Fermilab

SDC SOLENOID DESIGN NOTE # 129

TITLE: Choices for a 10,000 A to 15,000 A Dump Switch.

AUTHOR: C. Drennan (Fermilab)

DATE: January 11, 1991

ABSTRACT: This design note describes three possible configurations for a 10 kA to 15 kA dump switch to be used with the solenoid detector quench protection circuitry

SDC DUMP SWITCH INVESTIGATION

The following is a comparison of devices and configurations that can be used for the 10,000 to 15,000 A dump switches to be used with the SDC Solenoid quench protection circuit.

I investigated three possibilities for the dump switches. These are as follows:

A. High speed D.C. circuit breakers, rated as high as 12 kA, are available commercially. These devices were developed specifically for use in controlling the power supplies to heavy rail transit systems.

B. Solid state inverter type SCR's can be used in parallel for a custom switch design. Engineering for such a switch and the associated safety interlocks has been completed here at Fermilab. A switch of this type which can interrupt 10,000 A has been built and tested for use at the Magnet Test Facility here at Fermilab.

C. Mechanical contactors, similar to the 5,000 A dump switches used at CDF, can be used in parallel for a custom switch design. The engineering that went into the SCR type switch described above also applies directly to a switch that uses contactors.

All configurations can be specified to withstand 1000 V. The high speed circuit breakers commercially available are rated at 12 kA using a double contact assembly. The custom designs using SCRs or contactors can be designed to handle 15 kA.

From the time a remote signal to open is received by the dump switch to the time at which the current is interrupted is approximately 25 ms for the circuit breakers, less than 10 ms for the SCR device, and approximately 100 ms for the mechanical contactors.

Comparing the cost of a dump switch designed for 12 kA it is estimated that the configurations using circuit breakers or contactors will cost $35,000.00, and the switch using SCRs will cost approximately $20,000.00 including parts and labor. The cost of the circuit breakers were actually quoted as being in the range $28,000.00 to $34,000.00. The mechanical contactors are listed for $8,900.00 of which 3 would be necessary for a 12 kA switch. The cost for developing and constructing the switch using contactors in house is estimated at $8,000.00. The parts and labor necessary to build a switch using SCRs are estimated to cost $10,000.00 and $8,000.00, respectively.

The following is a list of the sources from which the components for the different switch configurations can be obtained:

High Speed Circuit Breakers

Whipp & Bourne Limited
Type MM74 High Speed D.C. Circuit Breakers

Joseph D. Mouzakis (Service Manager)
Whipp & Bourne Inc.
7260 Langtry
Houston, Texas 77040
(713) 460-0004/5

Mr. Peter Wilde (Marketing Director)
David Hargreaves (Contracts Manager)
Whipp & Bourne Ltd.
Switchgear Works,
Castleton Rochdale, England OL112SS
011-44-706-32051

GEC Transmission and Distribution Projects Limited
HSNP High Speed Switch Gear

Andrew Alexiades
The English Electric Corporation
4 Skyline Drive
Hawthorne, N.Y. 10532-2120
(914) 347-5177

GEC Transportation and Distribution Projects Limited
Transportation Power Supplies Division
Trafford Park, Manchester M601AF, England
Tel: 061-872 2431

Contactors

Siemens-Allis Type 703 5,000 A, 1,000 V D.C. Contactor (used for CDF).

Switchgear Systems, Inc.
David Muir (Sales Representative)
PO BOX 561104
Dallas, Texas 75356 (800) 289-2757

SCR Switch Design

A. T. Visser,"Design Note of a 10,000 A, 1,000V dc Solid State Dump Switch for the Magnet Test Facility," Fermi National Accelerator Laboratory, Batavia, Illinois, Oct 1990.

Another Possible Source

Paul Sievert
Sievert Electric (708) 771-1600

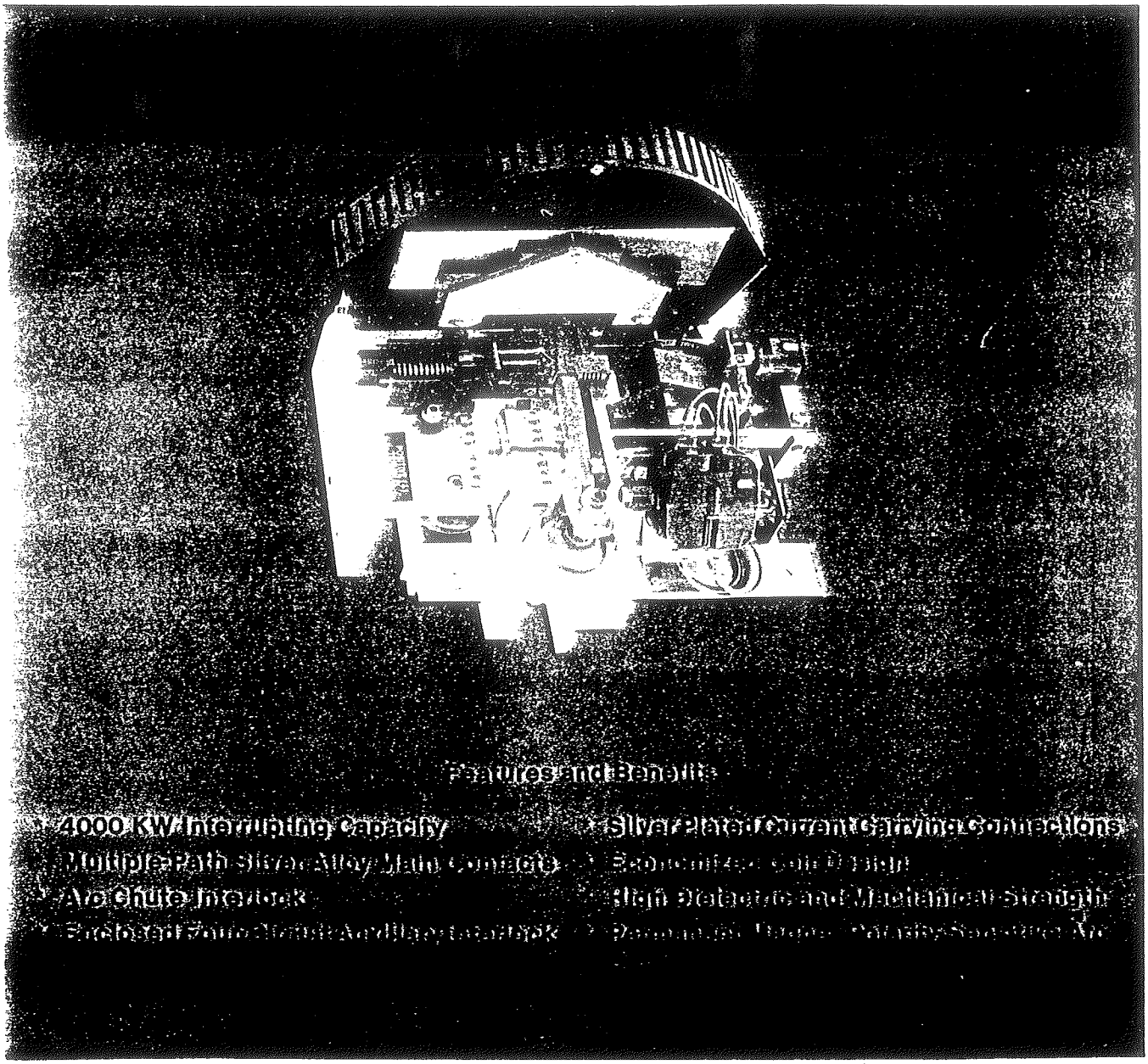
Conclusion

There are at least three types of 10-15 kA dump switches which are available or can be designed and built in-house. The cost is between $20,000.00 and $35,000.00. The availability of a fast dump switch is not an obstacle to designing the solenoid up to 15 kA.

SIEMENS-ALLIS

5000 Amp 1000 Volt DC Contactor

703



Form 14A703-01
April, 1983

GENERAL

If you are using a circuit breaker in a high current D.C. application that is tailor-made for a contactor, then consider the Siemens-Allis Type 703 5000 amp/1000 volt D.C. contactor advantages - smaller size, lower cost, and longer life.

The Type 703 contactor is a single pole normally open device rated at 5000 amps at 1000 VDC, with maximum interrupting capacity of 4000 KW. The device is designed for applications in D.C. systems which require limited interruption capacity, such as those found in adjustable speed drives, uninterruptable power supplies, oil well drilling, crane control, and transit vehicles.

A permanent magnet polarity-sensitive type arc chute is utilized which is capable of interrupting 5000 amps, 800 VDC with an inductive load. The device has successfully interrupted 4000 amps, 600 VDC with an inductive load for 25,000 operations. Arc interruption takes place entirely within the arc chute where the arc is elongated and cooled through arc splitters. The arc chute is electrically interlocked to prevent contactor operation when the arc chute is removed.

Standard operating coils are of molded construction for protection against dirt, moisture, and physical abuse, resulting in high reliability and long life. Operating coils include a pilot coil (74 VDC) and a main coil (74 VDC intermittent, 9 VDC continuous duty). The main coil is energized only long enough to close the arcing and main contacts.

The main coil can be operated from a 120 VAC source through a full wave bridge rectifier. The pilot coil can be operated from a 120 VAC source through a full wave bridge rectifier with a 75 ohm, 100 watt dropping resistor. (For D.C. coil voltages other than 74 VDC, consult factory.)

The Type 703 device utilizes multiple-path main contacts to provide exceptionally high contact reliability and low contact resistance. The unique flexible leaf contact support provides simple, positive connection to movable contacts. Main contacts are silver alloy and major current carrying connections, including customer connections, are silver plated for reliable electrical conductivity. Non-current carrying steel parts are painted or zinc plated with a dichromate finish for good corrosion protection.

A four-circuit auxiliary switch is available with any combination of N.O. and N.C. circuits. The auxiliary contacts are bifurcated fine silver and are completely enclosed.

SPECIFICATIONS

Main Contact Configuration:
Single Pole Normally Open (SPNO)

Contactor Rating:

Continuous Open Air Rating at 80°C ambient:	5000 Amps
Maximum Make Current:	12,000 Amps
Maximum Break Current:	5000 Amps
Maximum Interrupting Capacity:	4000 KW (Within limits of 5000 Amps and 1000 VDC)
Thru-Current Capability:	30,000 Amps
Close-On Capability:	12,000 Amps

Auxiliary Contact Configuration: 2 N.O.-2 N.C. Standard. Consult factory for other configurations.

Auxiliary Contact Ratings: Resistive Load
125 VDC or less = 10 Amps
250 VDC = 2.5 Amps

Mountings: Mounts on two 2" x 2" angle supports with three 0.375" screws.

Arc Chute Clearance: 3" minimum (face to nearest surface).

Power Connections: Eight 0.375"-16 tapped holes per terminal.

Coil Connections: 0.250" faston tabs.

Auxiliary Interlock Connections: 0.250" faston tabs.

Weight: Approximately 90 pounds.

Overall Dimensions (envelope): 12.8" high, 14.6" wide, 18.0" deep *

* From mounting support, 8" to rear and 10" to front.

Operating Coils: [1]

Pilot Coil: 74 VDC, 140 ohms (20°C), 48 VDC Max. Seal, 5-25 VDC Drop-Out.

Main Coil: 74 VDC Intermittent Duty
9 VDC Continuous Duty, 1.95 ohms (20°C)

[1]For coil voltages other than 74 VDC, consult factory.

Ordering Information/Dimensions

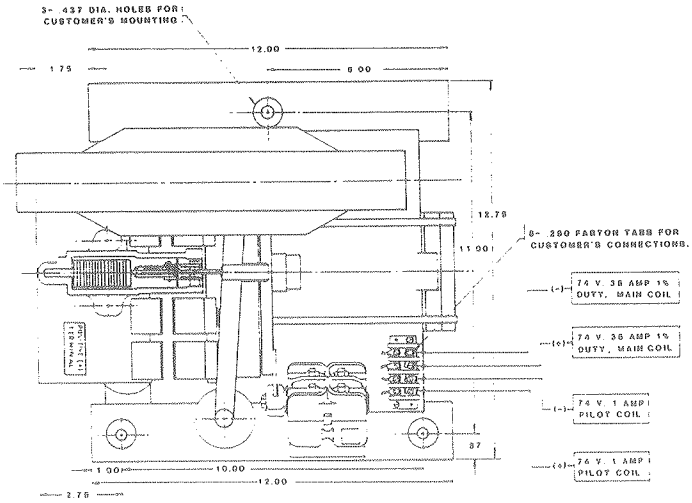
ORDERING INFORMATION

Contactor: Type 703 5000 Amp/1000 VDC, SPNO, 74 VDC Pilot Coil, 74 VDC Main Coil, 2 N.O.-2 N.C. Auxiliary Contacts

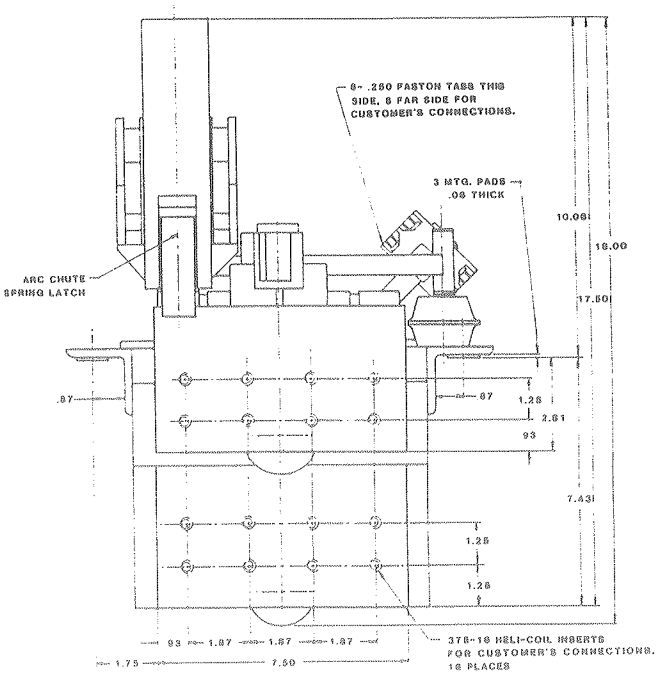
Catalog Number: 14193700562

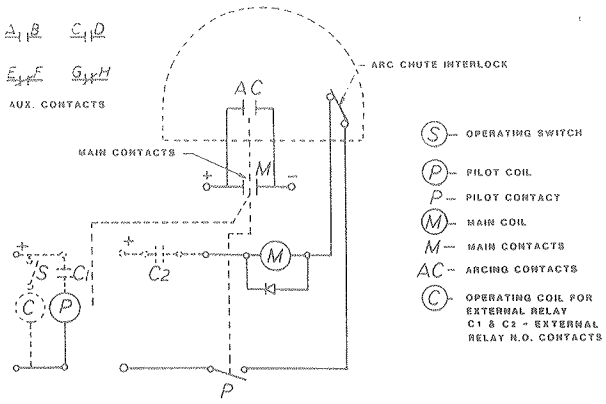
List Price: $ 8920.00

DIMENSIONS



FRONT VIEW





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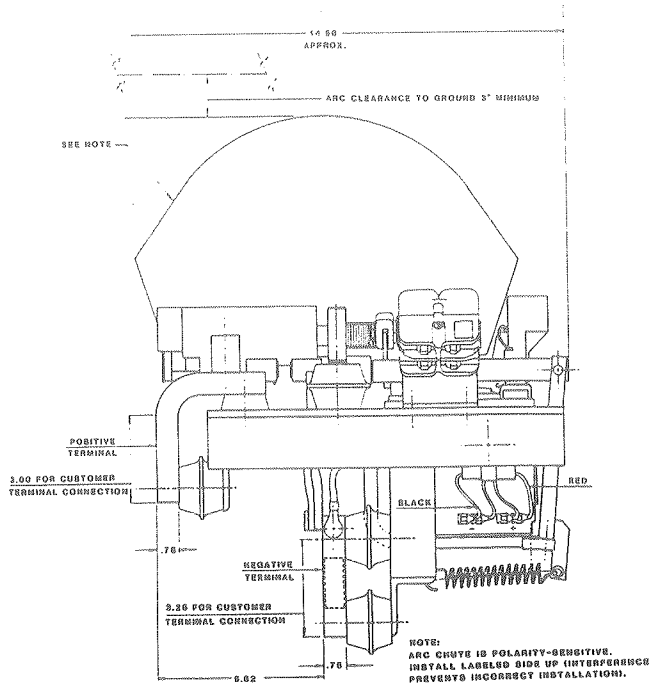


BOTTOM VIEW

SIEMENS-ALLIS

Siemens-Allis, Inc.
Control Products Division
P. O. Box 29265
New Orleans, Louisiana 70189
(504) 254-9140

The information contained herein is general in nature and not intended for specific application purposes. Siemens-Allis, Inc. reserves the right to make changes in specifications shown herein or make improvements at any time without notice or obligation. It does not relieve the user of responsibility to use sound practices in application, installation, operation and maintenance of the equipment purchased. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence. Prices are subject to change without notice.

A company jointly owned by SIEMENS and ALLIS-CHALMERS

Whipp & Bourne Inc.
An FKI Company

7260 Langtry, Houston, TX 77040
Telephone: (713) 460-0004/5
Telex: 251955 WHIPP UR
FAX: (713) 690-3504

December 19,90

Fermi National Excellerator
P.O. Box 500
Batabia, Illinois 60510

Attention: Craig Drennan M/S 219

As requested, here are a few of our brochures on MM74 high speed circuit breakers. If further information is needed, please contact our Houston office or our factory at the below address.

Whipp & Bourne Ltd.
Switchgear Works, Castleton
Rochdale, England OL112SS

Phone 011-44-706-32051

Mr. Peter Wilde, Marketing Director or Mr. David Hargreaves, Contracts Manager.

Regards

Joseph D. Mouzakis

Joseph D. Mouzakis
Service Manager

Whipp & Bourne Inc.
An FKI Company
7260 Langtry, Houston, TX 77040
Telephone: (713) 460-0004/5
Telex: 261955 WHIPP UR
FAX: (713) 690-3504

TELEFAX MESSAGE

Please call (713)-460-0004 immediately if this telefax is not received in its entirety.

Date: Dec. 21, 90 Time: Page 1 of 1

Fax No: 708-840-4343 Client: Fermi National Acc. File: Fermi

Attention: Craig Drennan M/S 219

Here are prices for DC circuit breakers that you requested.

Item	Description	Price Each
1	MM74, 8000A, 1500VDC, (2 X 4000A in parallel) Circuit Breaker and Cubicle.	$29,892.00
2	MM74, 12000A, 1500VDC, (2 X 6000A in parallel) Circuit Breaker and Cubicle.	$33,853.00

Above are in full front cubicles with interposing close & trip relays for remote closing.

Validity: 90 days from Dec. 21,90.
Delivery: 28 weeks from receipt of order. Carriage to first store and import duty paid.
Prices: Firm and fixed for the above delivery and validity period.
Terms: Net cash by 45 day Bill Of Exchange.
Conditions: Whipp & Bourne Ltd. Standard Conditions of Sale will apply.

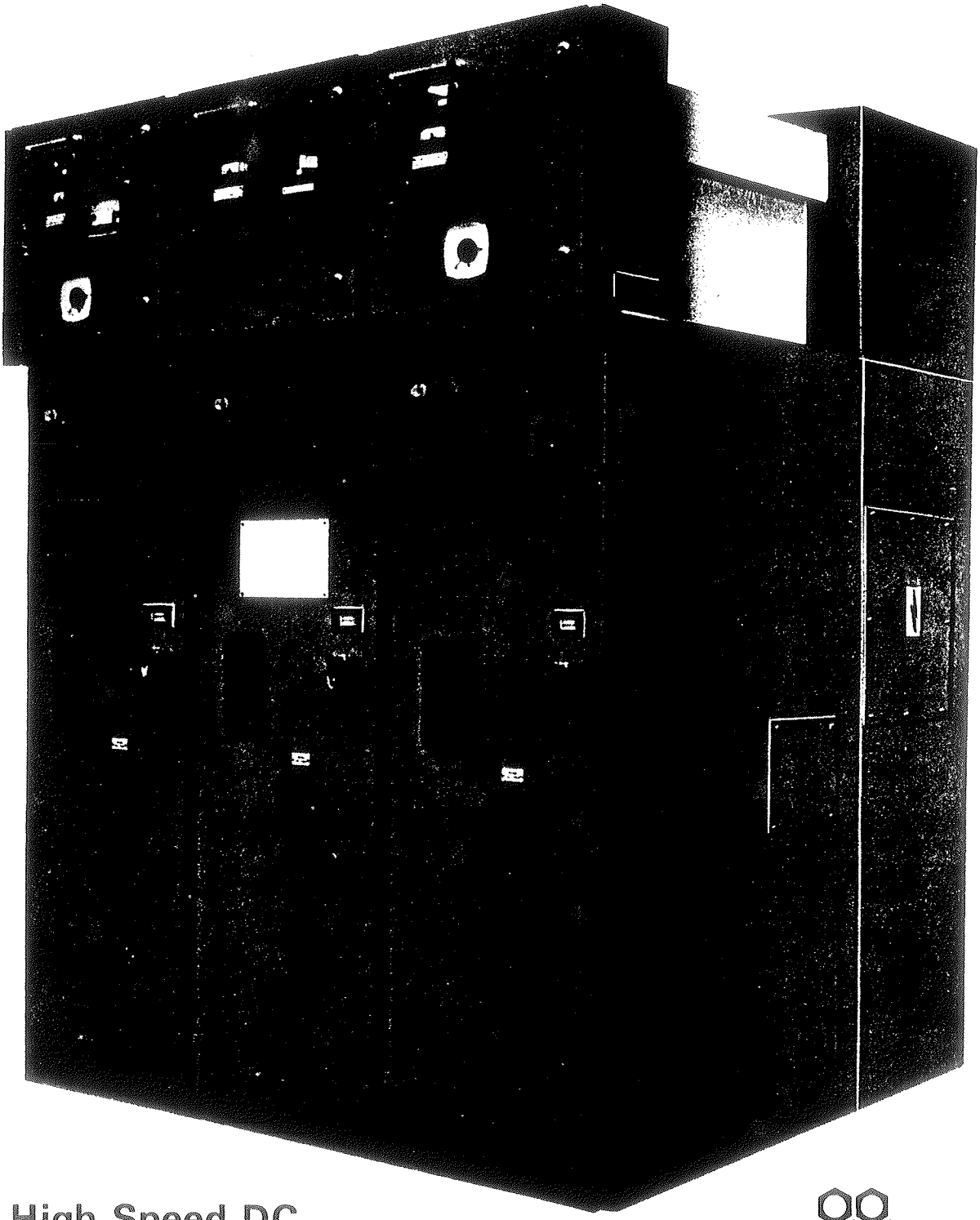
Regards

Joseph D. Mouzakis
Service Manager

Joseph D. Mouzakis
Houston, Texas

Whipp & Bourne Limited

Type MM74



High Speed DC
Circuit Breakers for
Heavy Rail Transit and
Industrial Uses.

FKI
plc

Introduction

The MM74 High Speed DC Circuit Breaker has been designed specifically to meet the system requirements of the DC Substation Switchgear for controlling the Power Supplies, to Heavy Rail Transit Systems.

It is also suited to the special applications of other fields as follows:-

Thyristor converter controlled motors.
Rolling units in steelworks.
Electrolytic plants.
Mine winders.

This truck type withdrawable circuit breaker has been developed from our long established panel and pedestal mounted circuit breakers which have been in service since 1936.

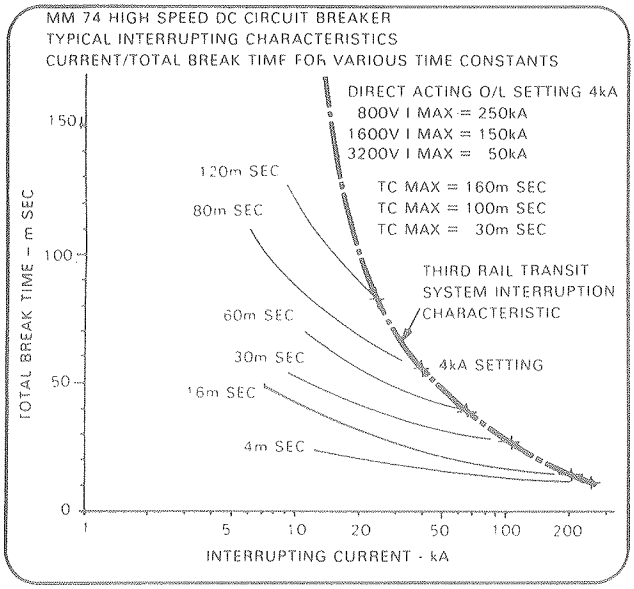
Standards

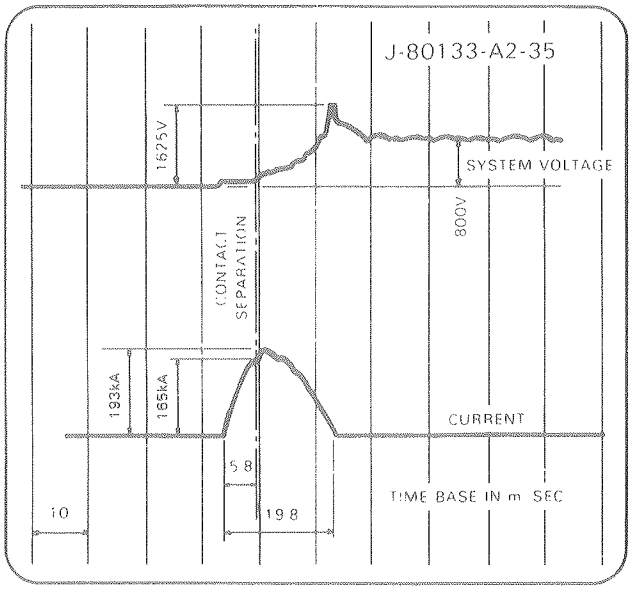
The circuit breaker has been designed and tested to comply with the High Speed classification and specification requirements of ANSI C37.14-1979 and C37.16-1980. It also complies with the requirements of NEMA SG3, BS 4752 and IEC 157-1.

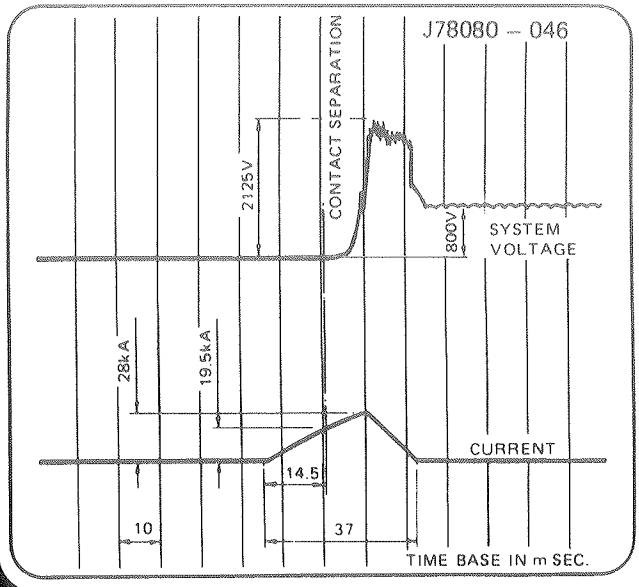
In addition, the circuit breaker has been tested for low current inductive switching to show that it should be capable of interrupting all values of current likely to be met on a Heavy Rail Transit System.

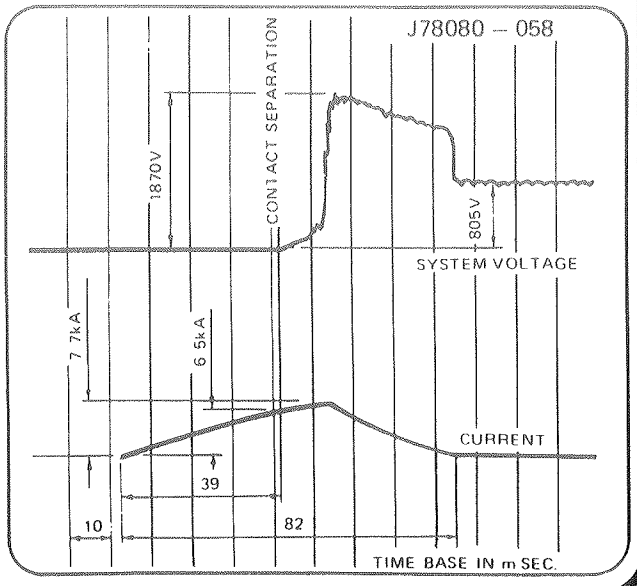
Ratings

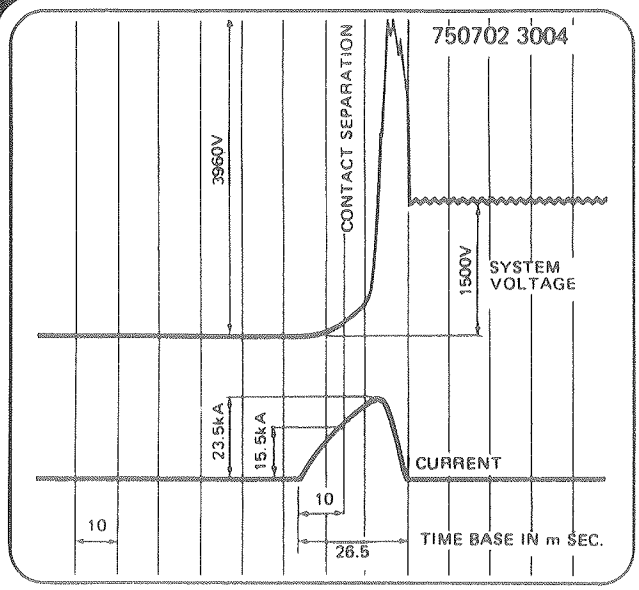
Voltage (Volts)	Normal Current (Amps)
300 & 800	2000,3000,4000,6000,8000,12000
1600	2000,3000,4000,6000
3200	2000,3000,4000

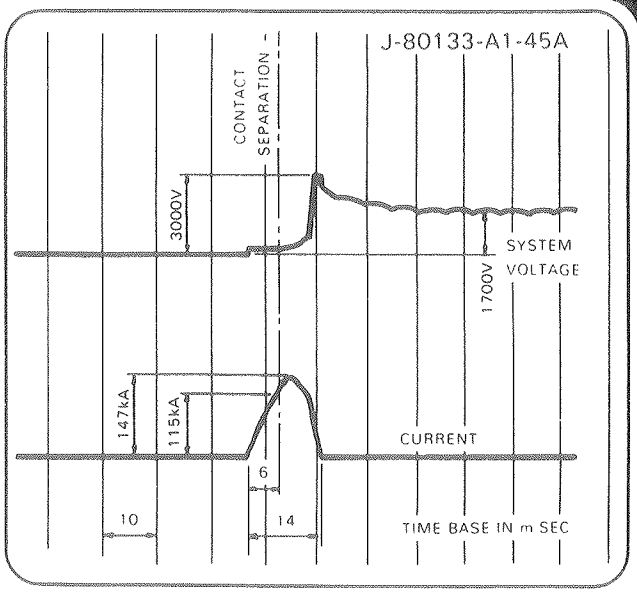


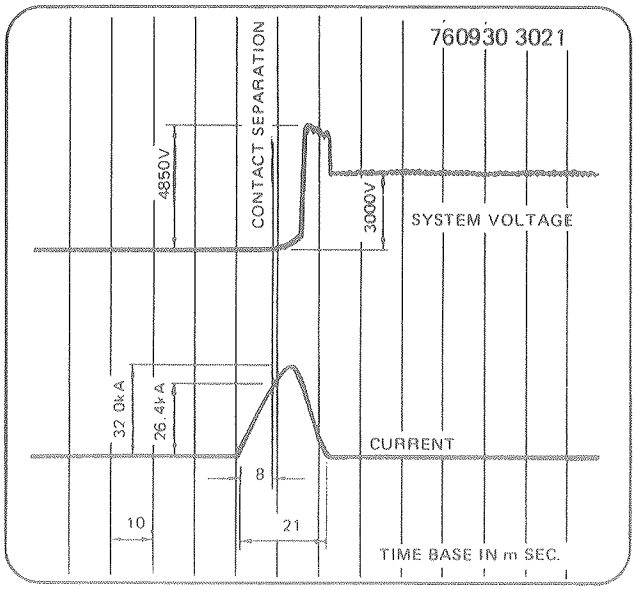












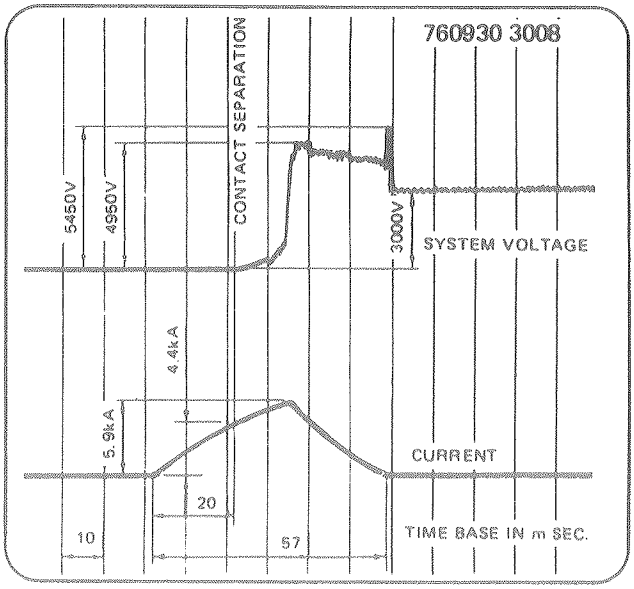


Table of Results

Test No.	System Volts	Prospective Current kA	Rate of Rise A/µ Secs.	Frame Size A	Overload Setting kA	Current at Contact Separation kA	Peak Current kA	Max. Arc Volts	Opening Time mSecs.	Total Break Time mSecs.
J80133-A2-35	800	255	41.4	6000	24	165	193	1625	5.8	19.8
J78080-046	800	80.4	1.4	6000	12	19.5	28	2125	14.5	37
J78080-058	800	19.1	0.214	2000	4	6.5	7.7	1870	39	82
750702 3004	1500	43	1.95	2000	4	15.5	23.5	3960	10	26.5
J80133 A1-45A	1700	158.2	27	4000	16	115	147	3000	6	14
760930 3021	3000	36	5.9	3000	4	26.4	32.0	4850	8	21
760930 3008	3000	9.25	0.3	3000	2	4.4	5.9	5450	20	57

Technical Data Sheet
Type MM74 HSCB.

Type Tests		
1.	Type No.	MM74
2a.	Rated normal current – single contact assembly.	2000A, 3000A, 4000A, 6000A.
2b.	Rated normal current – double contact assembly.	8000A, 12000A.
3.	Rated normal voltage.	300V, 800V, 1600V, 3200V.
4a.	Interrupting rating – 300V	50kA @ $di/dt = 6.6A/\mu$ sec.
4b.	Interrupting rating – 800V	19.1kA @ $di/dt = 0.21A/\mu$ sec. 80.4kA @ $di/dt = 1.4A/\mu$ sec. 255kA @ $di/dt = 41.4A/\mu$ sec.
4c.	Interrupting rating – 1600V	20kA @ $di/dt = 0.19A/\mu$ sec. 43kA @ $di/dt = 1.95A/\mu$ sec. 158.2kA @ $di/dt = 27.0A/\mu$ sec.
4d.	Interrupting rating – 3000V	9.3kA @ $di/dt = 0.3A/\mu$ sec. 36kA @ $di/dt = 5.9A/\mu$ sec.
5.	Momentary rating – 10 milliseconds	200kA
6.	Short time current rating 0.25 sec	2000/3000A–40.3kA peak 30kA Steady State. 4000A–75.4kA peak 55.1kA Steady State. 6000A–88.8kA peak 66.9kA Steady State. 8000A-140kA peak 108kA Steady State. 12000A-170kA peak 140kA Steady State.
7.	Air Puffer assisted currents	15-500A @ 0.03 sec Time Constant.
8.	Short circuit test certificates – 300V	KEMA 2172-77 Holland
	– 750V	KEMA 387-75 Holland
	– 1500V	KEMA 388-75 Holland
	– 3000V	KEMA 2495-76 Holland
	– 800V	Gould Inc J78080-A1 U.S.A.
	– 1600/800V	Gould-Brown Boveri J80133-A1/A2
	– 800/1600V	Brown Boveri Electric Inc J82125-A1/A2
9.	Field Tests	
	– 750V 10-50kA	British Rail (S.R.) Croydon.
	– 750V 7-12kA	British Rail (S.R.) Epsom.
	– 630V 10-40kA	London Transport Executive
	– 1500V 15A-6kA	Tyne & Wear PTE Test Track.
	– 1500V	Hong Kong MTRC.
	– 1500V	Sydney Railways, SRA.
	– 750V	British Rail (S.R.) Wimbledon.
	– 3000/4000V 50kA	South African Railways.
10.	Cubicle widths	500mm. 2000A 750V & 1500V 500mm. 3000A 750V & 1500V 500mm. 4000A 750V & 1500V 500mm. 6000A 750V 600mm. 6000A 1500V 600mm. 2000A–4000A 3000V 750mm. 8000A 750V & 1500V 750mm. 12000A 750V & 1500V

The above technical particulars are the standards available. However, deviations from these can sometimes be accommodated on request.

Cubicle Construction

The cubicle is of self-supporting, floor mounting, totally metal enclosed pattern, fabricated and formed from sheet steel of substantial section. The cubicles are integrally divided to provide individual metal enclosed compartments for the circuit breaker, busbar, cables and relay accommodation. (4 compartments).

The cubicle front door is of the hinged pattern, fitted with a car door type handle and glazed apertures for observation of the mechanical position indicators.

The bottom of the cubicle is provided with guide rails onto which the circuit breaker carriage is located.

The cubicles are recommended to be located on 'UNISTRUT' channels grouted into the floor and pre-positioned using specially designed removable jigs.

Busbar

The busbar is air insulated, made from hard drawn, high conductivity copper of unit lengths. It is mounted on insulated support-barriers which are firmly secured to the side of the cubicle. Any compatible size of busbar or rating can be provided.

Cables

Cubicles are normally supplied suitable for bottom entry cables. For top entry cables or bus duct a deeper rear cubicle is used to allow the cables/connections to pass behind the busbar chamber for termination in the circuit chamber.

The circuit chamber has ample provision for mounting shunts, transductors, etc.

When required, circuit chambers can be arranged so that cables can be installed without rear access.

Shutters

The primary disconnects are provided with two independently operated insulated shutters which are operated by the position of the circuit breaker in the cubicle.

On withdrawal of the circuit breaker the shutters can be individually padlocked closed.

Relay Accommodation

Relay panels can be mounted at the front and rear of the cubicle and varied to suit the equipment required. The doors of the panels are hinged and fitted with a dustproof seal.

Auxiliary Wiring

All secondary wiring is cleated and secured in metal wiring ducts located inside the circuit breaker compartment. The ducting runs from the secondary disconnects, mounted at the bottom rear of the circuit breaker compartment, to the front and rear relay chambers. Outlets to the busbar and circuit chambers are provided. Removable covers give access to the secondary wiring.

Circuit breaker carriage switches which operate when the carriage is in the Connected position can be provided when required.

Circuit Breaker General Description

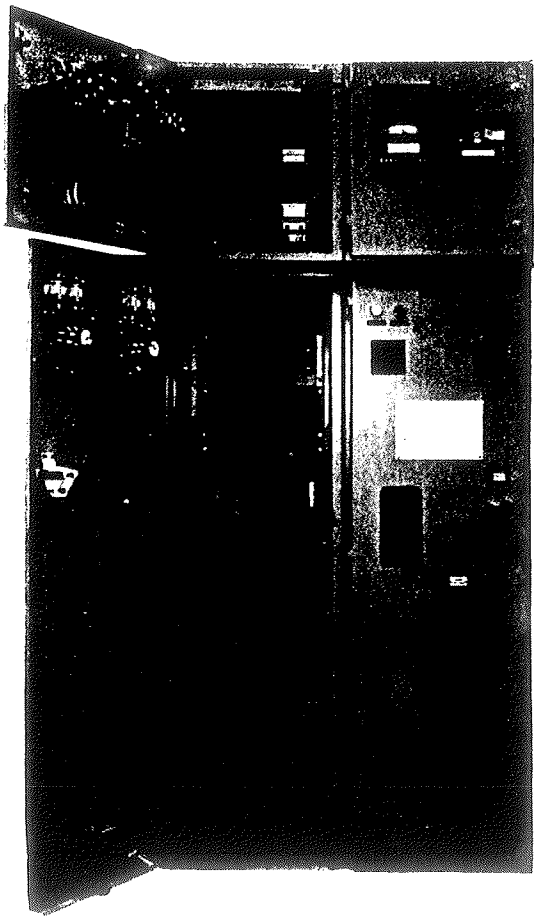
The type MM74 high-speed circuit breaker is electrically operated with a mechanical latch-in feature.

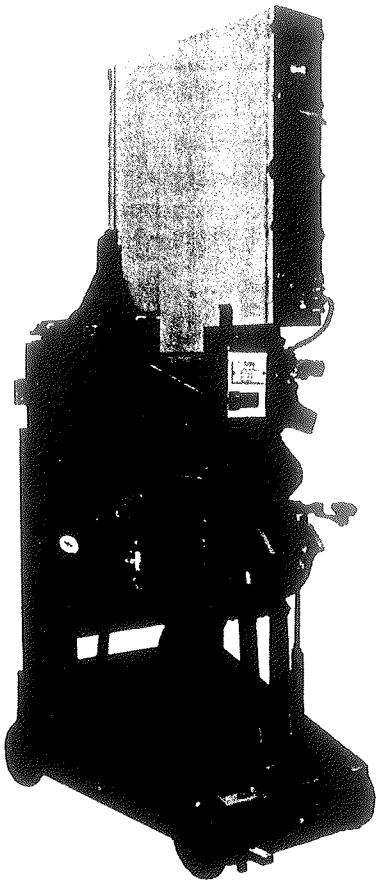
The latch mechanism is so designed that it is entirely independent of the closing mechanism and, although it is robust enough to preclude any possibility of mechanical failure, its response to the tripping devices is virtually instantaneous.

The successful use of the latch has been made possible by the adaption of a two-stage method of closing the circuit breaker. During the first stage the front contact is moved into position and the latch set. The second stage of operation results in the closing mechanism being retracted and the rear contact moving to the closed position. Stage two is achieved by the action of powerful springs.

As the circuit breaker is mechanically latched and does not depend upon any electromagnetic device for holding, it will be seen that the springs serve a dual purpose, in so much that they provide ample contact pressure, and ensure rapid acceleration of the moving contact when the circuit breaker trips on fault.

The circuit breaker is free to trip the instant the latch is set and cannot be closed and held closed against overload conditions.





Closing Mechanism

The closing mechanism comprises a D.C. solenoid actuating the main contacts through a toggle linkage. A magnetic brake, embodied in the solenoid, ensures freedom from excessive mechanical shock even with abnormally high voltages.

Manual closing is effected by a removable handle which drives the toggle linkage of the solenoid.

Tripping

Tripping is achieved by the action of an electromagnetic trip device acting on the trip latch, either directly or through a secondary trip shaft. The following types of trip device are available:-

A 1. Bi-directional overload
A 2. Uni-directional overload
A 3. Falling voltage overload
A 4. Uni-directional reverse
B 5. Shunt trip release
B 6. Undervoltage release
C 7. Impulse trip release.

Overload calibrations are normally set at 100% to 400% of rated current and reverses have a fixed 50% setting. Other ranges can be examined.

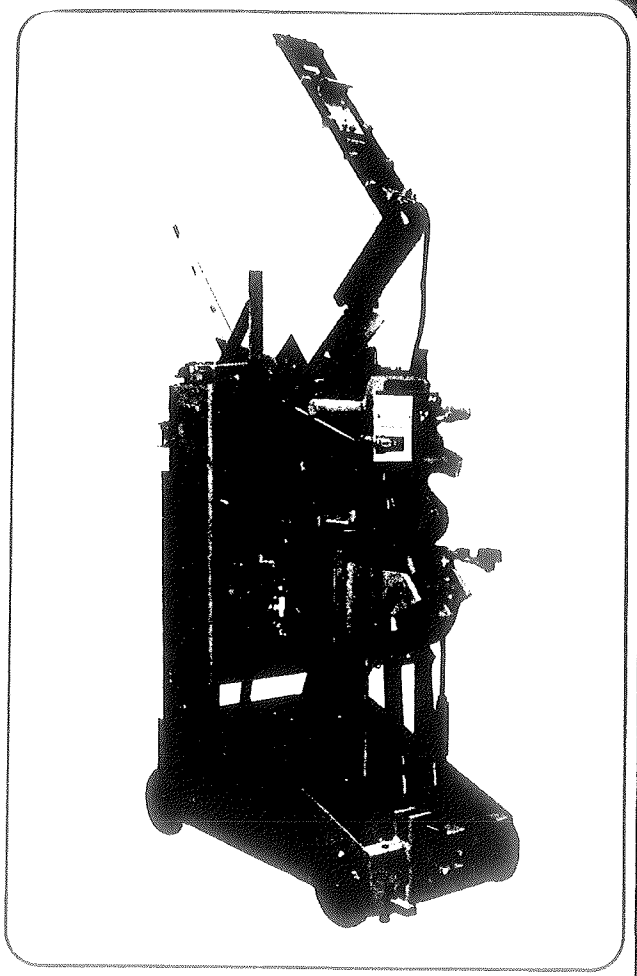
Any one of A, B and C trip devices can be fitted as required.

A manual trip button is provided on the circuit breaker and also on the front door of the cubicle.

Contacts & Arc Chute

The combined main and arcing contacts are of the butt type faced with silver tungsten. These are situated inside the arc chute such that the arc is initiated inside the iron circuit. The "blow-off" feature of the contacts inherently drives the arc up into the arc chute.

Arc extinction is achieved by the specially designed removable arc chute of the cold cathode steel splitter plate type. The series of specially shaped metal plates produce a magnetic field inside the arc chute, which is excited by the arc itself, thus eliminating the need for series or shunt coils and external iron circuits. Arc control is initiated by the specially designed contacts which ensure rapid transfer to the runner system within the magnetic field.



This effectively drives the arc into the final arc extinction region of the arc chute.

Exhaust gases are vented into an insulated chamber supported by the circuit breaker cubicle above the arc chute. The de-ionised gases then exhaust through side vents in the insulated chamber.

An air puffer is fitted to assist with interruption of the low currents.

Circuit Breaker Carriage

The panel mounted High Speed Circuit Breaker is mounted on a substantial steel carriage with accommodation for various ancillary equipment which includes:

1. Secondary disconnect contacts
2. Closing coil contactor and antipumping relay.
3. Interlocks both electrical & mechanical
4. Isolating mechanism.

Isolation

The mechanism for isolating the circuit breaker from the busbar is fully interlocked mechanically to prevent inadvertent operation. Isolation is effected by connecting a detachable handle onto the isolating mechanism shaft of the circuit breaker carriage.

The circuit breaker has to be tripped and locked off by the trip button on the front door before the isolating handle can be inserted through the appropriate aperture.

The circuit breaker carriage has 3 locations designated:

CONNECTED
TEST
DISCONNECTED

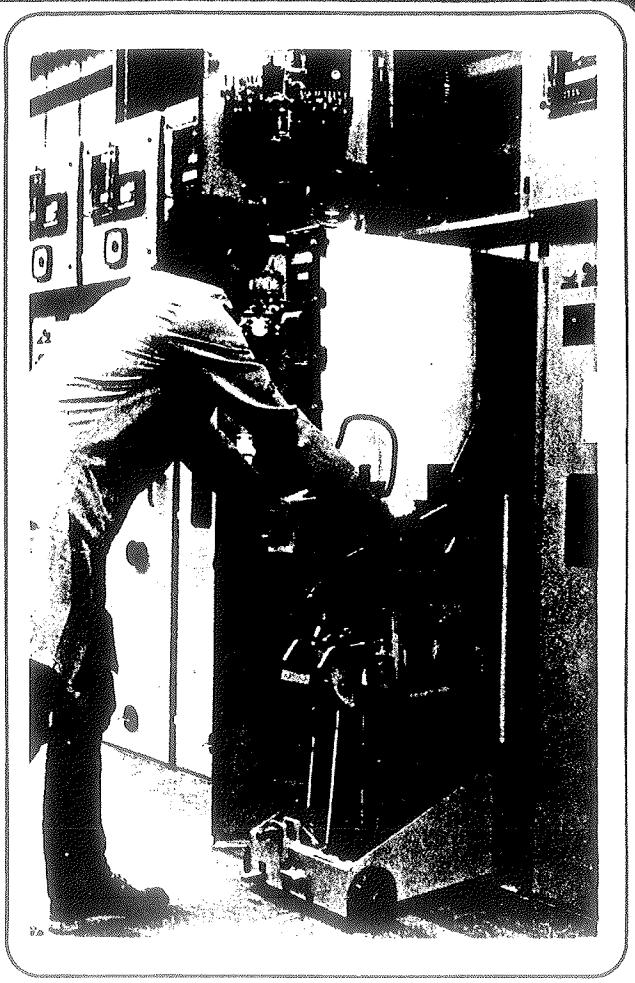
In the Connected location, the primary and secondary circuits are engaged.

In the Test location, the primaries are disconnected but the secondaries or selected secondaries remain engaged. The cubicle front door is still interlocked closed.

In the Disconnected location, both primary and secondary circuits are disconnected.

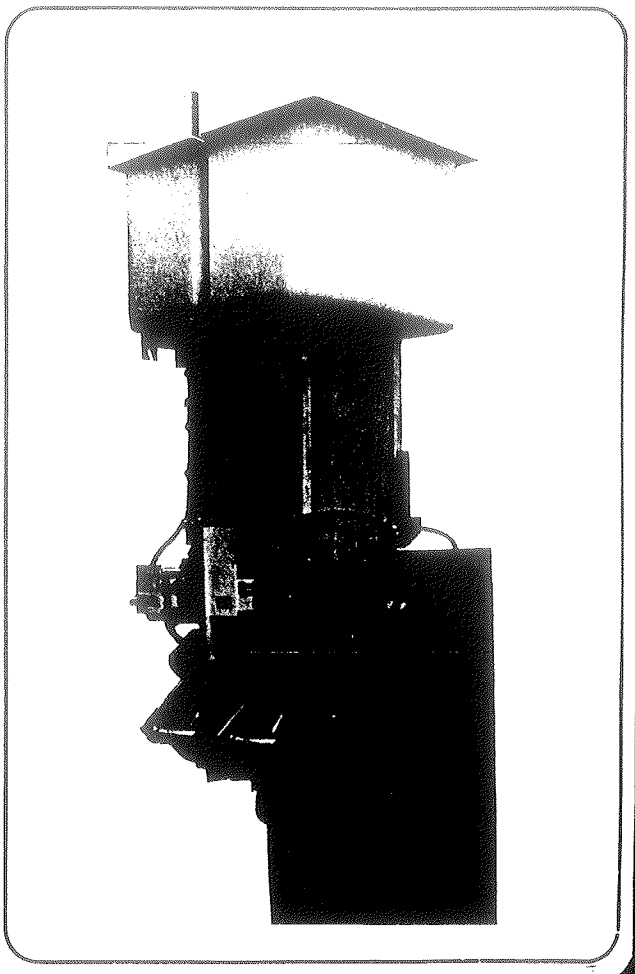
The circuit breaker can be wound to the required location as indicated on the label mounted on the cubicle front door. When the circuit breaker is in the Disconnected location the isolating mechanism disengages with the associated nut within the cubicle and the cubicle front door can be opened.

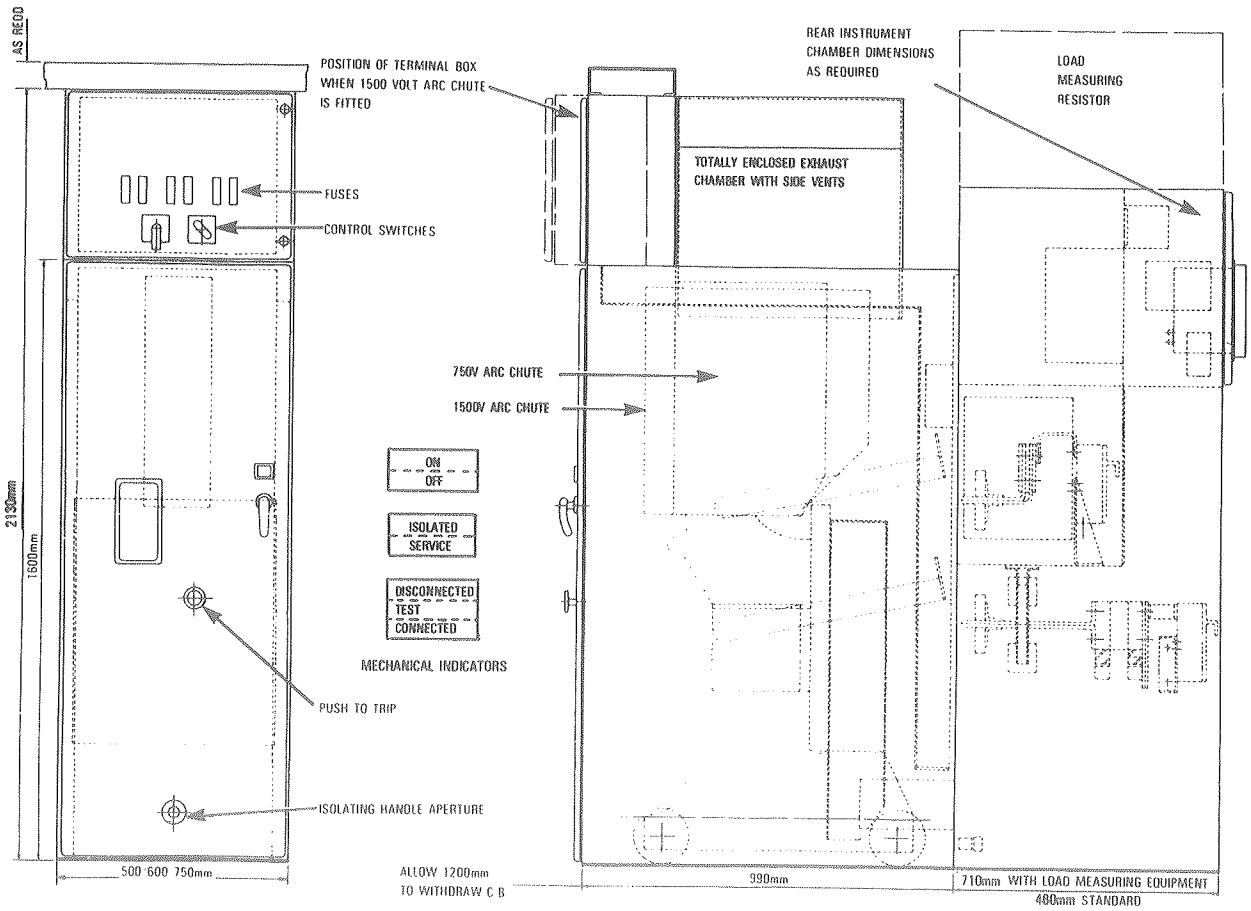
The circuit breaker can now be withdrawn from the cubicle.



Panel Mounted Circuit Breakers

The MM74 High Speed Circuit Breaker together with the ancillary equipment including auxiliary switches, on/off indicator, operation counter, etc., can be mounted on an insulated panel to form 'Flatback' switchboards. The Circuit Breaker can also be supplied in a pedestal mounted form.





FRONT VIEW

SIDE VIEW

ASSIGNED SHORT CIRCUIT RATINGS		
FRAME SIZE	VOLTAGE	SHORT CIRCUIT CURRENT
2000/3000A	800V	200kA
4000A upwards	800V	250kA
2000/3000A	1600V	125kA
4000A upwards	1600V	150kA
2000A upwards	3200V	50kA

Whipp & Bourne Limited

An FKI Company.
Switchgear Works, Castleton,
Rochdale OL11 2SS, ENGLAND.
Tel No (0706) 32051
Telex No 63442 (WHIPPS G)
Fax No (Groups 2/3) (0706) 345896

FKI plc

Whipp & Bourne Inc.

An FKI Company.
7260 Langtry Houston,
Texas 77040 U.S.A.
Tel No (713) 460 0004/5
Telex 251955 WHIPP UR
Fax No (713) 690 3504

The introduction of improvements from time to time
may result in products being supplied differing slightly from those described and illustrated in this publication
Certified drawings will be supplied on request.

THE ENGLISH ELECTRIC CORPORATION

4 SKYLINE DRIVE, HAWTHORNE, N.Y. 10532-2120 • TLX 4750323 • FAX (914) 347-5432 (914) 347-5508

General Management
(914) 347-5155

GEC Measurements
(914) 347-5166

Transportation/Energy
(914) 347-5177

Misc. Products
(914) 347-5188

January 2, 1991

Fermi National Accelerator
Post Office Box 500
Batavia, IL 60510

Att.: Mr. Craig Drennan
Mail Station 219

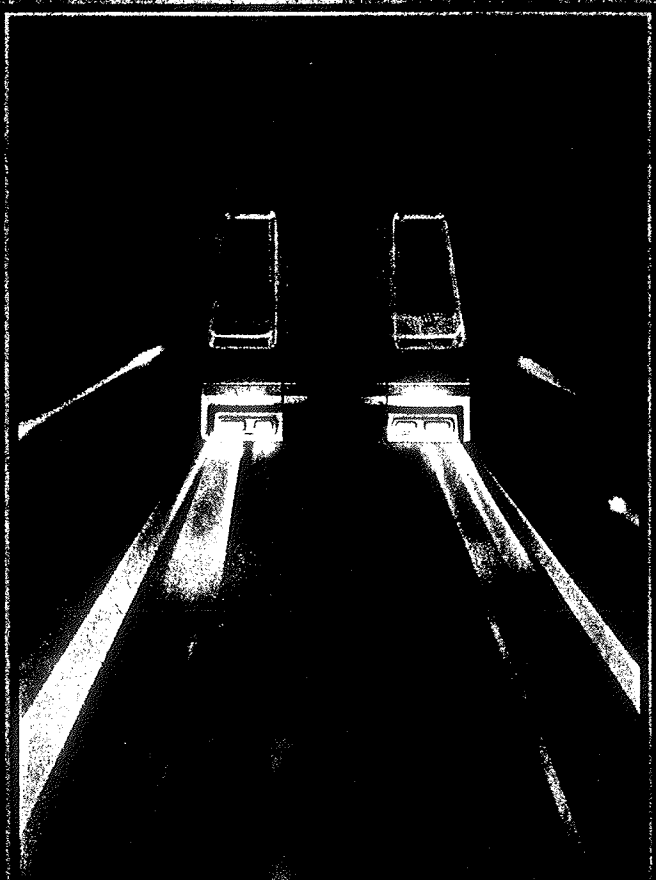
Dear Mr. Drennan,

Per your request I am enclosing descriptive literature on DC Switchgear products GEC-ALSTHOM offers here in the US.

Please review the attached and advise if you have any questions or need additional information.

Very truly yours,

Andrew N. Alexiades
Manager of Projects
Power Division



HSNP

[illegible] Speed Sw[illegible]

For DC Appli[illegible]

[illegible] Reliability [illegible]

[illegible] ANSI B[illegible]

[illegible] 12000A and [illegible]

G&C

TRANS[illegible]ION AND DISTRIBUTION [illegible] LIMITE[illegible]

KEEPING THE WORLD ON THE RIGHT TRACKS

There's one Great British company that still keeps the flag flying in every corner of the earth. It's Britain's No.1 and one of the world's largest electrical and electronic firms, employing 190,000 people world-wide, with annual sales of five billion dollars. It's called GEC.

But the secret behind the group's success lies in the specialist skills of its member companies, not least the companies within the GEC Power Engineering Group.

GEC's Transportation Power Supplies Division has enjoyed more than its fair share of success. Trains on inter-city and rapid transit systems all over the world roll safely and smoothly on their way, carrying people and freight to where they're most needed - in the third world, and the Antipodes, and in the West - thanks in no small part to GEC.

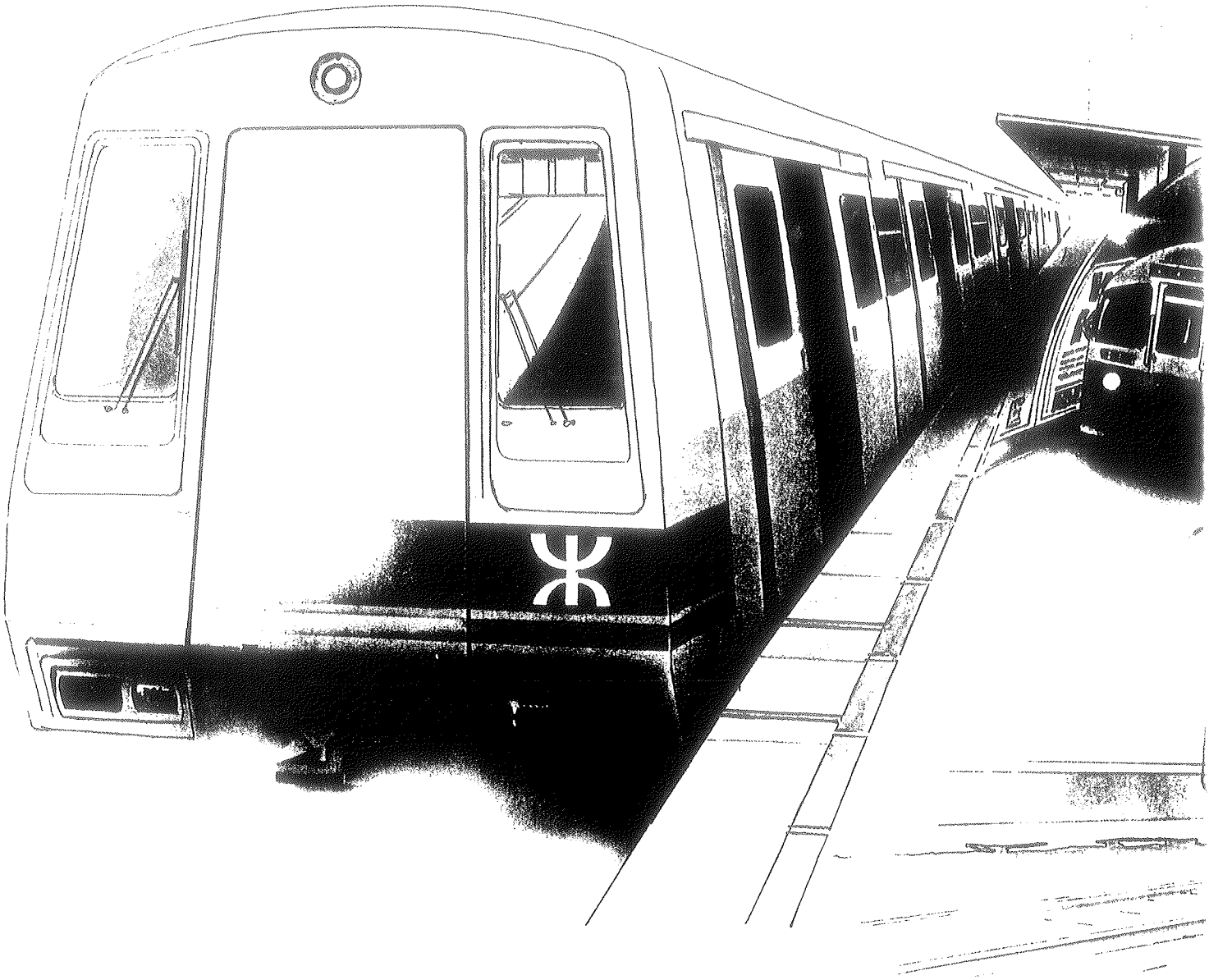
For over 70 years the Company has specialised in the design, development and application of d.c. traction switchgear, supplying vast quantities of high-speed air circuit breakers to railroads and rapid-transit authorities throughout the world -from the London Underground to the Long Island Railroad.

GEC has supplied large numbers of breakers for steel mills, electro-chemical plants, mine winders and continues to strive daily to improve the efficiency and safety of the world's railways.

Now, to meet International demands for increasing speed of operation, high current carrying and interrupting capability GEC Tranportation Power Supplies Division introduce their improved HSNP breaker.

The HSN Switchgear was introduced by Bertram Thomas in 1968. Further improvements incorporating the very latest design and manufacturing techniques, have led to the development of the new HSNP switchgear, which, together with its predecessor is already backed by 7,500 breaker years of satisfactory service.

Once again GEC have come up with a way to keep the world on the right tracks.



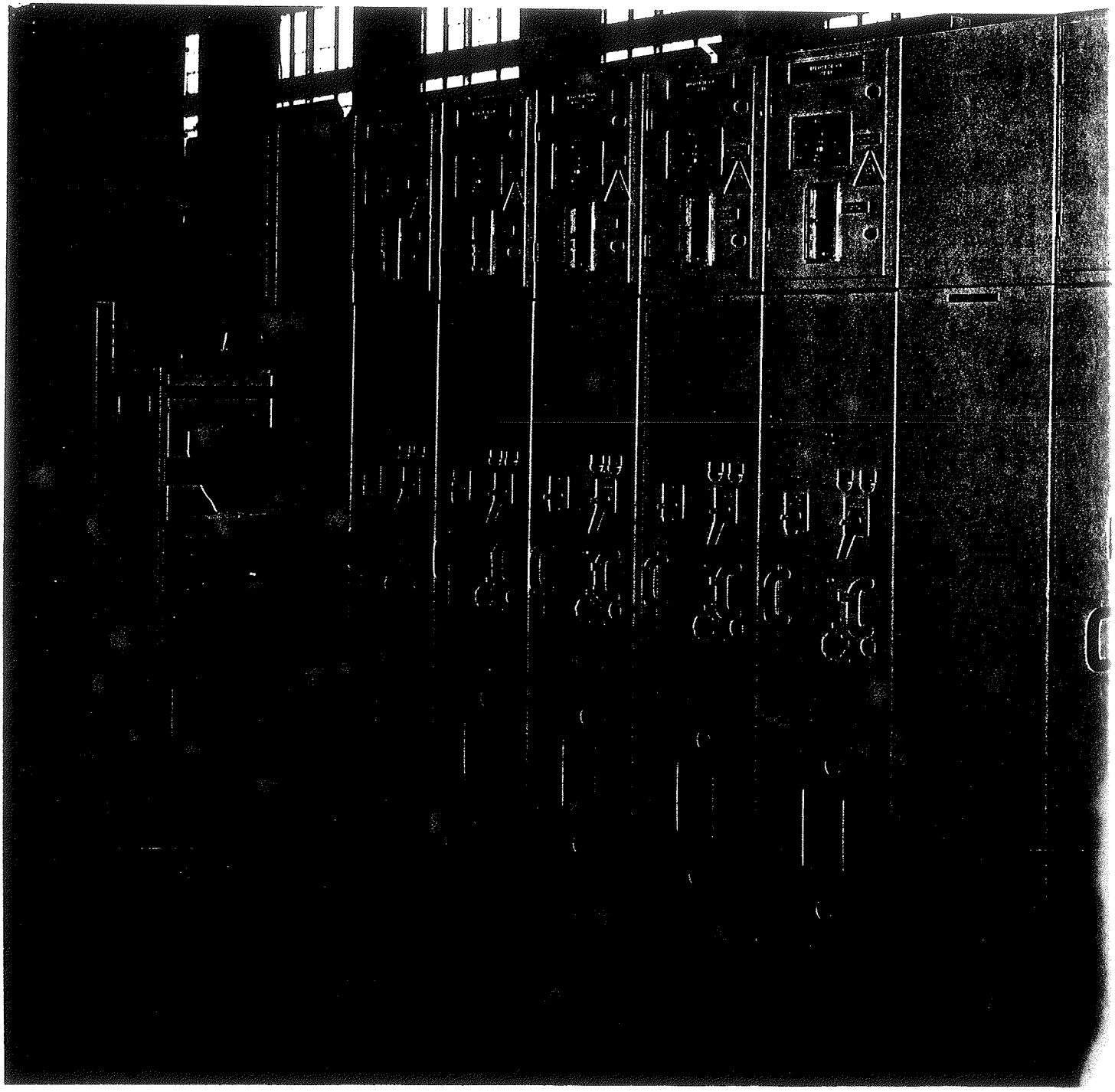
AVAILABILITY BY RATING

Breaker mounted on truck

ON TRUCK	VOLTS	NORMAL CURRENT kA				
Free Standing or in Switchboard Housing	800	4	6	8	10	12
	1200	4	6	8	10	12
	1600	4	6	8	10	12
UNIT WIDTH mm		457		610		

BUSBAR RATINGS	Up to 12,000 Amps
TESTED FAULT RATINGS	800V-200kA peak. 120kA sustained 1600V-100kA peak. 60kA sustained Associated ratings with corresponding circuit time constants.

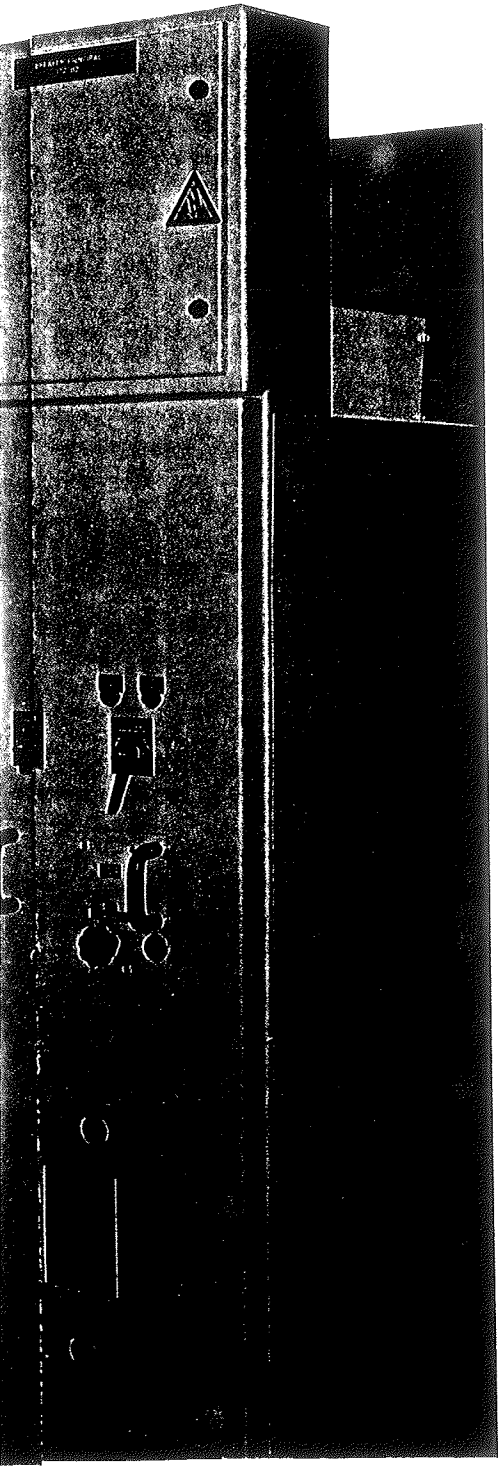
Fig 1. Switchboard with Open Top



AN OPEN AND CLOSED CASE

Switchboard Enclosure

All HSNP switchboards are metal enclosed and assembled on the unit principle. Each unit accommodates a horizontally isolated breaker, busbars, main and multicore cable terminations, together with control indication and protection equipment as required. Two forms of Enclosure are available:



Closed Top

For 800V breakers fitted with either magnetic blow out or steel plate arc chutes. For 1600V breakers fitted with steel plate arc chute.

Open Top

For all 800V and 1600V applications.

Type Tests

Type Tests have been carried out with breakers in both forms of unit, and also with free standing breakers.

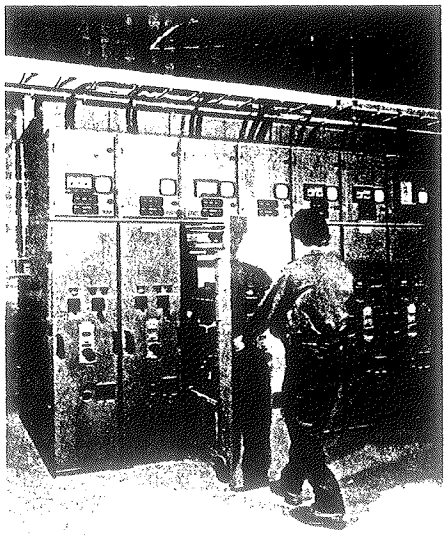


Fig 2. Switchboard with Closed Top

HIGH CONDUCTIVITY AND SPACE SAVING

Busbars

Busbars for ratings up to 12,000A are of high conductivity copper. Joints in the busbar run are positioned to suit splits in the switchboard for shipping purposes, and for easy access to buildings.

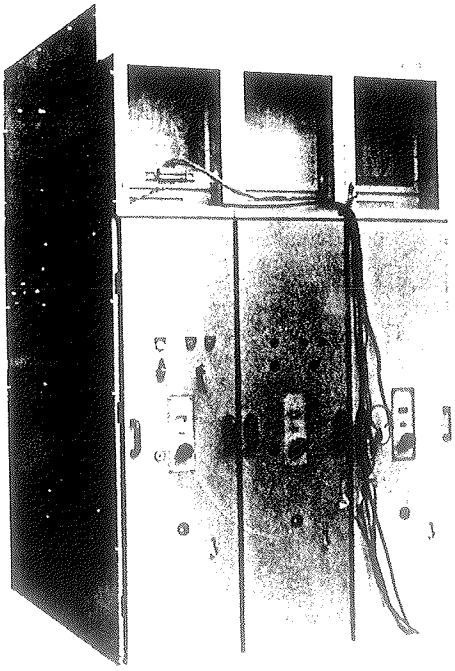


Fig 3. Circuit Breakers under test in Closed Top Housings

ROOM IN THE BACK

Primary Circuit Equipment

Adequate accommodation is provided in the rear cubicle of the unit for measuring equipment, e.g. shunts, transductors and fuses.

Cables

MAIN CABLES may enter from above or below the unit, and are terminated in the rear cubicle. Cable accommodation can be arranged to suit your requirements, and when necessary, a unit or breaker may be connected by copper bus instead of cable. MULTICORE CABLES are normally terminated in the panel at the front of the unit.

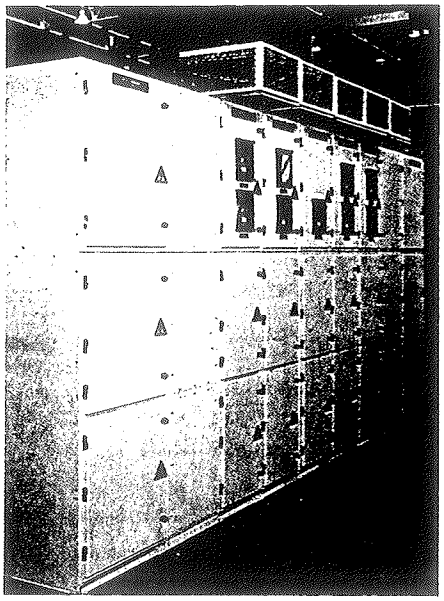
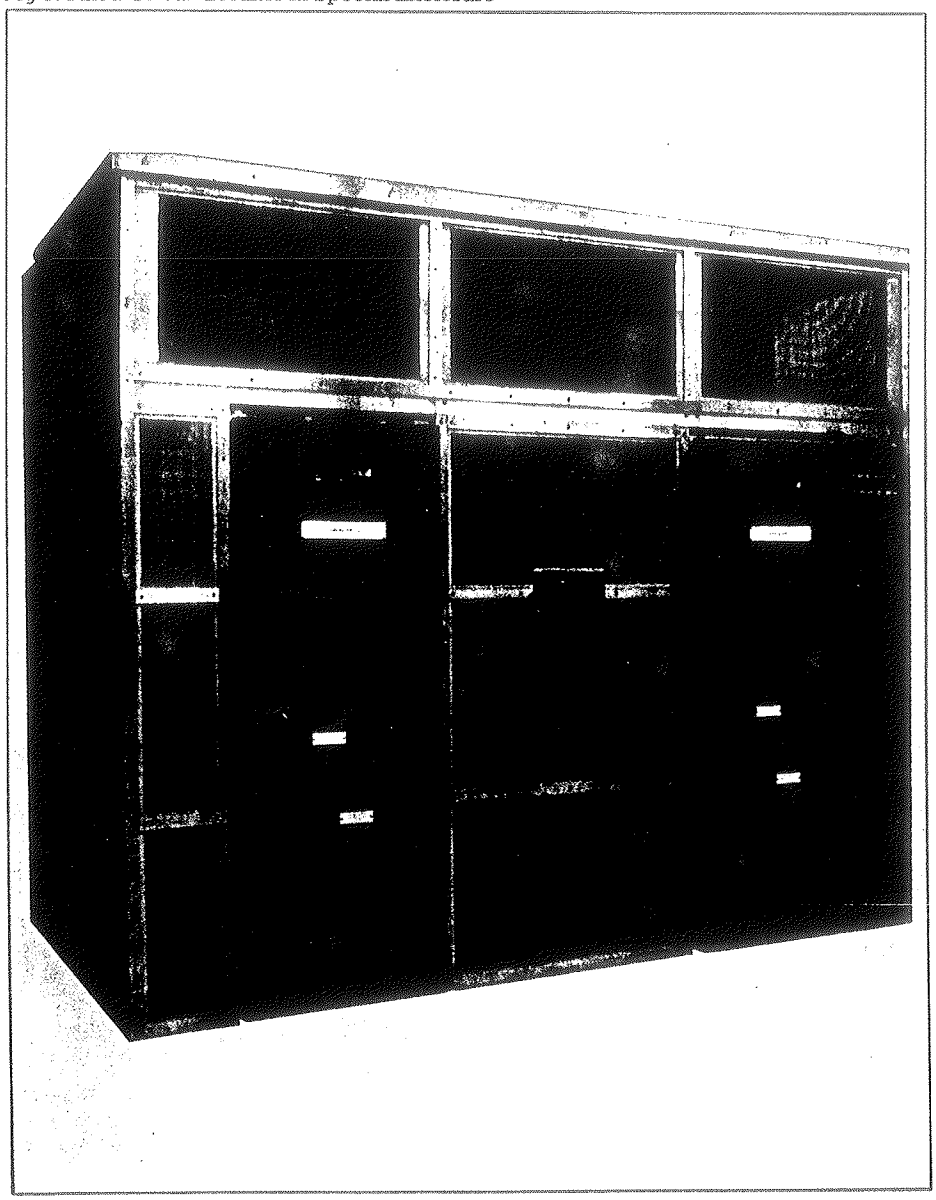


Fig 4. View of rear cubicle

Fig 5. Fixed Circuit Breaker in Special Enclosure



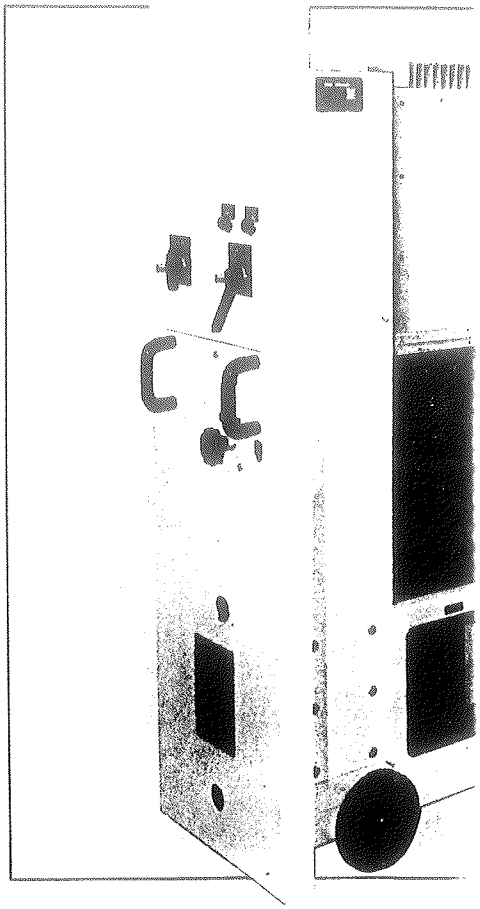
MAKING A CLEAN BREAK

The Circuit Breaker

The HSNP breaker is mounted on a wheeled truck with a castor for manoeuvrability together with controls to close and trip the circuit breaker. It can be used in a switchboard or bolted to the floor in a fixed arrangement (see Fig. 5)
The breaker is equipped with a trip-free closing mechanism operated by a low power solenoid suitable for battery, rectified a.c. or main power supply. A time delayed cut-off switch protects the solenoid coil and ensures full latching on a closing operation.
Several tripping options are available with settings in line with ANSI, IEC and BS specifications:

1. Overload trip - Direct acting, instantaneous and bi-directional
2. Reverse trip - Direct acting, instantaneous
3. Polarised Trip - Direct acting
4. Shunt trip
5. Undervoltage release
6. High speed trip-Impulse/Capacitor discharge device.

Fig 6. Breal
Steel Plate



MOBILITY FOR TESTING AND MAINTENANCE

The moving main contact system consists of several spaced lightweight alloy blades with silver contact tips which connect with spring loaded fixed contacts. The two centre moving blades are extended with a replaceable silver-cadmium oxide tipped arcing contact plate. This contact makes before and breaks after the main contacts, and carries the arc until it is transferred to arc runners in an arc chute.
The traditional arc chute achieves rapid arc transfer using magnetic flux from substantial blow-out coils continuously energised and mounted adjacent to the contact system. An alternative arc chute is available in which the arc is cooled and extended by being drawn upwards magnetically through a stack of steel splitter plates. Both forms of arc control device provide rapid interruption of all values of current within the rating.

Truck Mounting - Positioning and Location

Positioning

There are two operational positions within the unit:
1. Isolated/Test
2. Service.

The Isolated/Test position is reached by wheeling the truck manually into place. An integral screw racking device must then be used to move into the SERVICE position and engage the isolating contacts in a controlled manner.

Location

At the above positions the truck is easily located by means of a substantial bolt which ensures that the breaker can only be closed when it is positively located and interlocked in either position.

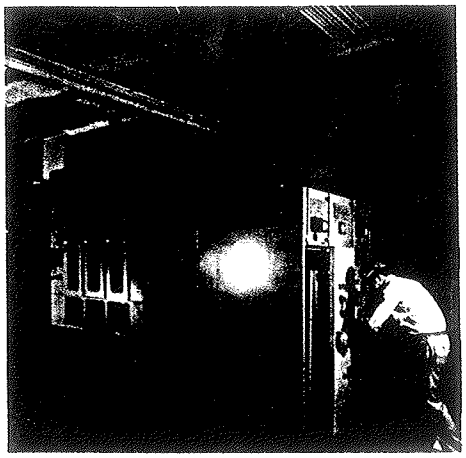


Fig 8. D.C. Switchgear and Rectifier Installation

Primary and Secondary Isolating Contacts

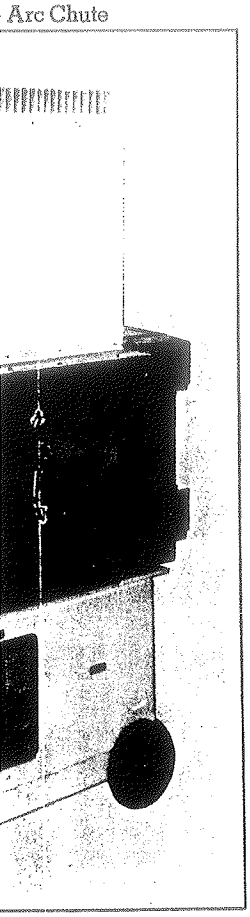
The primary isolating contacts are of the high pressure, multi-finger, self-aligning pattern.
Up to 36 secondary isolating contacts may be fitted and normally remain connected in the SERVICE and ISOLATED/TEST locations.

Maintenance Facilities

The arc chute and blowout coil system (when fitted) are readily moved to facilitate contact inspection and replacement.

The front panel on the truck is hinged to provide access to auxiliary switches, closing contactor and mechanism. Access is possible only when the truck is withdrawn from the SERVICE position.

aker with
Arc Chute



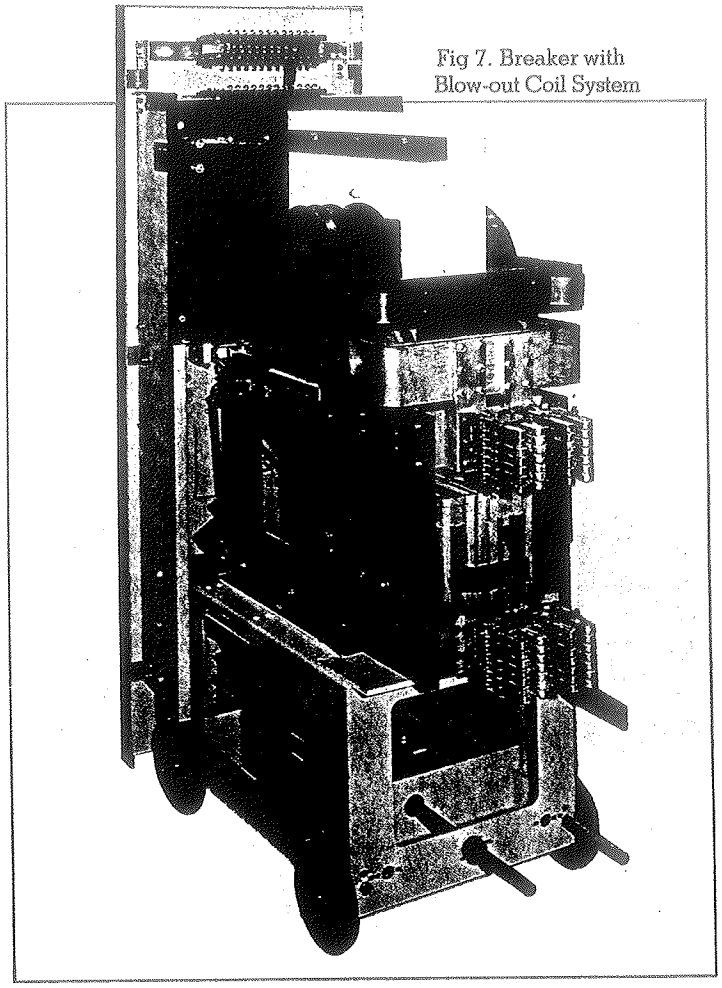
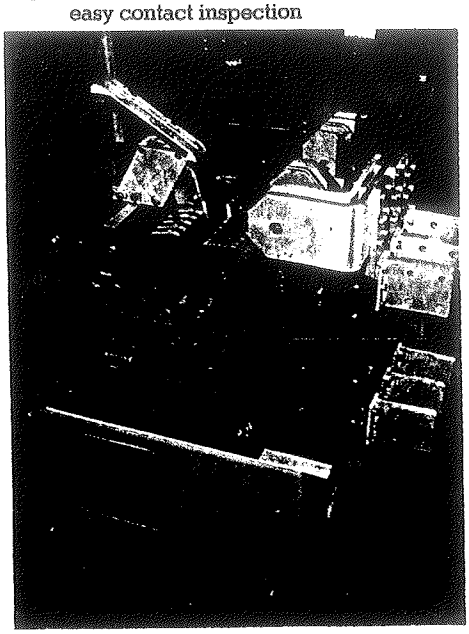


Fig 7. Breaker with Blow-out Coil System

Fig 9. Arc Control Device removed for easy contact inspection



MAXIMUM SAFETY

Safety Shutters and Interlocks

Shutters

Busbar and Circuit orifices are provided with shutters which operate automatically on the insertion or withdrawal of a circuit breaker.
For maximum safety, the shutters can only be padlocked in the closed position.

Interlocks

In order to protect both equipment and operator from the dangers of maloperation, each unit and breaker is provided with a system of mechanical interlocks which prevents:-

1. The circuit breaker being plugged in or isolated unless the main contacts are open and prevented from closing.
2. The breaker being closed unless it is in the SERVICE or ISOLATED/TEST positions, or when fully withdrawn.
3. The breaker causing damage to shutters which are padlocked closed (a stop restricts the travel of the truck within its unit).

An optional interlock is available to prevent a breaker of incorrect rating or function being engaged in a unit. Padlocking points can also be provided to prevent unauthorised operation.

CIRCUIT BREAKER RATING AND

GEC-HSNP breakers have been tested in both open and closed type housings and free standing, in accordance with ANSI, BS and IEC specifications:-

ANSI	C37-14:1979	BS 4752:1977	IEC 157:1976
	C37-16:1980	BS 5227:1975	IEC 298:1981
	C37-17:1972		
	C37-20:1974		

Short Circuit Rating and Performance to BS/IEC Requirements

800V - 120kA with 0.015 second time constant
1600V - 60kA with 0.015 second time constant

Short Circuit Rating and Performance to ANSI Requirements.

HSNP switchgear is designed to meet the full requirements of ANSI specifications C37-16: 1980 and C37-14: 1979. The graph below illustrates these requirements at 800 volts and also the compliance of the HSNP switchgear which exceeds the requirements of all known applications.

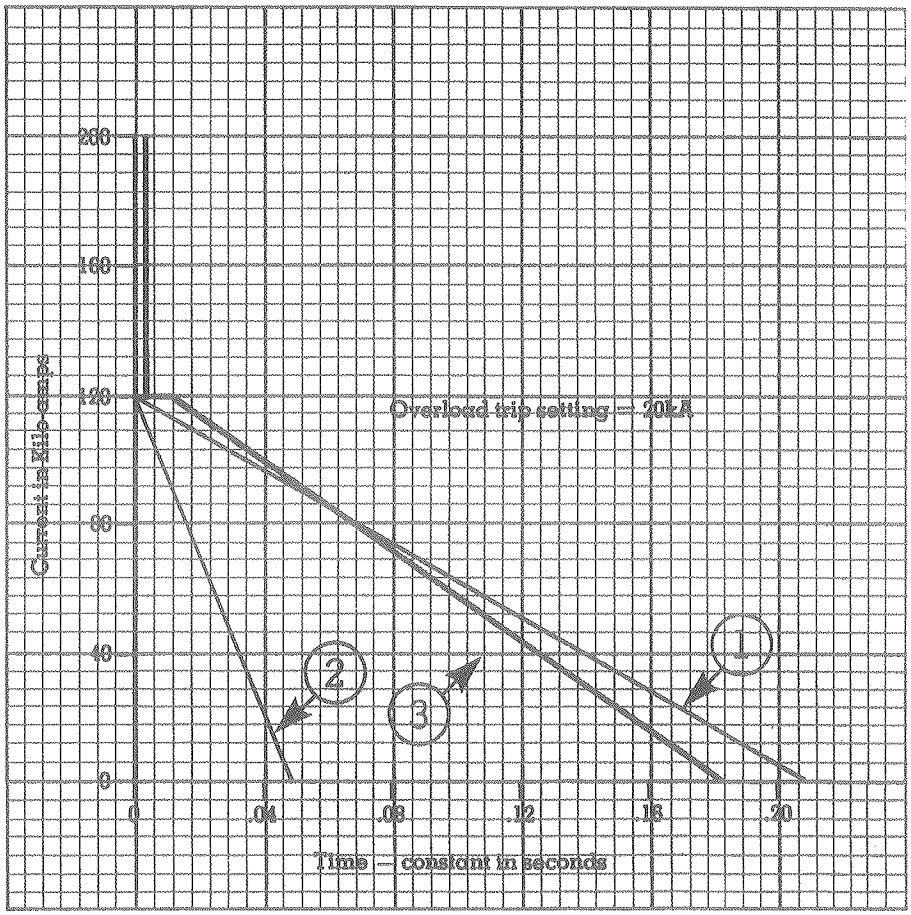


Fig 10.

Curve 1 - Requirements to table 12
Curve 2 - Requirements to table 12A
Curve 3 HSNP type tests

Type Tests carried out at 1600 volts exceed the requirements of ANSI C37-16:1980 table 12A. As applications having longer time constants develop, proving tests are being performed using the special equipment necessary.

PERFORMANCE

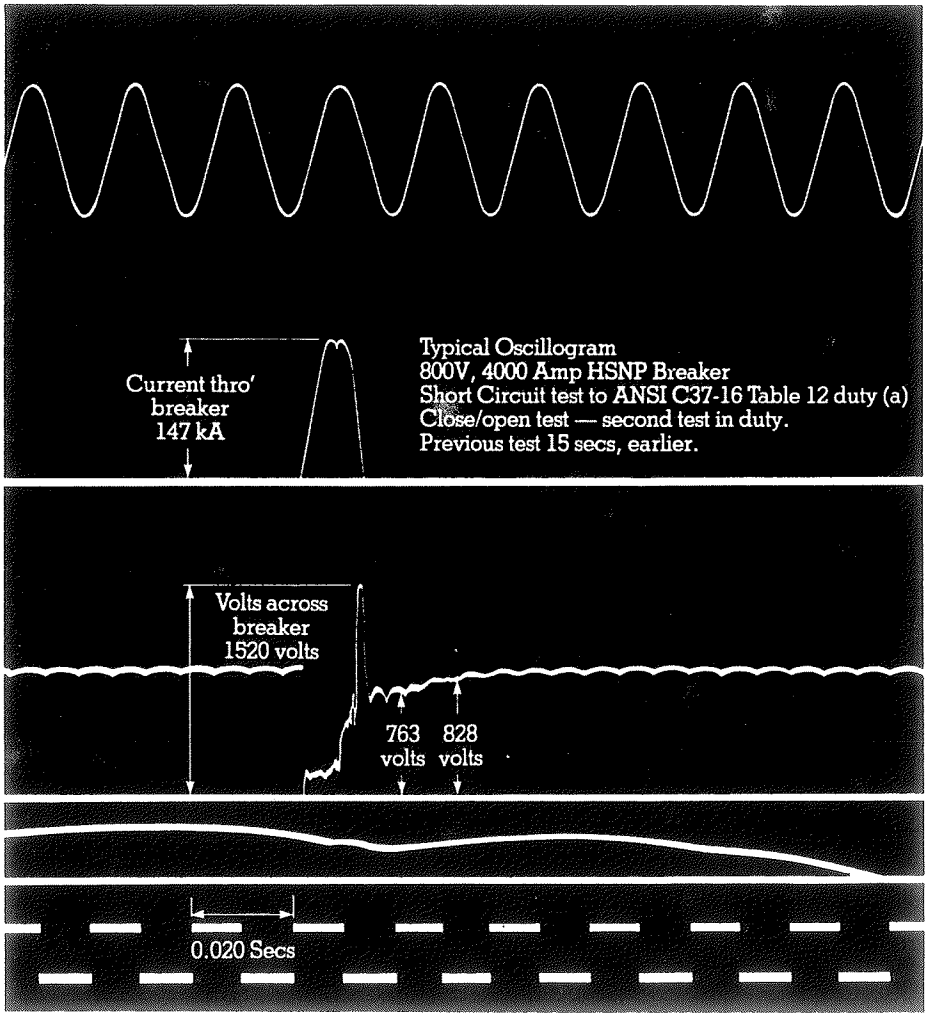


Fig 11.

ENDURANCE TESTS

A comprehensive series of tests for electrical and mechanical endurance has been performed, details of which can be provided on request.

Mechanical

All sizes have been proved to ANSI requirements of 1100 no-load operations. IEC and BS do not specify a number. The designed life of the breaker is 20,000 operations.

Electrical

HSNP breakers are proved to the latest ANSI requirements of number and rate of operation, current and time constant. The earlier ANSI, and the current BS and IEC requirements, are considerably less onerous.

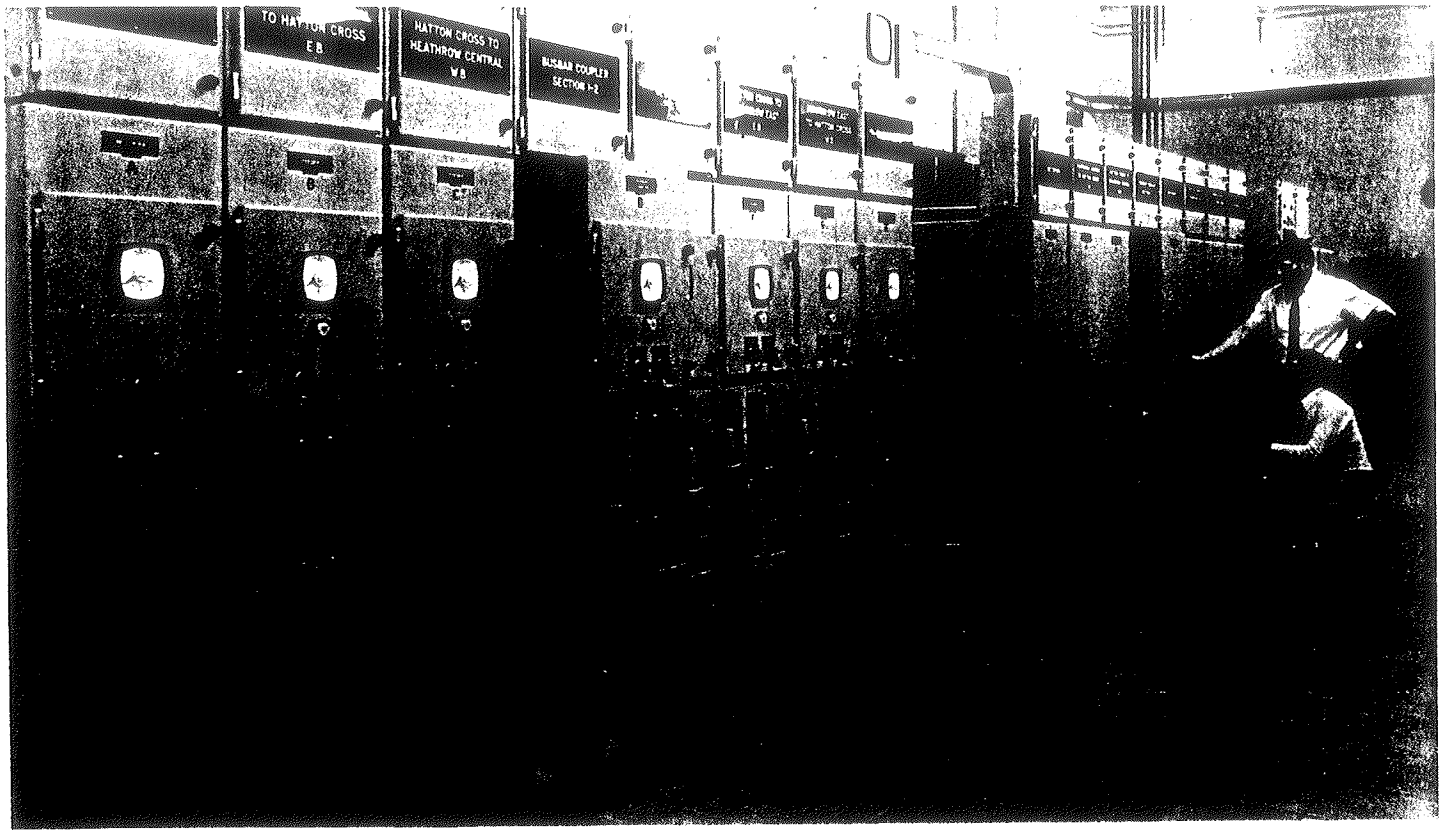


Fig 12.

INSTRUMENTS AND RELAYS

Ample accommodation is provided in two compartments, one is at the front of the housing above the circuit breaker and the other is in the upper part of the rear cubicle. Both compartments are fitted with hinged doors for ease of access to ancillary apparatus and connections. The doors are also used to carry instruments and relays when necessary.

Position Switches

Position Switches may be provided for the SERVICE position and the ISOLATED/TEST position of the circuit breaker truck. They are mounted on the unit housing.

Auxiliary Switches

There is ample provision for auxiliary switches which can be arranged to be either normally CLOSED or normally OPEN to suit requirements.

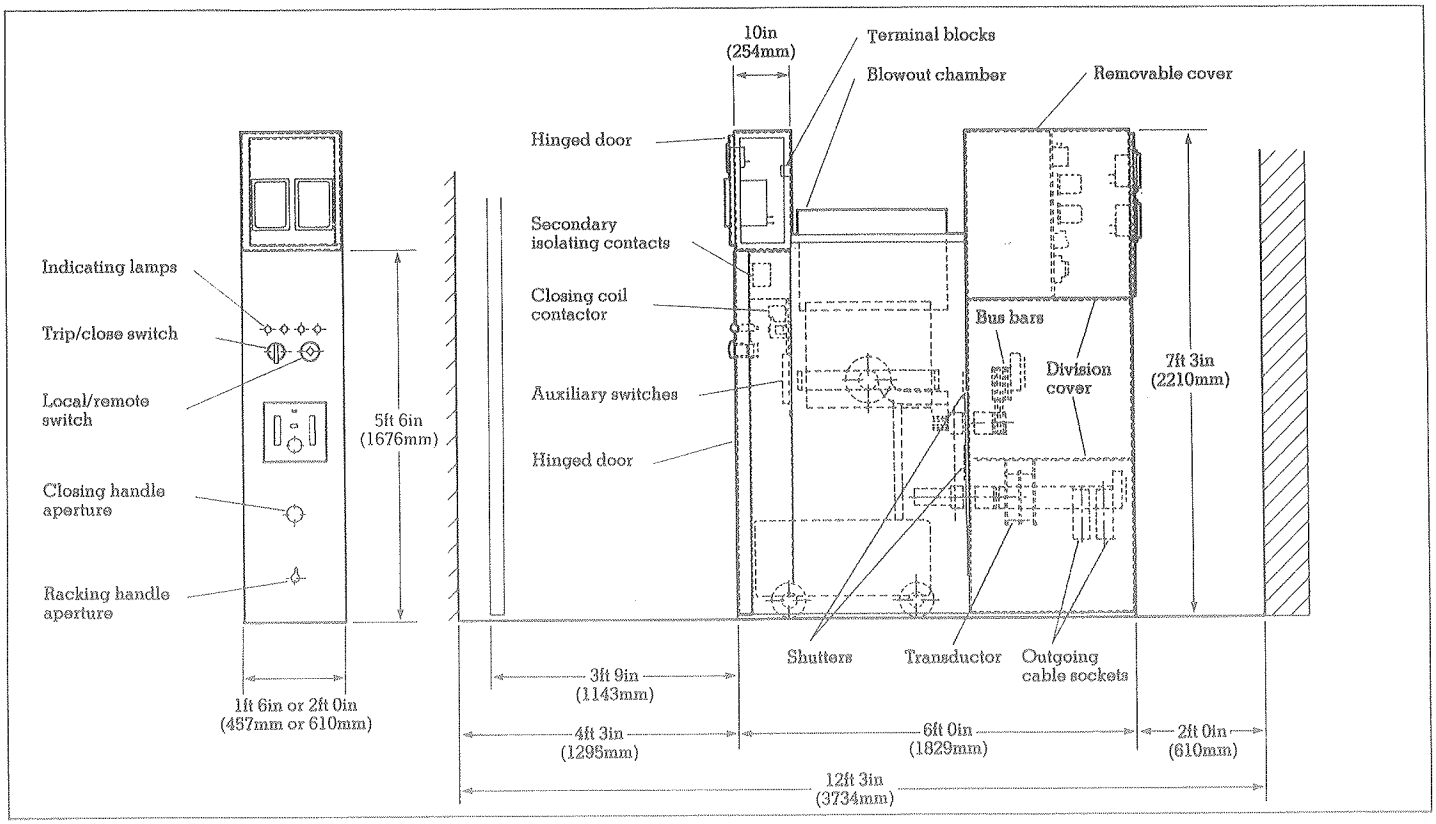


Fig 13. Unit with Open Top

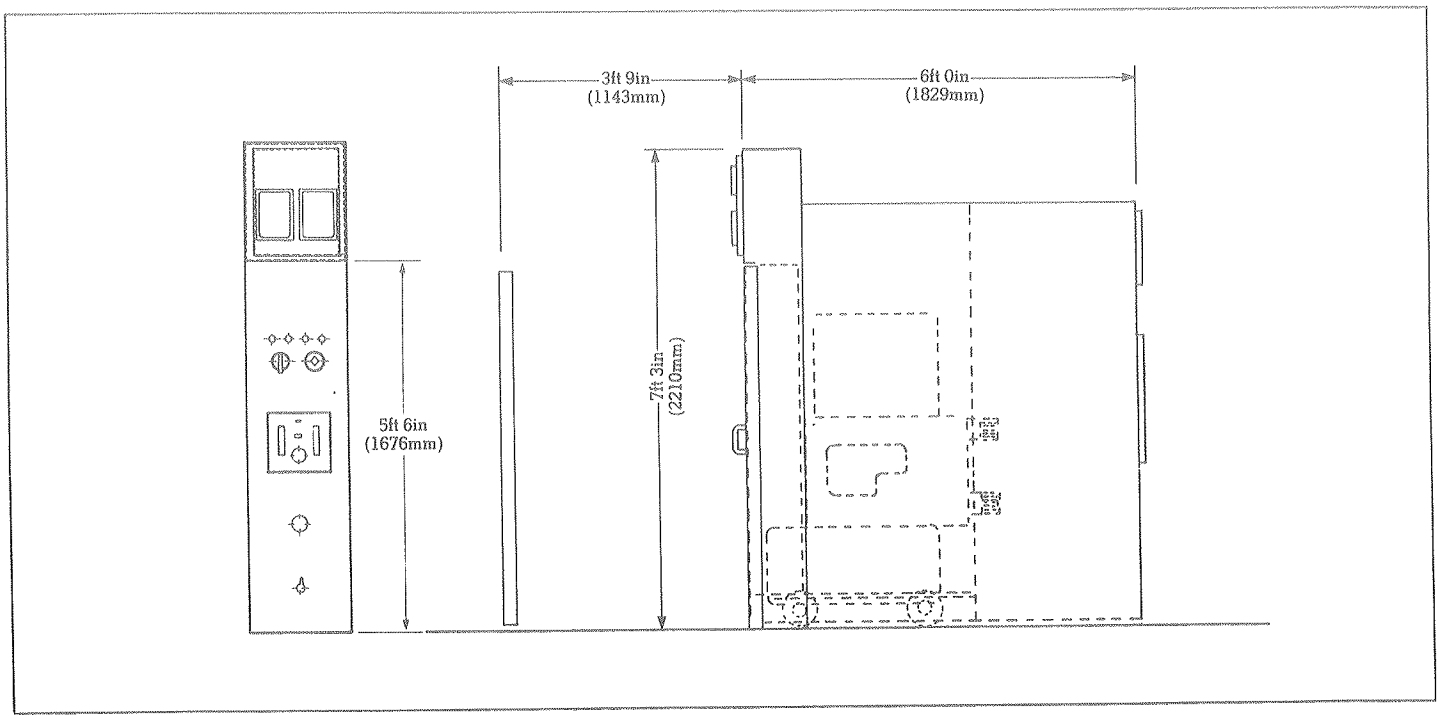
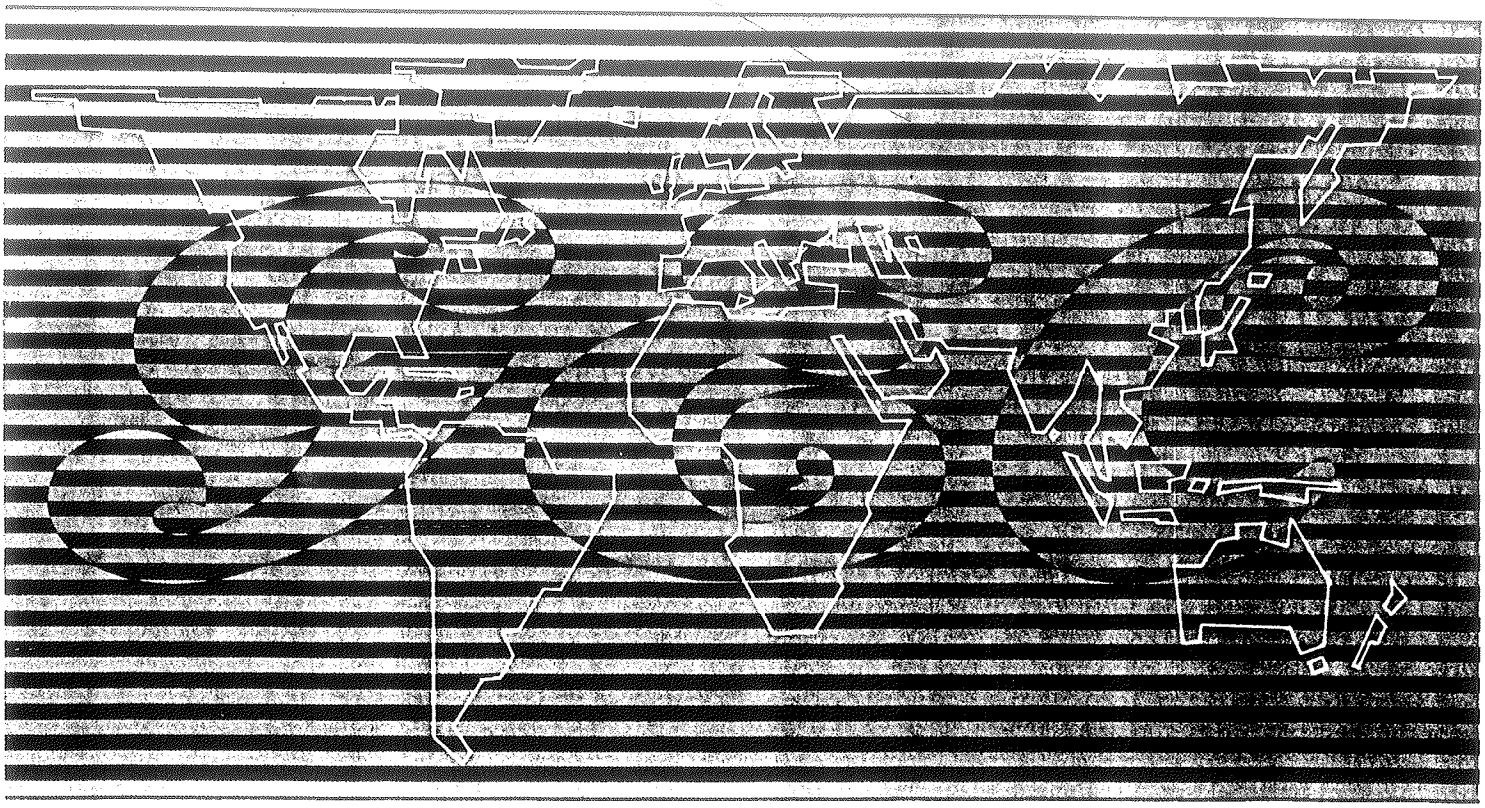


Fig 14. Unit with Closed Top (other details as fig. 13)

RELIABILITY IS THE KEYWORD

Below is a list of clients who repeatedly use GEC Switchgear because of its reliability.

Belgium	Antwerp Metro
Canada	Toronto Transit Commission
Hong Kong	Mass Transit Railway Corporation
Mexico	Mexico City
Portugal	Lisbon Metro
United Kingdom	Britsh Rail
United Kingdom	London Transport
USA	City of Cleveland and City of Shaker Heights
USA	Massachusetts Bay Transportation Authority, Boston
USA	Chicago Transit Authority
USA	Illinois Central Gulf Railroad
USA	Long Island Railroad
USA	New York City Transportation Authortiy
Venezuela	Caracas Metro