Introduction of Products

NEW TYPE INDOOR USE LOAD BREAK SWITCHES

I. PREFACE

A load break switch is provided with intermediate characteristics between a circuit breaker and a disconnecting switch and is used for load break switching. In the installations where many electrical equipment are used as in a private power plant, it costs much for construction to adopt circuit breakers to operate these electrical equipment in case of breakers' interrupting capacity being large. So if it needs only load break switching without having rupturing capacity against fault current, it is more economical to adopt load break switches than circuit breakers, and fault current can be interrupted by means of power fuses.

Load break switches are used not only for private power plants, but also for switching capacitor bank in power stations and sub-stations. Our company constructed expansion type load break switches RF 612 III/10/1000 D for Tunokawa power station of the Kansai Electric Power Co., Ltd. in 1955 and expansion type load break switch HFL 624 III/20/400 D for Wadagawa No. 2 power station of Hokuriku Electric Power Co., Ltd. in 1956.

These switches are designed for closing generator circuits for parallel running, and interrupting exciting current of main transformers. Their features are that there is no possibility of fire as water is main part of arc quenching liquid (expansin), and no abnormal voltage at interrupting small current, arc-time characteristic is flat and maintenance and inspection are easy.

Besides these expansion type, our company has newly developed load break switches with arc-quenching chamber of organic insulation plates which generates gas.

As the new type load break switch is made of an ordinary disconnecting switch by adding arc-quenching chambers and arcing contacts, and combined with various operation mechanism, tripping mechanism, power fuses and auxiliary device, it becomes simple and economical device suitable for many operation duty. Namely it can be used not only for interrupting exciting current of transformers, carring current of power transmission lines and load current, but also for switching capacitor bank, partitioning load and separating voltage regulators, and in addition, very large short circuit current can be interrupted by means of power fuses.

Table 1. List of types and ratings of new type indoor use load break switches

Type of switch	H 248/ 10 III/400	H 248/ 20 III/400
Rated voltage (kV)	11.5	23
Rated current (A)	400	400
Interrupting capacity (kVA)	400	600
(40∼60 c/s, cos φ=0.15)	(at 11.5 kV)	(at 23 kV)
Interrupting capacity (kVA)	1,400	1,200
(40∼60 c/s, cos φ=0.7)	(at 11.5 kV)	(at 23 kV)
Type of drive	H 288/612 n	H 288/612 n
Rated pressure (kg/cm^2)	5	5
Type of operating valve	R 287	R 287
Rated operating voltage (V)	AC, DC 110	AC, DC 110

II. CONSTRUCTION AND OPERATION

1. Main parts

The new type load break switch is made of an ordinary disconnecting switch by adding arc-quenching chambers and arcing contacts. In normal condition, auxiliary blade for arc-breaking are mounted in parallel to main blades in which load current flow. The auxiliary contact can move through a slit of the arc-quenching chamber made of two special synthetic resin plates in which a finger contact is there to catch the blade.

In opening a circuit, gas is generated from two arc-quenching plates in the arc-quenching chamber due to heat of electric arc between the finger contact and an auxiliary contact, and performs deion-action. As the upper part of the insulation plate is totally enclosed, so electric arc is driven downward in interrupting.

Although interrupting characteristic is changed due to width of the slit of the lower part of the arc-quenching chember, it is best when the width of the slit is about 3 mm. The contact resistance of the main blade is extremely small as a line contact is adopted.

2. Arc quenching plates

Comparing organic materials such as bakelite, polystyrol, fibre, urea resin and ebonite with inorganic materials such as asbestos, asbesto-cement, micalex and micanite, the latter is not deteriorated but the former is deteriorated due to carbonization when short-time arc is occurred. In order to generate gas from insulating plates, organic materials are selected as a matter of course. If carbon fully adheres on the surface of arc-quenching plate which generates gas, there are possibility to cause surface creepage. In this connection our special organic material heeps the surface always clean to make gas-effect effective, because the material is consumed a little in one interruption, and a little carbon adhering on arc-quenching plate has large adhesionless and evaporate very easily.

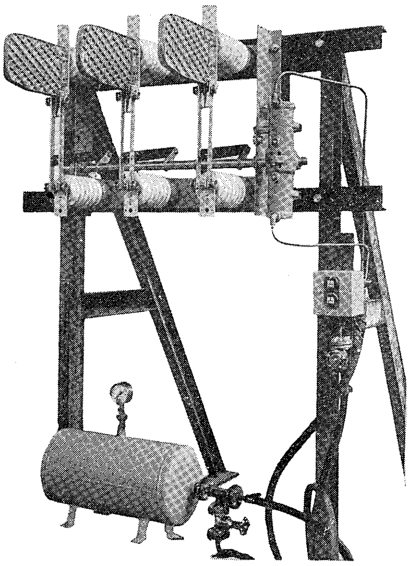


Fig. 1. (a) Compressed air operated load break switch

III. TEST RESULT

Various tests prescribed in JEC-125 as type tests were carried out, and more over load breaking test was made.

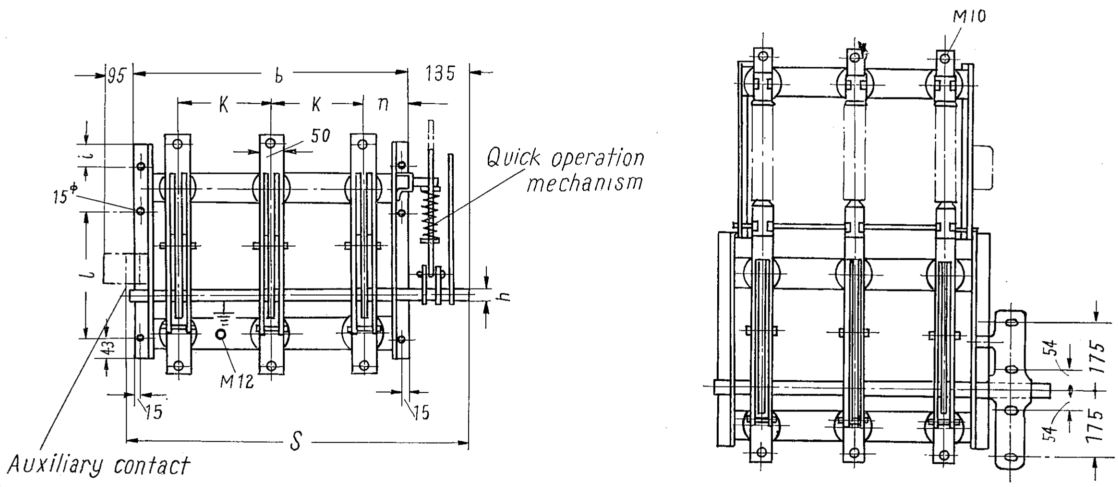
1. Temperature rise test

Results of heat run test of the new type load break switches H 248/10 III/400 and H 248/20 III/400 are shown in Fig. 2 (a) and (b). Temperature rise is stable and low.

2. Continuous operation test

After operating the switch H 248/10 III/400 (manual operation) more than 500 times at no load by hand, there was no abnormal point. After operating the switch H 248/20 III/400 (pneumatic operation) more than 500 times at no load with compressed air, there is no abnormal point at all.

As to the load break switch H 248/20 III/400 with compressed air drive, minimum operating pressure, minimum operating voltage of the magnet valve, capacity of the air tank and opening and



Type	b	h	i	k	l	n	s
H248/10/400	630	25	34	210	280	105	805
H248/20/400	780	25	58	295	350	115	955

Fig. 1. (b) Outline dimensions

closing characteristics were measured.

1) Minimum operating pressure measurement.

Nozzles are inserted at piping joints of the compressed air drive to control speed characteristics, and by changing nozzle diameters minimum operating pressure is changed.

Considering mechanical shock and interrupting characteristics, the most suitable minimum operating pressure was determined as follows:

Closing : 1.4 kg/cm^2

Opening : 1.2 kg/cm^2

Moreover there was no abnormal phenomenon when opening and closing at maximum operating air pressure, i.e., 5.5 kg/cm^2. From this test results it is found that the load break switch amply meets the requirement of JEC-125 prescribing that switches should be operated without any difficulty over the range of 75%～110% of the rated operating pressure. (As the rated operating air pressue is 5 kg/cm^2, so 75%～110% means 3.75 kg/cm^2–5.5 kg/cm^2)

2) Minimum operating voltage measurement.

Under the severest condition, i.e., 110% of the rated operating air pressure, minimum operating voltage of the magnet valve was measured.

Closing : 72 V

Opening : 71 V

Moreover there was no abnormal phenomenon when opening and closing at the maximum operating voltage (121 V). From this test result the load break switch meet the requirement of JEC-125 prescribing that switches should be operated over the range of 75%～110% of the rated operating voltage. (As the magnet valve needs dc power source and its rated voltage is 110 V, so 75%～110% means 82 V～121 V)

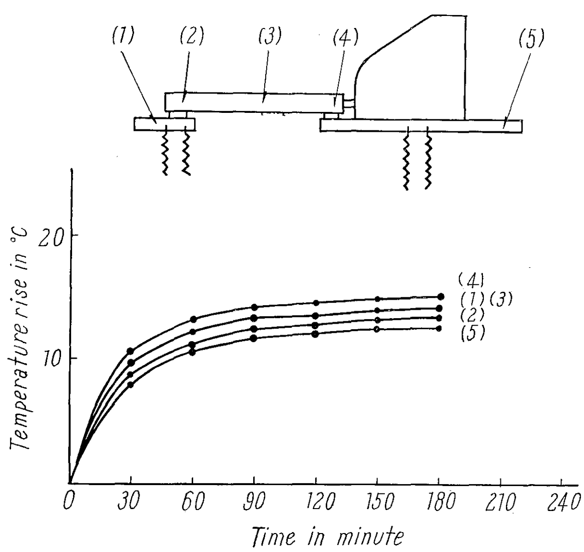


Fig. 2. (a) Heat run test of H 248/10III/400

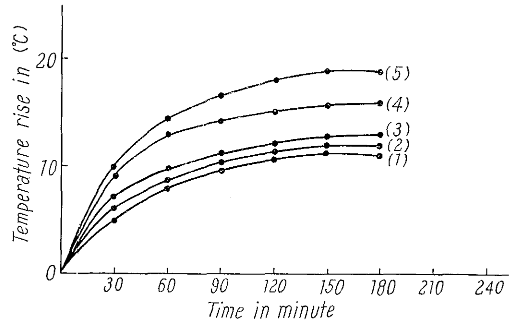


Fig. 2. (b) Heat run test of H 248/20III/400

(1) Lever terminal connecting part
(2) Lever main contact
(3) Main grate
(4) Upper main contact
(5) Upper terminal connecting part

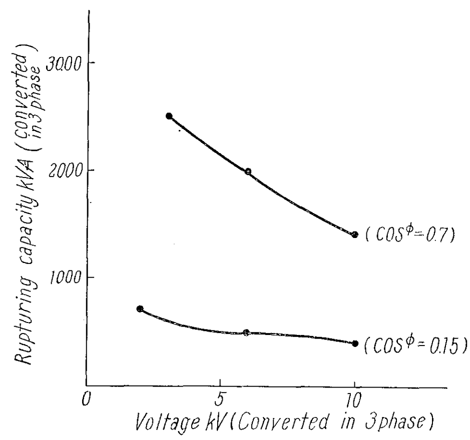


Fig. 2. (c) Characteristics of interrupting capacity of H 248/10III/400

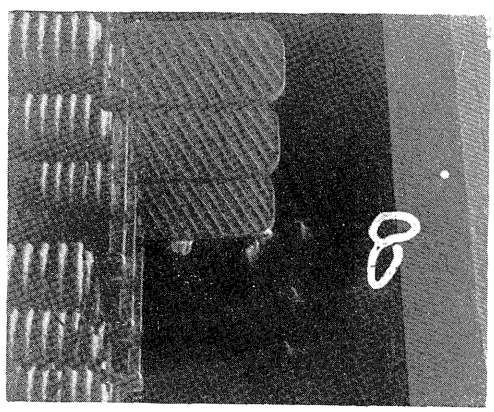


Fig. 2. (d) View of interruption test

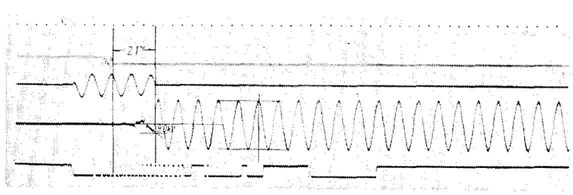


Fig. 2. (e) Oscillogram of single phase interruption test

3) Air tank capacity test.

Although there is no test item in JEC-125 regarding this test, tank capacity was measured. Capacity of the secondary air tank was 35 *l*. Continuous open-close times were 20 in case of initial pressure being rated 5 kg/cm^2.

4) Opening and closing characteristics test

The test was carried out by changing the nozzle N_1 which controls compressed air to enter a cylinder in closing and N_2 which controls compressed air to enter the cylinder in opening.

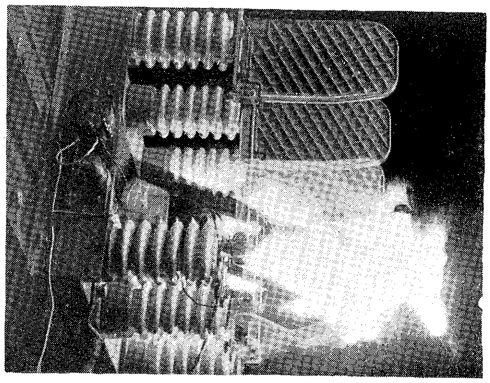


Fig. 2. (f) View of interruption test

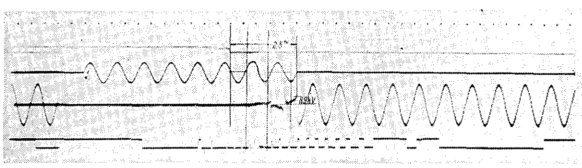


Fig. 2. (g) Oscillogram of single phase interruption test

3. Interrupting capacity test

Single phase test was carried out because of testing equipment, so interrupting capacity is converted into three phase interrupting capacity.

1) Interrupting capacity test of H 248/10 III/400 (manual operation)

As the inturrupting capacity was tested by hand operating, so interrupting speed was about 5 m/s, and test of interrupting capacity against inerrupting speed was not carried out. The relation between voltage and interrupting capacity is shown Fig. 2 (c). The relation is very different from that of an ordinary circuit breaker.

2) Interrting up characteristics test of H 248/20 III/400 (compressed air operation)

The relation between the control nozzle and the interrupting capacity is shown in Fig. 3.

Fig 2 (d), (e), (f), (g) show views of interruption tests and oscillograms. Fig. 2 (d) is the view of interruption test of interrupting capacity 1,350 KVA,

Table 2. Relation between control nozzle and interrupting capacity

Nozzle (mmφ) \ Interrputing (kVA)	cos φ=0.7, 23 kV			cos φ=0.15, 23 kV	
	1,350	1,120	920	630	396
5	△	○	○	○	○
3	×	△	○	△	○
2	×	×	×	△	○

× Interruption failed 3 times

△ Interruption succeeded 2 times, failed 1 time

○ Interruption succeeded 3 times

p.f. cos $\varphi=0.7$ and arc time $ta=2.1$ cycle and Fig. 2 (e) is its oscillogram. Fig. 2 (f) is the view of interruption test of interrupting capacity 3,240 KVA and in this case interrupting failed. Fig. 2 (g) is the oscillogram of interrupting capacity 630 KVA, p.f. cos $\varphi=0.15$, and arc time $ta=2.5$ cycles.

IV. CONCLUSION

The load break switches newly developed from ordinary disconnecting switches by adding arc-quenching chambers and arcing contacts are of very economical construction to switch exciting current of transformers and charging current of transmission lines and to separate load, and be able to interrupt the short circuit current by adding power fuses.

The load break switches are operated either by hand or with compressed air. Moreover quick closing and free tripping mechanism can be mounted in order to make manual operation easy. In case of compressed air drive system double piston mechanism is adopted and is of the construction to completely lock the load break switch at both ends to prevent the load break switch from operating due to outer shock. As control valves small and economical double magnet valves are used.

The load break switches H 248/10 III/400 (manual operation) and H 248/20 III/400 pnenuatic operation) are in operation at Asahi Chemical Industry Co., Ltd. and Nippon Kokan K. K. respectively.

(By Haruzo Mizutani, Electric Power Apparatus Sect., Design Dep't.)