US 20060233634A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0233634 A1**

Tisenchek (43) **Pub. Date: Oct. 19, 2006**

(54) **METHOD OF INDICATING SEALING STEAM TEMPERATURE AND RELATED APPARATUS**

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(21) Appl. No.: **11/107,808**

(22) Filed: **Apr. 18, 2005**

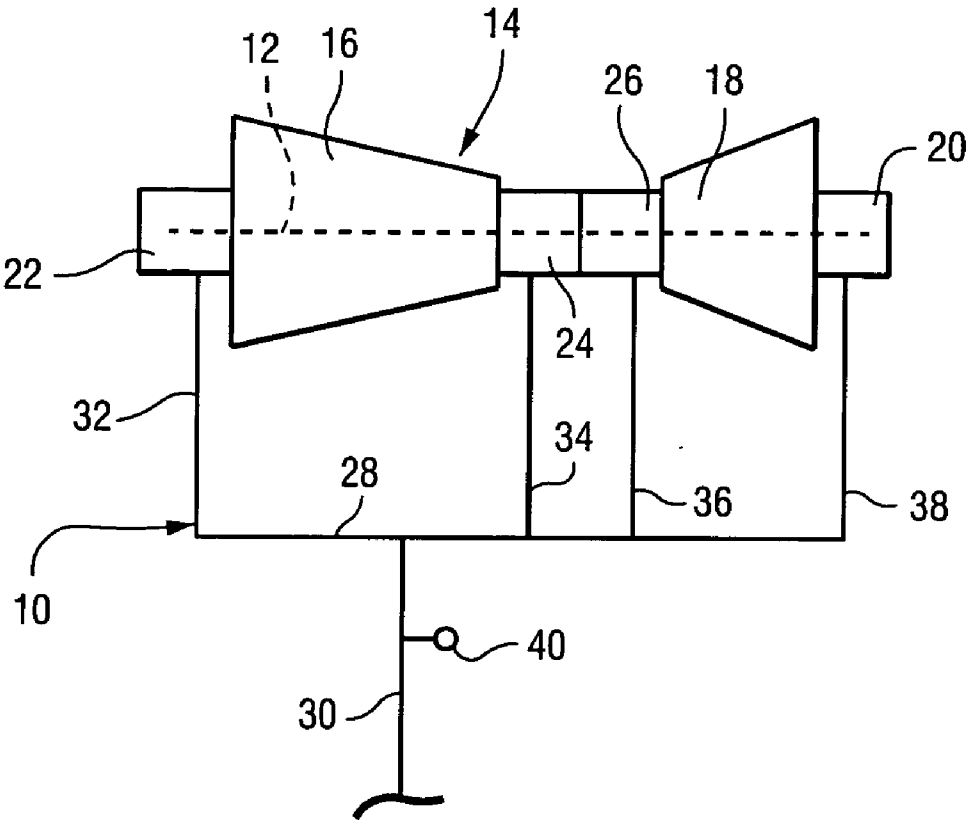
Publication Classification

(51) **Int. Cl.**
F04D 27/02 (2006.01)

(52) **U.S. Cl.** **415/1**

(57) **ABSTRACT**

A method of obtaining sealing steam temperature readings in a steam turbine where steam is used to seal turbine shaft ends includes (a) supplying pressurized sealing steam through a supply pipe to a steam seal header that, in turn, distributes the sealing steam to the shaft ends, respectively; (b) measuring temperature of the pressurized sealing steam at a location immediately adjacent at least one shaft end, downstream of the supply pipe; and (c) using temperature measurements from step (b) to insure that the pressurized sealing steam is within a predetermined acceptable range.



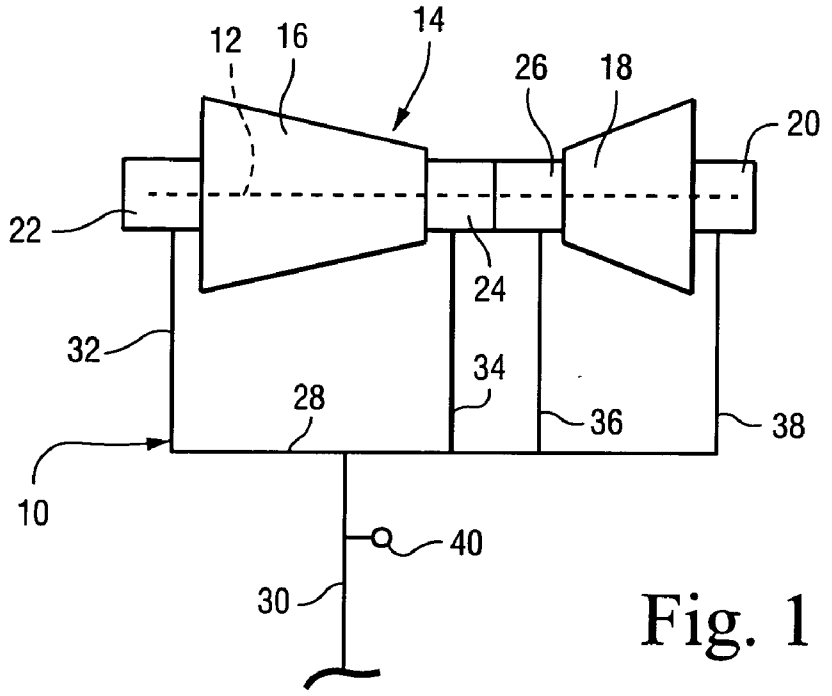

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Fig. 1

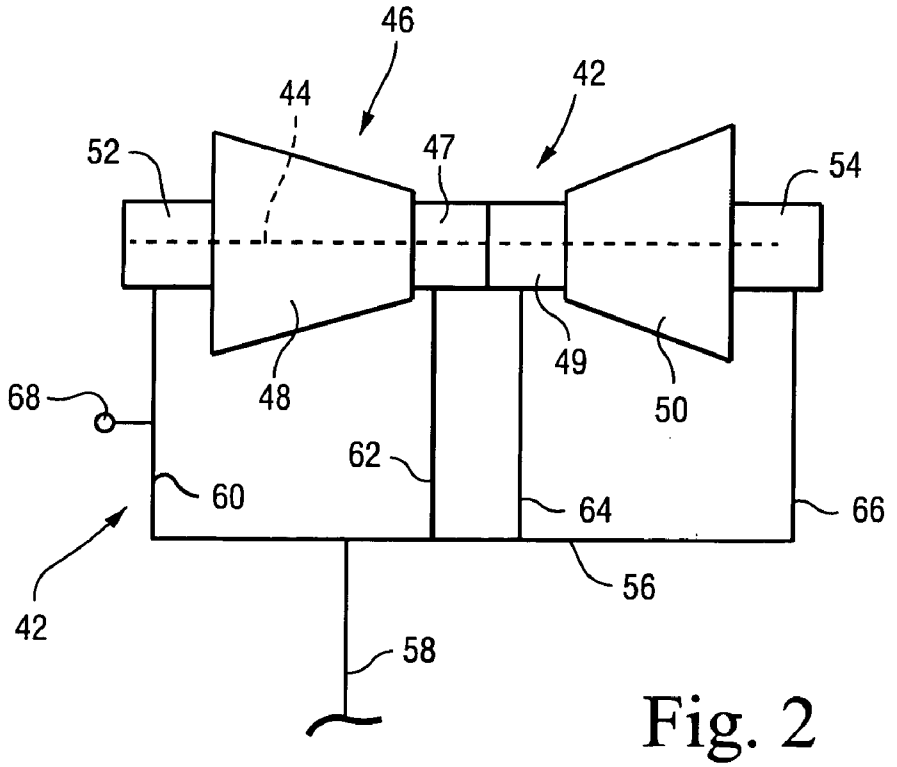
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Fig. 2

METHOD OF INDICATING SEALING STEAM TEMPERATURE AND RELATED APPARATUS

BACKGROUND OF THE INVENTION

[0001] This invention relates to steam turbine systems and, more specifically, to the utilization of steam turbine sealing steam for sealing steam turbine shaft ends.

[0002] As is well known in the art, before and during steam turbine operation, the turbine shaft ends require sealing by pressurized steam to avoid the leakage of air into the shaft ends and to avoid the leakage of high pressure steam into the turbine compartment. The temperature of steam used to seal the turbine shaft ends is critical and can affect the performance of the turbine. There exists an ideal temperature of steam to use as sealing steam and the ability to attain this temperature depends on the accuracy of the sealing steam temperature measurement.

[0003] Prior arrangements utilizing sealing steam to seal steam turbine shaft ends incorporate sealing steam temperature measurement devices in a header supply pipe that feeds auxiliary sealing steam to a sealing steam header. The header, in turn, supplies sealing steam to various packing boxes enclosing the turbine shaft, including the shaft ends. This has not proven to be a completely satisfactory arrangement for accurate temperature measurement due to the bidirectional steam flow in that location (depending on the operational state of the turbine), and the remoteness of that location relative to the shaft ends.

BRIEF DESCRIPTION OF THE INVENTION

[0004] The present invention provides an improved method of utilizing temperature measurement to assess the condition of steam being used to the steam turbine shaft ends, and to enable the temperature control system to adjust the temperature as necessary to maintain the sealing steam temperature within acceptable limits.

[0005] In accordance with an exemplary embodiment of this invention, the temperature of the sealing steam is measured directly before it enters the steam turbine shaft end, downstream of the sealing steam supply header. The temperature data is used to identify an out-of-specification temperature at that location. The measured temperature may then be connected via a conventional feedback loop and thus to fall within an acceptable range

[0006] Accordingly, in one aspect, the invention relates to method of obtaining sealing steam temperature readings in a steam turbine where steam is used to seal turbine shaft ends comprising (a) supplying pressurized sealing steam to a pair of steam seal header that, in turn, distributes the sealing steam to the shaft ends, respectively; (b) measuring temperature of the pressurized sealing steam at a location immediately adjacent at least one shaft end, downstream of the steam seal header; and (c) using temperature measurements from step (b) to insure that the pressurized sealing steam is within a predetermined acceptable range.

[0007] In another aspect, the invention relates to method of obtaining sealing steam temperature readings in a steam turbine where steam is used to seal at least one turbine shaft end comprising (a) supplying pressurized sealing steam to a pair of steam seal header that, in turn, distributes the sealing steam to the shaft ends, respectively; (b) measuring temperature of the pressurized sealing steam at a location immediately adjacent at least one of the shaft ends, downstream of the steam seal header; and (c) using temperature measurements from step (b) to insure that the pressurized sealing steam is within a predetermined acceptable range; wherein the predetermined acceptable range is between 300 and 700° F.; and wherein at least one shaft end is enclosed in a low pressure exhaust packing box.

[0008] In still another aspect, the invention relates to a steam seal system for sealing opposite ends of a steam turbine shaft, comprising a seal steam supply pipe; a seal steam header that receives seal steam from the seal steam supply pipe; a plurality of distribution pipes for supplying seal steam from the header to a plurality of packing boxes enclosing portions of the shaft; and a seal steam temperature sensor located, in one of the plurality of distribution pipes, downstream of the header.

[0009] The invention will now be described in detail in connection with the drawings identified below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a schematic diagram of a known steam seal circuit for a turbine shaft; and

[0011] **FIG. 2** is a schematic diagram of a steam seal circuit for a turbine shaft in accordance with an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] **FIG. 1** represents a current steam seal circuit configuration for shaft or rotor ends in a conventional steam turbine. Specifically, the sealing steam supply system **10** is arranged to seal the ends of a rotor **12** of a steam turbine **14** that includes a low pressure (LP) section **16** and a high pressure (HP) section **18**. The end of the rotor **12**, adjacent the HP section, is enclosed within an HP exhaust packing box **20** while the opposite end, adjacent LP section **16**, is enclosed within an LP packing box **22**. Between the LP turbine section **16** and the HP turbine section **18**, the rotor is enclosed within an LP inlet packing box **24** and an HP inlet packing box **26**.

[0013] A sealing steam header **28** is supplied with sealing steam via a sealing steam header supply pipe **30**, and supplies sealing steam to the LP exhaust packing box **22** via LP exhaust packing box supply pipe **32**; the LP inlet packing box **24** via LP inlet pipe **34**; the HP inlet packing box **26** via HP inlet packing box supply pipe **36**; and the HP exhaust packing box **20** via HP exhaust packing box supply pipe **38**. In this known arrangement, the temperature sensor **40** used to obtain and supply sealing steam temperature readings to the temperature control system (not shown) is located in the sealing steam header supply pipe **30**, upstream of the header **28**. For reasons already noted, this location for the sensor **40** is not completely satisfactory.

[0014] Referring now to **FIG. 2**, a modified sealing steam supply system **42** is illustrated. This configuration is substantially identical to the above-described system with the notable exception of the location of the sealing steam temperature sensor. Specifically, the sealing steam supply system **42** is arranged to seal the ends of a rotor or shaft **44** extending through a steam turbine **46** having an LP section

48 and an HP section 50. The ends of the rotor are enclosed in an LP exhaust packing box 52 and HP exhaust packing box 54. Between the LP and HP sections 48, 50, the rotor 44 is enclosed in an LP inlet packing box 46 and an HP inlet packing box 48.

[0015] Sealing steam header 56 is supplied with sealing steam via a sealing steam header supply pipe 58 and, in turn, distributes the sealing steam to the LP exhaust packing box 52, via LP exhaust packing box supply pipe 60; the LP inlet packing box 46, via IP inlet packing box supply pipe 62; the HP inlet packing box 48, via HP inlet packing box supply pipe 64; and the HP exhaust packing box 54, via HP exhaust packing box supply pipe 66. In this case, however, the temperature sensor 68 is located adjacent the shaft end and the LP exhaust packing box 52, in the LP exhaust supply pipe 60, downstream of the header 56. This location provides better accuracy with respect to sealing steam temperature readings used to obtain, through an otherwise conventional feedback loop arrangement, sealing steam temperatures within acceptable limits, e.g., between 300-700° F.

[0016] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

1. A method of obtaining sealing steam temperature readings in a steam turbine where steam is used to seal turbine shaft ends comprising:

(a) supplying pressurized sealing steam through a supply pipe to a steam seal header that, in turn, distributes the sealing steam to said shaft ends, respectively;

(b) measuring temperature of the pressurized sealing steam at a location immediately adjacent at least one said shaft ends, downstream of said supply pipe; and

(c) using temperature measurements from step (b) to insure that said pressurized sealing steam is within a predetermined acceptable range.

2. The method of claim 1 wherein said predetermined acceptable range is between 300 and 700° F.

3. The method of claim 1 wherein said header also supplies sealing steam to the other of said shaft ends.

4. The method of claim 1 wherein said shaft ends are enclosed in low and high pressure exhaust packing boxes, respectively.

5. The method of claim 4 wherein said steam turbine includes low and high pressure sections and wherein said steam seal header supplies seal steam to low and high pressure inlet packing boxes located axially between said low and high pressure sections.

6. A method of obtaining sealing steam temperature readings in a steam turbine where steam is used to seal at least one turbine shaft end comprising:

(a) supplying pressurized sealing steam through a supply pipe to a steam seal header that, in turn, distributes the sealing steam to said shaft ends, respectively;

(b) measuring temperature of the pressurized sealing steam at a location immediately adjacent at least one of said shaft ends, downstream of said supply pipe; and

(c) using temperature measurements from step (b) to insure that said pressurized sealing steam is within a predetermined acceptable range;

wherein said predetermined acceptable range is between 300 and 700° F.; and

wherein said at least one shaft end is enclosed in a low pressure exhaust packing box.

7. The method of claim 6 wherein said header also supplies sealing steam to the other of said shaft ends.

8. The method of claim 7 wherein said other of said shaft ends is enclosed in a high pressure exhaust packing box.

9. The method of claim 6 wherein said steam turbine includes low and high pressure sections and wherein said steam seal header also supplies seal steam to low and high pressure inlet packing boxes located axially between said low and high pressure sections.

10. A steam seal system for sealing opposite ends of a steam turbine shaft, comprising a seal steam supply pipe; a seal steam header that receives seal steam from said seal steam supply pipe; a plurality of additional supply pipes for supplying seal steam from said header to a plurality of packing boxes enclosing portions of said shaft; and a seal steam temperature sensor located, in one of said plurality of distribution pipes, downstream of said seal steam supply pipe.

11. The steam seal system of claim 10 wherein said one of said plurality of distribution pipes supplies sealing steam to a low pressure exhaust packing box enclosing one end of said steam turbine shaft.

12. The steam seal system of claim 11 wherein another of said plurality of distribution pipes supplies sealing steam to a high pressure exhaust packing box enclosing an opposite end of said steam turbine shaft.

13. The steam seal system of claim 11 wherein said seal steam temperature sensor is located in said one of said plurality of distribution pipes, adjacent said low pressure exhaust packing box.

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