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(54) **Method of and apparatus for cooling a seal for machinery**

Verfahren und Einrichtung zur Kühlung einer Wellendichtung

Méthode et dispositif pour le refroidissement d'un joint pour l'arbe d'une machine

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(73) Proprietor: **ORMAT INDUSTRIES, LTD.**
Yavne 70650 (IL)

(72) Inventors:
- **Zimron, Ohad**
  Gan Yavne (IL)
- **Rigal, Meir**
  Doar Na Avtah (IL)
- **Hatzir, Shimon**
  Holon (IL)
- **Amir, Nadav**
  Rehovot (IL)

(74) Representative: **Godwin, Edgar James et al**
MARKS & CLERK,
57-60 Lincoln's Inn Fields
London WC2A 3LS (GB)

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- **PATENT ABSTRACTS OF JAPAN vol. 10, no. 253 (M-512) (2309) 29 August 1986 & JP-A-61 079 808 (TOSHIBA) 23 April 1986**

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Description

1. Technical Field

This invention relates to a method of and apparatus for cooling a seal for machinery including rotating machinery, and more particularly, for cooling the seal of a turbine shaft.

2. Background of the Invention

Rotating machinery, such as turbine wheels mounted on a shaft, require rotary seals in the region where the shaft passes through the pressure chamber that contains the turbine wheels. Such seals inhibit leakage of working fluid from the pressure chamber into the seal operating environment and then into the atmosphere. In addition, seals are also required in other machinery.

Seals for rotating machinery usually comprise a labyrinth seal followed by a mechanical seal. Labyrinth seals serve to restrict the rate of flow of working fluid and reduce its pressure toward atmospheric pressure, but not to prevent or contain the flow. Typically, labyrinth seals have many compartments positioned very close to the surface of the shaft for presenting to the working fluid in the pressure chamber a torturous path that serves to reduce pressure and inhibit, but not halt leakage. A mechanical seal, on the other hand, serves to contain the working fluid. The extent to which containment is achieved depends on the design of the seal and the nature of the working fluid involved.

When the working fluid is steam, some escape of the working fluid can be tolerated. Nevertheless, a shaft seal for the steam turbine is a critical item. It is even more critical when the working fluid is a hydrocarbon, such as pentane or isopentane, and the turbine operates as part of an organic Rankine cycle power plant. In such case, the mechanical seals must preclude to as great an extent as possible the loss of working fluid to the atmosphere.

Reliable operation of the mechanical seals for turbines, as well as for other types of equipment where the temperature of the mechanical seal is elevated, requires the seals to operate under optimum working conditions of pressure, temperature, vibration, etc. These working conditions have a significant impact on seal leakage rates and seal life expectancy, for example. By extending seal life, turbine life and hence reliability is extended.

Seal life is adversely affected by high operating pressure which tends to distort seal faces. High operating pressure also increases wear rate, heat generated at the seal faces which further distorts seal faces and results in increased leakage. In addition, the high pressure increases power consumption for the turbine sealing system.

Seal life is adversely affected by high operating temperatures of the seal components. High seal component temperatures increase wear on the seal faces, and also increase the likelihood that the barrier fluid when used will boil.

It is therefore an object of the present invention to provide a new and improved method of and apparatus for cooling the seals of such equipment.

FR-A-574 737 discloses a method and apparatus in accordance with the precharacterising part of the independent claims.

The present invention provides a method and apparatus for cooling a seal located in a seal chamber through which a movable shaft passes, as defined in the independent claims.

As described below, a seal heated by hot pressurized vapor is cooled by providing a chamber in which the seal is located and for containing vapor that leaks thereinto. The pressure in the chamber is reduced by connecting it to a source of low pressure; and liquid is supplied to the chamber at a pressure above the reduced pressure of the chamber and at a temperature below the temperature of vapor leaking into the chamber. The liquid is introduced into the chamber as droplets for contacting vapor that leaks thereinto, thereby cooling the vapor and thus cooling the seal. The flow rate of the liquid is adjustable in accordance with the temperature of the liquid in the chamber.

Also as described below, the apparatus for cooling a hot mechanical seal, gas seal or other seal heated by hot pressurized vapor and/or friction includes a chamber for locating therein the seal and for containing vapor and a connection for connecting the chamber to a source of low pressure thereby reducing the pressure in the chamber to a level below the pressure of vapor that flows into the chamber. A further connection is provided for supplying liquid to the chamber at a pressure above the reduced pressure of the chamber. Finally, apparatus is provided for distributing the liquid throughout the chamber in the form of droplets that contact and cool vapors in the chamber, thus cooling the seal.

The seal may be associated with the turbine of a Rankine cycle power utilizing an organic working fluid, or a power plant utilizing steam. Preferably, the liquid is distributed throughout the chamber in the form of droplets which contact vapor leaking into the chamber through a labyrinth or other seal in its wall thus cooling the vapor thereby indirectly cooling the seal in the chamber by reducing the temperature of the environment surrounding or associated with the seal. Indirect cooling of the seal, as distinguished from applying the liquid directly to the seal, serves to prevent thermal shock to the materials of the seal.

In the preferred form of the invention, where the seal is part of a turbine that receives vaporized working fluid from a vaporizer and within which the vaporized working fluid expands producing expanded working fluid, and where the expanded working fluid is condensed in a condenser to produce condensate that is returned to a vaporizer by a cycle pump, the chamber containing the seal is connected to the condenser, and the liquid sup-

plied to the chamber is furnished by the cycle pump.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are described by way of example with reference to the accompanying drawings wherein:

Fig. 1 is a block diagram of a power plant into which the present invention is incorporated;
Fig. 2 is a pressure enthalpy diagram showing the sources of fluid that contribute to heating and cooling the seal;
Fig. 3 is a side view, partially in section, showing one embodiment of the present invention;
Fig. 4 is a block diagram of a modification of the embodiment shown in Fig. 3.
Fig. 5 is a further embodiment of the invention.

DETAILED DESCRIPTION

Referring now to the drawings, reference numeral 10 of Fig. 1 designates a power plant into which the present invention is incorporated. Power plant 10 includes vaporizer 12 for vaporizing a working fluid, such as water, or an organic fluid (e.g., pentane, or isopentane), and producing vaporized working fluid that is supplied to turbine 14. Usually, turbine 14 will be a multistage turbine, but the principle of the invention is applicable to a single stage turbine as well.

Vaporized working fluid supplied to turbine 14 expands in the turbine and produces work which is converted into electricity by a generator (not shown). The cooled, expanded working fluid is exhausted into indirect condenser 16 wherein the vaporized working fluid is condensed by the extraction of heat in the coolant supplied to the condenser. The condensate, at a relatively low pressure and temperature, as compared to the conditions at the outlet of the vaporizer, is pressurized by cycle pump 18 and returned to the vaporizer, completing the working fluid cycle.

Seal 20, which is the seal between the atmosphere and the pressure chamber (not shown) containing the inlet stage of the turbine, is contained in a seal operating environment that is isolated from the pressure chamber by a labyrinth seal (not shown) and a mechanical seal (not shown) which is to be cooled. As shown, condensate is supplied to the seal operating environment by pump 18 through valve 22 in connection 19, and the seal operating environment is connected to condenser 16 by connection 17.

When power plant 10 is an organic fluid Rankine cycle power plant, operating with pentane, for example, as the working fluid, the conditions in the condenser typically will be about 38°C (100°F) at about 140 kPa (20 psia), and the conditions at the outlet of the cycle pump typically will be about 38°C (100°F) at about 2 MPa (300 psia). Connection 17, by which the seal operating environment is connected to the condenser, maintains this environment at the condenser pressure conditions.

The actual conditions in the seal operating environment can be controlled by valve 22 by regulating the flow of condensate to the environment. Typically, the leakage of working fluid vapor through the labyrinth seal into the seal operating environment will produce vaporized working fluid at about 1 MPa (150 psia) and about 130°C (270°F). Under these conditions, the cooler liquid, which preferably will be distributed throughout the seal operating environment by converting the liquid supplied by the pump into droplets, will interact with the leakage vapor and cool the same by directly transferring heat to the liquid in the droplets and partially evaporating the liquid thus preventing the heating of the seal operating environment. This has the beneficial effect of reducing the temperature of the seal itself without directly cooling the seal with the condensate.

The operation described above is illustrated by Fig. 2. As indicated, leakage of vapors from the pressure chamber of the turbine whose conditions are indicated by point 22 to the seal operating environment whose conditions are indicated by point 24 result in a pressure reduction inside the seal operating environment which is held at the conditions of the condenser indicated by point 26. Condensate furnished by the pump to the seal operating environment, at the conditions indicated by point 28, changes state from point 28 to point 26. Based on this schematic showing, the heat balance is as follows:

$$(1) \qquad m_{liq}xh_{liq} + m_{vapor}xh_{vapor} = m_{mix}xh_{mix}$$

where

m_{liq} =	cold liquid flow rate
h_{liq} =	enthalpy of cold liquid
m_{vapor} =	vapor leakage flow rate
h_{vapor} =	vapor enthalpy
m_{mix} =	$m_{liq} + m_{vapor}$
h_{mix} =	enthalpy of mixture at condenser pressure and required mixture temperature.

Specific details of one embodiment of the invention is shown in Fig. 3 to which reference is now made where reference numeral 30 designates apparatus according to the present invention incorporated into turbine 14A. Apparatus 30 includes seal operating environment 20A in the form of chamber 32, defined by housing 34 rigidly attached to stationary mounting 36 containing bearing 38 on which shaft 40 of first stage turbine wheel 41 is mounted by a suitable key arrangement. Wheel 41 is contained by a housing that defines a high pressure housing or chamber 43 containing hot pressurized and vaporized working fluid.

Labyrinth seal 42 mounted in wall 44 of housing 34 provides the initial resistance to leakage of the hot va-

porized working fluid in chamber 43 into seal chamber 34. Such leakage is indicated by chain arrows A and B. Normally, this leakage would heat mechanical seal 46 having a sealing face carried by, and rotating with, shaft 40. This face is in contact with a stationary sealing face carried by hub 48 rigidly attached to housing 36. Normally, both stationary and rotating or dynamic seal faces are cooled by a barrier fluid, e.g., pressurized mineral oil pressurized to about 1.5 to 2 times the reduced chamber pressure (e.g., about 210 to 280 kPa [30 to 40 psia] in the present embodiment).

Chamber 32 is connected by connection 50 to a source of low pressure, and particularly, to the condenser of the power plant with which turbine 14A is associated. This chamber is also connected via connection 52 to the output of the cycle pump as shown in Fig. 1. Pressurized condensate at the temperature substantially of the condenser is supplied via connection 52 to spray head nozzles 54 that open to the interior of chamber 32, and relatively cold liquid working fluid is sprayed onto cylindrical shield 56 further converting the liquid into fine droplets that form a mist inside chamber 32. This mist interacts with hot vapor leakage B thereby cooling this hot vapor by means of direct contact heat transfer of heat in the vapor to liquid contained in the droplets and partial evaporation of the liquid in the droplets and thus forming a mixture of working fluid that is vented and drained by connection 50 into the condenser. As a result, the temperature of mechanical seal 46 can be maintained at a desired temperature by regulating the amount of liquid supplied to connection 52. Shield 56 shields mechanical seal 46 from direct contact with cool liquid from the condenser and thus protects the seal against thermal shock.

A second embodiment of the invention is shown in Fig. 4 and designated by reference numeral 60. This embodiment includes turbine wheel 41A rigidly attached to shaft 40A which passes though housing 34A, and mechanical seal 46A inside chamber 32A. Instead of labyrinth seal 42A engaging shaft 40A directly, as in the embodiment of Fig. 3, seal 42A engages hub 62 rigidly attached to the shaft. However, the labyrinth seal may engage the shaft if preferred. Hub 62 includes flange (disc) 64 that lies inside chamber 32A close to face 44A of housing 34A and thus rotates together with shaft 40A. Conduit 52A in wall 44A carries liquid working fluid from the cycle pump to nozzle 54A opening to chamber 32A and facing flange 64.

Pressurized cold working fluid condensate from the condenser is sprayed into contact with flange 64 producing a spray of fine droplets which are carried by centrifugal force into chamber 32A by reason of the rotational speed of the flange. In addition, leakage of vaporized working fluid A through seal 42A encounters the spray of cold liquid as soon as the vaporized working fluid passes through seal 42A so that most of leakage B is cooled before entering chamber 34A. This embodiment provides rapid engagement of the hot vapor leaking into chamber 32A with cold working fluid, and the rotational movement of flange 64 ensures intimate mixing of the spray of cold liquid with leakage vapors.

In the preferred embodiment of the present invention described with reference to Fig. 5, power plant 10A comprises high pressure turbine 14A serially connected to low pressure turbine 14B. In this arrangement, vapor from vaporizer 12 is supplied to the inlet of turbine 14A and the exhaust therefrom is supplied to the inlet of turbine 14B. High pressure seal environments 70A and 70B, respectively associated with the turbines, are each supplied with cool condensate from condenser 16 by pump 18 via flow conditioning apparatus 19A and 19B, respectively. Apparatus 19A and 19B serves both to the properly regulate the flow of condensate to the seal environments, to isolate the flow of cool condensate to the seal environments of the two turbines, and to allow maintenance to the apparatus without interrupting the operation of the turbines.

Apparatus 19A includes manually operated, infinitely variable, flow control valve 22A, fixed orifice device 23A, filter 24A, and on/off, or shut-off valve 25A serially connected together, and temperature indicator 26A; and apparatus 19B includes corresponding components 22B, 23B, 24B, 25B, and 26B. The size of the fixed orifices of each of devices 23A and 23B, together with the setting of valves 22A and 22B respectively, determines the flow rate of cool condensate to the seal environments. Filters 24A and 24B serve to filter from the condensate supplied to the seal environments any contaminants whose presence would adversely affect the the operation of the seal environments. Valves 25A and 25B are preferably manually operated ball-valves that can be selectively operated to disconnect the seal environments from pump 18 when filter replacement or other maintenance operations are necessary allowing the turbines to run for a short time without operation of the seal environments and until these maintenance operations are completed. Furthermore, maintenance operations, when the turbines or power plant is shut down or stopped, are also simplified by this aspect of the present invention. Finally, temperature indicators 26A and 26B provide an indication of the temperature of the fluid exhausted from seal environments 70A and 70B, respectively.

Valves 22A and 22B are manually operated, preferably in accordance with the temperature of the fluid in lines 17A and 17B connected to seal operating environments. That is to say, the amount of cooling condensate applied to a seal operating environment can be adjusted by an operator by changing the setting of valves 22A and 22B in response to the temperature indicated by indicators 26A and 26B. Optionally, the temperature indicators can be replaced by temperature sensors or transducers that produce control signals in accordance with the temperature of the cooling liquid leaving the seal environment. In such case, valves 22A and 22B could be replaced with valves which are responsive to such con-

trol signals for maintaining the proper flow rate of cooling liquid to the seal environments.

Modifications of the arrangement shown in Fig. 5 include connecting the turbines in parallel to the vaporizer instead of in series, or connecting several turbines in series or in parallel. This is suggested by the dashed lines extending from the output of the vaporizer, and extending to the inputs to the condenser. Furthermore, the invention is applicable to configurations in which separate vaporizers, feed pumps, and condensers are used. In such case, the flow rate to each seal environment can be controlled individually as a function of the temperature of the cooling liquid to take account of the specific operating conditions encountered by each seal environment. In addition, as shown in Fig. 5, turbines 14A and 14B preferably are directly connected to and drive a single, interposed, low speed (e.g., 1500 or 1800 RPM, depending upon the grid frequency) electric generator. Finally, if the prevailing conditions warrant, less than all of the turbines in a multiple turbine system may require a system for cooling the seals; and in such case, the seal cooling arrangement of the present invention would be used only as needed.

The present invention, while shown in connection with an organic vapor turbine is also applicable to cooling seals in a steam turbine, gas/vapor compressors, gas/vapor turbines, gas turbines, gas expanders and other types of rotary machines that employ seals for rotating shafts. In addition, the present invention may be used to cool seals in other machinery or engines including non-rotary machinery or engines, e.g., reciprocating machinery such as diesel engines and internal combustion engines, etc. As indicated, the present invention, which utilizes the working fluid itself for the coolant, does not require a separate recirculation system. However, if preferred, a separate auxiliary system can be used for the coolant which may use a fluid different from the working fluid.

While the description mentions the use of oil cooled seals, the present invention is useful for seals cooled by other fluids or even dry seals where no such cooling fluid is used. While the embodiments described above refer to a chamber as a form of the operating seal environment, any suitable enclosure may be used. The advantages and improved results furnished by the method and apparatus of the present invention are apparent from the foregoing description of the preferred embodiment of the invention.

Claims

1. A method for cooling a seal (46;46A) located in a seal chamber (32;32A) through which a movable shaft (40;40A) passes and into which hot pressurized vapor leaks between the shaft (40;40A) and a wall (44;44A) of the seal chamber (32;32A), the method comprising reducing the pressure in the seal chamber (32;32A) and supplying liquid to the seal chamber (32;32A) at a pressure above the reduced pressure of the seal chamber and at a temperature below the temperature of vapor leaking into the chamber, characterised in that the liquid is introduced into the seal chamber (32;32A) at a location remote from the seal (46;46A) and is formed into droplets which are distributed throughout the seal chamber (32;32A) for contacting the vapor therein, thereby cooling the vapor and thus cooling the seal (46;46A).

2. A method according to claim 1, wherein the hot pressurized vapor is contained in a pressure chamber (43) within which a turbine wheel (41;41A) is mounted on the shaft (40;40A), and vapor leaks past a labyrinth (42;42A) mounted in the said wall (44;44A) between the turbine wheel (41;41A) and the seal (46;46A).

3. A method according to claim 1 or 2, wherein the liquid is introduced into the seal chamber (32;32A) through an inlet (54;54A) which is shielded from the seal (46;46A).

4. A method according to claim 3, wherein the liquid is sprayed from the inlet (54) onto a fixed shield (56)

5. A method according to claim 3, wherein the liquid is sprayed from the inlet (54A) onto a disc (64) in the seal chamber (32A), the disc being mounted on, and rotatable with, the shaft (40A).

6. A method according to any preceding claim, used in a power plant that includes a vaporizer (12) for vaporizing a working fluid, a turbine (14) for expanding the working fluid, the turbine having the said shaft, a condenser (16) for condensing expanded working fluid, and a cycle pump (18) for returning condensate from the condenser (16) to the vaporizer (12), wherein the said seal chamber (32;32A) is connected to the condenser (16).

7. A method according to claim 6, wherein the liquid supplied to the seal chamber (32;32A) is derived from the output of the cycle pump (18).

8. Apparatus for cooling a seal (46;46A) located in a seal chamber (32;32A) through which a movable shaft (40;40A) passes and into which hot pressurized vapor leaks between the shaft (40;40A) and a wall (44;44A) of the seal chamber (32;32A), the apparatus comprising means (50) for connecting the seal chamber (32;32A) to a source of low pressure, thereby reducing the pressure in the seal chamber (32;32A), and means (52;52A) for supplying liquid to the seal chamber (32;32A) at a pressure above the reduced pressure of the seal chamber, charac-

terised in that the liquid is introduced into the seal chamber (32;32A) at a location remote from the seal (46;46A), and means (54,56; 54A,64) are provided for forming the liquid into droplets which are distributed throughout the seal chamber (32;32A) for contacting the vapor therein, thereby cooling the vapor and thus cooling the seal (46;46A).

9. Apparatus according to claim 8, wherein a turbine wheel (41;41A) is mounted on the shaft (40;40A) in a pressure chamber (43) for containing hot pressurized, vaporized working fluid, and the shaft (40; 40A) passes through a labyrinth (42;42A) mounted in the said wall (44;44A).

10. Apparatus according to claim 8 or 9, wherein the liquid is introduced into the seal chamber (32;32A) through an inlet (54;54A) which is shielded from the seal (46;46A) by shielding means (56;64) in the seal chamber (32;32A0.

11. Apparatus according to claim 10, wherein the shielding means is a fixed shield (56).

12. Apparatus according to any of claims 8 to 10, wherein the means for forming droplets which are distributed throughout the seal chamber comprises a disc (64) in the seal chamber (32A), the disc being mounted on the shaft (40A) and rotatable therewith so that the disc is impinged upon by the liquid supplied to the seal chamber (32A) and produces and distributes droplets of the liquid.

13. Apparatus according to any of claims 8 to 12, including a vaporizer (12) for vaporizing a working fluid, a turbine (14) for expanding the working fluid, the turbine having the said shaft, a condenser (16) for condensing expanded working fluid, and a cycle pump (18) for returning condensate from the condenser (16) to the vaporizer (12), the seal chamber (32;32A) being connected to the condenser (16).

14. Apparatus according to claim 13, wherein the output of the cycle pump (18) is connected to the seal chamber (32;32A).

Patentansprüche

1. Verfahren zur Kühlung einer Dichtung (46; 46A), die sich in einer Dichtungskammer (32; 32A) befindet, durch die eine bewegliche Welle (40; 40A) hindurchgeht, und in die heißer Druckdampf zwischen der Welle (40; 40A) und einer Wand (44; 44A) der Dichtungskammer (32; 32A) entweicht, wobei das Verfahren aufweist: das Reduzieren des Druckes in der Dichtungskammer (32; 32A), und das Zuführen von Flüssigkeit zur Dichtungskammer (32; 32A) mit einem Druck über dem reduzierten Druck der Dichtungskammer und mit einer Temperatur unterhalb der Temperatur des Dampfes, der in die Kammer entweicht, dadurch gekennzeichnet, daß die Flüssigkeit in die Dichtungskammer (32; 32A) an einer Stelle eingeführt wird, die von der Dichtung (46; 46A) entfernt ist, und zu Tröpfchen ausgebildet wird, die in der Dichtungskammer (32; 32A) verteilt werden, damit sie mit dem darin befindlichen Dampf in Berührung kommen, wodurch der Dampf abgekühlt wird, und wodurch auf diese Weise die Dichtung (46; 46A) gekühlt wird.

2. Verfahren nach Anspruch 1, bei dem der heiße Druckdampf in einer Druckkammer (43) enthalten ist, innerhalb der ein Turbinenlaufrad (41; 41A) auf der Welle (40; 40A) montiert ist, und der Dampf an einer Labyrinthdichtung (42; 42A) vorbei entweicht, die in der Wand (44; 44A) zwischen dem Turbinenlaufrad (41; 41A) und der Dichtung (46; 46A) montiert ist.

3. Verfahren nach Anspruch 1 oder 2, bei dem die Flüssigkeit in die Dichtungskammer (32; 32A) durch eine Eintrittsöffnung (54; 54A) eingeführt wird, die von der Dichtung (46; 46A) abgeschirmt ist.

4. Verfahren nach Anspruch 3, bei dem die Flüssigkeit aus der Eintrittsöffnung (54) auf eine stationäre Abschirmung (56) gespritzt wird.

5. Verfahren nach Anspruch 3, bei dem die Flüssigkeit aus der Eintrittsöffnung (54A) auf eine Scheibe (64) in der Dichtungskammer (32A) gespritzt wird, wobei die Scheibe auf der Welle (40A) montiert und mit dieser drehbar ist.

6. Verfahren nach einem der vorhergehenden Ansprüche, das in einer Energieerzeugungsanlage angewandt wird, die umfaßt: einen Verdampfer (12) für das Verdampfen eines Arbeitsmediums, eine Turbine (14) für das Ausdehnen des Arbeitsmediums, wobei die Turbine die Welle aufweist, einen Kondensator (16) für das Kondensieren des ausgedehnten Arbeitsmediums, und eine Umlaufpumpe (18) für das Rückführen des Kondensates vom Kondensator (16) zum Verdampfer (12), wobei die Dichtungskammer (32; 32A) mit dem Kondensator (16) verbunden ist.

7. Verfahren nach Anspruch 6, bei dem die Flüssigkeit, die der Dichtungskammer (32; 32A) zugeführt wird, vom Ausgang der Umlaufpumpe (18) erhalten wird.

8. Vorrichtung zur Kühlung einer Dichtung (46; 46A), die sich in einer Dichtungskammer (32; 32A) befindet, durch die eine bewegliche Welle (40; 40A) hin-

durchgeht, und in die heißer Druckdampf zwischen der Welle (40; 40A) und einer Wand (44; 44A) der Dichtungskammer (32; 32A) entweicht, wobei die Vorrichtung aufweist: eine Einrichtung (50) für das Verbinden der Dichtungskammer (32; 32A) mit einer Niederdruckquelle, wodurch der Druck in der Dichtungskammer (32; 32A) reduziert wird, und eine Einrichtung (52; 52A) für das Zuführen der Flüssigkeit zur Dichtungskammer (32; 32A) mit einem Druck über dem reduzierten Druck der Dichtungskammer, dadurch gekennzeichnet, daß die Flüssigkeit in die Dichtungskammer (32; 32A) an einer Stelle eingeführt wird, die von der Dichtung (46; 46A) entfernt ist, und daß eine Einrichtung (54; 56; 54A, 64) dafür bereitgestellt wird, daß die Flüssigkeit zu Tröpfchen ausgebildet wird, die in der Dichtungskammer (32; 32A) verteilt werden, damit sie mit dem darin befindlichen Dampf in Berührung kommen, wodurch der Dampf abgekühlt wird, und wodurch auf diese Weise die Dichtung (46; 46A) gekühlt wird.

9. Vorrichtung nach Anspruch 8, bei der ein Turbinenlaufrad (41; 41A) auf der Welle (40; 40A) in einer Druckkammer (43) montiert ist, die das heiße, unter Druck stehende, verdampfte Arbeitsmedium enthält, und worin die Welle (40; 40A) durch eine Labyrinthdichtung (42; 42A) hindurchgeht, die in der Wand (44; 44A) montiert ist.

10. Vorrichtung nach Anspruch 8 oder 9, bei der die Flüssigkeit in die Dichtungskammer (32; 32A) durch eine Eintrittsöffnung (54; 54A) eingeführt wird, die von der Dichtung (46; 46A) durch die Abschirmungseinrichtung (56; 64) in der Dichtungskammer (32; 32A) abgeschirmt ist.

11. Vorrichtung nach Anspruch 10, bei der die Abschirmungseinrichtung eine stationäre Abschirmung (56) ist.

12. Vorrichtung nach einem der Ansprüche 8 bis 10, bei der die Einrichtung für die Bildung der Tröpfchen, die in der Dichtungskammer verteilt werden, eine Scheibe (64) in der Dichtungskammer (32A) aufweist, wobei die Scheibe auf der Welle (40A) montiert und mit dieser drehbar ist, so daß die Scheibe von der Flüssigkeit getroffen wird, die der Dichtungskammer (32A) zugeführt wird, und die Flüssigkeitströpfchen erzeugt und verteilt.

13. Vorrichtung nach einem der Ansprüche 8 bis 12, die umfaßt: einen Verdampfer (12) für das Verdampfen eines Arbeitsmediums, eine Turbine (14) für das Ausdehnen des Arbeitsmediums, wobei die Turbine die Welle aufweist, einen Kondensator (16) für das Kondensieren des ausgedehnten Arbeitsmediums, und eine Umlaufpumpe (18) für das Rückführen des Kondensates vom Kondensator (16) zum Verdampfer (12), wobei die Dichtungskammer (32; 32A) mit dem Kondensator (16) verbunden ist.

14. Vorrichtung nach Anspruch 13, bei der der Ausgang der Umlaufpumpe (18) mit der Dichtungskammer (32; 32A) verbunden ist.

Revendications

1. Procédé pour refroidir un joint (46; 46A) situé dans une chambre de joint (32; 32A), à travers laquelle passe un arbre mobile (40; 40A) et dans laquelle de la vapeur chaude sous pression s'échappe entre l'arbre (40; 40A) et une paroi (44; 44A) de la chambre de joint (32; 32A), le procédé consistant à diminuer la pression dans la chambre de joint (32; 32A) et à amener un liquide dans la chambre de joint (32; 32A) sous une pression supérieure à la pression réduite de la chambre de joint et à une température inférieure à la température de la vapeur pénétrant dans la chambre, caractérisé en ce que le liquide est introduit dans la chambre de joint (32; 32A), à un endroit écarté du joint (46; 46A) et est constitué de gouttelettes qui sont réparties dans toute la chambre de joint (32; 32A) pour assurer le contact avec la vapeur qu'elle contient, de façon à refroidir la vapeur et à refroidir ainsi le joint (46; 46A).

2. Procédé selon la revendication 1, dans lequel la vapeur chaude sous pression est contenue dans une chambre à pression (43) dans laquelle est monté une roue de turbine (41; 41A) sur l'arbre (40; 40A) et la vapeur s'échappe par un joint à labyrinthe (42; 42A) monté dans ladite paroi (44; 44A) entre la roue de turbine (41; 41A) et le joint (46; 46A).

3. Procédé selon la revendication 1 ou 2, dans lequel le liquide est introduit dans la chambre de joint (32; 32A) par une entrée (54; 54A) qui est séparée du joint (46; 46A) par un écran.

4. Procédé selon la revendication 3 dans lequel le liquide est pulvérisé depuis l'entrée (54) sur un écran fixe (56).

5. Procédé selon la revendication 3, dans lequel le liquide est pulvérisé depuis l'entrée (54A) sur un disque (64) dans la chambre de joint (32A), le disque étant monté sur l'arbre (40A) et pouvant tourner avec celui-ci.

6. Procédé selon l'une quelconque des revendications précédentes utilisé dans une centrale comprenant un évaporateur (12) pour vaporiser un fluide de travail, une turbine (14) pour dilater le fluide de travail, la turbine ayant ledit arbre, un condenseur (16) pour

condenser le fluide de travail dilaté et une pompe de retour (18) pour renvoyer les condensats provenant du condenseur (16) vers l'évaporateur (12), dans lequel ladite chambre de joint (32; 32A) est connectée au condenseur (16).

7. Procédé selon la revendication 6, dans lequel le liquide amené à la chambre de joint (32; 32A) provient de la sortie de la pompe de retour (18).

8. Appareil pour refroidir un joint (46; 46A) situé dans une chambre de joint (32; 32A), travers lequel passe un arbre mobile (40; 40A) et dans lequel de la vapeur chaude sous pression s'échappe entre l'arbre (40; 40A) et une paroi (44; 44A) de la chambre de joint (32; 32A), l'appareil comprenant un moyen (50) pour connecter la chambre de joint (32; 32A) à une source à faible pression, ce qui diminue la pression dans la chambre de joint (32; 32A) et un moyen (52; 52A) pour amener du liquide à la chambre de joint (32; 32A) à une pression supérieure à la pression réduite de la chambre de joint, caractérisé en ce que le liquide est introduit dans la chambre de joint (32; 32A), à un endroit écarté du joint (46; 46A) et en ce que des moyens (54, 56; 54A, 64) sont prévus pour transformer le liquide en gouttelettes qui sont réparties dans toute la chambre de joint (32; 32A) afin de les mettre en contact avec la vapeur contenue dans cette chambre, de façon à refroidir la vapeur et donc à refroidir le joint (46; 46A).

9. Appareil selon la revendication 8, dans lequel une roue de turbine (41; 41A) est montée sur l'arbre (40; 40A) dans une chambre à pression (43) pour contenir un fluide de travail vaporisé, chaud et sous pression, et dans lequel l'arbre (40; 40A) passe à travers un joint à labyrinthe (42; 42A) monté dans ladite paroi (44; 44A).

10. Appareil selon la revendication 8 ou 9, dans lequel le liquide est introduit dans la chambre de joint (32; 32A) par une entrée (54; 54A), qui est séparée du joint (46; 46A) par un écran (56; 64) dans la chambre de joint (32; 32A).

11. Appareil selon la revendication 10, dans lequel l'écran est un écran fixe (56).

12. Appareil selon l'une quelconque des revendications 8 à 10, dans lequel le moyen pour former les gouttelettes qui sont réparties dans toute la chambre de joint comprend un disque (64) dans la chambre de joint (32A), le disque étant monté sur l'arbre (40A) et pouvant tourner avec celui-ci de façon que le disque reçoive le choc du liquide introduit dans la chambre de joint (32A) et produise et répartisse des gouttelettes de liquide.

13. Appareil selon l'une quelconque des revendications 8 à 12, comprenant un évaporateur (12) pour vaporiser un fluide de travail, une turbine (14) pour dilater le fluide de travail, la turbine ayant ledit arbre, un condenseur (16) pour condenser le fluide de travail dilaté et une pompe de retour (18) pour renvoyer les condensats du condenseur (16) vers l'évaporateur (12), la chambre de joint (32; 32A) étant connectée au condenseur (16).

14. Appareil selon la revendication 13, dans lequel la sortie de la pompe de retour (18) est connectée à la chambre de joint (32; 32A).

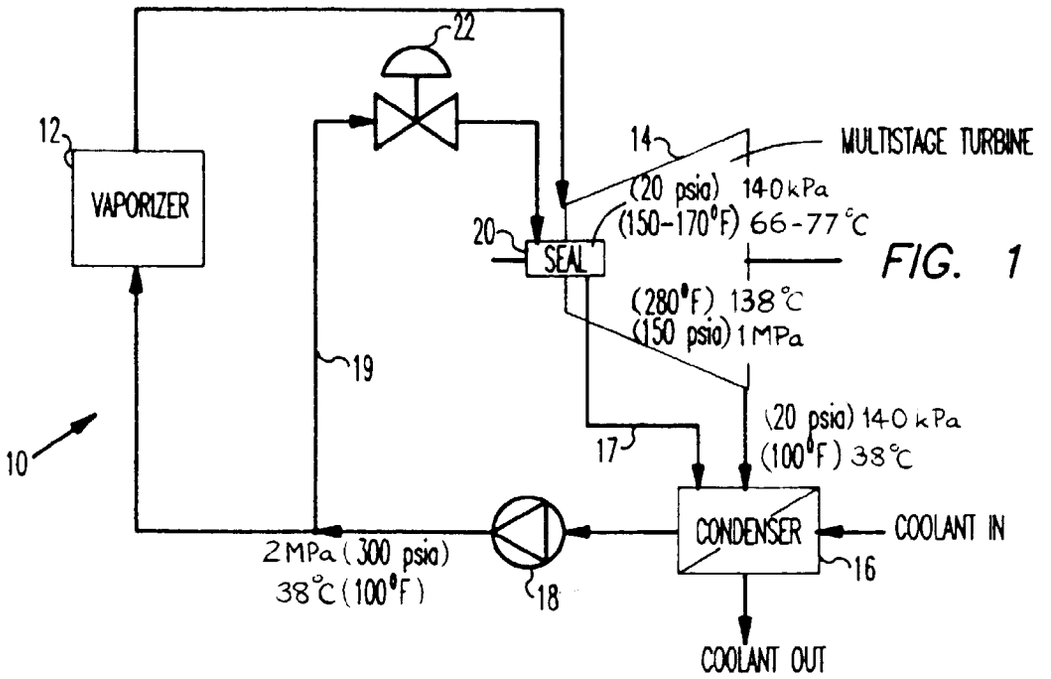

22
12
VAPORIZER
14
MULTISTAGE TURBINE
(20 psia) 140kPa
(150-170°F) 66-77°C
20
SEAL
(280°F) 138°C
(150 psia) 1MPa
19
(20 psia) 140 kPa
(100°F) 38°C
17
10
CONDENSER
COOLANT IN
16
2MPa (300 psia)
38°C (100°F)
18
COOLANT OUT

FIG. 1

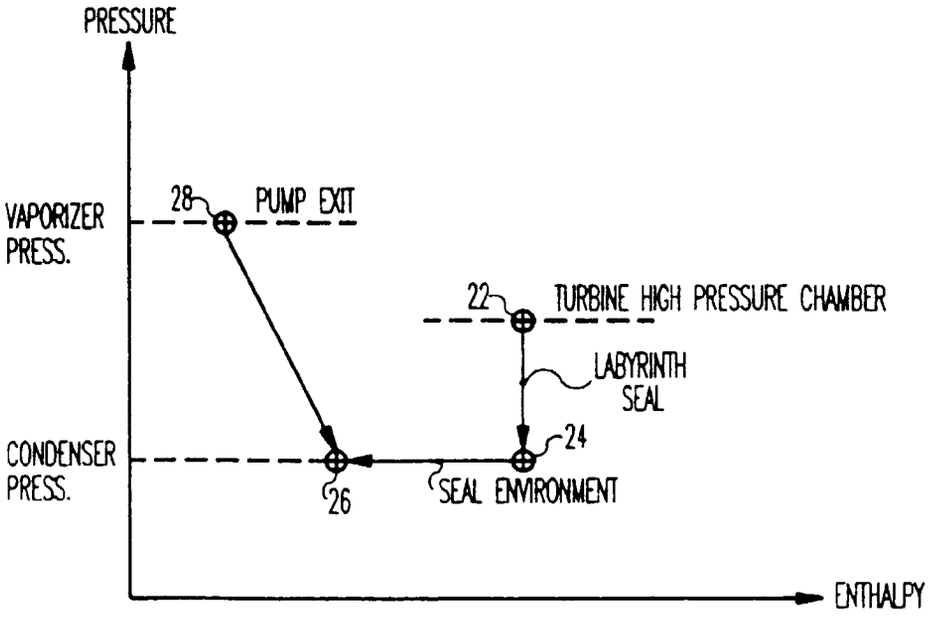
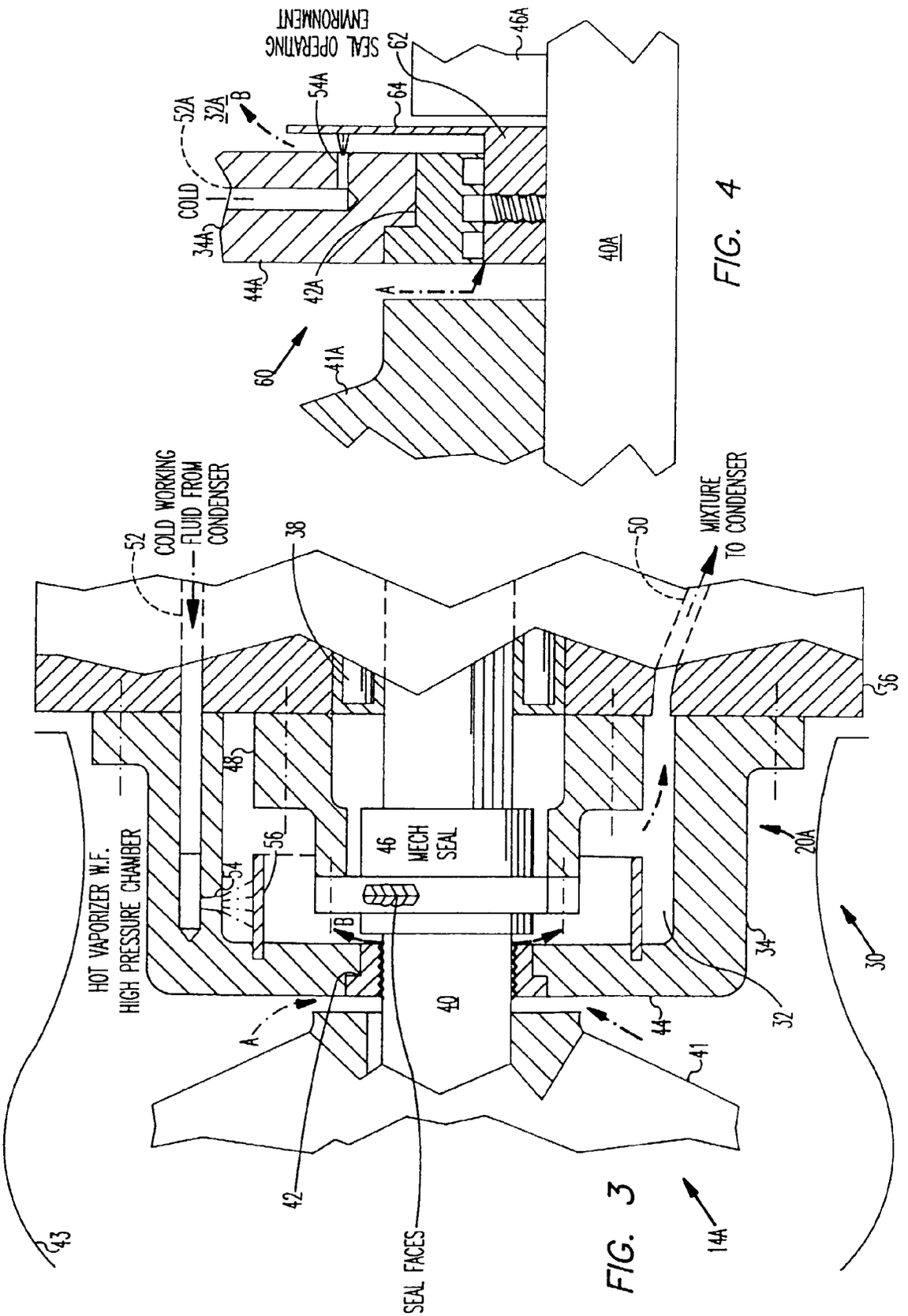

PRESSURE
VAPORIZER PRESS.
28
PUMP EXIT
22
TURBINE HIGH PRESSURE CHAMBER
LABYRINTH SEAL
24
CONDENSER PRESS.
26
SEAL ENVIRONMENT
ENTHALPY

FIG. 2


SEAL OPERATING ENVIRONMENT
62
46A
64
54A
52A
32A
B
COLD
34A
44A
42A
A
60
41A
40A
FIG. 4
52
COLD WORKING FLUID FROM CONDENSER
38
50
MIXTURE TO CONDENSER
36
48
46 MECH SEAL
56
54
HOT VAPORIZER W.F. HIGH PRESSURE CHAMBER
B
20A
34
30
A
40
44
32
41
42
SEAL FACES
43
14A
FIG. 3

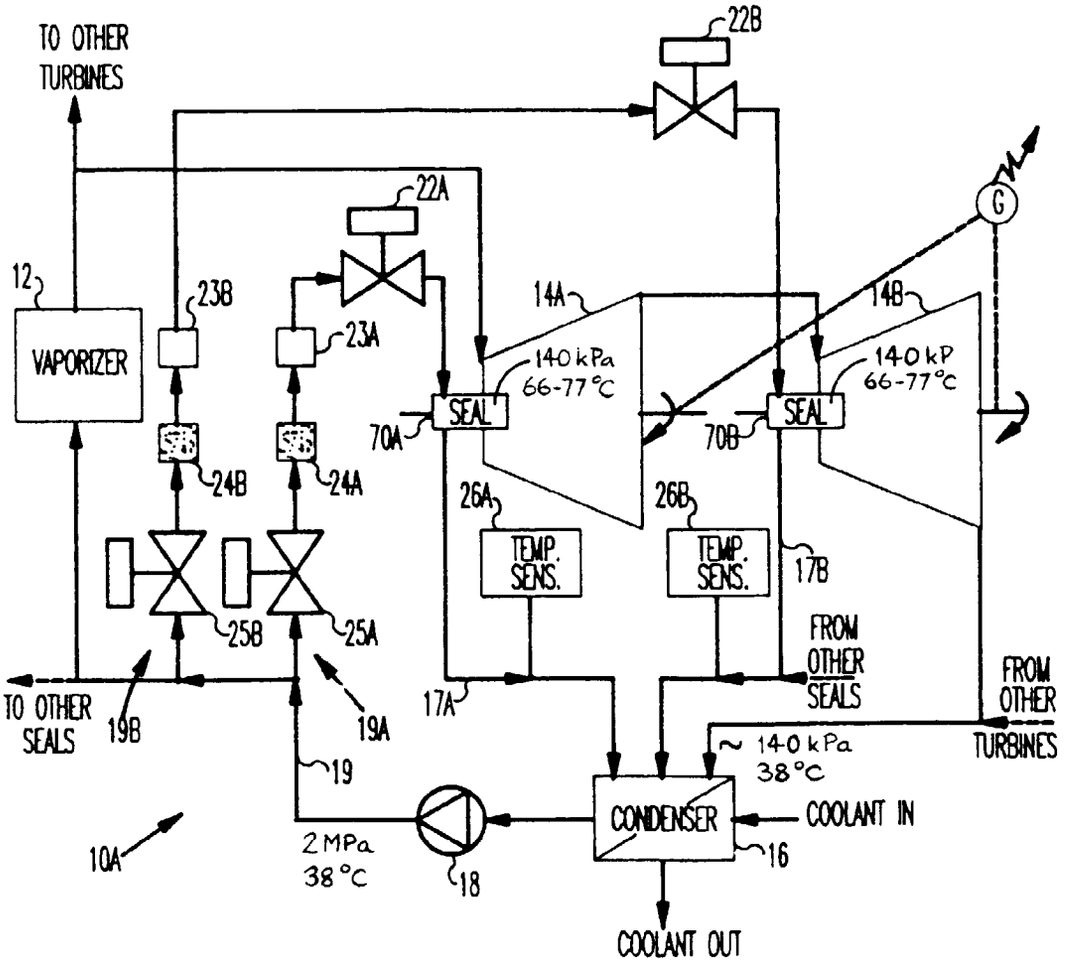

TO OTHER TURBINES
22B
22A
G
12
23B
23A
14A
14B
VAPORIZER
140 kPa 66-77 °C
140 kP 66-77 °C
SEAL
SEAL
70A
70B
24B
24A
26A
26B
TEMP. SENS.
TEMP. SENS.
17B
25B
25A
FROM OTHER SEALS
FROM OTHER TURBINES
TO OTHER SEALS
19B
19A
17A
19
~ 140 kPa 38 °C
CONDENSER
COOLANT IN
16
10A
2 MPa 38 °C
18
COOLANT OUT

FIG. 5