

Unceasing efforts are also made for the study of the composition of cathode alloy layer and the temperature treatment during the manufacture. As a result of these, products of such high efficiency as 91% are available. They are also excellent for durability and uniformity of characteristics, and are rapidly extending their application to various fields.

Among small-sized products, flat type and radiator type (Fig. VIII.8) are specially used in quantity for radio sets and T.V. sets, displaying superior characteristics to electronic tubes and enjoying reputation. Medium-sized ones are also extensively used for d-c welders and power source for circuit breaker operation as well as battery charging and electric

plating. A good number of large capacity units are also built with the capacities ranging from 2,000 to 3,000 A to be used for electrolysis (Fig. VIII.7) For d-c power sources of industrial factories, 100 V, 1,000 A units are being produced. To be used for d-c power source for electric railway several 600 V 200 kW units have been built. Some products were also used on board ships. A d-c constant voltage device as a power source of communication having accuracy $\pm 1 \sim 2\%$ by the use of d-c excited reactors has been produced. As a power source for Cottrell precipitators, scores of units have been built in various sizes of 10, 15, 20, 30 kW at 55~65 kV and are displacing old mechanical rectifiers completely.

IX. CIRCUIT BREAKERS

IX.1. OIL-POOR TYPE CIRCUIT BREAKERS

In the production of this type circuit breaker which is the predominant item of breakers manufactured, our Company has twenty-old years' experience; the excellent capacity of breaking a large current is widely recognized.

As for interruption of a small current, especially of exciting current or charging current, the recent problem concerning the self-controlled arc-quenching circuit breaker is to check the abnormal voltage caused by restriking or reignition at the time of breaking the current. As a solution to this problem, the Company has succeeded in developing a standard RF650 model Breaker of over 69 kV, with two chambers arranged in series, namely, a conventional self-controlled arc quenching chamber for large

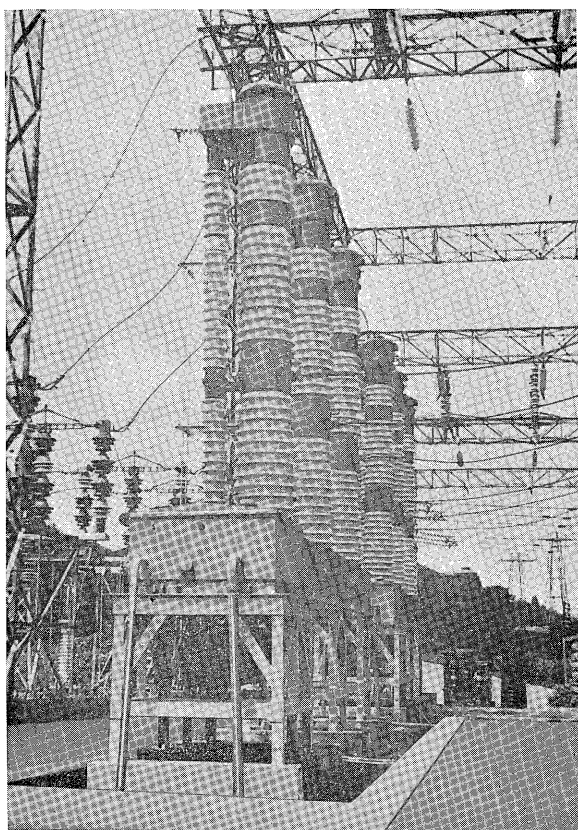


Fig. IX.1. 161 kV Oil-Poor Type Circuit Breaker

Materialization of a long-standing plan to establish a short-circuit testing equipment (Fig. IX.2) has made it possible to carry out the testing of various kinds of circuit breakers for their guaranteed performance; to make fundamental tests for development of new products; consequently to supply with confidence still more reliable circuit breakers. Aside from the electrical characteristics, further improvements have been made on the mechanical properties.

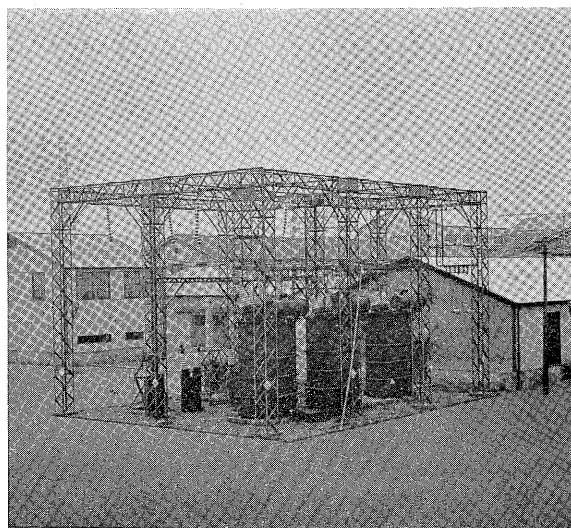


Fig. IX.2. Short-circuit Testing Equipment
400 MVA

current interruption and a separately-controlled arc quenching chamber for small current interruption (Fig. IX-1). These circuit breakers are operated pneumatically.

The 161 kV Breaker has a rupturing capacity of 2,500 MVA and its effect of checking the abnormal voltage has been confirmed in charging current breaking tests conducted at Kurobe Power Station and Shin-aimote Substation of the Kansai Electric Power Co.

The 115 kV Breaker has a rupturing capacity of 3,000 MVA, and its effect of checking the abnormal voltage has likewise been proved at the Sounkyo Power Station of Hokkaido Electric Power Co.

The 69 kV and the 80.5 kV one are each available in, 1,500 MVA or 2,500 MVA capacity. Charging-current breaking tests have been carried out at Yodobashi substation of the Tokyo Electric Power Co. and Hirakata Substation of the Kansai Electric Power Co., with no reignition. The 80.5 kV 2,500 MVA breaker took part in the short-circuit

IX-2. WATER CIRCUIT BREAKERS

They are characterized by use of water as breaking medium; the water is added with ethylenglycol for the purpose to get lower freezing temperature. This breaker has lately come into increasing use from the consideration for fire prevention; it has become popular as indoor breaker on the score of its feature that unlike the air-blast circuit breaker it does not issue an enormous loud noise at the time of operation (Fig. XI-4). Its voltage class ranges from 3.45 kV to 34.5 kV; rupturing capacity, 100 MVA to 1,000 MVA.

As it well fits in with the metal-clad panel which is recently coming into wide use, a large number of these products have been delivered to power companies for use on main and interior circuit of stations and substations; increasing orders are also expected to come from railways and industrial plants for receiving equipment.

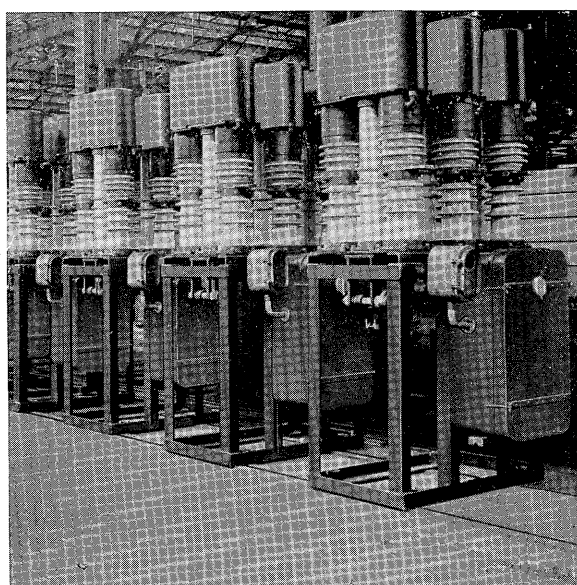


Fig. IX-3. 24.5 kV Oil-Poor Type Circuit Breaker

current breaking test at Ozone Substation of the Kansai Electric Power Co., with satisfactory results.

For the voltage 34.5 kV or less, reduction of the dimensions of RF 650 Model in proportion to voltage will make an expensive product, so that a new approach has been tried in development of RF 660 Model (Fig. IX-3). RF 660 is available in 750 MVA and 1,000 MVA at 23 kV and 34.5 kV; in 600 MVA and 750 MVA at 11.5 kV. It can be ordered for electromagnetic, electric or compressed air operation. Though it has only a self-controlled arc quenching chamber, it gave an excellent record of less than one reignition throughout the charging-current breaking test performed at Kakomachi Substation of the Chubu Electric Power Co.

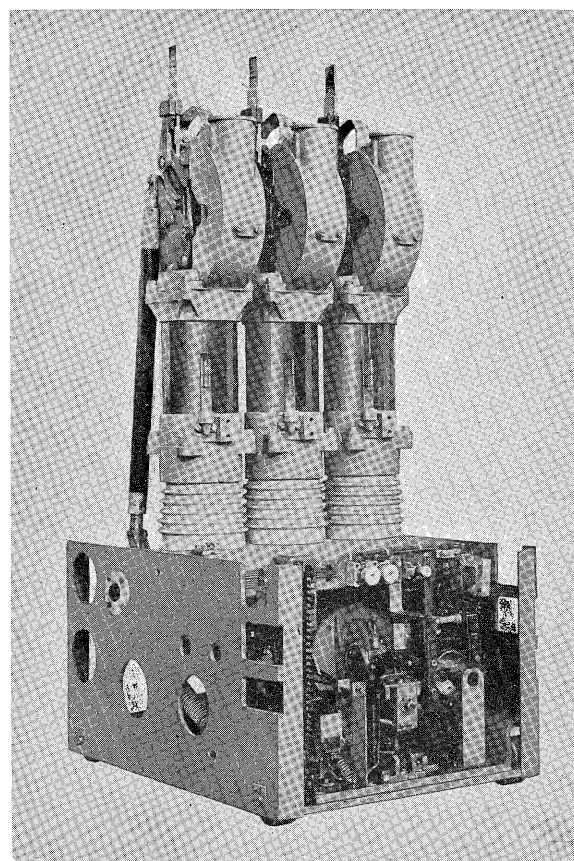


Fig. IX-4. 6.9 kV Water Circuit Breaker

IX-3. STEEL TANK TYPE OIL CIRCUIT BREAKERS

These breakers are also delivered in large quantities, presumably from the circumstances that the users are accustomed to them and the price is reasonable. Overseas customers almost without ex-

ception specify this type in their orders; an illustration is a 34.5 kV 1,000 MVA breaker exported to the Taiwan Power Co. (Fig. IX-5) This was the first of its kind that had been subjected to a large-current breaking test in our laboratory and the results were satisfactory.

As it has been required for the metal-clad panel to house this type breaker, our Company has been supplying various equipment for every electric power company and factories.

IX-4. D-C HIGH SPEED CIRCUIT BREAKERS

Inverse current type and overcurrent type breakers of this kind have been built for electric railways in large numbers; also inverse current types have been delivered to chemical plants. For chemical plant use, they have the auxiliary switches made in oil-immersed type in order to protect the contact surface from chlorine and other gases.

Actual load breaking test has been imposed on these breakers and will continue to be done so that

all their characteristics may be improved and, together with general advance in production technique, uniformity of product quality may be secured.

IX-5. LINE SWITCHES AND DISCONNECTING SWITCHES

From single break 161 kV and 115 kV delivered to the Chosen Electric Power Co. and the Chugoku Electric Power Co. to 11.5 kV ones, large quantities of these switches have been manufactured. Against 80.5 kV or less, horizontal double-break type (Fig. IX-6) was produced in large numbers.

Customers often demand for a line switch capable of breaking exciting current or charging current; the 80.5 kV switch is guaranteed up to 8.25 A exciting and 4.2 A charging currents in the breaking test. The 11.5 kV one has been tested up 1.5 A exciting current, as installed on the panel.

As a synchronizing switch of generator, a load break switch, a kind of simplified water circuit breaker, has been devised; it is popular on account of reduced dimensions.

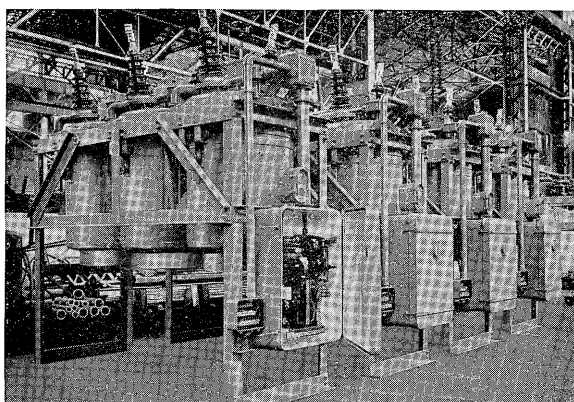


Fig. IX-5. 34.5 kV Oil Circuit Breakers

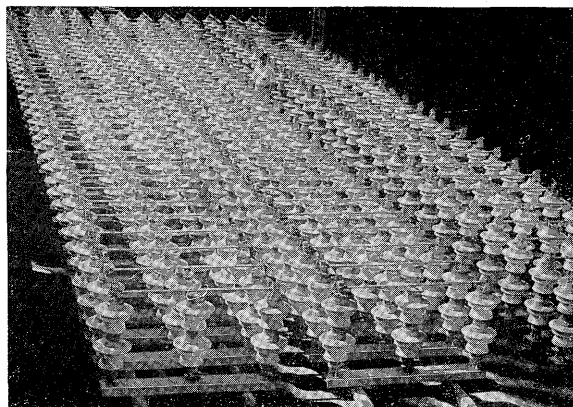


Fig. IX-6. 80.5 kV Line Switches

X. SWITCHBOARDS AND RELAYS

X-1. SWITCHBOARDS

Switchboards are produced in great quantities as control centres of electrical equipment for large-capacity power stations, substations and industries in general. In many cases, a large number of automatic control devices and sequence control devices are used and the one-man control system is adopted that makes it possible to operate every device from a switch board room. For medium to small capacity power stations and substations, the full automatic control or the remote control system is often required.

Switchboards are all fabricated of bent steel plates; well treated for corrosion resistance; and finished in light bluish-gray colour. The indicating meters are all of rectangular type and if required, wide angle meters may be used. Wide angle ones are available in a big type with 140 mm square and a small type with 100 mm square. The scale is 240 mm long for the former and 150 mm long for the latter; considering that the scale of a conventional product with 140 mm square is 120 mm long, these scales are very much extended. The smaller type is chiefly installed on the miniature switchboard which is to be described later. The present trend is to