WESTINGHOUSE ELECTRIC CORPORATION



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10 HIGH STREET BOSTON 10, MASS.

Oxford Paper Company Rumford Maine

April 18, 1952

Mr. J. A. Rogers Engineering Department

> 10,000 KW Condensing Extraction Turbine-Generator Unit Our Negotiation No. 8563

We are pleased to present herewith six copies of our proposal covering a 10,000 KW condensing automatic extraction turbine-generator unit in line with the specifications outlined in your letter of April 5, 1952. Our proposals are being forwarded at this time so that you and interested parties may have an opportunity to review same.

Price and shipment information is not yet available from our Headquarters at this writing but will be sent to you in a supplemental letter shortly.

We are looking forward to discussing our proposal and the details of construction of the equipment that we are offering with you and others interested in the not too distant future.

C. G. Parkér, Steam Engineer

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ENGINEERING DEPT.

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Job No. 2447

Job Title: BLEEDER TURBINE

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Explanation of Purpose:

The continuing increase in the power demand at Rumford has made it necessary to add steam power generating units to our system from time to time. In 1941 with a system load of 20,900 KW, a period of extremely serious power shortages was encountered and it became necessary on an emergency basis to install a secondhand, 7500 KW condensing turbine. By 1948 power demands had risen further to 28,200 KW, again presenting a situation of extreme power shortage, and in anticipation of this situation a new 8000 KW back pressure turbine was installed. Power loads continued to rise and in 1952 a recommendation was made to begin a plan of conversion from 40 cycle to 60 cycle power and to cover impending serious power shortages by installation of a 10,000 kW, 12,500 kVA bleeder turbine. eral approval of aplan for 40 to 60 cycle conversion was given, including the bleeder turbine and a new 80 foot, 60 cycle hydroelectric plant to replace worn out > hydro-mechanical and hydroelectric equipment in the Island Division and Oxford At the present time, installation of the hydroelectric plant has been completed but provision of the new bleeder turbine was deferred. In the meantime. rewinding of the generator on the condensing turbine had increased its capacity by 1000 KW in 1953 and the new hydroelectric plant will increase overall generating capacity by 1100 KW at 1700 CFS; 500 KW at 1500 CFS.

The Capital Work Program for 1954 and 1955 along with Light Company increases will add 3800 KW to the total power demand. This will bring the system load at the end of 1955 to 37,750 KW, and power shortages will be about the same as they were in 1941 when the company was forced to install the second-hand turbine and in 1948 when it was necessary to provide the back pressure turbine. The potential loss to the company through not having the new turbine was evaluated in a 13-year power study made in 1952 for system loads of 35,000 KW and 40,000 KW. Figures from this study have been adjusted and interpolated for the system load of 37,750 KW which will exist at the end of 1955. It is apparent that if a new turbine is not provided by that date, the company will be faced with serious monetary and production losses and that these will increase rapidly with the passage of time as can be seen from the following figures.

Power Demand	Loss in Average Water Year	Loss in Low Water Year
35,000 KW	\$ 50 , 300	
37,750 KW (end of 1955)	\$147,000	\$552 , 000
40,000 KW	\$320,000	

The above losses will be incurred in additional coal costs by use of condensing instead of back pressure power, cost of purchased chlorine and in actual loss in paper production by shutting down the machines in the order in which they can be best spared. If it should be found possible to purchase chlorine and caustic at regular prices and also to purchase suitable groundwood pulp whenever desired, the average loss for 37,750 kW might be reduced from \$147,000 per year to \$111,000 per year. If, on the other hand, the company should make special efforts to avert production losses for the benefit of the customer as was done recently by rental

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Job No. 2447 (Sheet #2)

of diesel generators, the costs associated with power shortages would undoubtedly be greater than the figures shown above.

The Company's Capital Work Program beyond 1955 is not sufficiently defined to permit a forecast of power demand above 37,750 kW. It is considered certain, however, that the town load will continue to increase at a substantial rate and that the Oxford demand will also continue to increase, even though all possible efforts are made to minimize future power additions. A load of 40,000 kW will be experienced in the near future, and without a new turbine, the losses associated with such a load are certainly prohibitive.

When the 8000 KW back pressure turbine was installed, a turbine hall was provided of sufficient capacity to accommodate a second turbine at a later date. It was foreseen at that time that increasing mill loads would require the second turbine and that such a turbine would be economical because it could draw steam at 375# per square inch from our old pulverized coal boilers and bleed substantial quantities for process use at a low operating cost for power generation from such steam. It was considered that this turbine would be the last steam unit which could be installed with economy for use with our present boiler plant, and building space was therefore provided for only the one additional unit.

The proposed new unit will be a 10,000 KW bleeder turbine taking steam at 375 psig throttle pressure, 625 degrees total temperature, extracting at 50 psig pressure and including a condensing section and condenser for 1.5" Hg. absolute pressure. The turbine generator will be rated at 12,500 KVA, 80% power factor, 11,500 volts and will be equipped with a direct connected exciter. The unit will furnish 60 cycle power, and the turbine capacity will be such that at unity power factor, 12,500 KW can be generated. The condenser will be a 9000 square foot surface condenser with auxiliaries including two condensate removal pumps and two cooling water pumps. A heavy reinforced concrete foundation will be necessary for the turbo-generator.

Suitable switchgear, including a voltage regulator, will be provided to deliver power from the turbine to the present 11,500 volt bus in the switchgear building. All necessary miscellaneous electrical equipment, including motors, controls and wiring for turbine and condenser auxiliaries is included. The operating panel for the turbine generator will be on the ground floor of the switchgear building, and an instrument panel for the turbine, reducing station and other controls will be located in the turbine building. The location of the turbo-generator in the turbine hall is shown on the attached drawing No. E-15902.

The steam extracted from the turbine will be carried by a new 24 inch, 50 psi main and distributed to electrically driven paper machines, evaporators, new and old bleach plants, acid plant, pulp dryer, kraft mill, blow tank room, causticizing room, electro-chemical plant and new finishing room as shown diagrammatically on drawing No. E-15895 and in quantities indicated on drawing No. F-15899.

The installation will also include three steam flow meters for measuring steam to the turbine, extraction from the turbine and the total 50 pounds per square inch steam delivered to the mill. Five reducing valve stations and two new desuperheating stations as shown on drawing No. F-15893 will be necessary in order to properly control pressures in the different steam mains, bypass steam to process when turbine units are shut down or operating at part load, and suitably control the temperature of steam at the various pressure levels.

In order to furnish steam to the new turbine it will be necessary to raise the pressure on #1 and 2 boilers from the present level of 200 psig header pressure to 400 psig header pressure for which they were designed. New superheaters will be added to the boilers in order to provide the proper steam temperature for the turbine, and it will be necessary to retube the economizers not because of the turbine installation but because the present economizers are worn out to such an extent that they are not suitable for the higher pressure. This work is included in the capital job.

Associated with the turbine installation but not included in this job request is the necessary conversion from 40 to 60 cycle of approximately 3265 KW of mill equipment. These conversions are necessary to properly balance the load on the 40 and 60 cycle systems with the new turbine in use and to reduce the load on No. 3 substation so that the load may be carried with any bank out of service or with all transformers in service and the back pressure turbine down. This represents the minimum recommended protection for No. 3 substation. However, in making these conversions an attempt has been made insofar as possible to replace equipment which is worn out and would need to be renewed if kept in service. Considered for conversion from 40 to 60 cycle is part of A-B-C machine load 1465 KW, part of electro chemical plant, 1300 KW and No. 5 and 6 beater drives, 500 KW.

The proposed capital job also will not include certain repair work which will be necessary to the present #1 and 2 boilersnor repairs to steam plant auxiliaries and existing piping, nor maintenance painting and clean-up costs after repair work.

The preliminary 1952 estimate and the budget for the bleeder turbine were in the amount of \$1,250,000, but these old estimates were prepared to cover additions only and omitted such items as clearing site, piping relocations, retubing economizers and electrical relocations which are included in the present capital job and account for thehigher estimate of \$1,348,000. The various items contributing to the total estimate are classified, including contingencies and engineering in the following list.

Cost of turbine and condenser including erection Turbine foundation	593,000
Condenser cooling and condensate pumps including foundations	27,000
and installation	17,000
50# steam distribution system from turbine room to mill in-	_, ,
cluding necessary changes to control valves and metering	
orifices	166,000
700# and 400# piping including reducing and desuperheating	
stations	78,000
Misc. 135# and 50# piping including reducing stations	44,000
Piping insulation	31,000
Condenser and miscellaneous water piping	49,000
Water screen and chlorination system for condenser	
cooling water	39,000
Co, system for turbine generator	4,000
Instruments and metering	29,000
Electrical, including motors, switchgear and power wiring	117,000
Additional superheater elements - Nos. 1 and 2 boilers	18,000
Miscellaneous structural changes	8,000

Painting, clean-up and miscellaneous protection	
during construction	26,000
Spare equipment	4,000
Clearing site	9,000
Piping relocation	28,000
Retubing economizers - No. 1 and 2 boilers	29,000
Electrical relocations in steam plant and mill	32,000
TOTAL -	\$1,348,000

From time to time during consideration of this problem, the question has been raised as to whether it would be necessary to install a new boiler to furnish steam for the proposed new bleeder turbine. It is known that with the present condensing turbine at full load, the three large boilers plus the recovery unit have no more than sufficient capacity to carry present winter peak loads. An estimate therefore, has been made of the effect of the new turbine on steam demands during the winter period. Pertinent figures in this connection are as follows:

Amount of by-product power which can be generated in new turbine from 182,000 pounds per hour of steam bled at 50 psi pressure

6250 KW

Additional steam required from boilers to generate this power by loading new bleeder turbine to 12,500 KW capacity and unloading present condensing turbine from 8500 KW to 2250 KW capacity in order to make use of the improved water rate in the new turbine

7000#/hour

Reduction in steam demand which would be made by shutting down the old condensing turbine and operating the new turbine at 12,500 KW capacity, a gain of 4000 KW

34,000#/hour

Increase in power which can be generated with no change in overall steam demand by virtue of increased efficiency of proposed bleeder turbine

5750 KW

The above figures indicate that the proposed turbine would permit an increase in power generation of 5750 KW in the winter with no increase in boiler capacity as a result of increased efficiency of the new turbine. In the summer time the potential increase in generating capacity would be 12,500 KW.

Looking further to some future time when the company might have a softwood kraft bleach plant, new evaporator causticizing plant, recovery unit, etc., the amount of steam available for bleeding at 50 psi could reach a winter figure of 280,000 per hour, and this amount of bled steam with no condenser operation would generate 10,400 kW of by-product power in the proposed new turbine. Even this large amount of additional power generation would require only a small additional steam plant capacity and would be much more than covered by the recovery unit which would be part of the expansion picture.

If a low water year should be experienced in 1955-56, its consequences could be averted or minimized only if the proposed new turbine were available by January 1, 1956 or earlier; therefore, delivery and construction schedules are being worked out on the basis of operation not later than the end of the year and earlier if possible.

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PROPOSAL

ROMAGNA MANAGONA

OXFORD PAPER COMPANY RUMFORD, MAINE

10,000 KW CONDENSING AUTOMATIC EXTRACTION
TURBINE GENERATOR UNIT

No3

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Negotiation No. 8563

April 18, 1952

Westinghouse Electric Corporation Steam Division

I'N DE X

20P1ECL 2	ECTION
Bill of Material, Engineering Data and Contract Forms	A
Description of Turbine Including Exhibits	В
Description of Generator Including	C

RM 2335

BILL OF MATERIAL ENGINEERING DATA CONTRACT FORMS

W E S T I N G H O U S E E L E C T R I C C O R P O R A T I O N



1/44/50

					4/28/52	19_
То	Oxford Paper	Company				
10	(Hereinafter called	the Purchaser)				
	P. O. Address	Rumford,	Maine			40.00
	Shipping Address	Rumford,	Maine			

Westinghouse Electric Corporation (hereinafter called the Company or Corporation) proposes to deliver f. o. b. point of shipment the apparatus described herein: including rail transportation prepaid to rail siding nearest Purchaser's Plant.

- ONE (1) 10,000 kw, 3600 rpm, condensing single automatic extraction turbine generator unit consisting of:
 - (1) 10,000 kw condensing single automatic extraction, 3600 rpm, impulse type turbine designed to operate on steam conditions of 375 psig-625 FTT at the throttle, extracting automatically at 50 psig and exhausting to 1.5 Hg. Abs.
 - (2) 10,000 kw, .80 P.F., 12,500 kva, .90 SCR, 3600 rpm, 3 phase, 60 cycle, 11,500 volts, air cooled generator.
 - (3) 60 kw, 250 volt direct connected main exciter.
 - (4) Two section generator air coolers mounted within the generator housing and designed for 85°F cooling water.
 - (5) Set of accessories and auxiliaries as outlined herein.

Supervisory engineering services shall be provided for installation in accordance with Form 18110-B included as a part of this proposal.

PAGE 1

WESTINGHOUSE FORM 15499-C THREE SHEETS, SHEET! PRINTED IN U.S.A.

STEAM TURBINE GENERATOR UNIT

FEATURES O AUXILIARIES AND ACCESSORIES

- 1. Steam strainer with screen encased within throttle valve body.
- 2. Combined throttle and stop valve with trip actuated by the overspeed governor (including solenoid trip).
- 3. Separate overspeed governor.
- 4. Multiple steam control valves hydraulically operated.
- 5. Speed-governing system.
- 6. Synchronizing device arranged for both manual and motor operation.
- 7. Automatic device for controlling the pressure of the extracted steam by varying the flow of steam to the lower pressure stages of the turbine.
- 8. Necessary inter-connections between speed governor and extraction control mechanism.
- 9. Automatic non-return valve, with trip actuated from the overspeed governor.
- 10. Electric indicating type tachometer.
- 11. Complete lubricating oil system including:
 - A. Main oil pump mounted upon the turbine shaft.
 - B. Oil reservoir with removable basket type strainer.
 - C. Twin oil coolers, each of sufficient thermal capacity to serve the unit when supplied with ample cooling water at a temperature not exceeding 85°F.
 - D. Motor or steam turbine-driven auxiliary oil pump with pressure regulating device.
 - E. Steel oil piping connecting integral parts of the units oiling system, except connections to purchaser's oil-tripped non-return valve, piping to the steam driven auxiliary oil pump and to and from the main oil coolers.

- F. Oil pressure gauges.
- G. Low oil pressure emergency protective devices.
- H. Dial or stem type temperature indicating thermometers at the thrust bearing, exhaust hood. All turbine, generator and exciter journal bearings and at the oil coolers.
- 12. Operating steam pressure gauges to indicate the following steam pressures.

Α.			Diameter
В.	First Stage pressure	8-1/2"	Diameter
		8-1/2"	Diameter
D.	Exhaust pressure	8-1/2"	Diameter
E.	Gland Seal pressure	4-1/2"	Diameter

Board for mounting gauges (and connecting piping) to be provided by purchaser.

- 13. Motor operated spindle turning gear with motor-driven auxiliary oil pump (For use when unit is on the turning gear).
- 14. Steam seal glands on turbine with appropriate gland leakage condenser.
- 15. New set wrenches for all special nuts and bolts.
- 16. Seating plates when required by the design of the unit.
- 17. Heat insulating material for the high temperature parts of the turbine and painted protective steel jacket where practical and expedient.
- 18. Shaft mounted generator ventilating fans.
- 19. Generator field discharge resistor.
- 20. Embedded temperature detectors in stator windings.
- 21. Motor operated exciter field rheostat.
- 22. Dial type thermometer to indicate generator ventilating air temperature complete with 50 feet capillary tubing.

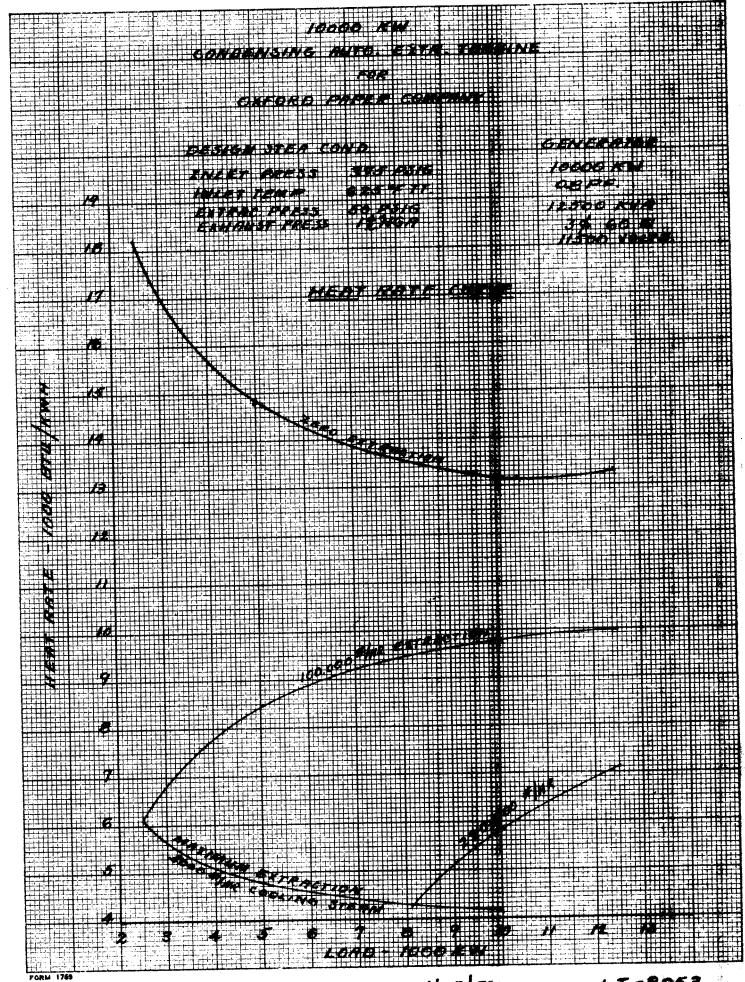
STEAM TURBINE PERFORMANCE SPECIFICATION

Oxford Paper Company	DATE 4/ 28 /52
Rumford, Maine	
GENERAL DESCRIPTION: The turbine will be of the Westing	
DIMENSIONS AND WEIGHTS—The approximate dimensions Length 32'8" Width 7'8" Height 7'8"	Net Weight 225,000 Shipping Weight 225,000
OPERATING CONDITIONS—The conditions under which the	turbine will be operated are understood to be
Steam pressure at throttle, pounds gauge	rometer)
CAPACITY—The maximum capacity of the turbine under al	pove conditions will be 12,500 Kw
ECONOMY—The steam consumption, when operating und with the generator herein described, will not exceed the clude all steam used and consumed by the turbine, and	quantities specified below. These quantities in-

economy—The steam consumption, when operating under the foregoing conditions and in connection with the generator herein described, will not exceed the quantities specified below. These quantities include all steam used and consumed by the turbine, and all losses in the generator including energy required in the field for excitation, and the losses of the direct connected exciter itself, if employed.

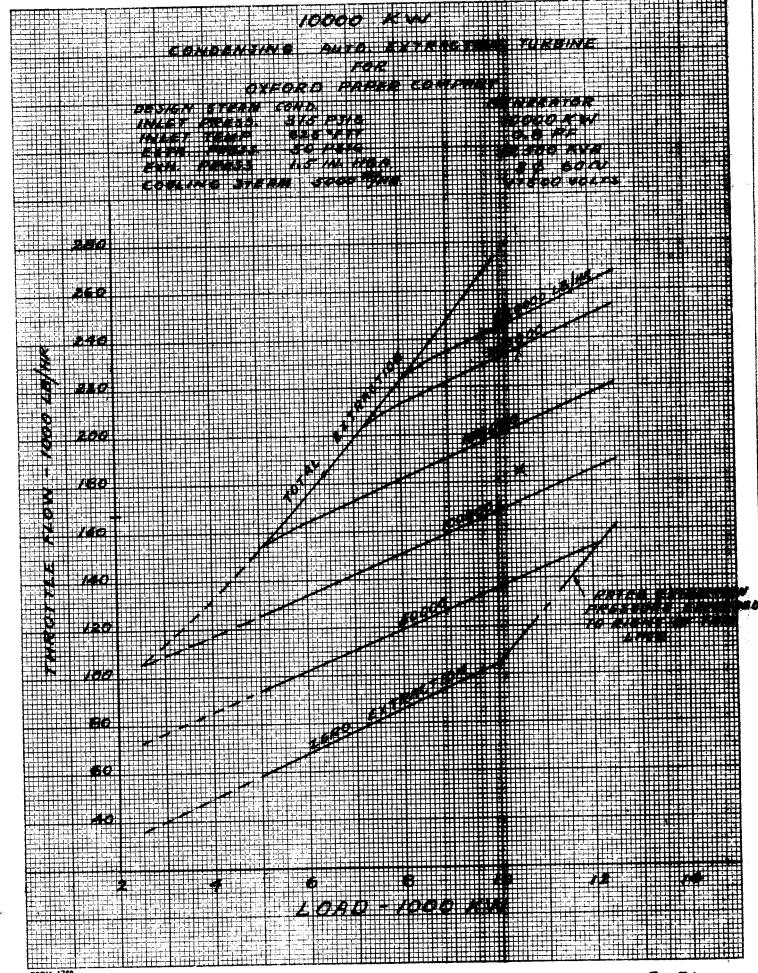
KILOWATT LOAD	POWER FACTOR	POUNDS OF STEAM PER KW. PER HOUR
Extraction performance	LT-8051	
Extracted steam enthalpy	LT-8052	
Turbine heat rates	LT-8053	

THROTTLE VALVE—The throttle valve will be located on the elither. XXXXX side of the turbine when viewed from the governor end. It will be arranged to be capable of being quickly closed, in the event of the turbine overspeeding, through the agency of the automatic stop governor.



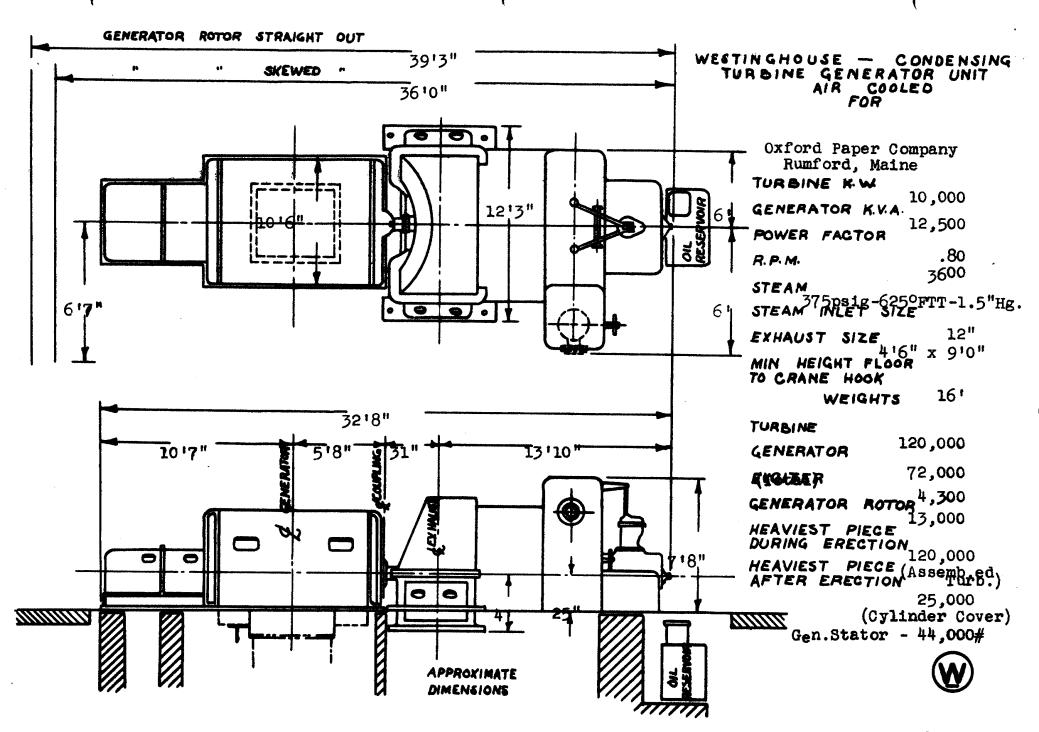
SIGNATURE_ W. 3.

DATE 4/ 15/52 CURVE NO. LT -8063



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WALL 4/15/52 CONVENT LT-8052



ALLOWABLE VARIATIONS FROM RATED

INITIAL STEAM PRESSURE AND TEMPERATURE

The turbine rating, capability, steam flow, speed regulation, and pressure control are based on operation at rated steam conditions. The turbine generator unit is capable of operation under the following variations in initial steam pressure and temperatures which may occur separately or simultaneously, but performance may not necessarily be in accordance with standards established for operation at rated steam conditions.

Pressure

The initial steam pressure at the turbine throttle valve inlet flange shall average not more than rated pressure at rated load and steam flow for any 12-month operating period. The turbine shall be capable of operating without injury at less than rated steam flow to the turbine with an average initial pressure of 420 psig. This permissible variation recognizes the increase in pressure with decrease in steam flow encountered in operation. The initial pressure shall not exceed 440 psig in maintaining this average.

During abnormal conditions, the initial pressure may swing momentarily to 480 psig, but the aggregate duration of such swings shall not exceed 12 hours per 12-month operating period.

Temperature

The steam temperature at the turbine throttle valve inlet flange shall average not more than 750 °F over any 12-month operating period. In maintaining this average, the temperature shall not exceed 765 °F.

During abnormal conditions, temperatures shall not exceed 775 °F for operating periods not more than 400 hours per 12-month operating period, nor 800 °F for swings of 15 minute duration or less, aggregating not more than 80 hours per 12-month operating period.

Page 6

Material Limitation Based on Materials of Construction.

GOVERNOR—A suitable and sensitive governor will be provided for controlling the speed by varying the admission of steam. The governor will be mounted on, or driven directly from, the turbine shaft.

When the turbine is operating under normal conditions, the change in speed resulting from a gradual change of load of 50% of rated load, will not exceed 2% of the normal full load speed.

The speed regulation may be greater than that specified, should the character of the load be such as to render a greater regulation desirable. In this case the governor will be so proportioned that there will be no tendency for the load to surge between this turbine and another with which it may be connected electrically in parallel, provided that the other unit is capable of performing in like manner.

Means will be provided whereby the speed of the turbine may be changed 5% above or below normal while the turbine is running. Such change will not in any way disturb the operation other than to cause the desired change in speed.

Unless otherwise specified, the governor speed changer motor will be arranged to be operated with 125 volts, direct current.

ADMISSION VALVES—Suitable governor controlled high pressure steam admission valves, will be provided.

SAFETY STOP—A separate safety governor will be provided, arranged to actuate a quick-closing device on the turbine throttle valve. Means will be provided for adjusting this governor so that the device will act at a predetermined speed (nominally 10% overspeed). It will be possible to trip this device by hand.

MATERIAL AND WORKMANSHIP—The various materials entering into the construction of the turbine will be of first class quality, and in kind conforming to approved practice.

The workmanship will be of high-grade character in every detail.

STATOR—The stator will be made of cast iron or steel as determined by the steam conditions and the character of the construction.

ROTOR—The rotor will be made of low-carbon or alloy steel as may be required. It will be accurately machined all over and of ample rigidity.

The turbine and generator rotors will be accurately balanced in a dynamic balancing machine, so as to run smoothly and without undue vibration.

TURBINE BLADES—The blades will be made of suitable material and of form and dimensions conductive to high economy.

MAIN BEARINGS—The bearings will be of design and construction suitable for the speed and load to be carried, so as to operate without excessive temperature or undue wear.

LUBRICATION—The lubrication of all main bearings will be effected by a continuous circulation of oil supplied through a system of delivery and return pipes, connected to a receiving reservoir. A suitable oil cooler and strainer will be furnished. A liberal supply of oil will be circulated for the purpose of cooling as well as lubricating the bearings.

A suitable oil pump will be furnished mounted on, or operated from the turbine shaft and which will deliver oil from the reservoir with sufficient head to insure ample flooding of the bearings. An auxiliary steam driven oil pump will be furnished by means of which the oil circulation may be maintained while starting and stopping the turbine.

LAGGING—The turbine parts enclosing steam of high temperature will be insulated with non-conducting material and when exposed above the floor line will be protected by sheet metal jackets, where practicable and expedient.

COUPLING—A suitable coupling will be provided for connecting the turbine and generator shafts. It will be arranged to be readily disconnected.

LIFTING GEARS, TOOLS, ETC.—A set of wrenches will be furnished to fit all nuts requiring adjustment. There will also be furnished necessary eye-bolts for handling the various parts, and suitable lifting gear for removing the turbine spindle.

PAINTING—All exposed surfaces that are not polished will be filled, rubbed down smooth and painted with flat paint before shipment. Any further painting will be done by the Purchaser after erection.

OILS AND SUPPLIES—Oils and supplies necessary for the erection and starting up of the turbine at the Purchaser's station are to be furnished by the Purchaser and are to be satisfactory to the Corporation in quality and quanity.

LIMITS OF TURBINE—Unless otherwise stated in these specifications or agreed upon in writing, the Corporation's work will begin at the throttle valve of the turbine, and end at the exhaust flange of the turbine.

The Purchaser, therefore, will furnish all the steam and exhaust piping outside of the above limitations, which will be designed so as to cause no undue stresses on the turbine either by weight or by expansion. The limiting forces imposed on the turbine shall be mutually agreed upon between the Purchaser and the manufacturer. Purchaser will furnish material and labor for grouting and any other material to go between turbine unit and foundation.

In the interest of both parties to this contract, it is expedient that the Corporation has the privilege of examining plans showing the steam and exhaust piping, the arrangement of the condenser, the foundations, and the machinery generally in the plant. This will enable the Corporation to offer suggestions to the end that, by reason of its experience, the installation may be the more satisfactory.

The Purchaser will furnish all steam and water supply and drain piping to and from the turbine and its parts. The Corporation will furnish and xxerectail oil piping directly contiguous to or mounted on the turbine unit.

TESTS—If tests are made after erection to demonstrate the ability of the unit to operate under the conditions and fulfill the warranties herein set forth, is it agreed that such tests are to be made within 90 days after the unit is put into service, or in any case, not later than 150 days from date of shipment. The conditions of test and methods employed are to be mutually agreed upon. The Purchaser is to make all preparations and incur all expenses incidental to said tests. The Corporation will have the right of representation at said tests but will make no charge for the expense of such representation. To insure the apparatus being in proper adjustment and in condition to undergo test. the Corporation may require, and the Purchaser will consent to conduct, preliminary tests, made under the Corporation's general direction. The Corporation representative shall be a party to all observations during the test and during this time shall have the right to direct the operation of the apparatus specified herein. It is agreed that this paragraph. insofar as it relates to turbine generator units, shall be the basis upon which all such tests shall be conducted and shall be accepted in lieu of any other clauses appearing herein with reference to such tests.

Apparatus which does not meet the guarantees herein contained may be removed and reclaimed by the Corporation, and upon repayment to the Purchaser of all sums paid to the Corporation on account of the purchase price of such apparatus, the Corporation shall be discharged from all liability hereunder to the Purchaser.

Alternating-Current Turbine Generator

PERFORMANCE SPECIFICATION AND DATA SHEET

CONTINUOUS RATING:

Specification	Kv-a.	Power Factor Per Cent	Kw.	Volts	Amperes per Terminal	Phase	Cycles	Poles	R.P.M.
	12,500	80	10,000	11,500	62 8	3	60	2	360 0

PERFORMANCE:

Observed Temperature Rise in Degrees Centigrade		Exciter	Capacity	Ventilation	
Armature by Detector	Field by Resistance	Kw.	Volts	Cubic feet per min. approx.	Allowable Pressure Drup Thru Cooler Inches Water Approx.
60	85	60	250	20,000	1.75

Temperature—The observed temperature rise is defined as the rise above the temperature of the intake air to the generator. The temperature of the intake air must not exceed 40°C.

Insulation—Full class B insulation will be used on the field.

On ratings of 5001 Kv-a. and above, the armature insulation will be full class B. On smaller machines the armature insulation is class A, inasmuch as cotton is used in the insulation of the individual strands.

Insulation Class will be as defined by the AIEE standards.

Method of Test—All tests will be in accordance with the Standards of the American Institute of Electrical Engineers, excepting as may be otherwise stated in this specification. The procedure followed in making tests will be in accordance with the testing rules of the Westinghouse Electric Corporation.

When completed, the apparatus will be subjected to an insulation test on the stator equal to twice normal rated voltage plus 1000 volts, and on the rotor to a test voltage equal to ten times the exciter voltage, but not less than 1500 volts nor more than 3500 volts. Insulation tests will be made for a period of one minute.

Exciter—The exciter capacity given is the maximum required by the generator to maintain normal voltage under the conditions of operation specified. It may be used to determine the proper size of cables and switchboard instruments.

Ventilation—Unless otherwise specified, the generator will be provided with internal fans mounted upon the rotor. Many for the recently are recently and the rotor.

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(Upon award of contract, Sheet 2 of this form must be filled in completely and made part of this contract)

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WESTINGHOUSE FORM 1746 Q (2 SHEETS—SHEET 1) PRINTED IN U.S.A.

GENERATOR SHORT CIRCUIT CHARACTERISTICS

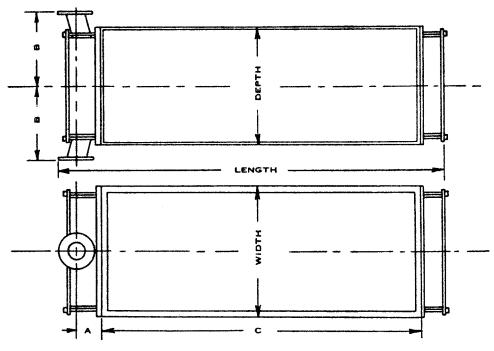
Turbine generators shall be braced to withstand any phase fault current which can be obtained from the generator alone. Where the generator neutral is used to establish the system neutral, a neutral reactor or resistor shall be used of such an ohmic value that the fault current taken by the generator cannot exceed the instantaneous generator fault current under 3 phase fault conditions.

SURFACE AIR COOLER

FOR	Oxford Paper Company	DATE 4/1	13. 18. /52
LOCATION_	Rumford, Maine	NEG. NO	8563
square for	ooler will consist oftwo sections having a section to the section of the section head through the cooler will not exceed . 1.75	feet per minute of ventiners tor	of 35.00

QUALITY OF WATER	Assumed Good		
HEAT LOSS IN KW.			
AIR TEMP. LEAVING COOLER °F.	104		
WATER QUANTITY GPM.	146		
COOLING WATER TEMP. °F,	85		
WATER PRESSURE DROP FT. OF WATER	Ĭ.		
NO. OF WATER PASSES	<u>L</u>		

Water boxes, nozzles and tubes will be suitable for working pressure of ... 50...... pounds per square inch gauge.



SECTIONS	LENGTH	WIDTH	DEPTH	A	В	С	APPROXIMATE WEIGHT—LBS.
	(0	oolers	mounted	within g	enerator	housing	

FORM 17027E (SHEET 1)

Page 11

SURFACE AIR COOLER

SHELL—The cooler shell will be fabricated of steel plates forming a rigid frame. Suitable flanges will be provided on the shell to which air ducts may be connected. The shell will be painted inside and out with bitumastic paint.

WATER BOXES—The water boxes will be made of copper bearing steel. Suitable flanged connections will be provided for the admission and discharge of cooling water.

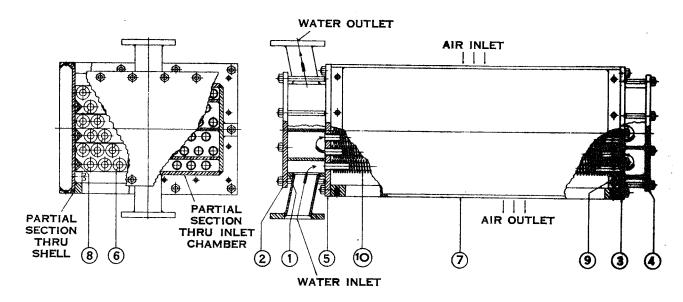
TUBES—Admiralty metal tubes having an outside diameter of one inch 18 Bwg will be furnished. The extended radiating surface will consist of copper fins spirally wound upon the tubes.

TUBE PLATES—The tube plates will be of Muntz metal. Suitable bracing will be provided to withstand the maximum water pressure specified herein.

ARRANGEMENT OF SECTIONS—If more than one section is used the water supply to the sections will be in parallel.

ACCESSORIES—Unless otherwise specified the purchaser shall furnish and install all gauges, valves, piping, supporting structure and connecting air ducts.

The various materials used in the construction of the air cooler will be of first-class quality and conform to the most approved practice with regard to each individual part of the apparatus. The workmanship will be high grade in every detail. The Corporation assumes no responsibility for any damage due to the corrosive action of the fluid handled, or to the presence of foreign substances in it.



ITEM NO.	NAME	ITEM NO.	MAME
1	Inlet Chamber	6	Tube Sheet (Reverse End)
2	Inlet Chamber Cover	7	Shell
3	Reverse Chamber	8	Deflector Angles
4	Reverse Chamber Cover	9	Tube Sheet Blocks and Screws
. 5	Tube Sheet (Inlet End)	10	Tubes

SUPERVISION OF INSTALLATION

The Corporation will furnish a competent and experienced engineer to supervise and to make recommendations concerning the erecting, starting and placing in good operating condition the apparatus covered by this proposal on foundations in Purchaser's power house. The Corporation warrants that such recommendations shall accurately reflect its best judgment in the premises, but no other warranty of any nature shall extend thereto or be implied therefrom. The Corporation shall not be responsible for defects in material and/or workmanship by others or for damages resulting from the acts or omissions of anyone other than the Corporation's employes, nor shall the Corporation be responsible in any event for consequential damages.

The Corporation has complied with the provisions of Workmen's Compensation Laws and has provided for the payment of compensation to its employes.

The Purchaser shall notify the Corporation of the arrival of the first shipment of the apparatus.

The Purchaser will provide: (1) Railroad track under power house crane; (2) Foundations with foundation bolts, wedges, plates, grouting forms, grouting and labor for pouring same, conduits, cable and cable supports; (3) a suitable crane, with operator and power, capable of handling the heaviest piece; (4) reinforcement of floors, overhead protection from the elements and otherwise, and such modifications in Purchaser's buildings or premises as are necessary for the proper erecting of the apparatus covered by this contract; (5) electric power and apparatus to dry out the equipment furnished hereunder; (6) painting, and all external steam, oil, and water piping not furnished as an integral part of the apparatus; (7) operating force, steam, and supplies for starting and preliminary run; (8) all necessary labor for erection.

*Supervision will be furnished on an 8 hour day, 40 hour per week basis, Monday to Friday inclusive, holidays excepted.

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WESTINGHOUSE FORM 18110-C

- 1. The Corporation warrants that the apparatus to be delivered hereunder shall be of the kind and quality described in the specifications and no other warranty, except of title, shall be implied. The conditions of any tests shall be mutually agreed upon and the Corporation shall be notified of and may be represented at all tests that may be made. If any failure to comply with the specifications appear within one year from the date of shipment, the Purchaser shall notify the Corporation thereof immediately and the Corporation shall thereupon correct the defect, or defects, by repair, or by replacement f.o.b. factory of the defective part or parts. But if the apparatus is installed or its installation supervised by the Corporation, said one year shall run from the completion of installation provided same is not unreasonably delayed by the Purchaser. The liability of the Corporation (except as to title) arising out of the supplying of said apparatus, or its use, whether on warranties or otherwise, shall not in any case exceed the cost of correcting defects in the apparatus and, upon the expiration of said one year all such liability shall terminate. The Corporation shall have no liability whatsoever (except as to title) with respect to items of apparatus not manufactured by the Corporation which are furnished pursuant to the Purchaser's specification or request.
- 2. The Corporation shall defend any suits or proceedings brought against the Purchaser so far as based on a claim that any apparatus, or any part thereof, furnished under this contract constitutes an infringement of any patent of the United States, other than a claim covering a process or a product thereof, if notified promptly in writing and given authority, information and assistance (at the Corporation's expense) for the defense of same, and the Corporation shall pay all damages and costs awarded therein against the Purchaser, provided that this agreement shall not extend to any infringement based upon the manufacture, use or sale of any of said apparatus or any part or parts thereof in combination with apparatus or things not furnished under this contract. In case the apparatus or any part thereof furnished under this contract is in such suit held to constitute infringement and its use is enjoined, the Corporation shall, at its own expense, either: procure for the Purchaser the right to continue using said apparatus or part thereof, or, replace same with non-infringing apparatus; or modify it so it becomes non-infringing; or remove said apparatus and refund the purchase price and the transportation and installation costs thereof. The foregoing states the entire liability of the Corporation with respect to patent infringement by said apparatus or any part thereof.
- 3. The title to the apparatus herein specified, and any replacement thereof or substitutes therefor, shall not pass from the Corporation until all payments due hereunder (including deferred payments and payments of notes and renewals thereof, if any) shall have been fully made in cash, and the apparatus specified shall remain personal property whatever may be the mode of its attachment to the realty or other property, until fully paid for in cash, and the Purchaser agrees to perform all acts which may be necessary to perfect and assure retention of title to the said apparatus in the Corporation. The Purchaser sahll assume all risk of loss after the apparatus is delivered as specified herein. If default is made in any of the payments, in the manner and form and at the time herein specified, the Corporation shall be entitled to the immediate possession of said apparatus and shall be free to enter the premises where such apparatus may be located and remove the same as its property, without prejudice to any further damages which the Corporation may suffer by reason of the Purchaser's refusal or failure to surrender the apparatus when so required. In case notes or trade acceptances are accepted, they shall be mere evidence of indebtedness and not payment and if any one is not paid when due, all outstanding notes shall, at the option of the holder, become immediately due and payable; all collection and exchange charges and all taxes shall be payable by the Purchaser.

4.PRICE—
Dollars, (\$) in Pittsburgh or New York funds

Price does not include state or local taxes based on or measured by sales, which tax or taxes will be added to the price where applicable.

An extra charge will be made for returnable containers and special shipping devices (such as oil barrels, reels, tarpaulins, commutator clamps, etc.), but refund will be made if returned in good condition to the factory, or other points designated by the Corporation, within ninety (90) days from date of original shipment, charges prepaid.

5. TERMS OF PAYMENT

Contracts \$100,000 and over

90% of total contract price in monthly progressive payments upon presentation of invoices during the production period of the apparatus as follows:

10% or balance due of contract price 60 days from date of final shipment.

Contracts under \$100,000

Net within thirty (30) days from date of shipment.

The Corporation reserves the right to ship to its order and make full collection of the contract price by sight draft with Bill of Lading attached.

If, in the judgment of the Corporation, the financial condition fo the Purchaser, at any time during the manufacturing period, or at the time apparatus is ready for shipment does not justify the terms of payment specified above, the Corporation has the right to require full payment in cash before continuing manufacture or making shipment.

Pro rata payments shall become due as shipments are made. If shipments are delayed by the Purchaser, payments shall become due from date when the Corporation is prepared to make shipment. If manufacture is delayed by the Purchaser, payment shall be made based on the contract price and per cent of completion. Apparatus held for the Purchaser shall be at the risk and expense of the Purchaser.

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Page.....

to the Corporation. In case of delay by the Purchaser in furnis	days for Purchaser to furnish complete information shing complete information, or returning accepted contract to the d, based on the period of Purchaser's delay and conditions at the
or caused by fire, strike, civil or military authority, restrictio or representative thereof, insurrection or riot, embargoes, car sl	tention or delay resulting from causes beyond its reasonable control as of the United States Government or any department, branch hortages, wrecks or delays in transportation, or inability to obtain uch causes. Receipt of the apparatus by the Purchaser upon its
agreement and understandings are superseded by this proposal	ts hereunder without written consent of the Corporation. Previous 1. No modification hereof shall be binding unless in writing duly representative of the Corporation. The Corporation shall not be
9. The foregoing proposal must be accepted by the pure from its date and must be approved in writing either by an exmanagers, in order to make it binding upon the Corporation.	chaser and delivered to the Corporation within fifteen (15) days ecutive officer of the Corporation or by one of its duly authorized
	Respectfully yours,
	WESTINGHOUSE ELECTRIC CORPORATION
	Ву
ACCE	PTANCE
The foregoing proposal is hereby accepted at the prices an	d upon the terms and conditions named therein.
Dated19	
Witness or Secretary	(Purchaser's Name)
	Ву
	(T):
Approved: At19	(Title) WESTINGHOUSE ELECTRIC CORPORATION
(Insert Place)	
Witness:	Ву
ÿ .	_
WESTINGHOUSE FORM 15499G THREE SHEETS, SHEET 3	1 5
PRINTED IN U.S.A. PAGE	

6. Shipment of the apparatus described herein will be made as follows:

CORPORATION

, before me
ned and acting as such, personally appeared
Secretary of
Notary Public
CountyINDIVIDUAL
, before me
commissioned and qualified, personally came

DESCRIPTION OF TURBINE INCLUDING EXHIBITS

GENERAL DESCRIPTION AND ILLUSTRATIONS FOR THE TURBINE-GENERATOR UNIT

The illustrations, photographs and description included in this proposal are presented to acquaint you with the excellent design features, construction, the pleasing contours and modern appearance of Westinghouse Turbine-Generator Units.

They represent units which have been manufactured and are not intended to show the exact design of the unit proposed.

The Turbine

Westinghouse turbines are of a design that provides the inherent flexibility needed to furnish efficient and economical power for modern industry. A successful application can be recommended by Westinghouse for almost any combination of steam conditions....and a unit custom-built to meet the specific requirements.

The design follows the sound practice of utilizing the advances associated with turbine manufacture and is backed up with over 50 years of experience.

Turbine Features

Economical Operation

Multiple valves used at each stage where steam flow must be controlled further improve partial-load economy.

Permanently Sensitive Governing

A sensitive, accurate and dependable speed-control system of the hydraulic type. Gears and knife edges which require maintenance, and rotating weights, have been eliminated.

Positive Lubrication System Oil pump is mounted directly on the turbine shaft....not driven through gearing. Protective devices prevent operation of the unit without adequate lubrication.

Constant Alignment

The supports for the turbine provide for freedom of expansion and contraction, and maintain alignment of the unit and its component parts.

Corrosion - Erosion Resistant Blading

Blades are fabricated from chrome-iron alloy to assure sustained efficiency and long life.

Smooth in Operation

Smooth operation results from the extreme care taken in the design, manufacture and dynamic balancing of the rotors.

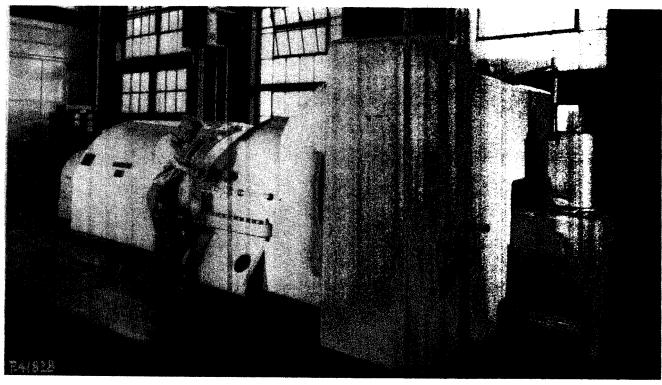
Pleasing Appearance

The visible contours of the unit...turbine, generator and exciter...present a modern and very pleasing appearance.

Effective Glands

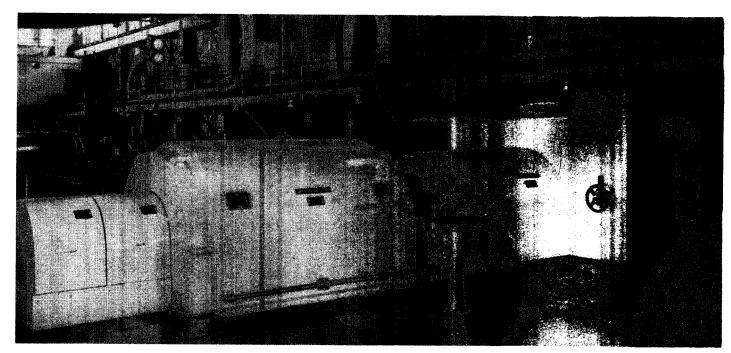
Leakage of steam from, and entry of air into, the turbine casing is effectively prevented.

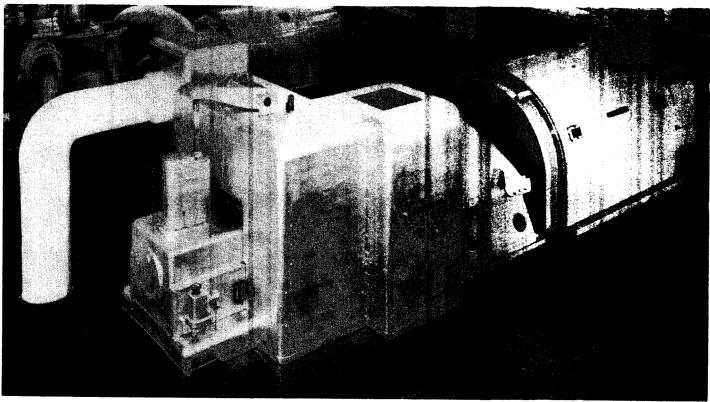
Condensing Turbine Generator Unit



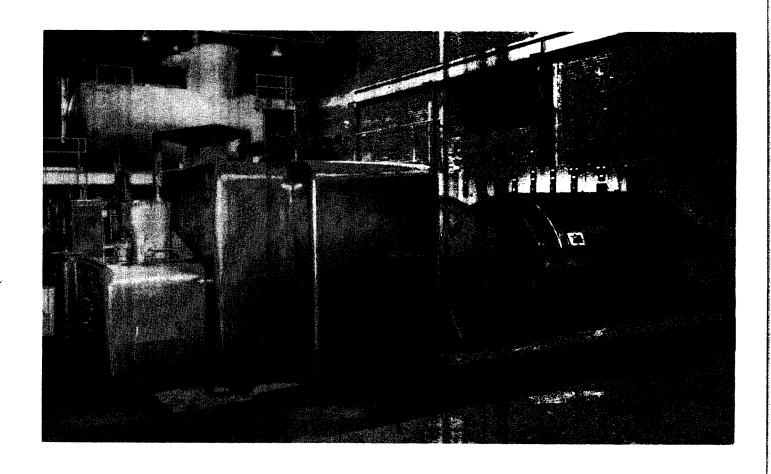


Condensing Single Extraction Unit

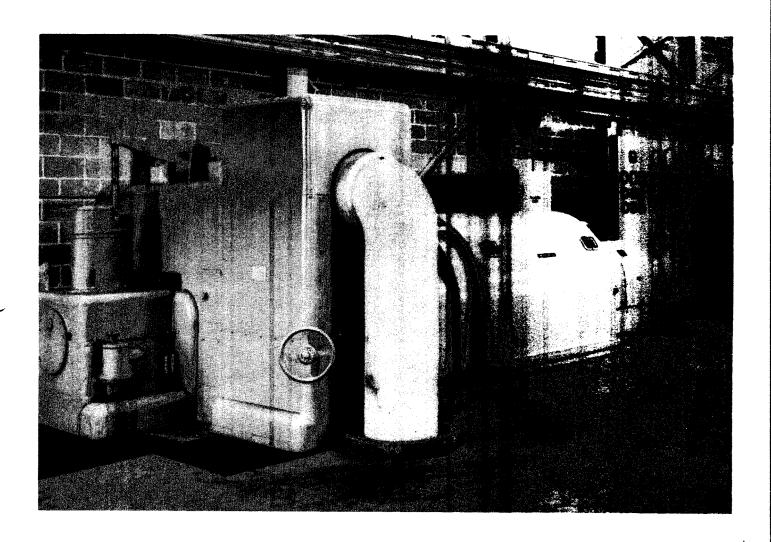


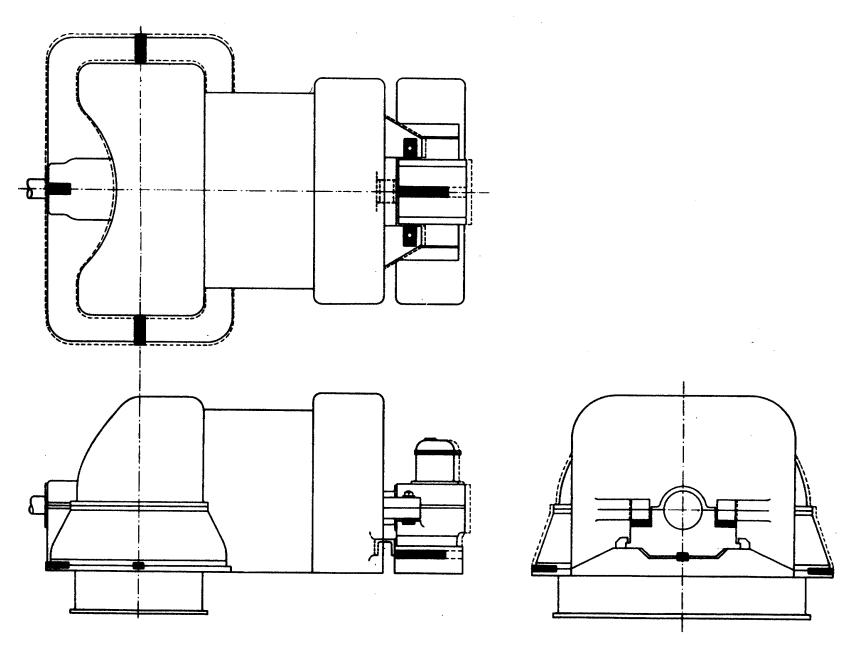


Condensing Double Automatic Extraction Unit

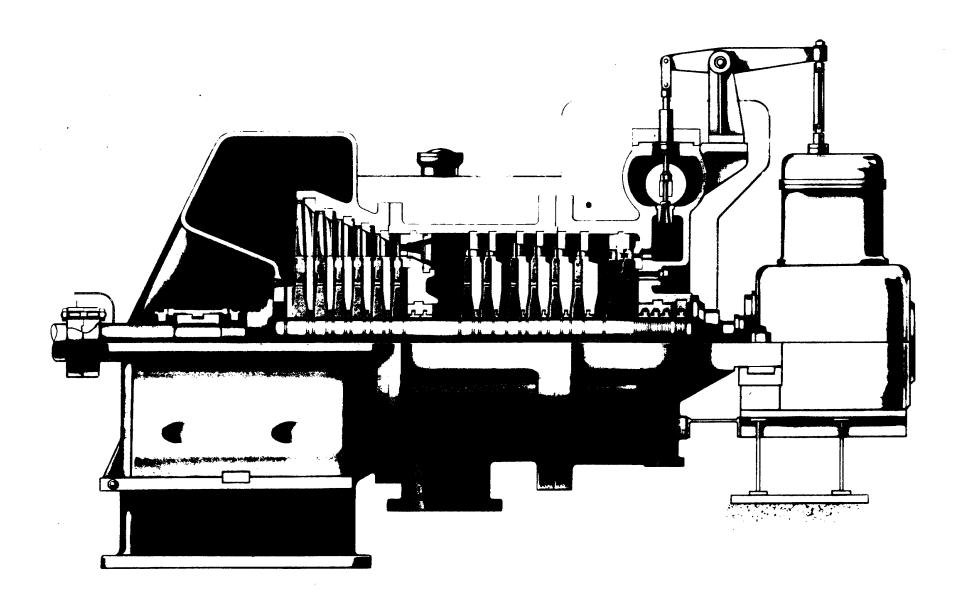


Non-Condensing Unit





Turbine Support & Provisions for Expansion



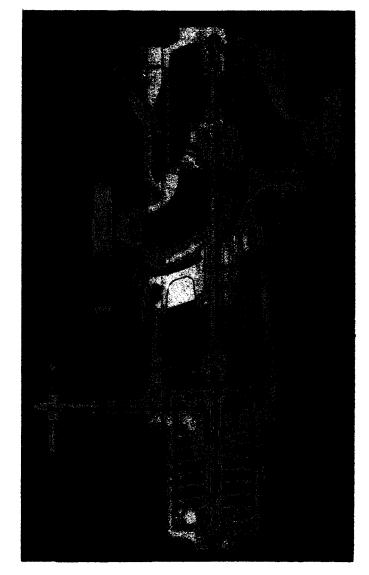
Throttle Valve

The Westinghouse hydraulicallyoperated throttle valve is used to control the flow of steam when starting the turbine.

There are several distinctive features incorporated in the design of the throttle valve. It functions as an automatic stop valve in case of overspeed. It is hydraulically operated and it cannot be opened, nor the turbine started, until after normal operating pressures for the turbine oiling system have been established. If at any time the motive oil pressure should fall to an unsafe value, the valve automatically closes and stops the flow of steam into the turbine.

The throttle valve is operated easily. Turning its handwheel merely positions a valve that controls the flow of high-pressure oil into the operating cylinder.

A cylindrical steam strainer is located within the valve body to protect both the valve and the turbine from foreign objects that may come from the steam line.

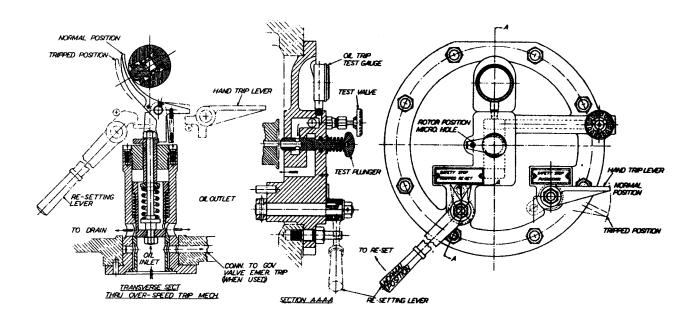


Emergency Overspeed Governor

The emergency overspeed governor is entirely separate from and independent of the speed governor. It functions to protect the unit from excessive speed by disengaging a trip, at a predetermined overspeed, which allows the throttle valve to close. The trip may be reset and the throttle valve reopened before the turbine speed returns to normal.



EMERGENCY OVERSPEED TRIP



Emergency Overspeed Trip

The emergency overspeed trip is entirely separate from and independent of the main governor. It functions to protect the turbine from overspeed and is usually adjusted to operate when the turbine speed reaches 10% above normal. It may be reset, and the throttle valve reopened, before the turbine speed drops to normal.

The overspeed trip body is screwed onto the governor end of the rotor shaft with a left hand thread and locked in place by screws. The trip weight is assembled in the body with its center of gravity offset from the axis of rotation, and the centrifugal force acting upon it is opposed by a compression spring. When the turbine reaches a speed approximately 10% above normal, the weight moves outward, trips the oil release valve, and the throttle valve closes instantly.

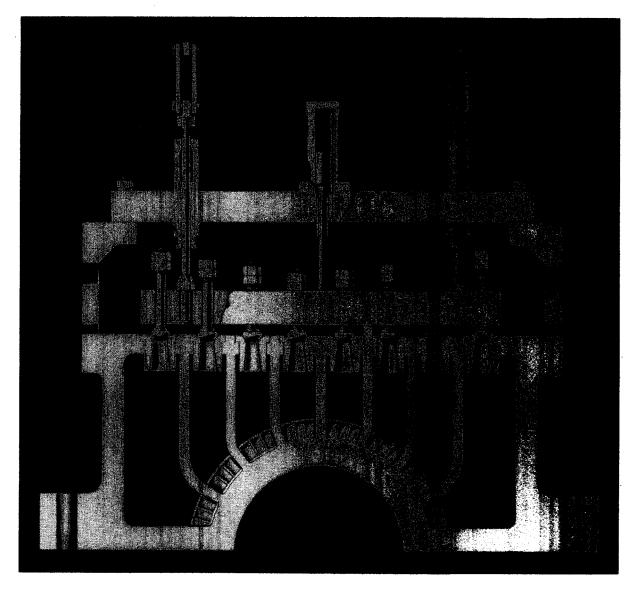
The operation of the mechanism may be checked while the turbine is operating at normal speed. Through the test plunger, an oil pressure is applied to the inner end of the weight, when the device is known to be in proper adjustment. The oil pressure required to overcome the compression force of the spring is measured and recorded. As long as the mechanism is in proper operating condition, future checks will indicate the same pressure value.

The absence of rods and linkage between the turbine and the throttle valve adds to the reliability of this important feature.

The mechanism is arranged for tripping by hand when desired.

T.P.L. 20.1

Steam Chest



The structural simplicity of the steam chest and valve assembly assures a minimum of attention and maintenance.

Economical partial-load operation is obtained because throttling losses are minimized. This is accomplished by dividing the first-stage nozzles into several groups and by providing a separate valve to control the flow of steam to each group. The valves are opened and closed in sequence and the number of nozzle groups in service is proportional to the load on the unit.

The design of the valve assembly is such that, although there is a multiplicity of valves, only two lift rods extend through the steam chest cover. Hence, only two stems must be sealed by glands.

The valve seats are of the diffuser type. They minimize the pressure drop through the steam chest and contribute to precise governing.

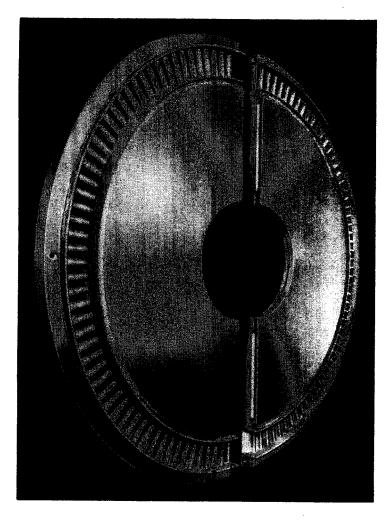
Nozzles



NOZZLE ASSEMBLY FOR CONTROL STAGES

Great emphasis is placed upon the exactness of the machining and the location of the nozzle vanes for both the control nozzles and the interstage diaphragms. The resulting accuracy assures maximum efficiency of the expansion of steam through the nozzles and the proper direction of the steam into the accompanying rotating blades.

Diaphragms



INTERSTAGE NOZZLES AND DIAPHRAGM ASSEMBLY

The interstage diaphragms are located in grooves which are accurately spaced and machined into the casing. Their upper halves are attached to and lift with the casing cover.

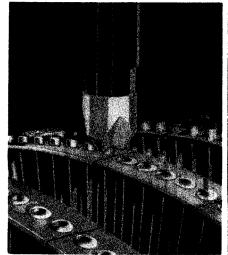
Generally, the method of fabricating nozzles is to electrically weld vanes made from chrome-iron alloy to a strong inner segment and an outer band. This forms a sturdy assembly which is capable of withstanding the pressure forces imposed against it.

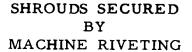


SECTION OF DIAPHRAGM SEAL

Labyrinth seals minimize steam leakage along the shaft where it passes through the diaphragms. The seal rings are spring-backed and are made of a material that permits close running clearances with complete safety.

Corrosion-Resistant Blades





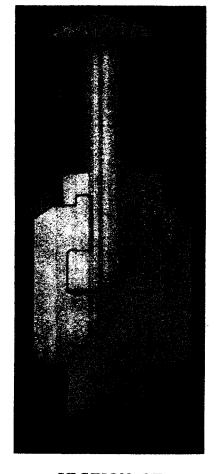


SECTION OF COMPLETED BLADE ROWS

Turbine blades are so vital to efficiency and contribute so much to reliability that blade design and manufacture is a business for experts. From the blueprint stage throughout the manufacture, final inspection and assembly, experienced Westinghouse engineers and skilled workmen design and produce blading that has superior qualities.

The especially designed contours of these blades, based upon a wealth of experience and research, provide for the maximum conversion of energy into useful work. Their generous proportions provide the necessary strength. Strong T-shaped roots hold the blades firmly in the rotor.

The blades are made of chrome-iron alloy, a material developed through research greatly contributed to by Westinghouse engineers and now almost universally used for turbine blading. It is a strong material that is highly resistant to erosion and corrosion.

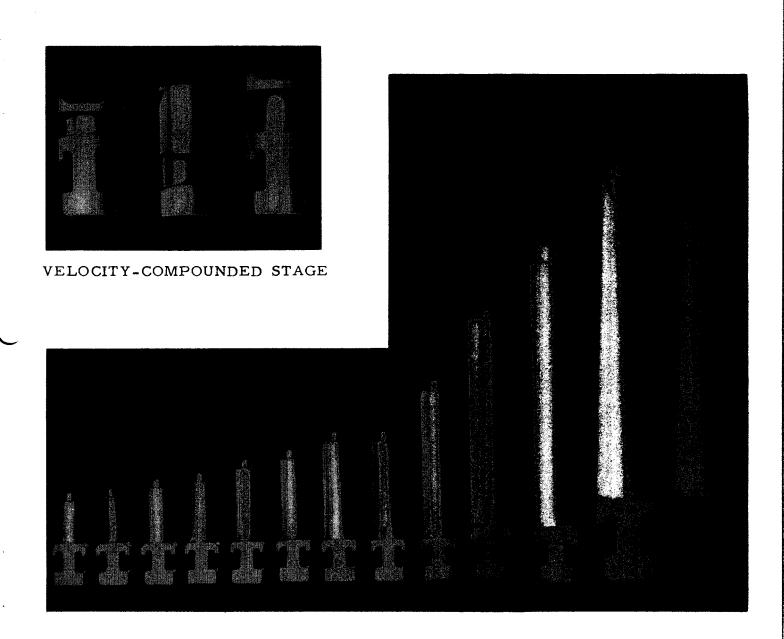


SECTION OF BLADE ROOT AND SHROUDING

The steel shroud attached to the end of the blade completes the enclosure of the steam passages between the blades and controls blade vibration. It is divided into segments to allow for expansion and provides the means by which appropriate numbers of blades are banded together into groups to control the frequency and magnitude of their vibration.

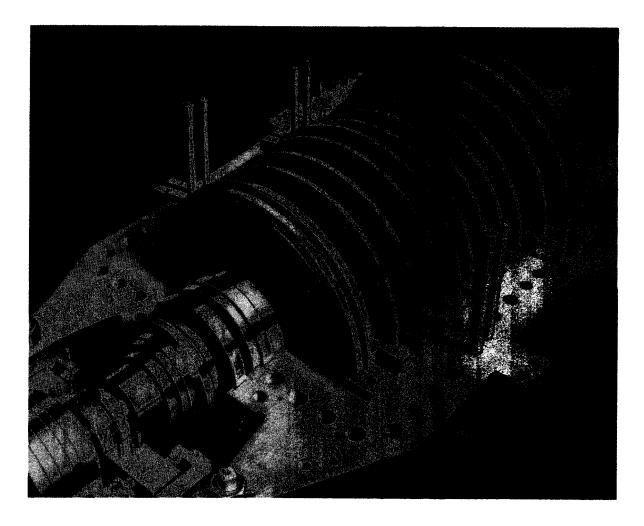
In single velocity stages, separate shroud strips are secured to the outer ends of the blades by machine riveting. Velocity compounded stages have a section of the shroud band integral with each blade. Where deemed necessary to control the vibration of these blades, they are bound together in groups by electric welding.

Typical Chrome Iron Alloy Blading



SINGLE VELOCITY STAGES

Rotor



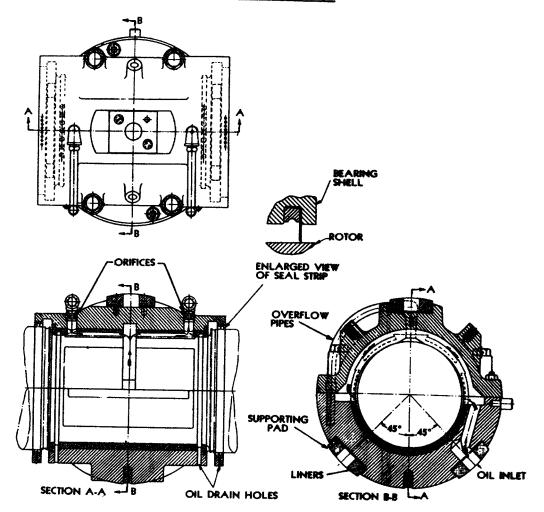
To insure their effective performance, the efficient and durable blades are mounted on rotors which are scientifically designed and skillfully constructed. The intense research by Westinghouse engineers over the years in the properties of metals and alloys has played a most important part in the ability of today's turbines to operate successfully with high steam temperatures and pressures. The value of much of this research is centered in the turbine rotor.

Forgings for the shafts and blade wheels are made to rigid specifications and are subjected to exacting physical and metallurgical tests. All parts are machined and finished to extremely close tolerances.

The bladed wheels are securely shrunk and keyed onto the shaft. Thus permanent stability of the rotor is assured, despite temperature variations within the turbine which are unavoidable with changing load.

Each finished rotor is dynamically balanced at the factory.

Main Bearings



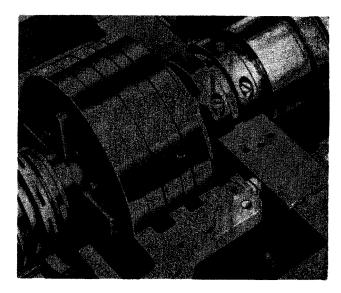
The main bearings consist of cast shells, split horizontally and lined with high grade tin base babbitt. The shells are centered in the bearing housings by three pads. Between each supporting pad and bearing shell, steel liners are provided which permits adjustments vertically and horizontally to accurately locate the rotor within the turbine cylinder.

Oil under pressure is supplied to the journals through drilled and machined passages.

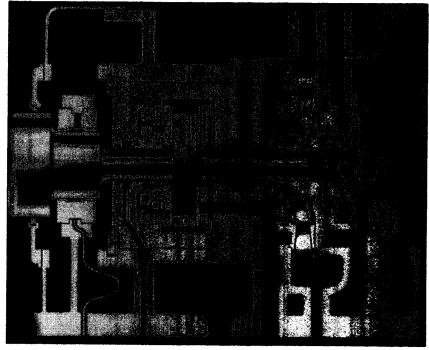
On high temperature units, where greater cooling effect is required, provision is made for circulating additional oil across the top of the journals, the oil flow being controlled by orifices.

Suitable oil baffles and labyrinth seals are provided in the bearings and housings to prevent the escape of oil vapor along the shaft.

Thrust Bearings



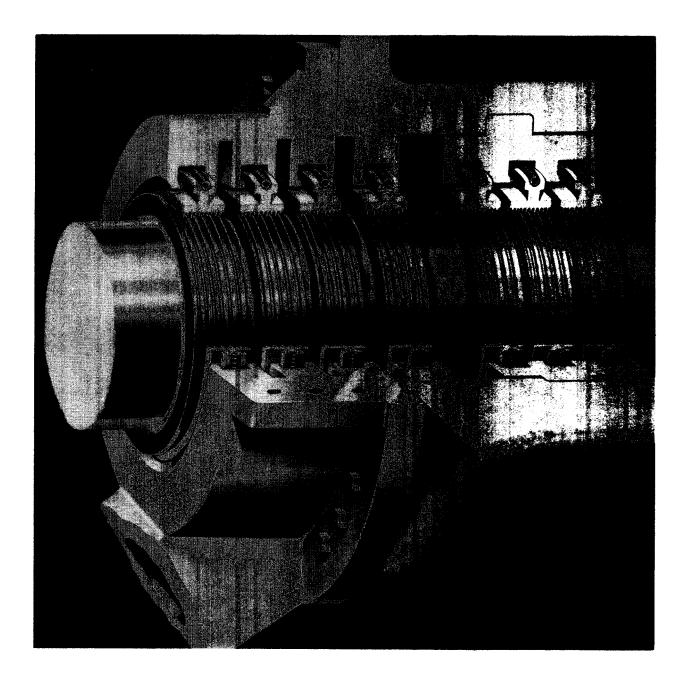
THRUST BEARING CAGE IN PLACE



SECTION OF THRUST BEARING AND HOUSING

Thrust due to unbalanced steam forces is practically negligible in Westinghouse turbines. However, a thrust bearing is provided to maintain correct axial relationship of the rotating and the stationary parts of the unit. The thrust bearing is a combination of the Kingsbury and the collar types. The active surfaces of the thrust bearing are pressure lubricated.

Labyrinth Gland



LABYRINTH-TYPE GLAND AS EMPLOYED ON NON-CONDENSING TURBINES

Each labyrinth consists of a multiplicity of seals to minimize steam leakage. The seal rings are spring-backed and, like those used in the interstage nozzle diaphragms, they are made of a material that permits close running clearances with complete safety.

Positive Lubrication

The turbine has a dependable system that supplies, under pressure, the oil that is used for lubricating and cooling the unit's bearings and as motive fluid for the various valve-operating mechanisms. The oil is delivered by a familiar centrifugal-type pump, that has its impeller mounted on the turbine shaft...not driven through gearing. The completely dependable supply of oil delivered by the pump is assured by eliminating suction lift. Oil, under positive pressure, is delivered to the impeller inlet by means of an oil ejector...devoid of moving parts...which receives its motive oil from the pump discharge. This improved and distinctive system is an origination of Westinghouse engineering and its superiority has been demonstrated by its successful use for more than twenty years.

The turbine governing system, the overspeed trip valve, and the throttle valve are connected to the oil system. These interconnections provide safety features which prevent operation of the unit without proper lubrication.

A steam-driven auxiliary oil pump provides for lubrication when the unit is operating at low speeds, such as during starting and stopping procedures.

Adequate cooling of the oil is insured by a cooler which is an integral part of the system.

The oil reservoir is of liberal size to allow a slow, even flow of oil through it...another assurance of a good lubricating system.

Extreme care is given to the design and location of the oil piping. The piping is fabricated from seamless steel tubing and is then thoroughly cleaned. There are a minimum number of flanged joints.

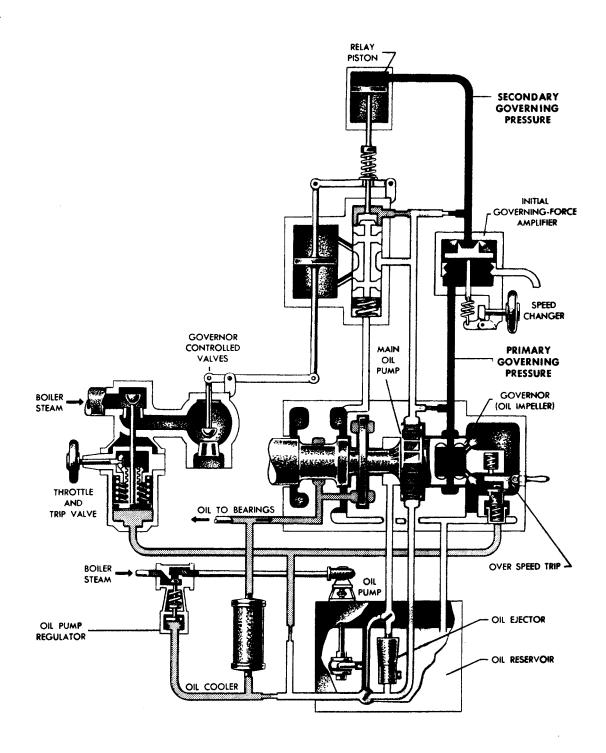
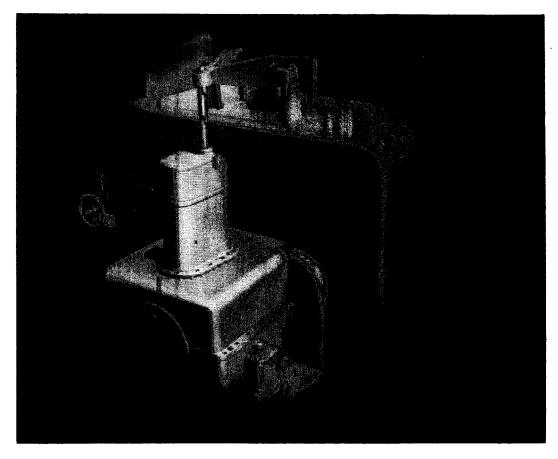


DIAGRAM OF LUBRICATION AND OPERATING OIL SYSTEM

Turbine Governing

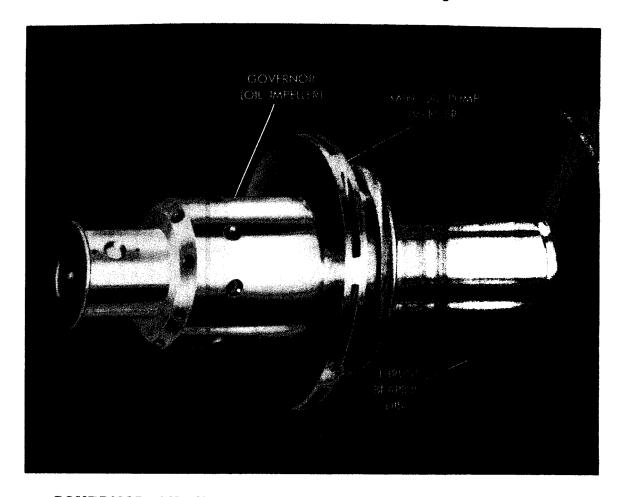


The success of a modern industry is determined largely by its ability to produce better products, faster and more economically. The degree of success is often influenced greatly by the preciseness with which electrical frequency and the pressure of steam used in processing are regulated automatically. Devices available with Westinghouse steam turbines provide accurate and dependable means for the precise control of these variables.

The problems of governing of steam turbines became increasingly complex over the years. At first, only speed or electrical frequency required regulation. Shortly afterward, it became necessary to provide improved controls suitable for the parallel operation of two or more electrical generating units. Later, there developed the possibilities of generating, most economically, increased increments of power as a by-product of steam used subsequently in manufacturing processes or in other prime movers. To achieve the full benefits of these potential economies, Westinghouse engineers developed and perfected steam turbine governing systems that are capable of regulating, automatically and simultaneously, electrical frequency or load and one, two or even three process steam pressures.

Accurate and dependable automatic regulation of each variable under its control is provided in the sensitive system of governing used on Westinghouse turbines. The superior qualities of this system are demonstrated in the wide variety of a multitude of economical turbine installations that have been in service for many years.

Hydraulic Governing System



GOVERNOR OIL IMPELLER AND MAIN OIL PUMP MOUNTED DIRECTLY ON THE TURBINE SHAFT

The Westinghouse system of control for steam turbines is fully hydraulic. The component of the governing system that produces forces which are a function of speed is a governor oil impeller that is mounted directly upon the turbine shaft. This oil impeller replaces the gear-driven, rotating weights more commonly used. All governing forces are transmitted hydraulically ... not mechanically. Friction and lost motion, detrimental to precise governing, are eliminated.

Because of its inherent flexibility, the hydraulic governing system is adaptable readily, through simple modifications, to the simultaneous control of speed and a variety of other variables. This is accomplished by means of frictionless hydraulic interconnections between additional regulating devices and the speed governing system to coordinate their respective functions. When arranged to control two or more variables, the combined governing system appropriately responds to changes that occur in any of the variables and each is precisely regulated.

Speed Control

The governor oil impeller is the component of the control system that detects changes in speed. A small quantity of oil from the main oil pump is supplied to the outer periphery of this impeller through a fixed orifice. This oil flows inwardly through the impeller and out to drain. Centrifugal force opposes the inward flow of oil and produces primary governing oil pressure that is exactly proportional to the square of the speed of rotation of the turbine.

The speed-responsive element and the initial governing force amplifier of the control system consists of a bellows to which is attached a spring and a cup valve. Changes in turbine speed produce proportional changes of primary governing oil pressure and the spring-opposed bellows moves slightly. The action of the cup valve produces magnified changes in secondary governing oil pressure. These in turn also are exactly proportional to the changes in speed. It is to these magnified pressure changes that the servomotor relay piston responds.

The cup valve actuated by this relay piston controls an oil pressure that is applied to one end of the servomotor relay. This controlled oil pressure force and an opposing spring serve to move the relay. The relay controls the position of the servomotor piston and the steam admission valves that regulate the input of energy into the turbine.

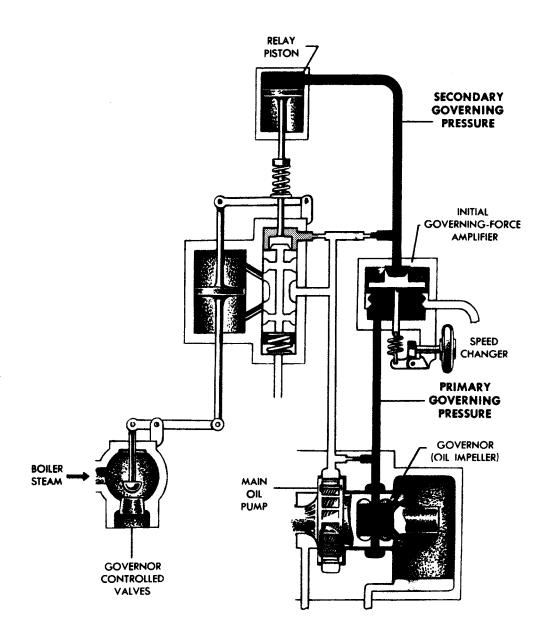
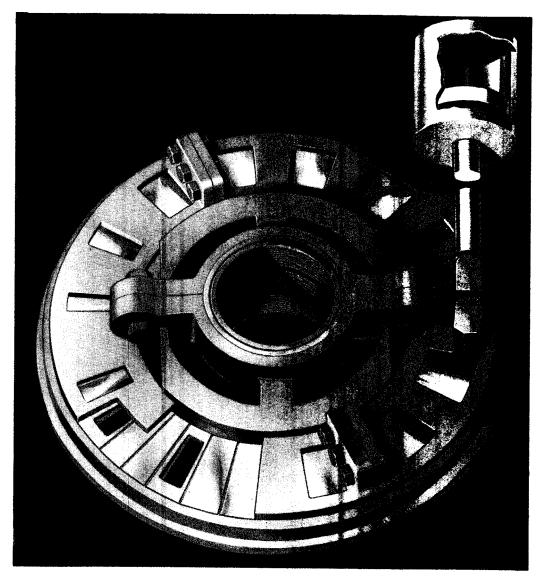


DIAGRAM OF SPEED-GOVERNING SYSTEM

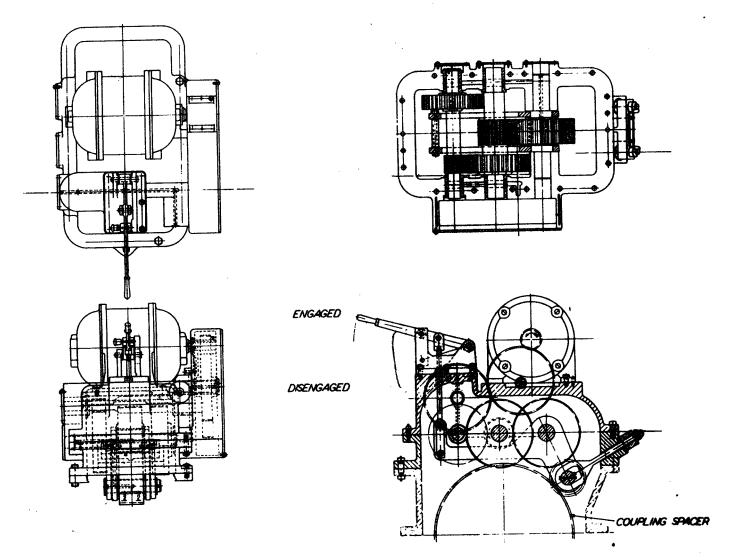
Grid-type Extraction Valve



Economical partial flow operation is obtained by keeping throttling losses to a minimum. This is accomplished by dividing the nozzles into several groups, and providing individual ports in the grid valve to control the flow of steam to each nozzle group. The rotation of the grid valve opens and closes these ports in sequence. The number of ports open and the number of nozzles in service are proportional to the flow of steam to the lower pressure stages of the turbine.

The grid valve is operated by a hydraulic servo-motor, which is controlled by the speed governor and the extraction pressure regulator. The valve is rotated to open the number of ports required to maintain the desired extraction pressure.

Steam leakage past the diaphragm, along the turbine rotor, is minimized by the use of labyrinth seals which are made of a material that permits close running clearances with complete safety.



Motor Driven Rotor Turning Gear

The rotor turning device is used mainly for slowly rotating the turbine rotor while the unit is being taken out of service. It may be used also during the starting of the unit.

It consists of a motor and a suitable compact train of spur gears. The gears are assembled in an oil tight case and the complete unit is mounted on the bearing and coupling housing between the turbine and

the generator.

Gear teeth are machined in the coupling spacer ring. When the turning gear is in use, its pinion meshes with this gear. The gears are engaged manually by means of an external lever, while the turbine is at rest. The pinion is mounted on an arm which is so pivoted that the gears remain in mesh only when the torque is being supplied by the motor. When steam is admitted to the turbine and its speed is increased beyond that produced by the turning gear, the torque reverses, the pinion automatically disengages and latches in the disengaged position.

A motor driven auxiliary oil pump is supplied as a part of the turning gear equipment. A pressure actuated switch in the turning gear motor circuit prevents starting this motor until after bearing oil

pressure has been established.

DESCRIPTION OF GENERATOR INCLUDING EXHIBITS

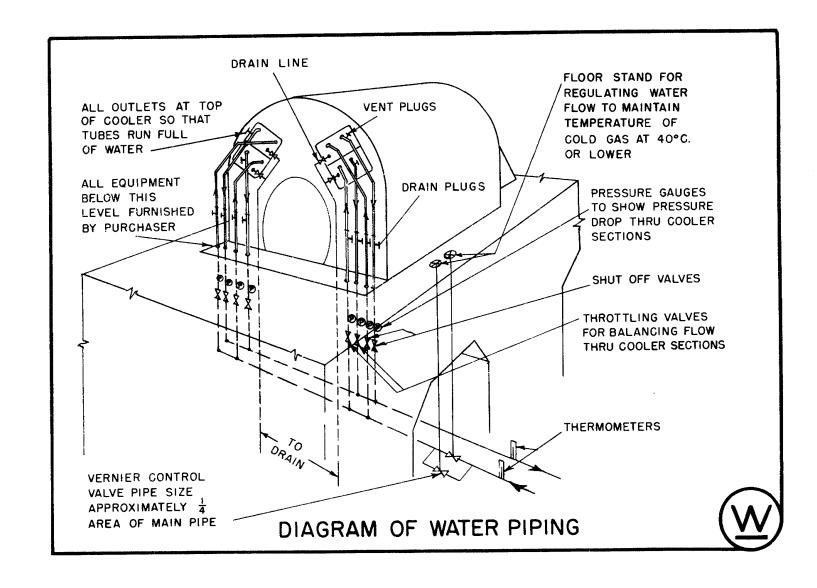
THE GENERATOR

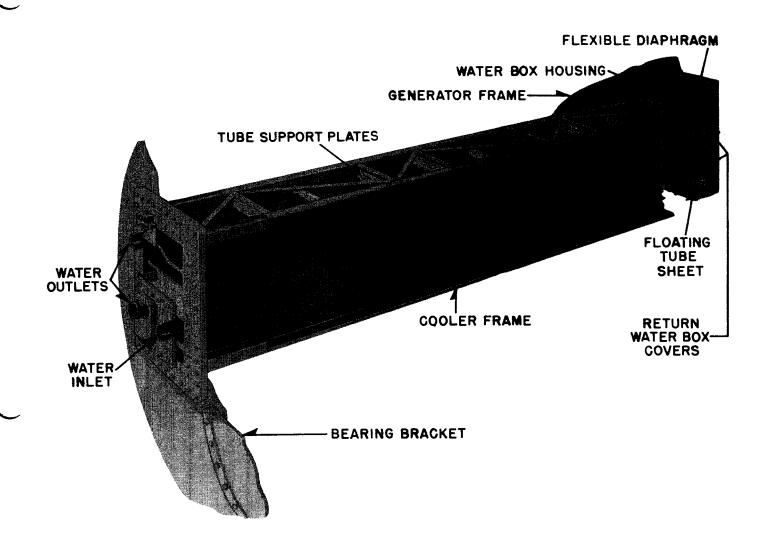
The first Westinghouse 3600 rpm air-cooled generator of 10,000 kw rating was built and tested in 1928. Since then over 70 such units with ratings from 12,500 kva up to 43,750 kva have gone into service. Nearly all of these are equipped with direct connected exciters.

The experience of many operators has fully demonstrated the high quality and reliability of these machines which is the result of the Westinghouse practice for conservative design based on many years of experience in building turbine generators.



HALF-SECTION SHOWING ARRANGEMENT OF COOLERS AND FLEXIBLE STATOR MOUNTING

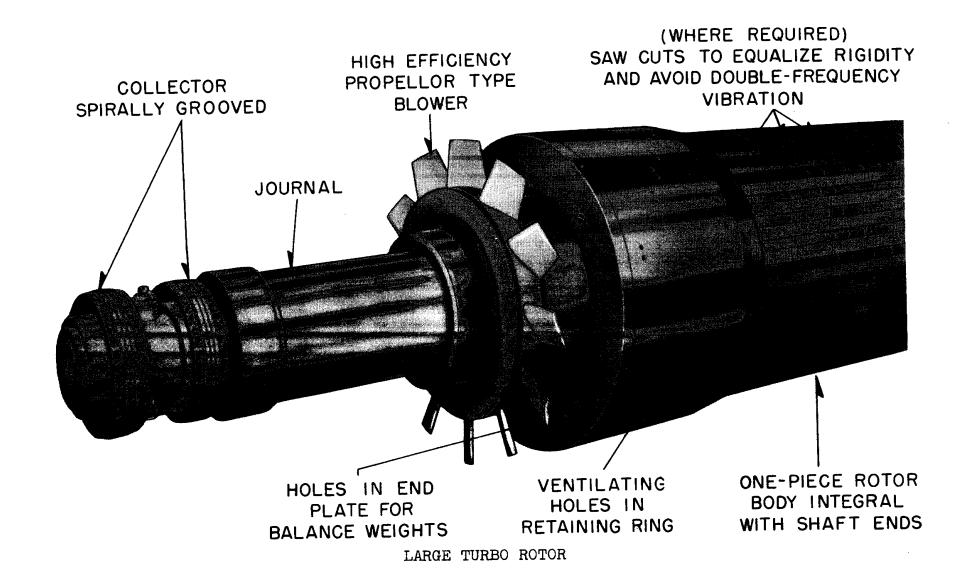


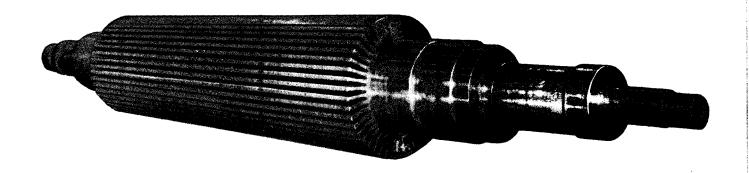


ARRANGEMENT OF COOLERS

The two coolers are placed parallel to the shaft. Tubes are rolled into the tube sheets at both sides. The water boxes are arranged so that the coolers will always run full of water. Each cooler has two sections and any section can be cleaned while carrying load.

The rear tube sheet floats free of the cooler frame, thus allowing for temperature changes.



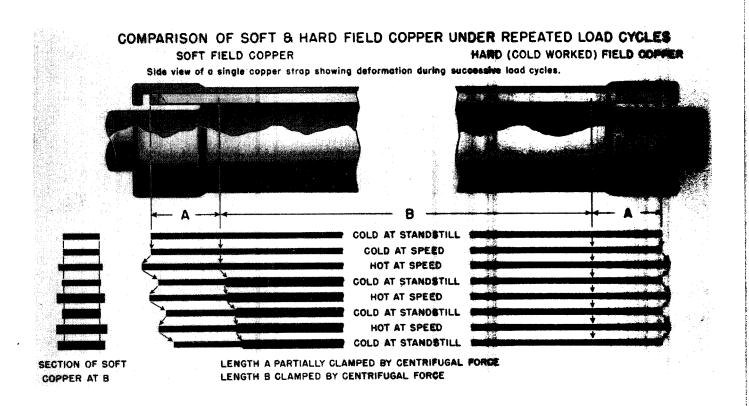


MACHINED GENERATOR ROTOR FORGING

The rotor is machined from a single solid forging, integral with the shaft ends. The material must meet rigid specifications as to composition as well as tensile strength and magnetic properties.

After the accepted forging has been turned to size, the slots for the winding are machined in it. Narrower slots, beneath the coil slots, are added to provide passages for ventilation.

The surface of the rotor body is grooved to reduce losses and to improve ventilation.



When a cold turbo rotor is brought up to speed, the winding is clamped along its length by centrifugal force. As the winding heats up the rotor body and winding will expand. The temperature coefficient of expansion for copper is greater than steel and its temperature rise is greater since it is the source of heat in the rotor. These two factors combine to cause greater expansion in the winding than in the rotor body. The winding tends to slip axially in the slots but is restrained by the clamping effect of centrifugal force. The increase in volume due to heating results in an increase in the coil cross section. The elastic limit of soft copper is exceeded by the stresses set up and the coil suffers plastic deformation. (Permanent increase in cross section).

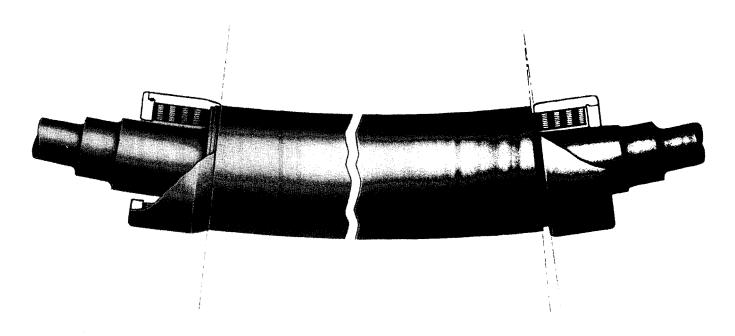
When the soft copper field cools at standstill the coils will reduce to their original volume, but due to plastic deformation they become increased in cross section along length B and diminished in axial length. As this cycle is repeated the winding becomes progressively greater in cross section and shorter, crushing the insulation and making a breakdown probable.

All large Westinghouse turbo rotors are now provided with field coils which are cold worked sufficiently to raise the elastic limit of the material above the stresses encountered at 125°C. This type of winding has been used since 1933 in a large number of machines with no cases of field winding distortion reported.

WESTINGHOUSE CONSTRUCTION

No Relative movement between retaining ring and winding due to rotor deflection.

Obsolete construction supports the retaining ring from the rotor shaft and causes relative movement between the ring and the winding.



EXAGGERATED DIAGRAM OF RETAINING RING MOVEMENT

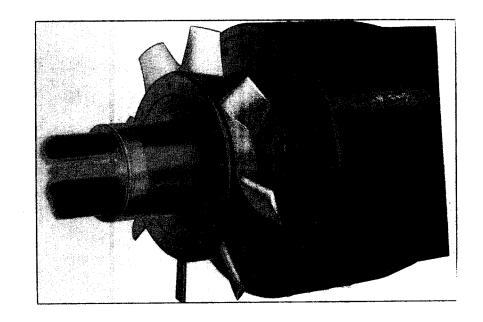
RETAINING RING

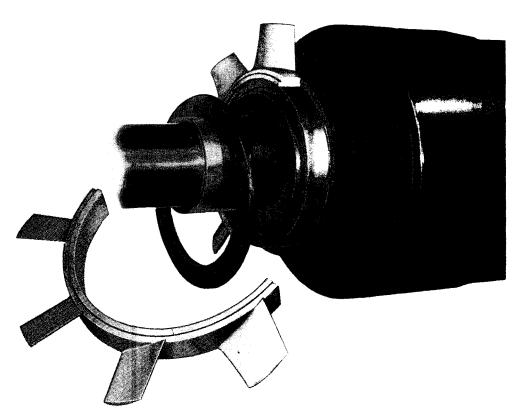
In any turbo generator rotor there is some elastic deflection due to rotor weight. This flexing causes a slight but continuous movement between the retaining ring and the rotor body when the earlier construction is used. It results in chafing and early failure of insulation near the end of the rotor body. This movement also imposes harmful alternating stresses on the conductors where they bridge across from the rotor body to the ring.

With the present Westinghouse construction, this movement is eliminated. The retaining ring is shrunk over a machined fit on the rotor body. This fit is great enough to insure tightness at overspeed. Thus there is always a continuous surface to support the rotor leads and there can be no bending or chafing of the rotor insulation at the end of the slot due to centrifugal force or rotor deflection. Another result is permanent centering of the retaining ring which assists in balancing and noise reduction. To resist end thrust due to coil expansion a circumferential locking key is added.

END PLATE

An end plate is shrunk into the outer end of the retaining ring to secure the coils and to avoid any tendency for the retaining ring to become elliptical. This end plate is entirely free of the shaft and thus provides a large area for the flow of ventilating gas.

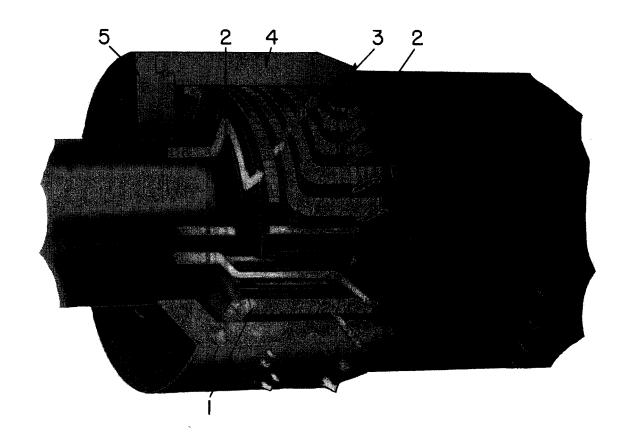




DEMOUNTABLE BLOWERS

The aluminum alloy blowers are cast in halves and assembled by a simple clamping ring. The blowers are of the propellor type which gives ample pressure and volume for ventilation with high efficiency.

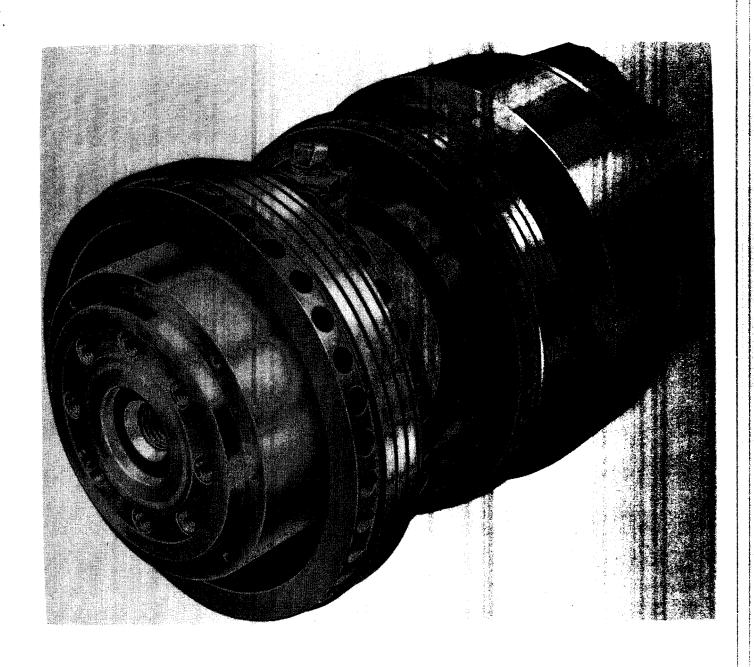
The blower may be simply and quickly removed for rotor inspection and is marked to permit reassembly without disturbing the running balance of the machine.



Rotor End-Turn Ventilation

- 1. Rotor Coil Ends
- 2. Bracing Blocks with ventilating channels
- 3. Locking Ring for Retaining Ring
- 4. Retaining Ring
- 5. End Plate

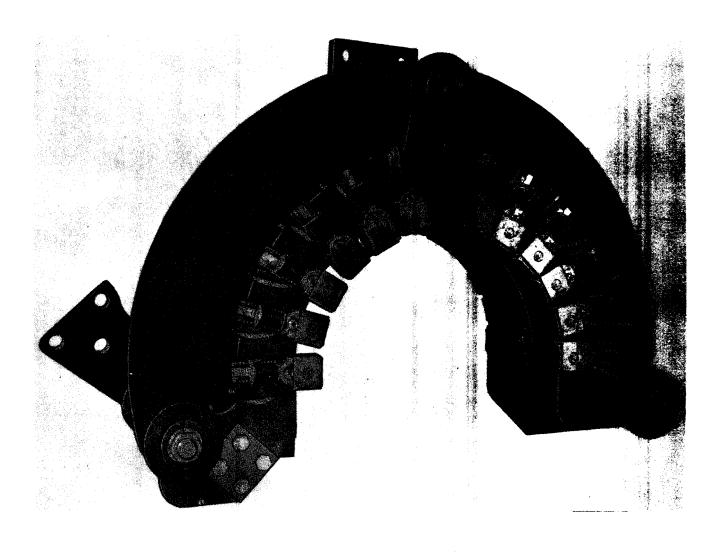
Ventilating gas enters the large opening between the end plate and the shaft. Some of it passes through the channels under the straight part of the coils and out through holes in the rotor body. Part of it is directed through passages in the end-turn bracing and out through holes in the retaining rings. This system cools the entire length of the rotor coils.



COLLECTOR

The collector rings are of high carbon steel located outside of the outboard bearing. They are mounted on individual steel bushings which are readily removable. The leads are brought from the field windings to the rings through a central hole in the shaft. To insure tightness at all times, the joints in the central hole between the longitudinal lead and the radial studs are expanded by a high strength steel bolt with a tapered head.

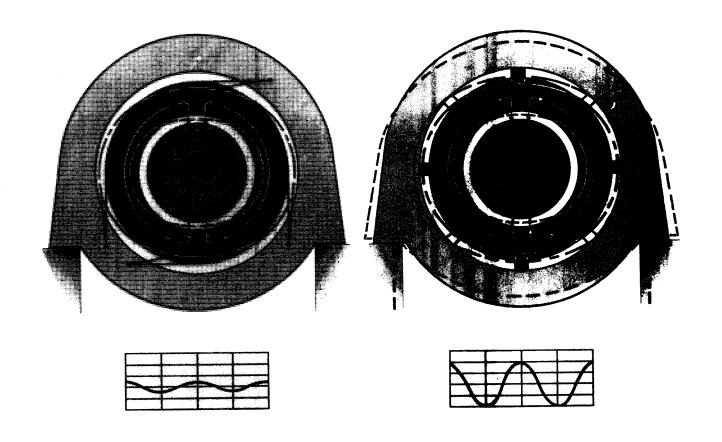
The collector rings are machined on their sides to facilitate their ventilation, and have spiral grooves in the periphery to improve current collection. This insures excellent collector and brush performance.



COLLECTOR BRUSH ASSEMBLY FOR LARGE TURBO GENERATOR

The collector brush rigging is assembled in one complete unit which can be unbolted from the machine. Each brushholder is readily accessible and each brush can be replaced, under load, by disconnecting the brush shunt, lifting back the spring and removing the brush. A large Micarta barrier separates one collector ring from the other to prevent the possibility of shorting while changing brushes.

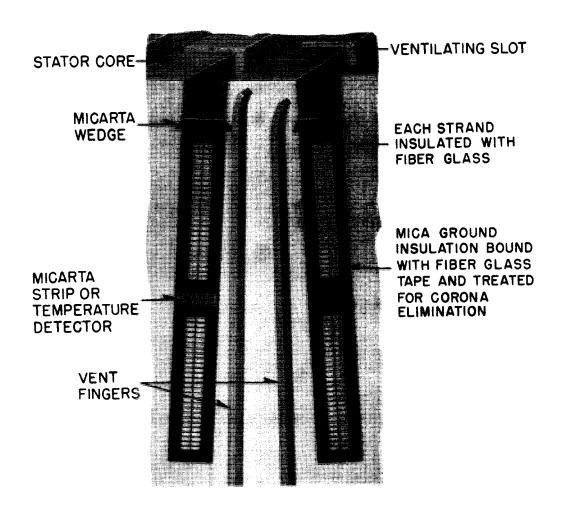
The brushholder is cast bronze and the box is broached to insure a good fit for the brush. A spring maintains proper pressure on the brush and by means of a calibrated scale and an adjustable springholder the proper pressure may be maintained as the brush wears.



FLEXIBLE MOUNTING

The frame and stator construction will be designed to minimize the effect of double frequency (120 cycles) vibration which is inherent in all two-pole generators.

The magnetic pull of the rotating field is sufficient to distort the armature into a slightly oval shape. Since the axis of distortion depends on the position of the field, any point on the armature vibrates twice for each revolution of a two-pole field. In the case of large machines, this vibration, if transmitted through the frame to the foundation and surrounding structures, may be objectionable. To prevent this, the core is practically isolated from the frame by supporting it on steel links which are relatively flexible. These links allow the core to distort radially with considerable freedom, but support it rigidly in the direction of torque loads.



STATOR WINDING - NEW WESTINGHOUSE THERMALASTIC CLASS B INSULATION

The new "Thermalastic" insulation, the result of extended research and development over a number of years, has outstanding properties in electrical, physical and thermal fields.

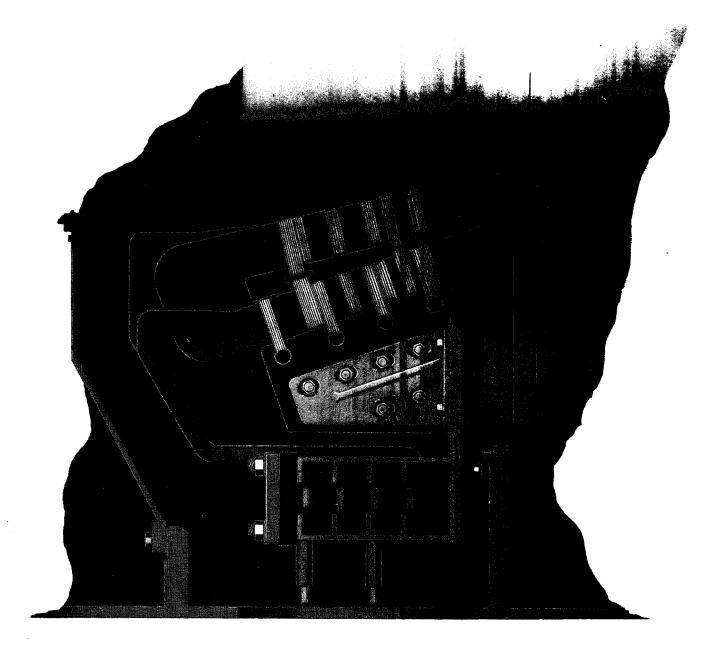
The coils are of the half-coil construction. All strands of each conductor are individually insulated with fiber glass insulation. The assembled strands are bonded solidly in the portion embedded in the slot. This insures a strong rigid straight part and consolidates the strands to a controlled size.

The coils are insulated from ground by multiple layers of continuous mica tape. The newly developed mica tape used is bonded with a synthetic resin with excellent electrical properties which contribute to low dielectric loss and high dielectric strength. After application of the mica tape, the coil is completely taped with a finish tape of fiber glass.

The coils are vacuum treated to remove moisture, solvents and gases. They are then impregnated under pressure with a newly developed thermosetting synthetic resin of low viscosity. The process used results in the greatest possible fill of the coil interstices. After impregnation the resin is cured by heating with physical restraint on the insulation to obtain a high degree of filling and excellent consolidation both on the straight part and the end winding. The resultant composite insulation is a tough yet flexible dielectric barrier with excellent electrical and physical properties. The insulation is elastic and possesses good dimensional stability.

The advantage of the new insulation is the nature of the resin impregnant and the impregnation process resulting in a high degree of fill. The excellent electrical properties of the resin coupled with improvements in fill and good insulation consolidation results in lower insulation power factor, increased dielectric strength and remarkable improvement of voltage endurance. The thermosetting character of the resin provides solid yet elastic physical bonds between mica flakes. The resilient nature of the resin bond permits elastic cyclic displacement of adjacent mica flakes and provides restoring force within the insulation wall.

To eliminate corona on the straight part of the coil, the surface is treated with a low resistance semi-conducting compound which keeps it at practically ground potential. A surface treatment of high resistivity Coronox eliminates end turn corona.



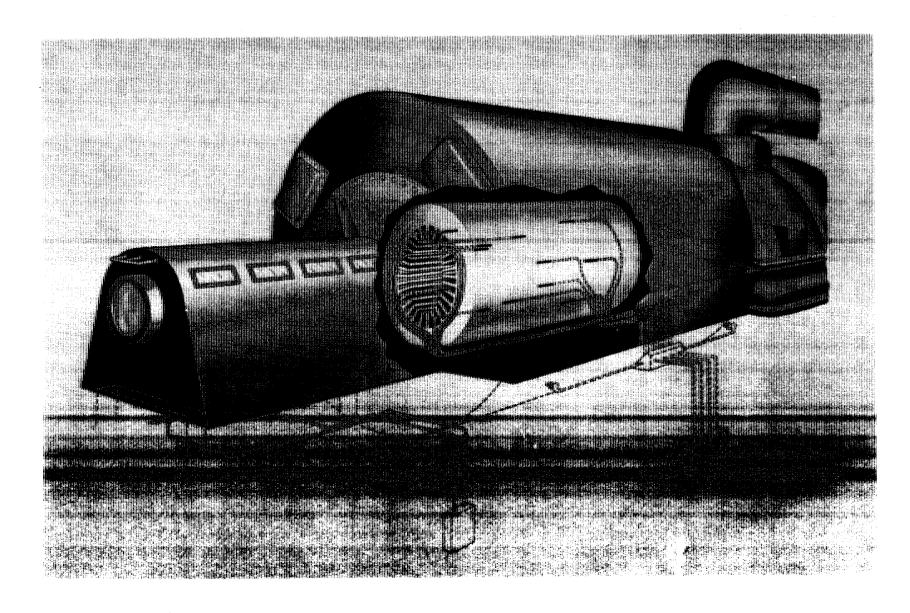
STATOR COIL BRACING

The end winding is braced against short circuit stresses by blocks and spacers between coils and is supported by lashing the coils with GLASWEVE twine to micarta brackets which are firmly bolted to the end plates. There are no metal parts adjacent to the end windings.

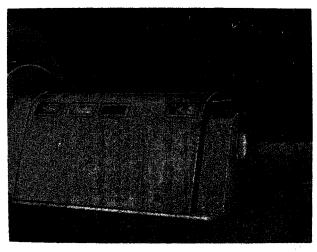
CORONOX PROTECTION

The end windings are treated with CORONOX compound, a high resistance material which permits charges on the surface of the coils to drain off, and thus practically eliminates corona at operating voltage.

After complete assembly and CORONOX treatment, a final coating of long life, moisture and oil resistant varnish is applied.



Distribution of 10 Ohm Temperature Detectors and Location of Terminal Boxes



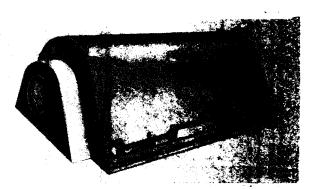
AIR-COOLED TURBO-GENERATOR WITH EXCITERS



METHOD OF REMOVING EXCITER HOUSING



AIR-COOLED TURBO-GENERATOR WITH EXCITER HOUSING WITHDRAWN



SKETCH OF DEVICE FOR RETRACTING HOUSING WHEELS

EXCITER SUPPORT

The exciters are mounted on a common separate bedplate arranged for easy removal and reassembly as a complete unit in case of major inspection or repairs to the A.C. generator.

EXCITER HOUSING

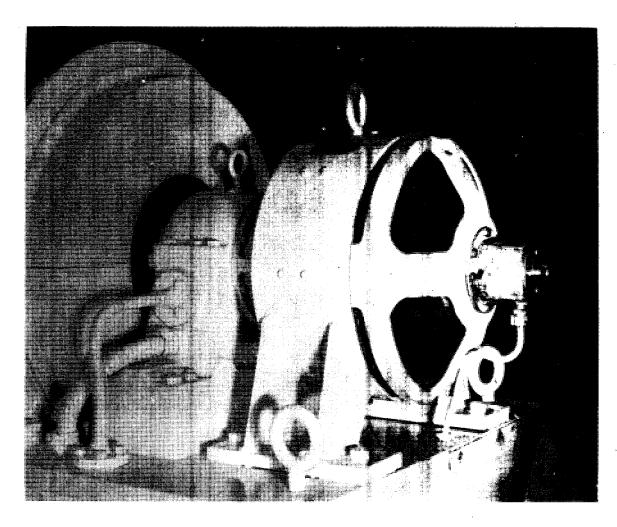
A recently developed exciter housing combines the ultimate in appearance, accessibility and ease of removal. A number of shatterproof glass windows are provided in the housing and the interior is lighted so that all parts can be inspected without moving the housing.

The housing is equipped with retractable wheels which permit the operator to roll it off in a few seconds with little effort, exposing as much of the assembly as desired.

EXCITER AND COLLECTOR VENTILATION

Ventilation of the exciter housing is accomplished by a double fan mounted on the generator shaft. One part of the fan forces air over the collector to a discharge opening. The other part forces air through the exciters. The direction of air flow is such as to drive most of the carbon dust away from conducting parts and out of the housing.

All ventilating air is taken in and discharged through holes in the bedplate.



Accessibility of Pilot Exciter and Tachometer

PILOT EXCITER

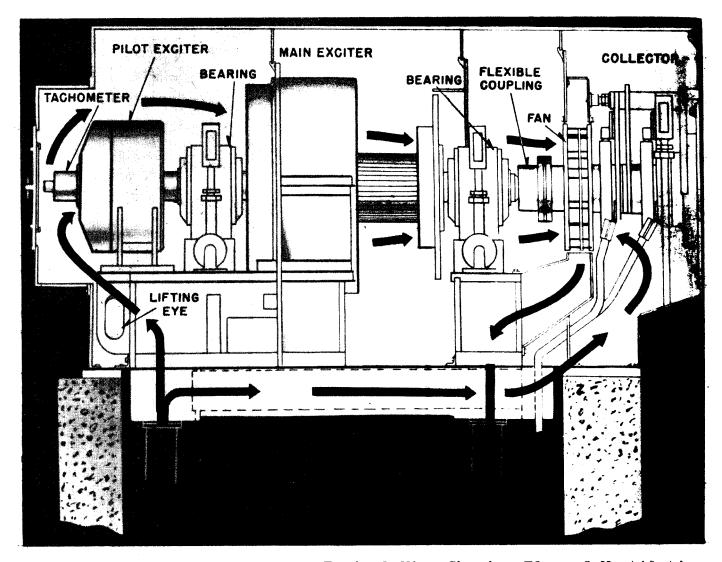
The pilot exciter stator is of conventional design, compound wound, and includes interpoles to assure good commutation at all loads.

The armature is overhung on the main exciter shaft, which is made of generous size to hold vibration to a minimum.

Accessibility is one of the outstanding characteristics of this pilot exciter. Large openings are provided in the bracket and the brush holders are located so as to be readily accessible through these openings.

There are two brushes per arm, set in heavy cast bronze reaction type brush holders. To facilitate changing brushes under load the brush shunts are cut and soldered about one inch from the brush, and the shunt is used only as a handle for removing and replacing the brushes, with the result that no tools are required to change brushes. The current per brush is small enough to permit satisfactory operation without customary brush shunts.

The pilot is ventilated by a fan located on the generator shaft and used also to ventilate the main exciter.



Typical View Showing Flow of Ventilation

EXCITER AND COLLECTOR VENTILATION

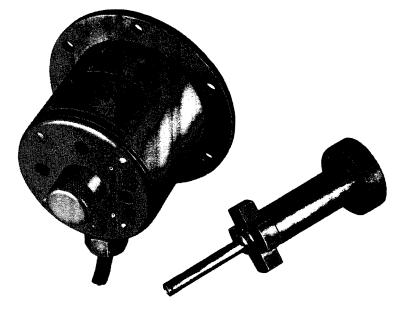
Air entering the exciter housing is divided between two paths. The larger protion is directed upward toward the tachometer whence it passes through and around the pilot exciter and then the main exciter, passing the commutator and brushes last, so that brush dust is not driven into the windings, but is taken directly to the fan and discharged.

The smaller portion of air is directed through passages in the sub-base into the collector compartment and is discharged by a separate section of the fan into the common air discharge. In this way, brush dust from the collector is driven out of the housing.

Removal of Exciter Unit

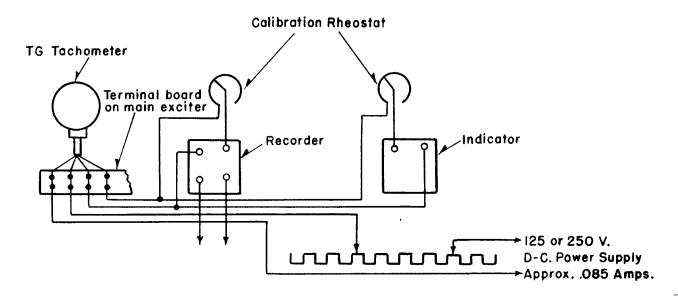
The entire exciter assembly is arranged for removal and replacement as a unit by making all oil and electrical connections accessible from the turbine room floor. The passages for air intake and discharge through the floor are equipped with soft joints so that there is no bolting to be removed from them.





Speed Indicator

Tachometer Generator with Rotor Removed



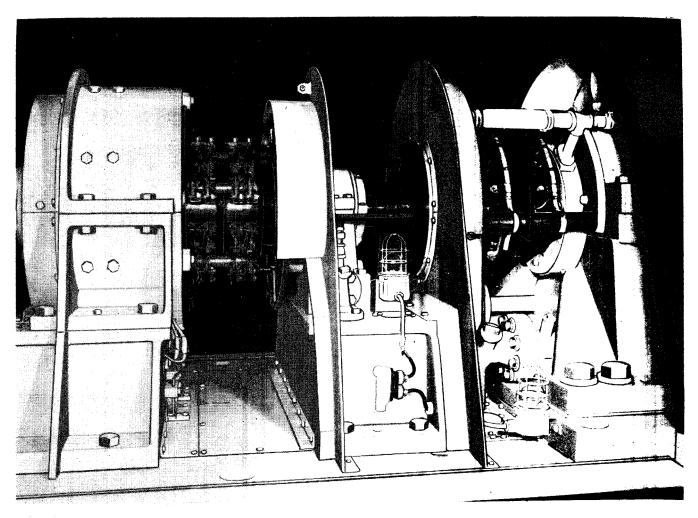
Schematic Diagram of TG Tachometer

TACHOMETER

A Type TG tachometer generator is overhung from the pilot exciter bracket. The rotor weighs only a few ounces, and carries no winding, so the generator operates without bearings or sliding contacts.

It requires a small amount of d-c for its field excitation, but since the field is highly saturated, variations in the excitation voltage do not appreciably affect speed indications.

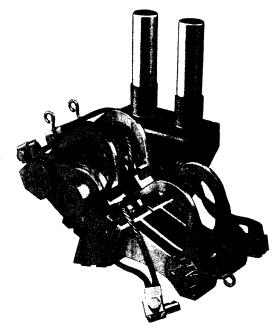
An indicating instrument of the Rectox type is furnished as standard, but a recorder can be furnished when ordered. The generator is capable of operating both indicating and recording instruments simultaneously.



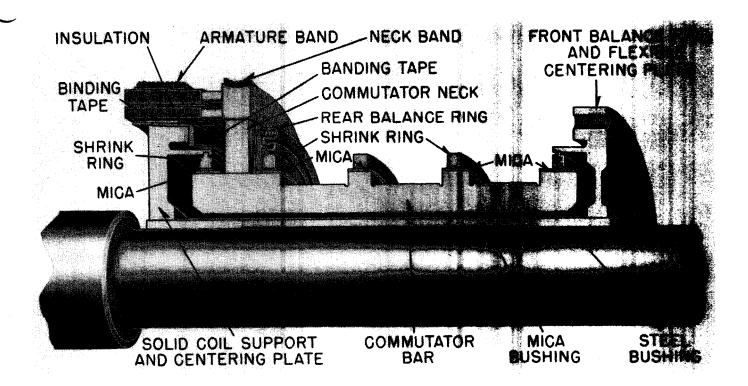
When the exciter housing has been rolled away, all parts that require occasional attention are fully accessible. Ample room is provided around the commutator for changing brushes.

To make this operation feasible while the machine is carrying load, special brush holders are provided, having a simple but vibration-proof plug and jack arrangement, so that brushes can be removed and replaced without the use of any tools near the commutator.

The illustration at the right shows such a brush holder with one of the plugs removed.



Exciter Brush Holder



Schematic Diagram Showing Construction of Exciter Commutator

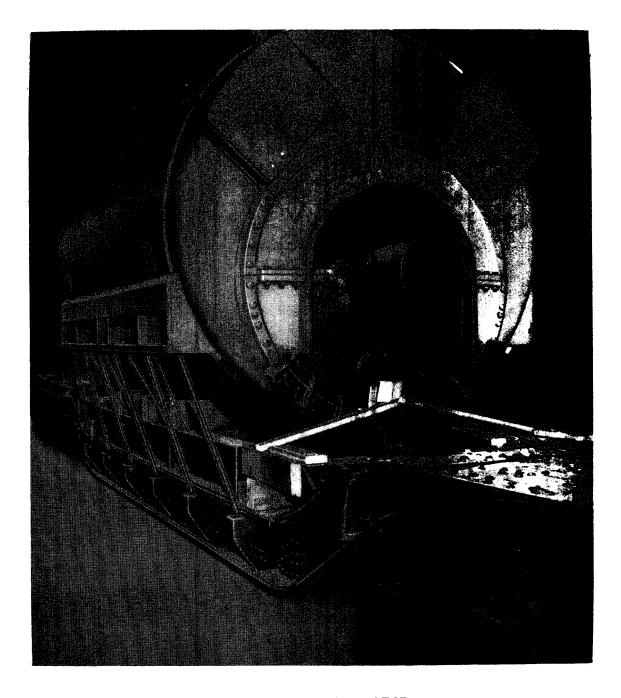
EXCITER COMMUTATOR CONSTRUCTION

The commutator is a highly improved type which provides for expansion in all directions without distortion or unbalance.

The commutator bar assembly is supported by the front and rear centering plates. The rear plate is very heavy so as to act as a fixed point for the commutator bars. The front plate, however, is made thin so that it will dish or warp as the commutator bars expand in an axial direction due to temperature. This movement is but a few thousandths of an inch, but unless provided for, the commutator will roughen and cause sparking.

The shrink rings provide for the radial expansion, and are designed so that as the commutator expands due to centrifugal force and temperature, the rings will expand within their elastic limits. Contraction of these rings as the commutator cools will force the commutator bars back into their original position, thus preventing buckling.

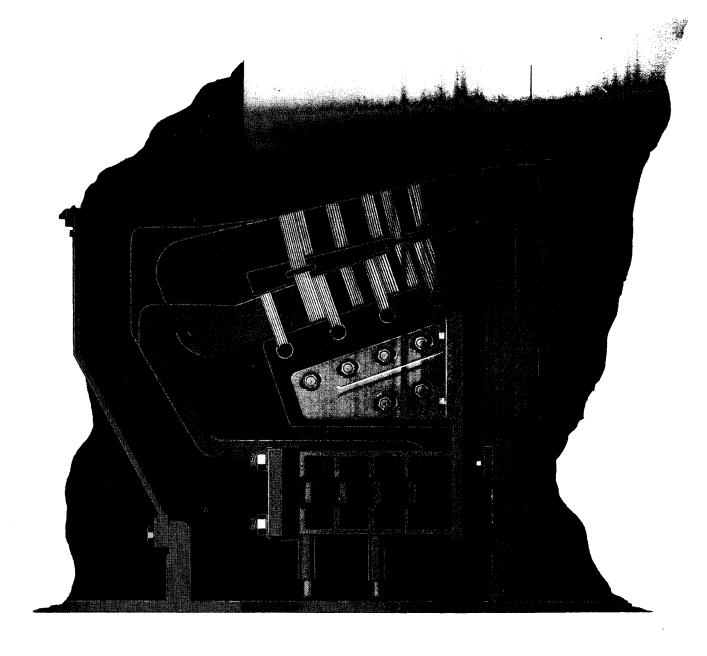
There are three balance rings on the armature shaft. Two of them are located on the commutator and a third one is on the opposite end of the armature shaft. By the use of these rings, a perfect dynamic balance may be obtained on the entire armature assembly before it leaves the factory.



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The above picture shows the procedure in which a generator is being shipped as a complete unit; this particular machine being shipped 1550 miles satisfactorily. This method serves to reduce erection time, as well as to provide a machine as built and tested at the factory. Lead bushings are protected by specially designed steel skids which are suitable for rolling or cribbing if a crane is not available.

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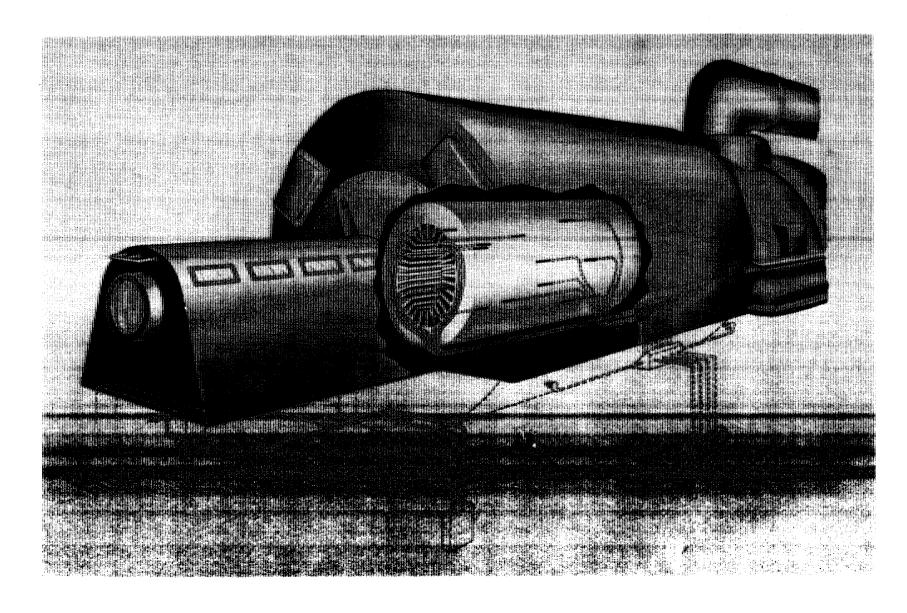
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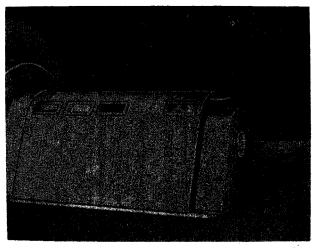
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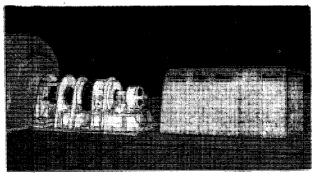
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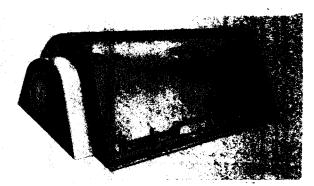
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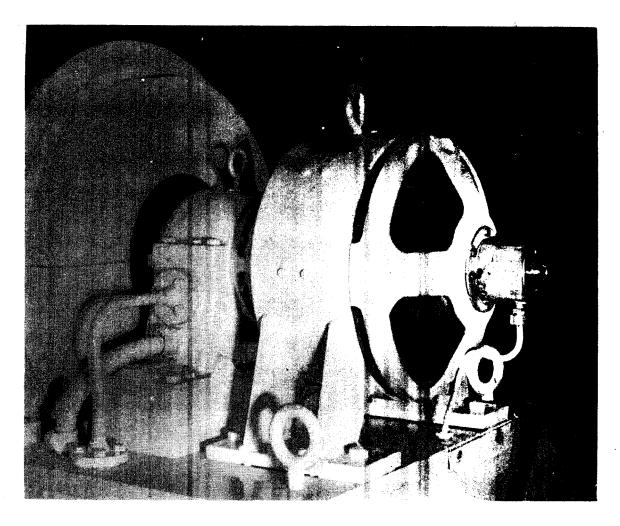
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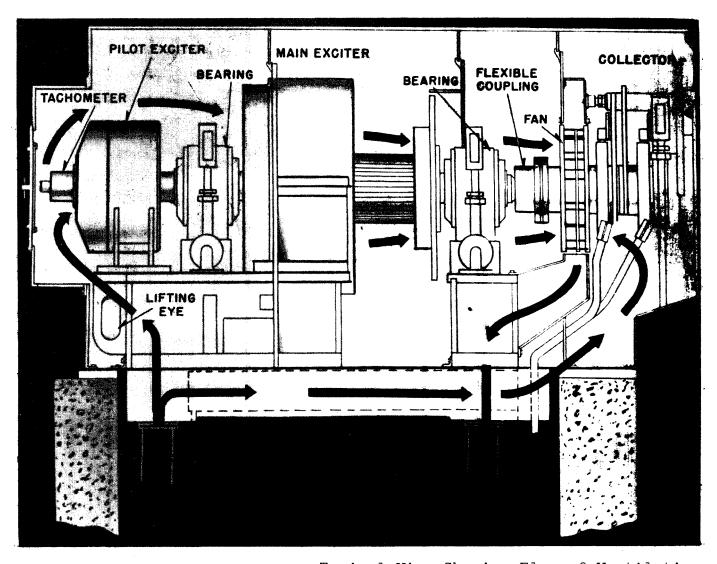
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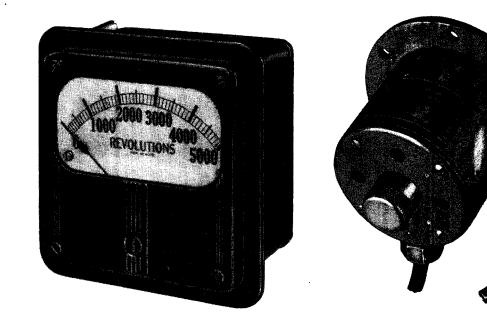
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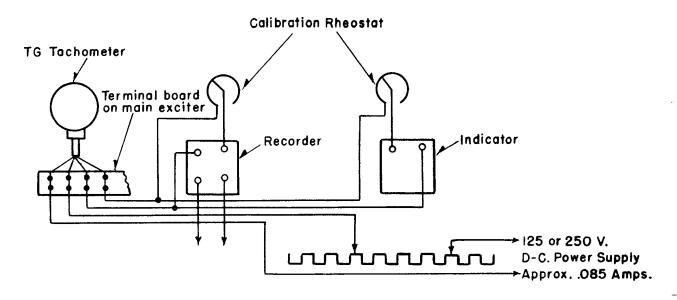
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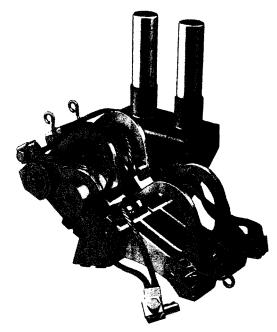
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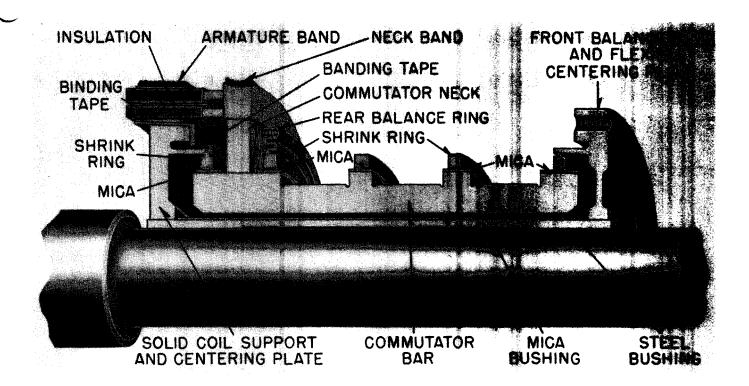
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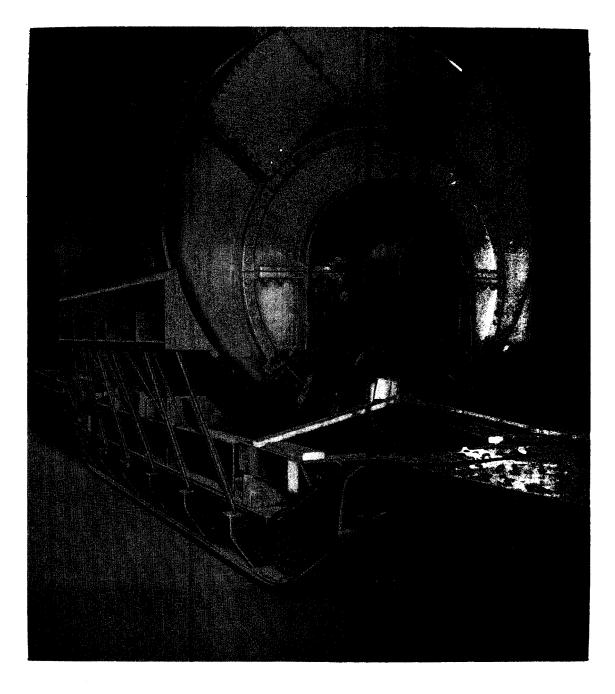
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