SIEMENS

SYSTEM DESCRIPTION MBB POWER TURBINE SYSTEM	Respons. dept GRPD	Date 2004-02-10	Reg. M DB 101
	Prepared B. Wassberg		YAMAMA CEMENT

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A 087 0474-B 00-03 MS Word 97

Approved 2004-02-19 Peter Lundin	Latest revision -	Archive 20	HG 9100
Checked 2004-02-18 Mathias Nilsson		No. 1CS39623	

SYSTEM DESCRIPTION MBB POWER TURBINE SYSTEM	Respons. dept GRPD	Date 2004-02-10	Reg. M DB 101
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Purpose of the system

The power turbine converts the pressurized hot gas flow from the gas generator to mechanical energy, driving a load (in power generation via a gearbox).

General description of the system

Refer to P&ID 2046 019

The GT 10B gas turbine operates in a simple open cycle with straight air and gas flow through the turbine. It can be divided into two main sections, the gas generator and the power turbine. The two main sections are not mechanically interconnected, so the gas generator speed is determined by the output of the unit as well as ambient conditions, which allows a wider control range at sustained efficiency.

The power turbine is a two-stage axial-flow turbine.

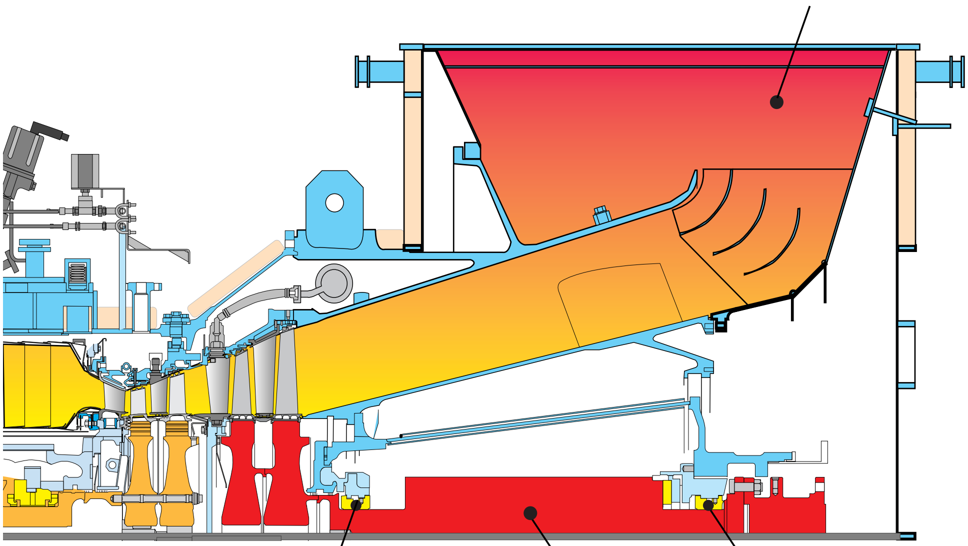

Fig.1 GT10 Power Turbine

Rotor

The power turbine rotor is solid, built up from two discs and a rotor shaft. The rotor is fully electron beam welded. The PT blades are fitted in fir-tree grooves and have shrouds to minimize the interstage gas leakage. The rotor blades as well as the guide vanes are precision cast.

Stator

The PT stator carries two guide vane stages. The first guide vane stage is permanently adjustable to obtain optimum efficiency at various climate conditions. The vanes in the first stage are also hollow to transport cooling air to the turbine disc. The stator surfaces above the blade tips are provided with honeycomb seals. Honeycomb is an abradable seal, which can withstand a blade tip rubbing.

Casings

The turbine casing houses the power turbine stages. The turbine casing is bolted to the diffusor casing. The purpose of the diffusor is to retard the velocity and gain static pressure, thereby increasing the pressure ratio across the power turbine. The bearing housings are attached to the diffusor casing.

The exhaust casing surrounds the greater part of the diffusor casing and directs the exhaust gases to the outlet duct. The casing is designed to provide a minimum back pressure, which is important in order to not affect the power output.

Bearings

The bearings are of tilting pad design with a directed lubrication system.

The bearings are equipped with temperature sensors and vibration transducers.

Two journal bearings, no 3 and 4, numbered from the inlet to the exhaust carries the power turbine rotor. Bearing no 3 is a journal bearing and number 4 are a combined thrust and journal bearing. During operation, oil is continuously supplied to the bearings. Return oil from the bearing casings is led back to the lubricating oil tank by gravity. See also the Lubrication oil system, MBV.

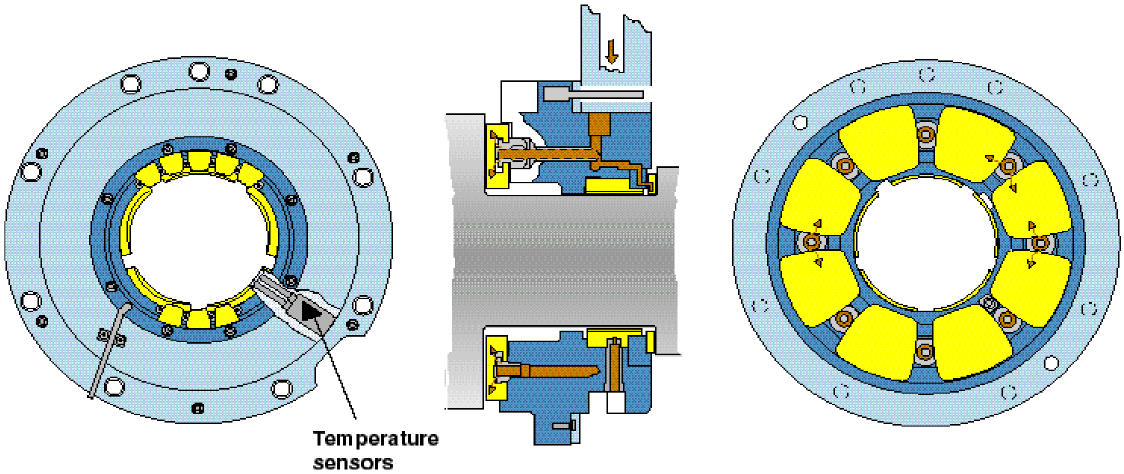

Fig.2 Combined journal/thrust bearing #4

Cooling and sealing air

The cooling and sealing air are taken from the bleed cavities.
The first guide vane stage is hollow and transports cooling air to the first rotor disc before entering the gas path. The cooling air is led via an external pipe into a manifold located in the diffusor. From there, air is distributed via flexible hoses to each individual guide vane.
A part of the supplied air is also tapped from the manifold to form a heat barrier between the stator and the surrounding turbine casing. This air enters the turbine gas path.
Sealing air is also used to prevent hot gases from entering the bearing housing or oil from leaking out from the bearing housings.

See also cooling and sealing air system, MBH

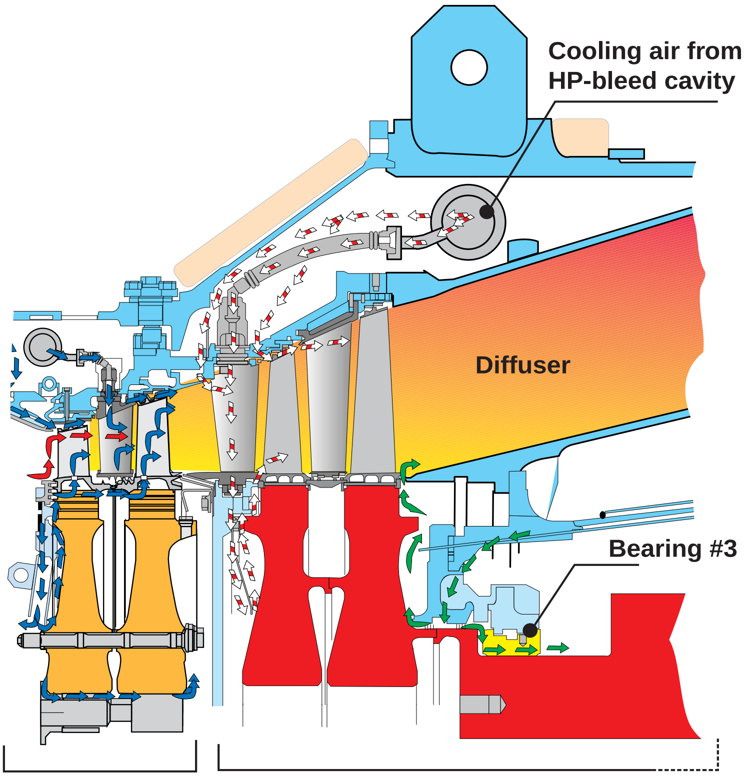

Fig.3 Cooling and sealing air power turbine

Main components

- Pressure transmitter, pressure exhaust gas
  MBB10CP005
  The transmitter is continuously monitoring the absolute exhaust pressure. Used for calculation of the limit set value of the exhaust gas temperature.

- Pressure transmitter, pressure exhaust gas
  MBB10CP010
  High diff. pressure (H1) over the casing wall initiates an alarm.
  (High diff. pressure (H2) over the casing wall initiates a turbine trip. -only when using a boiler).
  Protects the exhaust casing from being pressurized above design pressure.

- Speed transducer, PT speed
  MBB10CS005
  The transducer is continuously monitoring the speed of the PT rotor. It protects the rotor from over-speed and is also for governing.
  High speed (H1) initiates a turbine trip.
  Low speed (L1) initiates a generator circuit breaker trip or if low speed is still present after a set time a turbine trip.

- Speed transducer, PT speed
  MBB10CS010
  The transducer is continuously monitoring the speed of the PT rotor. It protects the rotor from overspeed and is also for governing.
  High speed (H1) initiates a turbine trip.
  Low speed (L1) initiates a generator circuit breaker trip or if low speed is still present after a set time a turbine trip.

- Axial position transducer, axial displacement PT rotor
  MBB10CG005
  The transducer is continuously monitoring the axial position of the PT rotor.
  Axial displacement (L1) initiates an alarm.
  Axial displacement (H1) initiates an alarm.
  Big axial displacement (L2) initiates a turbine trip.

- Key phasor, PT rotor angle
  MBB10CG010
  The key-phasor detects rotor angle at balancing of the PT rotor.

- Temperature transmitter, exhaust gas temperature
  MBB10CT005-MBBCT080
  The thermo couple is continuously monitoring the gas temperature after the PT. Each measuring point has got three thermo couples. The exhaust temperature measurement used by the control system have got the following main purposes:
  - limiting the maximum allowed average exhaust temperature.
  - supervision of combustion
  The computer calculates the maximum + and minimum - deviations from average. If the deviations gets too large there will be an alarm (H1) and in the worst case a trip (H2).
  High average exhaust temperature (H1) initiates an alarm.
  High average exhaust temperature (H2) initiates a turbine trip.

- Temperature transmitter, journal bearing (no.3) temperature
  MBB10CT085
  The PT100 is continuously monitoring the bearing temperature. The transmitter is measuring the temperature in one of the bearing pads.
  High temperature (H1) initiates an alarm.
  High temperature (H2) initiates an alarm.

- Temperature transmitter, journal bearing (no.3) temperature
  MBB10CT090
  The PT100 is spare for MBB10CT085.

- Temperature transmitter, thrust bearing (no.4) temperature
  MBB10CT095
  The PT100 is continuosly monitoring the bearing temperature. The transmitter is measuring the temperature of the escaping oil from the pads.
  High temperature (H1) initiates an alarm.
  High temperature (H2) initiates an alarm.

- Temperature transmitter, thrust bearing (no.4) temperature
  MBB10CT100
  The PT100 is spare for MBB10CT095.

- Temperature transmitter, journal bearing (no.4) temperature
  MBB10CT105
  The PT100 is continuously monitoring the bearing temperature. The transmitter is measuring the temperature in one of the bearing pads.
  High temperature (H1) initiates an alarm.
  High temperature (H2) initiates an alarm.

- Temperature transmitter, journal bearing (no.4) temperature
  MBB10CT110
  The PT100 is spare for MBB10CT105.

- Vibration transducer, bearing (no.3) vibration
  MBB10CY005
  The accelerometer is continuously monitoring the vibrations.
  High vibrations (H1) initiates an alarm.
  High vibrations (H2) initiates a turbine trip.

- Vibration transducer, bearing (no.4) vibration
  MBB10CY010
  The accelerometer is continuously monitoring the vibrations.
  High vibrations (H1) initiates an alarm.
  High vibrations (H2) initiates a turbine trip.

Function

Start up

The starting procedure is generally described in the Starting system description, MBJ.

During start up, which is after purging period and combustor ignition, the power turbine accelerates to nominal speed. The start up is finalized when the generator is syncronized and/or minimum continuous load is obtained.

Continuous operation

The speed is constant during normal operation (power generation). The power output is determined by the characteristics of gas flow entering the power turbine.

Shut down

As the gas generator is shut down, the power turbine output is decreased and the generator is disconnected from the grid at minimum load. Then the power turbine is coasting down.
During the subsequent gas generator cooling down period, when the gas generator is turned by the electrical starting motor, the power turbine may also rotate due to windmilling from the rotating gas generator.

Stand still

The power turbine is kept at stand still.

Disturbances

Gas turbine trip

A gas turbine trip shuts off the fuel flow to the gas generator. The power turbine is coasting down.

Generator breaker trip

The generator breaker trip causes a slight over speed before coasting down.

Loss of power supply

Loss of main AC power supply trips the gasturbine.

System faults

If there are any damages on turbine, compressor, bearings or combustion chamber the system may not be started or has to be shut down.

Other faults

The gas generator is dependent of its auxiliary systems for proper function. Faults in any of these systems may restrict or interrupt continued start up or operation.

Technical specification

Design criteria and standards

Direction of shaft rotation   Anti-clockwise looking in the reverse direction of flow.

Dimensioning data

- Pressure ratio   3.52:1 at ISO-conditions
- Nominal speed   7700 rpm
- (MD speed   3850 – 8085 rpm)

Engineering data

Figures given below might differ somewhat from project to project
Nominal flow   80 kg/s

Installation

The power turbine is bolted by a flange connection to the gas generator. The complete unit is mounted on the main base frame by a fix point and pendulum supports at the power turbine end and a flexible support in the front of the gas generator.
The power turbine section can be removed as modules, which permits easy access and fast maintenance.

Materials

- Discs   NIM 901

- Blades
  - Stage 3   IN 792
  - Stage 4   IN 792

- Vanes
  - Stage 3   IN 939
  - Stage 4   IN 738

Component data

- Number of turbine stages — 2
- Thrust bearing type — Tilting pad
- Journal bearing type — Tilting pad
- Rotor design — Electron-beam welded
- Rotor weight (incl. blades) — 975 kg

See the system lists.

Weight

The weight of the power turbine excluding the exhaust casing is 4900 kg.
Total weight of the power turbine including the exhaust casing is 6700 kg.

Testing and service

Testing during normal operation

N/A

Accesibility during normal operation

N/A

Index of components