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(54) Steam turbine system and method for controlling the steam flow of a steam turbine system

(57) The invention relates to a steam turbine system (10) for generating power, comprising a steam turbine (20) with turbine blades (22) surrounding a rotor (24) and being arranged inside a turbine casing (26). Furthermore, a nozzle box (30) is provided inside the turbine casing with nozzles (32) directing steam to the turbine blades (22) of the steam turbine (20). Moreover, a main steam system (40) with a main input port (42), a main valve (44), located downstream of the main input port (42), at least one control valve (46) located downstream of the main valve (44) and upstream of the nozzle box (30), and steam lines (48) connecting the main input port (42), the main valve (44), the at least one control valve (46) and the nozzle box (30) is provided.

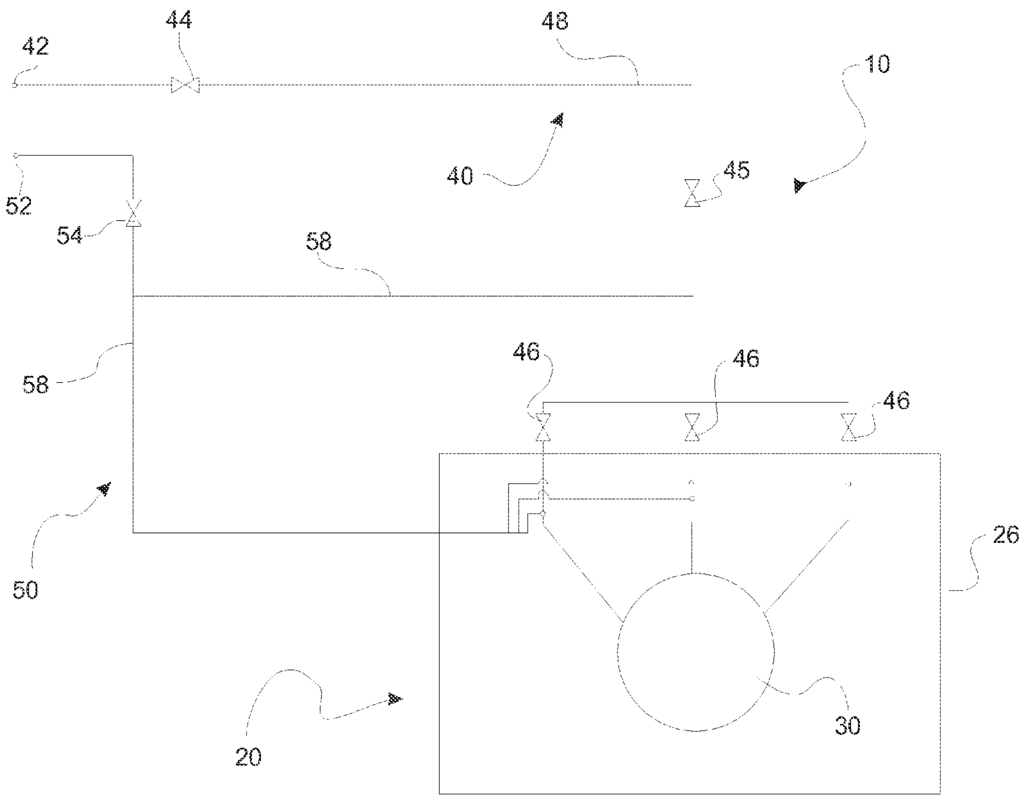

Fig. 1

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Description

[0001] The present invention relates to a steam turbine system as well as a method for controlling the steam flow of a steam turbine system.

[0002] Steam turbine systems are already known for generating power and usually comprise a steam system which provides steam to a steam turbine. One problem of already existing steam turbine systems is the fact that during the start phase of the steam turbine extensive thermal stress results in the turbine casing of the steam turbine as well as the nozzle box within the steam turbine. The thermal stress in such elements of the steam turbine system further results in the risk of material failure over time, in particular weakening of the material over time and multiple start phases. One high risk coming together with that problem is the fact that such thermal stress can introduce micro cracks into the material of the turbine casing as well as the nozzle box. Such micro cracks would lead to a dramatic material failure and the breakdown of the whole steam turbine during usage without any pre-warning.

[0003] It is an object of the present invention to solve the problems mentioned above. In particular it is an object of the present invention to provide a steam turbine system which is able to reduce the thermal stress of the elements in particular during the start phase of the steam turbine.

[0004] Afore-mentioned object is achieved by a steam turbine system comprising features of independent claim 1 as well as a method for controlling the steam flow of a steam turbine system with features of independent claim 9. Further embodiments of the present invention comprise for example the respective dependent claims.

[0005] According to the present invention, a steam turbine system for generating power comprises a steam turbine with turbine blades surrounding a rotor and being arranged inside a turbine casing. Such a steam turbine is meant for generating the power by rotation of the rotor, which is driven by steam running over the turbine blades and forcing the rotor to rotate within the turbine casing. Steam turbines are well known and therefore such a steam turbine has not to be described in more detail at this place.

[0006] The inventive steam turbine system further comprises a nozzle box which is provided inside the turbine casing with nozzles, directing steam to the turbine blades of the steam turbine. A nozzle box is used to direct the steam in the predefined direction, in particular in the direction of the turbine blades. The nozzle box improves the efficiency of the steam turbine due to the fact that the steam is introduced into the turbine casing in an adapted direction corresponding with the necessary direction of the steam to result in a more efficient rotation of the turbine blades and the rotor of the steam turbine.

[0007] To provide the steam turbine with steam for the rotation of the turbine blades and the rotor, a main steam system is provided within the steam turbine system. The main steam system comprises a main input port, a main valve, located downstream of the main input port, at least one control valve, located downstream the main valve and upstream the nozzle box, and steam lines connecting the main input port, the main valve, the at least one control valve and the nozzle box. In other words, the main steam system is used to provide steam from any kind of steam generator or steam source to the steam turbine. The main steam system therefore uses the main input port as a technical interface to be connected to any kind of steam source, such as for example a solar steam source, a boiler or any other technical kind of steam generator.

[0008] The rest of the main steam system is necessary to transport the steam from the steam source, in particular from the main input port, to the steam turbine. The main valve within such transport steam part is used to fully open or fully close the path for the steam. If the main valve is closed, no steam can arrive at the steam turbine and therefore the turbine blades as well as the rotor are not forced to rotate. In other words a closed main valve results in a stop of the steam turbine as well as in a stop of generating power. On the other hand, if the main valve is opened, steam can flow to the steam turbine and results in a rotation of the turbine blades and the rotor. Thus, the steam turbine generates power when the main valve has been opened.

[0009] Downstream of the main input port as well as downstream of the main valve, at least one control valve is positioned. The control valve is a valve, which has the possibility to vary the possible amount of steam, which can flow through the control valve. Therefore, between a fully open and a fully closed position, further positions with different levels of openness of the at least one control valve exist. The control valve of is used to control the explicit amount of steam which flows into the steam turbine and therefore it is used to control indirectly the amount of power which is generated by the steam turbine.

[0010] If more than one control valve is used, the steam can be introduced into the steam turbine at different positions. For example if three different control valves are used, three outlets are provided within the turbine casing, in particular within the nozzle box such that the amount of steam can be separated over the three control valves and the amount of distribution can be shifted between the three lines of the three control valves. Therefore the efficiency of the generation of power by the steam turbine can be further increased.

[0011] During the start phase of the steam turbine the whole system, in particular the nozzle box as well as the turbine casing, are cold respectively comprise a temperature close to the ambient temperature. The steam which is provided to the steam turbine is relatively hot. Therefore the provision of steam to the steam turbine results in heating up the material surrounding the main steam system, namely the steam lines as well as the turbine casing and the nozzle box. The increase of temperature of such components of the steam turbine system results in thermal expansion of the respective materials. Due to the fact that the nozzle box and the steam turbine comprise a lot more material than for example that main steam system, in particular steam lines, the velocity of heating up is different from component to component. Differences in the velocity of heating up result in differences of the temperature between different components. Furthermore, the differences in temperature result in different geometrical dimensions based on the respective temperature and therefore resulted in thermal stress.

[0012] According to the present invention, to avoid unnecessary high differences in temperature of the different components, a preheating steam system is provided. Such preheating steam system comprises a preheating input port, at least one preheating control valve, located downstream of the preheating input port and upstream of the nozzle box, and steam lines connecting the preheating input port, the at least one preheating control valve and the nozzle box. In other words, the preheating steam system can be understand as some kind of a bypass to the main steam system, providing steam in particular to the nozzle box and also, directly or indirectly to the turbine casing. By opening the preheating control valve, a steam flow can be separated from the main steam flow and being provided to the nozzle box as well as at least indirectly to the turbine casing. If in such situation the main valve is still closed, a preheating before the start phase of the steam turbine takes place of the material of the nozzle box as well as the turbine casing. After the preheating has been carried out, in particular the nozzle box and/or the turbine casing have arrived at a temperature which can be defined as pre-preheating temperature, the main valve is opened and the start of the steam turbine can take place. Due to the fact that the nozzle box as well as the turbine casing already have a relatively high temperature, the difference in temperature between the different components of the steam turbine system are a lot lower than compared to known systems according to the state of the art. The decrease in temperature difference results in the decrease of thermal stress and therefore decreases the risk of the possibility of micro cracks within the material of the different components.

[0013] The material of the nozzle box is heated up directly by the steam flowing through the preheating steam system. The material of the turbine casing can be heated up directly or indirectly. An indirect heating up would take place if the nozzle box is provided with steam by the preheating steam system and the steam within the nozzle box also influences, namely heats up, the material of the turbine casing. It is also possible, that the preheating steam system comprises steam lines which proceed through the turbine casing. In such a construction, the preheating of the turbine casing takes place directly, namely due to direct contact between the heated steam of the preheating steam system as well as the material of the turbine casing.

[0014] The steam lines of the main steam system as well as of the preheating steam system can be pipes, in particular pipelines made of any kind of material which can stand the temperature and pressure of the steam. In particular it is also possible that pipes, made of enforced plastics are used.

[0015] It is also possible that according to the present invention in one embodiment the input ports are from integral namely as one combined input port forming the main input port and the preheating input port. Located downstream of such combined input port, a preheating control valve can be located, providing two functionalities, namely first to separate the steam between the main steam system and the preheating steam system as well as closing/opening both systems by comprising the functionality of the main valve as well as of the preheating control valve. The use of such preheating control valve and one combined input port as inter face for steam sources reduces the complexity of the present invention thereby reduces costs of such an inventive steam turbine system.

[0016] It could be of advantage, when a steam turbine system according to the present invention is characterized in that the steam lines of the preheating systems from the at least one preheating control valve are connected to the steam lines of the main steam system between the at least one control valve and the nozzle box. In other words, both systems, namely the main steam system and the preheating steam system only need one connection to the nozzle box. The connection between the steam lines of the preheating system and the main heating system are placed upstream of such connection to the nozzle box. In particular lines for the steam within the steam turbine casing, can reduce complexity of such a way of construction.

[0017] It could be of advantage, if the steam turbine system according to the aforesaid embodiment is characterized such that the connection between the steam lines of the preheating system and the steam lines of the main steam system is located within the material of the turbine casing. That leads to a very efficient way of direct heating up of the material of the turbine casing. The steam, flowing through the preheating steam system, flows to such connection and thereby gets into direct contact with the material of the turbine casing. Such direct contact leads to transition of heat from the steam to the material of the turbine casing and thereby heats up the respective material directly. By following the flow path of the steam lines further, the steam arrives in the nozzle box and gets also into direct contact with the respective material to heat up the nozzle box. Such way of construction therefore leads to a direct heating up of the material of the turbine casing as well as the material of the nozzle box.

[0018] It could also be of advantage, if a steam turbine system of the present invention comprises an emergency stop valve which is provided within the main steam system, located downstream of the main valve and upstream of the at least one control valve. Such emergency stop valve can be used for emergency situations, in particular when any leakage within the steam turbine is detected.

[0019] It also could be possible, if a steam turbine system according to the present invention comprises explicitly one or two or three or four control valves, which are provided in the main steam system. The provision of specifically one, two, three or four control valves typically results in a respective construction of the nozzle box. For example, if the nozzle box is constructed to surround the rotor of the steam turbine by 180 degrees, two or specifically three control valves for that main steam system can be of advantage. If the nozzle box is bigger, for example fully surrounds the rotor of the steam turbine, four control valves and therefore four connections to the nozzle box from the main steam system can be of advantage. If it is a very small steam turbine, and a very small nozzle box is used, it could be of advantage if only one control valve is provided to reduce the complexity and the costs of the main steam system.

[0020] According to one further embodiment of the present invention the steam turbine system is characterized in that a nozzle box and a turbine casing are positioned in surface contact, in particular are manufactured to be integrally connected. The use of such construction, namely the surface contact between nozzle box and turbine casing results in a better and faster heat transmission from the nozzle box to the turbine casing and the other way round. In particular if such surface contact has an increased surface area, the temperature can flow fast between such two components and therefore thermal stress due to thermal differences between such two components is reduced.

[0021] According to one further embodiment of the present invention, the steam turbine can be constructed such that the nozzle box at least partly surrounds the rotor of the steam turbine. The level of surrounding the rotor can depend on the size of the steam turbine, in particular the size of the turbine blades. Once more it has to be noted that the level of surrounding of the rotor also influences the number of control valves which are to be used for the main steam system.

[0022] It is also possible that according to one embodiment of the present invention the steam turbine system is characterized in that at least one temperature sensor is provided at a position to measure the temperature of the nozzle box and/or the turbine casing. The temperature sensor leads to possibility to include the real time temperature of the respective material into the control of the main steam system as well as the preheating steam system. This further increases the advantage of the preheating system due to the fact that the preheating step can be controlled specifically with respect to the material temperature. In particular it is possible to use the preheating system until the material of the turbine casing and the material of the nozzle box has exceeded over a predefined threshold of temperature.

[0023] According to a further embodiment of the present invention, the steam lines of the preheating steam system downstream of the at least one preheating control valve are connected to the steam lines of the main steam system between the main valve or the emergency stop valve and the at least one control valve. By offering such an additional flow path for the steam of the preheating system, the main valve and/or the emergency stop valve are closed during preheating operation. That way, not only the nozzle box and/or the casing of the steam turbine is preheated, but also the casing of the at least one preheating control valve. Moreover, due to that parallel preheating, the differences between the temperature of the casing, the nozzle box and the casing for the at least one preheating control valve can be further reduced, thereby reducing the respective temperature stress within the material.

[0024] A further object of the present invention is to provide a method for controlling the steam flow of a steam turbine system with the features of the present invention. Such method comprises the following steps:

- Providing steam to the preheating input port,
- Opening at least one preheating control valve while the main valve of the main steam system remains at least party closed, thereby allowing steam to flow through the steam lines of the preheating steam system and to enter the nozzle box to heat up the nozzle box and/or the turbine casing,
- Opening the main valve of the main steam system and starting the control of the at least one control valve to start the generation of power by the steam turbine,
- Closing the at least one preheating control valve of the preheating steam system.

[0025] Is has to be noted that at least the last two steps, namely the opening of the main valve as well as the closing of the at least one preheating control valve can be carried out parallel or the other way round. In particular, for the functionality of the present invention it is necessary that the opening of the preheating control valve takes place in good time before the opening of the main valve, to provide efficient preheating of the nozzle box as well as the turbine casing. If the preheating steam system is still used while the main valve opens the main steam system for supplies steam to the steam turbine or if the preheating control of already closes that preheating steam system before the main steam system has opened up, depends on the respective situation of the specific steam turbine system.

[0026] It could also be of advantage if an inventive method is characterized in that the steps of opening the main valve of the main steam system and/or closing the preheating control valve of the preheating system are carried out after a predetermined time period. By using such a time period, during design of the steam turbine system, the size and geometry of the material of the nozzle box as well as the size and the geometry of the material of the turbine casing are used to calculate the necessary time to heat up the respective components that the steam provided by a steam source entering in the preheating input port. After such time period has passed by, the preheating will have resulted in the predefined material temperatures and therefore the main steam system can be opened to start the steam turbine to generate power.

[0027] One alternative or additional to the use of a time period, it is possible that according to an embodiment of the present invention the steps of opening the main valve of the main steam system and/or closing the preheating control valve of the preheating system are carried out after the temperature of the material of the nozzle box and/or the material of the turbine casing have exceeded a predetermined threshold. This is in particular meaningful, if the steam turbine system comprises a temperature sensor which informs a control system about the real temperature of the material of the nozzle box and7/or of the material of the turbine casing.

[0028] The present invention is explained in more detail with respect to the accompanying drawings. Such show in

Figure 1 a schematic view of one embodiment of an inventive steam turbine system,

Figure 2 one alternative steam turbine system,

Figure 3 one schematic view of a turbine casing of a steam turbine system,

Figure 4 one isometric schematic view of a turbine casing of one embodiment of the steam turbine system,

Figure 5 the embodiment of fig. 1 during preheating and

Figure 6 the embodiment of fig. 1 during normal operation

[0029] In figure 1 one embodiment of an inventive steam turbine system 10 is disclosed. The steam turbine system 10 comprises a steam turbine 20, which is enclosed by a turbine casing 26. Within such turbine casing 26 a nozzle box 30 is located. To provide the nozzle box 30 and thereby the steam turbine 20 with steam, a main steam system 40 is provided. The main steam system 40 comprises a main input port 42, which acts as an interface to a not depicted steam source. Steam, introduced into the main input port 42, follows the steam lines 48 and passes the main valve 44, the emergency valve 45 and the control valves 46. After passing the control valves 46, the three steam lines 48 enter the nozzle box 30 to let out the steam into the steam turbine 20.

[0030] To provide the possibility of preheating, the steam turbine system 10 according to the embodiment of figure 1 is provided with a preheating steam system 50. Such preheating steam system 50 comprises a preheating input port 52, acting as an interface also to a steam source. Such steam source can be the identical steam source acting as a steam source for the main steam system 40. The steam entering the preheating input port 52 passes the preheating control valve 54 and is split into three parallel steam lines 58, to connect to the steam lines 48 of the main steam system 40 between the control valves 46 and the nozzle box 30. Therefore, the functionality of a steam turbine system 10 of the present embodiment can be described as followed.

[0031] For starting the preheating, the main valve 44 of the main steam system 40 is closed. The preheating control valve 54 is opened such that steam coming from a steam source entering the preheating input port 52 can flow through the steam lines 58 of the preheating system 50. Such steam flows through the connections to the steam lines 48 of the main steam system 40 downstream of the in particular closed control valves 46 and enters the nozzle box 30. Thereby the nozzle box 30 is heated up. By following the steam path after having leaved the nozzle box 30, such steam also heats up the turbine casing 26 of the steam turbine. After the nozzle box 30 and/or the turbine casing 26 they have arrived at a material temperature which lies above predetermined threshold or after having carried out the preheating by the preheating steam system 50 over a predefined period of time, the preheating control valve 54 is closed and the main valve 44 of the main steam system 40 is opened. After opening up the main valve 44, the regular work of the steam turbine 20 can begin, namely the steam from a steam source can flow through the nozzle box 30 into the turbine casing 26 and the steam turbine 20 can start to generate power.

[0032] With the respect to figure 1, an alternative embodiment is depicted in figure 2. Same features comprise same reference signs and only differences between the two embodiments will be described below.

[0033] In difference to figure 1, the embodiment of figure 2 comprises one combined input port for the main input port 42 and the preheating input port 52. Located downstream of the combined input port a three-port valve is positioned, comprising the functionality of the main valve 44 of the main steam system 40 and the preheating control valve 54 of the preheating steam system 50. In other words, such three-port valve comprises the two functionalities of separating the steam from a steam source or steam generator from the combined input port as well as acting as the two necessary valves of the two steam systems 40 and 50. The rest of the functionality is identical between the embodiments of figure 1 and figure 2.

[0034] In figure 3 one embodiment of the turbine 20 is shown in further detail. The main steam system 40 comprising the main valve 44 is also provided with three control valves 46. The steam lines 48 follow the way to the nozzle box 30 downstream of the control valves 46 through the material of the turbine casing 26. Within the material of the turbine casing 26 there is also the connection to the steam lines 58 of the preheating steam system 50. In other words, during the work of the preheating steam system, the steam flows through the preheating steam lines 58 and by passing said connection to the steam lines 48 of the main steam system 40. Downstream of that connection, the steam flows within the material of the turbine casing 26 and due to that direct contact between such material and the steam the turbine casing 26 is heated up.

[0035] Within the embodiment of figure 3 it has to be noted that the nozzle box 30 comprises three nozzles 32, which are connected each to one steam line 48 of the main steam system 40. Thereby the nozzles 32 and the nozzle box 30 are connected to the main steam system 40 as well as to the preheating steam system 50 such that the nozzle box 30 is also preheated by the preheating steam system 50.

[0036] Furthermore, the embodiment of figure 3 comprises a temperature sensor 60, which is located at least partly with its sensing part inside the material of the turbine casing 26. Thereby it is possible to provide the explicit material temperature of the turbine casing 26 to a control system which is not depicted in the figures. For carrying out an inventive method such temperature parameter can be used to start and end the preheating process.

[0037] Figure 4 shows in a schematic view the embodiment of figure 3. As it can be seen there, the steam after leaving the nozzles 32 flows along a rotor 24 of the steam turbine 20 and forces the turbine blades 22 to rotate. It has to be noted that the amount of steam following through the preheating steam system 50 is a lot less than the amount of steam which flows through the main steam system 40. Therefore, the steam which is used to heat up the turbine casing 26 as well as the nozzle box 30 also enters the interior of the turbine casing 26 but does not result in a start of generating power due to the fact that the amount of steam is too low to result in a rotation of the turbine blades 22.

[0038] With respect to figs. 5 and 6, the two operational states of the steam turbine system are further described. Fig. 5 shows the preheating operation. The emergency stop valve 45 as well as the control valves 46 are closed. The preheating control valve 54 is open and thereby the steam can flow though the steam lines 58 of the preheating steam system 50 for heating up the nozzle box 30, the casing 26 as well as the control valves 46, respectively their casing. After preheating as been carried out, the preheating control valve is closed and the emergency stop valve 45, the control valves 46 as well as the main valve 44 are all set into an open state as it is shown in fig. 6. Thereby, the preheating steam system 50 is closed and the normal operation mode of the steam turbine 20 can be started.

Claims

1. Steam turbine system (10) for generating power, comprising:

   a steam turbine (20) with turbine blades (22) surrounding a rotor (24) and being arranged inside a turbine casing (26),

   a nozzle box (30) provided inside the turbine casing (26) with nozzles (32) directing steam to the turbine blades (22) of the steam turbine (20),

   a main steam system (40) with a main input port (42), a main valve (44), located downstream of the main input port (42),

   at least one control valve (46), located downstream of the main valve (44) and upstream of the nozzle box (30), and

   steam lines (48) connecting the main input port (42), the main valve (44), the at least one control valve (46) and the nozzle box (30),

   a preheating steam system (50) with a preheating input port (52), at least one preheating control valve (54), located downstream of the preheating input port (52) and upstream of the nozzle box (30), and steam lines (58) connecting the preheating input port (52), the at least one preheating control valve (54) and the nozzle box (30).

2. Steam turbine system (10) according to claim 1, **characterised in that** the steam lines (58) of the preheating steam system (50) from the at least one preheating control valve (54) are connected to the steam lines (48) of the main steam system (40) between the at least one control valve (46) and the nozzle box (30).

3. Steam turbine system (10) according to claim 2, **characterised in that** the connection between the steam lines (58) of the preheating steam system (50) and the steam lines (48) of the main steam system (40) is located within the material of the turbine casing (26).

4. Steam turbine system (10) according to any of claims 1 to 3, **characterised in that** an emergency stop valve (45) is provided in the main steam system (40), located downstream of the main valve (44) and upstream of the at least one control valve (46).

5. Steam turbine system (10) according to any of claims 1 to 4, **characterised in that** one or two or three or four control valves (46) are provided in the main steam system (40).

6. Steam turbine system (10) according to any of claims 1 to 5, **characterised in that** the nozzle box (30) and the turbine casing (26) are positioned in surface contact, in particular are manufactured to be integrally connected.

7. Steam turbine system (10) according to any of claims 1 to 6, **characterised in that** the nozzle box (30) at

least partly surrounds the rotor (24) of the steam turbine (20).

8. Steam turbine system (10) according to any of claims 1 to 7, **characterised in that** at least one temperature sensor (60) is provided at a position to measure the temperature of the nozzle box (30) and/or of the turbine casing (26).

9. Steam turbine system (10) according to any of claims 1 to 8, **characterised in that** the steam lines (58) of the preheating steam system (50) downstream of the at least one preheating control valve (54) are connected to the steam lines (48) of the main steam system (40) between the main valve (44) or the emergency stop valve (45) and the at least one control valve (46).

10. Method for controlling the steam flow of a steam turbine system (10) with the features of any of claims 1 to 9, comprising the following steps:

- providing steam to the preheating input port (52),
- opening at least one preheating control valve (54) while the main valve (44) of the main steam system (40) remains at least partly closed, thereby allowing steam to flow through the steam lines (58) of the preheating steam system (50) and to enter the nozzle box (30) to heat up the nozzle box (30) and/or the turbine casing (26),
- opening the main valve (44) of the main steam system (40) and starting the control of the at least one control valve (46) to start the generation of power by the steam turbine (20),
- closing the at least one preheating control valve (54) of the preheating steam system (50).

11. Method according to claim 10, **characterised in that** the steps of opening the main valve (44) of the main steam system (40) and/or closing the preheating control valve (54) of the preheating system (50) are carried out after a predetermined time period.

12. Method according to claim 10, **characterised in that** the steps of opening the main valve (44) of the main steam system (40) and/or closing the preheating control valve (54) of the preheating system (50) are carried out after the temperature of the material of the nozzle box (30) and/or the material of the turbine casing (26) have exceeded a predetermined threshold.

Amended claims in accordance with Rule 137(2) EPC.

1. Steam turbine system (10) for generating power, comprising:

a steam turbine (20) with turbine blades (22) surrounding a rotor (24) and being arranged inside a turbine casing (26),
a nozzle box (30) provided inside the turbine casing (26) with nozzles (32) directing steam to the turbine blades (22) of the steam turbine (20),
a main steam system (40) with a main input port (42), a main valve (44), located downstream of the main input port (42),
at least one control valve (46), located downstream of the main valve (44) and upstream of the nozzle box (30), and
steam lines (48) connecting the main input port (42), the main valve (44), the at least one control valve (46) and the nozzle box (30),
a preheating steam system (50) with a preheating input port (52), at least one preheating control valve (54), located downstream of the preheating input port (52) and upstream of the nozzle box (30), and steam lines (58) connecting the preheating input port (52), the at least one preheating control valve (54) and the nozzle box (30) **characterised in that** the steam lines (58) of the preheating steam system (50) from the at least one preheating control valve (54) are connected to the steam lines (48) of the main steam system (40) between the at least one control valve (46) and the nozzle box (30) and **characterised in that** the connection between the steam lines (58) of the preheating steam system (50) and the steam lines (48) of the main steam system (40) is located within the material of the turbine casing (26).

2. Steam turbine system (10) according to claim 1, **characterised in that** an emergency stop valve (45) is provided in the main steam system (40), located downstream of the main valve (44) and upstream of the at least one control valve (46).

3. Steam turbine system (10) according to any of claims 1 to 2, **characterised in that** one or two or three or four control valves (46) are provided in the main steam system (40).

4. Steam turbine system (10) according to any of claims 1 to 3, **characterised in that** the nozzle box (30) and the turbine casing (26) are positioned in surface contact, in particular are manufactured to be integrally connected.

5. Steam turbine system (10) according to any of claims 1 to 4, **characterised in that** the nozzle box (30) at least partly surrounds the rotor (24) of the steam turbine (20).

6. Steam turbine system (10) according to any of claims 1 to 5, **characterised in that** at least one temperature sensor (60) is provided at a position to measure the temperature of the nozzle box (30) and/or of the turbine casing (26).

7. Steam turbine system (10) according to any of claims 1 to 6, **characterised in that** the steam lines (58) of the preheating steam system (50) downstream of the at least one preheating control valve (54) are connected to the steam lines (48) of the main steam system (40) between the main valve (44) or the emergency stop valve (45) and the at least one control valve (46).

8. Method for controlling the steam flow of a steam turbine system (10) with the features of any of claims 1 to 7, comprising the following steps:

- providing steam to the preheating input port (52),
- opening at least one preheating control valve (54) while the main valve (44) of the main steam system (40) remains at least partly closed, thereby allowing steam to flow through the steam lines (58) of the preheating steam system (50) and to enter the nozzle box (30) to heat up the nozzle box (30) and/or the turbine casing (26),
- opening the main valve (44) of the main steam system (40) and starting the control of the at least one control valve (46) to start the generation of power by the steam turbine (20),
- closing the at least one preheating control valve (54) of the preheating steam system (50).

9. Method according to claim 8, **characterised in that** the steps of opening the main valve (44) of the main steam system (40) and/or closing the preheating control valve (54) of the preheating system (50) are carried out after a predetermined time period.

10. Method according to claim 8, **characterised in that** the steps of opening the main valve (44) of the main steam system (40) and/or closing the preheating control valve (54) of the preheating system (50) are carried out after the temperature of the material of the nozzle box (30) and/or the material of the turbine casing (26) have exceeded a predetermined threshold.

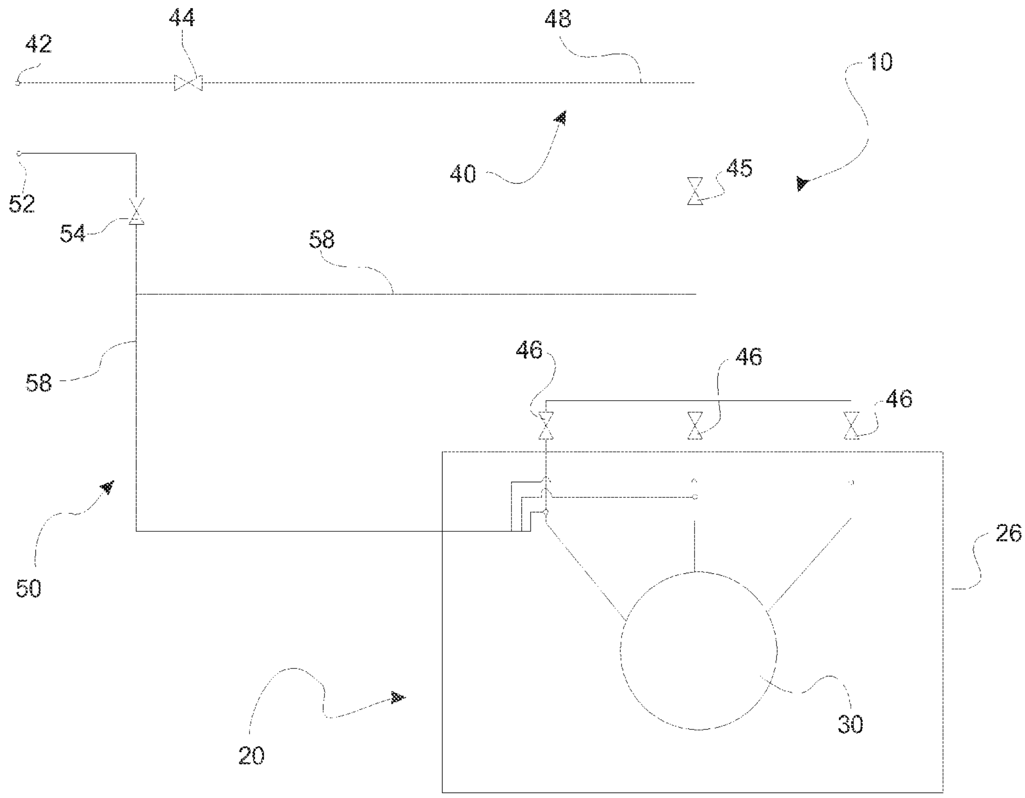

Fig. 1

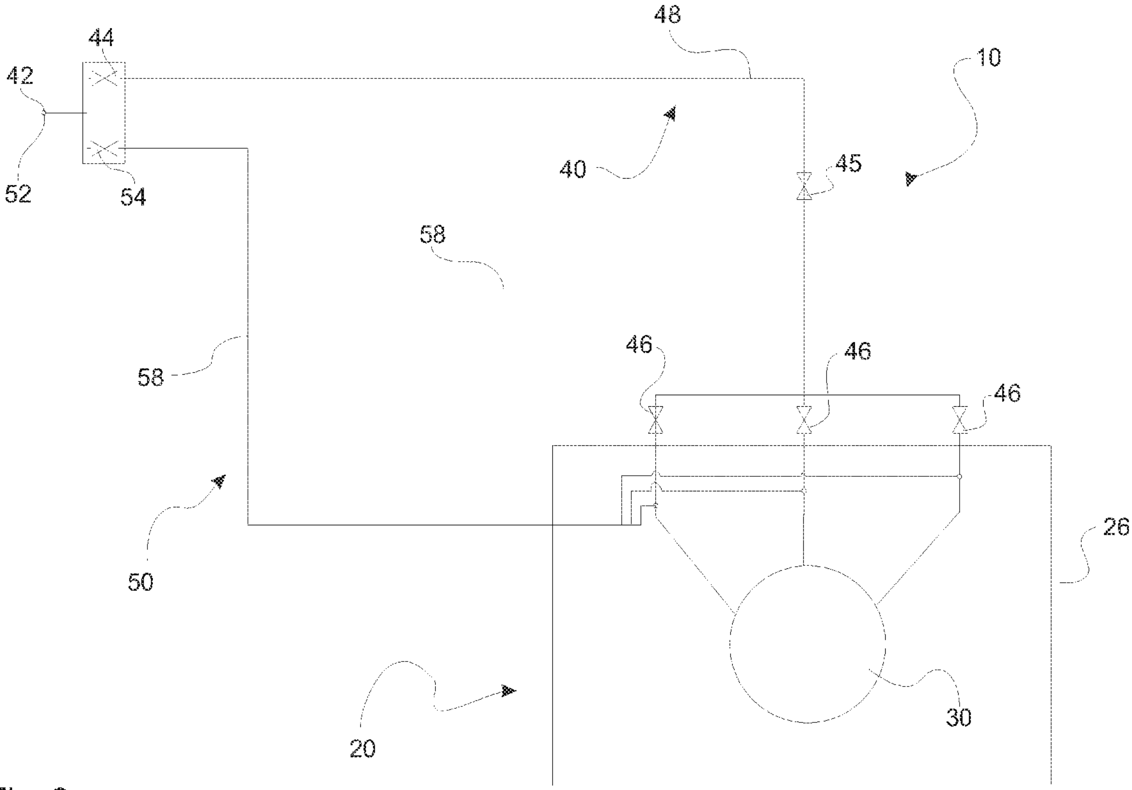

Fig. 2

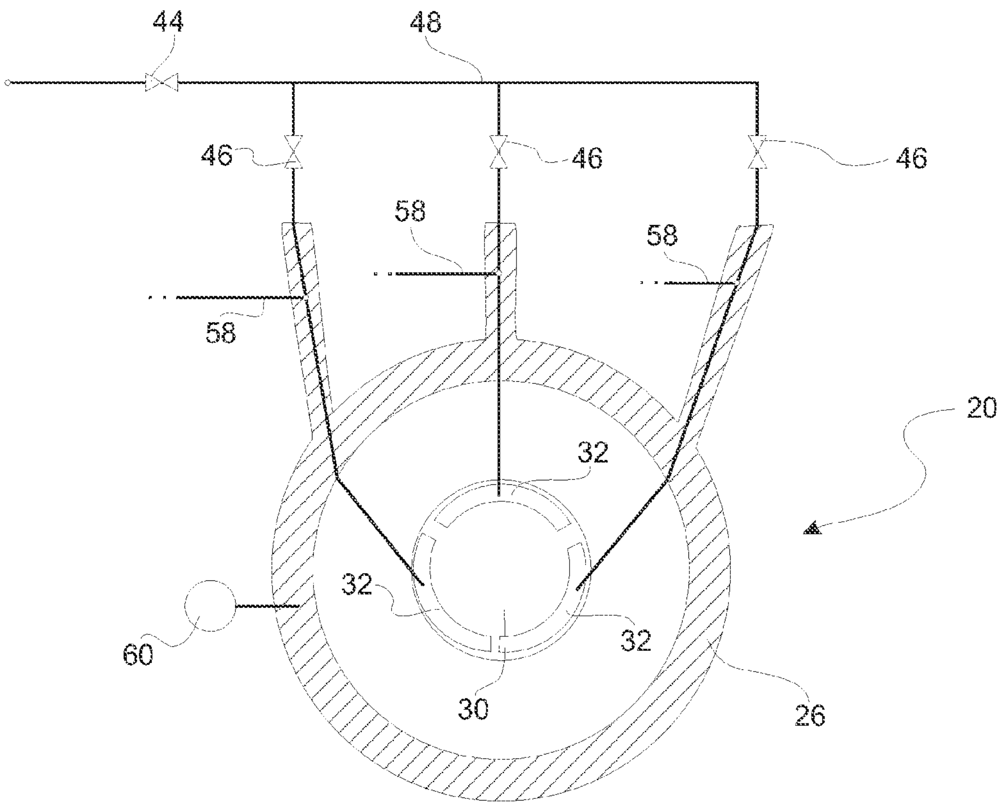

Fig. 3

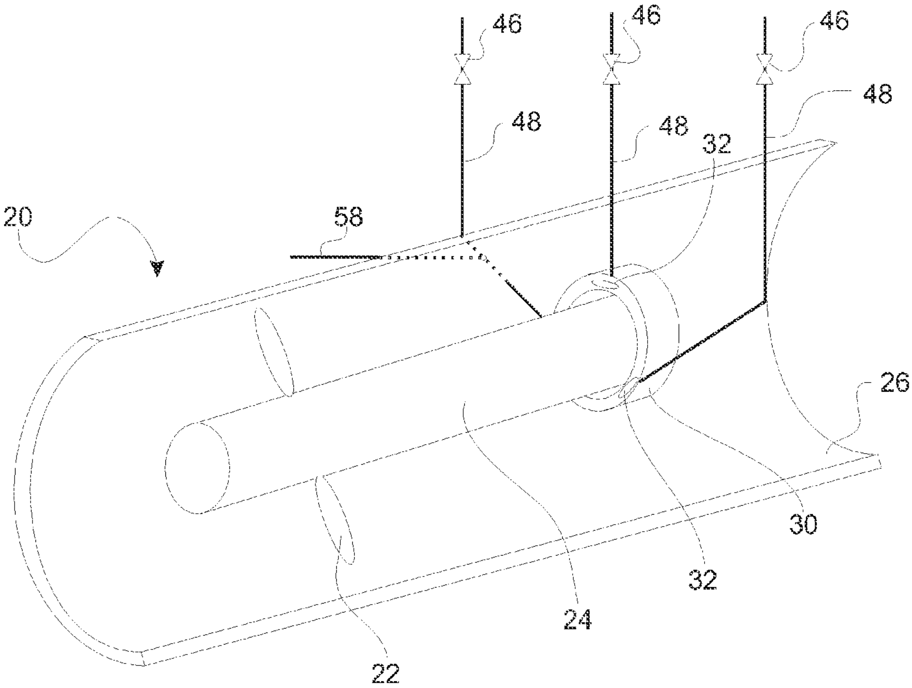

Fig. 4

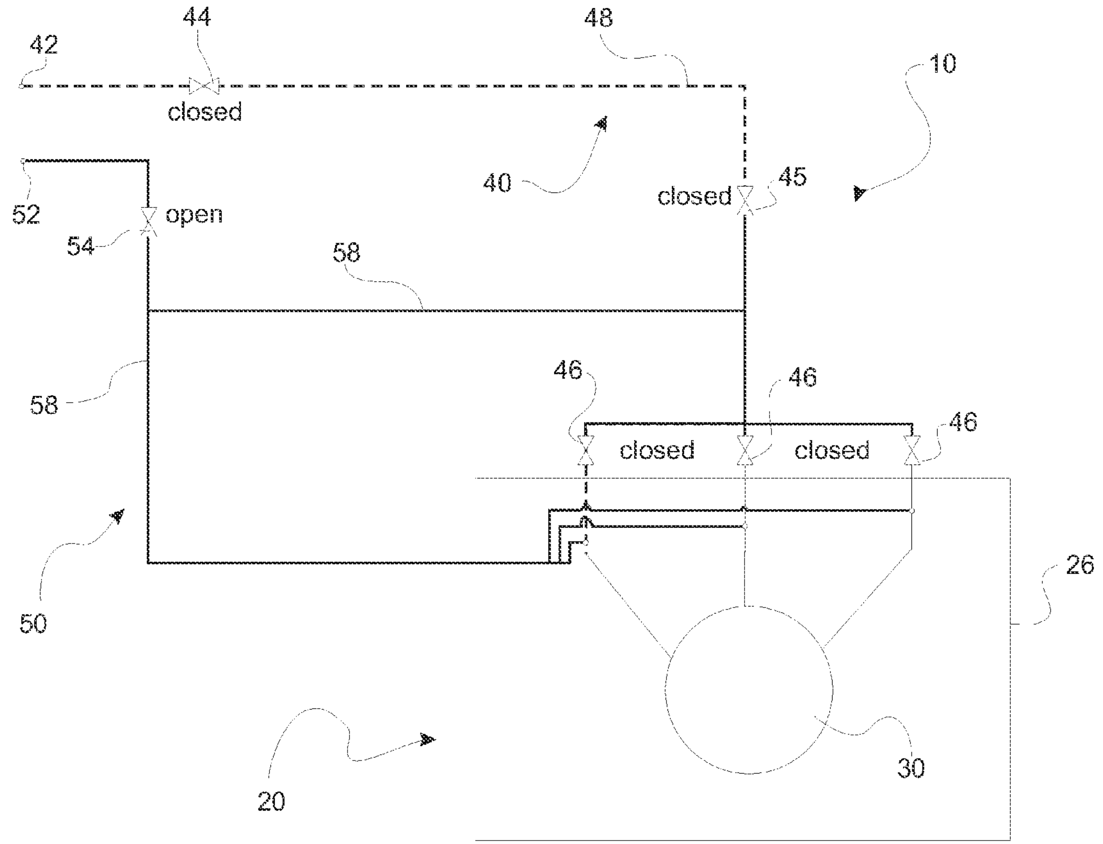
42
44
closed
48
10
40
closed
45
52
open
54
58
58
46
46
46
closed
closed
50
26
20
30

Fig. 5

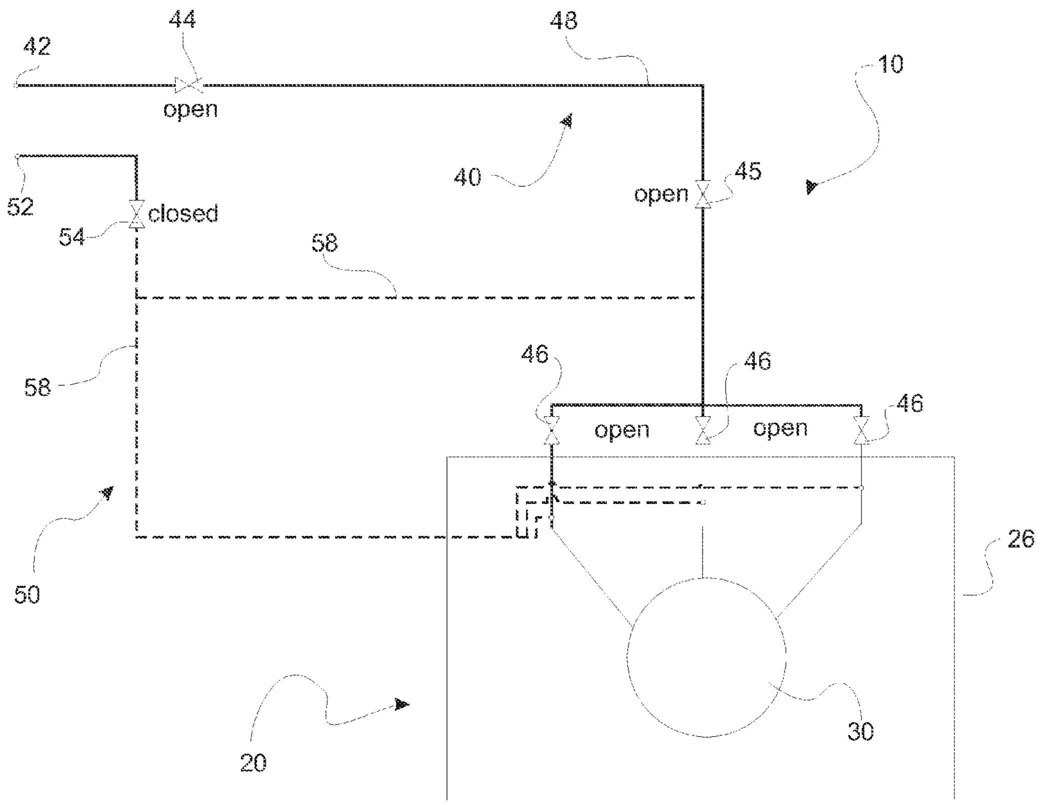
42
44
open
48
10
40
open
45
52
closed
54
58
58
46
46
46
open
open
50
26
30
20

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 11 15 5946

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 5 412 936 A (LEE DANIEL T [US] ET AL) 9 May 1995 (1995-05-09) * column 4, line 61 - column 6, line 19; figures 1,2 *	1,2,5,7, 10,11	INV. F01K13/02
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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	13 July 2011	Röberg, Andreas

1

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CATEGORY OF CITED DOCUMENTS

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