CONDENSING TURBINE
Type "A"

INTRODUCTION

The steam turbine, like any other high grade machine, requires, for sustained efficiency and continuity of operation a reasonable minimum of care and attention on the part of the operator. In order that the unit may receive such care and attention, it is necessary that the operators become thoroughly familiar not only with the mechanical structure of the several parts of the turbine, but also with their purpose, and, in a general way, with the reasons why they are so designed. The following brief instructions for the care and operation of the turbine have been prepared as an aid to the attainment of this desired information and it is hoped that they may be found to be broad enough in scope for that purpose.

GENERAL DESCRIPTION

This is a combination impulse and reaction turbine designed for high operating efficiencies, thus giving minimum steam consumption. The exact steam conditions with which it is intended to operate, the normal speed and the maximum load are given on the Title Page of the Instruction Book.

The construction of the entire turbine is shown in the longitudinal section photograph. (It should be noted that this illustration shows a side view below the horizontal centerline and a longitudinal section above the centerline.)

Cylinder

The structural shape of the cylinder and the method of support are carefully designed to obtain symmetrical movements resulting from thermal changes, and thereby reduce to a minimum the possibility of distortion. A feature of major importance in the accomplishment of this desired condition is the provision for an annular belt of steam extending around the entire cylinder at the high pressure end which maintains equal temperatures in the base and cover. This chamber serves as the steam passage between the No. 1 governing valve, located in the cylinder cover, and its nozzles which are located in the base. It, therefore, is filled with high temperature steam as soon as the first valve opens and remains filled until this valve closes.

The complete cylinder is made in two sections, the high pressure section being of cast steel and the low pressure of cast iron. Each section is split in the horizontal plane through the axis, so as to form a base and cover. During the installation, the vertical joint is made up permanently and thereafter the cover is handled as a single piece. The balance piston rings are formed integrally in the cylinder castings. The blade rings in the high pressure section are separate elements, supported in the cylinder at the horizontal joint and guided at the top and bottom by dowel pins so as to maintain the correct position with respect to the turbine axis, but to allow the parts to expand and contract freely in response to temperature changes.

Openings are provided in the cylinder, between adjacent blade rings, through which steam can be extracted, if desired, for feed water heating. The sizes of these openings and the exact locations are given on the "Outline" drawing.

The low pressure end of the cylinder is supported by feet projecting from the exhaust chamber, which extend along each side and along a portion of the exhaust end. These supporting feet rest on seating plates which are grouted to the foundation. The position of the cylinder at this end is maintained by three keys placed between the supporting feet and the seating plates. Two of these keys, one on each side, placed transversely on the transverse centerline of the exhaust, definitely locate the cylinder in an axial direction but permit free expansion in a transverse direction. The third key, placed axially on the longitudinal centerline just below the No. 3 bearing definitely locates this end of the cylinder in a transverse direction but permits free expansion in an axial direction. Therefore, from a point at the center of the exhaust opening, the cylinder can expand freely in any direction in the horizontal plane at the top of the foundation seating plates.

At the high pressure end, the cylinder is supported by two arms (or lugs) which are cast integrally at the top of the base, thus locating the point of support as closely as possible to the horizontal centerline. These arms rest on a separate pedestal and are free to slide in a transverse direction, being secured only loosely by bolts. The cylinder is connected to the pedestal by a single vertical pin placed on the longitudinal centerline, thus maintaining the correct axial and transverse position of the cylinder with relation to the pedestal. The pedestal, in turn, is free to slide axially on its base, but is held against transverse movement by an axial key, placed on the longitudinal centerline, between it and the base. Any tendency to tilt is limited by side gibs which are fitted with ample clearance to allow free movement axially.

The base and cover of the cylinder are bolted together by large studs. In order to obtain the proper stress in each of these studs, they must be tightened sufficiently to stretch them a definite amount. The correct method to obtain this stretch is described in Supplement No. 102, Rev.2.

Rotor

The main body of the turbine rotor is machined from a solid forging of alloy steel. As shown in the illustration of the longitudinal section, the blades of the last row are carried on a separate alloy steel disc which is shrunk onto the main body. In addition to the heavy shrunk fit, this disc is further secured by a split dowel ring which is, in turn, held by a solid ring shrunk on it. Balance plug holes are provided in a separate ring, which is shrunk on the hub of the disc. A separate stub shaft is bolted to the inlet end to form the thrust bearing collar and to carry the oil impellers and overspeed trip.

The entire rotor is finish-machined all over and, after being completely bladed, is given an accurate dynamic balance. The exhaust end is connected to the generator field by a rigid coupling and the main rotating element thus formed is carried in four bearings.

Blading

The blade path includes a Curtis stage followed by reaction blading. The exact blade arrangement and the number of stages or rows are given on the Title Page of the Instruction Book. Throughout the blade path, the massive rotating and stationary parts are separated by relatively large clearances, and the small clearances are maintained by thin seal strips. These strips are made of a special alloy material with excellent wearing qualities and if contact should occur, the strips wear away without resulting in any damage to major parts.

Balance Piston

The inlet end of the rotor is machined to form a two stage balance piston (or dummy) which is designed to over-balance the thrust on the blading and thus produce a thrust toward the inlet end of the machine under all operating conditions. With this arrangement, any floating of the rotor, such as is possible in case of loss of load, can occur toward the exhaust end only, thus temporarily increasing the axial running clearance by the amount of clearance in the thrust bearing.

The steam leakage past the balance piston seals is led through external pipes and is returned to the cylinder at lower pressure zones, as determined by the steam conditions and design of the machine.

The balance piston labyrinth seals are of the axial clearance type and are described in a separate leaflet. During starting and stopping periods, the rotor must be moved (by means of the thrust bearing adjusting mechanism) to the start and stop position which increases the clearance over these seals.

Control

The control and oil system diagram shows the various parts of the control system and their relation to one another. The detail operation of each particular part is described in its respective leaflet.

Enough oil should be provided so that when the turbine is running at full speed the oil level in the reservoir, as shown by the gauge is within the limits given on the indicator plate. Although there is a strainer in the oil system, it is desirable as a precaution to strain the oil through a fine mesh screen or cloth just before putting it into the reservoir.

The amount of water circulated through the oil cooler should be regulated to maintain the temperature of the oil leaving the cooler between 100 and 110° F. The correct criterion of oil cooler water supply is, of course, the temperature of the oil leaving the hottest bearing. This temperature will vary with different units and operating conditions. However, in general, oil return temperatures of 140 to 160°F. are considered good practice. When starting a turbine, the oil cooler water should not be turned on until the oil temperature has increased to the approximate limits given above.

Operation and Maintenance

A recommended procedure for operating the turbine is given in a separate leaflet. While these instructions are quite specific, it is impossible to cover all details. Hence, they do not in any way relieve the operator of using sound judgment and exercising due caution.

Likewise, it is impossible to give any detailed procedure for maintenance work. It is believed that the illustrations and descriptions of the detail parts as given in the Instruction Books should enable the Maintenance Engineer to care for the apparatus properly.

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