ
L.V.: 480Y/277
TAPS: 2± 2.5%
I_Z = 5.75 ± STD





LIQUID GAL = 294
TOTAL WT = 7050#
PAINT COLOR = ASA 70

92133

REV	DESCRIPTION
1	REVISED CHANGE H.V. BUSHINGS G.W. 12-10-80

BALTEAU STANDARD INC.
6001 TABLEROCK ROAD MEDFORD OREGON 97501

TITLE: OUTLINE DIMENSIONS
SECONDARY SUBSTATION F.O. PB92133
1000 KVA 65 °C RISE OA/FA

DRAWN: R. Keppel
CHKD: E/H
DATE: 9-24-80
APPR: MO
09600005803 1 2
SCALE: N.T.S.
TOLERANCE: ±.03
SHEET 1 OF 1

3.1.1-367

LINE	DRAWING TITLE	DRAWING NO.	SH	CHG	CUSTOMER	STOREROOM	INSPECTION	SHEET METAL	STRUC. & PNL.	DOOR AREA	SUB. ASS'Y	TRANSPORTER	CONVEYOR	PROD. FL.	TOTAL
1	MASTER DRAWING INDEX	LAI-16495-001	1	1	✓	1	1	X	1	1	1	1	1	1	8
2															
3															
4	LAYOUT + STRUCTURE SPECIFICATIONS		2	1	✓	1	1			1	1	1	1		
5	ADDITIONAL STRUCTURE SPECIFICATIONS		3	1	✓	1	1			1	1	1	1		
6															
7	NAMEPLATES		4	1	✓	1	1			1	1	1	1		
8	NAMEPLATES (CONT.)		5	1	✓										
9	UNIT SPECIFICATIONS		6	1	✓	1	1			1	1	1	1		
10	UNIT SPECIFICATIONS		7	1	✓	1	1			1	1	1	1		
11	ADDITIONAL UNIT SPECIFICATIONS		8	1	✓	1	1			1	1	1	1		
12															
13	MATERIAL LIST		MI-M4	–	-	1	1	1	1	1	1	1	1	1	
14	FLOOR PLAN	4710A30	1	1	✓										
15															
16	ELECTRICAL DRAWINGS	2251A01	1	1	✓		1				1	1	1		
17															
18	ELECTRICAL DRAWINGS	2251A11	1	1	✓		1				1	1	1		
19															
20	ELECTRICAL DRAWINGS	LAI-16499 WD-1	1	1	✓		1				1	1	1		
21		WD-3	1	1	✓		1				1	1	1		
22		WD-4	1	1	✓		1				1	1	1		

GENERAL ORDER NUMBER LAI-16499-001

VC	D	MTG	ENCL	FIN	WIRING
3	16	F	NEMA 12	STD	1B

T	C	F	DP	EXPORT PACK	CUST. INSPECT.
14	1	0	N	☐	☐ Days

E C

M I

NOTES:

STRUCTURE SPECIFICATIONS

1) GROUND BUS SUPPLIED WITH #6-350 MCM LUGS PER STRUCTURE MOUNTED IN BOTTOM

2) MCC TO BE FURNISHED WITH BOTTOM PLATES

UNITS SPECIFICATIONS

1) ALL CONTROL WIRES TO HAVE PRE-INSULATED RING TONGUE LUGS

Master Drawing Index
Control Center 5 STAR

Westinghouse Electric Corporation
General Control Division
Chicago

Westinghouse Electric Corporation
General Control Division
Chicago

GENERAL ORDER NO. LAI-16499-001- FRX

MCC TITLE MCC - 2

CUSTOMER ABBOTT POWER CORP.

LOCATION BUENA PARK, CALF.

NOTES:

PREPARED BY JOE KUSMISZ DATE 12-12-80

APPROVED BY [redacted] Murzyn DATE 12-15-80

SHEET 1 OF 8 SHEETS

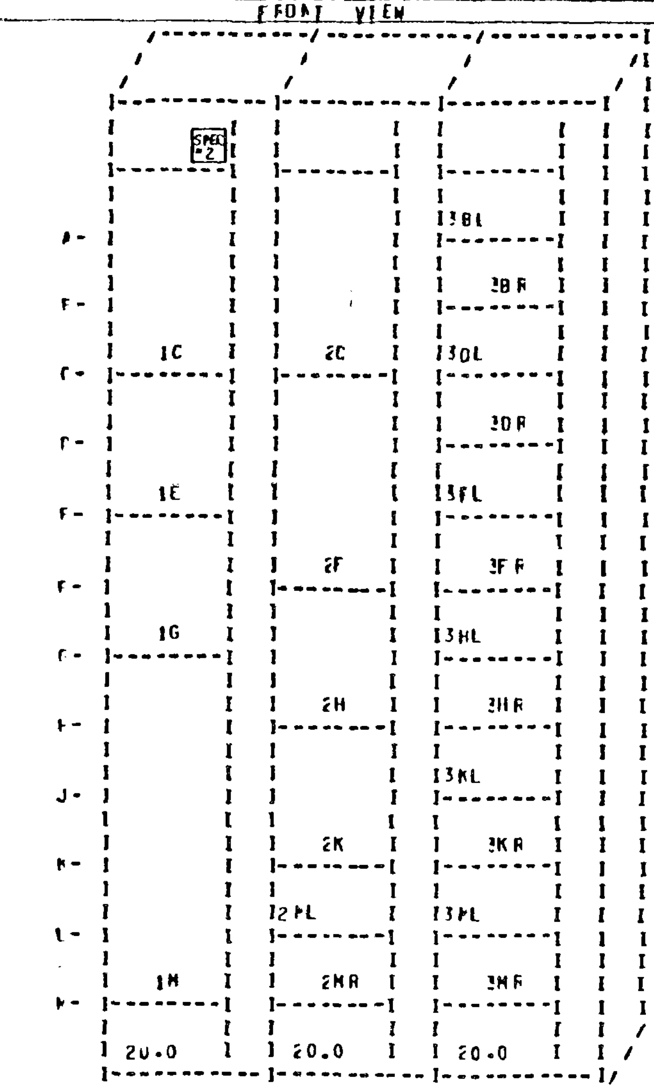
CHANGE 1

FORM 4590G

3.1.1-368

FURNISHED BY WESTINGHOUSE PRINTING DIV., TRAFFORD, PA.

FRONT VIEW



FL.FL. 471CA30 471CA30 471CA30

SHP.S ... 60.0

JOB SPECIFICATIONS 12/10/80 2 V2M4

NEMA TYPE 12 GASKETED

ENCL. DEPTH 16 INCHES

UNIT MOUNTING FRONT

PTB LOCATION BOT

FINISH-ASA-70 W/ DARK CHAR. TOP + SIDE COVERS

BUS BRACING 42000 RMS SYM.

MAIN HORIZ. BUS AL (600AMP.) 1/4X2 1/PHASE

VERTICAL BUS AL (300AMP.)

GROUND BUS CU (300AMP.) 1/4X1

ISOLATED VERTICAL BUS

NAMEPLATES ENGRAVED PLASTIC

INC. LINE LOC. UNIT 1M 2-350MCM P PH
(MAIN BREAKER)

SKID LENGTH = 60.0 AND DEPTH = 22

3.1.1-369

Enclosure Specifications
Control Center · 5 STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

General Order Number LAI-16499-001
Item Number

Customer ABBOTT POWER CORP.

Prepared by JOE KUSMISZ
Date 12-12-80

Approved by Customer
Date

Notes

Sheet 2 of 8 Sheets

CHANGE 1

LAI-16499-001

GS 117-72-02

FORM 45804

3.1.1-370

SPEC NUMBER ADDITIONAL STRUCTURE SPECIFICATIONS

4G	1	GROUND BUS SUPPLIED WITH #6-350 MCM LUGS PER STRUCTURE - MOUNTED IN BOTTOM
1N	2	MCC TO BE FURNISHED WITH MASTER NAMEPLATE MTD IN STRU. 1 ENGRAVED MCC-2
3C	3	MCC TO BE FURNISHED WITH CHANNEL SILLS
8B	4	MCC TO BE FURNISHED WITH BOTTOM PLATES
7F	5	MCC TO BE FURNISHED WITH TOUCH UP PAINT; 2 CANS PER COLOR

Enclosure Specifications
Control Center - 5 STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

General Order Number LAI-16499-001
Item Number

Customer ABBOTT POWER CORP

Prepared by JOE KUSMISZ
Date 12-12-80

Approved by Customer
Date

Notes

Sheet 3 of 8 Sheets

CHANGE 1

LAI-16499-001

CGS 117-72-02

FORM 4380A

3.1.1-371

GENERAL ORDER NAMEPLATE

G.O. LAT-16499 CGC

IT. 001 DATE ______ 19__

SECT 1=600 AMP

SECT 2-3=300 AMP

SUPPLY 600 A 480 V

3 PH 60 HZ NEUTRAL ____ A

PANELBOARD NAMEPLATE

______ CKT.

TYPE ______ PNLBD.

______ PH ______ WIRE

______ V ______ A

NP SIZE

☒ - 1.0 X 2.5
☐ - 1.25 X 3.5
☐ - 2.0 X 2.5

NAMEPLATE REF. DWG. 1428B04

NP TYPE

* ☒ - HOT STAMP ENGRAVED(STD)
☐ - MILLED ENGRAVED
☐ - ______

∅ - LN. 1 & 4 (22) 3/16 HI
LN. 2 & 3 (19) LETTERS

NP COLOR

☒ - BLACK w/ WHITE LETTERS
☐ - WHITE w/ BLACK LETTERS
☐ - ______

LETTER SIZE

* ☒ - 3/16"(M.C.C. STD.)
☐ - OTHER ______

METHOD OF MOUNTING

☐ - RIVET (STD. TYPE W)
☒ - SCREW (STD. FIVE STAR)
☐ - ______

MASTER NAMEPLATE

FOR LETTER SIZES & ARRANGEMENTS, SEE DWG. 1491C01

COLOR & SIZE

☒ - 1491C01H01 (BLACK)(5.05 X 6.72)
☐ - 1491C01H02 (WHITE (5.05 X 6.72)
☐ - ______

ENGRAVING

MCC-2

LETTER SIZE

☒ - 7/8" (10 LETTERS/LINE) (STD)
☐ - 1" (LETTERS/LINE)

LINE1
LINE2
LINE3

TYPICAL

UNIT	FIRST LINE (16)*	SECOND LINE (13)*	THIRD LINE (16)*	FOURTH LINE (16)*	FIFTH LINE (16)*
1C	PRIM. ELECTRIC	PUMP P705			
1E	SPARE				
1G	SPARE				
1M	INCOMING C/B	600A 3P			
2C	RAW SERVICE	WATER PUMP	P703		
2F	RAW SERVICE	WATER PUMP	P704		
2H	SPARE				
2K	DEMINERALISED	WATER PUMP	P710		
2ML	SPARE				
2MR	LIGHTING PANEL	LP3			
3BL	SPARE				
3BR	HEAT TRACE PAN	PP3			
3DL	SPARE				
3DR	SPARE				
3FL	SPARE				
3FR	EXH. FANS	EF2, EF-3			

Prepared by JOE KUSMISZ Date 12/12/80

Approved by Customer Date

NOTES

Westinghouse Electric Corporation
CONTROL CENTER DIVISION
Chicago

General Order No. LAT-16499 Item No. 001

CHANGE 1

SHEET 4 OF 8

(NP -- TYPE W & 5 STAR) FORM CGM-76-134-E

UNIT	FIRST LINE	SECOND LINE	THIRD LINE	FOURTH LINE	FIFTH LINE
3HL	RAW SERVICE	PUMP P715			
3HR	SPARE				
3KL	SPARE				
3KR	SPARE				
3ML	FIRE MAINT.	PUMP P707			

3.1.1-372

Prepared by JOE KUSMISZ	Date 12/12/80	Westinghouse Electric Corporation CONTROL CENTER DIVISION Chicago	CHANGE 1
Approved by Customer	Date	General Order No. LAI-16499 Item No. 001	
NOTES			

FORM CGM-76-136A NP-CONT.

12/10/80

NEMA Class 1 Type B Wiring
NEMA Type Gaskets YES
TOTALLY ENCLOSED MOTORS
Service 480 Volts 60 Hertz 3 Phase
Control 120 Volts 60 Hertz 3 WIRE
Source TX

Motor Protection
Overload Relay Heaters * 3
Ambient Compensated Overload
Service Factor 1.00
Fuse Type
Supplied by

FUSE TYPE CODES
- H1 10 000 ONE TIME FUSE
- H2 K1 CUR LIMIT
- H5 K5 DUAL EL 200 000
- J1 CUR LIMIT
- J2 CUR LIMIT TIME DELAY
- R1 K1 CUR LIMIT (REJ)
- R2 K5 DUAL EL 200 000 (REJ)

BREAKER OR SWITCH MOD CODES
- 1 - AUX SW 1NO
- 2 - AUX SW 2NO
- 3 - AUX SW 1NO INC
- C - CURRENT LIMITER
- F - FUNGUS PROOF
- H - MARK 75
- L - ALARM SWITCH
- M - MAGNETIC ONLY
- N - NON AUTO
- P - TRI PACK
- R - UN VOLT TRIP
- S - SAF T VUE
- T - SHUNT TRIP
- V - 50°C CALIBRATION

CONTROL DEVICE CODES

MIM DEV.	PUSH BUTTONS	IND. LIGHT	SEL SWITCH
F - AMMETER	L - START	S - GR (STOP)	W - 2 POSITION
G - VOLTMETER	M - STOP	T - RED (RUN)	X - 3 POSITION
H - ELAPSED T.M	N - MAINT CONT	U - AMBER	Y
J - AMM SW	O - FAST SLOW	V	
K - V.M. SW	P - FWD REV	Q - RED (STOP)	
	R	Z - GR (RUN)	

Customer Unit No.	Westinghouse Unit Number	Abbreviated NEMA Description	Westinghouse Class or Description	Size	Horsepower	Full Load Amps	Heater Code	Control Devices	Breaker Type or Switch Size	Poles	Continuous Amps or Fuse Clip Size	Trip Range or Fuse Size	Bkr or SW Modifications	Control Transformer Size (VA)	Total Interlocks N/O	N/C	Wiring Diagram Number	Wiring Diagram Combination	Unit Style Number	Door	Add'l Unit Spec. Note References	Shop Routing
	1C	BKR	FDR						HKB	3	225						2291A01	A	4703A23G01	G51		T
	1E	FVNR	206	1					MCP	3	15	50 - 150		100	2	1	LAI-16499	WD-1	4706A21G01	G91	D	T
	1G	FVNR	206	1					MCP	3	15	50 - 150		100	1	1	↓	WD-3	4706A21G01	G51		T
	1M	BKR	MAIN						MA	3	600						2291A11		4703A74G11	G91		C
	2C	FVNR	206	3	40.00		H8C		MCP	3	100	275 - 1000		200	1	1	LAI-16499	WD-4	4706A23G01	G51		T
	2F	FVNR	206	3	40.00		H8C		MCP	3	100	275 - 1000		200	1	1	↓	↓	4706A23G01	G51		T
	2H	FVNR	206	1					MCP	3	7	18 - 58		100	2	1	LAI-16499	WD-1	4706A21G01	G91	D	T
	2K	FVNR	206	1	5.00		H37		MCP	3	15	50 - 150		100	1	1	↓	WD-3	4706A21G01	G51		T
	2ML	BKR	DUAL						HFB	3	50						2291A01	B	4703A22G01	G92		T
	2MR		FDR						HFB	3	70											
	3BL	BKR	DUAL						HFB	3	50						2291A01	B	4703A22G01	G52		T
	3BR		FDR						HFB	3	50											
	3DL	BKR	DUAL						HFB	3	30						2291A01	B	4703A22G01	G52		T
	3DR		FDR						HFB	3	15											
	3FL	BKR	DUAL						HFB	3	30						2291A01	B	4703A22G01	G52		T
	3FR		FDR						HFB	3	15											

3.1.1-373

Unit Specifications
Control Center · FIVE STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

* IF ORDERED AND FULL LOAD CURRENT NOT PROVIDED, OVERLOAD RELAY HEATERS ARE SELECTED ON THE BASIS OF AVERAGE VALUES OF CURRENT (1975 NEC) FOR 1800 RPM MOTORS HAVING A SERVICE FACTOR OF 1.0 (NEW NEMA STDS) ALLOWING 115 PERCENT FULL LOAD PROTECTION

General Order Number LAI-16499-001
Item Number
Customer ABBOTT POWER CORP

Prepared by JOE KUSMISZ
Date 12-12-80

Approved by Customer
Date

Notes

Sheet 6 of 8 Sheets

CHANGE 1

CGS 101-72-04

FORM 45805

12/10/80

NEMA Class 1 Type B Wiring
NEMA Type Gaskets YES
TOTALLY ENCLOSED MOTORS
Service 480 Volts 60 Hertz 3 Phase
Control 120 Volts 60 Hertz 3 WIRE
Source TX

Motor Protection
Overload Relay Heaters * 3
Ambient Compensated Overload
Service Factor 1.00
Fuse Type
Supplied by

FUSE TYPE CODES
H1 - 10,000 ONE TIME FUSE
H2 - K1 CUR LIMIT
H5 - K5 DUAL EL 200,000
J1 - CUR LIMIT
J2 - CUR LIMIT TIME DELAY
R1 - K1 CUR LIMIT (REJ)
R2 - K5 DUAL EL 200,000 (REJ)

BREAKER OR SWITCH MOD CODES
1 - AUX SW 1NO
2 - AUX SW 2NO
3 - AUX SW 1NO INC
C - CURRENT LIMITER
F - FUNGUS PROOF
H - MARK 75
L - ALARM SWITCH
M - MAGNETIC ONLY
N - NON AUTO
P - TRI PACK
R - UN VOLT TRIP
S - SAF 1 VUE
T - SHUNT TRIP
V - 50°C CALIBRATION

CONTROL DEVICE CODES
MINI DEV.: F - AMMETER; O - VOLTMETER; H - ELAPSED T M; J - AMM. SW; K - V.M. SW
PUSH BUTTONS: L - START; M - STOP; N - MAINT CONT; O - FAST-SLOW; P - FWD REV; R -
IND LIGHT: S - GR (STOP); T - RED (RUN); U - AMBER; V -; Q - RED (STOP); Z - GR (RUN)
SEL. SWITCH: W - 2 POSITION; X - 3 POSITION; Y -

CUSTOMER UNIT NO.	WESTINGHOUSE UNIT NUMBER	ABBREVIATED NEMA DESCRIPTION	WESTINGHOUSE CLASS OR DESCRIPTION	SIZE	HORSEPOWER	FULL LOAD AMPS	HEATER CODE	CONTROL DEVICES	BREAKER TYPE OR SWITCH SIZE	POLES	CONTINUOUS AMPS OR FUSE CLIP SIZE	TRIP RANGE OR FUSE SIZE	BKR OR SW MODIFICATIONS	CONTROL TRANSFORMER SIZE (VA)	TOTAL INTERLOCKS N/O	N/C	WIRING DIAGRAM NUMBER	WIRING DIAGRAM COMBINATION	UNIT STYLE NUMBER	DOOR	ADD'L UNIT SPEC. NOTE REFERENCES	SHOP ROUTING
	3HL	EKR	DUAL						HFB	3	15						2291A01	B	47C3A22G01	G52		T
	3HR		FCR						HFB	3	15											
	3KL	BKR	DUAL						HFB	3	15						2291A01	B	4703A22G01	G52		T
	3KR		FCR						HFB	3	30											
	3ML	BKR	DUAL						HFB	3	15						2291A01	C	4703A22G04	G91		T
	3MR		FOR						HFB	3	0											

311-374

Unit Specifications
Control Center · FIVE STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

* IF ORDERED AND FULL LOAD CURRENT NOT PROVIDED, OVERLOAD RELAY HEATERS ARE SELECTED ON THE BASIS OF AVERAGE VALUES OF CURRENT (1975 NEC) FOR 1800 RPM MOTORS HAVING A SERVICE FACTOR OF 1.0 (NEW NEMA STDS) ALLOWING 115 PERCENT FULL LOAD PROTECTION.

General Order Number LAI-16499-001
Item Number
Customer ABBOTT POWER CORP

Prepared by JOE KUSMISZ
Date 12-12-80

Approved by Customer
Date

Notes

Sheet 7 of 8 Sheets

CHANGE 1

FORM 45803

CGS 101-72-04

Spec Number		Additional Specifications
3C	A	COMMON CONTROL WIRING TO BE NO.14 AWG
6C	B	EACH STARTER UNIT TO HAVE 50 VA EXTRA CAPACITY CONTROL TRANSFORMER
9L	C	ALL CONTROL WIRES TO HAVE PRE-INSULATED RING TONGUE LUGS
	D	UNITS 1E, 2H TO CONTAIN (1) 120V 4 POLE AR RELAY

3.1.1-375

Unit Specifications
Control Center ·

Westinghouse Electric Corporation
Control Center Division
Chicago

General Order Number
Item Number: LA1-16499-C01
Customer ABBOTT POWER CORP

Prepared by JOE KUSMISZ
Date 12-12-80

Approved by Customer
Date

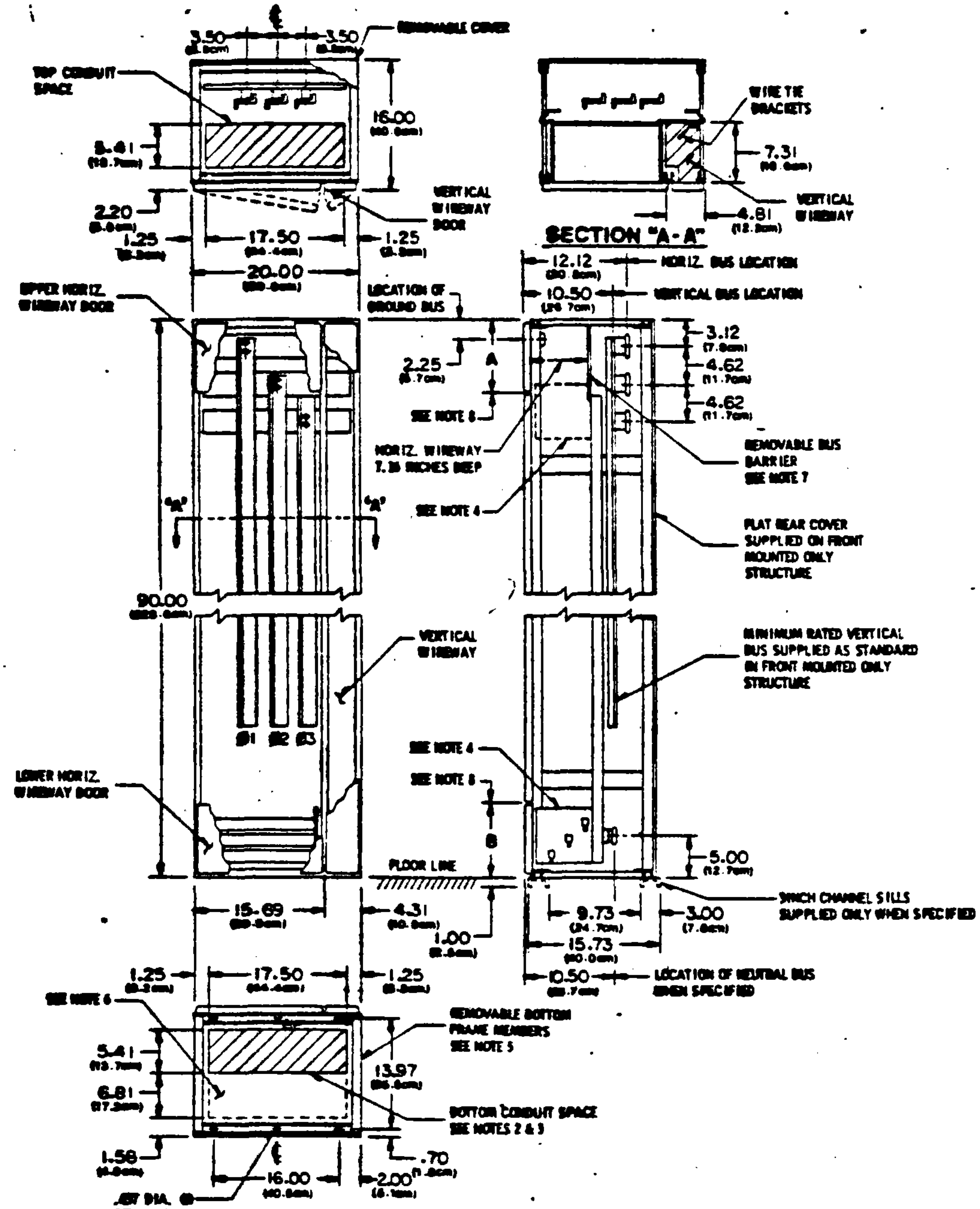
Notes

Sheet 8 of 8 Sheets

CHANGE 1

CGS 101 12-04

FORM 45805



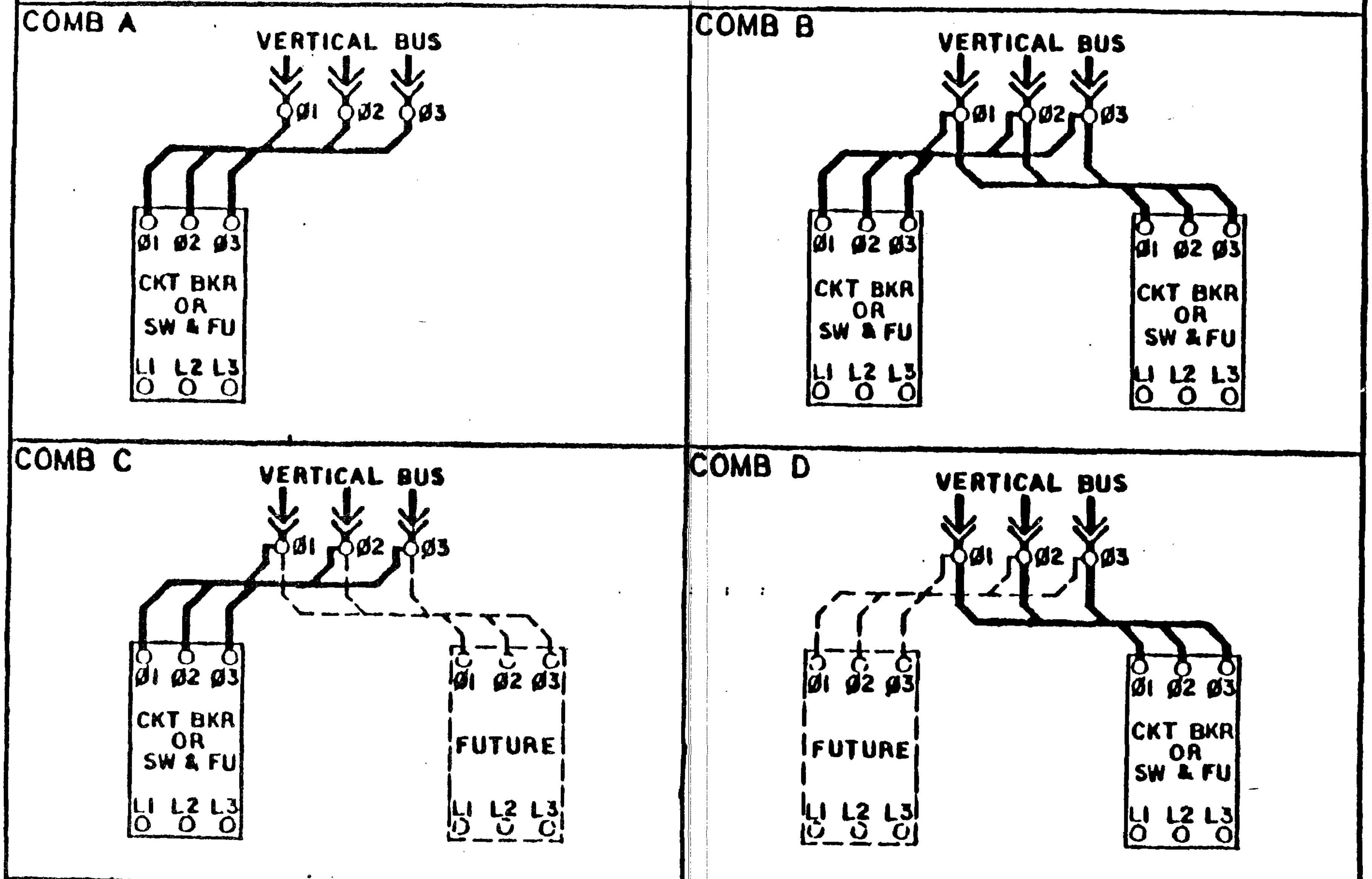
NOTES

1. MIN. LENGTH OF ANCHOR BOLT 2 INCHES (.38—16 RECOMMENDED).
2. RECOMMENDED MAX. CONDUIT HEIGHT ABOVE FLOOR LINE 3.50 IN.
3. MAX. CONDUIT SPACE WITH CHANNEL SILLS 17.50 X 9.73 INCHES.
4. MASTER TERMINAL BLOCK ASSEMBLY FURNISHED FOR TYPE 'C' WIRING ONLY. WHEN LOCATION NOT SPECIFIED MTB SUPPLIED AT THE BOTTOM.
5. FOR MULTIPLE STRUCTURE ASSEMBLIES EITHER ONE OR BOTH OF THESE MEMBERS ARE REMOVED TO PROVIDE MAXIMUM UN-RESTRICTED CONDUIT SPACE AT BOTTOM.
6. THIS CONDUIT SPACE NOT RECOMMENDED WHEN NEUTRAL BUS REQUIRED. OTHERWISE AVAILABLE.
7. REAR HORIZONTAL BUS BARRIER NOT SUPPLIED WITH FRONT MOUNTED ONLY STRUCTURE.
8. STANDARD STRUCTURE ARRANGEMENT (IN FRONT)
   WITHOUT MASTER TERMINAL BLOCK; A & B—9 INCHES.
   WITH MASTER TERMINAL BLOCK AT BOTTOM; A & B—9 INCHES.
   WITH MASTER TERMINAL BLOCK AT TOP; A—15 IN. B—3 IN.

STANDARD VERTICAL SECTION
20 INCHES WIDE
16 INCHES DEEP
FRONT MOUNTED ONLY

Westinghouse Electric Corporation
General Control Division Chicago Illinois
FIVE STAR MOTOR CONTROL CENTER
OUTLINE AND FLOOR PLAN

4710A30



3.1.1-377

2291A01

NEMA TYPE 'A' OR 'B'

COMB	DESCRIPTION
A B C D	FEEDER CKT BKR OR SW & FU

WESTINGHOUSE ELECTRIC CORPORATION

MOTOR CONTROL CENTER-TYPE W-
STANDARD UNIT WIRING DIAGRAM

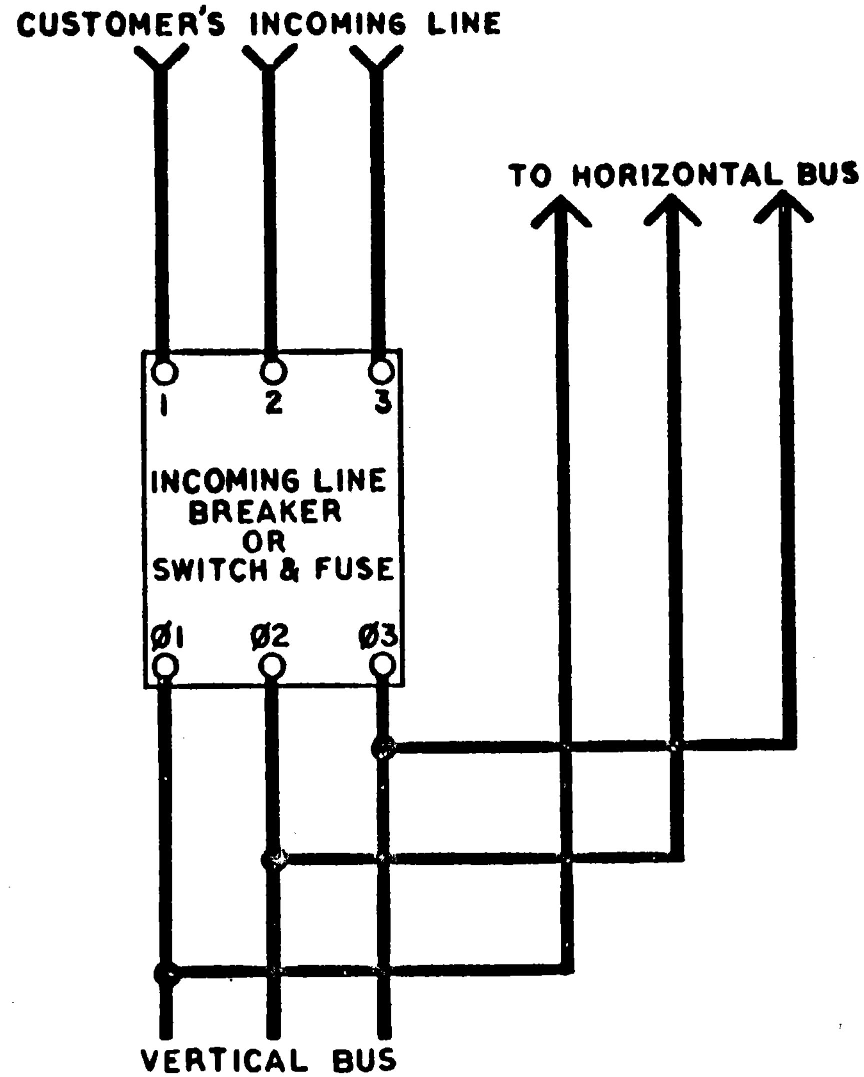
L.V.D.E. DIVISION

CHICAGO, ILL.

2291A01

FORM CGM-66-181 (1A01)

3.1.1-378



2291A11

NEMA TYPE 'A' OR 'B'

INCOMING LINE BREAKER
OR
SWITCH & FUSE

WESTINGHOUSE ELECTRIC CORPORATION

MOTOR CONTROL CENTER – TYPE W –
STANDARD UNIT WIRING DIAGRAM

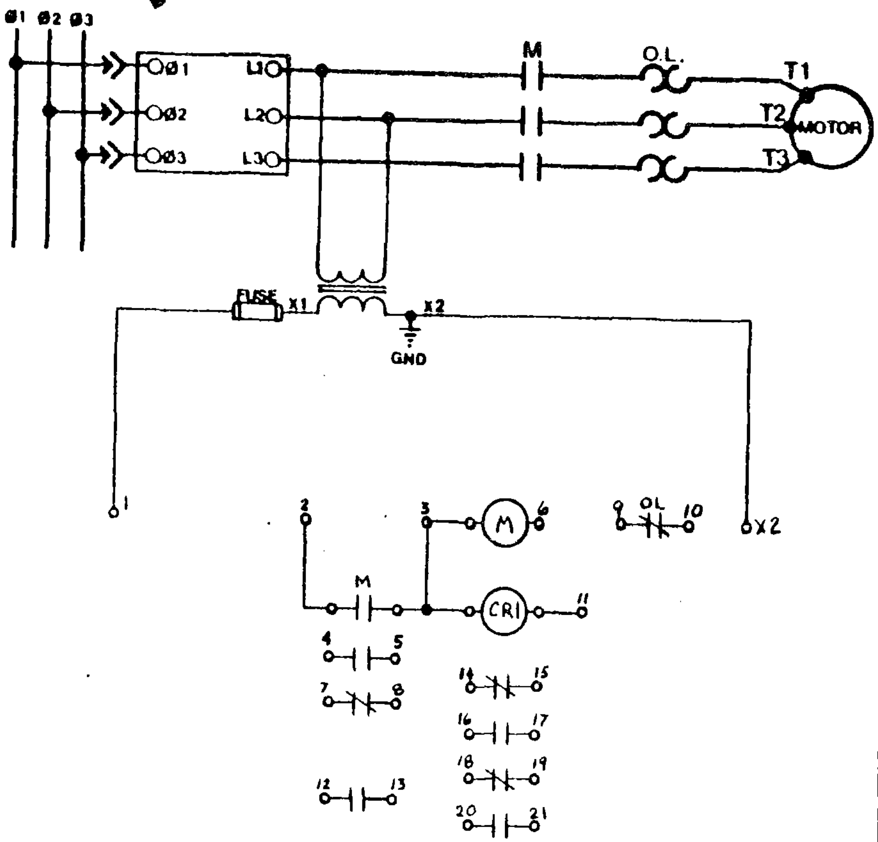
L.V.D.E. DIVISION

CHICAGO, ILL.

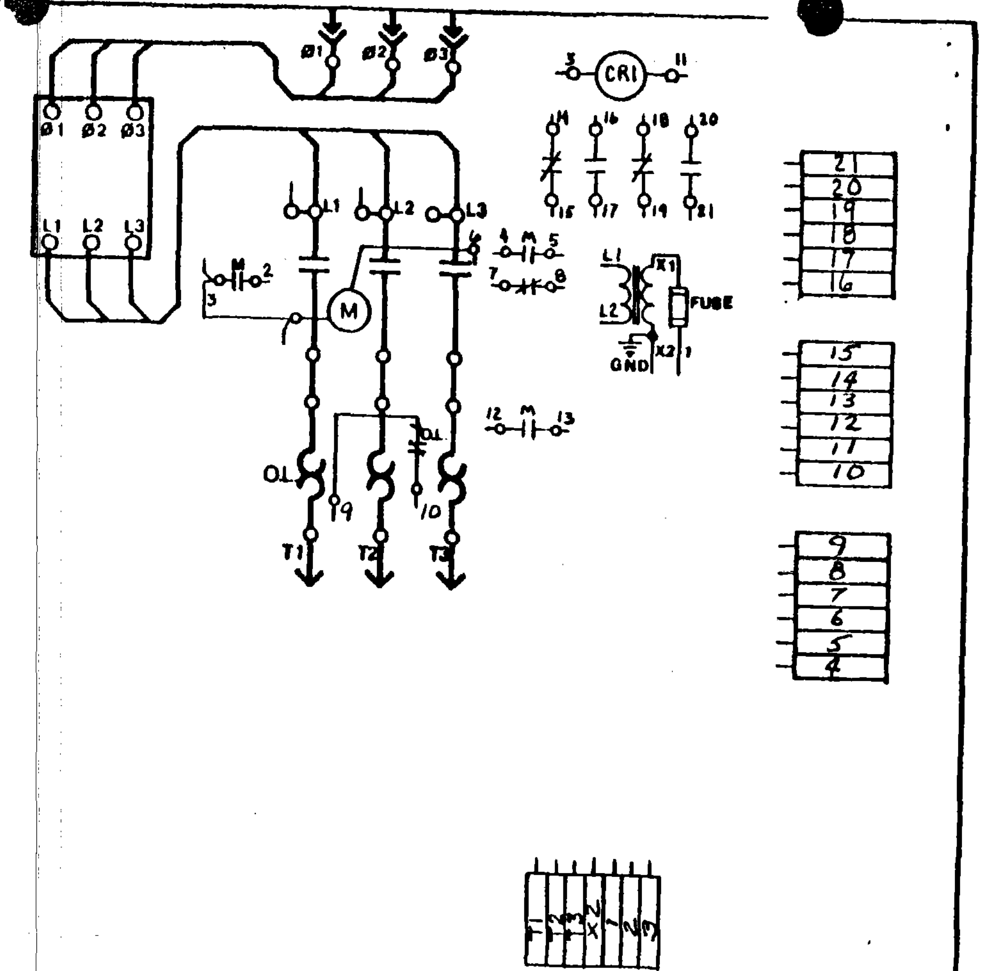
2291A11

FORM C[illegible]-66-131 (1A11)

3.1.1-379



SCHEMATIC



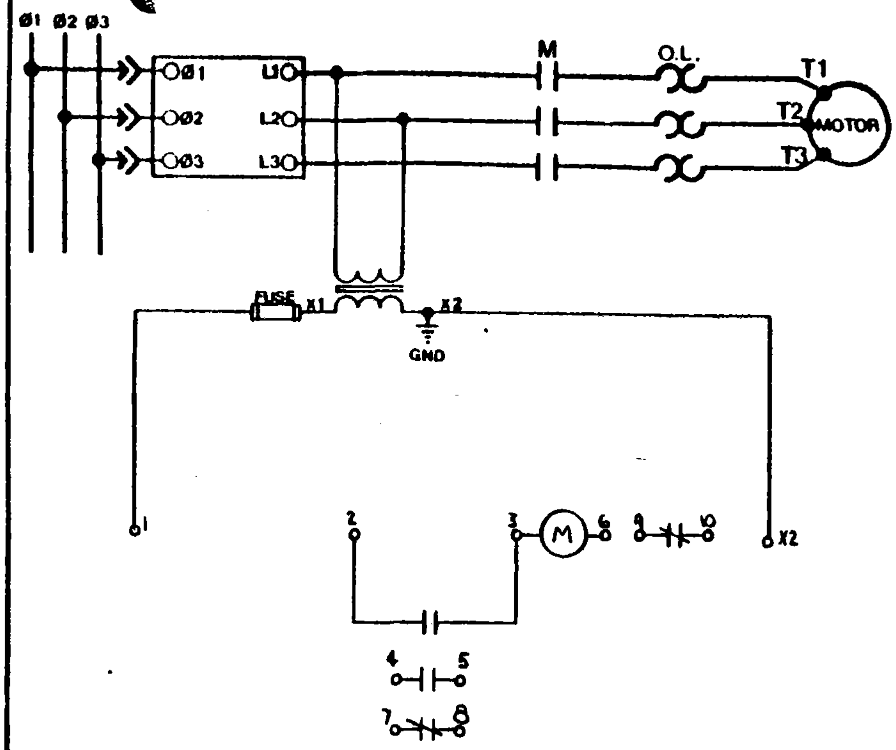
CONNECTION

PREPARED BY JOE KUSMISZ	DATE 12-11-80	Westinghouse Electric Corporation General Control Division, Chicago	
APPROVED BY CUSTOMER	DATE	GENERAL ORDER NO.	
DESCRIPTION FVNR NEMA SIZE 1 THRU 4	☒ 5 STAR ☐	LAI-16499	WD-1

CHANGE 1

FORM CGM-77-505

3.1.1-380



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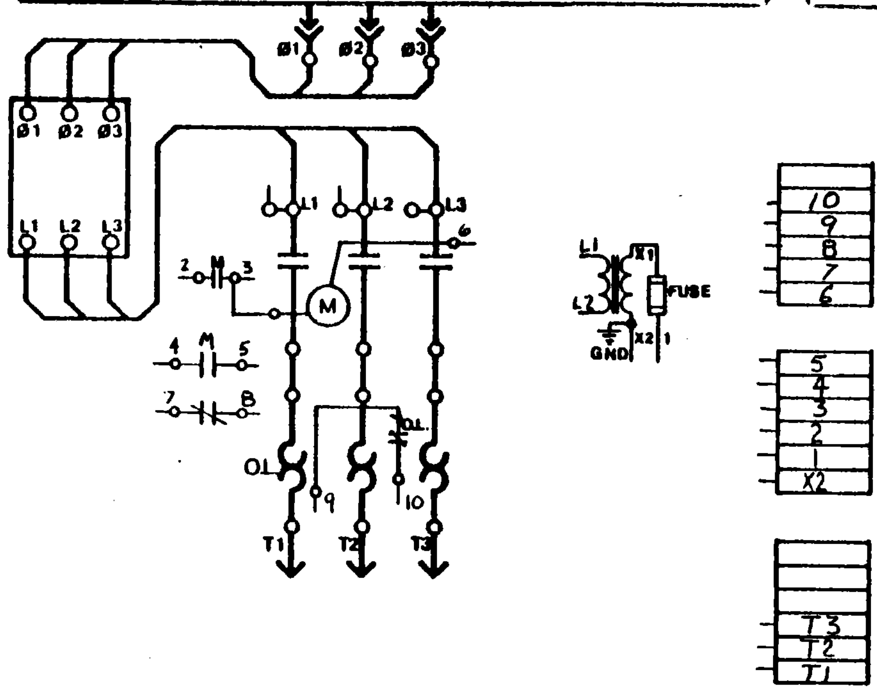
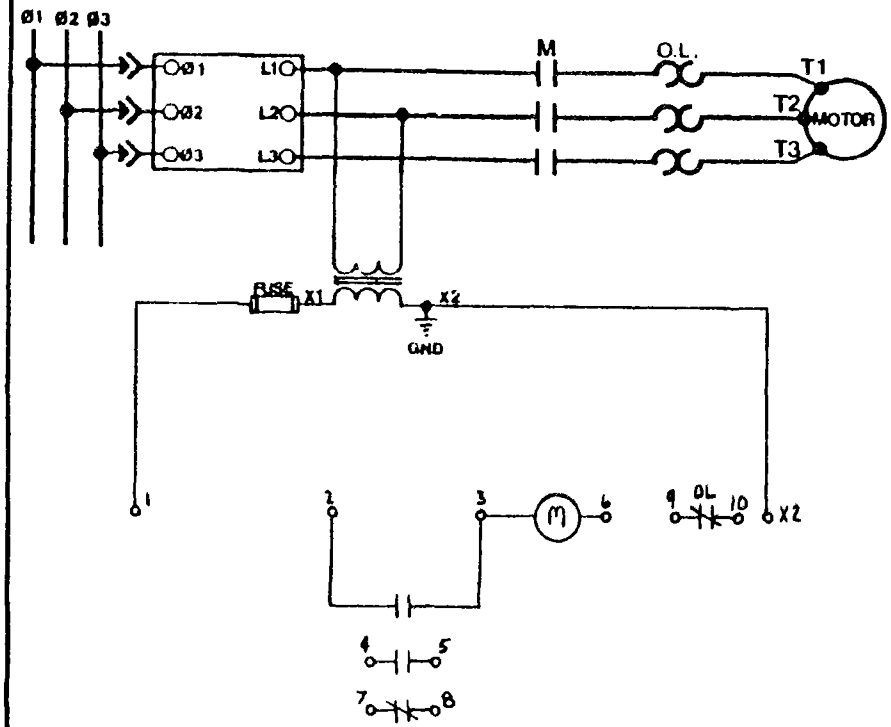


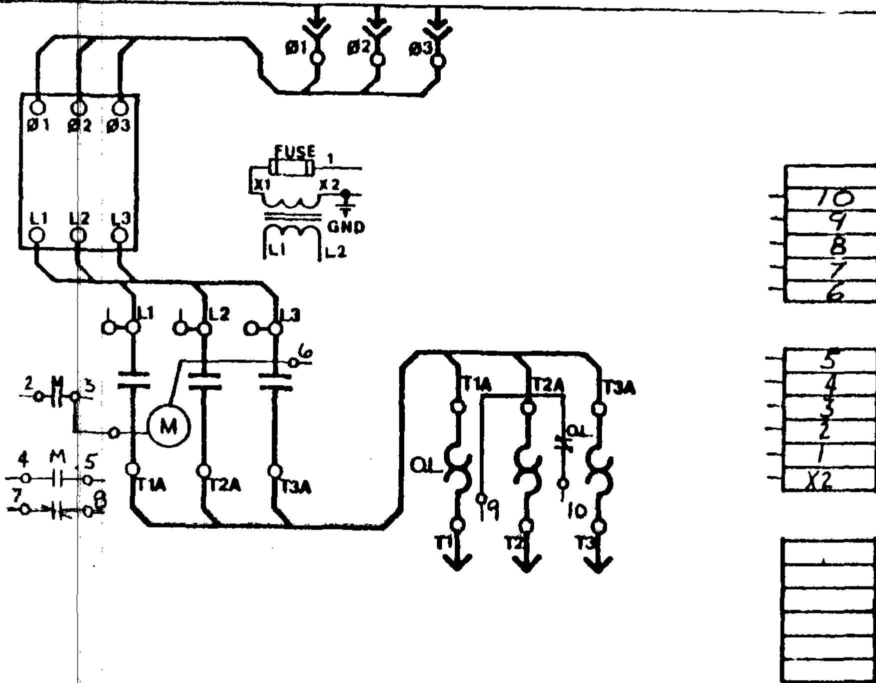
CONNECTION

PREPARED BY JOE KUSMISZ	DATE 12/12/80	Westinghouse Electric Corporation General Control Division, Chicago		CHANGE 1
APPROVED BY CUSTOMER	DATE	GENERAL ORDER NO.		
DESCRIPTION FVNR NEMA SIZE 1 THRU 4	☒ 5 STAR ☐	LAI-16499	WD-3	

FORM CGM-77-505



SCHEMATIC



CONNECTION

PREPARED BY JOE KUSMISZ	DATE 12-15-80	Westinghouse Electric Corporation General Control Division, Chicago GENERAL ORDER NO.	CHANGE 1 2
APPROVED BY CUSTOMER	DATE		DELETE T LEADS TO TERMINAL BLOCK J.K. 1-22-81
DESCRIPTION FVNR NEMA SIZE 3 AND 4	☒ 5 STAR ☐	LAI-16499	WD-4

FORM CGM-77-508

LINE	DRAWING TITLE	DRAWING NO.	SH.	CHG.	CUSTOMER	STOREROOM	INSPECTION	SHEET METAL	STRUC. & FINL	DOOR AREA	SUB. ASSY	TRANSPORTER	CONVEYOR	PROD. FL	TOTAL
1	MASTER DRAWING INDEX	LAI-16495-002	1	1	✓	1	1	1	1	1	1	1	~~1~~	1	8
2															
3															
4	LAYOUT + STRUCTURE SPECIFICATIONS		2	1	✓	1	1			1	1	1	1		
5	ADDITIONAL STRUCTURE SPECIFICATIONS		3	1	✓	1	1			1	1	1	1		
6															
7	NAMEPLATES		4	1	✓	1	1			1	1	1	1		
8	NAMEPLATES (CONT.)		5	1	✓										
9	UNIT SPECIFICATIONS		6	1	✓	1	1			1	1	1	1		
10	UNIT SPECIFICATIONS		7	1	✓	1	1			1	1	1	1		
11	ADDITIONAL UNIT SPECIFICATIONS		8	1	✓	1	1			1	1	1	1		
12															
13	MATERIAL LIST		M1-M5	-	-	1	1	1	1	1	1	1	1	1	
14	FLOOR PLAN	4710A30	1	1	✓										
15															
16	ELECTRICAL DRAWINGS	2291A01	1	1	✓		1				1	1	1		
17															
18	ELECTRICAL DRAWINGS	LAI-16499	WD 1	1	✓		1				1	1	1		
19			WD 2	1	✓		1				1	1	1		
20			WD 3	1	✓		1				1	1	1		
21															
22															

GENERAL ORDER NUMBER LAI-16495-002

VC	D	MTG	ENCL	FIN	WIRING
4	16	F	NEMA 12	STD	1B

T	C	F	DP	EXPORT PACK	CUST. INSPECT. Days
19	C	0	N	☐	☐

EC

MI

NOTES:

STRUCTURE SPECIFICATIONS

1) GROUND BUS SUPPLIED WITH #6-350 MCM LUGS PER STRUCTURE MOUNTED ON BOTTOM

2) MCC TO BE FURNISHED WITH BOTTOM PLATES

3) STRUCTURE NO 1 ONLY TO BE FURNISHED WITH 600 AMP VERTICAL BUS

UNITS SPECIFICATIONS

1) ALL CONTROL WIRES TO HAVE PRE-INSULATED RING TONGUE LUGS

Master Drawing Index
Control Center 5 STAR

Westinghouse Electric Corporation
General Control Division
Chicago

Westinghouse Electric Corporation
General Control Division
Chicago

GENERAL ORDER NO. LAI-16499-C02- FAX

MCC TITLE MCC-3

CUSTOMER ABBOTT POWER CORP.

LOCATION BUENA PARK, CALF.

NOTES:

PREPARED BY JOE KUSMISZ DATE 12-15-80

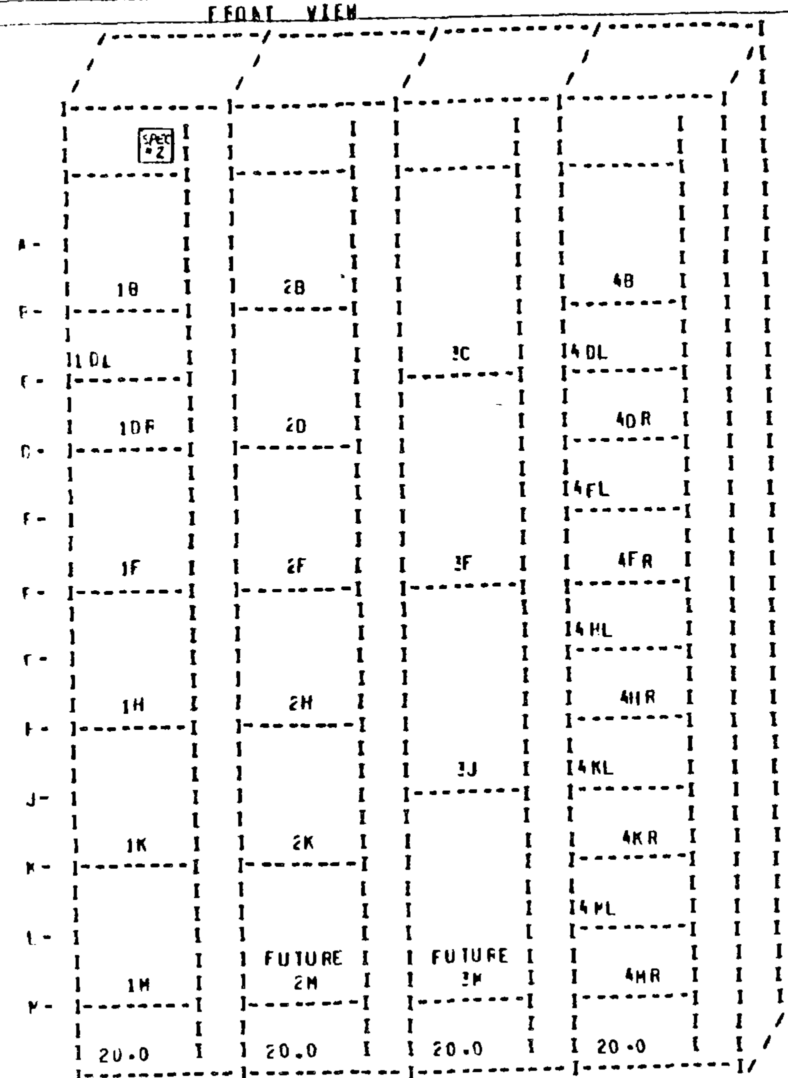
APPROVED BY [redacted] Murzyn DATE 12-15-80

SHEET 1 OF 8 SHEETS

CHANGE

3.1.1-382

FRONT VIEW



FL.PL. 4710A30 4710A30 4710A30 4710A30

SUB. S. A B C C

JOB SPECIFICATIONS 12/10/80 2 V2MA

NEMA TYPE 12 GASKETED

ENCL. DEPTH 16 INCHES

UNIT MOUNTING FRONT

MTB LOCATION BOT

FINISH-ASA-70 W/ DARK CHAR. TOP + SIDE COVERS

BUS BRACING 42000 RMS SYM.

MAIN HORIZ. BUS AL (600 AMP.) 1/4X2 1/PHASE

VERTICAL BUS AL (300 AMP.)
AL (600 AMP.) VC-1

GROUND BUS CU (300 AMP.) 1/4X1

ISOLATED VERTICAL BUS

NAMEPLATES ENGRAVED PLASTIC

INC. LINE LOC. LUGS ONLY

SKID LENGTH = 80.0 AND DEPTH = 22

Enclosure Specifications
Control Center · 5 STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

LAI-16459-002

General Order Number LAI-16499-C02
Item Number

Customer ABBOTT POWER CORP.

Prepared by JOE KUSMISZ
Date 12-15-80

Approved by Customer
Date

Notes

Sheet 2 of 8 Sheets

CHANGE 1

3.1.1-383

CGS 117-72-02

FORM 43804

SPEC	NUMBER	ADDITIONAL STRUCTURE SPECIFICATIONS
4G	1	GROUND BUS SUPPLIED WITH #6-350 MCM LUGS PER STRUCTURE
1N	2	MCC TO BE FURNISHED WITH MASTER NAMEPLATE MTD IN STRU. 1 ENGRAVED MCC-3
3C	3	MCC TO BE FURNISHED WITH CHANNEL SILLS
8B	4	MCC TO BE FURNISHED WITH BOTTOM PLATES
7F	5	MCC TO BE FURNISHED WITH TOUCH UP PAINT; 2 CANS PER COLOR
4V	6	STRUCTURE NO 1 ONLY TO BE FURNISHED WITH 600 AMP VERTICAL BUS
	7	GROUND BUS TO BE INSTALLED IN BOTTOM OF STRUCTURES

3.1.1-384

Enclosure Specifications
Control Center · 5 STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

General Order Number LAI-16499-C02
Item Number

Customer ABBOTT POWER CORP.

Prepared by JOE KUSMISZ
Date 12-15-80

Approved by Customer
Date

Notes

Sheet 3 of 8 Sheets

CHANGE 1

☐ LAI-16499-002

CGS 117-72-02

GENERAL ORDER NAMEPLATE

G.O. LAI-16499 CGC

IT. 002 DATE ______ 19__

SECT 1-600 AMP

SECT 2-4-300 AMP

SUPPLY ______ A ______ V

______ PH ______ HZ NEUTRAL ______ A

PANELBOARD NAMEPLATE

______ CKT.

TYPE ______ PNLBD.

______ PH ______ WIRE

______ V ______ A

NP SIZE

☒ - 1.0 X 2.5
☐ - 1.25 X 3.5
☐ - 2.0 X 2.5

NAMEPLATE REF. DWG. 1428B04

NP TYPE

* ☒ - HOT STAMP ENGRAVED (STD)
☐ - MILLED ENGRAVED
☐ - ______

∅ - LN. 1 & 4 (22) 3/16 HI
LN. 2 & 3 (19) LETTERS

NP CO.

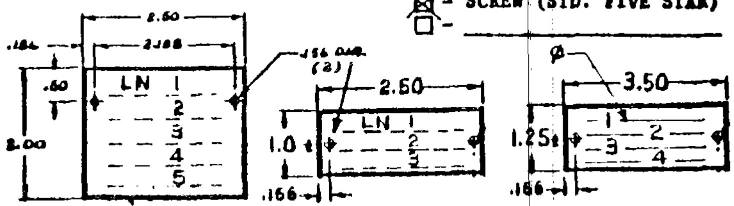
☒ - BLACK w/ WHITE LETTERS
☐ - WHITE w/ BLACK LETTERS
☐ - ______

LETTER SIZE

* ☒ - 3/16"(M.C.C. STD.)
☐ - OTHER ______

METHOD OF MOUNTING

☐ - RIVET (STD. TYPE W)
☒ - SCREW (STD. FIVE STAR)
☐ - ______



MASTER NAMEPLATE

FOR LETTER SIZES & ARRANGEMENTS, SEE DWG. 1491C01

COLOR & SIZE

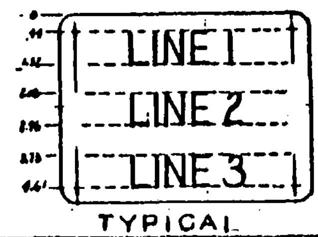
☒ - 1491C01H01 (BLACK)(5.05 X 6.72)
☐ - 1491C01H02 (WHITE (5.05 X 6.72)
☐ - ______

ENGRAVING

MCC-3

LETTER SIZE

(STD)
☒ - 7/8" (10 LETTERS/LINE)
☐ - 1 " (LETTERS/LINE)



UNIT	FIRST LINE (16)*	SECOND LINE (13)*	THIRD LINE (16)*	FOURTH LINE (16)*	FIFTH LINE (16)*
1B	INCOMING POWER				
1DL	MAINT. OIL SUMP	PUMP P-718			
1F	SPARE				
1H	SPARE				
1K	SPARE				
1M	FLASH TANK DRAIN	PUMP P-307			
2B	NITROGEN SUPPLY	UNIT SA-701			
2D	CAROBIA MAKE-UP	PUMP P-306			
2F	SPARE				
2H	SPARE				
2K	SPARE				
3C	SPARE				
3F	TSS FEED WATER	MOV 1030			
3J	TSS FEED WATER	MOV 1031			
4B	SPARE				

Prepared by: KE KUSMISZ Date: 12-15-80

Approved by Customer Date

NOTES

Westinghouse Electric Corporation
CONTROL CENTER DIVISION
Chicago

General Order No. LAI-16499 Item No. 002

CHANGE 1

SHEET 4 OF 8

(NP -- TYPE W & 5 STAR) FORM CGM-76-134-E

3.1.1-385

3.1.1-386

UNIT	FIRST LINE	SECOND LINE	RD LINE	FOURTH LINE	FIFTH
4DL	AUX EXTRACTION	OIL PUMP P305			
4DR	MCC1				
4FL	MCC 2				
4FR	MCC 3				
4HL	LIGHTING PANEL	LP4			
4HR	HEAT TRACE	PNL PP2			
4KL	TSU AREA SUMP	PUMP			
4KR	OIL-WATER	SEPARATOR	UNIT		
4ML	WELDING	RECEPTACLE	TSS AREA		
4MR	WELDING	RECEPTACLE	PSS AREA		

Prepared by JOE KUSMISZ Date 12-15-80

Approved by Customer Date

NOTES

Westinghouse Electric Corporation
CONTROL CENTER DIVISION
Chicago

General Order No. LAI-16499 Item No. 002

CHANGE 1

FORM CGM-76-136A NP-CONT.

SHEET 5 OF 8

12/10/80

NEMA Class 1	Type B	Wiring	Motor Protection
NEMA Type	Gaskets YES		1 Overload Relay Heaters *
			Ambient Compensated Overload
Service 480 Volts	60 Hertz	3 Phase	1.00 Service Factor
Control 120 Volts	60 Hertz	3 WIRE	Fuse Type
Source TX			Supplied by

FUSE TYPE CODES

- H1 - 10,000 ONE TIME FUSE
- H2 - K1 CUR LIMIT
- H5 - K5 DUAL EL 200,000
- J1 - CUR LIMIT
- J2 - CUR LIMIT TIME DELAY
- R1 - K1 CUR LIMIT (REJ)
- R2 - K5 DUAL EL 200,000 (REJ)

BREAKER OR SWITCH MOD CODES

- 1 - AUX SW 1NO
- 2 - AUX SW 2NO
- 3 - AUX SW 1NO INC
- C - CURRENT LIMITER
- F - FUNGUS PROOF
- H - MARK 75
- L - ALARM SWITCH
- M - MAGNETIC ONLY
- N - NON AUTO
- P - TRI PACK
- R - UN VOLT TRIP
- S - SAF T VUE
- T - SHUNT TRIP
- V - 50°C CALIBRATION

CONTROL DEVICE CODES

MINI DEV.	PUSH BUTTONS	IND. LIGHT	SEL. SWITCH
F - AMMETER	L - START	S - GR (STOP)	W - 2 POSITION
G - VOLTMETER	M - STOP	T - RED (RUN)	X - 3 POSITION
H - ELAPSED T M	N - MAINT CONT	U - AMBER	Y
J - AMM SW.	O - FAST-SLOW	V -	
K - VM SW.	P - FWD REV	Q - RED (STOP)	
	R -	Z - GR (RUN)	

CUSTOMER UNIT NO	WESTINGHOUSE UNIT NUMBER	ABBREVIATED NEMA DESCRIPTION	WESTINGHOUSE CLASS OR DESCRIPTION	SIZE	HORSEPOWER	FULL LOAD AMPS	HEATER CODE	CONTROL DEVICES	BREAKER TYPE OR SWITCH SIZE	POLES	CONTINUOUS AMPS OR FUSE CLIP SIZE	TRIP RANGE OR FUSE SIZE	BKR OR SW MODIFICATIONS	CONTROL TRANSFORMER SIZE VA	TOTAL INTERLOCKS N/O	N/C	WIRING DIAGRAM NUMBER	WIRING DIAGRAM COMBINATION	UNIT STYLE NUMBER	DOOR	ADD'L UNIT SPEC NOTE REFERENCES	SHOP ROUTING
	1D		INC.	LINE LUGS		ENT.	AT	BOT	350MCM		2	PER PH							ML-5			
	1DL	BKR	DUAL						HFB	3	15						2291A01	C	4703A22G04	G91		T
	1DR		FDR						FUT	3	0											
	1F	FVNR	206	1					MCP	3	30	100 - 300		100	1	1	LAI-16499	WD-3	4706A21G01	G91		T
	1H	FVNR	206	1					MCP	3	30	100 - 300		100	1	1			4706A21G01	G91		T
	1K	FVNR	206	1					MCP	3	3	7 - 22		100	1	1			4706A21G01	G91		T
	1M	FVNR	206	1	1.00		H22		MCP	3	3	7 - 22		100	2	1	LAI-16499	WD-1	4706A21G01	G91	D	T
	2B	FVNR	206	1	5.00		H38		MCP	3	15	50 - 150		100	1	1	LAI-16499	WD-3	4706A21G01	G91		T
	2D	FVNR	206	1	.33		H12		MCP	3	3	7 - 22		100	1	1			4706A21G01	G91		T
	2F	FVNR	206	1					MCP	3	7	18 - 58		100	1	1			4706A21G01	G91		T
	2H	FVNR	206	1					MCP	3	15	50 - 150		100	2	1	LAI-16499	WD-1	4706A21G01	G91	D	T
	2K	FVNR	206	1					MCP	3	15	50 - 150		100	2	1			4706A21G01	G91	D	T
	2M		FUTURE	SPACE																		
	3C	FVR	216	1					MCP	3	3	7 - 22		150	2		LAI-16499	WD-2	4706A31G01	G91	E	T
	3F	FVR	216	1					MCP	3	3	7 - 22		150	2				4706A31G01	G91	E	T
	3J	FVR	216	1					MCP	3	3	7 - 22		150	2				4706A31G01	G91	E	T
	3M		FUTURE	SPACE																		

3.1.1-387

Unit Specifications
Control Center · FIVE STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

* IF ORDERED AND FULL LOAD CURRENT NOT PROVIDED, OVERLOAD RELAY HEATERS ARE SELECTED ON THE BASIS OF AVERAGE VALUES OF CURRENT (1975 NEC) FOR 1800 RPM MOTORS HAVING A SERVICE FACTOR OF 1.0 (NEW NEMA STDS) ALLOWING 115 PERCENT FULL LOAD PROTECTION

General Order Number LAI-16499-002
Item Number
Customer ABBOTT POWER CORP.

Prepared by JOE KUSMISZ
Date 12-15-80

Approved by Customer
Date

Notes

CHANGE 1

Sheet 6 of 8 Sheets

CGS 101-72-04

FORM 4505

12/10/80

NEMA Class 1 | Type B | Wiring
NEMA Type | Gaskets YES
Motor Protection
Overload Relay Heaters * 3
Ambient Compensated Overload
Service 480 Volts 60 Hertz 3 Phase
Service Factor 1.00
Control 120 Volts 60 Hertz 3 WIRE
Fuse Type
Source TX
Supplied by

FUSE TYPE CODES

- H1 10,000 ONE TIME FUSE
- H2 K1 CUR LIMIT
- H5 K5 DUAL EL 200,000
- J1 CUR LIMIT
- J2 CUR LIMIT TIME DELAY
- R1 K1 CUR LIMIT (REJ)
- R2 K5 DUAL EL 200,000 (REJ)

BREAKER OR SWITCH MOD CODES

- 1 - AUX SW 1NO
- 2 - AUX SW 2NO
- 3 AUX SW 1NO INC
- C CURRENT LIMITER
- F FUNGUS PROOF
- H - MARK 75
- L ALARM SWITCH
- M MAGNETIC ONLY
- N NON AUTO
- P TRI PACK
- R UN VOLT TRIP
- S - SAF T VUE
- T SHUNT TRIP
- V 50°C CALIBRATION

CONTROL DEVICE CODES

MINI DEV.
- F - AMMETER
- G - VOLTMETER
- H ELAPSED T M
- J AMM. SW.
- K V.M. SW

PUSH BUTTONS
- L - START
- M - STOP
- N MAINT CONT
- O - FAST SLOW
- P FWD REV
- R

IND LIGHT
- S - GR (STOP)
- T RED (RUN)
- U - AMBER
- V
- Q RED (STOP)
- Z GR (RUN)

SEL SWITCH
- W 2 POSITION
- X 3 POSITION
- Y

CUSTOMER UNIT NO.	WESTINGHOUSE UNIT NUMBER	ABBREVIATED NEMA DESCRIPTION	WESTINGHOUSE CLASS OR DESCRIPTION	SIZE	HORSEPOWER	FULL LOAD AMPS	HEATER CODE	CONTROL DEVICES	BREAKER TYPE OR SWITCH SIZE	POLES	CONTINUOUS AMPS OR FUSE CLIP SIZE	TRIP RANGE OR FUSE SIZE	BKR OR SW MODIFICATIONS	CONTROL TRANSFORMER SIZE (VA)	TOTAL INTERLOCKS N/O	TOTAL INTERLOCKS N/C	WIRING DIAGRAM NUMBER	WIRING DIAGRAM COMBINATION	UNIT STYLE NUMBER	DOOR	ADD'L UNIT SPEC. NOTE REFERENCES	SHOP ROUTING
	4B	FVNR	206	1					MCP	3	3			100	1	1	LAI-16499	WD-3	4706A21G01	G91		T
	4DL	BKR	DUAL						HFB	3	30						2291A01	B	4703A22G01	G92		T
	4DR		FCR						HFB	3	90											
	4FL	BKR	DUAL						HFB	3	90						2291A01	B	4703A22G01	G92		T
	4FR		FCR						HFB	3	90											
	4HL	BKR	DUAL						HFB	3	50						2291A01	B	4703A22G01	G92		T
	4HR		FCR						HFB	3	50											
	4KL	BKR	DUAL						HFB	3	15						2291A01	B	4703A22G01	G92		T
	4KR		FCR						HFB	3	70											
	4ML	BKR	DUAL						HFB	3	70						2291A01	B	4703A22G01	G92		T
	4MR		FCR						HFB	3	70											

3.1.1-388

Unit Specifications
Control Center FIVE STAR

Westinghouse Electric Corporation
Control Center Division
Chicago

* IF ORDERED AND FULL LOAD CURRENT NOT PROVIDED, OVERLOAD RELAY HEATERS ARE SELECTED ON THE BASIS OF AVERAGE VALUES OF CURRENT (1975 NEC) FOR 1800 RPM MOTORS HAVING A SERVICE FACTOR OF 1.0 (NEW NEMA STDS) ALLOWING 115 PERCENT FULL LOAD PROTECTION

General Order Number LAI-16499-002
Item Number
Customer ABBOTT POWER CORP

Prepared by JOE KUSMISZ
Date 12-15-80

Approved by Customer
Date

Notes

Sheet 7 of 8 Sheets

CHANGE 1

CDS 101-72-04

FORM 45805

Spec Number		Additional Specifications
3C	A	COMMON CONTROL WIRING TO BE NO.14 AWG
6C	B	EACH STARTER UNIT TO HAVE 50 FOR 206'S 180 FOR 216'S VA EXTRA CAPACITY CONTROL TRANSFORMER
9L	C	ALL CONTROL WIRES TO HAVE PRE-INSULATED RING TONGUE LUGS
	D	UNITS 1M, 2H, 2K TO HAVE (1) AR RELAY 4 POLE 120V PER UNIT
	E	UNITS 3C, 3F, 3J, TO HAVE 2 AR RELAY 4 POLE 120V PER UNIT

3.1.1-389

Unit Specifications
Control Center

Westinghouse Electric Corporation
Control Center Division
Chicago

General Order Number
Item Number LAJ-16499-C02
Customer ABBOTT POWER CORP.

Prepared by JOE KUSMISZ
Date 12-15-80

Approved by Customer
Date

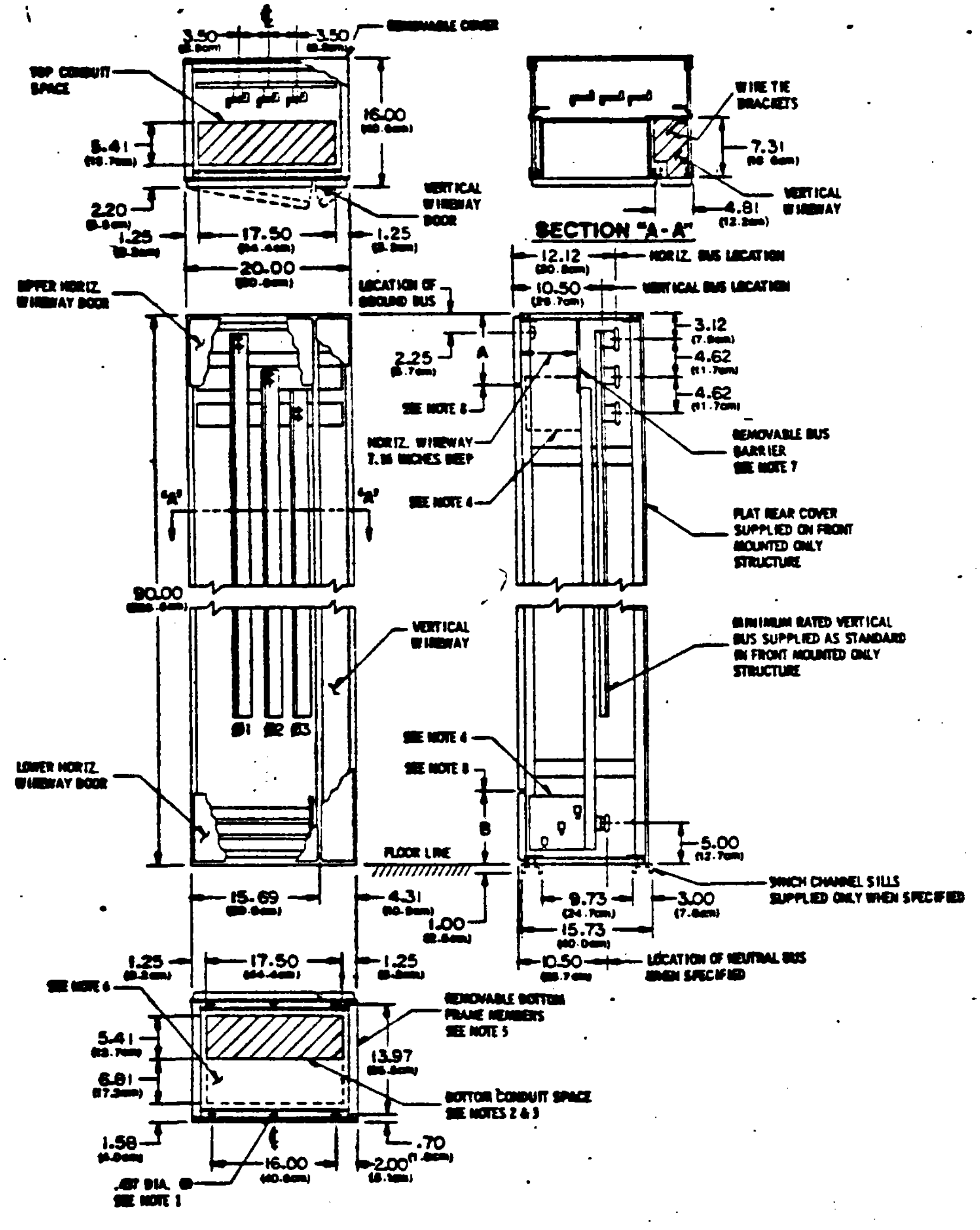
Notes

Sheet 8 of 8 Sheets

CHANGE 1

FORM 45805

01-72-04



NOTES

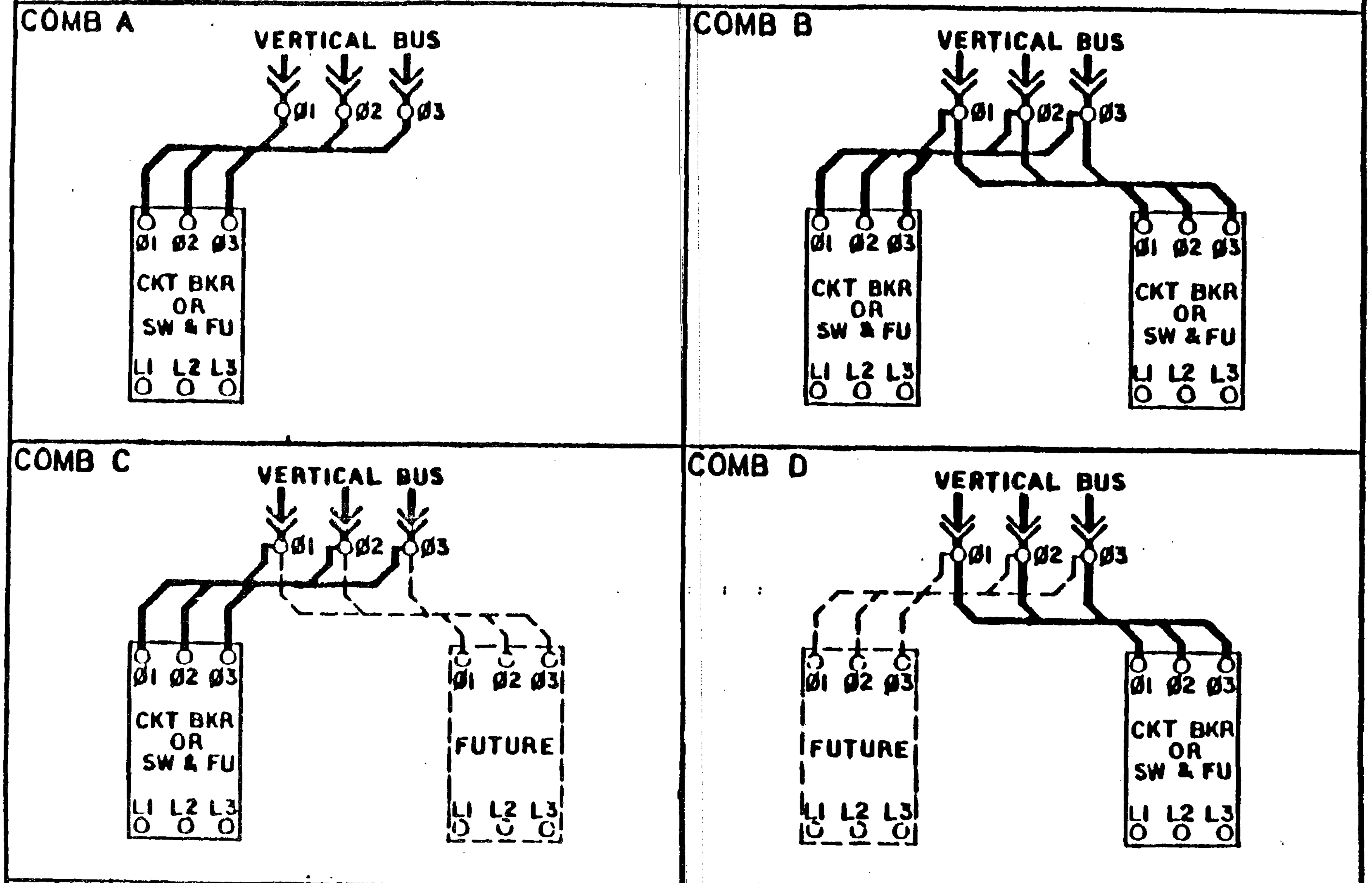
1. MIN. LENGTH OF ANCHOR BOLT 2 INCHES (3/8—16 RECOMMENDED).
2. RECOMMENDED MAX. CONDUIT HEIGHT ABOVE FLOOR LINE 3.50 IN.
3. MAX. CONDUIT SPACE WITH CHANNEL SILLS 17.50 X 9.73 INCHES.
4. MASTER TERMINAL BLOCK ASSEMBLY FURNISHED FOR TYPE 'C' WIRING ONLY. WHEN LOCATION NOT SPECIFIED MTB SUPPLIED AT THE BOTTOM.
5. FOR MULTIPLE STRUCTURE ASSEMBLIES EITHER ONE OR BOTH OF THESE MEMBERS ARE REMOVED TO PROVIDE MAXIMUM UN-RESTRICTED CONDUIT SPACE AT BOTTOM.
6. THIS CONDUIT SPACE NOT RECOMMENDED WHEN NEUTRAL BUS REQUIRED. OTHERWISE AVAILABLE.
7. REAR HORIZONTAL BUS BARRIER NOT SUPPLIED WITH FRONT MOUNTED ONLY STRUCTURE.
8. STANDARD STRUCTURE ARRANGEMENT (IN FRONT)
   WITHOUT MASTER TERMINAL BLOCK: A & B—9 INCHES.
   WITH MASTER TERMINAL BLOCK AT BOTTOM: A & B—9 INCHES.
   WITH MASTER TERMINAL BLOCK AT TOP: A—15 IN. B—3 IN.

STANDARD VERTICAL SECTION
20 INCHES WIDE
16 INCHES DEEP
FRONT MOUNTED ONLY

Westinghouse Electric Corporation
General Control Division Chicago Illinois
FIVE STAR MOTOR CONTROL CENTER
OUTLINE AND FLOOR PLAN

4710A30

3.1.1-391



2291A01

NEMA TYPE 'A' OR 'B'	
COMB	DESCRIPTION
A	FEEDER CKT BKR OR SW & FU
B	
C	
D	

WESTINGHOUSE ELECTRIC CORPORATION

MOTOR CONTROL CENTER – TYPE W –
STANDARD UNIT WIRING DIAGRAM

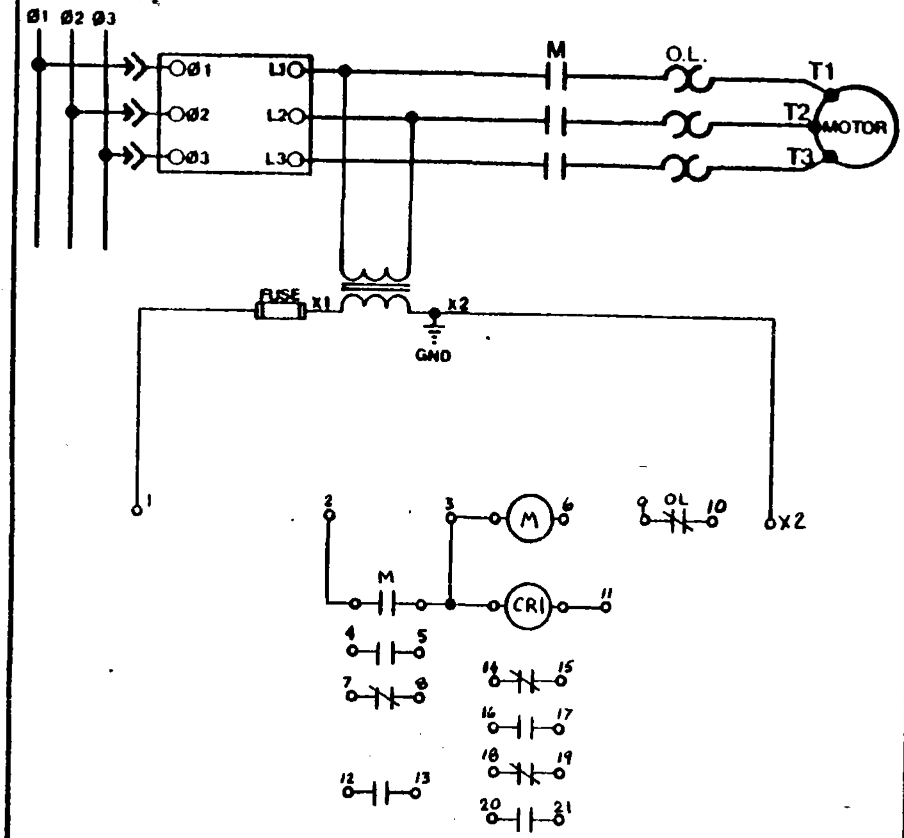
L.V.D.E. DIVISION

CHICAGO, ILL.

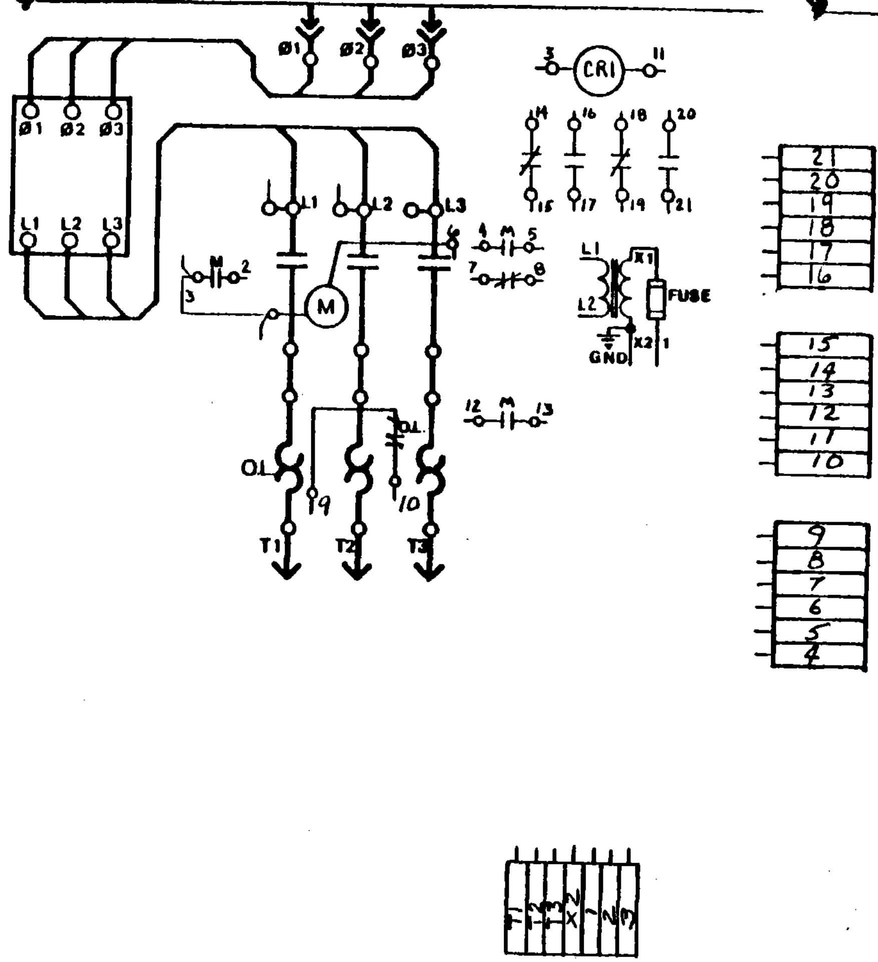
2291A01

FORM CGM-66-131 (1A01)

3.1.1-392



SCHEMATIC



CONNECTION

PREPARED BY	DATE
JOE KUSMISZ	12-11-80
APPROVED BY CUSTOMER	DATE

Westinghouse Electric Corporation
General Control Division, Chicago

GENERAL ORDER NO.

LAI-16499

WD-1

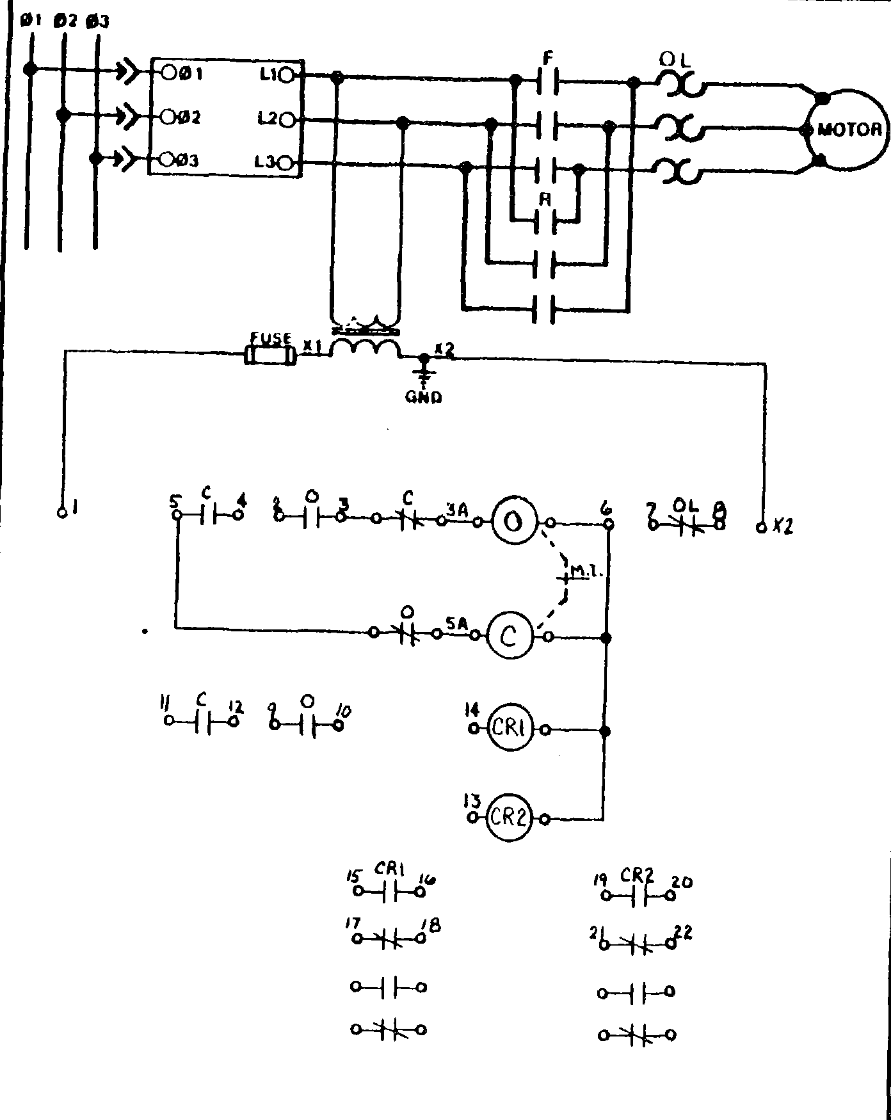
CHANGE 1

DESCRIPTION
FVNR
NEMA SIZE 1 THRU 4

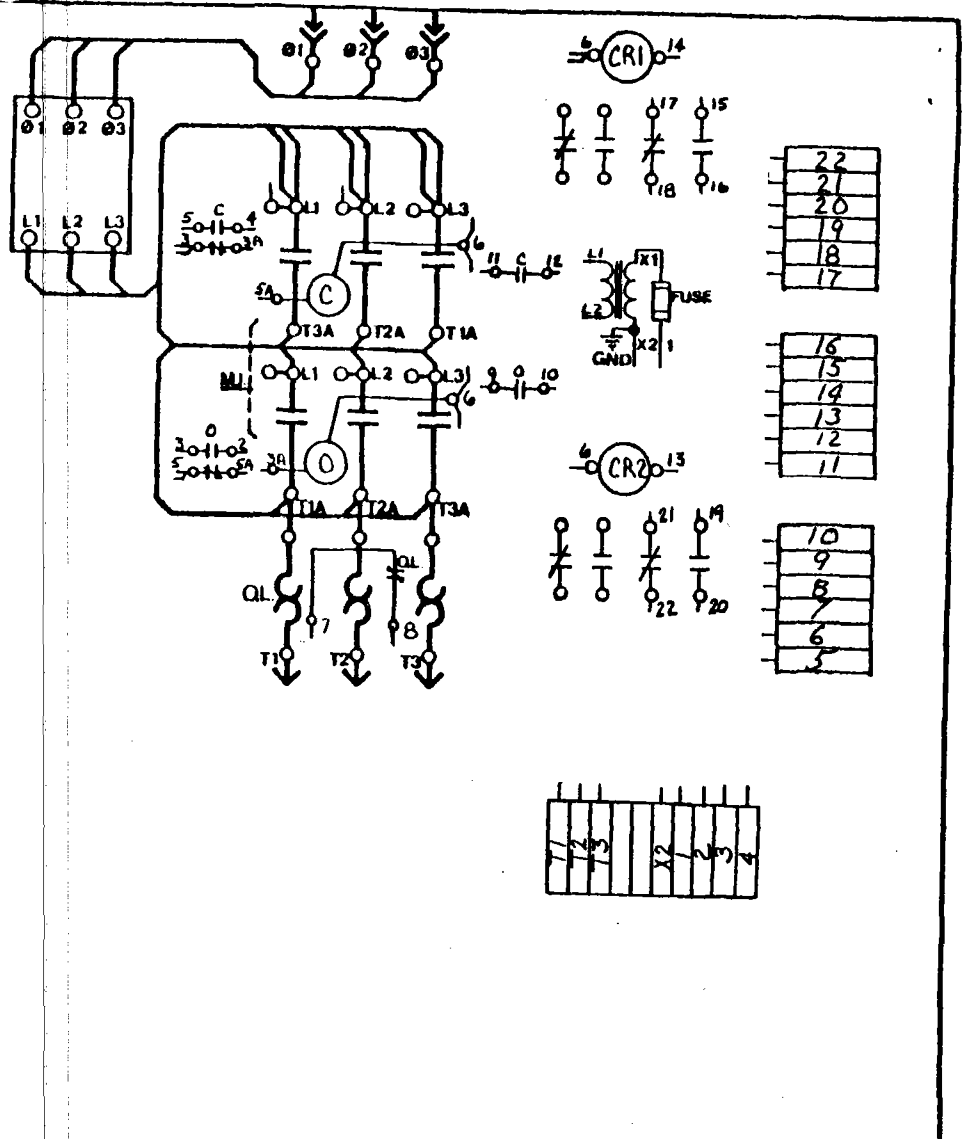
☒ 5 STAR
☐

FORM CGM-77-505

3.1.1-393



SCHEMATIC

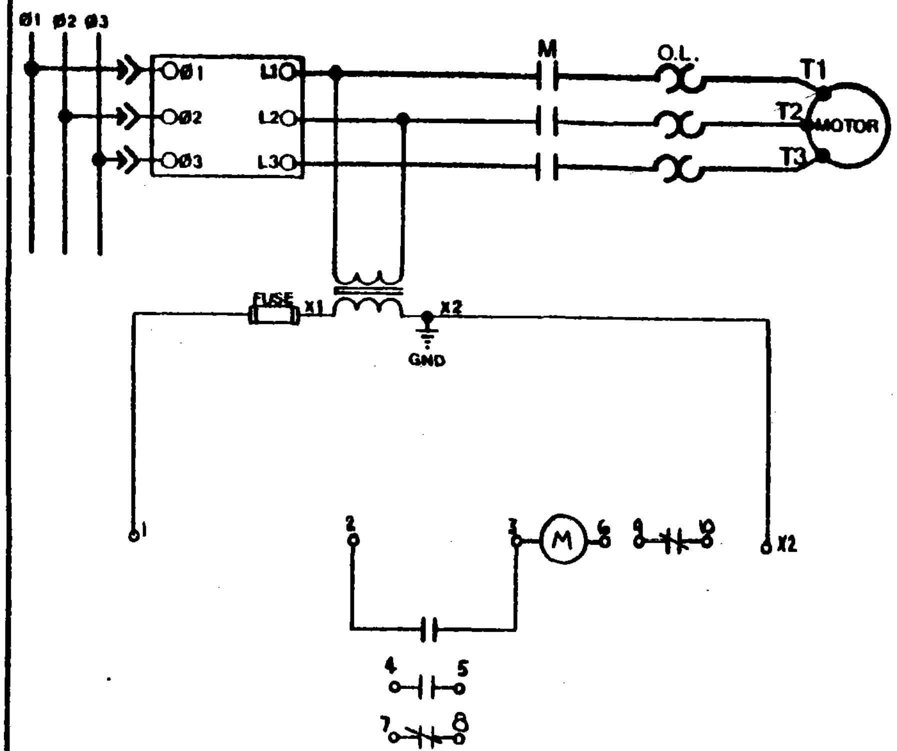


CONNECTION

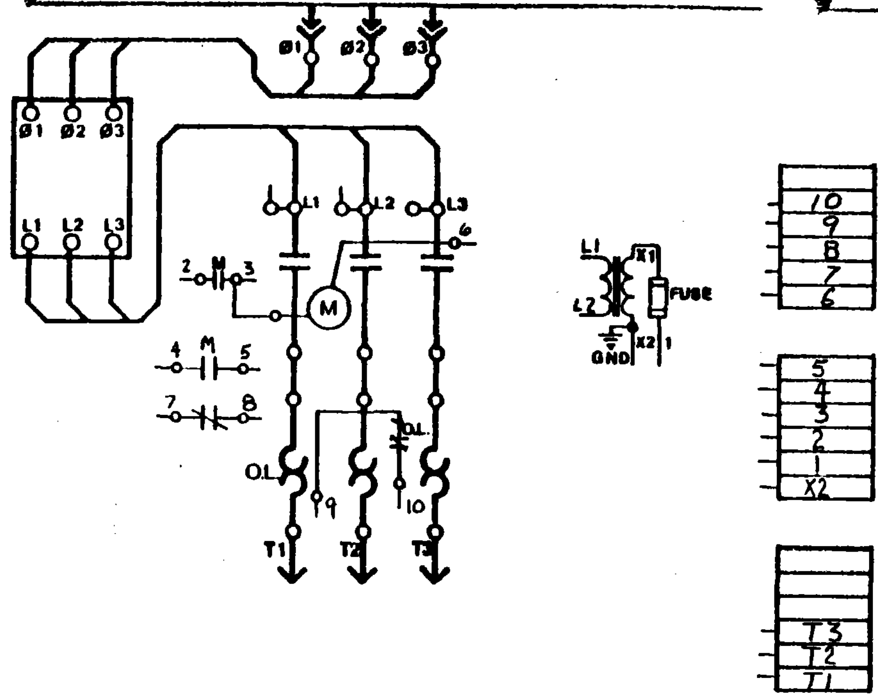
PREPARED BY JOE KUSMISZ	DATE 12-12-80	Westinghouse Electric Corporation General Control Division, Chicago	CHANGE 1
APPROVED BY CUSTOMER	DATE	GENERAL ORDER NO.	
DESCRIPTION FVR NEMA SIZE 1 AND 2	☒ 5 STAR ☐	LAI-16499	WD-2

FORM CGM-77-514

3.1.1-394



SCHEMATIC

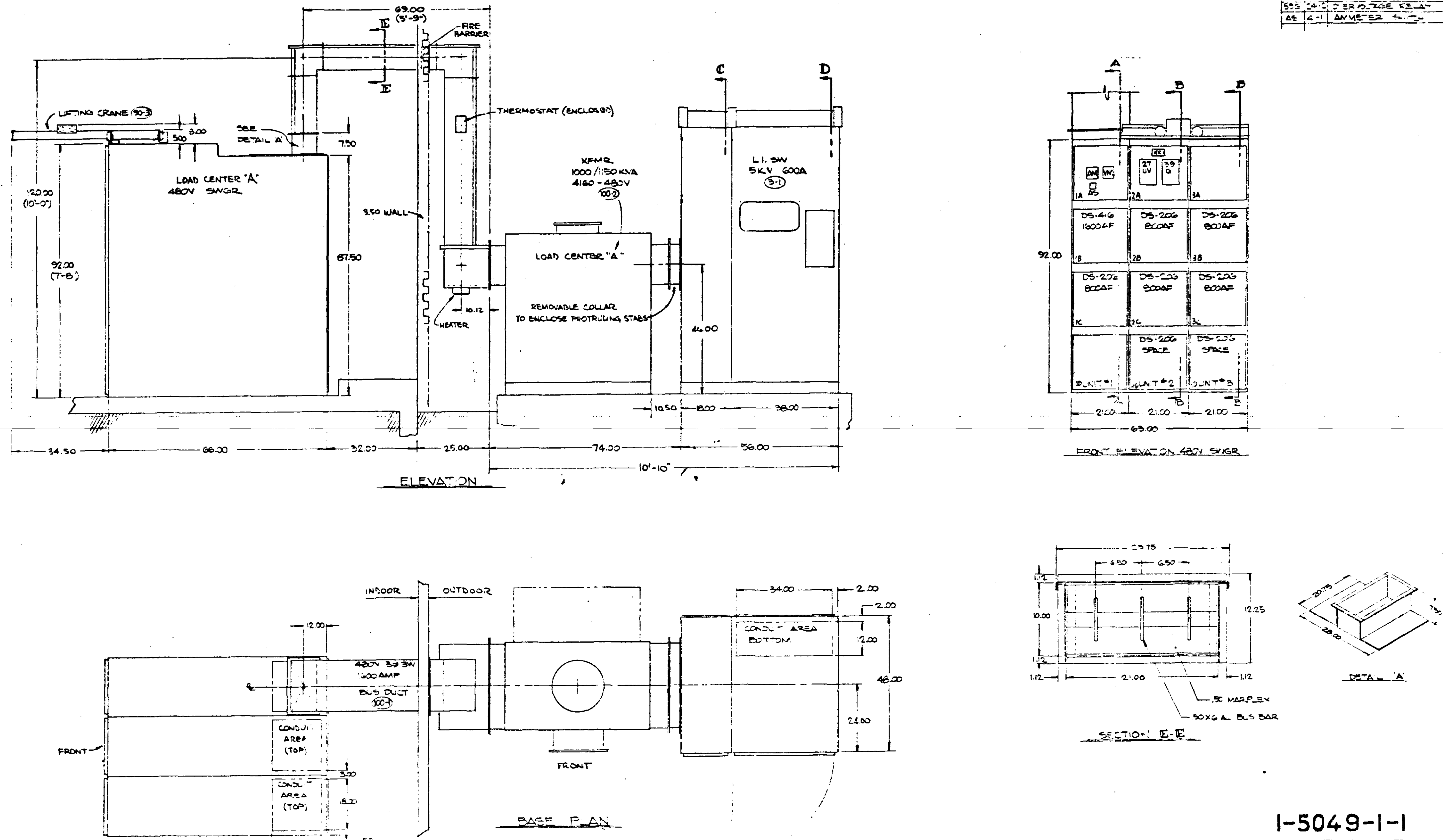


CONNECTION

PREPARED BY JOE KUSMISZ	DATE 12/12/80	Westinghouse Electric Corporation General Control Division, Chicago	CHANGE 1
APPROVED BY CUSTOMER	DATE	GENERAL ORDER NO.	
DESCRIPTION FVNR NEMA SIZE 1 THRU 4	☒ 5 STAR ☐	LAI-16499	WD-3

FORM CGM-77-505

DEV. NO.	P.M. NO.	DESCRIPTION
AM	[illegible]	AMMETER
VM	[illegible]	VOLTMETER
27U	24-	UNDERVOLTAGE RELAY
59G	24-[illegible]	OVERVOLTAGE RELAY
AS	4-1	AMMETER SWITCH



1-5049-1-1

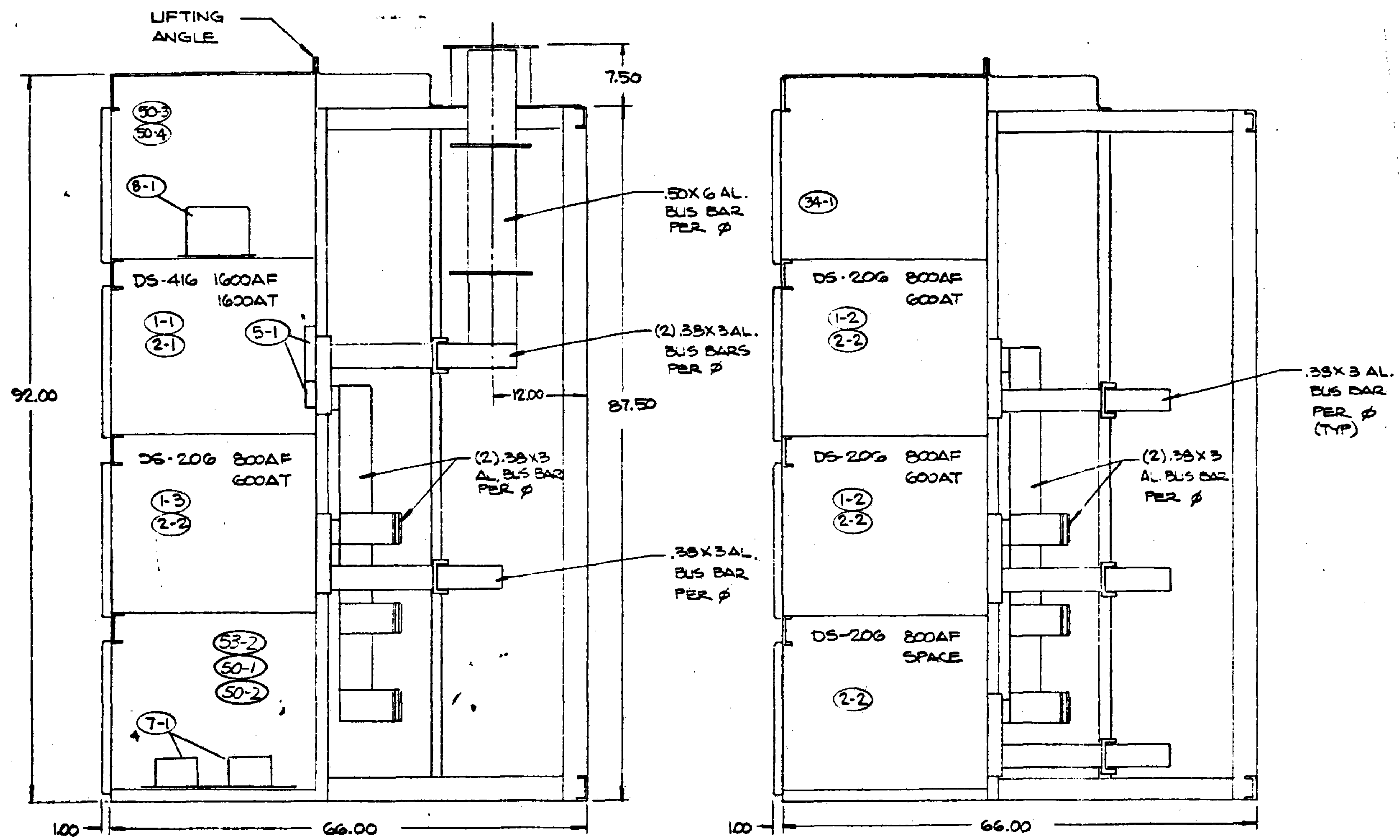
REVISION	BY / DATE

Abbott Power Corporation

7540 STAGE ROAD · BUENA PARK · CALIFORNIA 90620

A MEMBER OF [illegible]

LOAD CENTER 'A'



SECTION A-A

UNIT #1

SECTION B-B

UNIT #2 + #3

1-5049-1-2

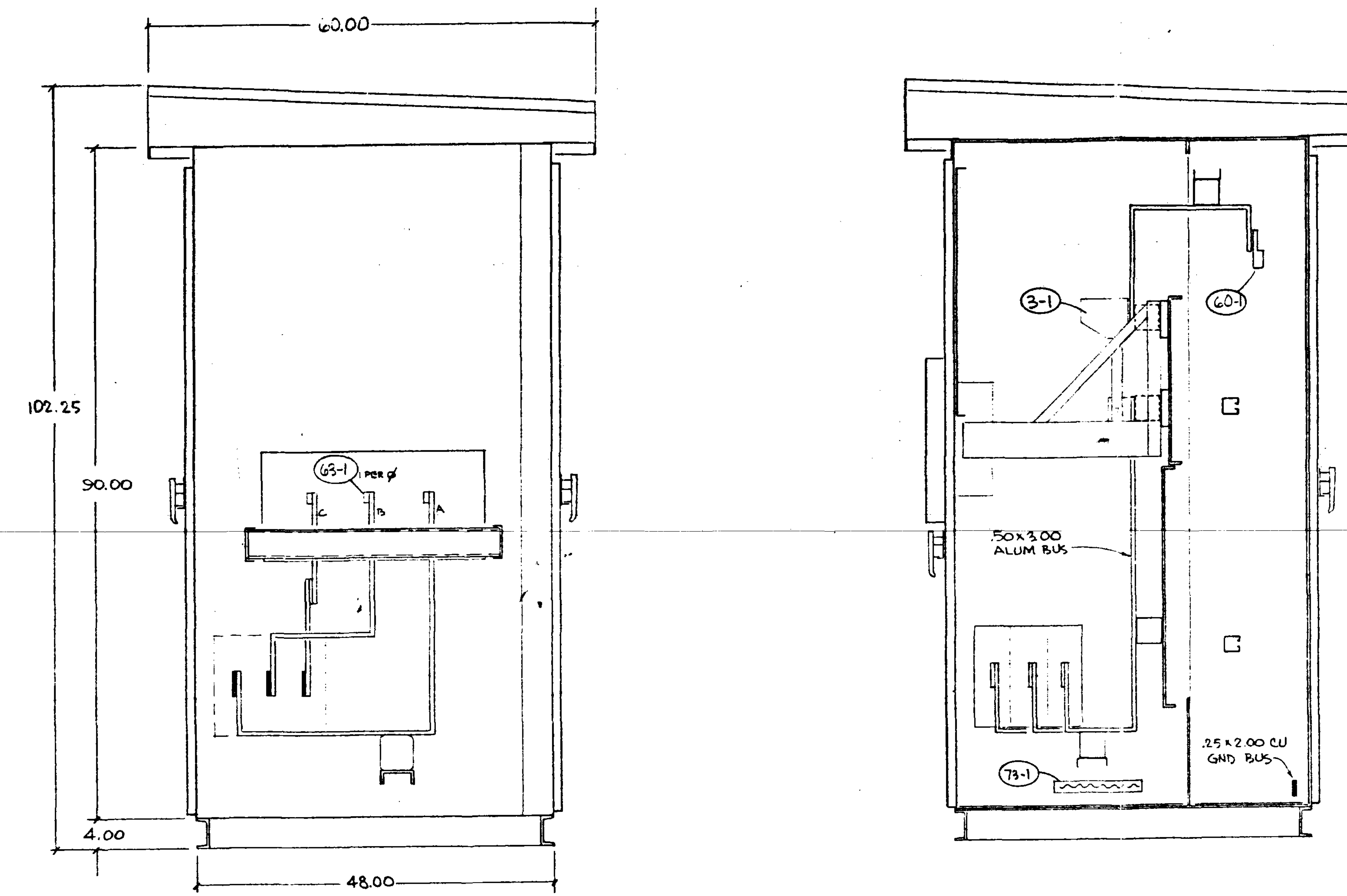
F				C				DRAFT. LELAND · DATE 9-15
E				B				CHK'R · DATE
D				A				APP'D · DATE
	REVISION	BY	DATE		REVISION	BY	DATE	

Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

TITLE DAGGETT, CALIF. LOAD CENTER 'A' SECTION VIEWS 4KV SWGR

PROJ. NO.: 5049
CUST. NO.:
DWG. NO.: OF

3.1.1-396



SECTION C-C
TRANSITION

SECTION D-D
LOAD INTERRUPTER

1-5049-1-3

F				C				DRAFT. TV	DATE 9-30-80
E				B				CHK'R	DATE
D				A	RLY PHASING TO TRANSFORMER	TV	12-12-80	APP'D	DATE
	REVISION	BY	DATE		REVISION	BY	DATE		

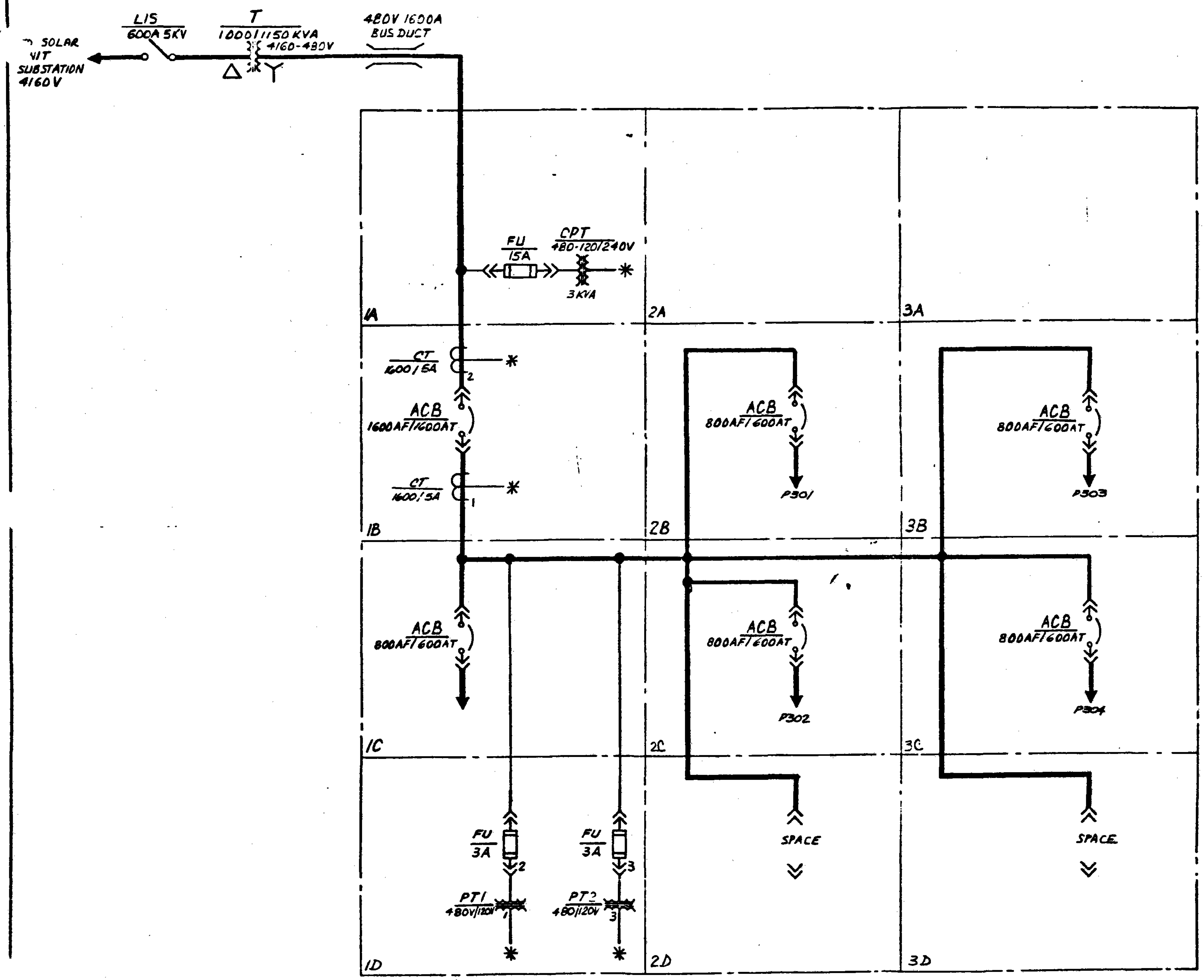
Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

TITLE 10MWe SOLAR PILOT PLANT
DAGGETT, CALIF
LOAD CENTER "A"
SECTION VIEWS 5KV SWGR

PROJ. NO.: 5049
CUST. NO.: 4004CZ1700
DWG. NO.: 1-5049-1-3 PAGE ___ OF ___

3.1.1-397

VU-COLOR REORDER NO. 1203



SYMBOL	DESCRIPTION
LIS	LOAD INTERRUPTER SWITCH
T	TRANSFORMER
PT	POTENTIAL TRANSFORMER
CT	CURRENT TRANSFORMER
ACB	CIRCUIT BREAKER
TB	TERMINAL BLOCK
SB	SHORTING BLOCK
ST	SHUNT TRIP
R	RESISTOR
FU	FUSE
CPT	CONTROL POWER TRANSFORMER
AS	AMMETER SWITCH
AM	AMMETER
59G	OVER VOLTAGE RELAY
27UV	UNDERVOLTAGE RELAY
VM	VOLTMETER
BA	BELL ALARM CONTACT
SH	STRIP HEATER
23	THERMOSTAT

* SEE THREE-LINE FOR DETAIL CONN. AND FRONT ELEVATION FOR PHYSICAL LOCATION.

2-5049-1-1

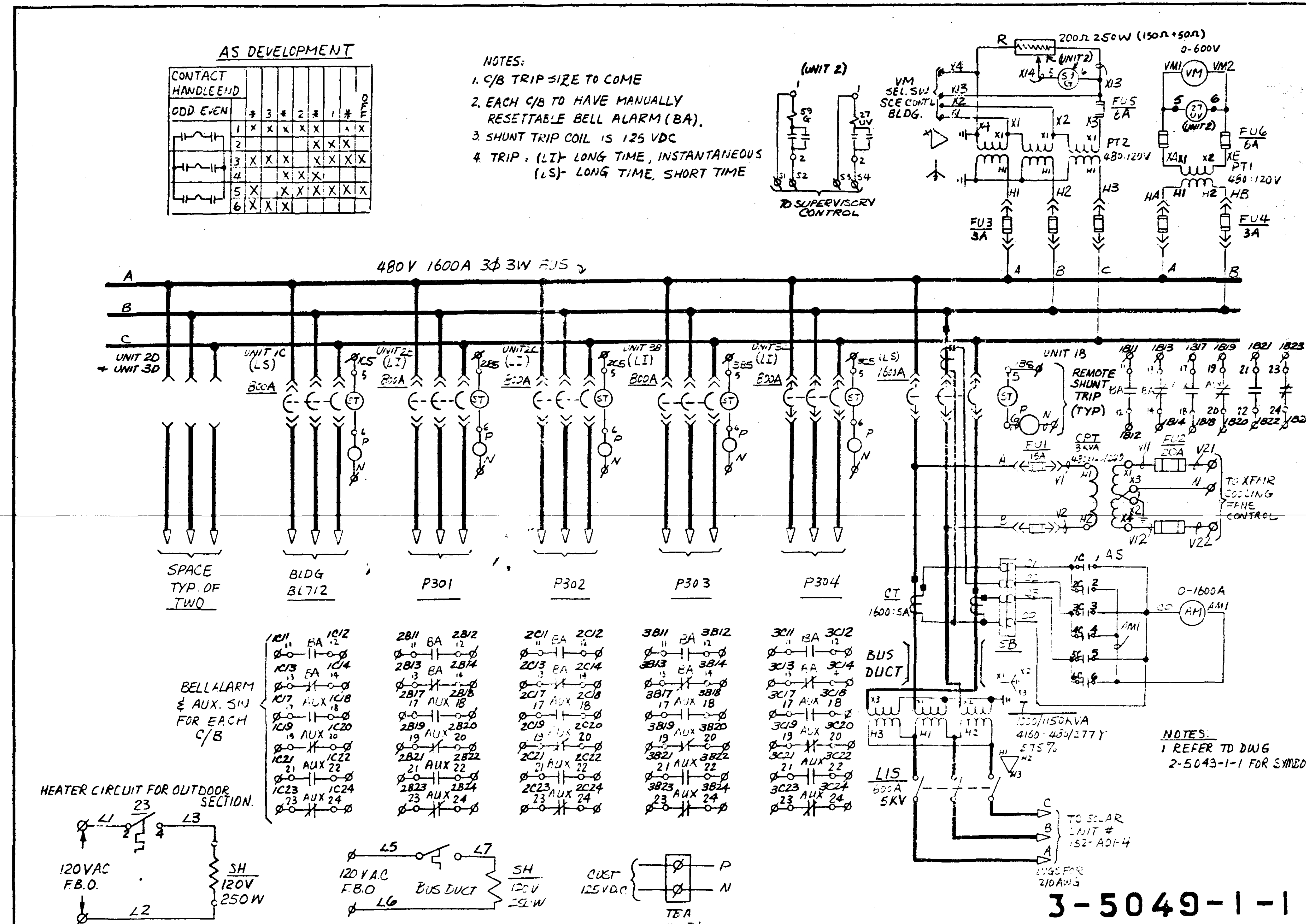
REVISION	BY	DATE	REVISION	BY	DATE	REVISION	BY	DATE	REVISION	BY	DATE	REVISION	BY	DATE
O			L			I			F			C		
N			K			H			E			B		
M			J			G			D			A		

DRAFT M. YOULDEN DATE
CHK'D DATE
APP'D DATE

Abbott Power Corporation
A MEMBER OF NEMA

TITLE LOAD CENTRE 'A'
10 MWe SOLAR PILOT PLANT
DAGGETT CALIF.
SINGLE LINE DIAGRAM

PROJ NO 5049
DWG NO 2-5049-1-1

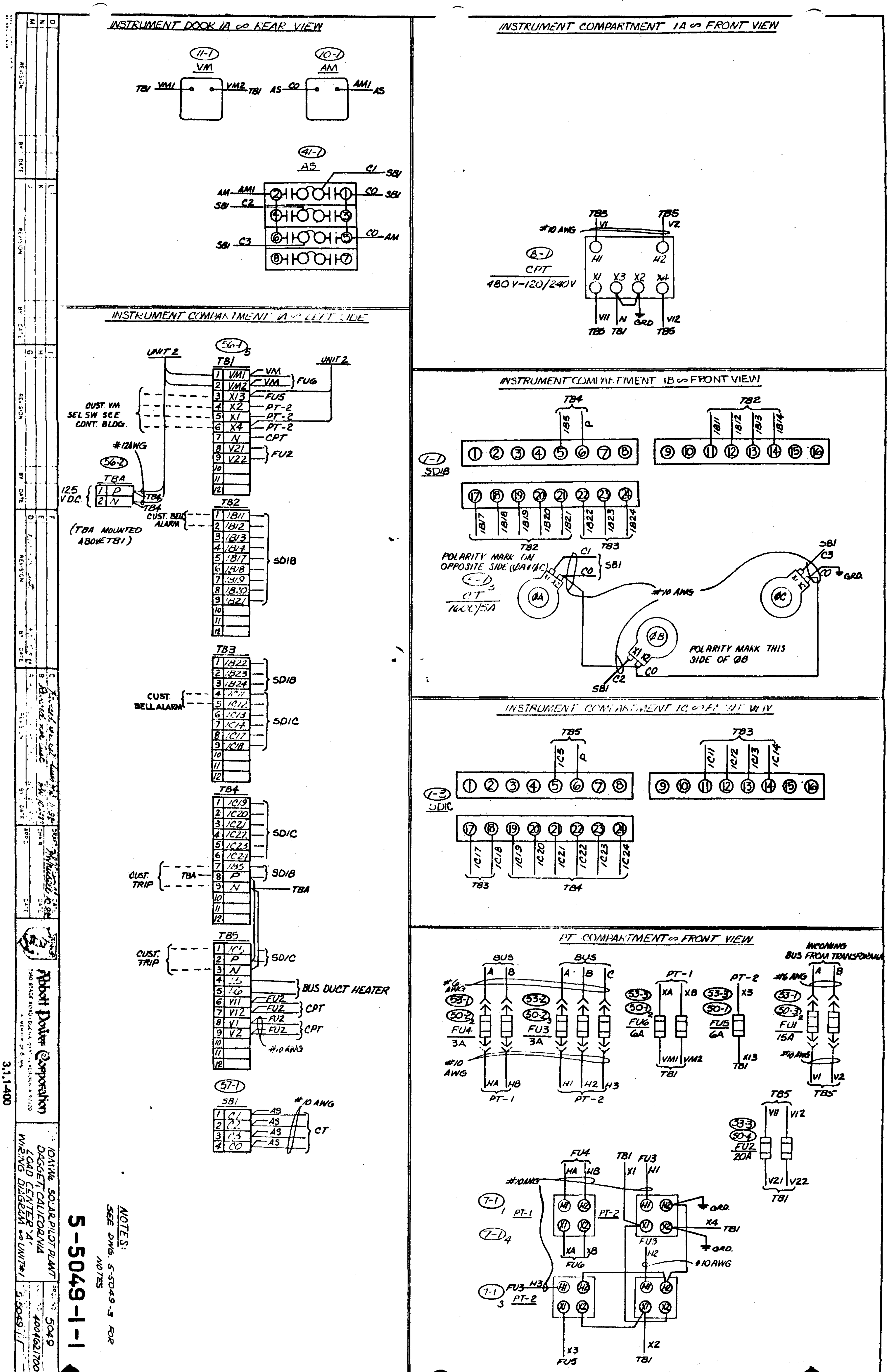


F				C				DRAFT.	DATE
E				B	REVISED PER CUST		10-24-80	CHK'R	DATE
D				A		AC		APP'D	DATE
	REVISION	BY	DATE		REVISION	BY	DATE		

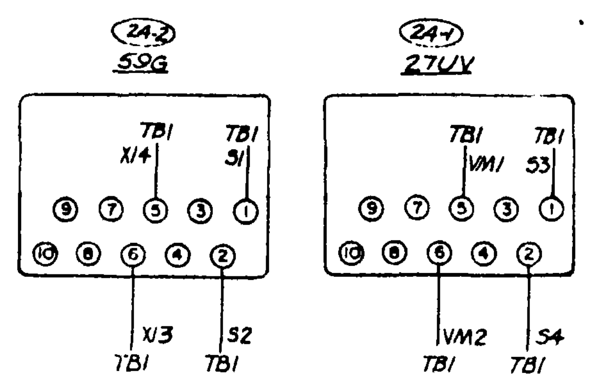
Abbott Power Corporation
7050 STAGE ROAD • BUENA PARK • CALIFORNIA 90620
A MEMBER OF NEMA

TITLE LOAD CENTER "A" 10 MW SOLAR PILOT PLANT DAGGETT CALIF 3-LINE DIAGRAM

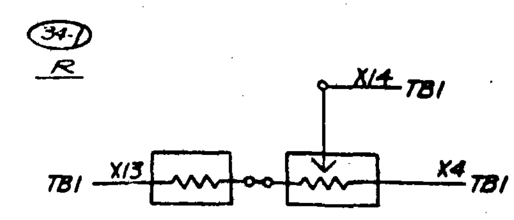
PROJ. NO.: 5049
CUST. NO.: 4004CZ1700
DWG. NO.: 3-5049-1-1 PAGE ___ OF ___


INSTRUMENT DOOR 1A REAR VIEW
INSTRUMENT COMPARTMENT 1A FRONT VIEW
INSTRUMENT COMPARTMENT 1A LEFT SIDE
INSTRUMENT COMPARTMENT 1B FRONT VIEW
INSTRUMENT COMPARTMENT 1C FRONT VIEW
PT COMPARTMENT FRONT VIEW
CPT
480V-120/240V
CT
1600/5A
POLARITY MARK ON OPPOSITE SIDE
POLARITY MARK THIS SIDE OF ØB
CUST. VM SEL SW SCE CONT. BLDG.
125 VDC
(TBA MOUNTED ABOVE TB1)
CUST. BELL ALARM
CUST. TRIP
BUS DUCT HEATER
INCOMING BUS FROM TRANSFORMER
NOTES:
SEE DWG. 5-5049-3 FOR NOTES
5-5049-1-1
Abbott Power Corporation
10MWe SOLAR PILOT PLANT
DAGGETT, CALIFORNIA
LOAD CENTER 'A'
WIRING DIAGRAM UNIT #1
3.1.1-400

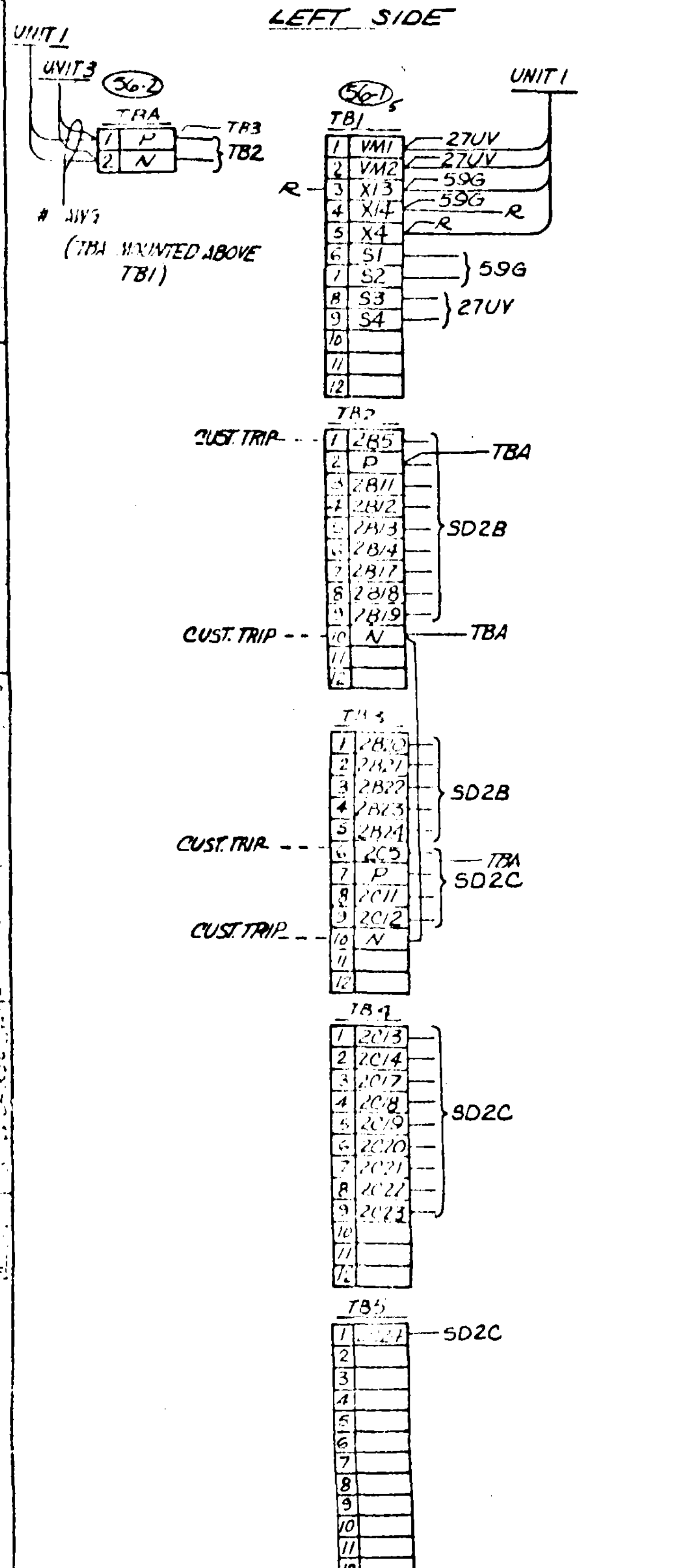
INSTRUMENT PANEL 2A – REAR VIEW



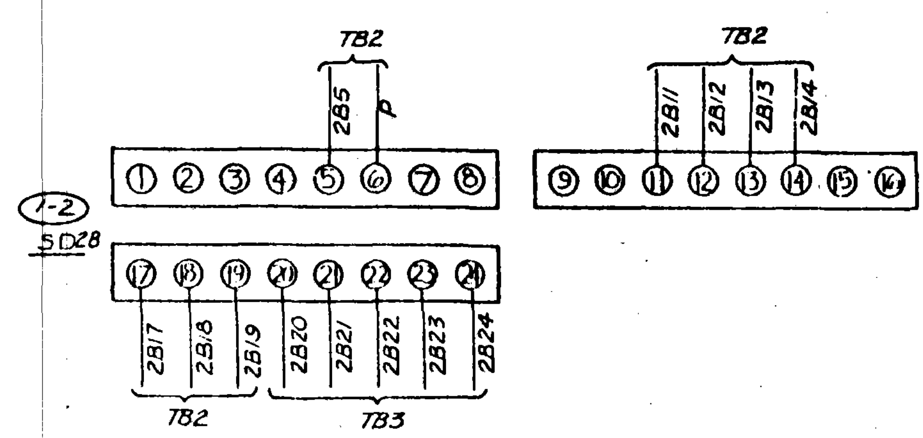
INSTRUMENT COMPARTMENT 2A – FRONT VIEW



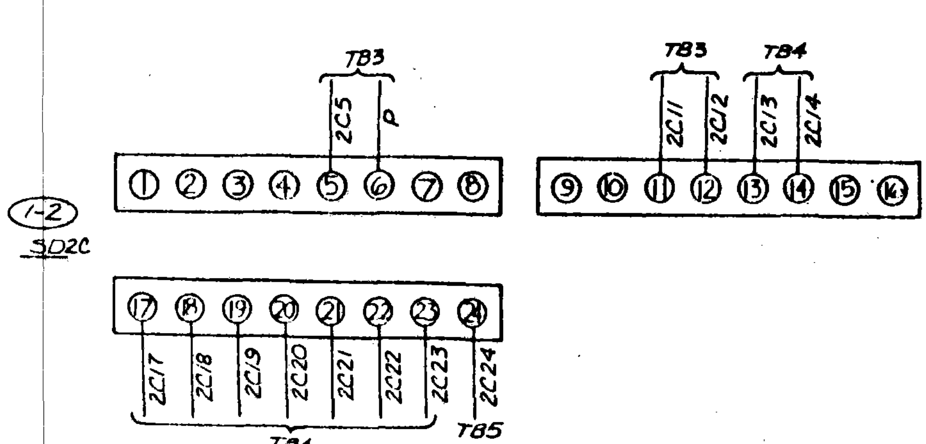
INSTRUMENT COMPARTMENT 2A – LEFT SIDE



BREAKER COMPARTMENT 2B – FRONT VIEW



BREAKER COMPARTMENT 2C – FRONT VIEW



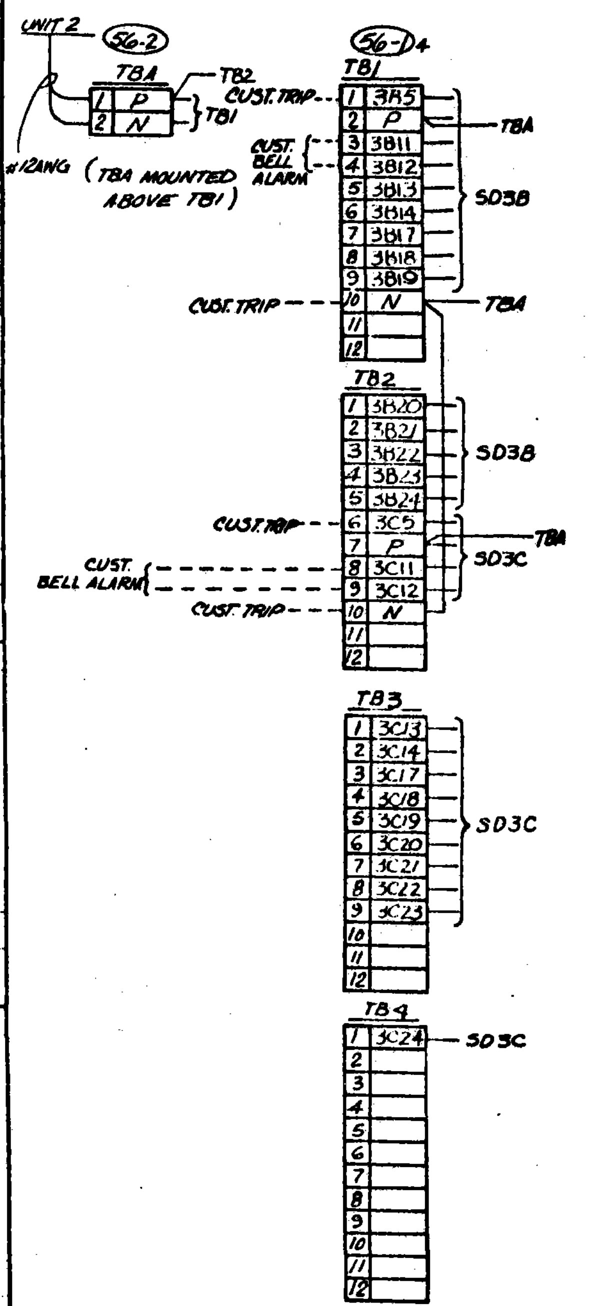
BREAKER COMPARTMENT 2D – FRONT VIEW

NOTES:
SEE DWG. 5-5049-3 FOR NOTES.

5-5049-1-2

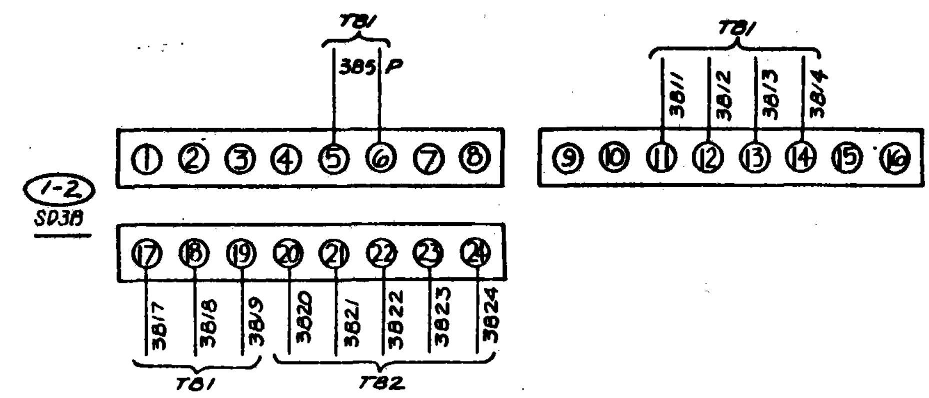
3.1-401

INSTRUMENT COMPARTMENT 3A ~ LEFT SIDE

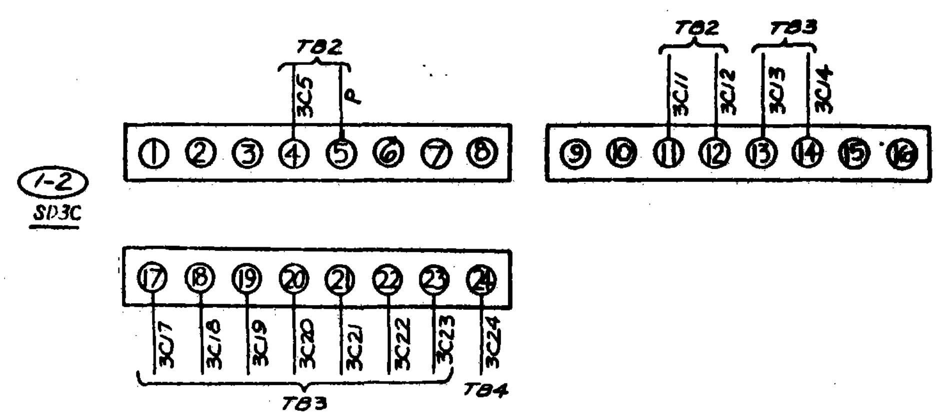


INSTRUMENT COMPARTMENT 3A ~ FRONT VIEW

BREAKER COMPARTMENT 3B ~ FRONT VIEW



BREAKER COMPARTMENT 3C ~ FRONT VIEW



BREAKER COMPARTMENT 3D ~ FRONT VIEW

NOTES:

1.) REFER TO BILL OF MATERIAL 5049-1 AND DWGS. 1-5049-1-1 THRU 3-5049-1-1
2.) ( ) DENOTES ITEM NUMBER ON BILL OF MATERIAL.
3.) USE RING TONGUE INSULATED TERMINAL LUGS TO TERMINATE ALL CONTROL WIRING.
4.) HINGE WIRE TO BE 41 STR., USE SPIRAL WIRE PROTECTORS.
5.) CONTROL WIRING TO BE TYPE SIS, 600V, 90°C, SIZE #14 AWG.
6.) CT SECONDARY WIRING TO BE #10 AWG.
7.) SD DENOTES CIRCUIT BREAKER SECONDARY DISCONNECT.
8.) ALL GROUND WIRE TO BE GREEN #12 AWG, TYPE SIS.
9.) FUSE BLOCKS, CB'S, METERS AND RELAYS NOT TO BE MOUNTED OVER 6 1/2 FEET HIGH.

Abbott Power Corporation

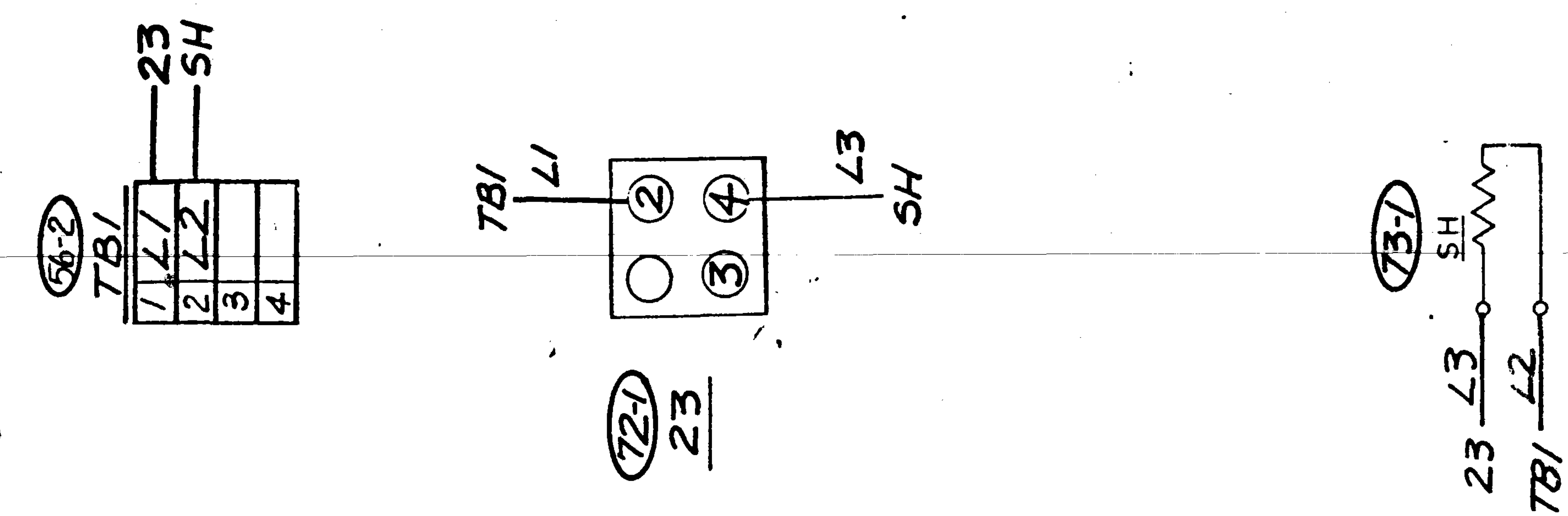
10MWe SOLAR PILOT PLANT
DAGGETT, CALIFORNIA
LOAD CENTRE 'A'
WIRING DIAGRAM ~ UNIT 2

5049
400682700
5-5049-1-3

5-5049-1-3

3.1.1-402

HEATER WIRING ∞ OUTDOOR ENCLOSURE



NOTES:

1. REFER TO DWG. 5-5049-1-3

5-5049-1-4

	REVISION	BY	DATE
C			
B			
A	REVISED PER ENG.	MI	10-14-80

DRAFT. H. Whitsell DATE 10-13-80
CHK'R DATE
APP'D DATE

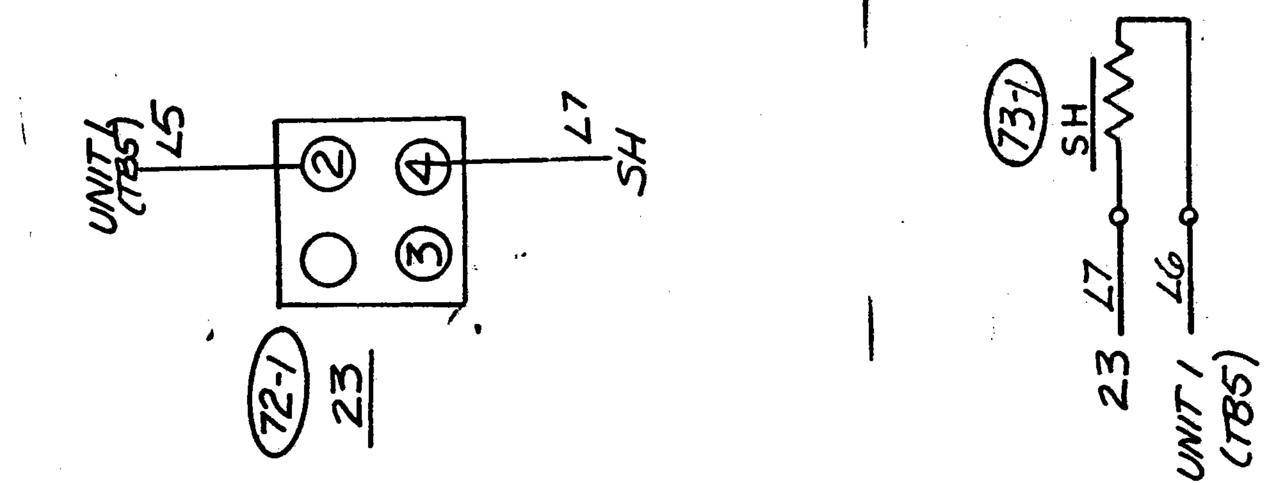
Abbott Power Corporation
7650 STAGE ROAD • BUENA PARK • CALIFORNIA 90620
A MEMBER OF NEMA

TITLE 10 MWe SOLAR PILOT PLANT
DAGGETT, CALIF.
LOAD CENTER 'A'
HEATER WIRING ∞ OUTDOOR ENC.

PROJ. NO.: 5049
CUST. NO.: 4004621700
DWG. NO.: 5-5049-1-4 PAGE ___ OF ___

3.1.1-403

BUS DUCT HEATER WIRING



NOTES:
SEE DWG. 5-5049-3

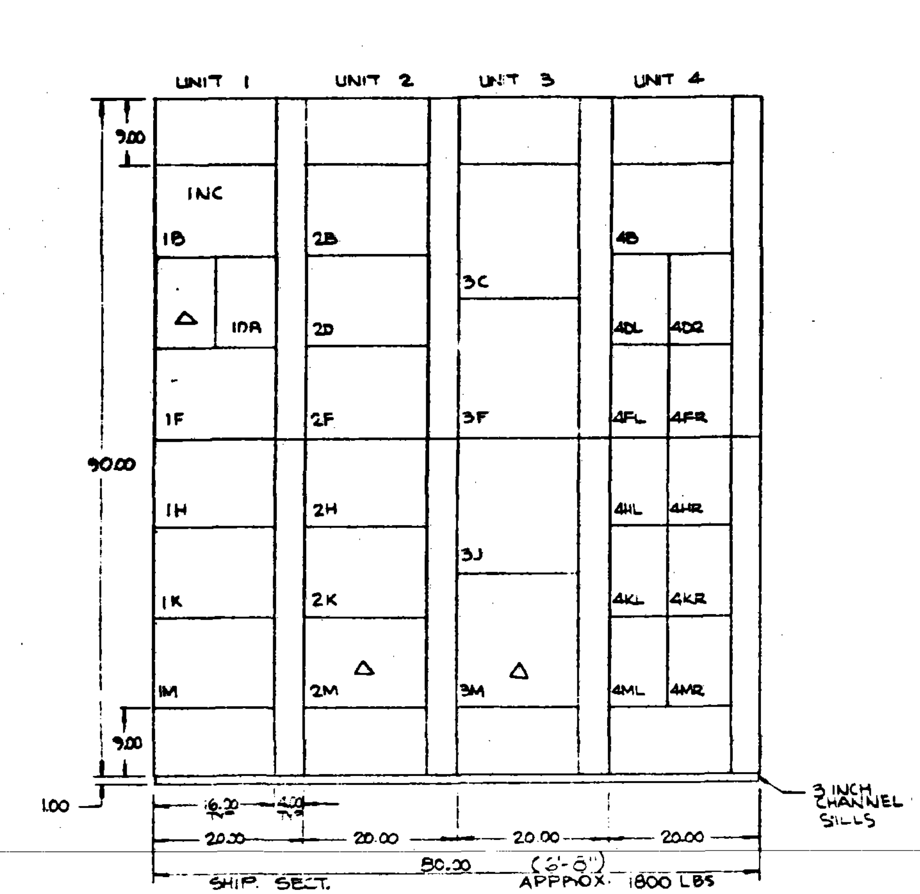
5-5049-1-5

C				DRAFT H. Whitsell	DATE 11-3-80	
B				CHK'R	DATE	
A				APP'D	DATE	
	REVISION	BY	DATE			

Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

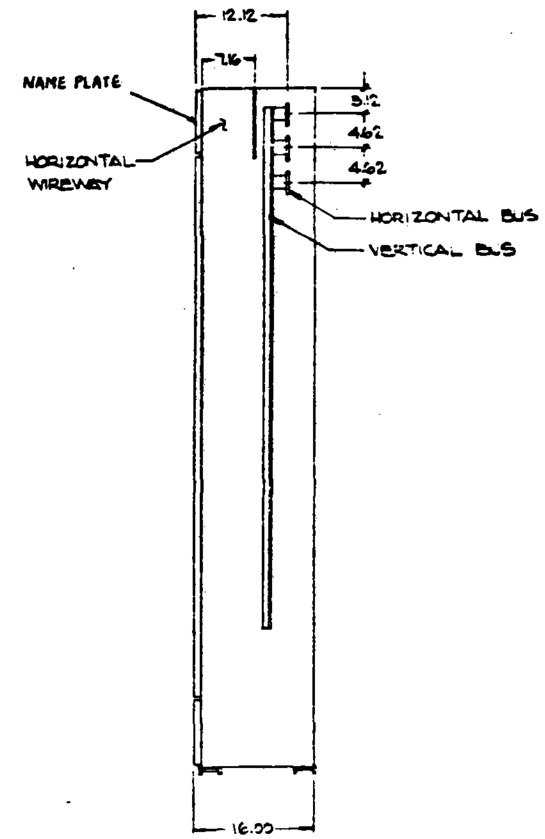
TITLE 10MWe SOLAR PILOT PLANT DAGGETT CALIFORNIA LOAD CENTER 'A' WIRING DIAGRAM - BUS DUCT	PROJ. NO.: 5049
	CUST. NO.: 4004621700
	DWG. NO.: PAGE ___ OF ___ 5-5049-1-5

3.1.1-404



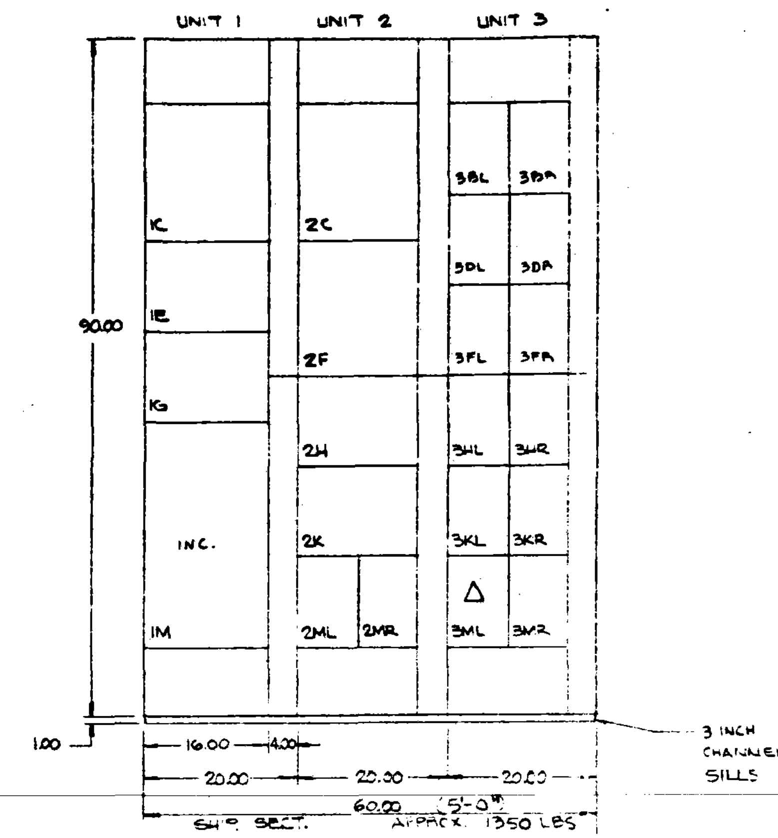
FRONT ELEVATION

MCC - B



SECTION VIEW

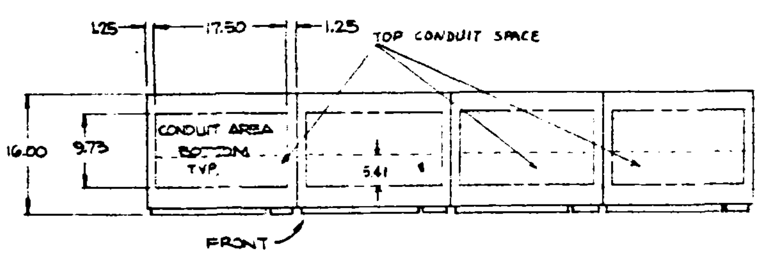
TYP MCC-B & MCC-C



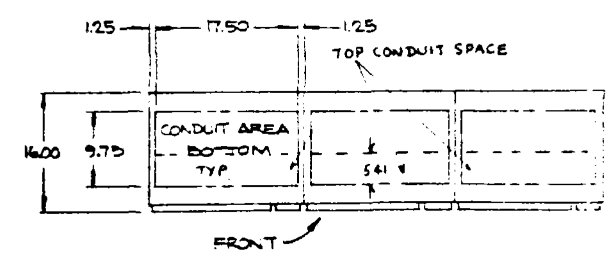
FRONT ELEVATION

MCC - C

NOTE
△ - FUTURE SPACE



BASE PLAN



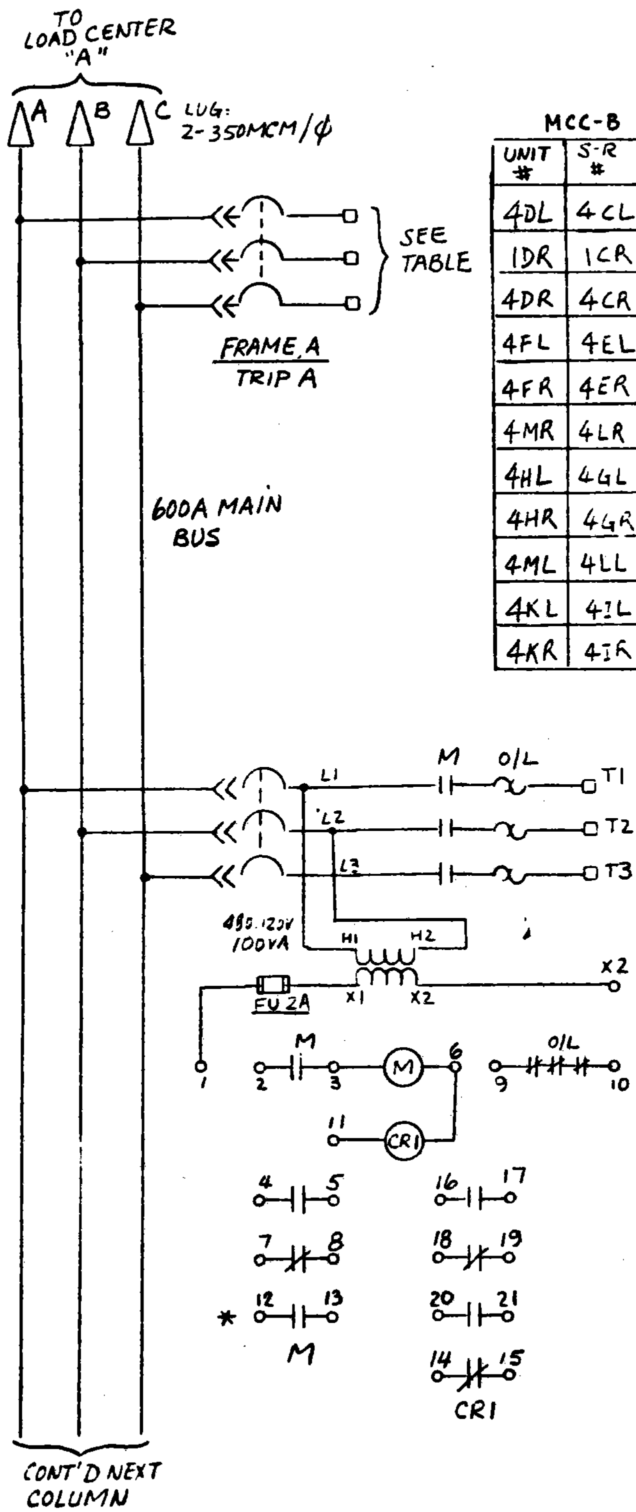
BASE PLAN

1-5049-2-1

O			L			I			F			C		
N			K			H			E			B		
M			J			G			D			A		
	REVISION	BY DATE		REVISION	BY DATE		REVISION	BY DATE		REVISION	BY DATE		REVISION	BY DATE

DRAFT. · DATE
CHK'R · DATE
APP'D · DATE

Abbott Power Corporation



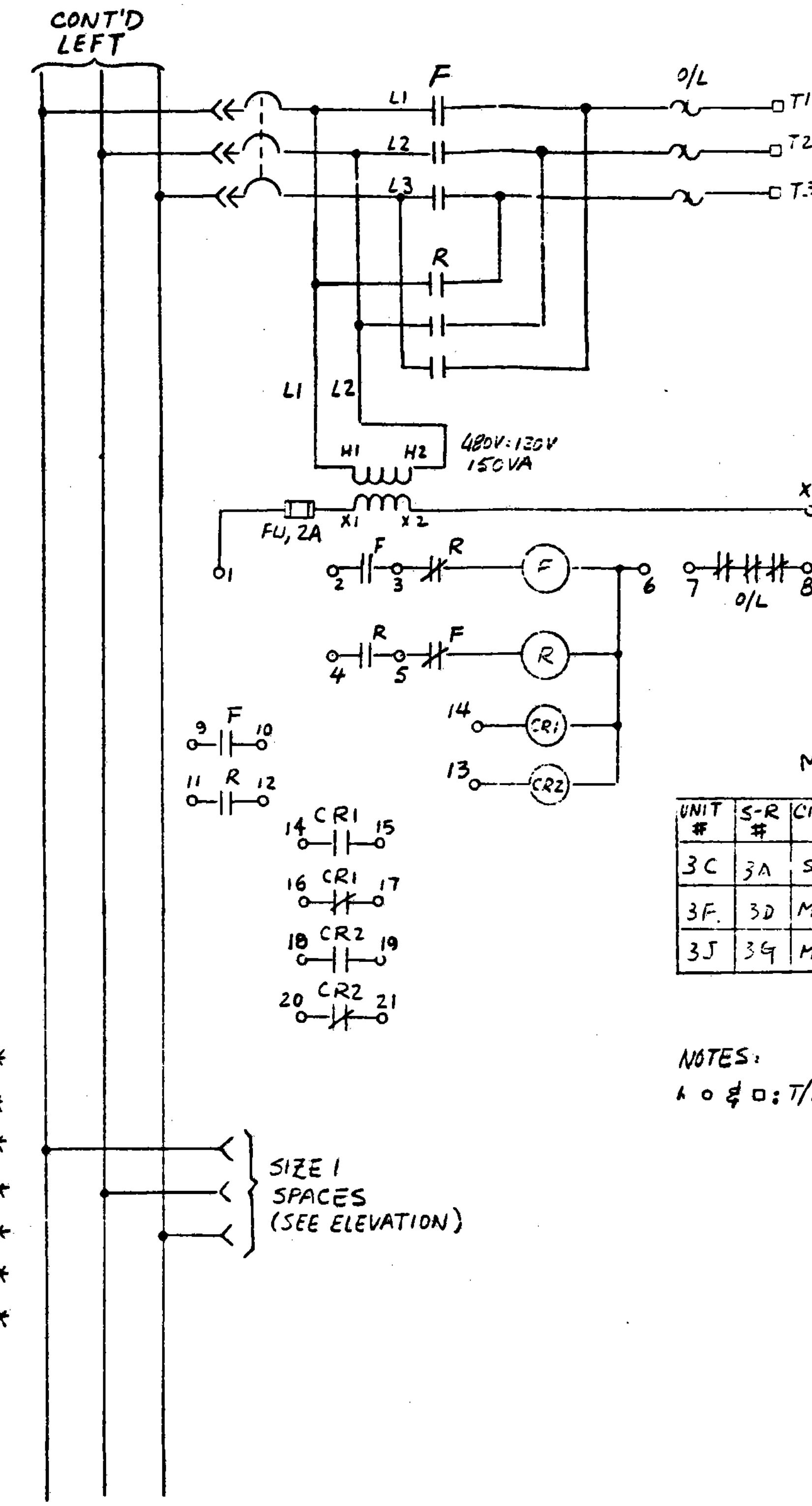
MCC-B

UNIT #	S-R #	CIRCUIT #	FRAME A	TRIP A
4DL	4CL	P-305	100A	30A
1DR	1CR	P718		15
4DR	4CR	MCC#1		90
4FL	4EL	MCC#2		90
4FR	4ER	MCC#3		90
4MR	4LR	RECEPTACLE RECEIVER		70
4HL	4GL	LP4		50
4HR	4GR	PP2 XFMR		50
4ML	4LL	RECEPTACLE TS SKID		70
4KL	4IL	P717		15
4KR	4IR	OIL WATER SEPARATOR		70

MCC-B

UNIT #	SR #	CIRCUIT #	C/B TYPE	TRIP A	STR SIZE	
1M	1L	P-307	MCP	3	1	
2H	2G	SPARE		15	1	
2K	2J	SPARE		15	1	
1F	1E	SPARE		30	1	*
1H	1G	SPARE		30	1	*
4B	4A	SPARE		3	1	*
2B	2A	SA-701		15	1	*
2D	2C	P-306		3	1	*
2F	2E	SPARE		7	1	*
1K	1J	SPARE		3	1	*

* FOR THESE UNITS, OMIT CR1 & ITS CONTACTS AND CONTACT 12-13



MCC - B

UNIT #	S-R #	CIRCUIT #	C/B TYPE	TRIP A	STR SIZE
3C	3A	SPARE	MCP	3	1R
3F	3D	MOV-1030		3	1R
3J	3G	MOV-1031		3	1R

NOTES:

1. o & □: T/B IN OR NEAR WIRE GUTTERS

3-5049-2-1

	REVISION	BY	DATE		REVISION	BY	DATE
F				C			
E				B	REVISED PER CUSTOMER	AC	11/5/80
D				A	REARRANGE UNIT #	AC	[illegible]

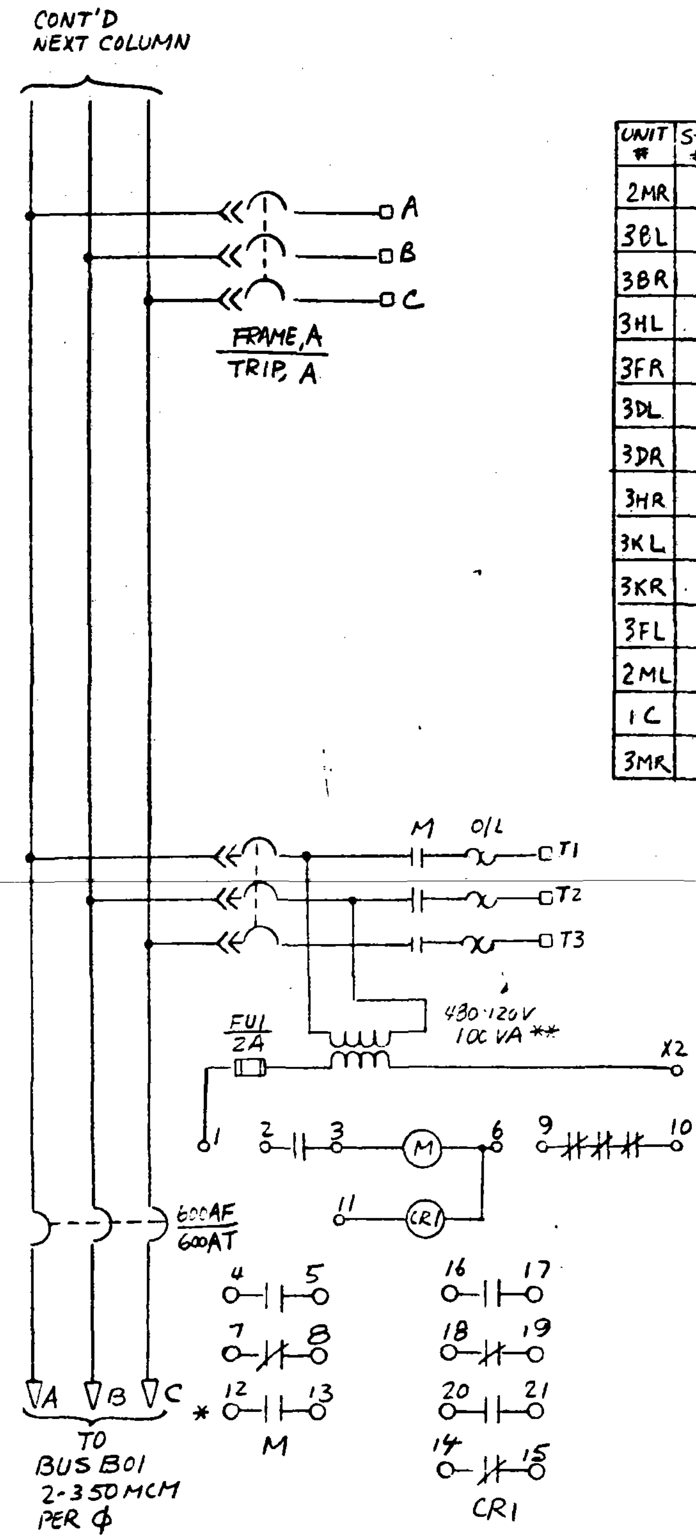
DRAFT. AC DATE · CHK'R AC DATE · APP'D DATE

Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

TITLE MCC-B
10 MWe SOLAR PILOT PLANT
DAGGETT, CALIF.
1-LINE SCHEMATIC DIAGRAM

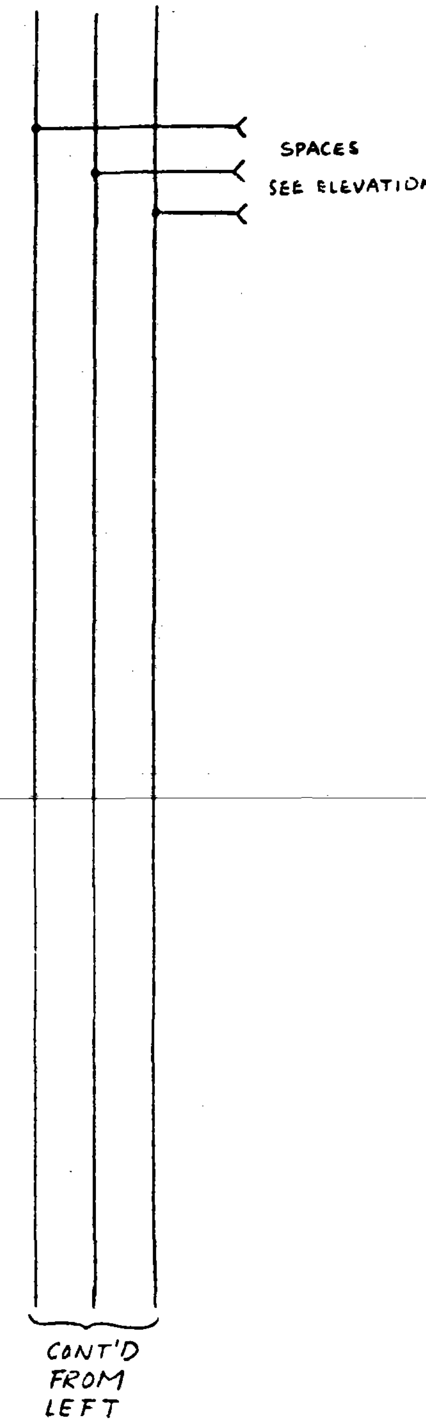
PROJ. NO.: 5049
CUST. NO.: 4034C21700
DWG. NO.: 3-5049-2-1 PAGE OF

3.1.1-406



MCC-C

UNIT #	S-R #	CIRCUIT #	FRAME, A	TRIP, A
2MR		LP3, XFMR	100A	70A
3BL		SPARE		50
3BR		PP3 XFMR		50
3HL		P715		15
3FR		EF2, EF3		15
3DL		SPARE		30
3DR				15
3HR				15
3KL				15
3KR				30
3FL				30
2ML		SPARE		50
1C		P-705	225	225
3MR		P-707	100	15



MCC-C

UNIT #	SR #	CIRCUIT #	C/B TYPE	TRIP SIZE	STR SIZE	
2K	2J	P-710	MCP	15A	1	*
2C	2A	P-703		100	3	*
2F	2D	P-704		100	3	*
1E	1D	SPARE		15	1	*
2H	2G			7	1	
1G	1F			15	1	

* FOR THESE UNITS OMIT CR1 & ITS CONTACTS AND CONTACT 12-13

3-5049-2-2

	REVISION	BY	DATE
F			
E			
D			
C			
B	REVISED PER CUSTOMER	AC	11/5/80
A	REARRANGE UNIT #	AC	9/23/80

DRAFT. LC DATE
CHK'R LC DATE
APP'D DATE

Abbott Power Corporation
7650 STAGE ROAD · BUENA PARK · CALIFORNIA 90620
A MEMBER OF NEMA

TITLE MCC-C
10 MW SOLAR PILOT PLANT
DAGGET, CALIF
3-LINE SCHEMATIC DIAGRAM

PROJ. NO.: 5049
CUST. NO.: 4004C21700
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