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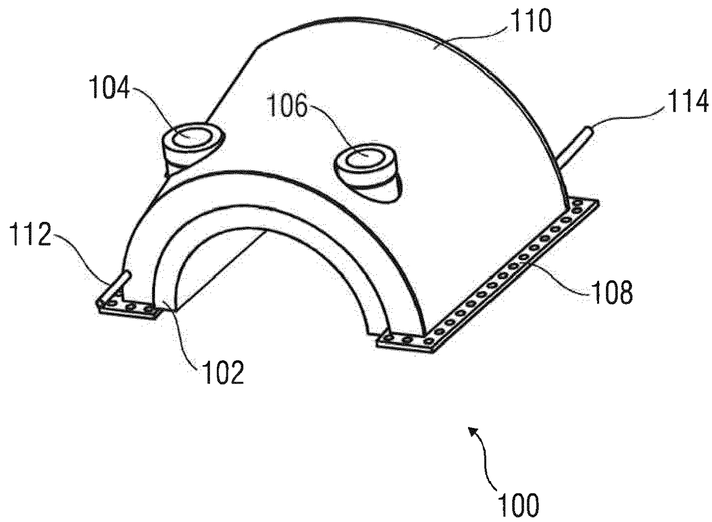
(54) **IMPROVED TURBINE CASING**

(57) An improved turbine with shorten start-up, restart and shutdown duration is disclosed in the present invention. The improved turbine comprises at least one turbine casing (102) and at least one fluid carrying chamber (110). The at least one fluid carrying chamber (110) encloses at least one part of the at least one turbine casing (102) and one or more components, other than the at least one turbine casing, of the improved turbine.

FIG 1



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Description

[0001] The present invention relates to improved turbines with high efficiency and more particularly, to improved steam turbines having reduced start-up, restart and shutdown duration.

[0002] From last few decades there is a continuously increase in demand of power for various residential and industrial applications. Natural sources of power, like wind, water etc., are considered as promising solution to fulfil the increasing demand of power. A turbine is a well known mechanical device that extracts power from a flowing substance, like water, steam, wind etc., and converts it into a useable form of power. There are various types of turbines like steam turbines, gas turbines, water turbine, wind turbine, and so on. The turbines are further classified based on the turbine mechanical structure, casing type, operating principle and like.

[0003] Steam turbine is an important class of turbines. The steam turbines extract energy from steam and convert it to mechanical energy. The operation of the steam turbine, in principle is, when high temperature and high pressure steam passes through a series of rotor blades of the steam turbine, the rotor blades absorb the energy from the steam and start rotating. Typically for maintenance and/or operational purposes, it is required to shutdown and restarts the steam turbine. The shutdown and restart frequency for the steam turbine depends upon the type of maintenance and/or application. However the steam turbine shutdown and restart procedures are very time consuming thus the steam turbine unproductive time is directly proportional to the number of times the steam turbine shutdown and restart procedures. In other words, the steam turbine shutdown and restart procedures negatively affect the efficiency of the steam turbine. Hence in order to achieve an efficient steam turbine operation it is required to reduce the time consumed during the steam turbine shutdown and restart procedures.

[0004] One simplest method of reducing the steam turbine start-up and/or restart duration is by increasing ramp rate of the turbine but high ramp rate leads to high thermal gradients across the turbine that induces high mechanical stress at various parts of the steam turbine. The high mechanical stress limits operational life of the steam turbine. Another way of reducing the steam turbine start-up/restart time is performing a pre-warming procedure for valves and other internal components of the steam turbine by using hot but low pressure steam and after the pre-warming procedure the low pressure steam parameters are slowly ramped up to full load condition. However the ramp up rate of the steam parameters is restricted by a permissible level of thermal and/or pressure gradient for the steam turbine during start-up/restart procedure thus the pre-warming approach is also restricted and may negatively affect the operational life of the steam turbine.

[0005] Similarly a known method for reducing steam turbine shutdown duration is blowing air inside the turbine over hot components of the turbine i.e. forced cooling along with free cooling. However forced cooling does not reduce the steam turbine shutdown duration significantly and the forced cooling also causes stress at various parts of the steam turbine which in turns again limits the operational life of the steam turbine.

[0006] In accordance with the state of the art it is well known that large pressure and temperature gradient across heavy flanges and thick casing of the steam turbines are mainly responsible for high shutdown and restart duration. Hence reducing weight and thickness of the turbine flanges is also an approach for reducing the shutdown and restart duration of the steam turbine. Many researchers had worked and are still working in this direction but still the results are not satisfactory due to the size and weight limitations of the steam turbines.

[0007] From the foregoing description it is evident that there is a strong need of a highly efficient improved turbine having reduced start-up, restart and shutdown duration.

[0008] It is therefore an object of the present invention to provide an improved turbine with shorten start-up, restart and shutdown duration in comparison to the steam turbines known in the state of the art.

[0009] The object is achieved by providing an improved turbine with shorten start-up, restart and shutdown duration according to claim 1.

[0010] In an aspect of the present invention, an improved turbine is disclosed. In accordance to the disclosed aspect of the present invention the improved turbine comprises at least one turbine casing and at least one fluid carrying chamber. The at least one fluid carrying chamber encloses at least one part of the at least one turbine casing. In addition to it, the at least one fluid carrying chamber may also encloses one or more sections of one or more components, other than the at least one turbine casing, of the improved turbine. Also the at least one fluid carrying chamber comprises at least one fluid inlet pipe and at least one fluid exit pipe.

[0011] Further in accordance with the disclosed aspect of the present invention at least one fluid enters in the at least one fluid carrying chamber through the at least one fluid inlet pipe and the at least one fluid exit from the at least one fluid carrying chamber through the at least one fluid exit pipe. Also according to the disclosed aspect, the temperature of the at least one fluid is in accordance with the temperature of the at least one turbine casing. In other words, the temperature of the at least one fluid should be low if a turbine shutdown procedure is in progress and the temperature of the at least one fluid should be high if a turbine start-up or restart procedure is in progress. The at least one fluid may include, but not limited to, water.

[0012] Furthermore in accordance with the disclosed aspect of the present invention the improved turbine comprises at least one finned jacket wherein the at least one finned jacket comprises one or more fins. The at least one finned jacket is placed in between one or more segments of the at least one turbine casing and the at least one fluid carrying chamber. It is preferred to place the at least one finned jacket in proximity of at least one steam inlet of the improved turbine that is in connection with the at least one turbine casing.

[0013] Furthermore in accordance to the aspect of the present invention, the improved turbine further comprises at least one insulating layer (210). The at least one insulating layer completely or partially covers top surface of the at least one fluid carrying chamber.

[0014] Accordingly, the present invention provides an improved turbine with shorten start-up, restart and shutdown duration.

[0015] The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 illustrates turbine with fluid carrying chamber in accordance with an embodiment of the present invention, and

FIG 2 illustrates cross section view of the turbine with the fluid carrying chamber in accordance with FIG 1.

[0016] Various embodiments are described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more embodiments. It may be evident that such embodiments may be practiced without these specific details.

[0017] Referring to FIG 1, a turbine 100 with a fluid carrying chamber 110 is illustrated. For description purpose only a part of the turbine 100 and a part of the fluid carrying chamber 110 are illustrated in FIG 1 however in physical embodiments of the present invention whole turbine casing of a turbine is covered with a fluid carrying chamber. The turbine 100 also includes a turbine casing 102, a steam inlet 104, a steam exhaust 106 and a base 108. The fluid carrying chamber 110 is placed on top of the turbine casing 102 in such way that the fluid carrying chamber 110 covers the turbine casing 102 completely, as illustrated in FIG 1. The fluid carrying chamber 110 also includes a fluid inlet pipe 114 and a fluid exit pipe 112, as shown in FIG 1.

[0018] The fluid carrying chamber 110 carries hot water during start-up or restart duration. The hot water flows in the fluid carrying chamber 110 through the fluid inlet pipe 114 and exits from the fluid exit pipe 112. In addition to it, one or more pre-warming procedures for valves and other internal components, not shown in FIG 1, of the turbine 100 are performed. The one or more pre-warming procedures include blowing hot but low pressure steam inside the turbine 100 or any other method known in the state of the art. After initiating the pre-warming procedures, the low pressure steam parameters are slowly ramped up to full load condition and due to the pre-warming procedures the start-up or restart duration of the turbine 100 reduces significantly. Also, due to the circulation of hot water in the fluid carrying chamber 110 through the fluid inlet pipe 114 and the fluid exit pipe 112 reduces the thermal and pressure gradients between the internal components and the outer section of the turbine 100 during pre-warming procedure. Due to significant reduction in the thermal and pressure gradients the stress between the internal components and the outer section of the turbine 100 also reduces which leads to longer operational life of the turbine 100. In other words, the invention suggests use of the fluid carrying chamber 110, having hot water and/or any other suitable fluid at a temperature in accordance with the temperature of the turbine 100 internal components during pre-warming procedures, over the turbine casing 102 for reducing the thermal and pressure gradients during pre-warming procedures which leads to a short start-up or restart duration of the turbine 100 without stressing the components of the turbine 100.

[0019] Similarly, during shutdown operation, the fluid carrying chamber 110 carries cold water. The cold water flows in the fluid carrying chamber 110 through the fluid inlet pipe 114 and exits from the fluid exit pipe 112. In addition to it, air is blown over the internal components of the turbine 100 i.e. forced cooling along with the free cooling of the turbine 100 for reducing the shutdown duration, as suggested in the state of the art. Due to the circulation of cold water in the fluid carrying chamber 110 through the fluid inlet pipe 114 and the fluid exit pipe 112 reduces the thermal gradients between the internal components and the outer section of the turbine 100 during force cooling procedure. Due to significant reduction in the thermal gradients the stress between the internal components and the outer section of the turbine 100 also reduces which leads to longer operational life of the turbine 100. In other words, the invention suggests use of the fluid carrying chamber 110, having cold water and/or any other suitable fluid at a temperature in accordance with the temperature of the turbine 100 internal components during forced cooling procedure, over the turbine casing 102 for reducing the thermal gradients during forced cooling procedure which leads to a short shutdown duration of the turbine 100 without stressing the components of the turbine 100.

[0020] During steady state operation of the turbine 100, the fluid inlet pipe 114 and the fluid exit pipe 112 of the fluid carrying chamber 110 remains in closed position. Some amount of water or fluid, i.e. used during start-up or restarting procedure of the turbine 100, get trapped inside the fluid carrying chamber 110 during the steady state operation. The thermal conductivity of the trapped water or fluid is very low hence it acts as an insulator i.e. it restricts the transfer of heat, through it, from the turbine casing 102 during normal operation. However the heat transfer from the turbine casing 102 to the fluid carrying chamber 110 can occur due to radiation. Hence to avoid the heat transfer due to radiation, a resistance is provided by applying an insulating layer 210 at the outer surface of the fluid carrying chamber 110 as illustrated in FIG 2. In addition to it, one or more seals 206A, 206B are provided at the boundaries of the turbine casing 102, as shown in FIG 2, to minimise flow of heat from the turbine casing 102. A persona ordinarily skilled in the art would appreciate that the method and system for reducing the start-up, restarting and/or shutdown duration of the turbine described in the invention is used in all kind of turbines like, but not limited to, high pressure turbines, intermediate pressure turbines and low pressure turbines, with slight or without any type of modifications.

[0021] In an embodiment of the present invention, the start-up, restarting and/or shutdown duration can further reduced by faster cooling/heating of a high temperature zone of the turbine 100, specifically in case of high pressure turbines. Faster cooling/heating of a high temperature zone of the turbine 100 is achieved by increasing heat transfer area of the turbine casing 102 i.e. by increasing outer surface area of the turbine casing 102. The outer surface area is increased by adding a finned jacket 202 close to the steam inlet 104 over the turbine casing 102, as shown in FIG 2. The finned jacket 202 has multiple parallel fins 204. For simplicity only one fin 204 of the finned jacket 202 is shown in the cross sectional view of the turbine 100 i.e. FIG 2. In other embodiment of the present invention, the finned jacket 202 is added all over the turbine casing 102. In another embodiment of the present invention, the finned jacket is added selective different sections of the turbine 100. By using the finned jacket 202 over the turbine casing 102 and/or over other parts of the turbine 100, the outer surface area increases and the surface area is inversely proportional to thermal resistance, as demonstrated in following mathematical equation:

$$\text{EQU:} \qquad Rth = 1/hA$$

[0022] In the above equation, Rth is thermal resistance, h is convective heat transfer coefficient and A is heat transfer area. From the above mentioned mathematical equation is it evident that if the outer surface area or the heat transfer area of the turbine casing 102 or other parts of the turbine 100 is increased using the finned jacket 202 then thermal resistance Rth reduces which facilitates the turbine casing 102 and/or other components of the turbine 100 to heat-up or cool-down faster which significantly reduces the overall start-up, restart or shutdown duration of the turbine 100.

[0023] It is evident from the foregoing description of the present invention that the invention provides an improved turbine having reduced start-up, restart and shutdown duration in comparison to the start-up, restart and shutdown duration of the turbine known in the state of the art.

[0024] In addition to it, due to the fluid carrying chamber and finned jacket, mechanical and/or thermal stress experienced by various internal and external parts of the turbine reduces during transient periods i.e. during start-up, restart and shutdown of the turbine. Reduction in stress of the turbine components improves operational life of the turbine. Also due to less stress more number of shutdowns and restarts, for better maintenance of the turbine, can be availed during the operational life of the turbine.

[0025] While the present invention has been described in detail with reference to certain embodiments, it should be appreciated that the present invention is not limited to those embodiments. In view of the present disclosure, many modifications and variations would present themselves, to those of skill in the art without departing from the scope of various embodiments of the present invention, as described herein. The scope of the present invention is, therefore, indicated by the following claims rather than by the foregoing description. All changes, modifications, and variations coming within the meaning and range of equivalency of the claims are to be considered within their scope.

LIST OF REFERENCES

[0026]

100 TURBINE
102 TURBINE CASING
104 STEAM INLET
106 STEAM EXHAUST
108 BASE
110 FLUID CARRYING CHAMBER
112 FLUID EXIT PIPE
114 FLUID INLET PIPE

202 FINNED JACKET
204 FIN
206A SEAL
206B SEAL
208 TURBINE INTERNAL SECTION
210 INSULATING LAYER

Claims

1. An improved turbine (100) comprises:

   - at least one turbine casing (102); and
   - at least one fluid carrying chamber (110) wherein the at least one fluid carrying chamber (110) encloses at least one part of the at least one turbine casing (102).

2. The improved turbine (100) according to claim 1 wherein the at least one fluid carrying chamber (110) comprises at least one fluid inlet pipe (114) and at least one fluid exit pipe (112).

3. The improved turbine (100) according to claim 2 wherein at least one fluid enters in the at least one fluid carrying chamber (110) through the at least one fluid inlet pipe (114).

4. The improved turbine (100) according to claim 3 wherein the at least one fluid exit from the at least one fluid carrying chamber (110) through the at least one fluid exit pipe (112).

5. The improved turbine (100) according to claim 4 wherein temperature of the at least one fluid is in accordance with the temperature of the at least one turbine casing (102).

6. The improved turbine (100) according to claim 1 wherein the at least one fluid carrying chamber (110) further encloses one or more sections of one or more components of the improved turbine (100).

7. The improved turbine (100) according to claim 1 further comprises at least one finned jacket (202) wherein the at least one finned jacket (202) is placed between one or more segments of the at least one turbine casing (102) and the at least one fluid carrying chamber (110).

8. The improved turbine (100) according to claim 7 wherein the at least one finned jacket (202) comprises one or more fins (204).

9. The improved turbine (100) according to claim 7 wherein the at least one finned jacket (202) is enclosed at least one steam inlet (104) connected with the at least one turbine casing (102).

10. The improved turbine (100) according to claim 1 further comprises at least one insulating layer (210) wherein the at least one insulating layer (210) covers at least one surface of the at least one fluid carrying chamber (110).

11. An improved turbine (100) comprises:

    - at least one turbine casing (102);
    - at least one finned jacket (202) wherein the at least one finned jacket (202) enclosed at least a first part of the at least one turbine casing (102);
    - at least one fluid carrying chamber (110) wherein the at least one fluid carrying chamber (110) enclosed the at least one finned jacket (202) and at least one second part of the at least one turbine casing (102).

12. The improved turbine (100) according to claim 11 wherein the at least one fluid carrying chamber (110) further encloses one or more sections of one or more components of the improved turbine (100).

13. The improved turbine (100) according to claim 11 wherein the at least one finned jacket (202) comprises one or more fins (204).

14. The improved turbine (100) according to claim 11 wherein the at least one finned jacket (202) is enclosed at least one steam inlet (104) connected with the at least one turbine casing (102).

15. The improved turbine (100) according to claim 11 further comprises at least one insulating layer (210) wherein the at least one insulating layer (210) covers of at least one surface of the at least one fluid carrying chamber (110).

FIG 1

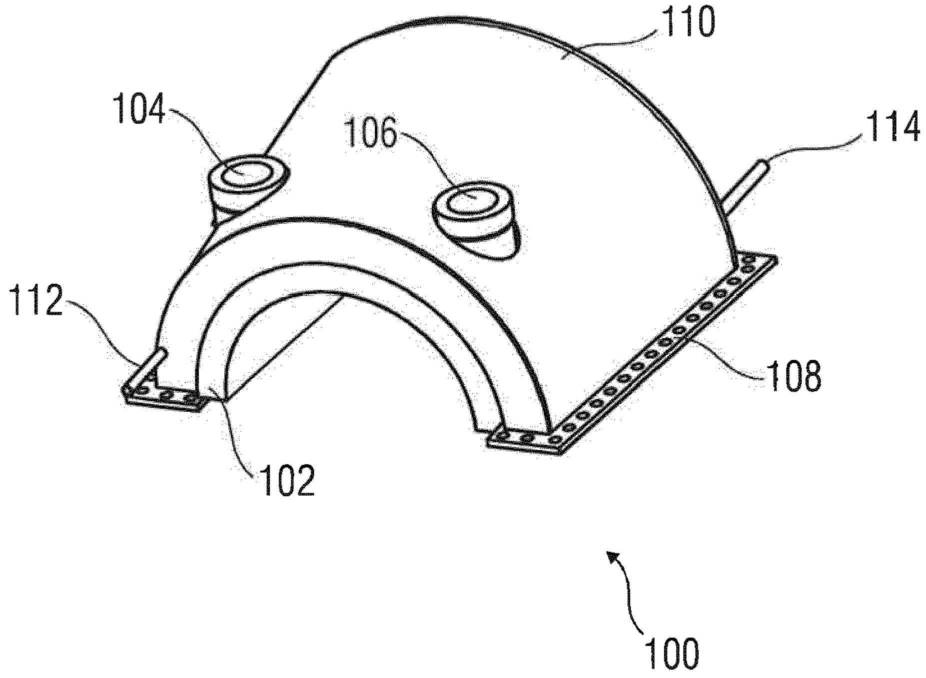
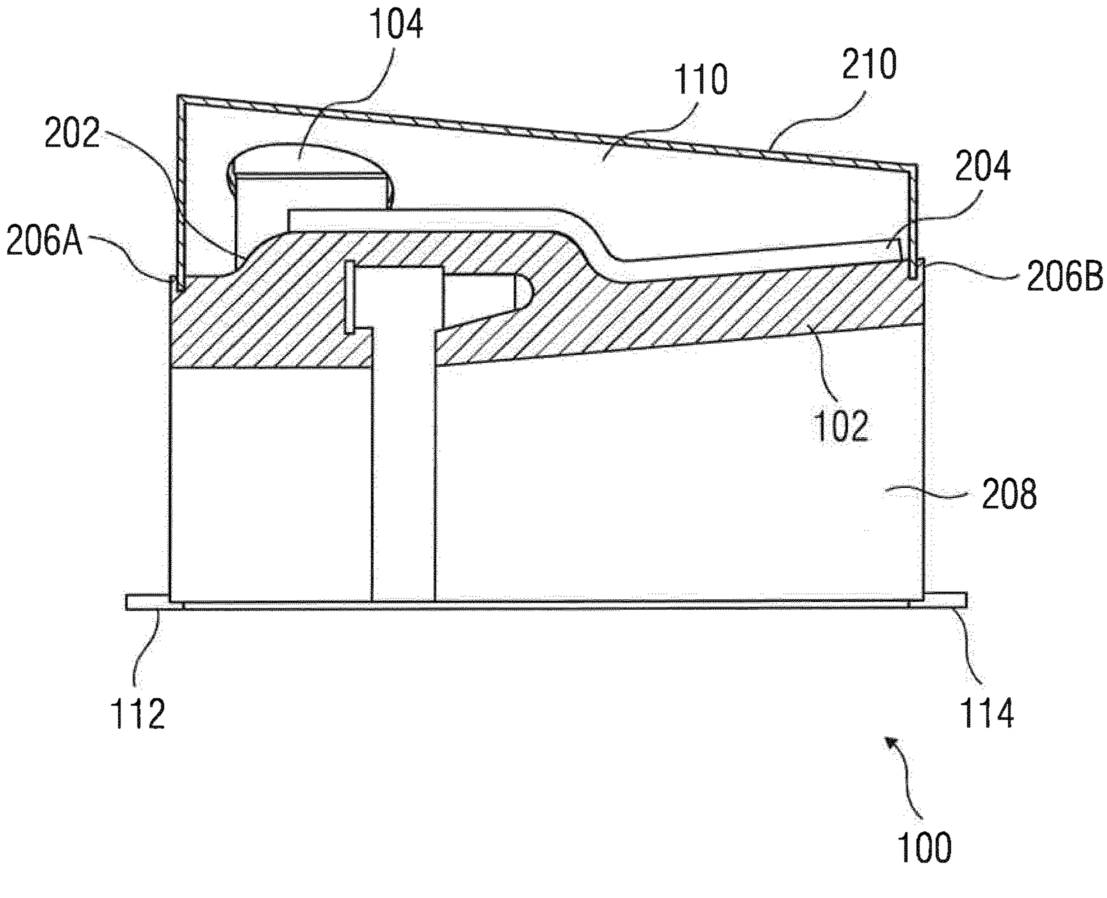


FIG 2



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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 9459

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 November 2015	Delaitre, Maxime

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CATEGORY OF CITED DOCUMENTS

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