# HIGH PRESSURE, NON-CONDENSING TURBINE WITH FEED HEATING TURBINE

## 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, 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 unit consists of two turbines connected in tandem and driving a single generator, a direct connected exciter and a pilot exciter. The main turbine is a single cylinder, combination Curtis and reaction machine of the high pressure, non-condensing type. The auxiliary or feed heating turbine is of the combination Rateau and reaction type. It is connected in tandem to the main turbine and arranged to receive steam at the main exhaust pressure and bleed into 60 lb. and 5 lb/in$^2$g. heaters. The normal speed of the entire unit is 3600 rpm. The main turbine is designed to operate with steam conditions of 1200 lb/in$^2$g. 900°F total temperature and 200 lb/in$^2$g. back pressure. When operating under these conditions and with the feed heating turbine utilizing a part of the main exhaust steam at 200 lb/in$^2$g. the two turbines operating as a unit will carry a maximum load of 53000 kw.

In normal operation, the main turbine is superposed on condensing units. That is, the main turbine exhausts into a nominal pressure header (which may or may not be supplied also by nominal pressure boilers) and supplies steam to the inlet of one or more condensing machines. When operating in conjunction with the nominal pressure boilers, the high pressure turbine operates with constant exhaust pressure. If the nominal pressure boilers are not used, the high pressure turbine may operate with constant exhaust pressure, or, by taking the pressure regulator out of service, it may be operated with the condensing turbines as a cross-compound unit with variable exhaust pressure on the main turbine.

The construction of the entire turbine is shown in Figure 1. It should be noted that this illustration shows a side view below the horizontal centerline and a longitudinal section above the centerline.

## Cylinders

The main turbine cylinder is made of cast carbon molybdenum steel, due to the high steam temperature encountered, and is split in the horizontal center plane to form a base and cover. Blade ring elements are cast integrally, and passages are provided for bypassing the Curtis stage at maximum load. An important feature of this cylinder design is an annular steam belt extending around the entire cylinder at the high pressure end, which equalizes the temperatures of the base and cover and thus greatly decreases the possibility of cylinder distortion. This chamber serves as the steam passage between the No. 1 inlet valve located in the cover, and its nozzles located in the base, and therefore is filled completely with steam as soon as the first valve is opened.

bearing is used on the stub shaft adjacent to this coupling. The main turbine rotor is connected to the generator field by a rigid coupling, and the complete rotating element thus formed is carried in seven bearings.

## Blading

The blading of the main turbine consists of a single Curtis stage followed by fourteen pairs of rows of reaction type, and that of the feed heating turbine consists of a single Rateau stage followed by nineteen pairs of rows of reaction type. 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.

The various blade types are described in the following I.B. Leaflets:

## Main Turbine

Curtis Stage . . . . . I.B. 6330

Reaction,
- First eight pairs of rows . . . I.B. 5305-06 Supp. 302
- 9th & 10th pairs of rows . . . I.B. 5305-06 Supp. 303
- Last four pairs of rows . . . I.B. 5305-06 Supp. 302

## Feed Heating Turbine

Rateau Stage . . . . . I.B. 5305-06 Supp. 292
Reaction. . . . . I.B. 6156

## Balance Pistons

The inlet end of each turbine rotor is machined to forma single stage balance piston (or dummy) to counteract the thrust on the reaction blading. On the main turbine, the balance piston is designed to overbalance 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 clearances by the amount of the clearance in the thrust bearing.

The steam leakage past the balance piston seals is led through external pipes connecting to the respective turbine exhausts.

The balance piston labyrinth seals of the main turbine are of the radial clearance type and are described in I.B. 6278. The balance piston seals of the feed heating turbine are of the radial clearance type and described in I.B. 5305-06 Sup. 326, Rev. 1.

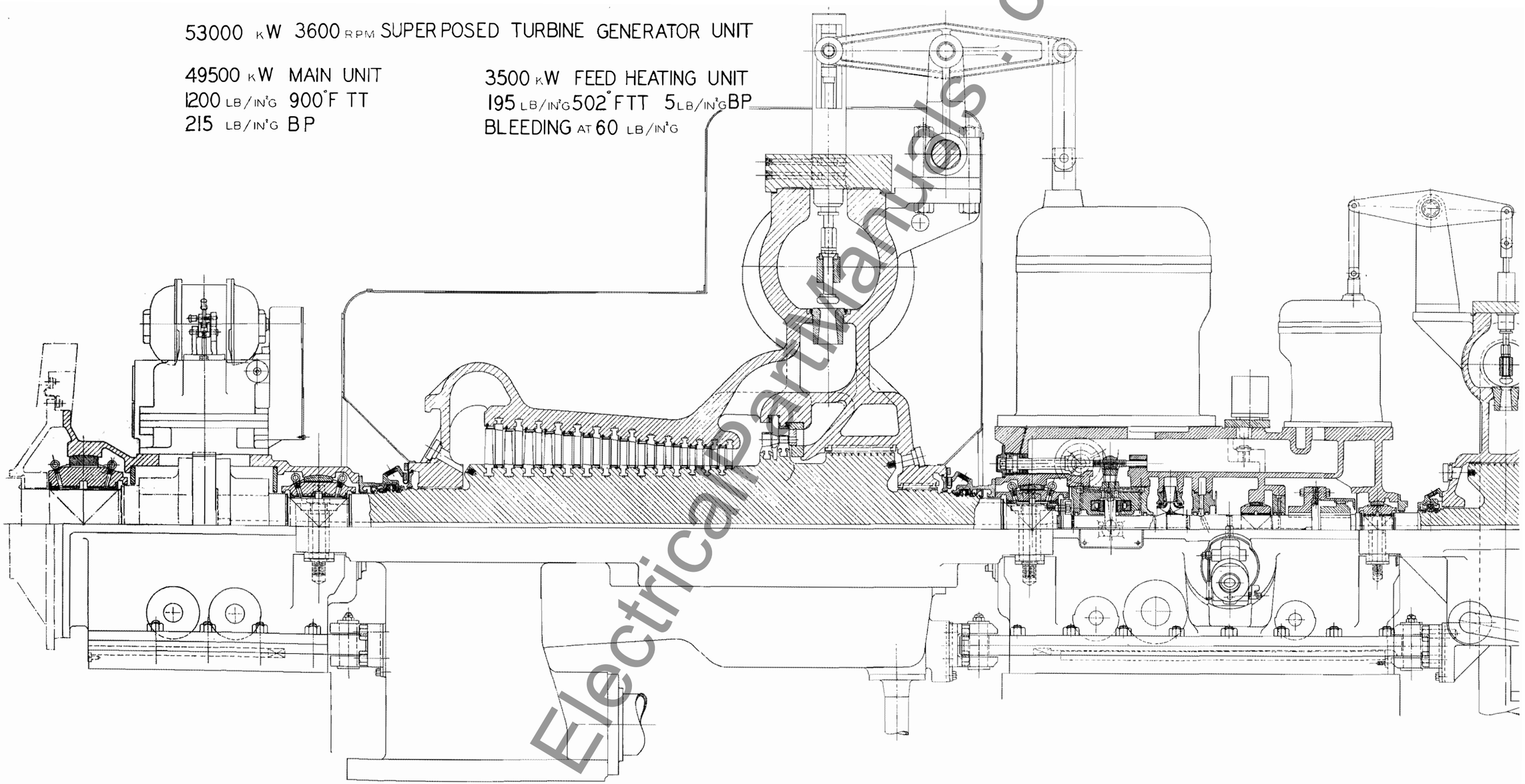
## Control

Steam is admitted to the turbine through an inverted, hydraulically operated, combination hand throttle and automatic trip valve. It is located below the floor with the operating handwheel and a suitable stand extending above the floor to a convenient height. The valve is connected to the turbine by two pipes, thus admitting steam at both ends of the steam chest. A cylindrical type strainer is built in the main valve body and is accessible from the operating floor level. This valve is described in I.B. 6110, Rev. 1.

53000 KW 3600 RPM SUPERPOSED TURBINE GENERATOR UNIT

49500 KW MAIN UNIT
1200 LB/IN²G 900°F TT
215 LB/IN²G BP

3500 KW FEED HEATING UNIT
195 LB/IN²G 502°F TT 5 LB/IN²G BP
BLEEDING AT 60 LB/IN²G



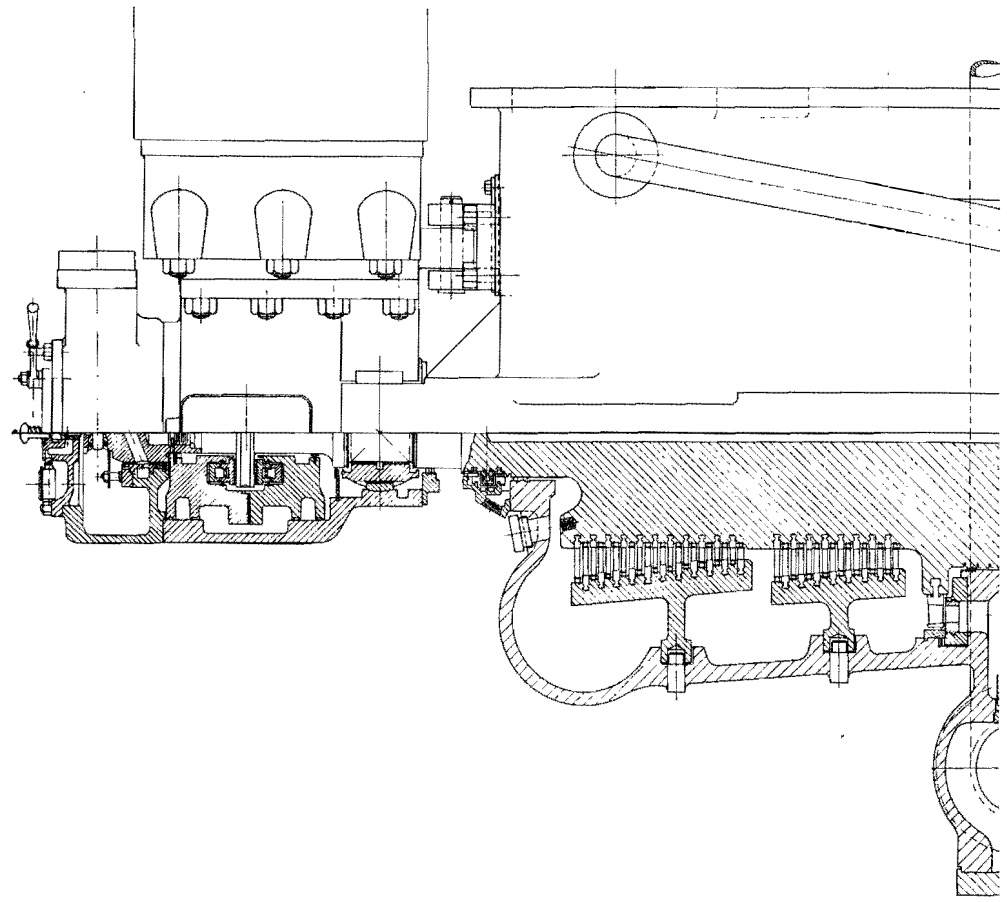


Figure 1