

Fig. IV-3. Marine Diesel Engine for Fishing Boat
Model 6SD30, 400 HP, 360 r.p.m.

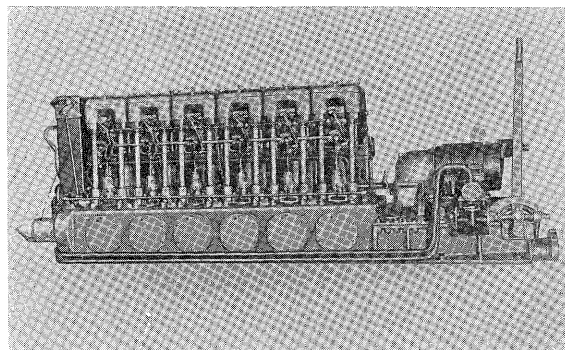


Fig. IV-4. Marine Diesel Engine for Main Motor
of Patrol Boat, Kaijo Hoan-cho, Model
6HD20, 350 HP, 1,200 r.p.m.

V. ALTERNATING CURRENT MACHINES

V-1. SYNCHRONOUS MACHINES

Our production of synchronous generators has increased year by year and now amounts to over 100,000 kVA per year. In table 1, our recent products of water turbine generators over 10,000 kVA are enumerated. Our record in capacity is 30,000 kVA generator of the Utsubo Power Station,¹⁾ but the gene-

rator of the Akiba Second Power Station, under construction, is the larger one, i.e. 41,000kVA generator.

Ordinarily, the form and construction of water turbine and generator are each separately designed and manufactured, but the thrust bearing of the 23,500 kVA Jintsugawa Second Power Station generator is arranged on the upper cover of the Kaplan turbine and this construction was the newest at the

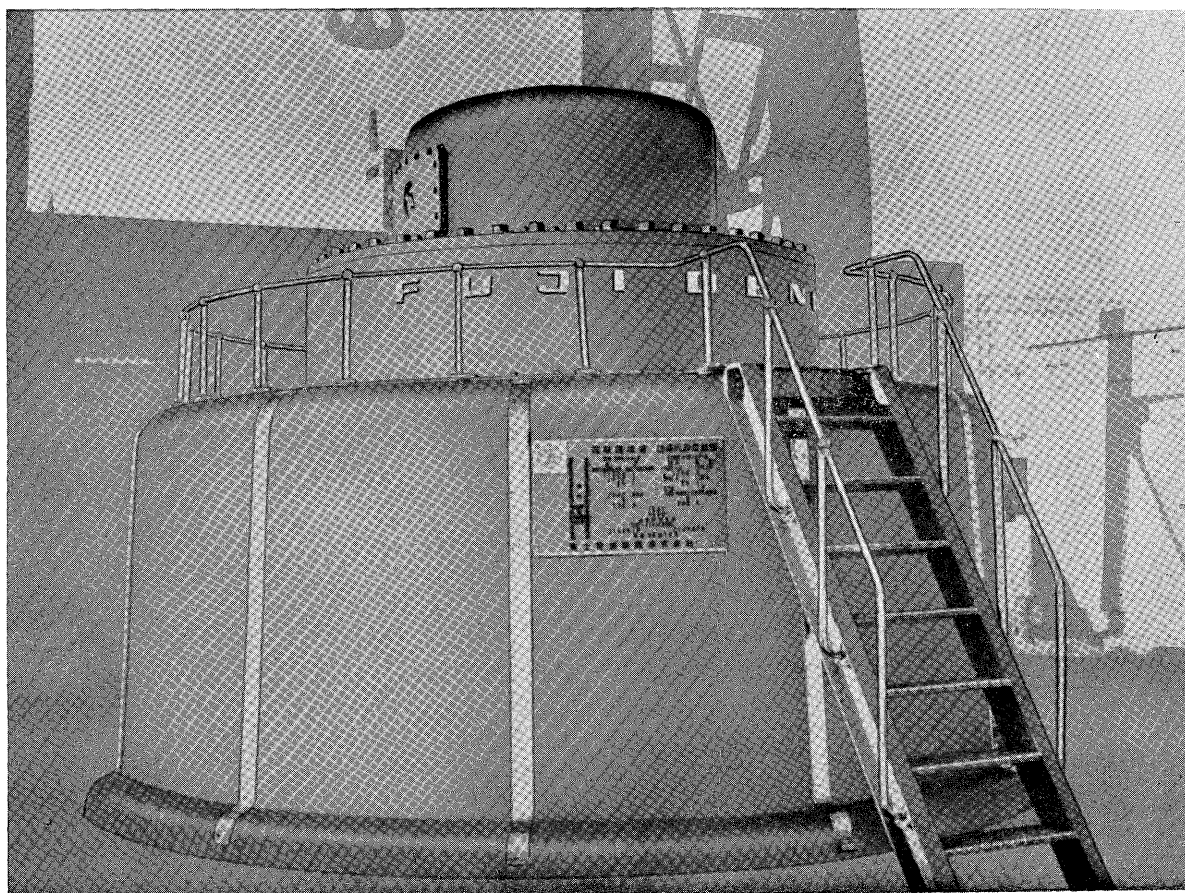


Fig. V-1. 30,000 kVA Rotary Condenser at Shin-Sapporo S.S. in Hokkaido Electric Power Co.

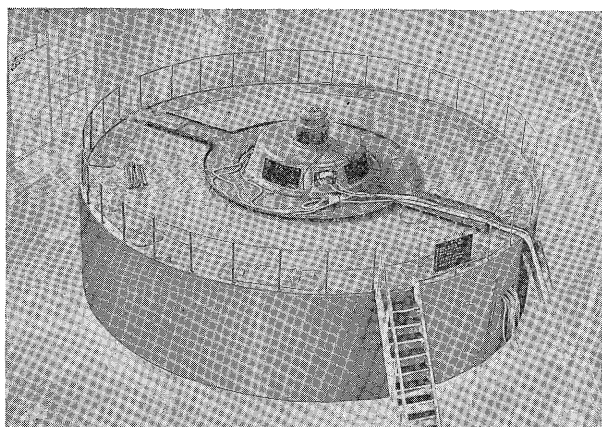


Fig. V-2. 30,000 kVA Umbrella Type Generator for Utsubo P.S.

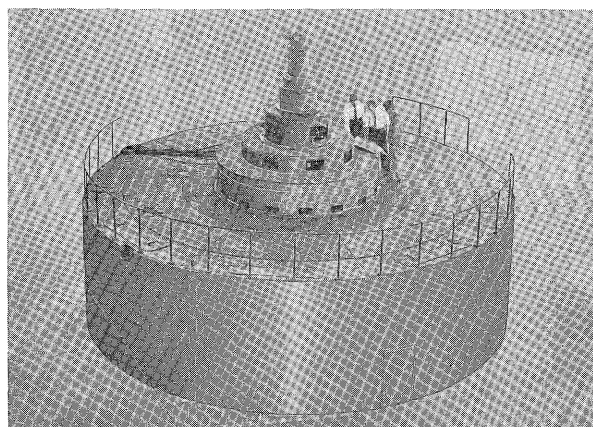


Fig. V-3. 23,500 kVA Generator for Jintsugawa No. 2 P.S.

time in Japan. Furthermore, the 11,000 kVA generator of the Jintsugawa Third Power Station forms a consistent whole with the Kaplan turbine, whose runner servo motor is contained in the center boss of the generator.

Main insulation of the stator coil is roll mica by baking method; recently our insulation process is more advanced, special consideration taken to reduce the heat deformation of the coil. The Company uses ordinarily so called "Gitter-Stab" windings for generators whose voltage is 10 kV class and capacity over than 20,000 kVA, e.g. the 30,000 kVA generator of the Utsubo Power Station, the 24,000 kVA generator of the Sudagai Power Station and so on. "Gitter-Stab" coils are made one turn for one coil and preventing layer short circuit, they are therefore the most reliable.

The rotor of our high speed generator is ordinarily the grooved rotor of comb shaped pole (e.g. the 13,000 kVA 600 r.p.m. generator of the Kakkonda First Power Station, the 30,000 kVA 2,000 r.p.m. synchronous condenser of the Shin-Sapporo Substation and so on). Large capacity generators whose rotors are splitted for transportation are made with the dove-tailed pole construction (e.g. the 30,000 kVA generator of the Utsubo Power Station, the 23,500 kVA generator of the Jintsugawa Second Power Station and so on). The rotor yoke is shrunk fit to the shaft or the spider, therefore vibration of the machine is effectively damped. Because our spider is made of welded steel plates, it is very stiff and light in weight. Lubrication of the bearing is generally the self-contained, water-cooled system and so maintenance of the bearing is very easy.

Our recent generator has no sub-exciter and generator voltage is excellently regulated by the magnetic amplifier type AVR, our unique product. The Company adopted this system as the first in Japan to the 8,500 kVA 500 r.p.m. generator of the Izawa Power Station in 1953 and gained excellent results in the site.

In Table 1, the 24,000 kVA generator of the Sudagai Power Station is the first product for the underground power station in Japan, and the noise reduction and humidity-proof construction are specially considered in design and manufacturing.²⁾ The 11,000 kVA generator of the Jintsugawa Third Power Station is the record in Japan as the low speed Kaplan turbine generator. And the 41,000 kVA generator of the Akiba Second Power Station under construction is the largest Kaplan turbine generator in Japan.³⁾

The 30,000 kVA 1,000 r.p.m. synchronous condenser⁴⁾ of the Shin-Sapporo Substation, Hokkaido Electric Power Co., is the record unit in the world as the outdoor use hydrogen-cooled vertical shaft type with the magnetic bearing. Pulling up the rotor weight by the magnetic bearing, thrust bearing loss is greatly reduced and total loss of the condenser is smaller than that of the horizontal type of the same capacity. The 13,000 kVA generator of the Motosu Power Station and the 17,000 kVA generator of the Tochio Power Station, are vertical shaft type Pelton wheel generators, and their thrust bearing losses are reduced by magnetic bearings. They are the first water turbine generators with the magnetic bearing in Japan.

Our recent production of Diesel generators for land and marine use is more than twenty pieces per year. As recent tendency the higher speed Diesel generator is preferable, and smaller or larger capacity generators have one bearing and medium capacity generators two bearings. In table 2 our recent products of Diesel generators are enumerated.

Lately design and manufacturing of synchronous motors have progressed greatly and it is usual practice that low speed large capacity motor as the compressor motor is a synchronous machine. Our recent synchronous motors are the 4,200 HP 200 r.p.m. motor of the Sumitomo Chemical Industry Co., the 2,900 HP 150 r.p.m. motor of the Befe Chemical Industry Co., the 2,200 HP 257 r.p.m. motor of the Ube Industry Promotion Co. and so

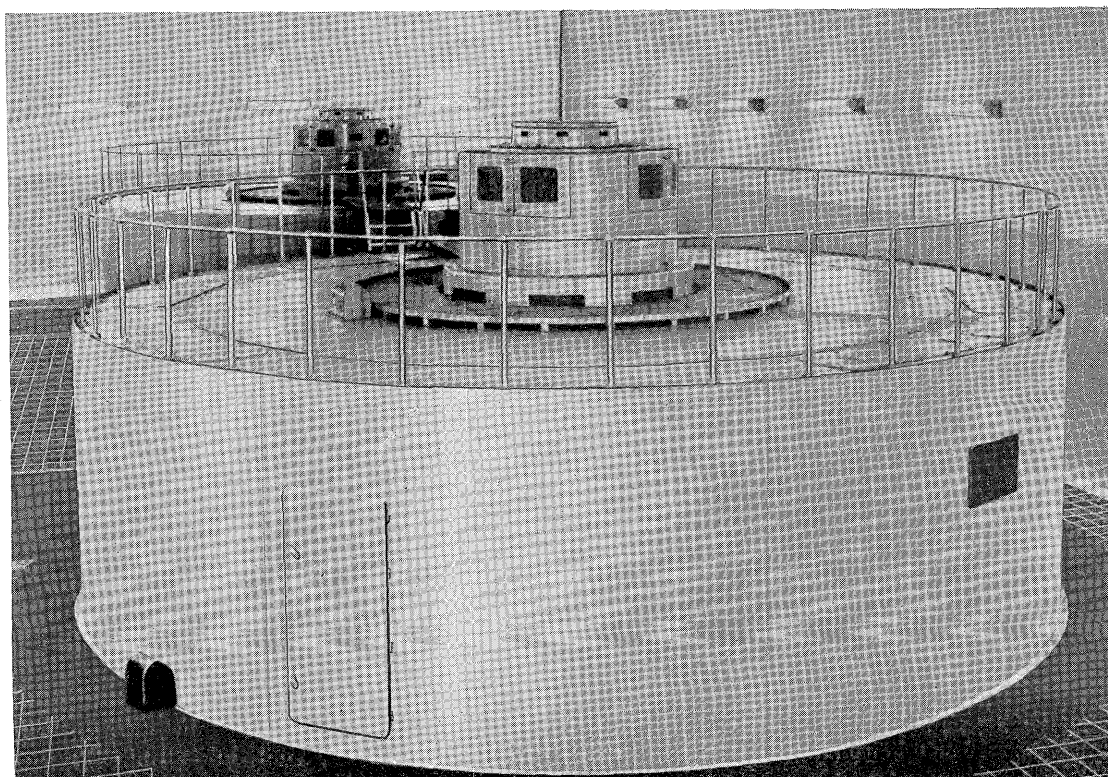


Fig. V-4. $2 \times 24,000$ kVA Generators for Sudagai Under-Ground P.S.

on for compressor use; the 1,500 HP 500 r.p.m. motor of the Nihon Steel Pipe Co., the 1,200 HP 500 r.p.m. motor of the Special Steel Manufacturing Co. and so on for steel mill use. For above-mentioned motors the split stator winding start method is used in the case of small back power, the stator winding connected single star at start and double star at running operation, and then starting current is reduced to about 200% of rated current at line start. The damper winding is ordinary special cage winding of double cage or inverted T type by which larger starting torque is gained with smaller starting current.

Our Simplex motor is preferable to starting heavy load as cement mill use, having two-phase starting winding on its rotor pole shoe, it starts as a wound rotor type induction motor and its starting efficiency is very good. Our typical Simplex motors are the 2,500 HP 300 r.p.m. motor of the Jujo Paper Manufacturing Co. for pulp grinder use, the 1,000 HP 130 r.p.m. motor of the Onoda Cement Co., the 1,000 HP 144 r.p.m. motor of the Nozawa Asbestos Co. for cement mill use and so on. Our production of the Simplex motor is more than twenty pieces and all the motors are operated satisfactorily in the site.

V-2. ASYNCHRONOUS MACHINES

By progress of silicon steel, insulated wire and other materials and improvement of cooling method, our standard induction motors are extremely small and light. Our enclosed ventilated type general

purpose motors with sealed bearings are much used in all fields of industries and have gained excellent popularity for their good electrical and mechanical characteristics. Now the Company has started manufacturing new type totally enclosed type and enclosed ventilated type standard motors according to the standard outline dimension of JEM (Japan Electrical Machinery Association).

The Company has made unceasing improvement and progress on several motors for special use—textile motor, explosion proof motor, crane motor, machine tool motor, geared motor and so on. Specially, the spinning pot motors and their frequency changer set for rayon industry are one of our products which the Company can be proud of and the new type pot motors which the Company completed several years ago, have excellent mechanical and electrical characteristics enjoying good reputation in the circles.

Our recently developed motors for special use—chemical motor, submersible motor, motor pulley, SB motor, KS motor and so on—are much demanded.⁵⁾ SB motor (Self-Brake motor—our trade name) is a motor of the cone shaped rotor, and brakes itself by magnetic thrust pull between stator and rotor core without any special brake mechanism as electromagnetic brake; therefore it is the most proper motor for severe start and stop cycling use. KS motor (our trade name) is a speed changeable motor, composed of a cage rotor type motor and a eddy current coupling, and its speed may be regulated

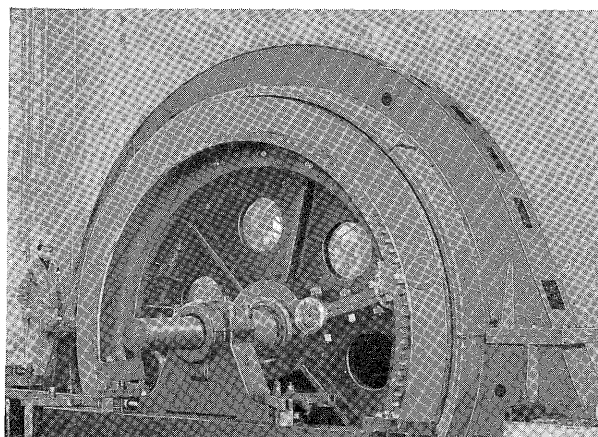


Fig. V-5. 4,200 HP 200 r.p.m. Synchronous Motor

smoothly and automatically with small exciting energy of the coupling by the magnetic amplifier device. KS motor will be much used in place of d.c. motor, a.c. commutator motor and wound rotor type motor.

Lately special outline dimension motors are required for wood machine tool use and so on, to be composed with machine tool in one compact body as the most matched form. The Company has been producing such motors of several types—axially long motor, rectangular frame motor, grooved frame motor for axial shifting. The 400 W and 200 W 12,000 r.p.m. motors of the Nihon Musical Instrument Manufacturing Co. are used for special wood machine tool and have speciality in using their grease-lubricated ball bearings for ultra high speed operation.

For iron and steel industry use, specially Ilgner set driving, the Company delivered many large induction motors—the 5,000 HP 428 r.p.m. motor of the Nihon Steel Pipe Co., the 6,000 HP 514 r.p.m. motor of the Yawata Iron Manufacturing Co., the 5,000 HP 428 r.p.m. motor of the Kawasaki Iron Manufacturing Co. and so on. Maximum torques of these motors are over 250% and temperature rise of stator coils lower than 40°C for B class insulation. For steel mill use, the 2,500 HP 88 r.p.m. and 2,500 HP 240 r.p.m. motors of the Kawasaki Iron Manufacturing Co. and so on have been delivered.

High speed large capacity induction motors of two poles and four poles for high speed compressor, blower and pump use are one of the machines, which the Company is proud of. Our recent high speed motors are the 2,600 HP 3,600 r.p.m. motor of the Sumitomo Chemical Industry Co., the 2,500 HP and 2,200 HP 3,000 r.p.m. motors of the Tokyo Gas Co., the 1,800 HP 3,000 r.p.m. motor of the Tokyo Electric Power Co.,⁶⁾ the 1,000 kW 1,500 r.p.m. motor of the Fuji Iron Manufacturing Co. and so on. These motors are all wound rotor type ones. The 1,300 kW 3,600 r.p.m. motor of the Sanyo Chemical Industry Co. is a cage rotor type one, using deep slot bar of special form, and has

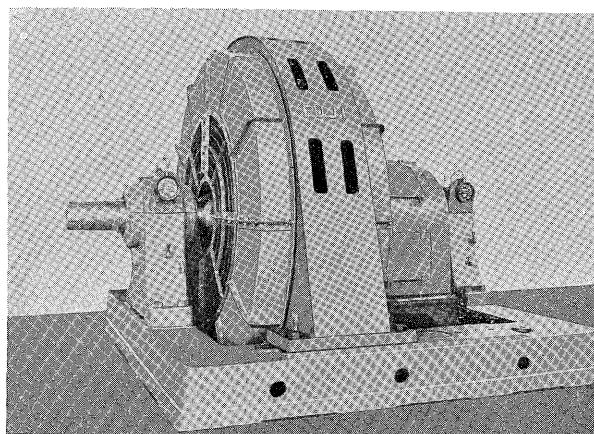


Fig. V-6. 2,500 HP 300 r.p.m. Simplex Motor

good starting characteristics at about 200% starting current with the starting compensator.

Large capacity totally enclosed fan-cooled induction motors are standardized as the NR motor⁷⁾—the pipe-cooler type motor. The Company has delivered numerous NR motors—vertical and horizontal, cage and wound type, and various no. of poles. Our recent NR motors are the 400 kW 3,000 r.p.m. motor of the Furukawa Mining Co., the 450 HP 3,600 r.p.m. motor of the Sumitomo Chemical Industry Co., the 300 HP 750 r.p.m. motor of the Tokyo Gas Co. and so on.

By progress of Silicone insulation materials, H class induction motors have generally been used in several cases—at places of high ambient temperature, for reducing the outline dimension of motor and so on. Our recent products of H class induction motors are the 250 HP 750 r.p.m. motor of the Nihon Cement Mfg. Co., the 400 kW 720 r.p.m. motor of the Matsushima Coal Mining Co. and so on. Terminal voltage of these motors are 3,000 V class, the wound rotor type, and the stator and rotor windings insulated carefully by Silicone materials by our unique insulating process. Low tension small capacity H class induction motors have been numerously delivered to several fields by the Company.

Numerous induction motors for winding machine use—the 700 HP 327 r.p.m. of the Furukawa Mining Co. and so on—were designed and manufactured; it is worth mentioning that the Company now manufactures the electric driving set for the Koepe type blind-shaft winding machine of the Omine Coal Mine, Furukawa Mining Co. The main motor is the 380 kW 600 r.p.m. wound rotor type induction motor, its braking and low speed operation made by the 3 c/s 60 kVA a-c exciter, and this system is the first in Japan.

The 310 kVA a-c exciter delivered to the Fuji Iron Mfg. Co. in 1954 is the record unit in Japan for its capacity and frequency range. Being the existing 1,400 HP 500 r.p.m. mill motor excited by

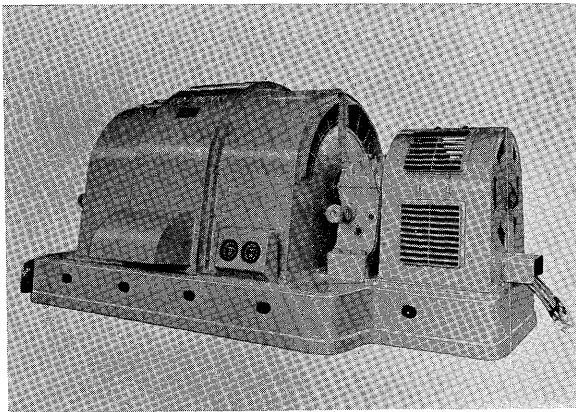


Fig. V-7. 1,800 HP 2p High Speed Induction Motor

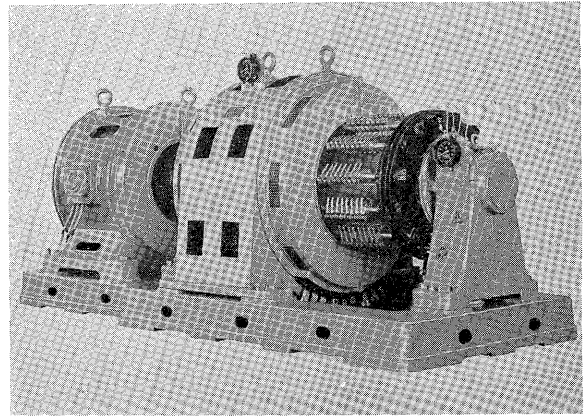


Fig. V-8. 310 kVA A-c Exciter

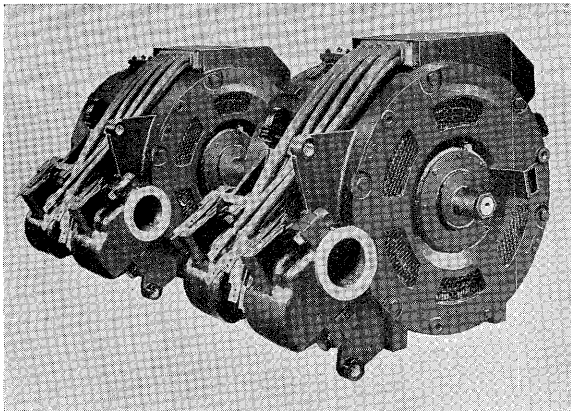


Fig. V-9. 335 kW 50 c/s Locomotive Motor

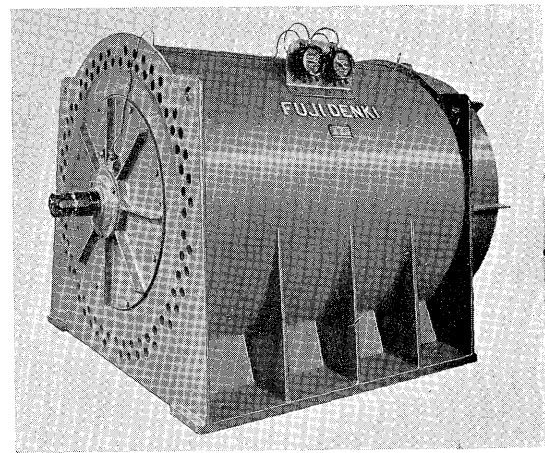


Fig. V-10. 450 HP Totary Enclosed Induction Motor with Pipe Cooler

this machine, the motor speed is regulated between 360 and 600 r.p.m. for changing of the wire mill speed. The SK type a-c exciter has large no. of poles for higher slip frequency, reducing flux per pole, so the commutation is better. The machine speed being 1,000 r.p.m., the dimension and weight are much reduced. For compensating the field reactance of SK type exciter, self-excited commutator type exciter is driven by the low frequency cage motor, connected electrically to the secondary side of the main motor. This reactance compensation method is our unique technique and its excellency also has been verified by this set.

The 50 c/s a-c single-phase series commutator motor delivered to the Japan National Railways Cor. in 1955 is the record product in Japan and a noteworthy machine in the world. The motor is designed and manufactured as the main motor for commutator motor type locomotive, tested at the Sendai-Yamagata line for practical research of a-c electrification of the railway. Specification of our motors is: output 335 kW, speed 1,160 r.p.m., voltage 200 V, current 2,350 A, one-hour rating and no. of poles 14.

Excellent results were gained at home test and field running test.⁸⁾

"No Break" a-c power equipment is mainly used for telephone and telegram, its demand increases rapidly in proportion to erection of the non-maintenance substation for wireless or micro wave telephone and telegram. The Company paid special attention to the equipment several years ago, and making much experiments and researches, now manufactures as standard three different forms of "No Break" equipment—IG, MSG and MIG system—according to service conditions.⁹⁾

Reference

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| (2) | " | " | 1956 No. 2 P. 48~55 |
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Table V-1. Our Recent Products of Water Turbine Generators (over than 10,000 kVA)

Customer	Power Station	Output kVA	Voltage V	Speed r.p.m.	Type	No. of piece	Water turbine	Delivered year
Kansai E. P. Co.	Utsubo	30,000	11,000	200	V (u)	1	F	1953
Tohoku E. P. Co.	Kakkonda I	13,000	11,000	600	V	1	F	"
Hokuriku E. P. Co.	Jintsugawa II	23,500	11,000	200	V (su)	2	K	"
Kansai E. P. Co.	Tsunokawa	13,000	11,000	300	V (su)	1	K	1954
Hokuriku E. P. Co.	Jintsugawa III	11,000	11,000	100	V (u)	1	K	"
Tokyo E. P. Co.	Sudagai	24,000	11,000	250	V (su)	2	F	1955
"	Fujiwara	21,000	11,000	250	V (su)	1	F	1956
Fukui Pref.	Nakajima	11,000	11,000	600	V	2	F	"
Yamanashi Pref.	Nishiyama	10,800	11,000	600	V	2	F	"
Nippon Light Metal Co.	Motosu	13,000	6,600	720	V	1	P	"
Hokuriku E. P. Co.	Tochio	17,000	11,000	400	V	1	P	"
Electric Power Development Co.	Akiba I	30,000	11,000	200/167	V (u)	2	F	} Under Con- struction
"	Akiba II	41,000	11,000	180/150	V (su)	1	K	

Note: V—Vertical type V (u)—Vertical shaft umbrella type V (su)—Vertical shaft semi-umbrella type
 F—Francis turbine K—Kaplan turbine P—Pelton wheel

Table V-2. Our Recent Products of Diesel Generators (over than 500 kVA)

Customer	Output kVA	Voltage V	Speed r.p.m.	No. of pieces	Delivered year	Service
Omi Silk Mfg. Co.	500	3,300	400	1	1954	Land use
Ube Promoting Ind. Co.	625	3,300	600	2	"	"
Yokohama Gum Co.	625	3,300	514	1	"	"
"	560	3,300	600	1	"	"
Mitsubishi Ship Bldg.	687.5	450	360	3	1955	Marine use
Tohoku E. P. Co.	950	3,450	240	1	"	Land use
Bridge Stone Tyre Co.	500	3,300	600	1	"	"
Tokyo Gas Co.	1,250	3,450	333	1	"	"
Osaka Ship Bldg.	680	450	450	3	1956	Marine use
Nisshin Chem. Industry.	625	3,300	600	1	"	Land use
Taiyo Fishing Co.	687.5	450	600	3	"	Marine use

VI. DIRECT CURRENT MACHINES

VI-1. INTRODUCTION

Recently, our d.c. machines made surprising progress for all over the industries and especially in the iron and steel industry, we manufactured large electrical equipments one after another, which were planned for the First and Second Rationalization of Iron and Steel Industry in Japan, and they won always the admiration of customers on their excellent characteristics.

Fuji Control-dynamo (rototrol type) were used for the automatic control for these d.c. machines, to-

gether with the amplitrans or electronic amplifiers. Otherwise, it is our recent progress that the static Ward-Leonard System by the mercury arc rectifier is applied for all industries, especially in the iron and steel industry or paper making industry, as the d.c. source of these motors, before other makers.

As to the d.c. machines for marine services, the cargo winch, especially Ward-Leonard Winch, is most popular in our country because of the excellent characteristics and the light weight, and almost all winches of this type in Japan are supplied by us.