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MAGNETIC BLOW-OUT CIRCUIT BREAKER, TYPE RM 10M

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I. PREFACE

The demand for magnetic blow-out circuit breakers as breakers for circuits of 3 kv and 6 kv has been increasing in recent years. We have finally developed a magnetic blow-out circuit breaker, type RM 10 M, to fully meet users' demands.

Its structure and the results of the break test are described below.

The features of magnetic blow-out circuit breaker are :

(1) There are no oil-caused fire hazards and no oil filtration is required.
(2) The service life of the contacts is extremely long and their security is easy to maintain.
(3) The breaking capacity is not reduced by deterioration of the arc chute, which is constructed with arc-proof, heat-resistant porcelain and can be used semi-permanently.
(4) In contradistinction to air blast circuit breakers, special equipment, such as compressed air generating equipment, is not required.
(5) The switching surge is extremely low compared to other circuit breakers.

Because of the features mentioned above, it can be used as a circuit breaker for generators, auxiliary motors, transformers, feeders, tie lines and capacitive loads in substations and power plants in congested areas where extreme fire cautions are required or without any security personnel.

It also can be used as a circuit breaker to make and break switches of motors which are required to start and stop frequently.

It is installed in a metal-clad switchgear for outdoor or indoor use. It has many other applications as well.

The ratings of this circuit breaker are given in *Table 1,* an external view of the circuit breaker in *Fig. 1* and its dimensions in *Fig. 2.*

II. CONSTRUCTION

This equipment is a horizontal draw-out mechanism to be installed in a metal-clad switchgear. Its upper part is the circuit breaker section and its lower part the operating section ; that is, it consists of a high-tension part and a low-tension part. By means of the draw-out mechanism, the circuit breaker can be withdrawn from the metal-clad switchgear. The installation and withdrawal operations are easily performed, since a primary disconnecting part, a connector for auxiliary circuits and an earth terminal

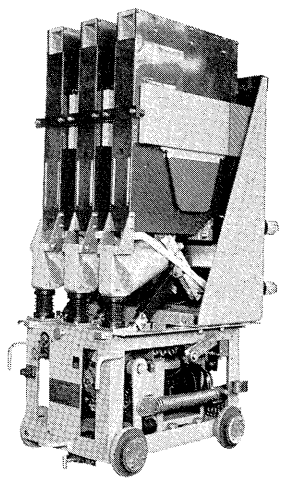

Fig. 1 Magnetic blow-out circuit breaker, type RM 10 M, with front barrier removed

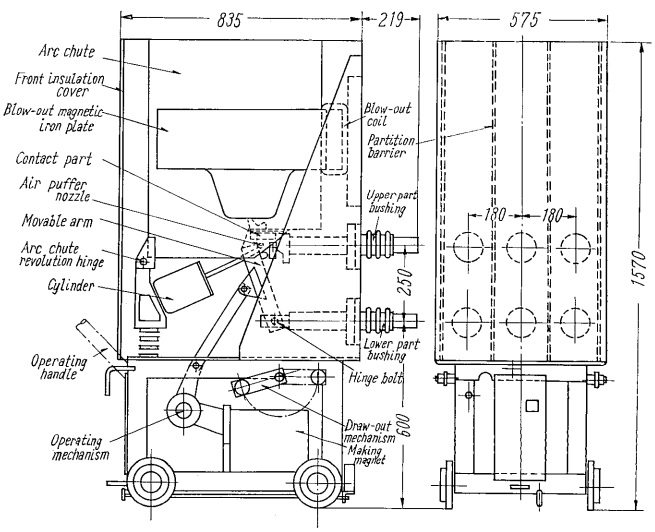

Fig. 2 Dimensions of magnetic blow-out circuit breaker, model RM 10 M-25/6-12 H

Table 1 **Ratings of Magnetic Blow-out Circuit Breaker, Type RM 10 M**

Model	Ratings							Insulation Level	Rated Operating Duty	Solenoid Operated Closing Mechanism	Voltage Trip	No-load Make Time
	Current (amp)	Breaking Capacity At 3.6 kv (Mva)	Breaking Capacity At 7.2 kv (Mva)	Short-time Current (ka)	Peak Making Current (ka)	Total Break Time (∿)	Opening Time (sec)					(sec)
RM10 M-25/6-6H	600							Ac 22 kv 1 min	O-1 min-CO-			
RM10 M-25/6-12 H	1200	150	250	24	65.5	5	0.06	Imp. 60 kv	3 min-CO	100 v 70 amp	100 v 5 amp	0.4
RM10 M-25/6-20 H	2000											

are installed in the breaker and the switchgear (See *Fig. 3*)

The method, which is used for the OCB of our company, employs the operation system and the trip free mechanism; the user can rely on it with confidence. After mechanical endurance test of 20,000 times, it was demonstrably confirmed that the equipment can endure severe operating conditions.

1. Arc Chute

After performing the tests stated below, it was confirmed that the insulation plates are not affected by sudden changes in temparature, only slightly soiled by frequent breaking operation and its efficiency is not effected by humidity.

The arc chute is required to be as compact as possible and ionized exhaust gas be minimized, since the magnetic blow-out circuit breaker is used as installed in a metal-clad switchgear.

The arc chute of model RM 10 M–25/6–12 H is shown in *Fig. 4*. The arc is produced equally in all the plates since the insulation plates are arranged with the overlapped end *A–B–A'* set into the grooves of the protruding portions of the insulation plates. The amount of exhaust gases around an arcing horn will be reduced when the arc chute has been constructed as in *Fig. 4* (A patent has been applied for).

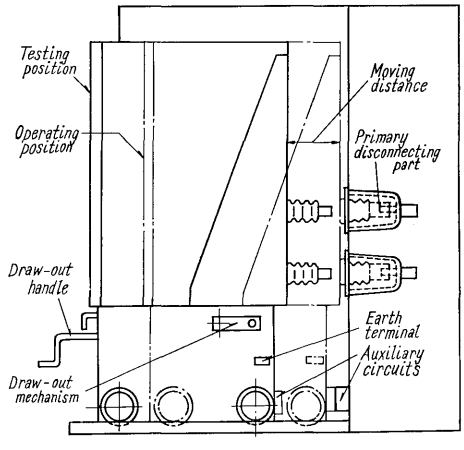

Fig. 3 Moving arrangement of circuit breaker

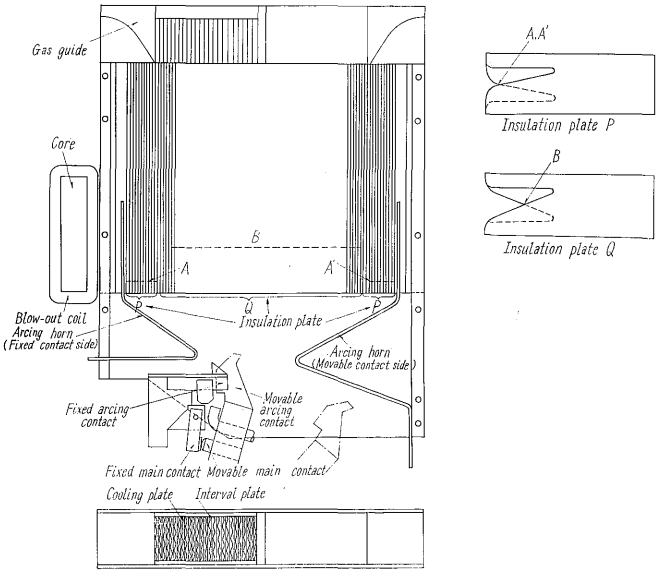

Fig. 4 Arc chute of model RM 10 M-25/6-12 H

The gas guide located in the upper part of the arc chute will prevent flashing over caused by the ionized gas which exhausts out along the arcing horn. A cooling plate installed in the upper part of a blow-out coil in the arc chute operates to cool and neutralize the ionized gas which is exhausted out of the arc chute.

2. Contact Part

The construction of the contact part comprises a movable arcing contact and a main contact placed between two copper plates and a movable arm fixed with the springs of the hinge-bolt to the lower part bushing. An air piston installed at the rear of the movable arm will operate effectively for breaking a small current.

The main contact is bat-shaped and the arcing contact is wedge-shaped in appearance. The main contact is made of silver and the arcing contact is made of silver-tungsten alloy.

3. Bushing

The material of the upper and lower part bushings are epoxy resin, which has particularly excellent

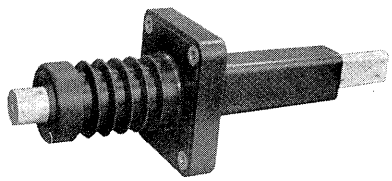

Fig. 5 Epoxy resin bushing

properties, both mechanically and electrically. *Fig. 5* is a photograph of an epoxy resin bushing. As seen from *Fig. 5,* it is compact in size and light in weight and the flange is molded into one unit.

III. TESTS

1. Mechanical Endurance Test

After a continuous 20,000 times operating test under the rated supply voltage, it was found that the operating characteristics, contact part and mechanism remain in the same condition as before the test was conducted, and can be used over again.

2. Short-circuit Breaking Test

In addition to the rated operating duty test of JEC–145 under the using conditions installed in a metal-clad switchgear, just after being kept at 100% humidity for 48 hours, the breaking test at the rated breaking current to inspect its moisture resistance for use in swampy areas, such as in tropical areas, and tolerance margin tests have been conducted. An oscillogram of 7.2 kv 250 Mva CO duty is shown in *Fig. 6* and an oscillogram of 3.6 kv 150 Mva CO duty in *Fig. 7*. All arcing times are approximately 1 cycle and only small quantities of conductive gases were blown out of the upper part of the arc chute during operation.

In the break test just after keeping it at 100% humidity for 48 hours, it was able to break 7.2 kv 21,400 amp, 3.6 kv 25,000 amp with an arcing time below 1 cycle. The good breaking efficiency was maintained the same as in tests under moistureless

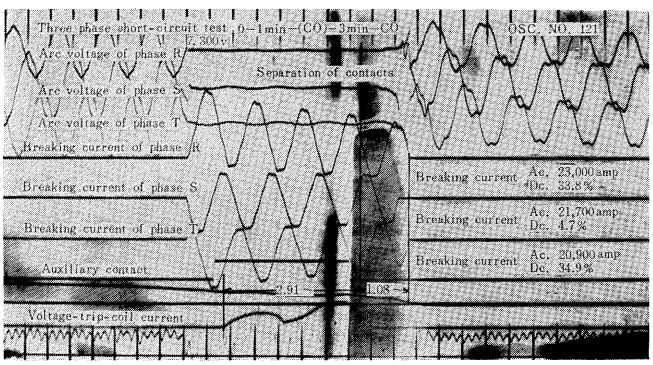

Fig. 6 Oscillogram of 7.2 kv 250 Mva CO duty

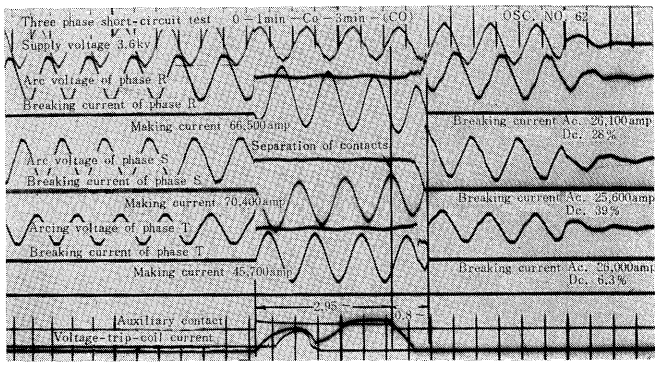

Fig. 7 Oscillogram of 3.6 kv 150 Mva CO duty

conditions. In the tolerance margin tests, it was confirmed that all arcing times are below 1 cycle and breaking capacity has a sufficient tolerance margin after conducting operation duty O at single phase 6.3 kv 31,300 amp, 3.2 kv 42,000 amp.

After many short-circuit breaking tests under conditions more severe than described above, it was found that the arcing contact was worn only slightly and the arc chute remained almost in same condition as before testing; other satisfactory results, even better than expected, were attained.

3. Small Current Breaking Test

In the range of 10～1000 amp, which is low in magnetic blow-out energy, the arcing time was shortened by the effective puffing of an air puffer. The effect on the breaking efficiency of the direction of air puffing, the form of arcing contact and horn, the magnetic flux density and the phase difference between the magnetic flux and current, were examined. After performing detailed examination and several comparison tests in order to minimize the arcing time stated above, the best condition of the breaker was attained. In the range of 10～100 amp current, it can perform breaking only with air puffer. In the range of 100～1000 amp load current, it is shifted to the arcing horn on the fixed contact side around 1 cycle by air puffing after separation of the arcing contact as shown in the oscillogram in *Fig. 8* and *9*. After that, the blow-out magnetic

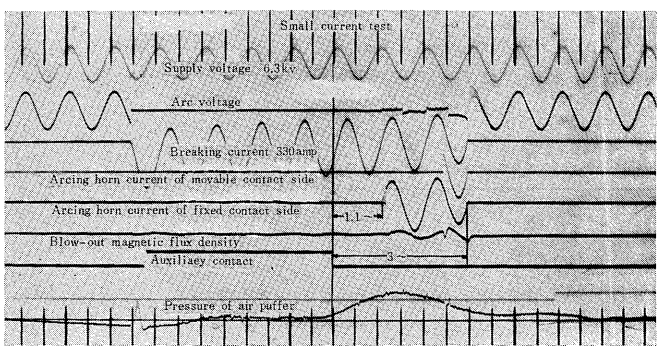

Fig. 8 Oscillogram of single phase 6.3 kv 330 amp small current test

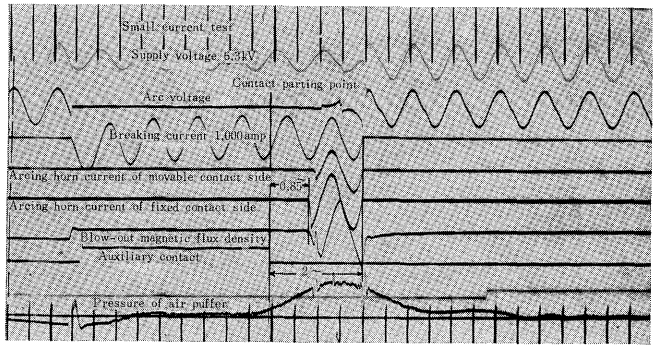

Fig. 9 Oscillogram of single phase 6.3 kv 1000 amp small current test

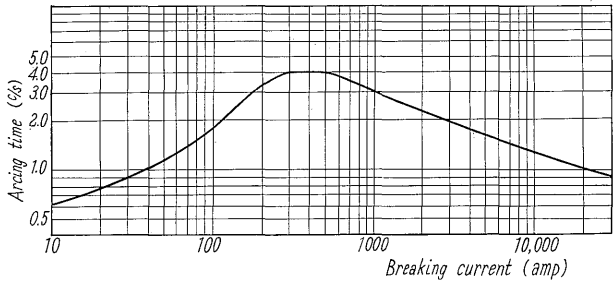

Fig. 10 Breaking characteristics of model RM 10 M-25/6-12 H

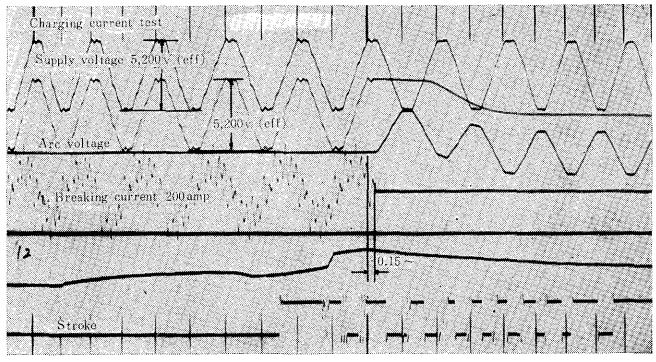

Fig. 11 Oscillogram of single phase 5.2 kv 200 amp charging current test

field is generated and the arc is enlarged and shifted to the arcing horn located beside movable arcing contact. It is then blown into the arc chute, extinguishing the arc. In this test, the best result was recorded when the phase difference between the magnetic flux and current was 30 degrees. *Fig. 10* shows the breaking characteristic curve.

After the charging current breaking test for current of single-phase $7.2/\sqrt{3} \times 1.25 = 5.2$ kv 5～200 amp, it was found that restriking of the arc did not occur; the arcing times were 0.15～0.43 cycles (See *Fig. 11*).

Table 2 **Results of Temperature Rise Test**

Tested Parts	Temperature Rise (°C)
Upper Part Terminal	36
Upper Part Bushing	25.5
Main Contact	31
Movable Arm Hinge	32
Lower Part Bushing	26
Lower Part Terminal	35

4. Other Tests

The making test was conducted several times to verify that the rated peak making current is able to be maintained within the supply voltage alteration range (85～110%) without any difficulties; this movement was examined by the stroke curve. From the test results it was found that 67 ka (65.5 ka for standard) at 80% voltage is able to be made without any trouble and a sufficient margin of tolerance remained.

A temperature rise test was conducted after 1000 times of continuous operating tests and short-circuit breaking tests (See *Table 2*). Then a short time current test was conducted by two-second charging with a current of 30.2 ka (24.1 ka for standard). However no fusion of the contacts and only slight rises in temperature were recorded.

Commercial frequency dielectric test (22 kv 1 min) and impulse voltage test (60 kv 1×40 μs) were conducted between poles and frame with the circuit breaker closed, between poles with the circuit breaker closed and across the terminals of each pole with the circuit breaker open.

The test results revealed no abnormal condition and confirmed the voltage rating mentioned.

IV. CONCLUSION

The above information is a summary of the results of tests and construction of a magnetic circuit breaker, type RM 10 M. After 20,000 times of continuous operating tests, the short-circuit breaking test, the breaking test at 100% humidity and the tolerance margin test, it was confirmed that the equipment is reliable and practical for electrical applications.

In the near future, types with 7.2/3.6 kv 150/100 Mva and 350/250 Mva ratings will be offered in answer to the demands of users.