30 MVA SYNCHRONOUS CONDENSER, DELIVERED TO THE RANGOON PRIMARY SUBSTATION

The Rangoon Primary Substation, which was planned out by the Government of the Union of Burma, is now under its construction at the spot surrounded by the rubber woods in the suburb of Rangoon. Being generated at the Balu Chaung Power Station No. 2 located in the mountains about 400 km distant from the Rangoon Primary Substation, the power is transmitted to this substation through a 230 kV trunk line, from which it is supplied through the 33 kV secondary transmission lines toward the consumers in the city of Rangoon and in the neighbouring industrial areas.

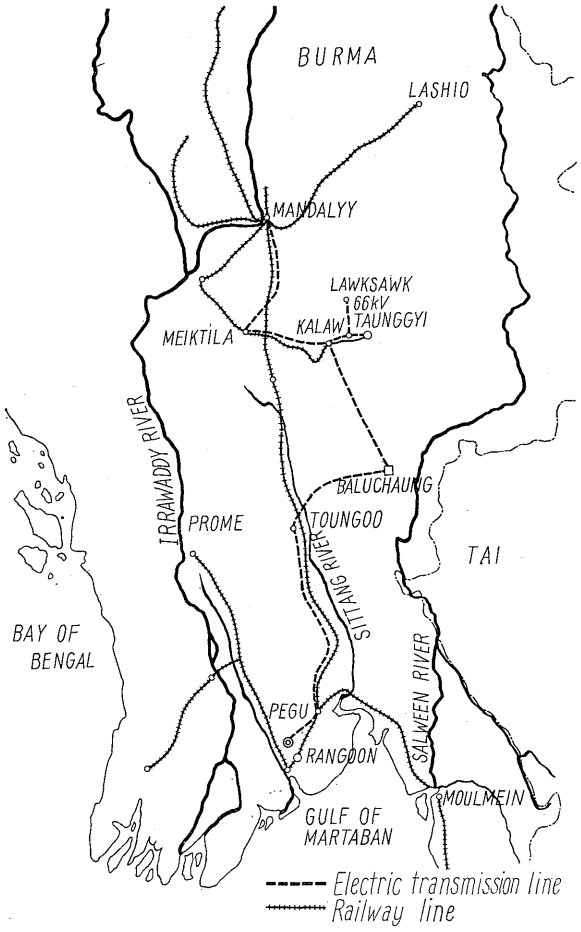

Fig. 1. Transmission line system nearby Rangoon

One of the significant points in the construction of this primary substation may consist in the fact that it is exported from Japan to Burma as a Reparation Plant. Among those main equipment and machines for this substation, the Fuji Denki Seizo K.K. accepted the order to manufacture the horizontal type synchronous condenser, starting transformer, control board, and so forth.

These equipment are to be installed at such a place of tropical climates that it is subject to the dry season, without raindrop, about a half of an year and to the rainy season, with consecutive raindrop, for the rest of it, and that the ambient temperature rises up to 41°C at the highest outside of the door.

Our Company has completed these equipment by taking into the precautions consideration both these high-temperature and high-humidity climates and other unfevourable conditions; so that we may have a confident belief that these equipments should display their functions to our satisfaction for a very long duration.

Among those equipment manufactured by our Company, the specifications of the synchronous condenser and its auxiliary apparatus are particularly given in the following lines:

1) Synchronous Condenser

Type :	Indoor, enclosed, self-ventilated type
Capacity :	30,000 kVA (leading) 20,000 kVA (lagging)
Voltage :	11,000 V
Current :	1,570 A
Power factor :	0
Frequency :	50 c/s
Speed :	750 rpm
Starting system :	Self-starting by starting transformer,
Control system :	Automatic control and one man control
Connection :	Single-star type with resistance grounded neutral
Rule :	BSS

2) Main Exciter

Type : Enclosed, self-ventilated type (direct-coupled with synchronous condenser)
Output : 135 kW
Voltage : 220 V
Excitation : Separate excitation
Speed : 750 rpm

3) Sub-exciter
Type : Enclosed self-excited compound type
Output : 3 kW
Voltage : 230 V
Speed : 1,450 rpm

4) High Frequency Generator
Type : Enclosed permanent magnet type
Output : 10 kVA
Voltage : 200 V
Number of phases : 1. (Single)
Frequency : 350 c/s
Speed : 1,450 rpm

A brief introduction shall be given on this synchronous condenser in the following lines.

I. GENERAL ARRANGEMENT

The rotor of this condenser is supported by two bearings, overhanging the main exciter onto the shaft protruded from a bearing in one side ; while in an opposite side, the tachometer is mounted.

The slip-rings are located nearby the bearing in exciter side and covered by the guard with an opening provided for easy inspection.

Both the exciter and bearings are protected by the covers which are not only to serve for noise suppression but also to give a refined appearance.

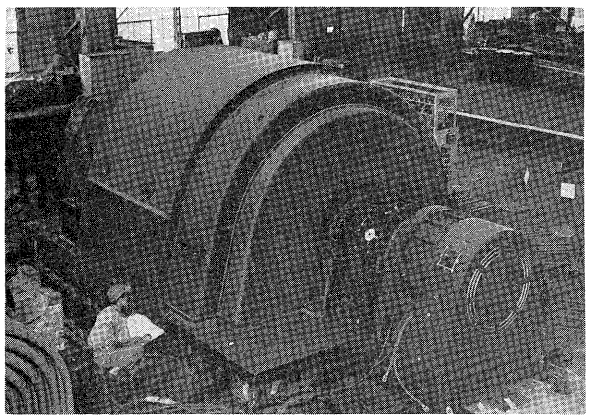

Fig. 2. 30 MVA synchronous condenser for Burma.

II. STATOR

This stator may be separated into two parts, namely the upper part and lower part, in order to meet with a limited weight of transportation up to 25 tons. The stator core is made of the laminated silicon steel sheets of the T class which are clamped together with the special steel studs. The vibration-protecting support is made for these studs at several points in their longer sides.

A wave winding of one coil and one turn is employed for the winding of the stator, and the conductors are transposed within the slots ; while a complete moisture-proof finishing is applied for necessary parts of insulation.

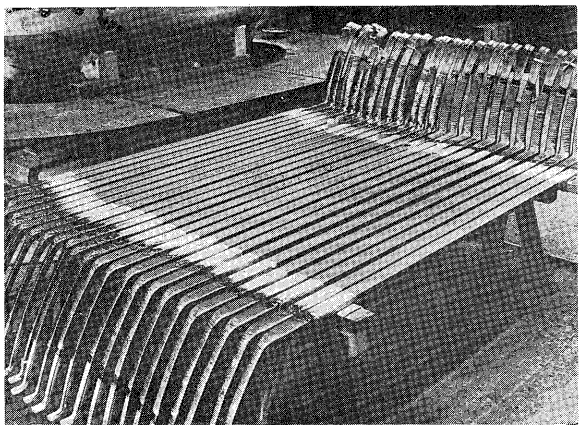

Fig. 3. Stator coil

III. ROTOR

As for the method of fixing the magnetic pole, we have employed a special comb-form pin fitting system, and these pin holes are made with a precise reamer finishing ; while, for material of these pins, a forged special steel is used. This method might be said the most reliable and safest for fixing the magnetic pole of the high-speed salient synchronous machine. Both the shaft and rotor-center are made of a mono-construction forging in order to increase its mechanical reliability.

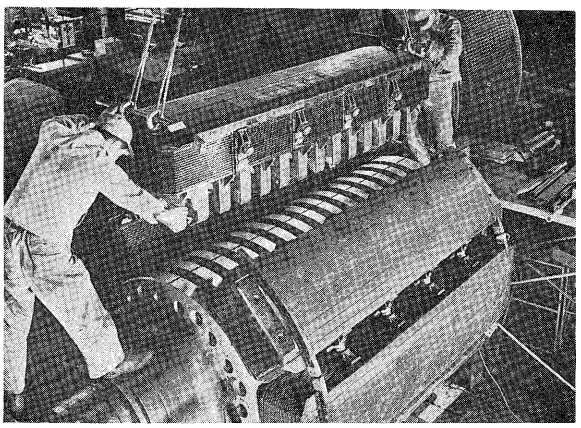

Fig. 4. Rotor in assembly

IV. BEARINGS

The turbine oil is stored within the bearing stand to lubricate onto the bearing surface with oil rings. The bearing bush is made of cast backing iron lined with white metal, and the cooling water pipe

is embedded within this bush. This pipe is also arranged within the turbine oil kept in the bearing stand in order to prevent the bearing temperature from rising even in such a tropical area as Burma.

At starting time, a state of fluid friction may be secured by supplying oil onto the bearing surface from a high pressure oil pump for the purpose of lessening the bearing friction. This oil pump is located directly nearby the bearing stand.

V. VENTILATION

The air required for cooling both the rotor and the stator, is to be absorbed from the space under the floor of the synchronous machine into it through the air filter mounted on the wall of the building. For this purpose, two axial fans are provided to the rotor shaft. The air, finished cooling the machine, is to be exhausted to the outdoors through the duct under the floor.

As the carbon di-oxide fire extinguisher is fitted to this equipment against an accidental fire, the air damper is provided at both the inlet and outlet of cooling air in order to secure a complete sealing of it at the time of carbon di-oxide discharge. This air damper can be operated in either automatic or manual system.

VI. COOLING WATER

The cooling water necessary for the bearings can be supplied by a deep well about 30 meters distant from the synchronous machine building. This water is once reserved in the water reservoir and then pressure is imposed upon it by the vertical centrifugal volute pump needless to prime. Thus the water is delivered to the bearing through the piping embedded under the ground. The lukewarm water after cooling the bearing is to be exhausted through another piping also embedded under the ground.

VII. DISASSEMBLING AND ASSEMBLING

The disassembling and assembling is to be carried out by the overhead travelling crane of 50-ton capacity. At first, the stator is installed, and then the rotor is to be placed at a designated position by the crane. At this time, the stator frame must be kept elevated with jacks at the height of approximately 30 cm above the floor level. The band and beam for hanging the rotor, and these jacks are made of special design, respectively.

The reamer pin for fixing the magnetic pole of the rotor is pushed into its assembled position by the oil jack, which is also used for pulling out of the rotor. Thus, the work can be carried out with safety and easiness.

VIII. RESULT OF TESTS

As this substation does not require a line charge, the starting may be carried out in the direct way through the starting transformer. As a result of the starting test, it has been proved that synchronization can be secured within three minutes or so after its starting, and that the starting power (kVA) is only 23% of its rating. A result of the charateristic test is given by the Fig. 5. The losses on

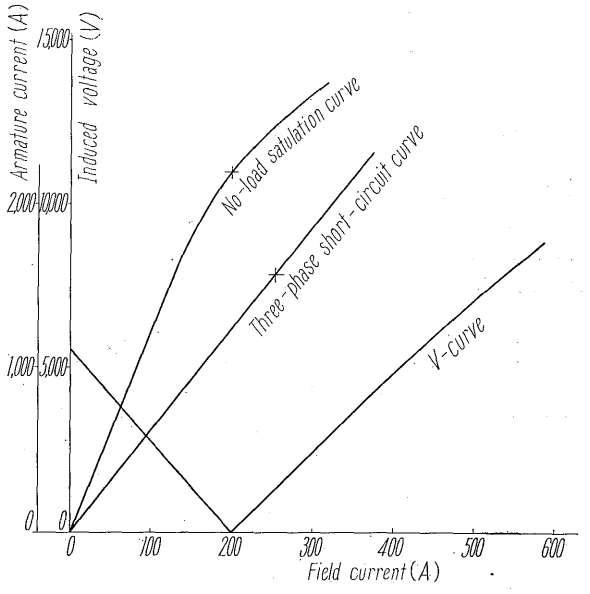

Fig. 5. Characteristic curve

each different load have been kept at such values much below the guaranteed ones, as a result of our efforts so as to minimize windage loss, stray loss and so forth. Also, we have been nearly unable to find any distortion in the no-load induced voltage wave form ; and besides, expected results have been obtained to our satisfaction as to the measuring of various reactances, time constants and to the exciter quick response test. Because of the operation in the tropical area, special requirements have been provided as to keep the temperature rise below the standard, and the results of temperature test have shown lower temperature rise than the value of requirements at every part of the machine.

These equipments are to be shipped from Yokohama, Japan, to Rangoon, Burma, and to be delivered up to the construction spot on the trailer-trucks.

The deepest acknowledgement should be expressed by the author for cooperation offered by our company staff and others concerned, at the completion of these equipment. And the whole hearted blessing shall be given to the future of these equipments to be delivered abroard as one symbol of Japan's industrial levels.

(By Kei Yoshida, Rotary Machine 2nd Div., Design Dep't).