

Fig. 5. Solubility change of nitrogen for oil by temperature

saturated as the oil temperature of the transformer falls, resulting in the release of nitrogen from oil.

V. CORRELATION BETWEEN ABNORMAL GASES AND TROUBLES

Results of experiment on abnormal gases by the use of the model of nitrogen sealed-in transformer will be summarized as follows. High temperature local heating such as discharging decomposes the insulation oil almost to hydrogen, producing little

intermediate gas substance such as unsaturated hydrocarbon. Low temperature heating such as the mechanically local heating, on the contrary, produces less hydrogen and slightly more intermediate gas substance than the former. In either case, the oil is saturated with nitrogen and there is no oxygen dissolved in it, which leads to very little formation of oxidized substance such as carbon dioxide and carbon mono-oxide. However, if the insulation paper is subjected to local heating, oxidized compound such as carbon dioxide is invariably produced regardless the temperature.

On occurrence of the above mentioned abnormal gas production, nitrogen is released from oil, and also sudden drop of oil temperature leads to release nitrogen.

When the generation of abnormal gases is observed in the Buchholz relay, an approximate presumption on which material is under effect of what degree of temperature may be made by investigating the composition of gases and comparing it with the foregoing experimental results to find which one will be the answer. It is needless to mention that, before making any presumption, the state of the gas generation—sudden generation or slow release from oil—and changes of oil properties together with ordinary electrical routine tests must be made.

11.5 kV, 750 MVA EXPANSION CIRCUIT BREAKERS

Expansion Circuit Breakers rated at 11.5 kV 750 MVA are here to be announced as new products. Having passed a series of tests, they were delivered to the Chugoku Electric Power Company for installation at their Ube Substation.

Fig. 1 shows the outer appearance of the breaker with a head protective cover in Fig. 2 removed. As seen from this sketch, it has practically the same construction as that of Expansion Circuit Breaker, type RF 660, which has been produced with high reputation. The advantage of the new product, that is one named RF 660 A, over RF 660, is that it can guarantee 750 MVA at 11.5 kV against 600 MVA of the old type; 1,000 MVA at 23 and 34.5 kV against 800 MVA of the old type, satisfying such necessary conditions for the increased interrupting capacity as to gain stronger mechanical strength of every part and to make easy path for larger volume of generated gas through insulator, enlarged in its dimension. RF 660 A is generally based on RF 660 with special emphasis on the following features:

- 1) In consideration of high frequency of service, two breaks per pole and disconnection in the oil are adopted to strengthen insulation.
- 2) Paying special attention to oil spouting, an

apparatus of confirmed performance is provided at the top of arc quenching chamber.

- 3) Moving and fixed contacts are carefully designed so that the tip of arc never comes in contact with parts rather than arc-resistant metal.
- 4) Maintenance and inspection requires no special tools.

Being intended for outdoor use as three-pole, single-throw, magnetic operated expansion circuit breaker, this has the following ratings:

Type : RF 660A f III/10/1,500 H
 Rated Voltage : 11.5 kV
 Rated current : 1,500 A
 Rated rupturing capacity : 750 MVA at 11.5 kV
 Rated frequency : 50/60 ~
 Rated closing current : 100 kA
 Short-time current : 45 kA one second
 Closing magnet current for closing : d.c. 100V 100A
 Opening time : 0.06 sec.
 Total breaking time : less than 6 cycle
 Closing time : 0.6 sec.

Various tests prove that these ratings are guaranteed, moreover they have passed the following test; one-minute power frequency withstand voltage tests at voltage 28 kV and impulse withstand voltage tests at voltage

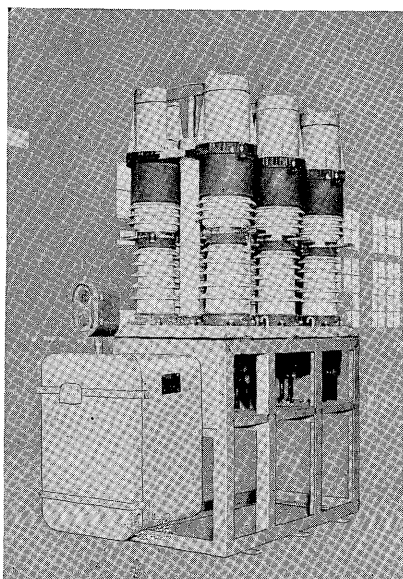


Fig. 1. Outer view of 11.5 kV, 750 MVA expansion circuit breaker

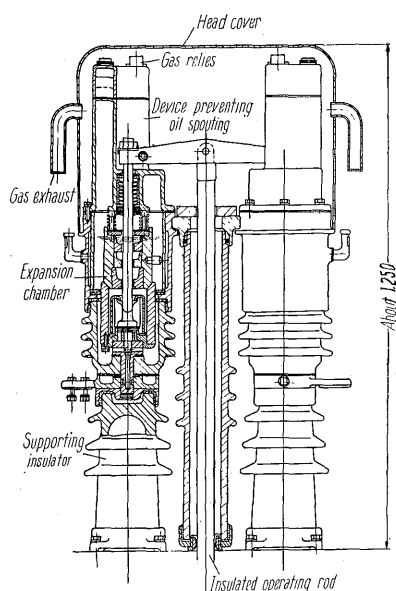


Fig. 2. Interior construction of expansion chamber

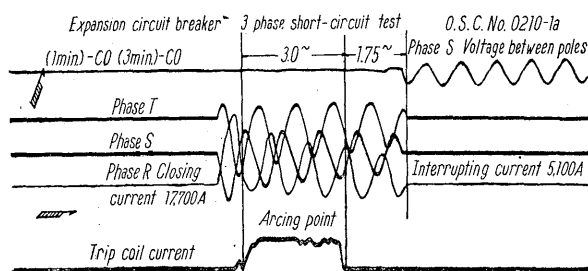


Fig. 3. Oscillogram of short circuit test, voltage 11.5 kV, breaking current 5,100 A

99 kV 1×40 full wave, between phases, across open contacts and terminals to ground respectively, and successive 500 times of close-open operation test. In short-circuit tests at our short-circuit testing station, each current interruption succeeded with good results as expected, i.e., without any spouting of oil, any smoking and any marked shock in the breaker. Particularly upon inspection after one-"A" operating duty according to J. E. C. rules (0-1 min-

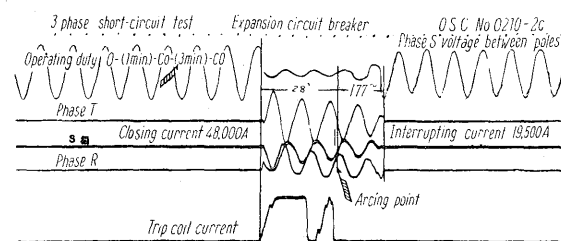
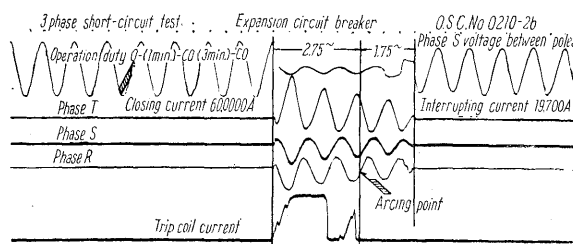
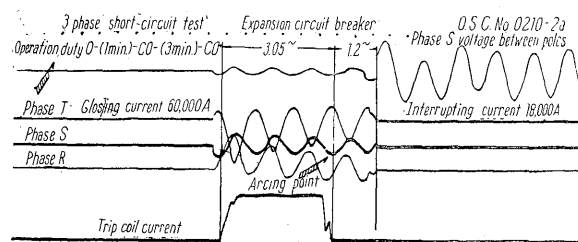


Fig. 4. Oscillograms of short circuit test "A" operating duty at voltage 3,400 V

CO-3 min.-CO) at 11.5 kV with closing current about 18,000 A, breaking current about 5,000 A, immediately followed by the same duty at 3,400 V with closing current 60,000 A, breaking current about 20,000 A, there was no damage observed on the contact surface of each contacts that would endanger further use of the breaker. Figs. 3 and 4 show some oscillograms representing these tests.

This breaker is available for pneumatically operated and magnetically operated type working at rated current 600~1,500A. In addition, a line of products using the same arc quenching chamber and having a rupturing capacity of 1,000 MVA at 23 kV and 34.5 kV are produced over the range of rated current 600 ~ 1,500 A. For the operating system hereby, compressed air, electric motor, or electromagnet are adopted.

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