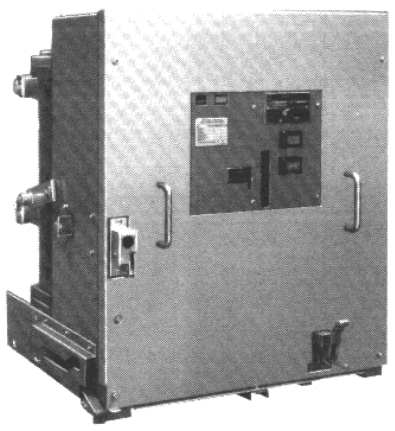
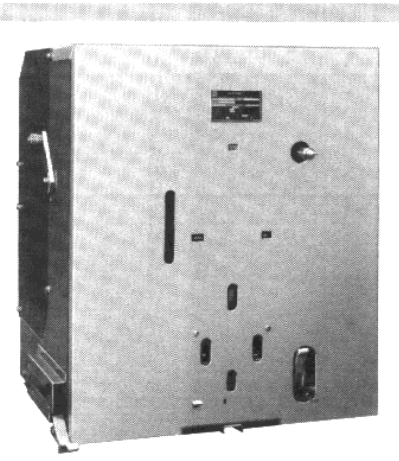
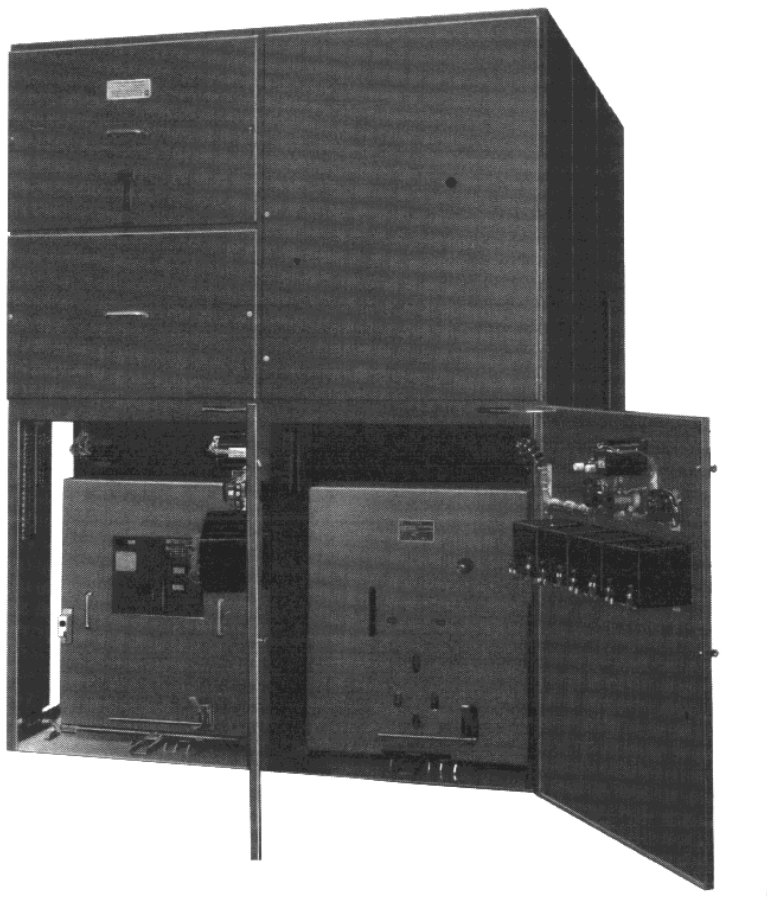






Metal-Clad Switchgear
Two-High 5-15kV
WITH SF_6 AND/OR VACUUM CIRCUIT BREAKERS

CONTENTS

FILE: Distribution Products Catalog

SQUARE D COMPANY

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

GENERAL DESCRIPTION

APRIL, 1984

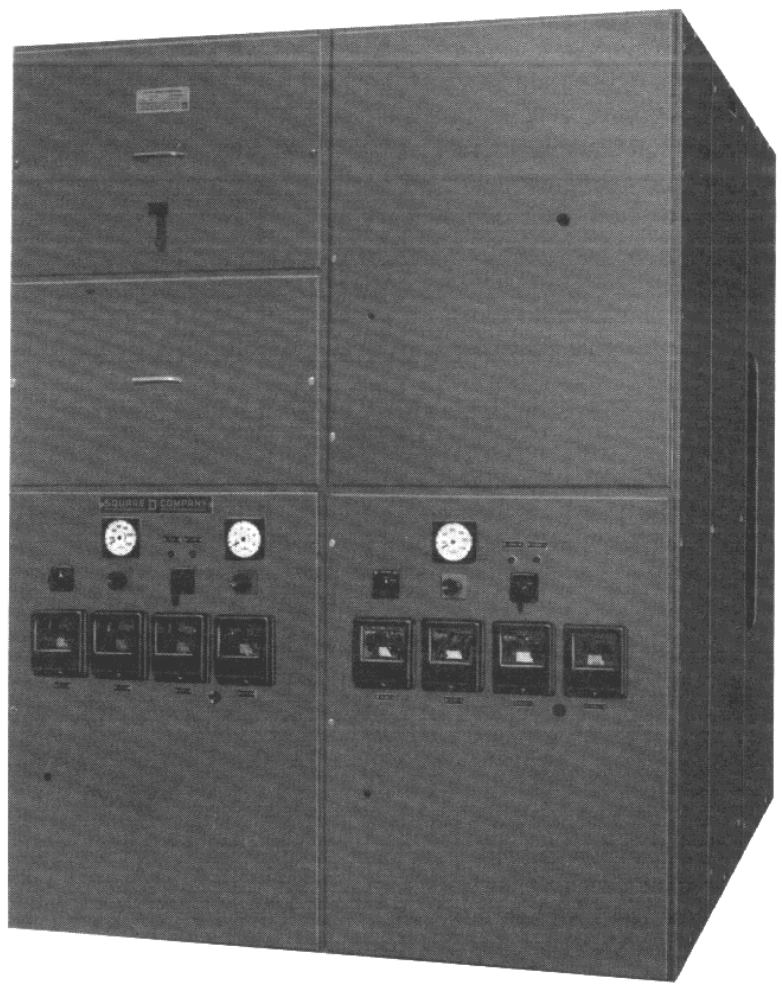
CONTENTS

APRIL, 1984

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

GENERAL DESCRIPTION

CLASS 6070



TYPICAL NEMA 1
SWITCHGEAR ASSEMBLY

RATINGS AND DESCRIPTION

- 2.4 to 13.8kV (nominal)
- 1200 to 3000 amperes
- 250 to 750 MVA interrupting capacity
- 60 and 95kV BIL
- Stored energy operating mechanism
- Drawout construction
- Insulated bus
- Indoor (NEMA 1)

GENERAL

Square D's 5-15kV Two-High Metal-Clad Switchgear utilizing FG-2 (SF_6) and/or VAD-2 (Vacuum) circuit breakers is designed for use on electrical distribution systems rated from 2400 volts to 13,800 volts nominal.

SF_6 and vacuum interruption technologies have been proven over the past quarter century, being used extensively in various applications. The evolving of SF_6 and vacuum interruption techniques represent years of development, testing, and engineering experience.

FG-2 (SF_6) and VAD-2 (Vacuum) circuit breakers are used in a wide variety of switching, control and protective circuits. Two-High Metal-Clad Switchgear combined with the use of protective relays provides complete flexibility in application and protection of medium voltage equipment. Metal-Clad Switchgear is typically used in electric utility systems, industrial plants, commercial buildings, hospitals, municipal pumping stations, wastewater treatment plants, transportation systems and pipeline stations. Transformers, motors, generators, capacitors, transmission and distribution lines, and feeder circuits are protected by this class of switchgear.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

APRIL, 1984

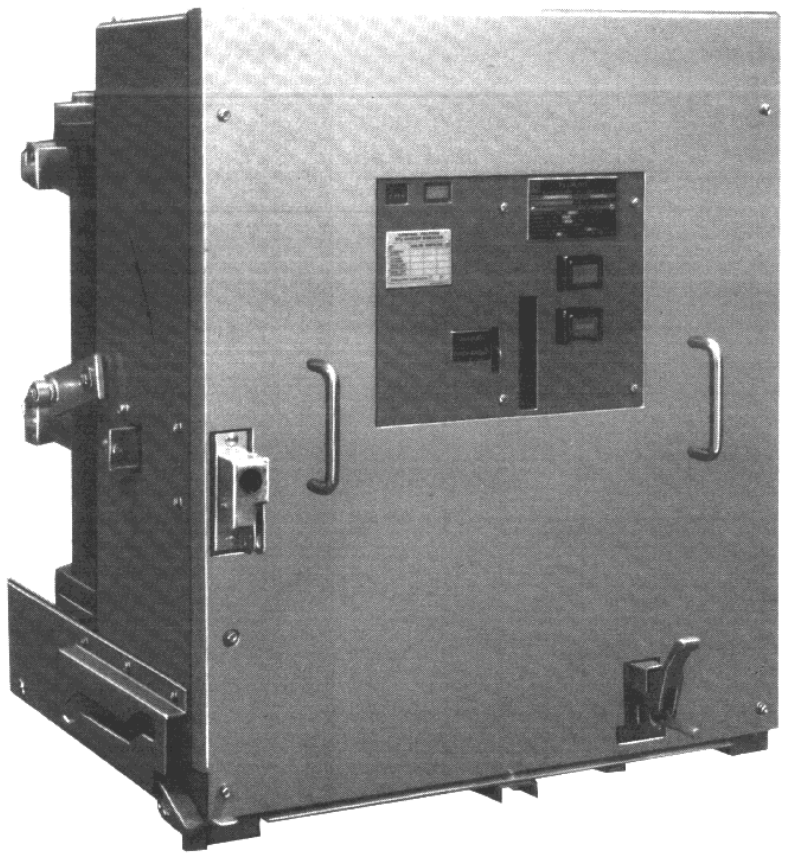
GENERAL DESCRIPTION

Newly designed Two-High Metal-Clad Switchgear incorporates the flexibility to use either sulphur hexafluoride (SF_6) gas filled interrupter breakers, or vacuum interrupter breakers. The combination of both type breakers may be used in the same switchgear to accommodate particular circuit requirements.

The FLUARC type FG-2 circuit breaker utilizes sulphur hexafluoride (SF_6) at a low pressure as the insulating and arc extinguishing dielectric medium. Soft, quiet, dependable interruption of the circuit breaker is performed within 5 cycles.

The VACARC type VAD-2 circuit breaker power contacts are hermetically sealed in a high vacuum. Vacuum is the insulating and arc extinguishing medium. High speed, quiet, dependable interruption of the circuit is performed within 3 cycles.

Both SF_6 and vacuum breakers have permanently sealed interrupters (keeping moisture and contaminants out), operate quietly, and have long life. The interrupters are maintenance-free. These breakers provide traditional top quality and high performance.

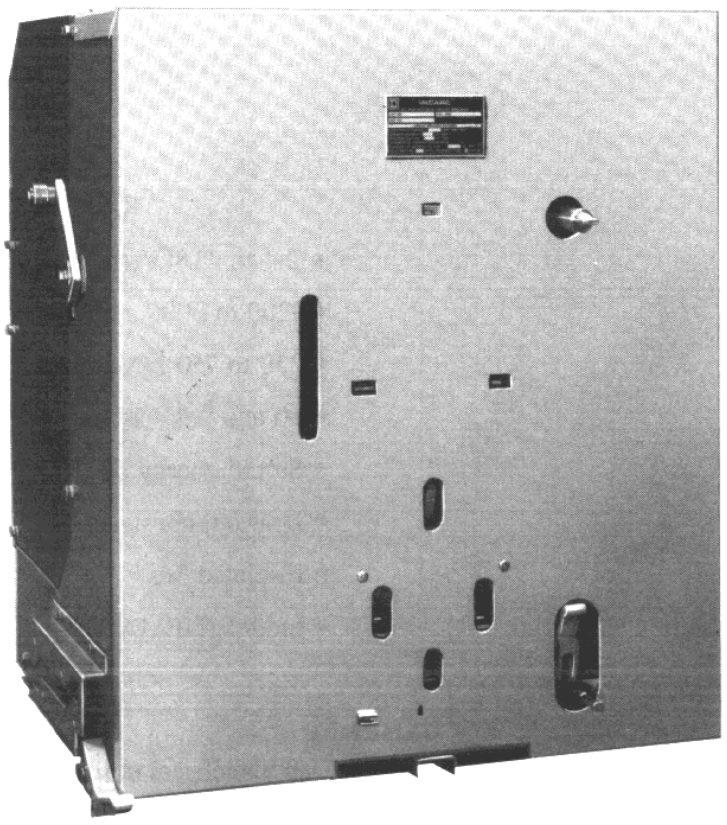


FLUARC FG-2 CIRCUIT BREAKER

STANDARD FEATURES

Metal-Clad switchgear is characterized by these necessary features as required by ANSI Standard C37.20:

- removable type breaker
- grounded metal barriers
- automatic shutters
- insulated bus
- grounded breaker truck between test and connected positions
- mechanical interlocks
- disconnect type voltage transformers
- low voltage control compartment



VACARC VAD-2 CIRCUIT BREAKER

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

FEATURES, BENEFITS AND TEST PROGRAM

STANDARDIZATION

Standardization of the design incorporates a series of steel framework skeleton cells, basic modular units, control packages, and instrumentation. For all switchgear ratings, circuit configurations, and functions, one basic unit size is used. These features provide application flexibility, versatility, efficiency and economy in minimizing engineering time to plan and layout the switchgear.

FLOOR SPACE ECONOMY

The new two tier configuration permits breakers to be stacked two high, or stacked one high combined with auxiliary units to save valuable floor space. Two high and one high constructions are available.

VERSATILITY

SF_6 and vacuum interrupter technology, each having world-wide reputation of highest quality, offer the best of both worlds in Two-High Metal-Clad Switchgear with interchangeability of the type FG-2 (SF_6) and type VAD-2 (vacuum) circuit breakers.

MINIMUM MAINTENANCE

The main electrical contacts and arcing contacts of the FG-2 breaker are hermetically sealed in a sulphur hexafluoride gas environment.

The VAD-2 vacuum breaker main electrical contacts are hermetically sealed in a vacuum environment.

Both type bottles are designed to be sealed for life and are protected from the environment and atmospheric influences. Dust, moisture and other contaminants are sealed out.

For wear evaluation on the contacts of either breaker, an occasional check of the contact erosion indicator may be performed.

LONG LIFE

The FG-2 (SF_6) interrupter has special features which result in high electrical endurance. The insulating and arc extinguishing properties of SF_6 gas are maintained by action of a dehydrated alumina silicate filter inside each pole unit. The mechanical parts maintain a high reliability through the operating principle, which dampens out the motion of the moving parts. Interrupters have a long life as a result of the negligible wear of the gas and the contacts. The FG-2 (SF_6) breaker gives long life meeting and exceeding industry standards.

The VAD-2 (vacuum) breaker is designed for long life. The dielectric strength of the vacuum is very high allowing a very short clearing time for the arc. Less energy is dissipated into the arc. Contact travel is only 1/2 to 3/4 inch depending upon the rating of the breaker. A short stroke produces less mechanical shock to the mechanism. These features permit a simple and reliable breaker.

FAST & QUIET OPERATION

The Fluarc (SF_6) and Vacarc (vacuum) systems of arc interruption utilize hermetically sealed interrupters. The short operating stroke of the interrupter permits minimum contact travel and a low mechanical sound level. Interruption of the arc is fast and quiet.

SAFETY BARRIERS AND INTERLOCKS

Full compartmentation is supplied with primary functions separated by grounded metal barriers. Live parts are kept unexposed. Safety interlocks work with the breaker racking system. These protective features furnish integrity to the equipment and provide safety for operating personnel.

REDUCED SIZE AND WEIGHT

Breakers are horizontal drawout type reduced in size and weight provides convenience of maintenance. A 30% weight reduction as compared to air magnetic circuit breakers allow ease of handling.

COMPREHENSIVE TEST PROGRAM

A comprehensive design and conformance testing program has been performed by Square D Company development engineers. The switchgear and breakers are tested in accordance with the latest applicable ANSI, IEEE and NEMA standards. The switchgear and breakers meet or exceed the requirements of the standards. The standard design tests include, and are not limited to:

- continuous current
- dielectric strength
- mechanical life
- short circuit withstand
- short circuit interruption
- and more

Breaker short circuit interruption design tests were performed at KEMA high power laboratories Arnhem, Netherlands.

High current withstand tests for the breaker and cubicle assembly were performed at the Square D Company high power test laboratory located at Cedar Rapids, Iowa.

Dielectric, temperature rise, and other tests were performed at our switchgear test facilities.

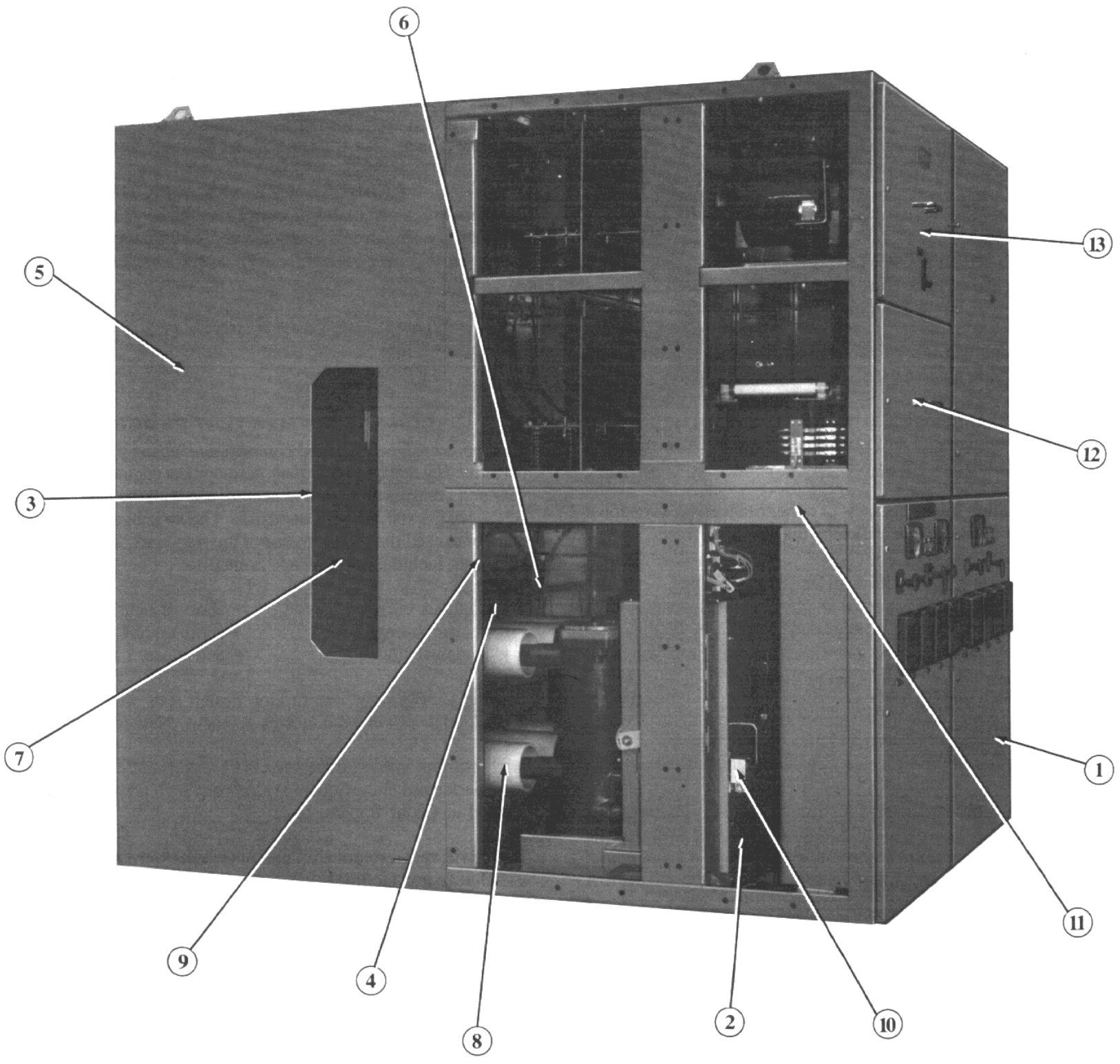
PRINTED IN U.S.A.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

PRINCIPAL COMPONENTS

APRIL, 1984



TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

PRINCIPAL COMPONENTS

1. HINGED FRONT DOOR
Relays, instruments and meters are mounted on the door space in a standardized arrangement.

2. HORIZONTAL DRAWOUT CIRCUIT BREAKER
The FLUARC FG-2 (SF_6) and VACARC VAD-2 (vacuum) circuit breakers are horizontal drawout design. Disconnect, test, and connect positions are provided with the door in the closed position.

3. MAIN BUS BARRIERS (not shown)
Main bus barriers between bays are track resistant, flame retardant glass polyester, with porcelain inserts at 8.25kV and 15kV ratings.

4. CURRENT TRANSFORMERS
Space is available for four front accessible bushing type current transformers per phase. Two of these current transformers may be placed on the line side and two on the load side of the breaker on each phase.

5. CABLE SPACE
Top or bottom cable entry with adequate space for cables, potheads, cable supports, and surge arresters is provided.

6. AUTOMATIC SHUTTERS
When the circuit breaker is withdrawn from the connected position, the breaker forces the steel shutter to rotate automatically into a position which covers the energized components.

7. MAIN BUS AND SUPPORTS
Insulated bus is provided with fluidized bed epoxy insulation, and with a special design combination of porcelain and main bus supports. Porcelain or glass polyester bus supports and insulators as specified are provided in the cable and auxiliary compartments.

8. INSULATING TUBES
Porcelain insulating tubes are used to insulate the primary stationary contacts and breaker runbacks at both 5 and 15kv ratings.

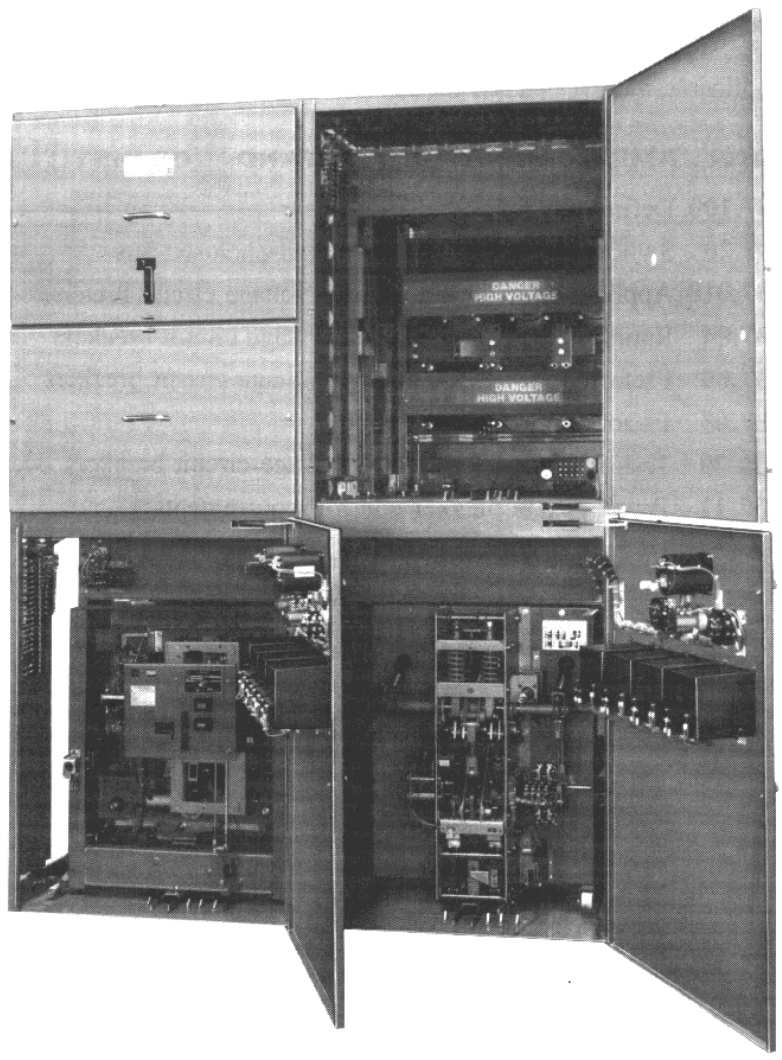
9. COMPARTMENT BARRIERS
All main compartments are separated by grounded metal barriers.

10. RACKING MECHANISM
The gear driven racking system incorporates safety interlocks.

11. FRAME AND HOUSING
Steel frames provide a strong rigid structure. The structure is engineered for flexibility to allow modifications and future addition of equipment.

12. VOLTAGE TRANSFORMERS
Front accessible drawer mounted voltage transformers can be completely withdrawn through the use of rollers and drawer mounted cantilever rails. For safety, the voltage transformers are grounded when moved to the withdrawn position.

13. CONTROL POWER TRANSFORMERS
Control power transformers rated up to 15 kVA are drawer mounted and can be completely withdrawn from the front for ease of accessibility.



CIRCUIT BREAKERS
FG-2 and VAD-2 circuit breakers using SF_6 and Vacuum interrupters offer application flexibility. The breakers are designed, manufactured, and tested per ANSI standards, and are of compact size and weight (as shown).

BREAKER LIFT TRUCK
A portable lifter device is required to install the breaker in the upper tier breaker compartment. This device uses a height adjustable platform, and is latched to the cell for safety.

All breakers located in the bottom compartments can be rolled directly on the floor, and the use of a breaker lifting truck is not required.

PRINTED IN U.S.A.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

STANDARDS

APRIL, 1984

Two-High Metal-Clad Switchgear is designed, tested and manufactured to meet ANSI, IEEE and NEMA standards.

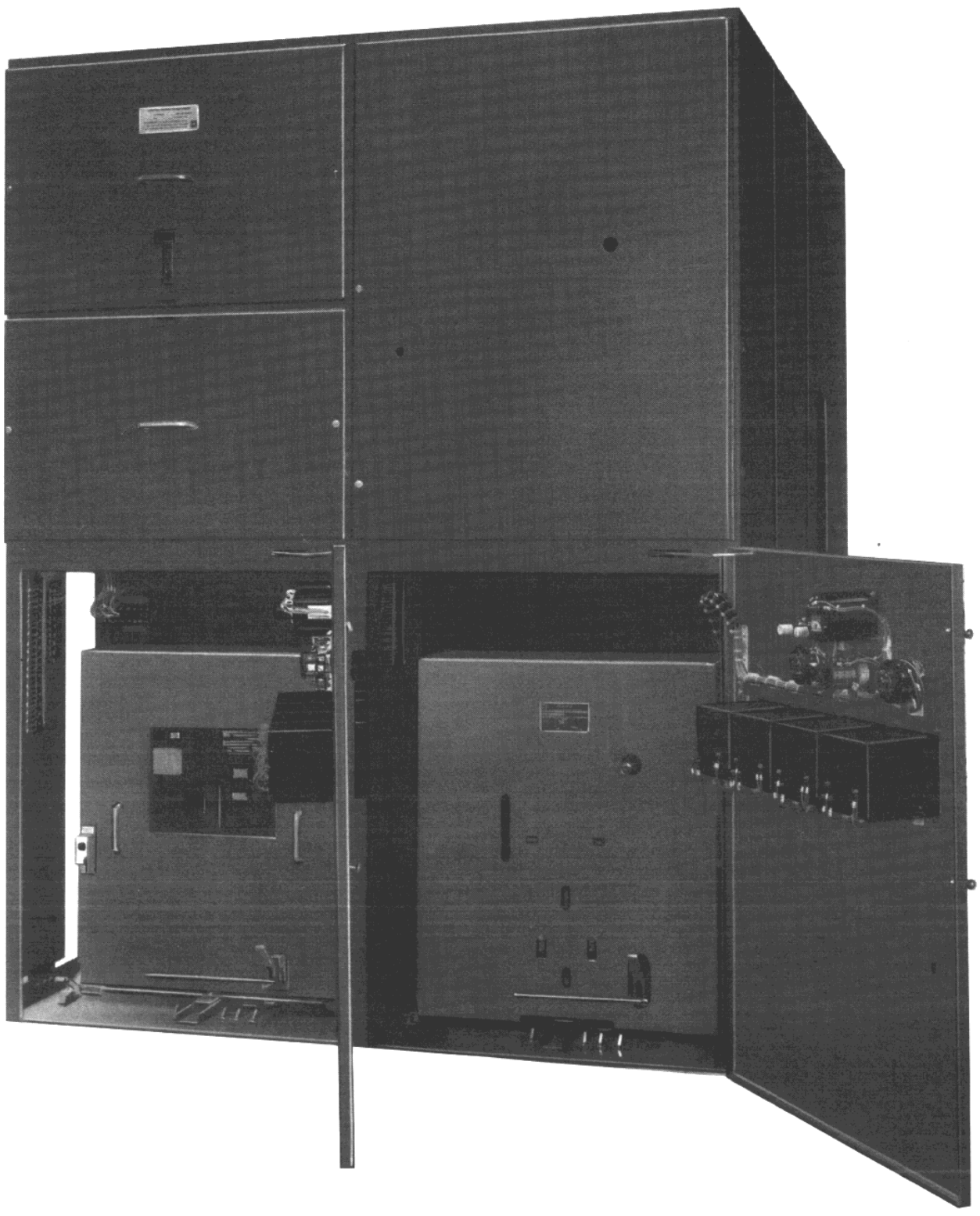
Applicable industry standards are:

ANSI AMERICAN NATIONAL STANDARDS INSTITUTE

C37.100 Definitions for power switchgear
C37.20 Switchgear assemblies and metal-enclosed bus
C37.010 Application guide for ac high voltage circuit breakers
C37.04 Rating structure for ac high voltage circuit breakers
C37.06 Preferred ratings for ac high voltage circuit breakers
C37.07 Factors for reclosing service
C36.09 Test procedure for ac high voltage circuit breakers
C37.11 Power circuit breaker control requirements

NEMA NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

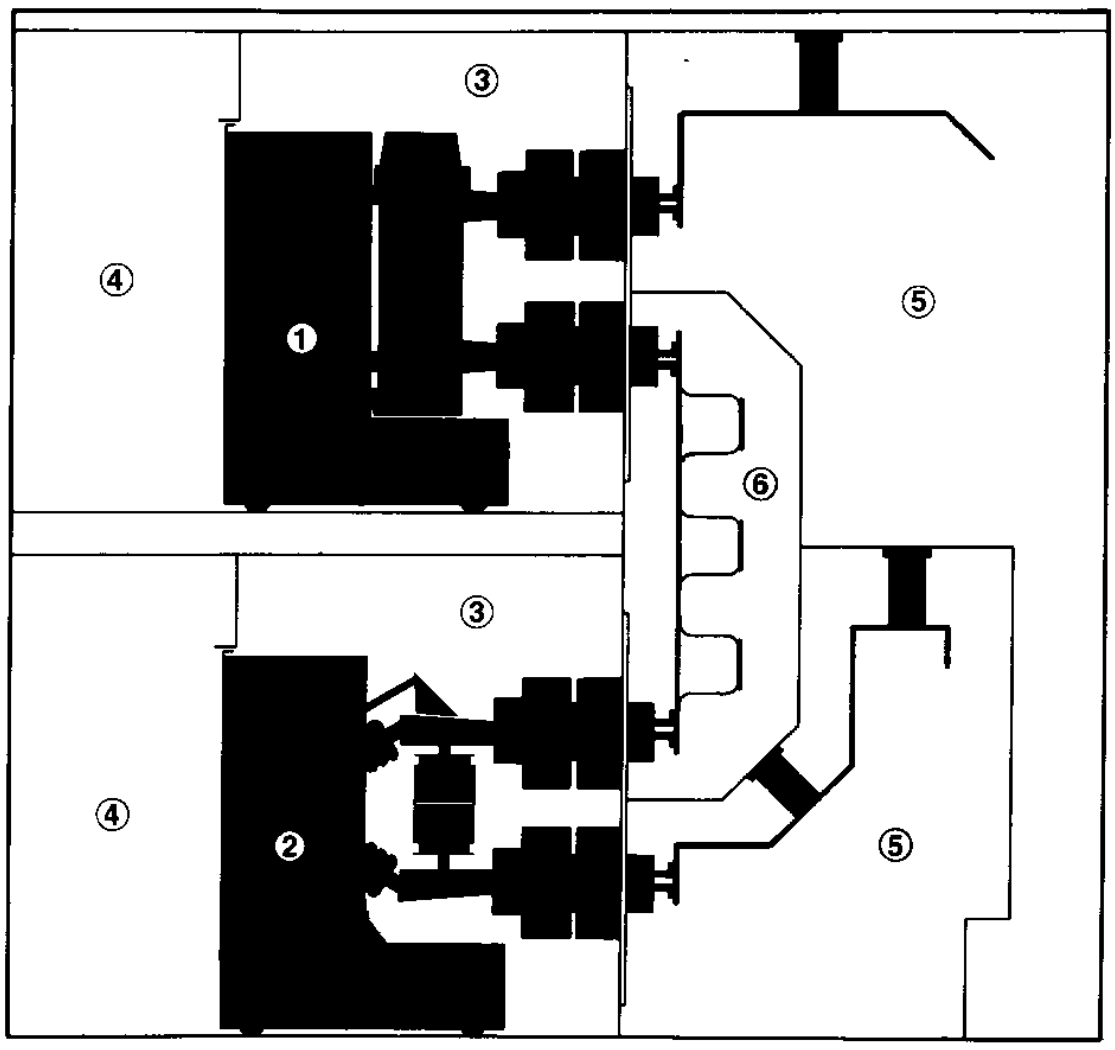
SG-4 Power Circuit Breakers
SG-5 Power Switchgear Assemblies



TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

STANDARDS

CLASS 6070



CONSISTING OF FIVE MAJOR COMPONENTS:

1. FG-2 (SF_6) CIRCUIT BREAKER
2. VAD-2 (VACUUM) CIRCUIT BREAKER
3. CIRCUIT BREAKER COMPARTMENT
4. RELAYS AND INSTRUMENTS
5. CABLE COMPARTMENT
6. MAIN BUS COMPARTMENT

PRINTED IN U.S.A.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

APRIL, 1984

FG-2 BREAKER APPLICATION DATA

FG-2 (SF_6) CIRCUIT BREAKER DATA

Type of Breaker	Nominal Rating: Three Phase MVA	Nominal Rating: Voltage kV—RMS	Rated Cont. Current 60 Hertz Amps.—RMS	Rated Voltages: Maximum Voltage kV—RMS	Rated Voltages: K—Factor Max. kV / Min. kV	Rated Voltages: Minimum Voltage kV—RMS	Insulation Level Rated Withstand: Low Frequency kV—RMS	Insulation Level Rated Withstand: △Impulse 1.2x50MS kV—CREST	Interrupting Ratings† Amps.—Symmetrical: Maximum kV Amps.—RMS	Interrupting Ratings† Amps.—Symmetrical: Nominal kV Amps.—RMS	Interrupting Ratings† Amps.—Symmetrical: Minimum kV Amps.—RMS	Asymmetrical Rating Factor *	Short Time Rating 3 Sec. Amps.—RMS	Close & Latch Rating Amps.—RMS	Interrupting Time Cycles
FG-2-05025-12	250	4.16	1200	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05025-20	250	4.16	2000	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05025-30	250	4.16	3000 ▪	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-08050-12	500	7.20	1200	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-20	500	7.20	2000	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-30	500	7.20	3000 ▪	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-15050-12	500•	13.8	1200	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-20	500•	13.8	2000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-30	500•	13.8	3000 ▪	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15075-12	750•	13.8	1200	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-20	750•	13.8	2000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-30	750•	13.8	3000▪	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5

†—For interrupting current ratings at operating voltages other than those listed, use the following formula:

$$I_{op} = \frac{V_{max}}{V_{op}} \times I_{V_{max}}$$

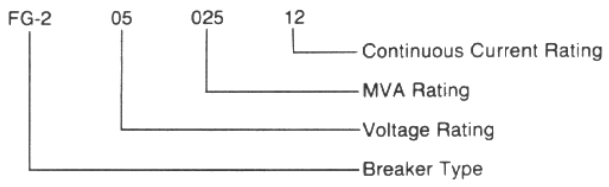
The calculated current should not exceed the maximum interrupting current rating.

$$I_{max} = K \times I_{V_{max}}$$

*—Rating factor is based on breaker speed from initiation of trip signal to contact parting, allowing for 1/2 cycle relay time. To obtain the asymmetrical current interrupting capability of the breaker, multiply the symmetrical current by 1.1.

▪—Availability to be announced.

BREAKER IDENTIFICATION:



△—These values apply with circuit breaker in or out of enclosure.

•—Available with ratings exceeding ANSI requirements—Contact Square D Plant.

TABLE 1

FG-2 INTERRUPTER

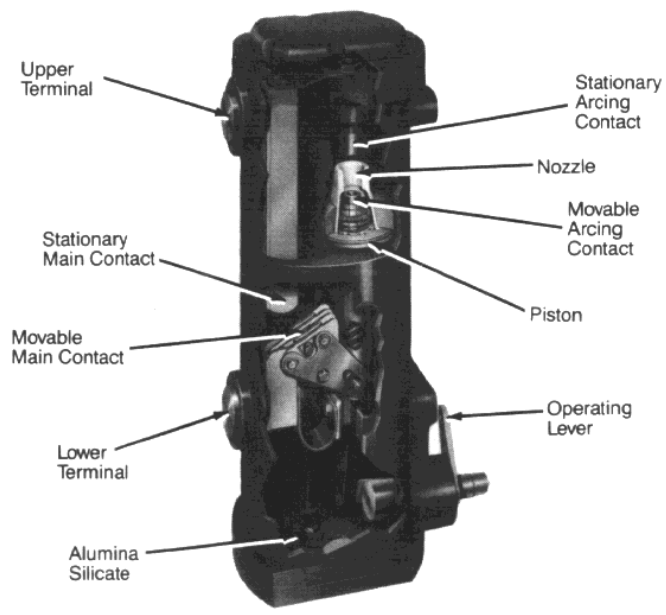
The FLUARC system of arc interruption provides a soft high speed interruption with quiet operation.

Sulphur hexafluoride (SF_6) gas used in the FG-2 circuit breaker is a nonflammable, colorless, odorless, nontoxic gas which is extremely stable and has a dielectric strength of 2.5 times that of air at atmospheric pressure.

The gas maintenance is assisted by a molecular sieve of dehydrated alumina silicate located at the bottom of each interrupter.

- The arcing contacts and main contacts provide a parallel path for the current. On closing, the arcing contacts make first. On opening, the arcing contacts break last.
- As the arcing contacts part, gas is compressed by the piston and is forced through the nozzle into the arc region and across the arc.
- During the arcing and ionization of the gas, a great amount of arc energy is absorbed and evacuated due to the high specific heat rating of SF_6.
- As the arc is cooled radially, the action of the fluorine becomes more dominant, absorbing electrons from the arc and aiding the dielectric recovery across the contacts.
- Due to the special chemical property and high heat transfer characteristics of the SF_6, the gas rapidly cools and de-ionizes the arc reducing its conductance to practically zero, allowing total extinction at first current zero.

The gas that is forced through the nozzle also serves to damp out the physical motion of the breaker, providing a highly reliable mechanism that lends itself well to the minimum maintenance concept of these breakers.



FG-2 INTERRUPTER

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

VAD-2 BREAKER APPLICATION DATA

CLASS 6070

VAD-2 (VACUUM) CIRCUIT BREAKER DATA

Type of Breaker	Nominal Rating		Rated Cont. Current 60 Hertz Amps.—RMS	Rated Voltages			Insulation Level Rated Withstand		Interrupting Ratings† Amps.—Symmetrical			Asym-metrical Rating Factor*	Short Time Rating 3 Sec. Amps.—RMS	Close & Latch Rating Amps.—RMS	Inter-rupting Time Cycles
	Three Phase MVA	Voltage kV—RMS		Maximum Voltage kV—RMS	K—Factor Max. kV / Min. kV	Minimum Voltage kV—RMS	Low Frequency kV—RMS	△Impulse 1.2x50MS kV—CREST	Maximum kV Amps.—RMS	Nominal kV Amps.—RMS	Minimum kV Amps.—RMS				
VAD-2-05025-12	250	4.16	1200	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-05025-20	250	4.16	2000	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-05025-30	250	4.16	3000▪	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-08035-12	350•	7.20	1200	8.25	1.25	6.6	36	95	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-08035-20	350•	7.20	2000	8.25	1.25	6.6	36	95	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-08035-30	350•	7.20	3000▪	8.25	1.25	6.6	36	95	29,000	33,200	36,000	1.2	36,000	58,000	3
VAD-2-15050-12	500	13.8	1200	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.2	23,000	37,000	3
VAD-2-15050-20	500	13.8	2000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.2	23,000	37,000	3
VAD-2-15050-30	500	13.8	3000▪	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.2	23,000	37,000	3
VAD-2-15075-12	750	13.8	1200	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.2	36,000	58,000	3
VAD-2-15075-20	750	13.8	2000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.2	36,000	58,000	3
VAD-2-15075-30	750	13.8	3000▪	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.2	36,000	58,000	3

†—For interrupting current ratings at operating voltages other than those listed, use the following formula:

$$I_{op} = \frac{V_{max}}{V_{op}} \times I_{V_{max}}$$

The calculated current should not exceed the maximum interrupting current rating.

$$I_{max} = K \times I_{V_{max}}$$

*—Rating factor is based on breaker speed from initiation of trip signal to contact parting, allowing for 1/2 cycle relay time. To obtain the asymmetrical current interrupting capability of the breaker, multiply the symmetrical current by 1.2

▪—Availability to be announced.

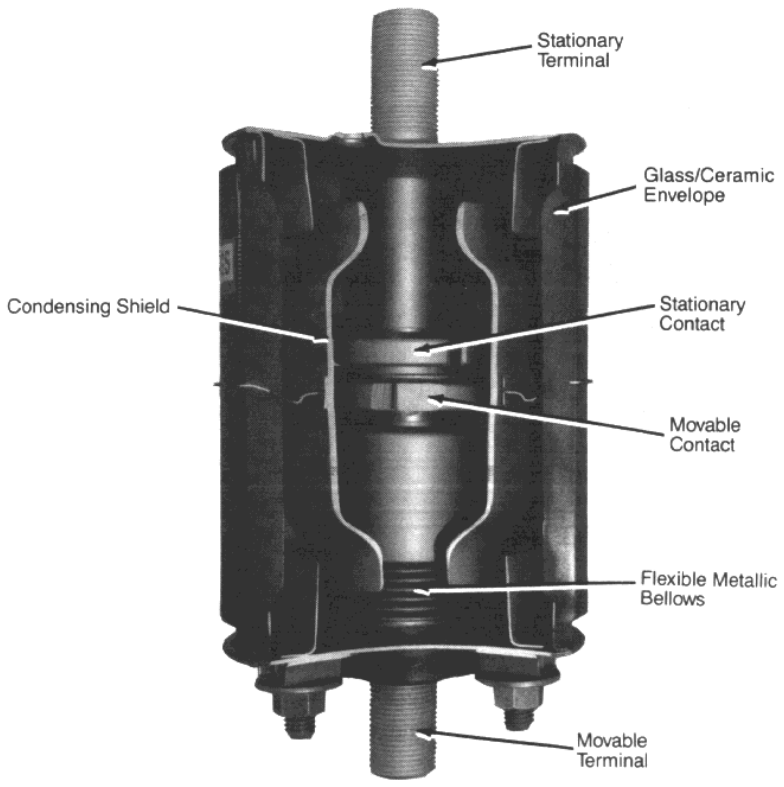
BREAKER IDENTIFICATION:

VAD-2 05 025 12
- 12 — Continuous Current Rating
- 025 — MVA Rating
- 05 — Voltage Rating
- VAD-2 — Breaker Type

△—These values apply with circuit breaker in or out of enclosure.

•—Non-standard ANSI rating.

TABLE 2



VAD-2 VACUUM BOTTLE

VAD-2 INTERRUPTER

The modern vacuum interrupters utilized in VAD-2 circuit breakers are designed for high speed operation, rapid dielectric recovery, quiet operation, minimum maintenance and long life.

- As the contacts part, the arc develops a plasma of metallic ions released by the contacts.
- This plasma provides transfer media for electron flow until the arrival of the first current zero.
- The condensation of the metallic vapor on the condensing shield is rapid and the dielectric recovery rate is much faster than the rate of rise of the transient recovery voltage (TRV).
- This metallic vapor provides a gettering action which removes gas molecules from the evacuated space, therefore assisting in maintaining the high vacuum.

Because the vacuum interrupters are small in size and weight and utilize a short operating stroke, there is minimum physical shock to the mechanical system during operation. This makes an ideal situation for long life and low maintenance.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

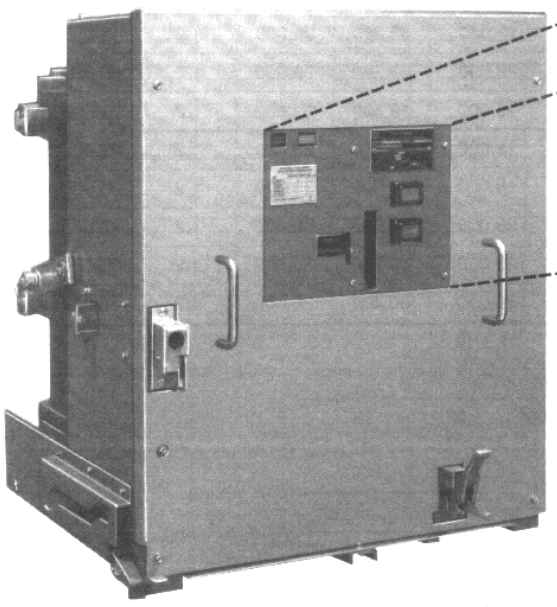
FG-2 BREAKER FEATURES

FG-2 (SF_6) CIRCUIT BREAKER FEATURES

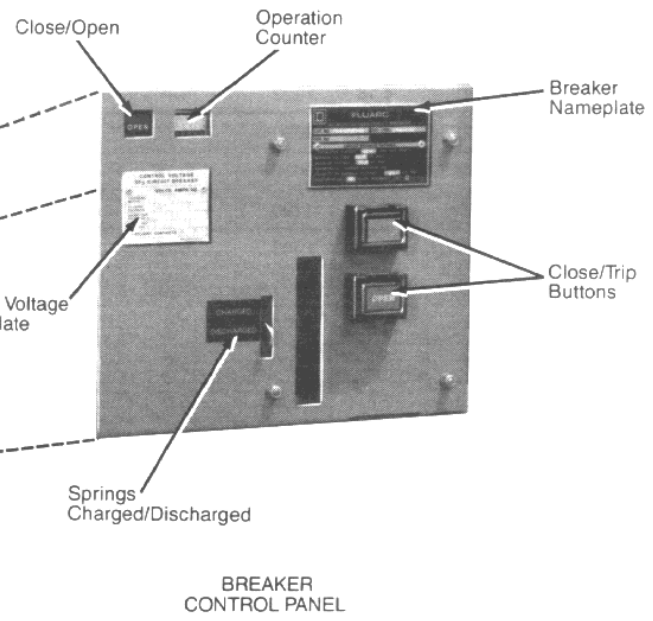
The type FG-2 circuit breaker uses three molded epoxy sealed interrupters filled with sulphur hexafluoride (SF_6) gas. The interrupters are low pressure, self-regulating and maintenance free.

The mechanism is a spring-charged stored energy type.

The FG-2 is interchangeable with the VAD-2 vacuum circuit breaker.



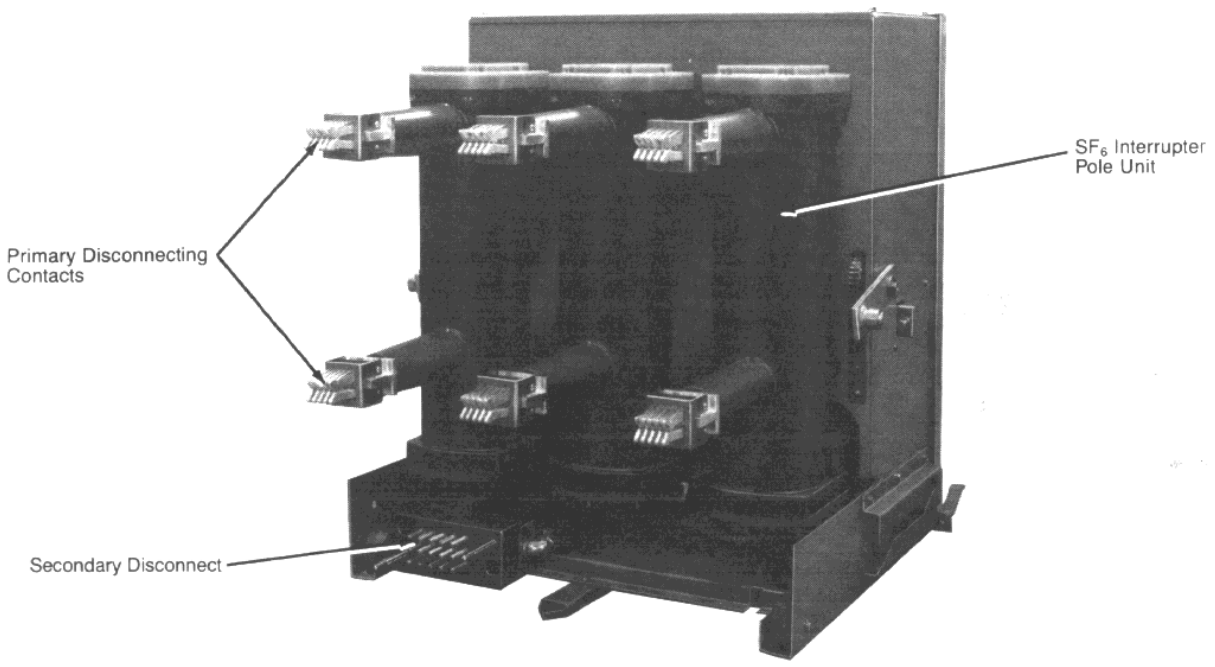
FRONT VIEW



BREAKER CONTROL PANEL

BREAKER FRONT PANEL

The FG-2 breaker front panel is constructed of heavy gauge steel for durability. Controls and indicators are located on the front of the breaker, visible and accessible for the convenience of the operator.



REAR VIEW

SF_6 INTERRUPTER MOUNTING

The SF_6 interrupter is bolted to the metal housing using self contained mounting provisions. Metal inserts are molded into epoxy extrusions in upper and lower positions on each bottle, and form a three point mounting system. Each pivot shaft is connected by a common linkage mechanism for operation of the interrupter.

PRIMARY DISCONNECTING CONTACTS

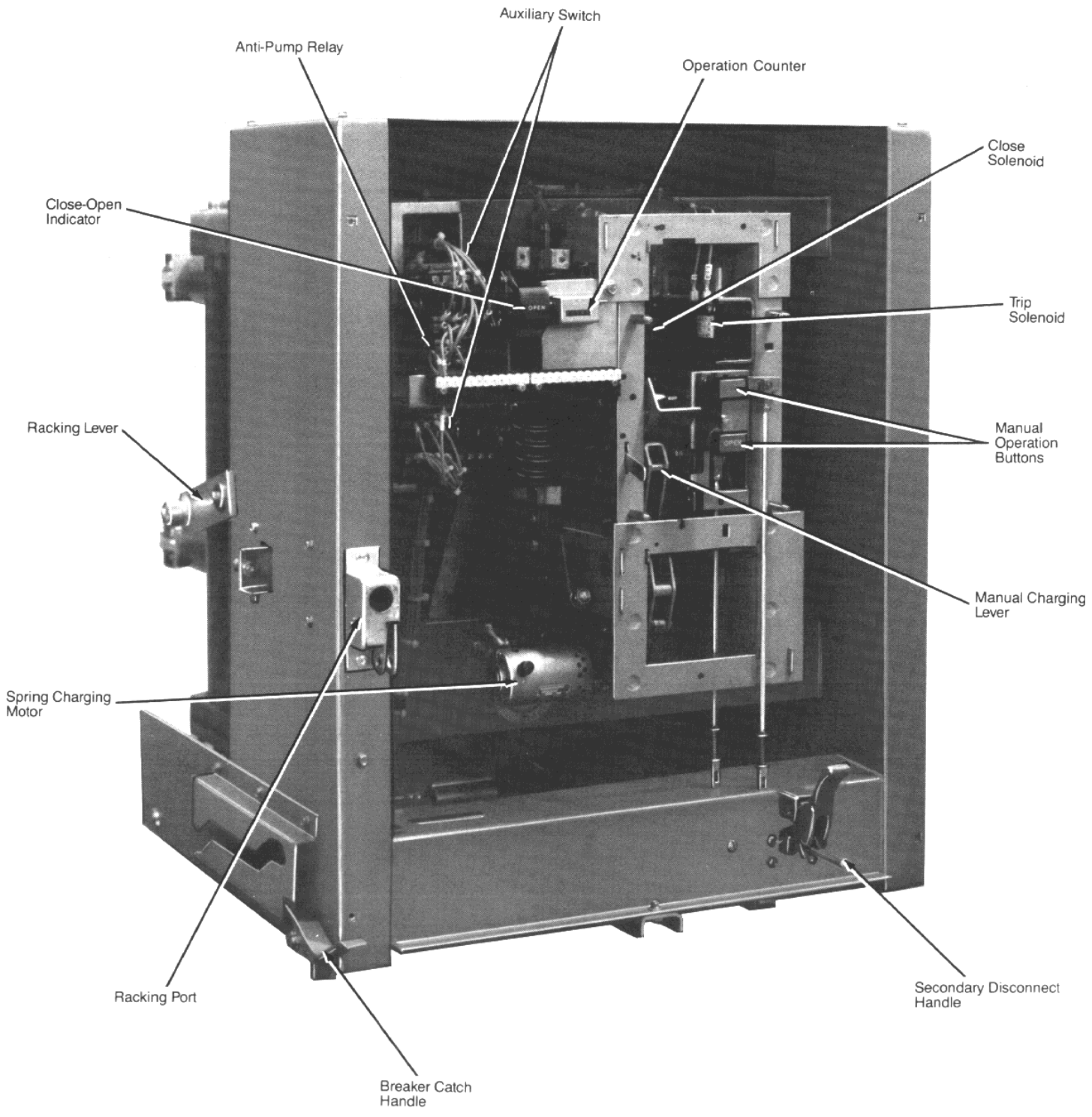
The primary disconnecting contacts are made of silver-plated copper and are spring loaded to provide contact pressure. Contacts are rated for 1200, 2000 and 3000 amperes continuous current.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

FG-2 BREAKER FEATURES

STORED ENERGY MECHANISM

The stored energy mechanism is shown with breaker front panel removed. One stored energy mechanism is used with variations to accommodate all the FG-2 breaker ratings. The rugged fabricated steel construction provides long life and reliable operation. Breakers are available for either AC or DC control power.



PRINTED IN U.S.A.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

VAD-2 BREAKER FEATURES

VAD-2 VACUUM CIRCUIT BREAKER FEATURES

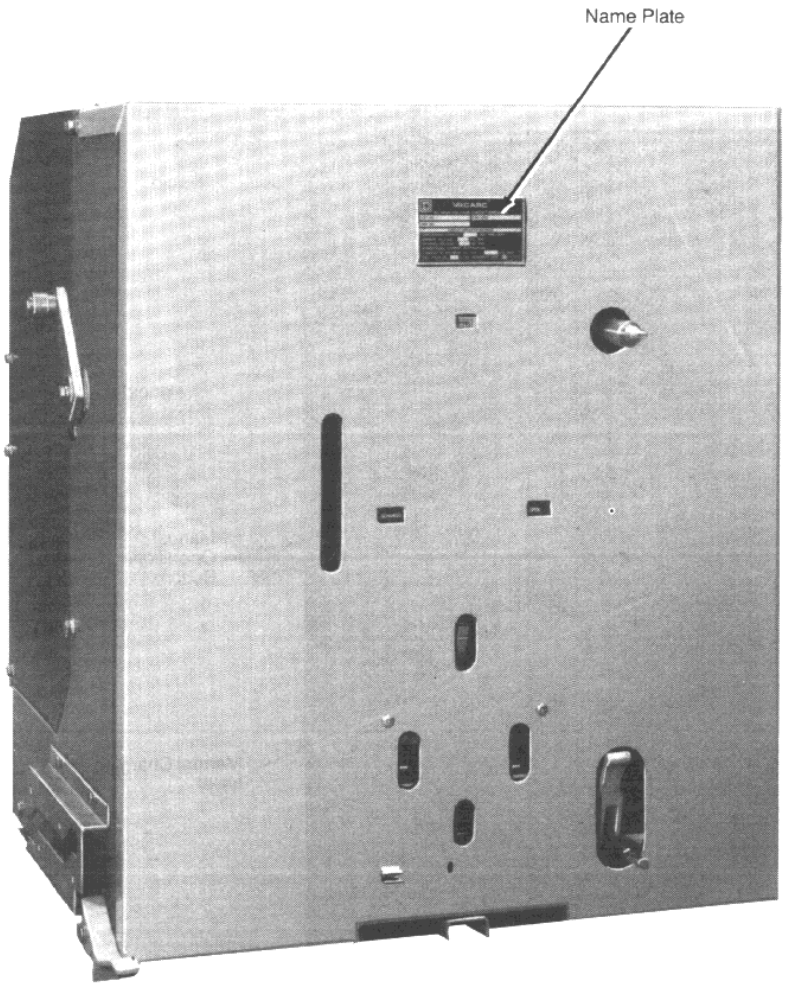
The VAD-2 circuit breaker uses three vacuum interrupters with porcelain support and insulation system. The contacts are sealed in a high vacuum. The interrupters are light weight and maintenance-free.

The mechanism is a spring-charged stored energy type.

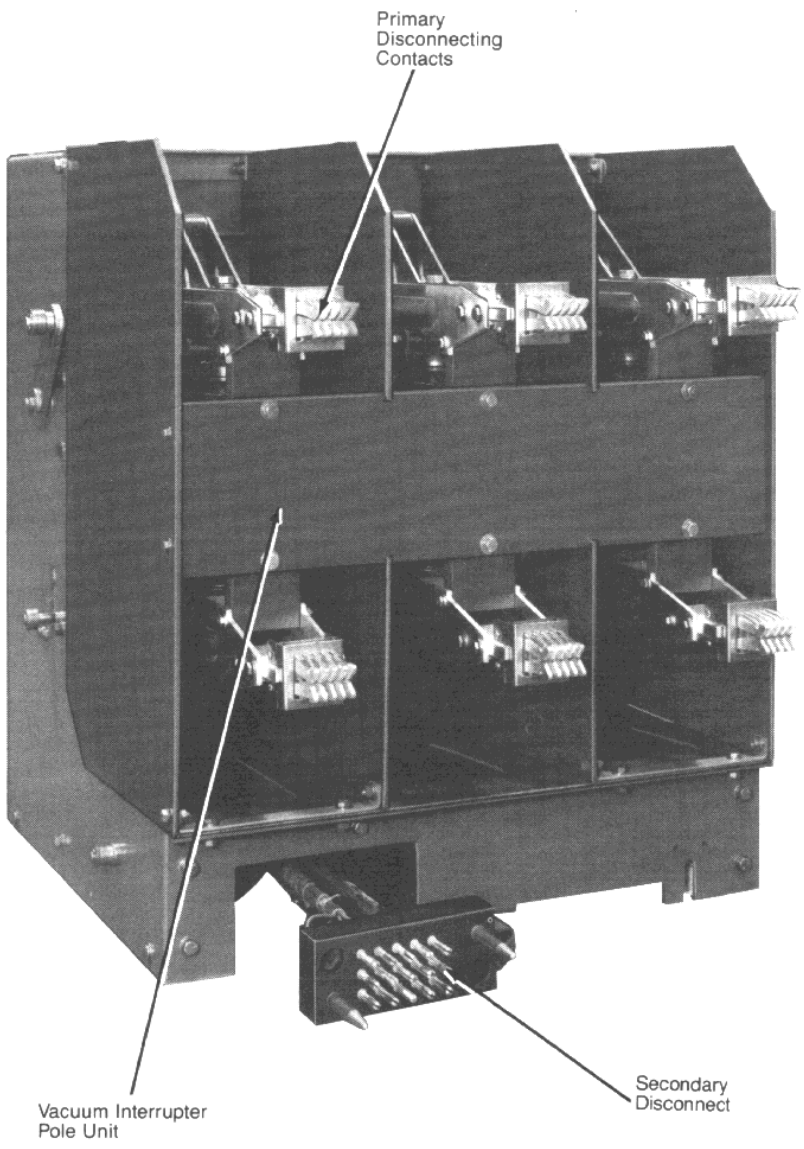
The VAD-2 is interchangeable with the FG-2 (SF_6) circuit breaker.

VACUUM INTERRUPTER MOUNTING

The vacuum interrupter mounting is a modular structure made of steel. Each vacuum bottle is supported on porcelain supports which are mounted to the steel frame structure. The bottles are barriered with glass polyester insulation which is track resistant, flame retardant, with high mechanical strength.



FRONT VIEW



REAR VIEW

BREAKER FRONT PANEL

The VAD-2 breaker front panel is constructed of heavy gauge steel for durability. Controls and indicators are located on the front of the breaker, visible and accessible for the convenience of the operator.

PRIMARY DISCONNECTING CONTACTS

The primary disconnecting contacts are made of silver-plated copper and are spring loaded to provide contact pressure. Contacts are rated for 1200, 2000 and 3000 amperes continuous current.

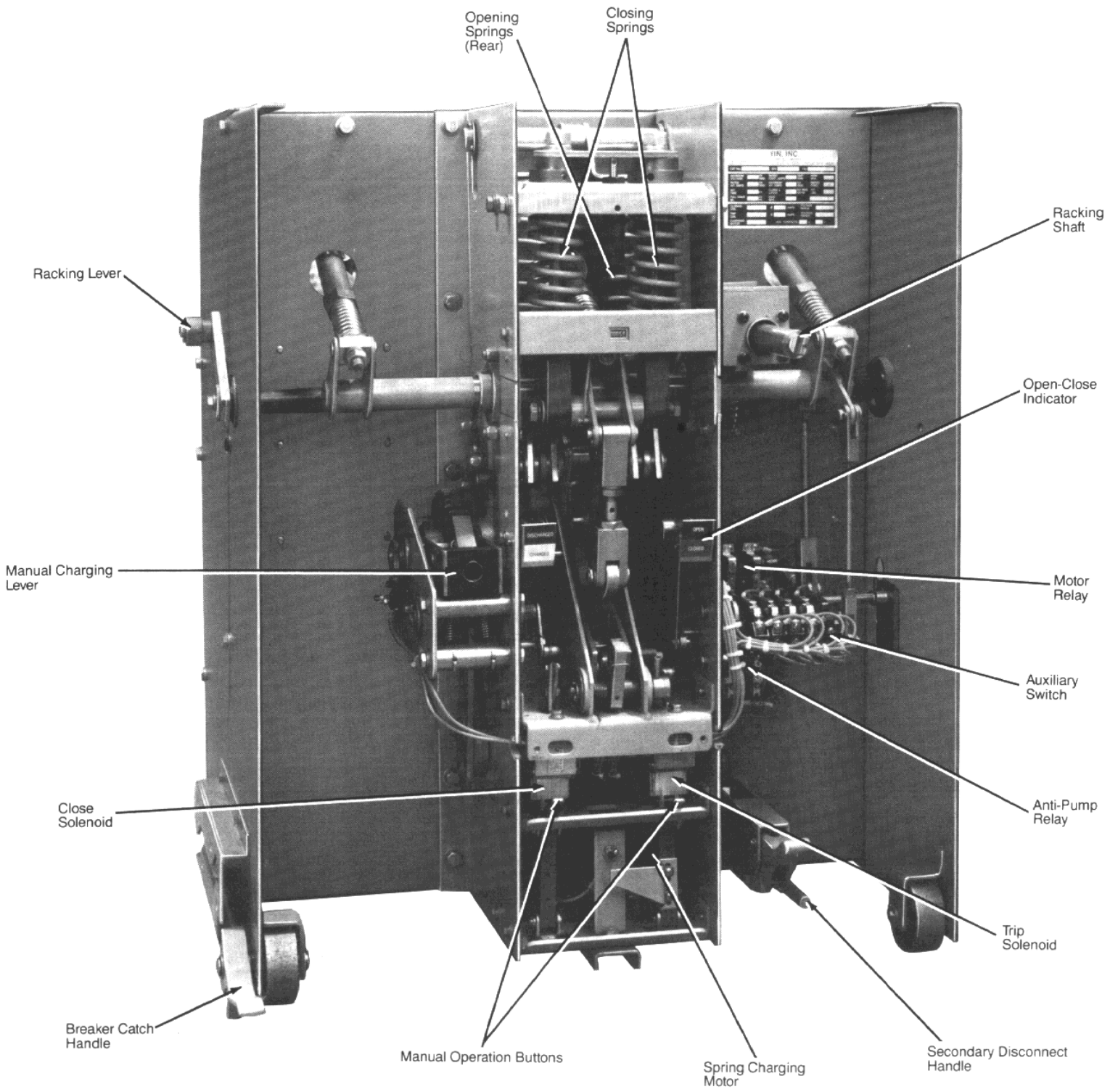
TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

VAD-2 BREAKER FEATURES

CLASS 6070

STORED ENERGY MECHANISM

The stored energy mechanism is shown with breaker front panel removed. One stored energy mechanism is used with variations to accommodate all the vacuum breaker ratings. The rugged fabricated steel construction provides long life and reliable operation. Breakers are available for either AC or DC control power.



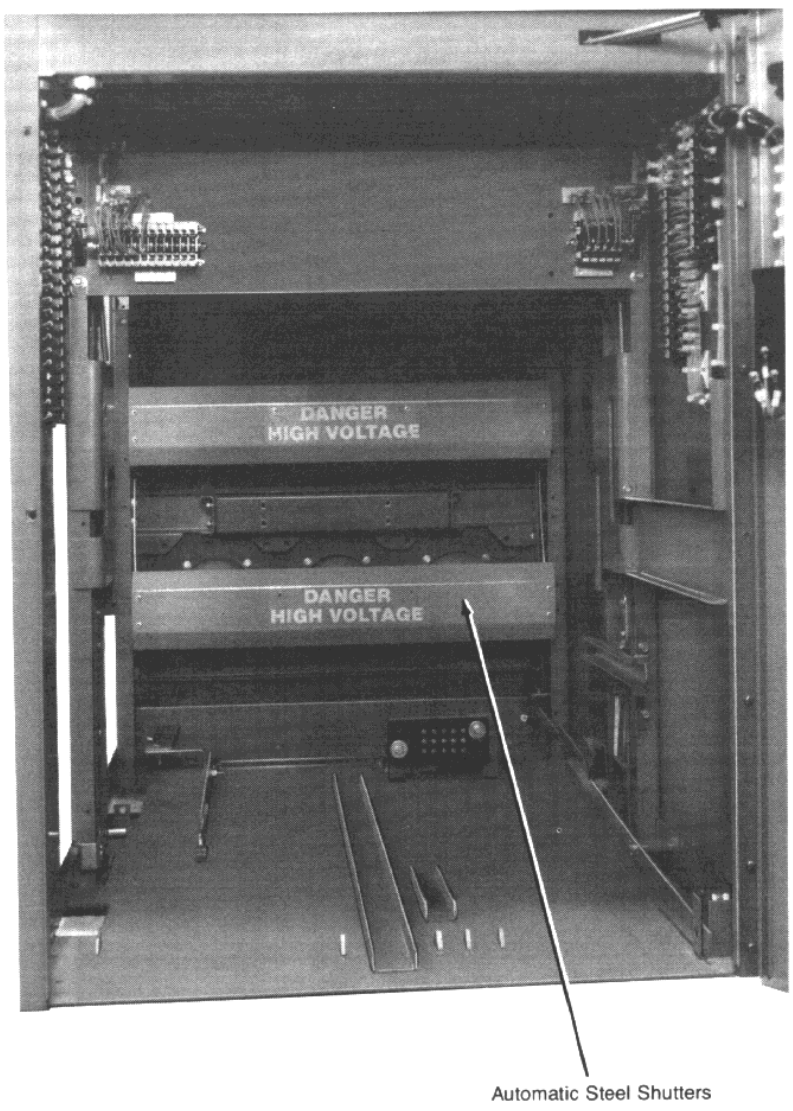
PRINTED IN U.S.A.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

CELL FEATURES

BREAKER COMPARTMENT

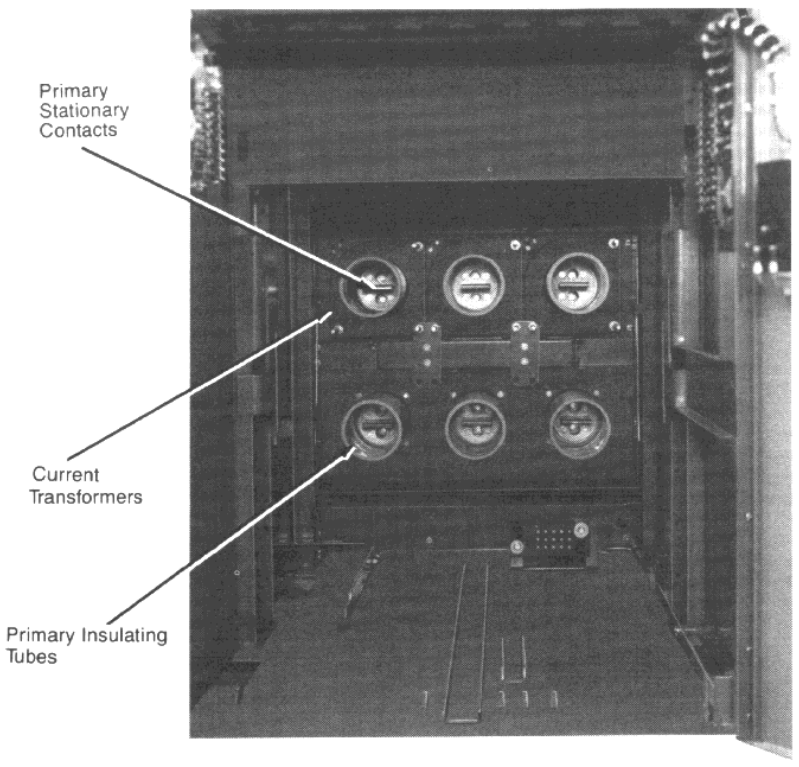
The stationary primary disconnect contacts are automatically covered by bright orange steel shutters when the breaker is withdrawn. Accidental contact with primary voltage live parts is prevented.



Steel shutters are shown in the closed position. Shutters may be padlocked in the closed position for additional safety.

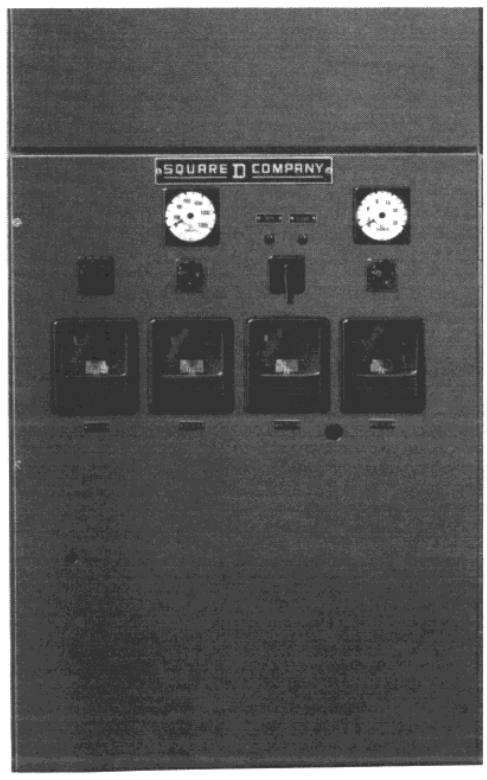
Breaker compartment is shown with steel shutters forced into the open position. Shutters are shown in the open position for illustration only. The shutters should not be forced into the open position or removed for inspection or maintenance when the unit is energized.

The primary porcelain insulating tubes, primary stationary contacts, and current transformers are shown.



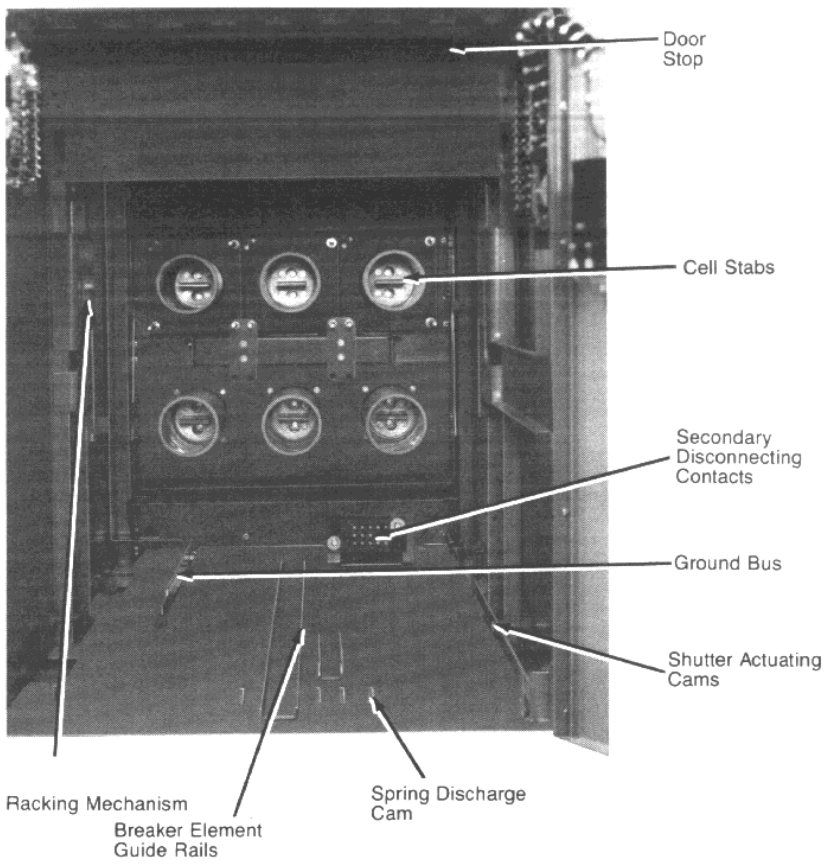
DOORS

Relays, instruments, meters, indicating lights, control switches and other control devices may be mounted on the front door of the breaker and auxiliary compartments.



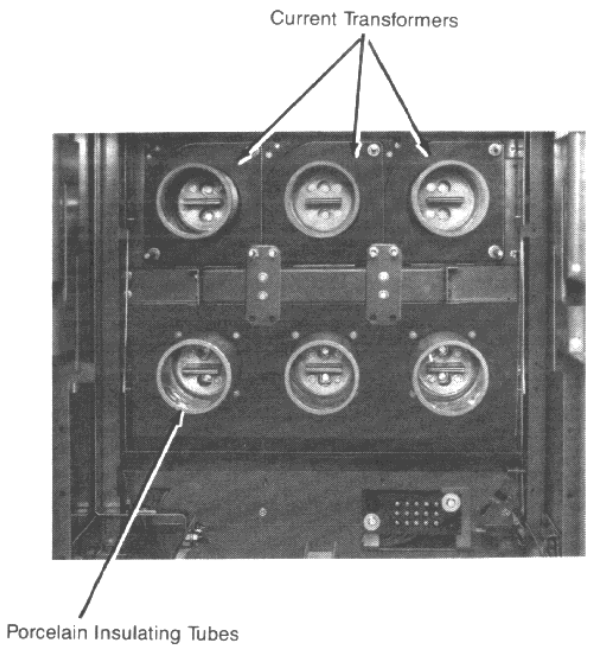
TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

CELL FEATURES



The racking mechanism is an internal part of the breaker. It consists of a self-engaging, self-aligning screw device that becomes spin-free in the connected position at the end of the breaker travel. This prevents possible damage due to over-tightening.

Safety interlocks, as required by ANSI, are provided to prevent electrical or mechanical operation of the breaker during the racking procedure.



CURRENT TRANSFOMERS

Current transformers are front accessible from the breaker compartment.

Space is available for four bushing type current transformers per phase. Two of these current transformers may be placed on the line side and two on the load side of the breaker on each phase.

Space is limited to two current transformers per phase for items marked * on tables 3 and 4.

Standard and high accuracy multi-ratio current transformers are available with ratings from 600 to 3000 amperes.

Current transformers for overcurrent sensing are shown installed around each porcelain insulating tube. The transformers may be changed or added from the front of the cell. High voltage cable connections and primary insulation does not have to be disturbed.

CURRENT TRANSFORMER
STANDARD UNIT SINGLE RATIO

Catalog Number	Ratio	Metering Acc. Class			Relay Acc. Class
		B0.1	B0.5	B2.0	
190-402	4000:5	0.3	0.3	0.3	C100
190-302	3000:5	0.3	0.3	0.3	C100
190-202	2000:5	0.3	0.3	0.3	C100
190-152	1500:5	0.3	0.3	0.3	C100
190-122	1200:5	0.3	0.3	0.3	C100
190-102	1000:5	0.3	0.3	0.6	C50
190-801	800:5	0.3	0.3	0.6	C50
190-601	600:5	0.3	0.3	1.2	C50
190-401	400:5	0.3	0.6	1.2	C50
190-301	300:5	0.6	1.2	2.4	C20
190-201	200:5	0.6	2.4	—	C20
190-151	150:5	0.6	2.4	—	C20
*190-101	100:5	1.2	—	—	C20
*190-750	75:5	1.2	—	—	C20
*190-500	50:5	2.4	—	—	C10

*Space is limited to two current transformers per phase (one per bushing).

TABLE 3

CURRENT TRANSFORMER
HIGH ACCURACY SINGLE RATIO

Catalog Number	Ratio	Metering Acc. Class			Relay Acc. Class
		B0.1	B0.5	B2.0	
191-302	3000:5	0.3	0.3	0.3	C200
191-202	2000:5	0.3	0.3	0.3	C200
191-122	1200:5	0.3	0.3	0.3	C200
191-801	800:5	0.3	0.3	0.6	C100
191-601	600:5	0.3	0.3	0.6	C100
*191-401	400:5	0.3	0.3	1.2	C100
*191-301	300:5	0.3	0.6	2.4	C50
*191-201	200:5	0.6	1.2	—	C50
*191-151	150:5	0.6	1.2	—	C50

*Space is limited to two current transformers per phase (one per bushing).

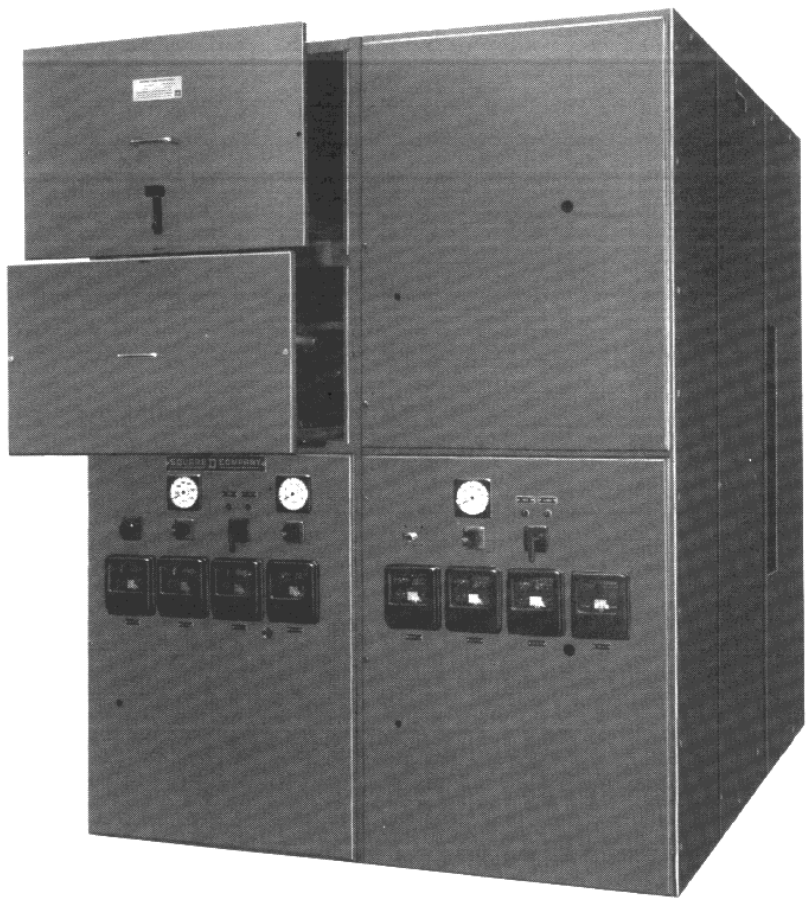
TABLE 4

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

AUXILIARY COMPARTMENT

APRIL, 1984



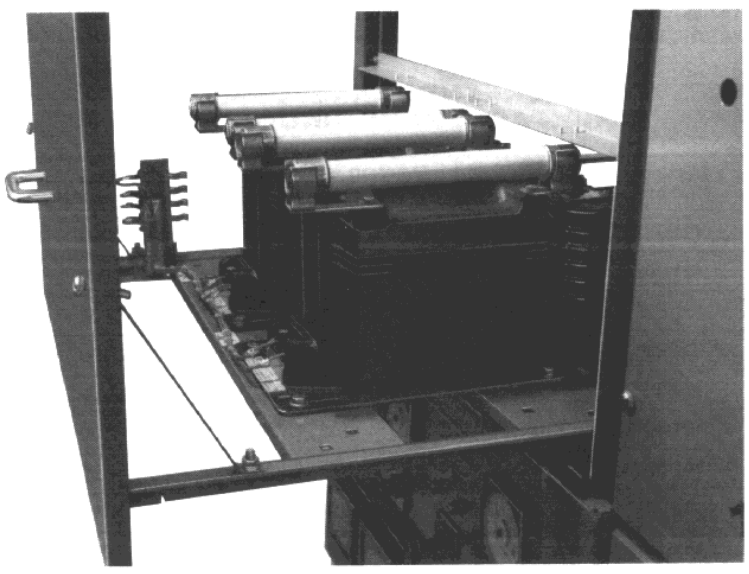
AUXILIARY COMPARTMENTS

Each vertical section will accommodate up to four auxiliary drawers. Shown are a potential transformer drawer and control power transformer drawer. Rails and rollers using the cantilever principle of operation allow each drawer to be withdrawn for maintenance, and permit easy fuse replacement or testing from the front of the unit.

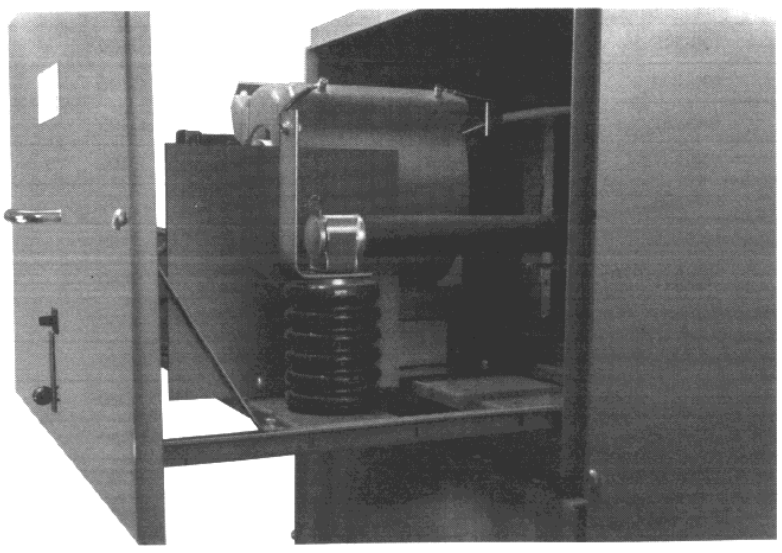
Each potential transformer drawer can hold up to three potential transformers. The drawer can be unlatched and withdrawn using the handle. The potential transformers are automatically disconnected and grounded when withdrawn.

One single phase control power transformer with ratings up to 15kVA and with primary fuse protection can be installed in each drawer. The drawer may be withdrawn using the handle following the same procedure as that for the potential transformers.

The control power transformer secondary main breaker is interlocked with the drawer handle to prevent the control power transformer from being withdrawn until the secondary load is disconnected.



Potential Transformers



Control Power Transformer

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

MAIN BUS COMPARTMENT

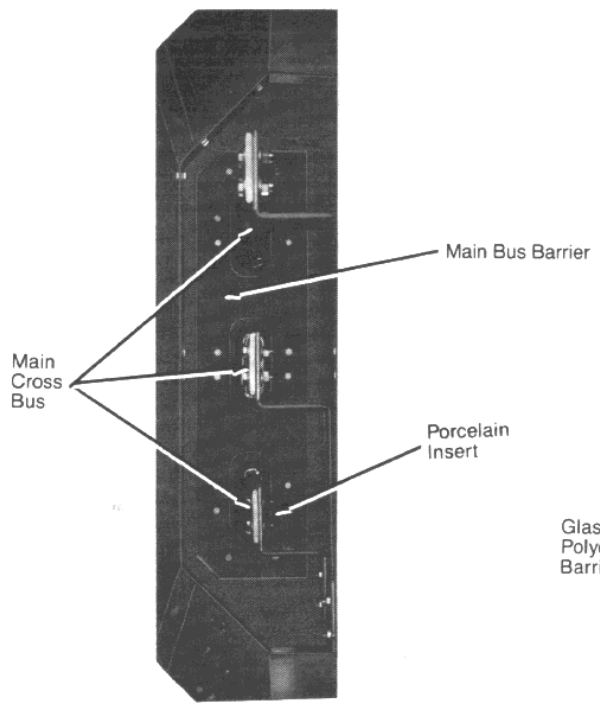
CLASS 6070

MAIN BUS AND BARRIER

The standard main bus system is tin-plated aluminum with fluidized bed epoxy insulation.

Snap-on boots are used to insulate the bus joints.

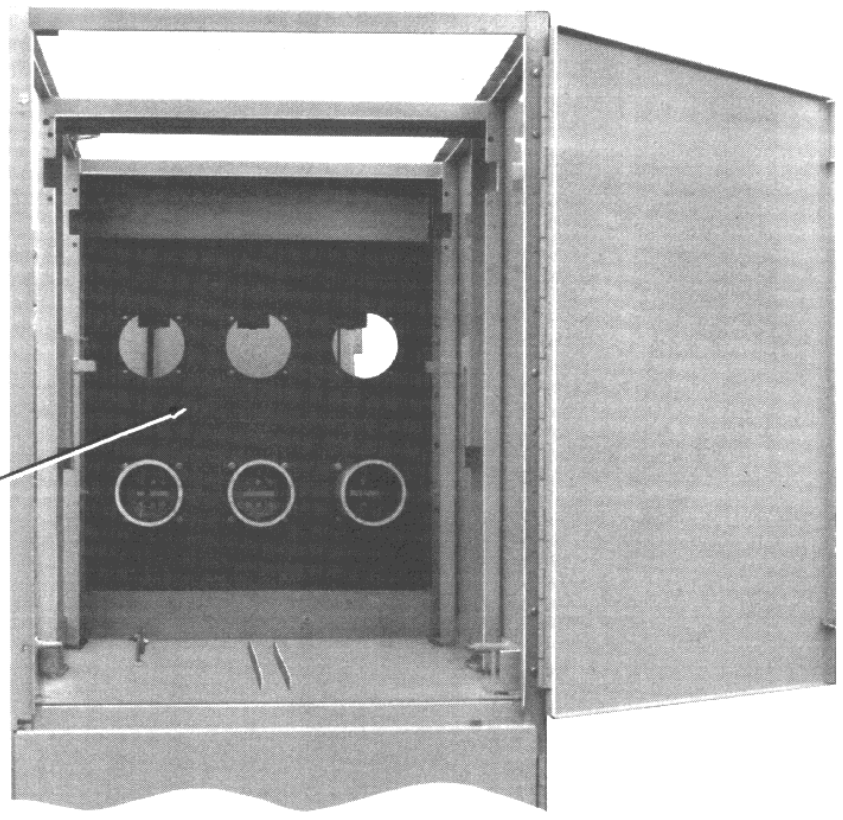
Silver-plated copper bus is available as an option.

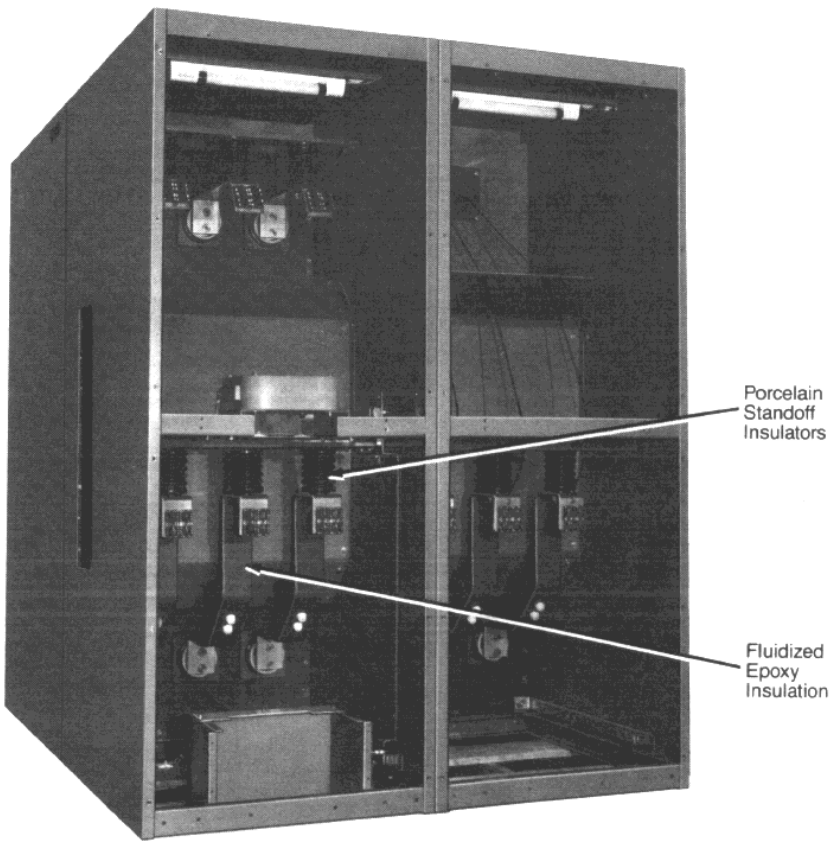


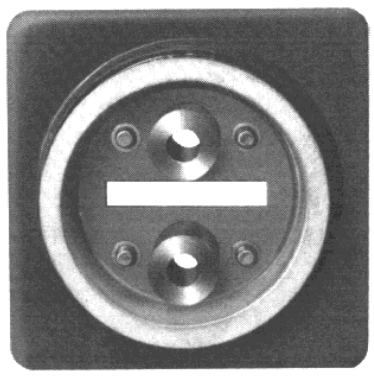
MAIN BUS STRUCTURE

The barriers between vertical sections are glass polyester, with porcelain inserts at 8.25kV and 15kV ratings.

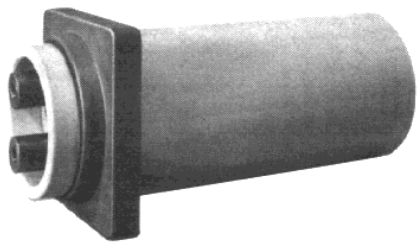
Main bus supports are designed with a special combination using porcelain insulating tubes and glass polyester. The porcelain insulating tubes insulate the primary stationary contacts (cell stabs). Glass polyester is track resistant, flame retardant, and has high mechanical strength.







MAIN BUS SUPPORT
END VIEW



MAIN BUS SUPPORT
SIDE VIEW

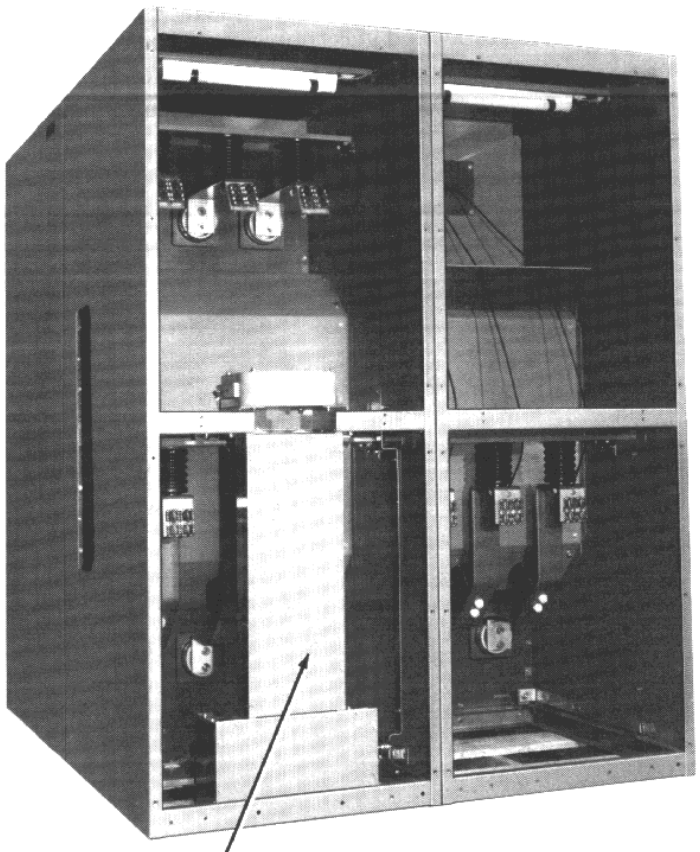
Bus in the cable compartment is supported by porcelain stand-off insulators.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

APRIL, 1984

CABLE COMPARTMENT

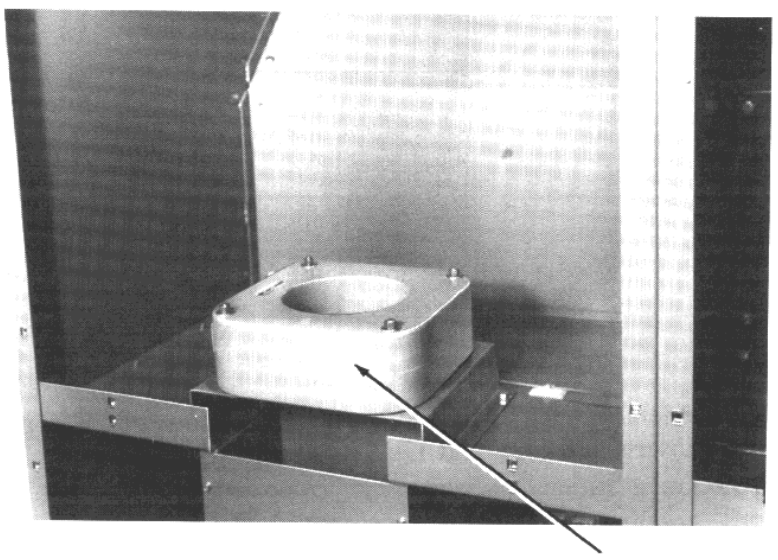


Metal Barriers
Cable Isolation

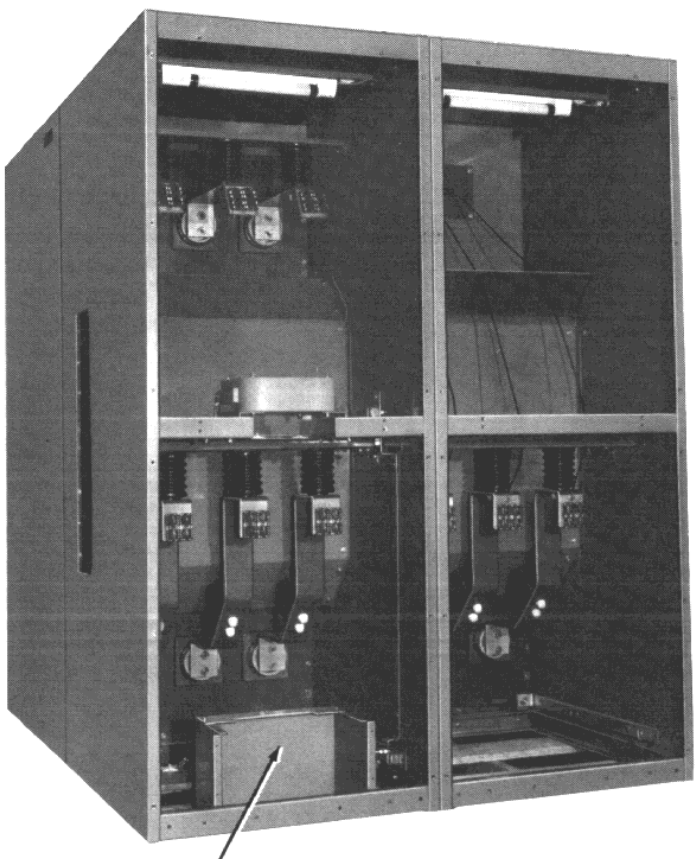
Space is provided in the cable compartment to accommodate up to four-750 MCM cables per phase with appropriate terminations such as stress cones or potheads. Top or bottom entrance is available for both top and bottom compartments of the two-high arrangement. Space is limited to two-750 MCM cables per phase if both circuit breaker cable circuits are top entry, or if both cable circuits are bottom entry. The top and bottom cable compartments are isolated by a horizontal metal barrier.

A metal barrier separates the two cable circuits in the two-high breaker arrangement when both circuits exit from the bottom or top. The barriers are removable.

Zero sequence current transformer location is shown.

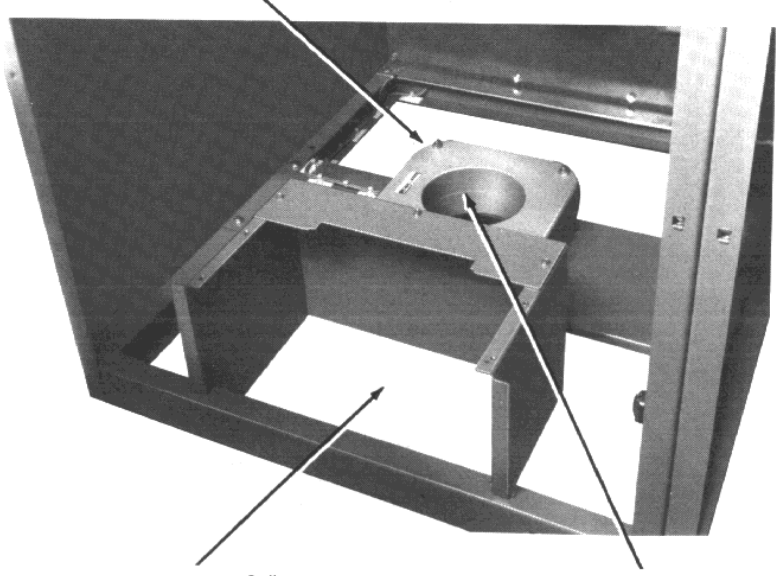


Zero Sequence
CT Top Cell



Metal Barriers
Removed

Zero Sequence
CT Bottom Cell



Cable Entry Area—Top Cell

Cable Entry Area
Bottom Cell

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

SAFETY AND MAINTENANCE

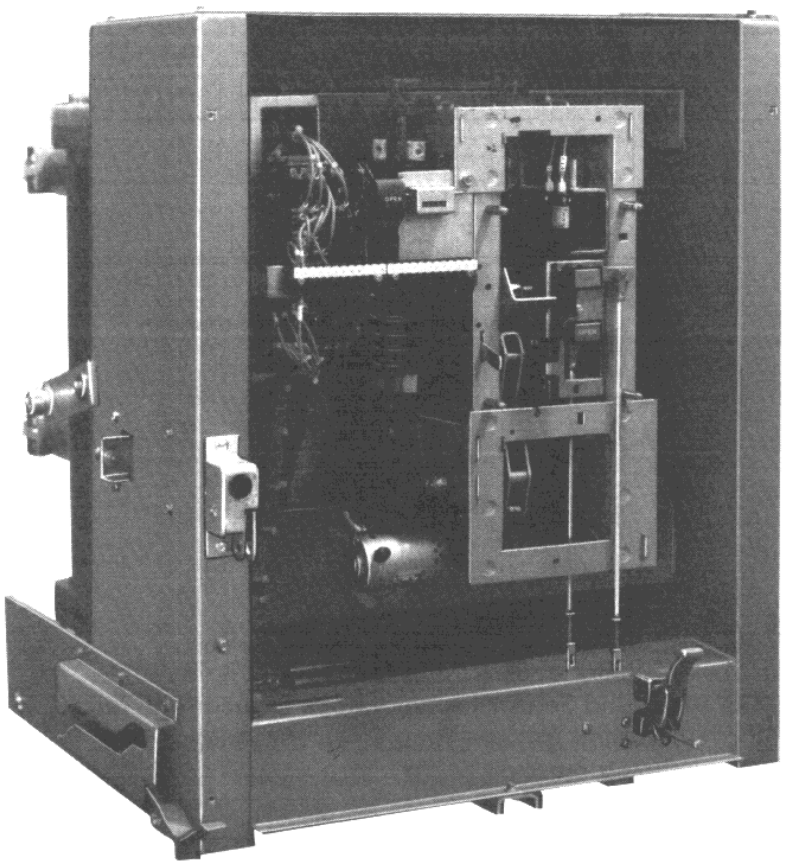
MAINTENANCE

The circuit breakers used in Two-High Metal-Clad Switchgear are considered MINIMUM MAINTENANCE devices.

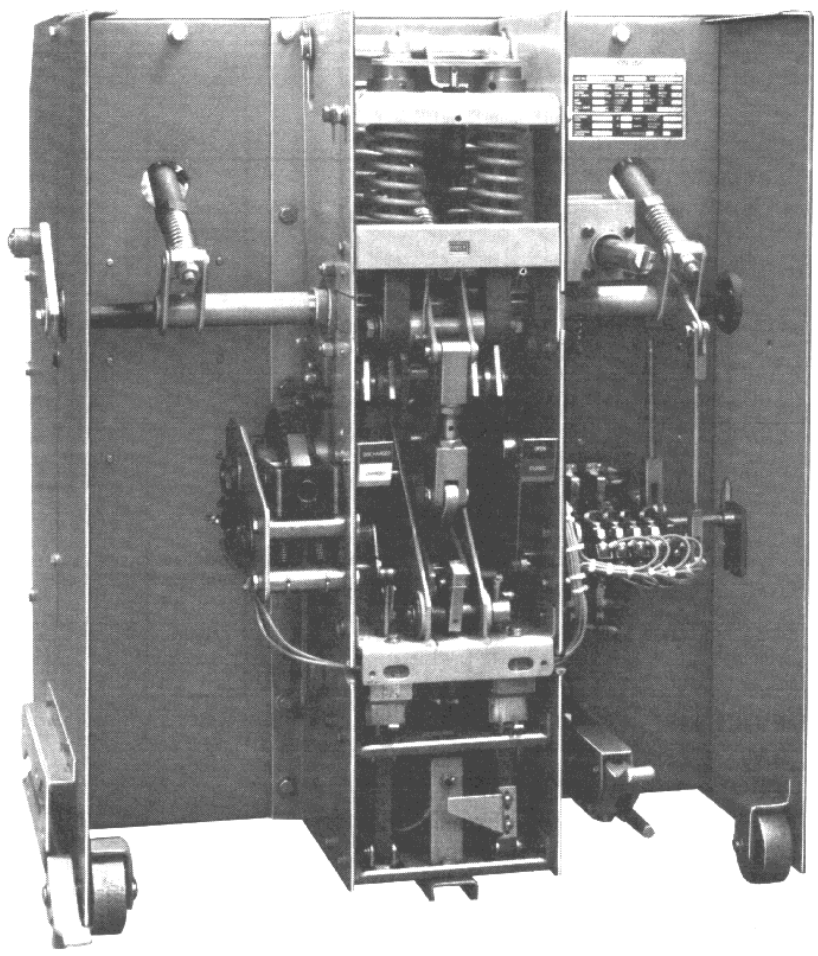
FG-2 and VAD-2 interrupters are sealed and require no direct maintenance on the dielectric medium. Since both interrupters are low mass, short stroke devices they require little effort for operation thereby creating minimal mechanical wear. The only areas of concern in mechanism maintenance is that of regular exercise and lubrication.

Contact wear can be checked periodically by measuring operator penetration through the use of an external indicator. After erosion reaches a limit point (as designated in the instruction manuals) the interrupters should be replaced.

Both the SF_6 and Vacuum integrity may be checked periodically through the use of a hi-pot test set.



TYPE FG-2
SF_6 CIRCUIT BREAKER



TYPE VAD-2
VACUUM CIRCUIT BREAKER

SAFETY

Safety features are an integral part of Two-High Metal-Clad Switchgear. These features include:

SAFETY BARRIERS

The major parts of the primary circuit are the breaker, the main bus, the potential transformers and control power transformers. Each of these compartments is completely enclosed by grounded metal barriers for protection. These barriers prevent direct access to energized equipment. Metering, relaying, and low voltage control devices are separated from the high voltage circuits by grounded metal barriers.

SHUTTERS

As the circuit breaker is withdrawn, the steel shutter assembly closes automatically to protect operating personnel from accidental contact with energized stationary primary contacts. The shutter assembly has provisions for padlocking in the closed position for additional safety.

BREAKER

The breaker front panel is a heavy gauge steel barrier. The breaker is grounded in the connected position and during racking. Breaker rating interlocks prevent an incorrectly rated breaker from being racked into the cell.

RACKING SYSTEM WITH INTERLOCKS

- Interlocks incorporated in the breaker racking assembly provide protection for the operator and the equipment.
- Levering can be performed with the door closed.
- During racking the breaker is mechanically and electrically trip-free.
- The interrupter contacts must be open before the breaker can be racked.
- The racking mechanism disengages or spins free when breaker racking is completed into the connected position of the breaker cell.
- The breaker is latched in place when in the test or disconnected positions.
- The breaker closing spring is discharged when the breaker is withdrawn from the cell.

CLASS 6070

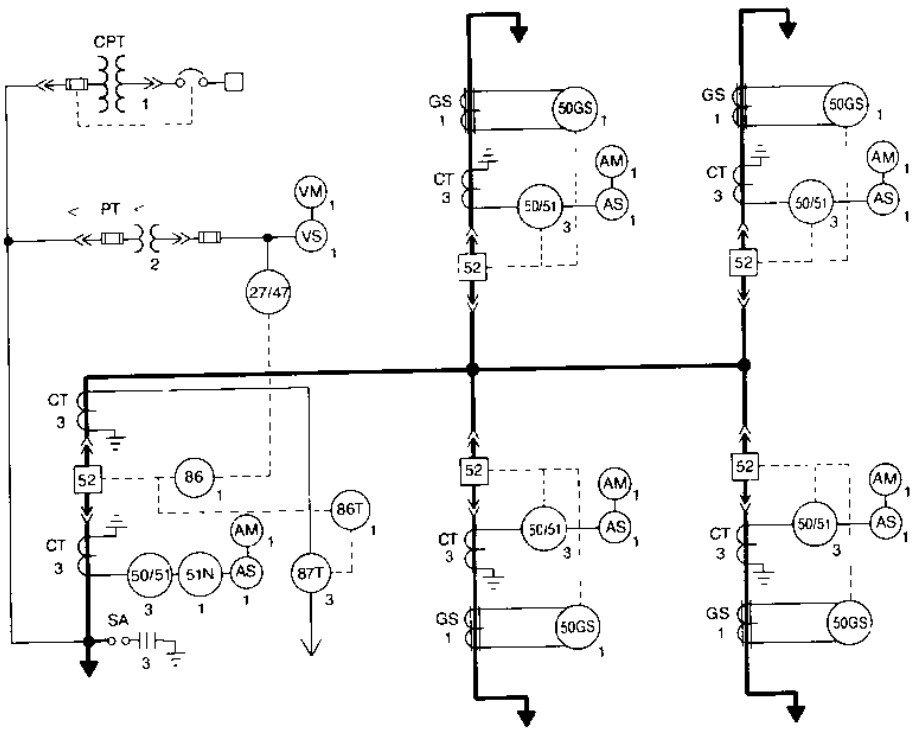
TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

APPLICATION DATA

APRIL, 1984

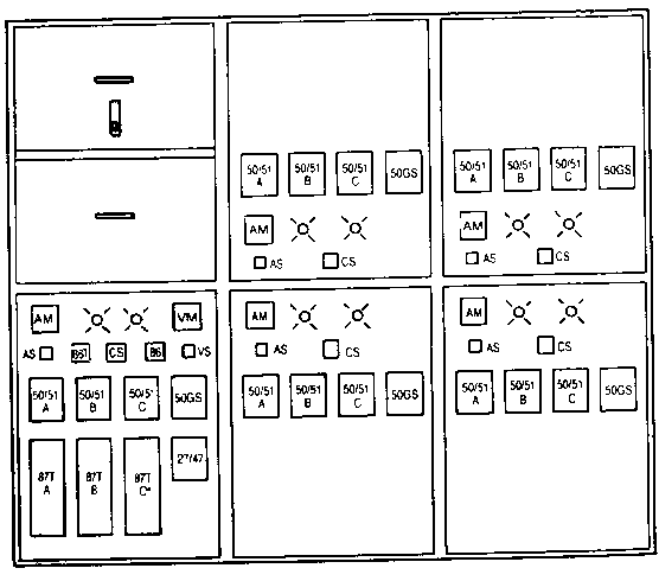
One of the outstanding design features of Two-High Metal-Clad Switchgear is a saving of almost 50% floor space using two-high construction compared to conventional one-high switchgear construction.

A unique feature is the interchangeability of FG-2 (SF_6) and VAD-2 (vacuum) circuit breakers of the same rating.



TYPICAL TWO-HIGH SINGLE LINE DIAGRAM

FIGURE 1



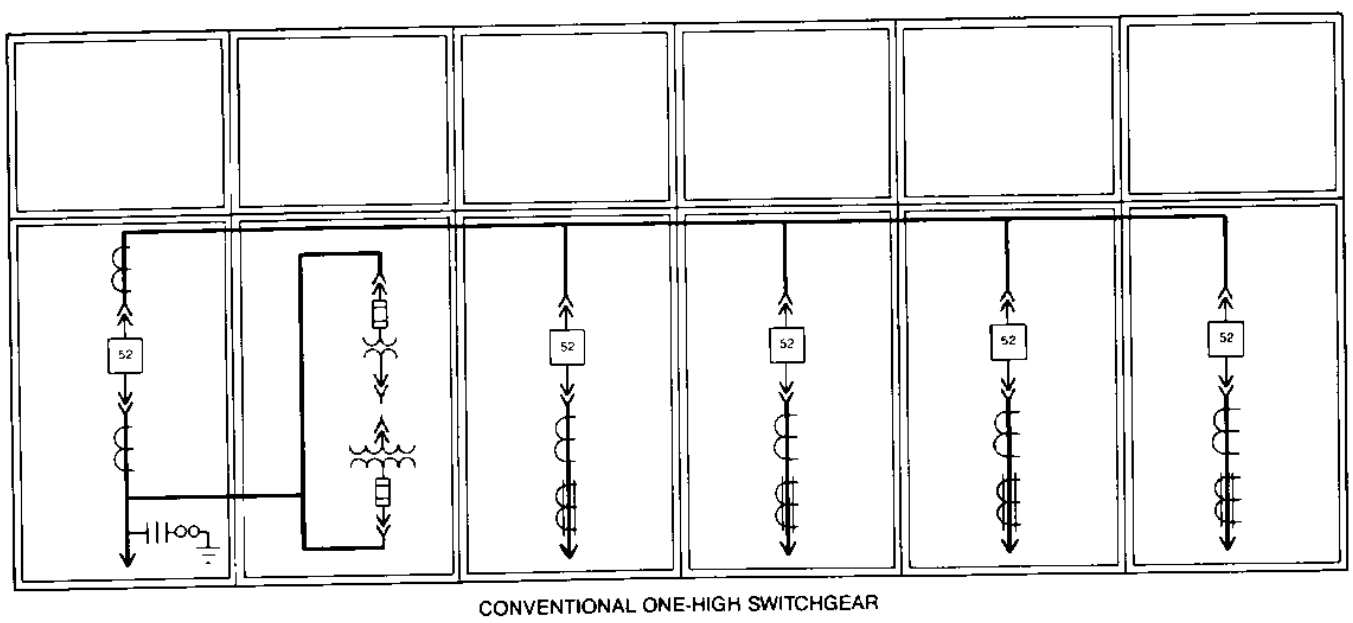
TWO-HIGH METAL-CLAD SWITCHGEAR

FIGURE 2

DEVICE LIST

AM —Ammeter
AS —Ammeter Switch
CPT —Control Power Transformer
CS —Circuit Breaker Control Switch
CT —Current Transformer
GS —Ground Sensor Current Transformer
PT —Potential Transformer
SA —Surge Arrester
VM —Voltmeter
VS —Voltmeter Switch

27/47 —Undervoltage, Phase Sequence Relay
50/51 —Instantaneous & Time Overcurrent Relay
50GS —Ground Sensor Instantaneous Overcurrent Relay
51N —Residual Ground Time Overcurrent Relay
52 —Circuit Breaker
86 —Lockout Relay
87T —Transformer Differential Relay



CONVENTIONAL ONE-HIGH SWITCHGEAR

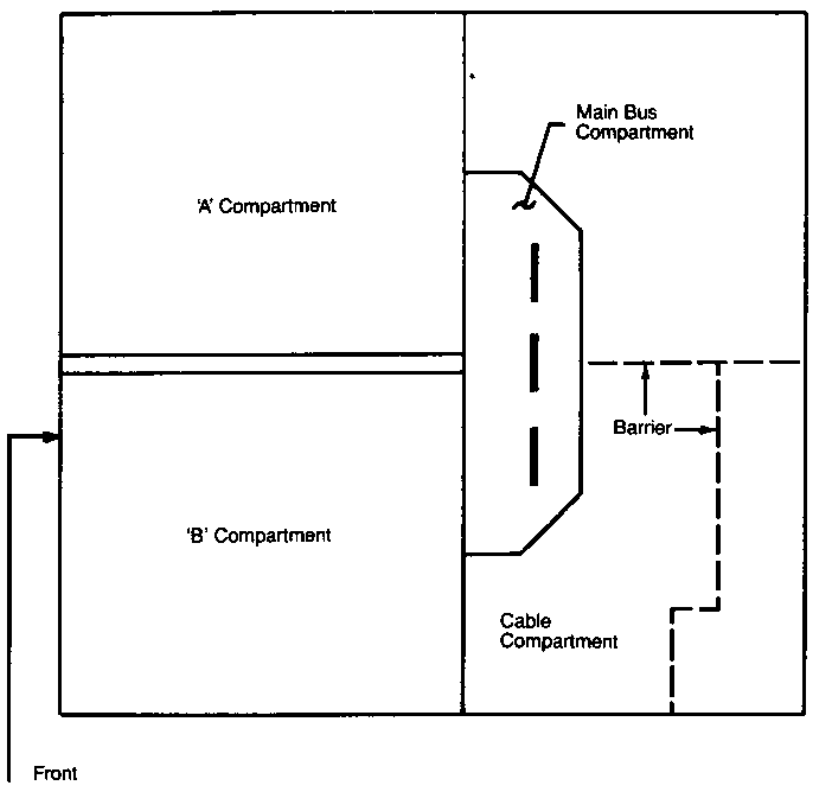
FIGURE 3

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

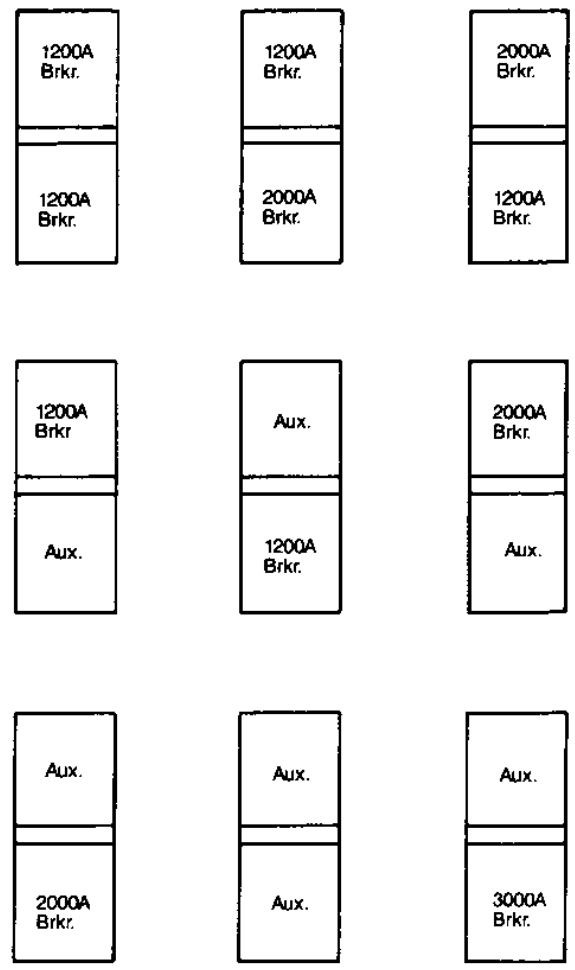
APPLICATION DATA

CLASS 6070

SECTION ARRANGEMENT



AVAILABLE COMBINATIONS



Brkr = Circuit Breaker
Aux. = Auxiliary Compartment

IMPORTANT APPLICATION FEATURES:

- Range of circuit breakers with ANSI and higher ratings are available (refer to table #1 and 2).
- Provisions for up to four ANSI rated current transformers per phase, two on line side and two on load side of the circuit breaker.
- Can provide up to four sets of potential transformers or a combination of potential and control power transformers within one vertical section.
- Cable compartment can accept top or bottom cable entry with provisions for zero sequence CT and pothead connection.
- Full height section is available to facilitate bus transition or utility metering compartment.
- Ease of installation and provision for future extension.

USUAL SERVICE CONDITIONS

Two-High Metal-Clad Switchgear assemblies conform to ANSI C37.20 and are suitable for operation at nameplate rating with the following conditions:

(1) The temperature of the cooling air surrounding the enclosure of the switchgear assembly (ambient temperature) is within the limits of −30 °C (−22 °F) and +40 °C (+140 °F).
(2) The altitude does not exceed 1000 meters (3300 feet).

PRINTED IN U.S.A.

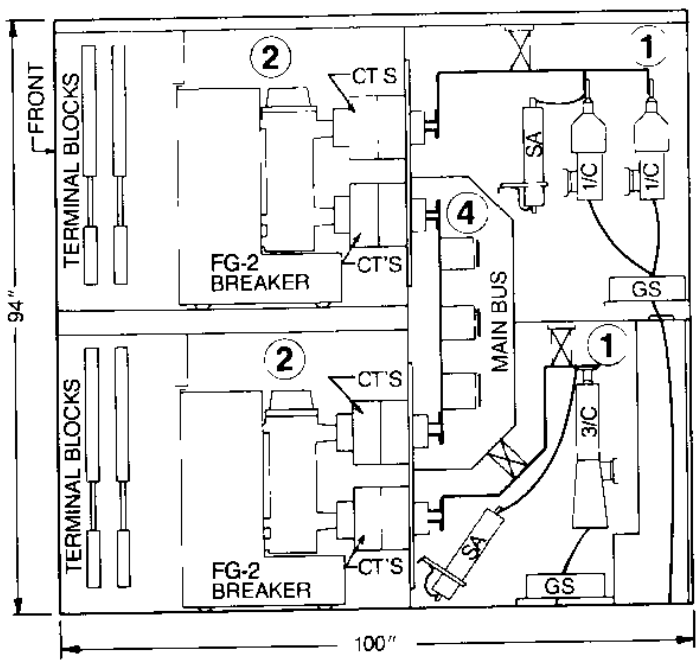
CLASS 6070

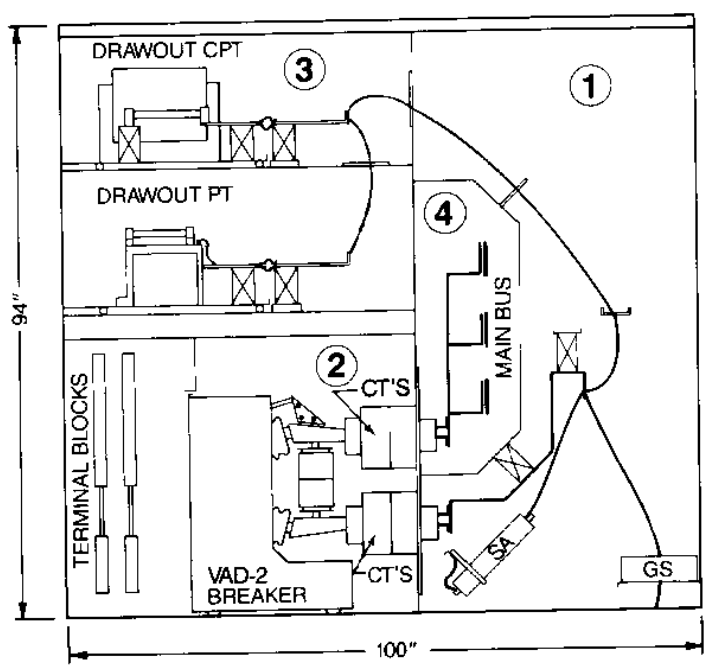
TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

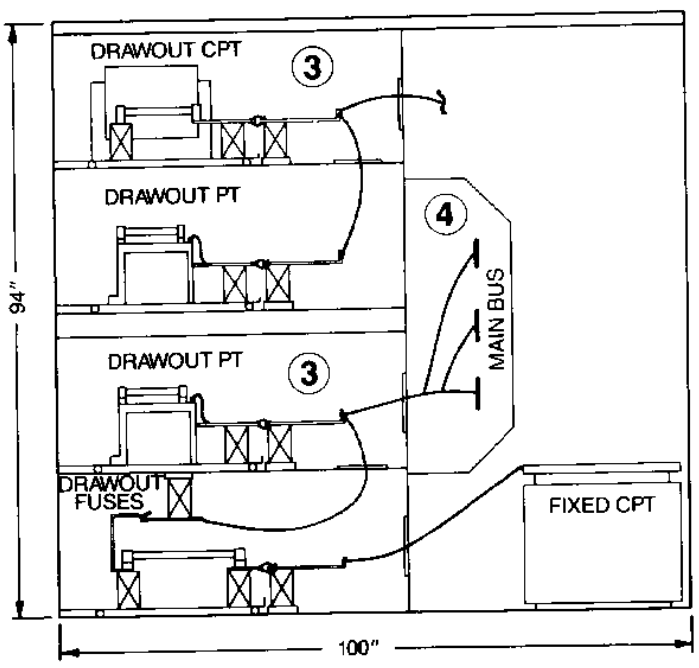
APPLICATION DATA

APRIL, 1984

TYPICAL SECTION VIEWS (36″ WIDE)







AVAILABLE OPTIONS

①CABLE COMPARTMENT

- Bottom or top cable entry
- Ground sensor current transformer (zero sequence)
- Space for stress cone termination
- 1/C or 3/C pothead
- Surge arresters, if required
- Fixed mounted CPT, with no cable entry at the bottom

②BREAKER COMPARTMENT

- 1200/2000A SF_6 or Vacuum circuit breaker in two high construction
- Side space available for terminal block connections
- Maximum 4 CT's per phase (two on either side of breaker pole)

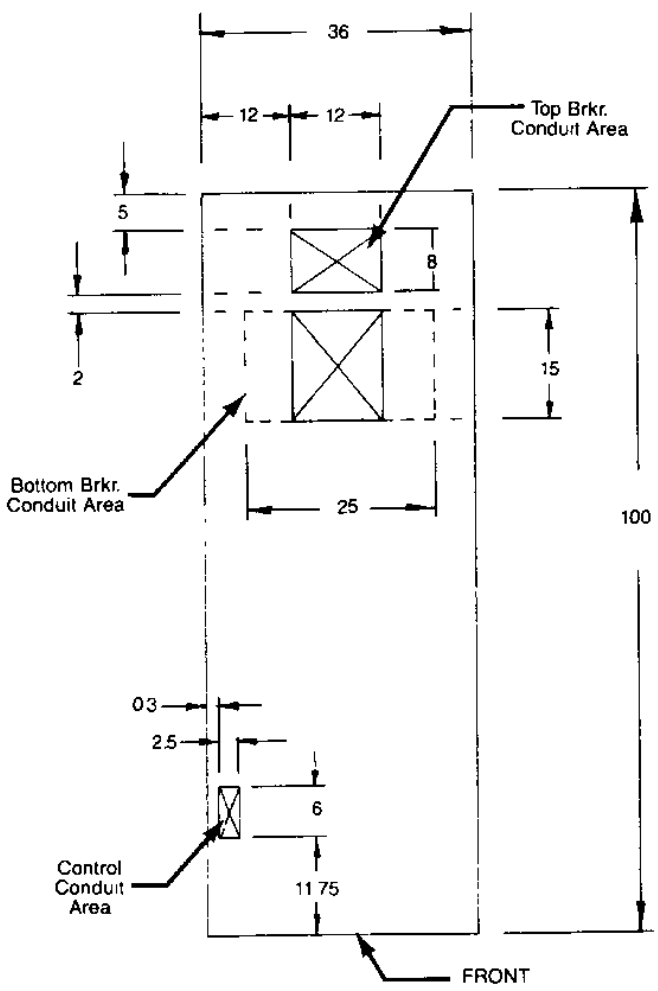
③AUXILIARY COMPARTMENT

- Fused drawout PT's or single phase CPT (15 kVA maximum)
- Drawout fuses

④MAIN BUS COMPARTMENT

- 1200/2000 ampere insulated aluminum (copper optional) main bus

FLOOR PLAN
(Typical two breaker combination)



ALL DIMENSIONS IN INCHES

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

APPLICATION DATA

CLASS 6070

CIRCUIT BREAKER SELECTION

Voltage Rating Nominal kV	Interrupting Rating MVA	Continuous Current Rating Amperes	Breaker Type FG-2 (SF_6)	Breaker Type VAD-2 (Vacuum)
4 16	250	1200	□	□
		2000	□	□
		3000	●	●
7.2	350	1200	□	□
		2000	□	□
		3000	●	●
	500	1200	□	–
		2000	□	–
		3000	●	–
13 8	500	1200	□	□
		2000	□	□
		3000	●	●
	750	1200	□	□
		2000	□	□
		3000	●	●

□ Indicates breaker availability. For details refer to table #1 and table #2.

● Availability to be announced.

TABLE 5

WEIGHTS

Assemblies (Without Breakers)		
Type of Vertical Section	Main Bus Rating Amperes	Weight (Indoor) Pounds
Breaker/Breaker	1200	2500
	2000	2600
	3000	2700
Breaker/Aux. or Aux /Breaker	1200	2600
	2000	2700
	3000	2800
Aux./Aux	1200	2500
	2000	2600
	3000	2700
Breaker	1200	2450
	2000	2550
	3000	2650

TABLE 6

Circuit Breaker Element				
Voltage Rating Nominal kV	Interrupting Rating MVA	Continuous Current Rating Amperes	Weight (Pounds) Breaker Type FG-2 (SF_6)	Weight (Pounds) Breaker Type VAD-2 (Vacuum)
4 16	250	1200	500	530
		2000	550	580
		3000	●	●
7 2	350	1200	500	530
		2000	550	580
		3000	●	●
	500	1200	500	–
		2000	550	–
		3000	●	–
13 8	500	1200	500	530
		2000	550	580
		3000	●	●
	750	1200	500	530
		2000	550	580
		3000	●	●

●Availability to be announced

TABLE 7

PRINTED IN U.S.A.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

CONTROL POWER DATA

Control power for the switchgear can be derived from several sources. The three most common sources are:

1) Control Power Transformer (AC)
2) Battery and Charger (DC)
3) Combination of Items 1 & 2

The user requirements will dictate which of these control power sources should be selected.

If the system is small or is situated where it receives only minimal attention (such as a remotely located substation), a control power transformer is probably the most practical choice. When a control power transformer is utilized, the secondary voltage is usually 120/240 VAC. A circuit breaker's closing motor and relays can be rated for either 120 VAC or 240 VAC. Tripping power on an AC system is usually supplied by a capacitor trip device. The capacitor insures that there is adequate tripping power, under short circuit conditions, to trip the power circuit breaker. One capacitor trip unit is supplied with each circuit breaker when specified.

If the system is large or is adequately maintained by service personnel, a DC battery system is recommended. A normal battery system includes:

a) A battery charger to supply control power to continuous loads (such as pilot lights or normally energized devices) and also to keep the batteries at maximum charge.
b) Batteries to supply DC control power during a loss of AC power to the charger. Installations using a battery system for control purposes do require routine maintenance by operating personnel.

Control power (120 or 240 VAC) from a control power transformer in the switchgear or from an existing source is required to supply AC control power for the charger input, space heaters, emergency lighting, ventilating fans and other AC accessories as used in outdoor switchgear.

When sizing the control power source for a switchgear assembly allow for the circuit breaker coils and charging motors (see tables #8 and #9), indicating lights, relays, space heaters, emergency lighting, ventilating fans, and any other control circuit requirements.

FG-2 BREAKER COIL AND MOTOR ELECTRICAL DATA

Description	Control Voltage	Voltage Operating Range**	Amps	VA	DC Resistance (Ohms)
Closing Solenoid	24 VDC	—	—	—	—
"	48 VDC	38-56 VDC	0.71	34	68
"	125 VDC	100-140 VDC	0.26	33	480
"	250 VDC	200-280 VDC	0.15	37	1700
"	120 VAC	104-127 VAC	0.70	84	26
"	240 VAC	208-254 VAC	0.40	96	115
Trip Solenoid	24 VDC	14-28 VDC	—	—	—
"	48 VDC	28-56 VDC	1.08	52	44 5
"	125 VDC	70-140 VDC	0.68	85	184
"	250 VDC	140-280 VDC	0.23	57	1100
"	120 VAC	104-127 VAC	0.60	72	44.5
"	240 VAC	208-254 VAC	0 33	79	184
Charging Motor	24 VDC	—	—	—	—
"	48 VDC	38-56 VDC	6.00	288	—
"	125 VDC	100-140 VDC	3.20	400	—
"	250 VDC	200-280 VDC	1.60	400	—
"	120 VAC	104-127 VAC	3.00	360	—
"	240 VAC	208-254 VAC	1.60	384	—
Anti Pump Relay	24 VDC	—	0 073	1 75	213
"	48 VDC	38-56 VDC	0 037	1 78	1210
"	125 VDC	100-140 VDC	0.02	2.50	6220
"	250 VDC	200-280 VDC	0.018	4.50	6220-6000*
"	120 VAC	104-127 VAC	0.09	10.50	160-500*
"	240 VAC	208-254 VAC	0.015	3 34	3380

*6000 is external resistance in series with 6220 ohm coil
500 is external resistance in series with 160 ohm coil
**Per table 10, ANSI Standard C37.06-1979

TABLE 8

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

CONTROL POWER DATA

BREAKER OPERATION

VAD-2 BREAKER COIL AND MOTOR ELECTRICAL DATA

Description	Control Voltage	Voltage Operating Range**	Amps	VA	DC Resistance (Ohms)
Closing Solenoid	24 VDC	—	—	—	—
"	48 VDC	38-56 VDC	13 6	653	2.7
"	125 VDC	100-140 VDC	6 0	750	17 5
"	250 VDC	200-280 VDC	3 0	750	84 5
"	120 VAC	104-127 VAC	6 0	720	4 5
"	240 VAC	208-254 VAC	3 0	720	17 5
Trip Solenoid	24 VDC	14-28 VDC	—	—	—
"	48 VDC	28-56 VDC	13.6	653	2.7
"	125 VDC	70-140 VDC	6.0	750	17.5
"	250 VDC	140-280 VDC	3.0	750	84.5
"	120 VAC	104-127 VAC	6.0	720	4.5
"	240 VAC	208-254 VAC	3.0	720	17.5
Charging Motor	24 VDC	—	—	—	—
"	48 VDC	38-56 VDC	9.0	432	—
"	125 VDC	100-140 VDC	5.0	625	—
"	250 VDC	200-280 VDC	5.0	1250	—
"	120 VAC	104-127 VAC	5.0	600	—
"	240 VAC	208-254 VAC	5.0	1200	—
Anti Pump Relay	24 VDC	—	—	—	—
"	48 VDC	38-56 VDC	0 042	2 0	1200
"	125 VDC	100-140 VDC	0 016	2 0	6000
"	250 VDC	200-280 VDC	0 008	2.0	24000
"	120 VAC	104-127 VAC	0 083	10 0	280
"	240 VAC	208-254 VAC	0 042	10.0	1200

**Per table 10, ANSI Standard C37.06-1979

TABLE 9

DESCRIPTION OF ELECTRICAL OPERATION

The following description of electrical operation includes: Applying control power to an installed breaker, the automatic charging of closing springs, an external command to close the breaker, and an external command to trip the breaker. The electrical switching required to control these operations is described below.

The following sequence assumes these initial conditions: The breaker is open, all springs are discharged, and control power (Vc) is not yet applied.

TYPE FG-2 (SF_6) CIRCUIT BREAKER

REFERENCE SCHEMATIC—TYPE FG-2

Limit switch contact 52LS/bb is closed because the closing springs are discharged. With the breaker installed in the test or connected position, the gear motor charges the closing springs when control power is applied. This requires approximately seven seconds. When the springs are charged, contact 52LS/bb opens, de-energizing the motor, and contact 52LS/aa closes to permit energization of the closing circuit. The circuit breaker closing springs are now charged and waiting for a "CLOSE" command.

A "CLOSE" command is given by closing an external CLOSE control switch. This energizes latch release coil 52X through contacts 52/b, 52LS/aa and 52Y/b. The circuit breaker snaps closed under pressure from the closing springs. When the circuit breaker closes, contact 52/b opens, turning off the green "OPEN" pilot light. The circuit breaker closing causes contact 52/a to close, lighting the red "CLOSED" pilot light. Closing the circuit breaker discharges the closing springs and limit switch contact 52LS/bb closes. The gear motor re-charges the closing springs following the breaker closure. When the springs are fully charged, contact 52LS/bb opens.

Anti-pump relay 52Y and resistor RES are included to limit the circuit breaker to one closing operation per "CLOSE" command. Should the "CLOSE" command remain applied, and the breaker be tripped open, an automatic reclosure of the breaker following the recharging of the closing springs is prevented by the anti-pump relay. The anti-pump circuit serves as a lockout to prevent breaker pumping until an operator can reclose the circuit breaker under a no-trip condition.

The anti-pump circuit works as follows: When the circuit breaker closes, contact 52a closes, energizing anti-pump relay 52Y. Relay contact 52Y/b opens and inhibits closing latch release coil 52X from any additional reclosings. Relay contact 52Y/a closes and holds anti-pump relay 52Y energized until the external "CLOSE" command is removed. At that time, anti-pump relay 52Y is de-energized.

A "TRIP" command is given by closing the external TRIP control switch. The shunt trip coil 52/TC is energized through contact 52/a which is closed due to an earlier closing of the breaker. Contact 52/a opens after the circuit breaker contacts open to clear coil 52/TC. When the circuit breaker opens, contact 52/b closes, causing the green "OPEN" pilot light to illuminate. The circuit breaker is ready for its next "CLOSE" command—the closing springs having been charged immediately following the previous close operation.

Refer to table #8 for the electrical specifications of the type FG-2 circuit breaker control components.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

BREAKER OPERATION

TYPE VAD-2 (VACUUM) CIRCUIT BREAKER

REFERENCE SCHEMATIC—TYPE VAD-2

Limit switch contact LS is closed because the closing springs are discharged. When control power is applied, motor relay MR is energized. This causes contact MR to close, energizing the spring charging motor M which charges the springs. When the springs are charged, limit switch contact LS opens de-energizing the motor relay MR which causes contact MR to open, de-energizing the motor. The circuit breaker closing springs are now charged and waiting for a "CLOSE" command.

Since the motor relay and anti-pump relay are de-energized, contacts MR and Y (in the closing coil X circuit) are closed and since the breaker is open, contact 52/b is closed. A "CLOSE" command is given by closing an external CLOSE control switch, energizing closing coil X, thereby closing the breaker. Closing the breaker discharges the springs and again closes limit switch LS. The spring charging sequence cycles again to charge the springs immediately following the breaker closure.

When the motor relay MR is energized, contact MR (in the anti-pump relay Y circuit) energizes anti-pump relay Y, which closes contact Y in the anti-pump circuit, and opens contact Y in the coil X circuit. In the event that the breaker trips upon initial closing, the breaker is prevented from pumping (repeated close and open operations). Contact Y in the anti-pump relay circuit seals in anti-pump relay Y until the "CLOSE" command is removed, de-energizing the anti-pump relay. When the breaker closes, contact 52/a in the pilot light circuit closes, causing the red pilot light to illuminate. At the same time contact 52/a in the trip coil (TC) circuit closes, making the breaker ready for a "TRIP" command.

A "TRIP" command is given by closing the external TRIP control switch which energizes trip coil TC. The trip coil causes the breaker to open and contact 52/a in the trip circuit opens, clearing trip coil TC. Contact 52/a opens turning off the red pilot light, contact 52/b closes causing the green pilot light to illuminate, and contact 52/b closes in the closing coil X circuit. With the circuit breaker closing springs being charged earlier, the circuit breaker is waiting for its next "CLOSE" command.

Refer to table #9 for the electrical specifications of the type VAD-2 circuit breaker control components.

DESCRIPTION OF MECHANICAL OPERATION

TYPE FG-2 AND VAD-2

Opening and closing of the breaker is performed by releasing stored energy in the corresponding springs. The closing springs are charged by an electric motor working through a series of gears. The springs can also be manually charged with the manual charging handle. The closing motion of the breaker charges the opening springs.

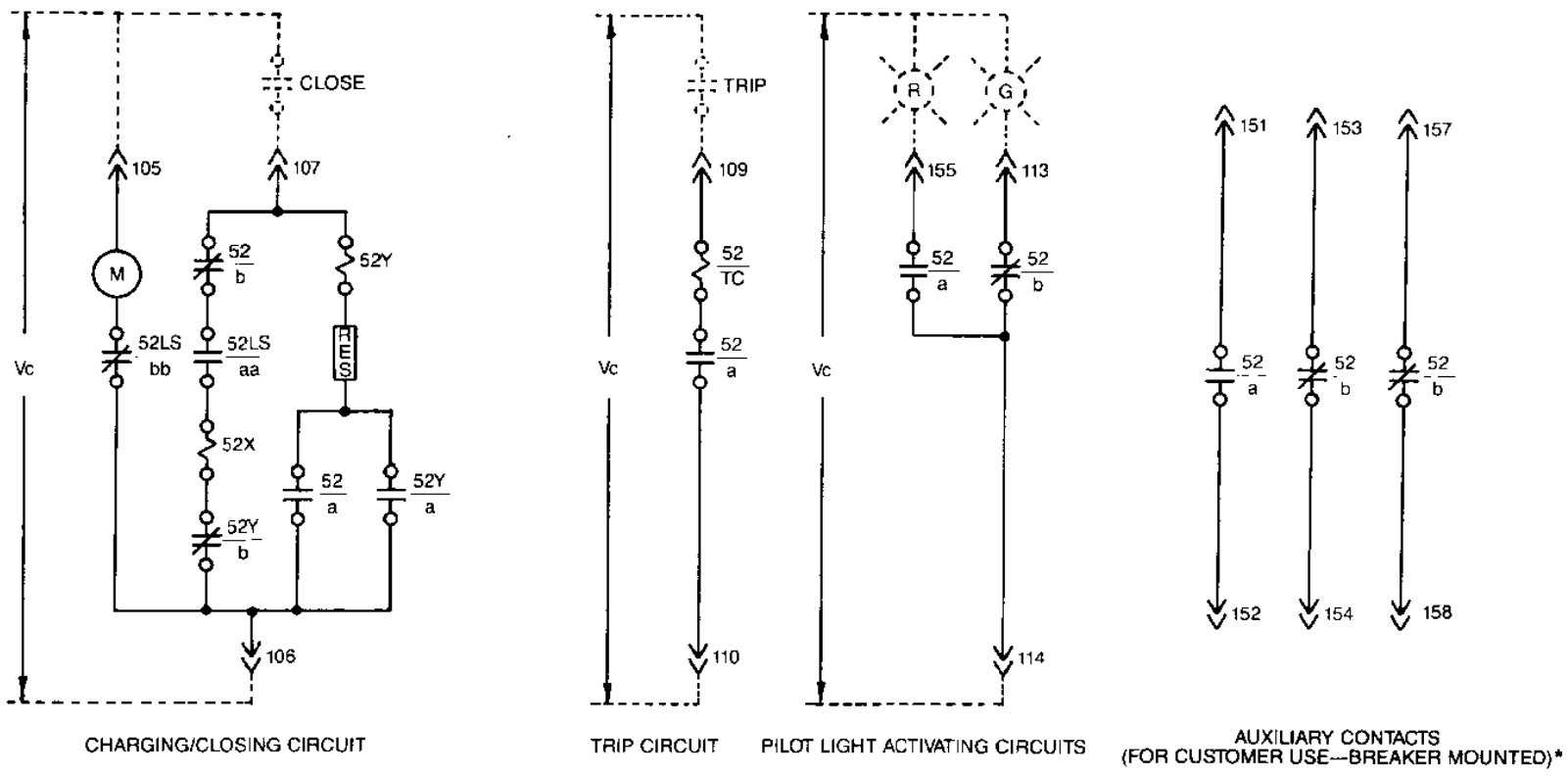
The three pole units are closed/opened simultaneously by the operating rods which are connected to a common drive shaft.

Releasing the close or open latch can be done mechanically with the CLOSE/OPEN buttons (or levers) located on the front of the breaker.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

CONTROL CIRCUIT SCHEMATICS

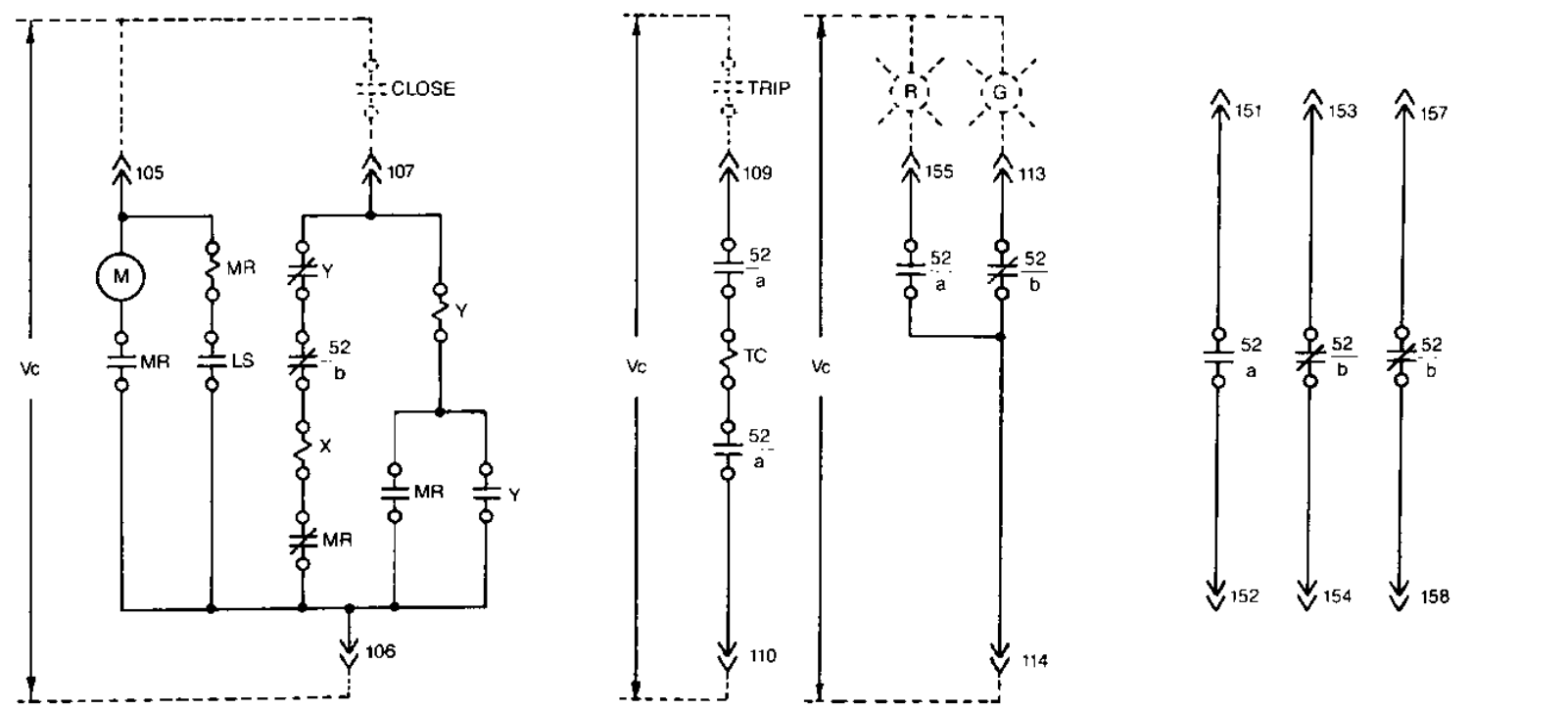
TYPE FG-2 CIRCUIT BREAKER



*OPTIONAL: a) A maximum of 12 additional auxiliary contacts (mechanism operated, cell mounted, MOC) are available
b) A maximum of 12 cell switch contacts (truck operated, cell mounted, TOC) are available

Vc = Control Voltage

TYPE VAD-2 CIRCUIT BREAKER



*OPTIONAL: a) A maximum of 12 additional auxiliary contacts (mechanism operated, cell mounted, MOC) are available
b) A maximum of 12 cell switch contacts (truck operated, cell mounted, TOC) are available

Vc = Control Voltage

PRINTED IN U.S.A.

CLASS 6070

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

SUGGESTED SPECIFICATIONS

APRIL, 1984

Available Ratings:
VOLTAGE: 4.16kV-13.8kV Nominal, 3ϕ 3W, 3ϕ 4W
MAIN BUS: 1200, 2000, 3000 Ampere
CIRCUIT BREAKER NOMINAL RATING: 250 MVA-750 MVA

SPECIFICATION CHECK LIST:

☐ Breaker type
  ☐ FG-2 (SF_6)
  ☐ VAD-2 (Vacuum)
☐ Service voltage
  _____ Volts, 3ϕ, _____ Wire
  ☐ Grounded
  ☐ Ungrounded
☐ Breaker MVA _____
☐ Breaker continuous current _____ Amps.

☐ Breaker control voltage
  ☐ charging motor _____ V AC/DC
  ☐ close coil _____ V AC/DC
  ☐ trip coil _____ V AC/DC
☐ Control power source
  ☐ Control power transformer
  ☐ Battery & charger
    ☐ Existing
    ☐ Supply with switchgear

☐ Main Bus _____ Amps.
  ☐ Aluminum
  ☐ Copper
☐ Switchgear Construction
  ☐ Indoor (NEMA I)
  ☐ Outdoor
    ☐ Walk in (NEMA 3R)
    ☐ Non-walk in (NEMA 3R)

SPECIFICATIONS

a. **General**
The (indoor) (outdoor non-walk-in) (outdoor walk-in) metal-clad switchgear described in this specification is intended for use on a (2400) (4160) (4800) (7200) (13,800) ( ) volt 3-phase (3) (4) wire (grounded) (ungrounded) 60 Hertz system. The switchgear shall be rated (4760) (8250) (15,000) maximum volts and have horizontal drawout circuit breakers. The switchgear and circuit breaker either individually or as a unit shall have an impulse rating of (60) (95) kV. The entire switchgear assembly including circuit breakers, meters, relays, etc., shall be completely factory tested and the circuit breakers of like ratings shall be interchangeable.

b. **Applicable Standards**
The switchgear covered by these specifications shall be designed, tested and assembled in accordance with the latest applicable standards of ANSI and NEMA.

c. **Stationary Structure**
The switchgear shall consist of _____ sections comprising of _____ breaker compartments and _____ auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing painted steel between sections. Each section shall be segregated by metal barriers into the following separate compartments: circuit breaker, main bus, auxiliary device and cable.

d. **Circuit Breaker Compartment**
Each circuit breaker compartment shall be designed to house a horizontal drawout (4760) (8250) (15,000) volt SF_6 or Vacuum circuit breaker. SF_6 and Vacuum circuit breakers shall be interchangeable within the same breaker compartment. The stationary primary disconnecting contacts are to be silvered copper and field replaceable. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection.

Entrance to the stationary primary disconnecting contacts shall be automatically covered by bright orange shutters when the circuit breaker is withdrawn to the test or disconnected positions or removed from the circuit breaker compartment. Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Welded guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampacity or interrupting capacity element into a compartment designed for one of a higher rating.

e. **Cable Compartment**
The primary disconnecting contacts shall be extended into the cable compartment by means of porcelain bushings. The current transformer for overcurrent protection and other relaying functions are to mount on these bushings and be accessible from the front of the unit. (Clamp type cable lugs) (Potheads) (Cable terminators) shall be furnished as shown on plans. The ground bus shall extend through this compartment for the full length of the switchgear.

f. **Main Bus Compartment**
The main power disconnecting contacts shall be extended into the bus compartment by means of porcelain bushings. These bushings shall also have provision for mounting current transformers. The main bus is to be rated (1200) (2000) (3000) amperes and be fully insulated for its entire length. The conductors are to be (tin plated aluminum) (silver plated copper) and be of a bolted (not welded) design. Access to this compartment is gained from the rear of the structure by removing a steel barrier.

g. **Doors and Panels—Indoors**
Relays, meters, instruments, control switches, etc., shall be mounted on a formed front hinged panel.

The cable compartment shall have a screw removable rear plate or a bolted rear panel.

TWO-HIGH METAL-CLAD 5-15kV SWITCHGEAR

SUGGESTED SPECIFICATIONS

h. **Circuit Breakers**

The circuit breakers shall be rated (4760) (8250) (15,000) maximum volts, 60 Hertz, having a continuous current rating of (1200) (2000) (3000) amperes and an interrupting rating of (250) (350) (500) (750) MVA. Breakers of equal rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor, but can also be charged by a manual handle for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker element designed to barrier operating personnel from live primary bus when the breaker is installed in the circuit breaker compartment. Positive contact secondary disconnect shall be through automatic self-aligning, self-engaging type plug and contact arrangement. Provision shall be made for control power plug to be disconnected in test position. A minimum of 3 auxiliary contacts (1a, 2b), shall be provided for external use. Provisions shall be made for 12 additional auxiliary contacts (MOC type) for external use.

An interlocking system shall be provided to make it impossible to rack a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored-energy operating mechanism closing spring upon removal of the breaker out of the compartment.

The circuit breaker control voltage shall be:
(24) (48) (125) (240), volts DC
(120) (240), volts AC

FLUARC FG-2 (SF_6) TYPE CIRCUIT BREAKER

The FG-2 circuit breaker shall have three independently sealed SF_6 interrupters. The interrupter contacts shall be protected from moisture and contaminated atmosphere. Arc interruption shall be based on the SF_6 single-pressure puffer principle. The interrupter shall be a low pressure device. The normal operating pressure of SF_6 shall not exceed 2.5 bar gauge. Provision shall be made for a low pressure alarm switch (optional) for external use. The circuit breaker shall have a contact wear indicator and provisions for slow closing. The circuit breaker total interrupting time shall not exceed 5 cycles. The interrupters shall be maintenance free.

VACARC VAD-2 (Vacuum) Type Circuit Breaker

The vacuum interrupters shall be hermetically sealed in a high vacuum, protecting butt contacts from moisture and contaminated atmosphere. Provisions shall be made for slow closing of the contacts. The circuit breaker shall have a contact wear indicator readily accessible to the user. The circuit breaker total interrupting time is not to exceed 3 cycles. The interrupters shall be maintenance free.

i. **Instrument Transformers**

Current transformers—each breaker compartment shall have provision for mounting of up to four ANSI rated current transformers per phase, two on line side and two on load side of circuit breaker. The current transformer assembly shall be insulated for the full voltage rating of the switchgear. Relaying and metering accuracy shall conform to ANSI standards.

Voltage transformers—voltage transformers with primary fuses shall have ratio as indicated. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI standards.

j. **Control Wiring**

The switchgear shall be wired with type SIS #14 AWG, except where larger size wire is specified. The switchgear shall be provided with terminal blocks for outgoing control connections.

k. **Drawings**

Upon award of the contract, the manufacturer shall furnish drawings for (approval) (record) showing the general arrangement and schematic diagrams. These drawings shall supply all installation and coordination data required by the purchaser for the preparation of electrical and mechanical details necessary to the installation of the switchgear by the purchaser.

PRINTED IN U.S.A.

SQUARE D COMPANY

4/84 PS 8M

Printed in U.S.A.