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(54) **SUPERHEATED STEAM GENERATOR AND MAINTENANCE METHOD THEREFOR**

(57) The present invention is intended to inform a user of a maintenance timing for a superheated steam generator. The present invention includes an induction heating type or electrically heating type superheated steam generation section and an informing section. The superheated steam generation section generates superheated steam by heating steam. The informing section transmits maintenance information by employing, as a parameter, an operating temperature of the superheated steam generation section and an operating time at the operating temperature.

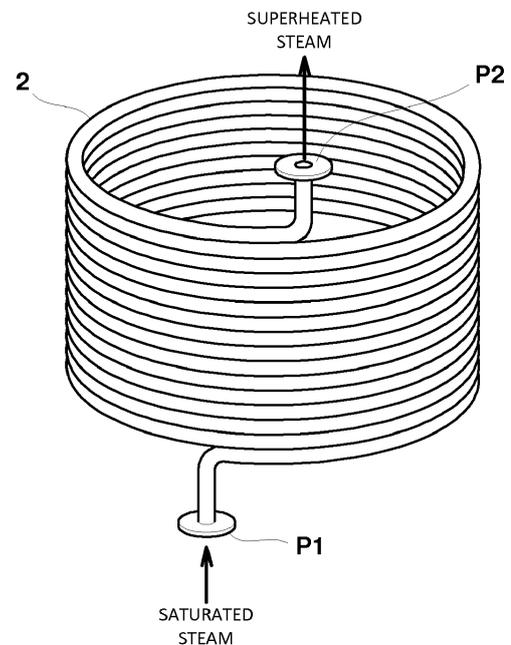


FIG. 2

EP 3 502 558 A1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a superheated steam generator and a maintenance method therefor.

BACKGROUND ART

[0002] Austenitic stainless steels such as SUS304, and alloys such as INCONEL (registered trademark), each of which has high heat resistance and high mechanical proof stress, are used for an induction heating type or electrical heating type superheated steam generation section (for example, Patent Document 1).

[0003] However, even though these stainless steels and alloys have a melting point of approximately 1400°C, volume reduction may occur due to steam oxidation in superheated steam having high temperatures exceeding 1000°C.

[0004] The above superheated steam generation section includes a conductor tube composed of stainless steel or alloy. Therefore, when the volume reduction occurs due to the steam oxidation, the conductor tube cannot withstand the pressure of the superheated steam and deformation due to thermal expansion, thus causing damage to the conductor tube. The superheated steam may leak outside due to the damage to the conductor tube. This may cause, for example, fire and personal injury.

PRIOR ART

[0005] Patent Document 1: Japanese Unexamined Patent Publication No. 2016-176613

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] Accordingly, the present invention has been made to solve the above problem and has for its main object to inform a user of a maintenance timing for a superheated steam generator.

MEANS OF SOLVING THE PROBLEMS

[0007] In one embodiment, a superheated steam generator includes an induction heating type or electrically heating type superheated steam generation section, and an informing section. The superheated steam generation section is configured to generate superheated steam by heating steam. The informing section is configured to transmit maintenance information by employing, as a parameter, an operating temperature of the superheated steam generation section and an operating time at the

operating temperature.

[0008] With the above configuration, the maintenance information is transmitted by employing the operating time at the operating temperature as a parameter. It is therefore possible to inform a user of a maintenance timing for the superheated steam generator. This makes it possible for the user to carry out maintenance before the superheated steam generation section breaks down.

[0009] Degrees of deterioration and fatigue of the superheated steam generation section differ depending on an operating temperature. Hence, preferably, the informing section acquires operating temperature data indicating the operating temperature of the superheated steam generation section, and operating time data indicating the operating time at the operating temperature. The informing section then converts the operating time to the operating time at a predetermined temperature (for example, 1200°C) and integrates converted values. Subsequently, the informing section transmits the maintenance information when an integration value exceeds a predetermined integration threshold value.

[0010] The superheated steam generator may include a conductor tube to generate the superheated steam by being subjected to induction heating or electrical heating, and a steam adjustment mechanism for adjusting an amount of superheated steam to be generated. A flow rate of the superheated steam in the conductor tube is increased or decreased depending on whether the amount of superheated steam generation increases or decreases. A high flow rate leads to a great volume reduction rate, and a low flow rate leads to a small volume reduction rate.

[0011] Because a volume reduction rate is proportional to a flow rate to the power of 0.8 in actual measurements at 1200°C, a flow rate is halved when the amount of superheated steam generation is halved, and a corrected integration value (operating time) reaches a value of $0.5^{0.8}=0.574$ times with respect to an integration value before correction. In other words, assuming that the superheated steam generator is operated for 1000 hours at an amount of generation of 100% in the case of generating superheated steam at the same temperature, the operating time reaches 574 hours by operating at an amount of generation of 50%.

[0012] Thus, the volume reduction rate differs depending on the amount of superheated steam. Hence, preferably, the informing section corrects the integration value on a basis of an amount of superheated steam generation in the superheated steam generation section, and the informing section transmits the maintenance information when a corrected integration value exceeds the integration threshold value.

[0013] The superheated steam generation section includes a conductor tube to generate the superheated steam by being subjected to induction heating or electrical heating. The conductor tube is susceptible to steam oxidation due to the superheated steam, and the volume reduction is remarkable. Therefore, the informing section

is preferably configured to transmit the maintenance information containing a replacement timing for the conductor tube.

[0014] The useful lifespan is less likely to become a problem even without consideration of the operating time in a range of temperatures at which a volume reduction due to steam oxidation does not substantially become a problem. For example, when the superheated steam at 1000°C is passed through a conductor tube composed of INCONEL for 1000 hours, a volume reduction rate is approximately 5%. In other words, it takes several tens of thousands of hours at 1000°C or below until a remaining amount of a flow tube is reduced to 10% or less. It is therefore less likely that the useful lifespan will become a problem in a short period of time. Hence, the informing section is preferably configured to transmit the maintenance information by employing, as a parameter, an operating temperature at which the volume reduction rate of the flow tube reaches or exceeds a predetermined value by operating for a predetermined period of time. The informing section also preferably specifies a temperature range used for the maintenance information at the operating temperatures of the superheated steam generation section, and utilizes the operating time at the operating temperatures included in the temperature range, as the operating time at a highest temperature in the temperature range.

[0015] It is conceivable to include a first superheated steam generation section of the induction heating type and a second superheated steam generation section of the electrically heating type, as a specific configuration of the superheated steam generation section. The first superheated steam generation section carries out induction heating by using, as a secondary coil, a first conductor tube that permits passage of steam. The second superheated steam generation section further heats the superheated steam by electrically heating a second conductor tube that permits passage of superheated steam generated by the first superheated steam generation section.

[0016] A use method is conceivable which accelerates fatigue of the second conductor tube by setting a higher temperature to the second superheated steam generation section than the first superheated steam generation section in the above configuration. Here, it is preferable that the informing section is disposed at a side of the second superheated steam generation section and is configured to transmit the maintenance information indicating a replacement timing for the second conductor tube.

[0017] More preferably, the informing section is also disposed at a side of the first superheated steam generation section so as to transmit the maintenance information indicating the replacement timing of a conductor tube of the first superheated steam generation section. This makes it possible to also inform the user of the maintenance timing for the first superheated steam generation section aside from the second superheated steam gen-

eration section. Here, a maintenance frequency for replacement of the second conductor tube or the like in the second superheated steam generation section is higher than the maintenance frequency of replacement of the first conductor tube or the like in the first superheated steam generation section.

[0018] Because the first conductor tube is wound around an iron core in the first superheated steam generation section of induction heating type, disassembly for replacing the conductor tube is complicated and time-consuming. It is therefore difficult to carry out maintenance, such as replacement of the first conductor tube. In contrast, it is easy to carry out maintenance, such as replacement, by a simple operation, such as removal of power source wiring from power supply terminals of the second conductor tube, in the second superheated steam generation section of electrically heating type. Consequently, the first superheated steam generation section is used under service conditions (for example, at below 1000°C) under which the conductor tube is less likely to deteriorate or fatigue, thereby minimizing the frequency of maintenance, such as replacement. The second superheated steam generation section is configured to generate the superheated steam having high temperatures (for example, 1000°C or higher) because it is easy to carry out maintenance for replacement of the second conductor tube.

EFFECTS OF THE INVENTION

[0019] With the present invention configured as described above, the maintenance information is transmitted by employing, as a parameter, the operating time at the operating temperature. It is therefore possible to inform a user of maintenance timing for the superheated steam generator. This makes it possible for the user to carry out maintenance before the superheated steam generation section breaks down.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a diagram schematically illustrating a configuration of a superheated steam generator in one embodiment;

FIG. 2 is a perspective view illustrating one embodiment of a conductor tube of a superheated steam generation section in the embodiment;

FIG. 3 is a diagram illustrating superheated steam-INCONEL 601 alloy volume reduction characteristics after 1000 hours; and

FIG. 4 is a diagram schematically illustrating a configuration of a superheated steam generator in a modified embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0021] One embodiment of a superheated steam generator according to the present invention is described below with reference to the drawings.

[0022] As illustrated in FIG. 1, a superheated steam generator 100 in the present embodiment includes a superheated steam generation section 10 configured to generate superheated steam exceeding 100°C (e.g., 200-2000°C) by heating water or steam.

[0023] The superheated steam generation section 10 employs induction heating, and includes a spiral-wound circular tube-shaped conductor tube 2 and a magnetic flux generation mechanism 3 by which the conductor tube 2 is subjected to induction heating.

[0024] As illustrated in FIG. 2, the conductor tube 2 is composed of a metal tube, and includes a winding part being wound spirally. One end of the conductor tube 2 is provided with an inlet port P1 that permits introduction of water or steam, and the other end is provided with an outlet port P2 that permits discharge of generated superheated steam. Austenitic stainless steels such as SUS304, and alloys such as INCONEL, each of which has a high heat resistance and high mechanical proof stress, is usable for the conductor tube 2.

[0025] External piping for supplying water or steam to the conductor tube 2 is coupled to the inlet port P1. Specifically, an induction heating type saturated steam generation section (not illustrated) is coupled to the inlet port P1 in the present embodiment. The saturated steam generation section has the same configuration as the superheated steam generation section 10. External piping for supplying generated superheated steam to a use-side (for example, a heat treatment chamber) is coupled to the outlet port P2.

[0026] The magnetic flux generation mechanism 3 includes an iron core 31 and an induction coil 32 wound along the iron core 31. An alternating current (AC) power source 4 is coupled to the induction coil 32 so as to supply controlled power thereto. A power source frequency of the AC power source 4 is a commercial frequency of 50 Hz or 60 Hz. The induction coil 32, to which the power is supplied from the AC power source 4, serves as a primary coil. By supplying power through the primary coil, an induced current flows to the conductor tube 2, and the conductor tube 2 serves as a secondary coil. The conductor tube 2 is subjected to Joule heating, so that steam passing through the interior of the conductor tube 2 can be heated.

[0027] With the superheated steam generator 100, an AC voltage applied to the induction coil 32 is controlled by detecting through a temperature detector 5 a temperature of superheated steam discharged from the conductor tube 2, and by inputting a control signal according to a deviation between a detected temperature and a target temperature, to a voltage controller 6 (for example, a thyristor). Specifically, a temperature controller 7 configured to perform the above control performs a feedback control

of the temperature of the superheated steam heated through the conductor tube 2 so that a deviation from the target temperature is less than $\pm 1^\circ\text{C}$. The temperature controller 7 is a computer including, for example, a central processing unit (CPU), memory, and an input/output interface.

[0028] The superheated steam generator 100 of the present embodiment further includes an informing section 8 configured to transmit maintenance information by employing, as a parameter, an operating temperature of the superheated steam generation section 10, an operating time at the operating temperature, and a volume reduction rate at the operating temperature.

[0029] The informing section 8 acquires operating temperature data indicating the operating temperature of the superheated steam generation section 10, and operating time data indicating the operating time at the operating temperature. The informing section 8 then converts this data to the operating time at a predetermined temperature and integrates converted values. The informing section 8 transmits the maintenance information when an integration value exceeds a predetermined integration threshold value. The informing section 8 is a computer including, for example, a processor such as a central processing unit (CPU), memory, and an input/output interface.

[0030] Specifically, the informing section 8 employs, as operating temperature data, detected temperature data indicating a detected temperature obtained through the temperature detector 5, or target temperature data indicating a target temperature controlled by the temperature controller 7. The informing section 8 acquires the operating time data indicating operating time from a timer included in the informing section 8, or a timer of the temperature controller 7. The informing section 8 converts this data to the operating time at 1200°C and integrates the converted values. The informing section 8 transmits maintenance information when the integration value exceeds a predetermined integration threshold value. Alternatively, temperatures of the conductor tube 2 may be used as the operating temperature data. In this case, a temperature detector is contactedly disposed, for example, at the outlet port P2 of the conductor tube 2 or in the vicinity thereof. Particularly, when the superheated steam generation section 10 is in a standby state or performs an intermittent operation, it is preferable to use the temperatures of the conductor tube 2.

[0031] The predetermined integration threshold value corresponds to a volume reduction limit time, and needs to be determined by previously calculating from a pressure of superheated steam and a thermal expansion deformation value of the conductor tube 2. An approximation formula of a relationship between volume reduction rate and temperature needs to be obtained by carrying out measurements at several points (refer to FIG. 3). Using a detected temperature obtained through the temperature detector 5 or a target temperature controlled by the temperature controller 7, a volume reduction rate is cal-

culable from the detected temperature or the target temperature.

[0032] A test operation for each type of superheated steam generator is carried out at a highest temperature until the conductor tube 2 breaks down. This is because fracture conditions differ depending on a curvature of the conductor tube 2, the flow rate of the superheated steam, and the amount of superheated steam generation.

[0033] A fracture test was conducted by using a model having, for example, an amount of superheated steam generation of 60 kg/h and a capacity for generating superheated steam at 1200°C, and by using a conductor tube composed of INCONEL (with an outer diameter of ϕ 33.4 mm, an inner diameter of ϕ 26.64 mm, and a tube thickness t of 3.38 mm). A remaining wall thickness of a fractured highest-temperature part was 0.45 mm. Volume reduction rate characteristics after 1000 hours are presented in FIG. 3, and a reduction rate is given by equation "y."

[0034] When operated for 1000 hours at the superheated steam temperature of 1200°C, a tube thickness t is 1.4872 mm (a reduction rate $y_{1200}=0.56$), resulting in a reduction of 1.8928 mm.

[0035] When a usable limit is set to 0.5 mm, a tube thickness reduction value is $3.38-0.5=2.88$ mm. Reach time T is as follows: $T=2.88/(1.8928/1000)\approx 1521$ hours.

[0036] When set to a reduction rate y_0 for an operating time h_0 at an operating temperature θ , a converted operating time h_{1200} at 1200°C is $h_{1200}=y_0 \times h_0 / y_{1200}$.

[0037] In cases where the operating time at each temperatures is, for example, 500 hours at 1200°C, 500 hours at 1100°C, and 500 hours at 1000°C, the converted operating time at 1200°C is as follows.

[0038] Converted operating time $h_{1200}=500+(0.33/0.56) \times 500+(0.05/0.56) \times 500 \approx 840$ hours

[0039] The maintenance information, such as an alarm sound, indicating a replacement timing for the conductor tube 2 is transmitted when the above converted operating time reaches a predetermined integration threshold value.

[0040] The transmission of the maintenance information includes, for example, displaying a warning on a display, outputting the alarm sound from a speaker, and turning on or flashing a lamp, such as a light emitting diode (LED). Alternatively, the predetermined integration threshold value may be set in multiple stages, and the maintenance information may be transmitted stepwise according to the converted operating time. Furthermore, the time remaining until reaching the volume reduction limit time may be displayed on the display.

[0041] With the superheated steam generator 100 so configured, the maintenance information is transmitted by employing, as a parameter, the operating time at the operating temperature. It is therefore possible to inform a user of the maintenance timing for the superheated steam generator 100. This makes it possible for the user to carry out maintenance before, for example, the con-

ductor tube 2 of the superheated steam generator 100 breaks down.

[0042] The present invention is not limited to the above embodiment.

[0043] For example, as a value calculated in order that the informing section 8 transmits the maintenance information, an integration value of a product of the operating time at the operating temperature multiplied by the volume reduction rate at the operating temperature may be used instead of the converted operating time in the above embodiment.

[0044] Alternatively, the informing section 8 may transmit the maintenance information by taking into consideration only an operating temperature at which the volume reduction substantially becomes a problem. Specifically, the informing section 8 transmits the maintenance information by employing, as a parameter, the operating temperature at which a volume reduction rate of the conductor tube 2 reaches or exceeds a predetermined value (for example, 5%) by operating for a predetermined period of time. For example, the informing section 8 integrates the operating time at or above an operating temperature (1000°C for INCONEL) at which the volume reduction rate of the conductor tube 2 reaches, for example, 5% by operating, for example, for 1000 hours. The informing section 8 transmits maintenance information, for example, when an obtained integration value exceeds a predetermined integration threshold value.

[0045] The informing section 8 may specify a temperature range used for the maintenance information in the operating temperatures of the superheated steam generator 10, and may utilize the operating time at the operating temperatures included in the temperature range, as the operating time at a highest temperature in the temperature range. For example, temperature ranges used for the maintenance information may be specified as 900-1000°C, 1000-1100°C, and 1100-1200°C. The informing section 8 utilizes the operating time in the range of 900-1000°C as the operating time at 1000°C, and accumulates as the operating time at 1000°C. Similarly, the informing section 8 utilizes the operating time in the range of 1000-1100°C as the operating time at 1100°C, and the operating time in the range of 1100-1200°C as operating time at 1200°C.

[0046] The temperature controller 7 may cause the superheated steam generation section 10 to stop operation by acquiring a signal indicating that the informing section 8 has transmitted the maintenance information. The temperature controller 7 and the informing section 8 may be configured with an identical computer.

[0047] Although the above embodiment is configured to transmit the maintenance information indicating the replacement timing for the conductor tube 2, the above embodiment may be configured to transmit the maintenance information indicating the replacement timing for external piping coupled to the outlet port P2 of the conductor tube 2.

[0048] The informing section may employ, as a param-

eter used for the maintenance information, the flow rate of superheated steam flowing through the conductor tube 2, and the amount of superheated steam generation. For example, the informing section may correct an integration value on the basis of the amount of superheated steam in the superheated steam generation section. The informing section transmits the maintenance information when a corrected integration value exceeds an integration threshold value. When the amount of superheated steam generation is employed as a parameter, the informing section may be configured to increase or decrease the operating time by using an amount of adjustment obtained through a steam adjustment mechanism or a measurement value obtained through a measuring section for measuring the amount of superheated steam generation. When the amount of generation is greater than a predetermined amount of superheated steam generation, it is conceivable to increase the operating time accordingly. When the amount of generation is smaller than the predetermined amount of superheated steam generation, it is conceivable to decrease the operating time accordingly. Here, the informing section corrects the operating time (an integration value) by using a relationship between the volume reduction rate and flow rate at each temperature (a volume reduction rate is proportional to 0.8 times a flow rate at 1200°C).

[0049] Alternatively, the informing section may be configured to transmit the maintenance information by employing a wall thickness of the conductor tube 2 as a parameter.

[0050] The superheated steam generation section 10 may be of the electrically heating type instead of the induction heating type. In this case, the conductor tube 2 is subjected to Joule heating by coupling an AC power source or a direct current (DC) power source to both end portions of the conductor tube 2 that permits passage of fluid, and by passing an AC current or a DC current through the conductor tube 2.

[0051] Alternatively, a superheated steam generator may be one which is obtained by combining the induction heating type and the electrically heating type as illustrated in FIG. 4. Specifically, the superheated steam generation section 10 includes a first superheated steam generation section 10A of the induction heating type configured to carry out induction heating by using, as a secondary coil, a conductor tube that permits passage of steam, and a second superheated steam generation section 10B of the electrically heating type configured to further heat the superheated steam by electrically heating the conductor tube that permits passage of the superheated steam generated by the first superheated steam generation section 10A.

[0052] The first superheated steam generation section 10A has the same configuration as that in the above embodiment. The first superheated steam generation section 10A is configured to generate superheated steam at less than 1000°C. The second superheated steam generation section 10B includes a conductor tube 11 coupled

directly or through an intermediate pipe to the outlet port P2 of the conductor tube 2 in the first superheated steam generation section 10A. The conductor tube 11 is provided with a plurality of nozzles 11a for spraying superheated steam. Power supply terminals 12 and 13 are respectively disposed at both end portions of the conductor tube 11, and an AC power source 17 is coupled to these power supply terminals. A current flows through the conductor tube 11 by the AC power source, and therefore the conductor tube is subjected to Joule heating, so that the superheated steam passing therethrough can be heated.

[0053] With the above superheated steam generator 100, an AC voltage applied to the induction coil 32 is controllable by detecting through a temperature detector 14 a temperature of superheated steam discharged from the conductor tube 11, and by inputting a control signal according to a deviation between a detected temperature and a target temperature to a voltage controller 15 (for example, a thyristor). Specifically, the temperature controller 16 configured to perform the above control performs the feedback control of the temperature of the superheated steam heated through the conductor tube 11 so that a deviation from the target temperature is less than $\pm 1^\circ\text{C}$. The temperature controller 16 is a computer including, for example, a processor such as a CPU, memory, and an input/output interface.

[0054] The informing section 8 is disposed on a side of the second superheated steam generation section 10B. Detected temperature data indicating detected temperatures obtained through the temperature detector 14 or target temperature data indicating a target temperature controlled by the temperature controller 16 are used as operating temperature data. The informing section 8 also acquires the operating time data indicating the operating time from a timer included in the informing section 8 or a timer of the temperature controller 16. The informing section 8 then converts this data to the operating time at 1200°C and integrates the converted values. When an integration value exceeds a predetermined integration threshold value, the informing section 8 transmits the maintenance information, such as the warning indicating the replacement timing for the conductor tube 11. Functions of the informing section 8 other than the above are the same as those in the foregoing embodiment. In addition to the configuration illustrated in FIG. 4, the informing section 8 may also be disposed on a side of the first superheated steam generation section 10A so as to transmit the maintenance information indicating the replacement timing for the conductor tube 2 in the same manner as in the foregoing embodiment.

[0055] It will be understood that the present invention is not limited to the above-described embodiments, and various modifications may be made without departing from the scope of the present invention.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0056]

- 100 superheated steam generator
 10 superheated steam generation section
 2 conductor tube
 8 informing section

Claims

1. A superheated steam generator, comprising:

an induction heating type or electrically heating type superheated steam generation section configured to generate superheated steam by heating steam; and
 an informing section configured to transmit maintenance information by employing, as a parameter, an operating temperature of the superheated steam generation section and an operating time at the operating temperature.

2. The superheated steam generator according to claim 1, wherein

the informing section acquires operating temperature data indicating the operating temperature of the superheated steam generation section, and operating time data indicating the operating time at the operating temperature,
 the informing section converts the operating time to an operating time at a predetermined temperature and integrates converted values, and
 the informing section transmits the maintenance information when an integration value exceeds a predetermined integration threshold value.

3. The superheated steam generator according to claim 1 or 2, wherein the informing section corrects the integration value on a basis of an amount of superheated steam generation in the superheated steam generation section, and the informing section transmits the maintenance information when a corrected integration value exceeds the integration threshold value.

4. The superheated steam generator according to any one of claims 1 - 3, wherein the informing section is configured to convert to an operating time at 1200°C and integrate the converted values.

5. The superheated steam generator according to any one of claims 1 - 4, wherein
 the superheated steam generation section comprises a conductor tube that permits passage of the superheated steam, and
 the informing section is configured to transmit the

maintenance information indicating a replacement timing for the conductor tube.

6. The superheated steam generator according to any one of claims 1 - 5, wherein the informing section is configured to transmit the maintenance information by employing, as a parameter, an operating time at an operating temperature at which a volume reduction rate of the conductor tube reaches or exceeds a predetermined value by operating for a predetermined period of time.

7. The superheated steam generator according to any one of claims 1 - 6, wherein the informing section specifies a temperature range used for the maintenance information at the operating temperatures of the superheated steam generation section, and utilizes the operating time at the operating temperatures included in the temperature range, as the operating time at a highest temperature in the temperature range.

8. The superheated steam generator according to any one of claims 1 - 7, wherein the superheated steam generation section comprises:

a first superheated steam generation section of the induction heating type configured to carry out induction heating by using, as a secondary coil, a first conductor tube that permits passage of steam, and
 a second superheated steam generation section of the electrically heating type configured to further heat superheated steam generated in the first superheated steam generation section by electrically heating a second conductor tube that permits passage of the superheated steam.

9. The superheated steam generator according to any one of claims 1 - 8, wherein the informing section is configured to transmit the maintenance information indicating a replacement timing for the second conductor tube.

10. The superheated steam generator according to claim 8, wherein
 the first superheated steam generation section generates superheated steam at less than 1000°C, and
 the second superheated steam generation section generates superheated steam at 1000°C or above.

11. A maintenance method for a superheated steam generator of an induction heating type or an electrically heating type configured to generate superheated steam by heating steam, the maintenance method comprising:

transmitting maintenance information by em-

ploying, as a parameter, an operating temperature of the superheated steam generation section and an operating time at the operating temperature.

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- 12.** The maintenance method according to claim 11, wherein the superheated steam generator is implemented according to any one of claims 1 - 10.

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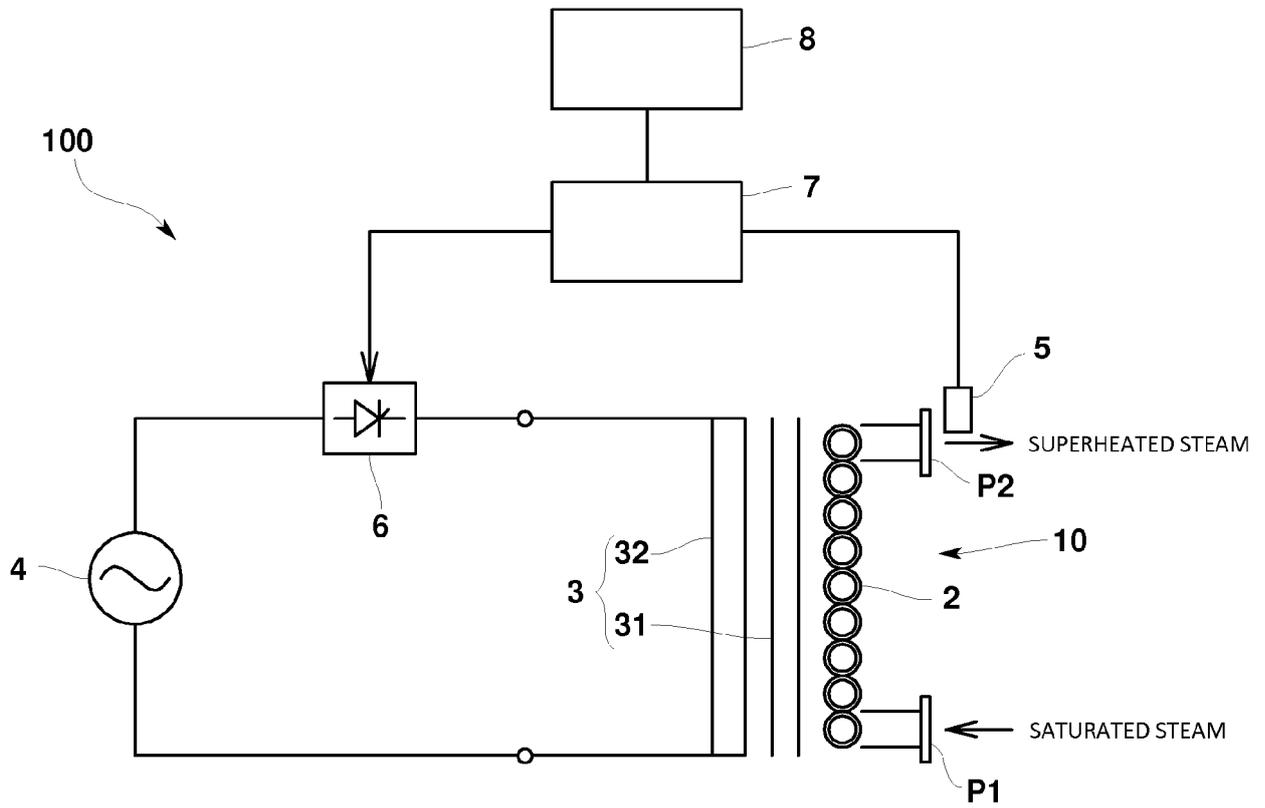


FIG. 1

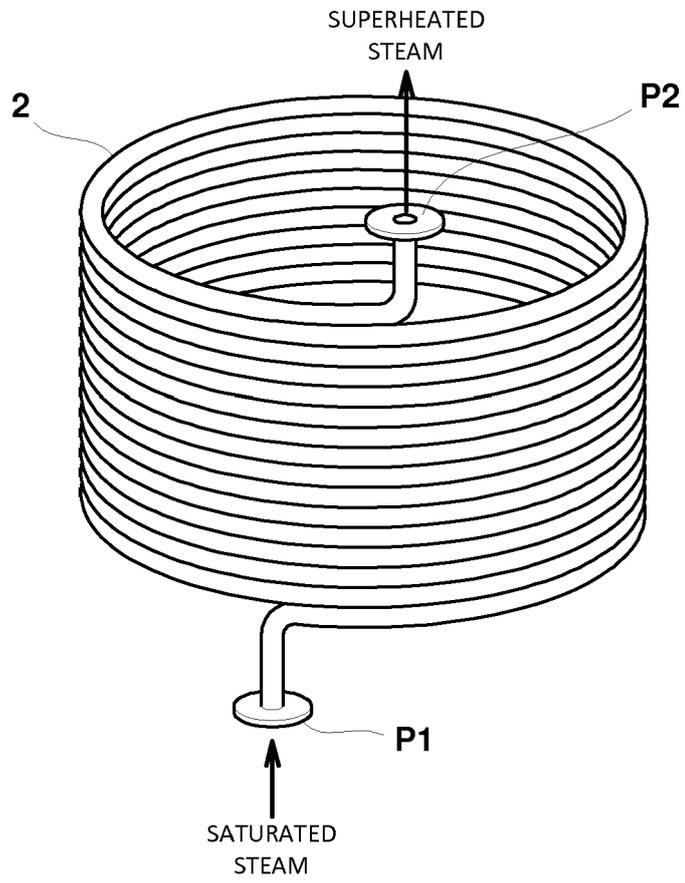


FIG. 2

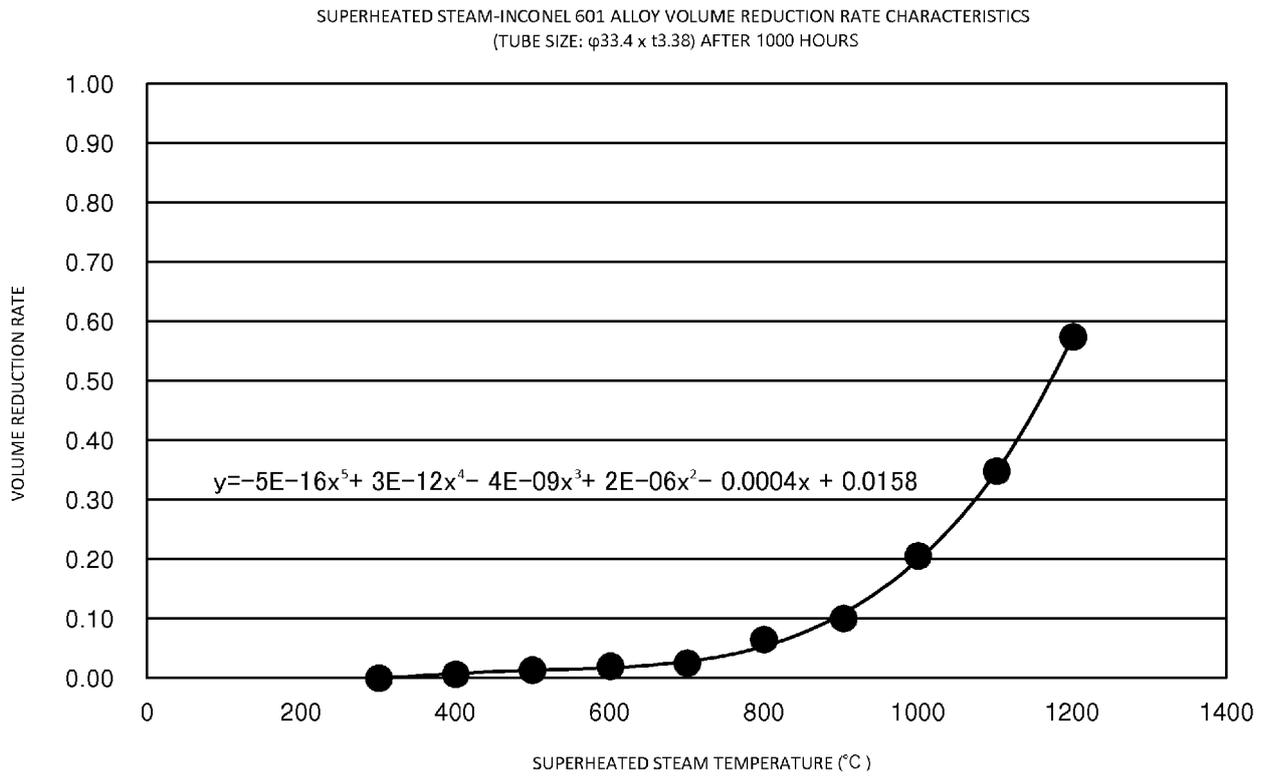


FIG. 3

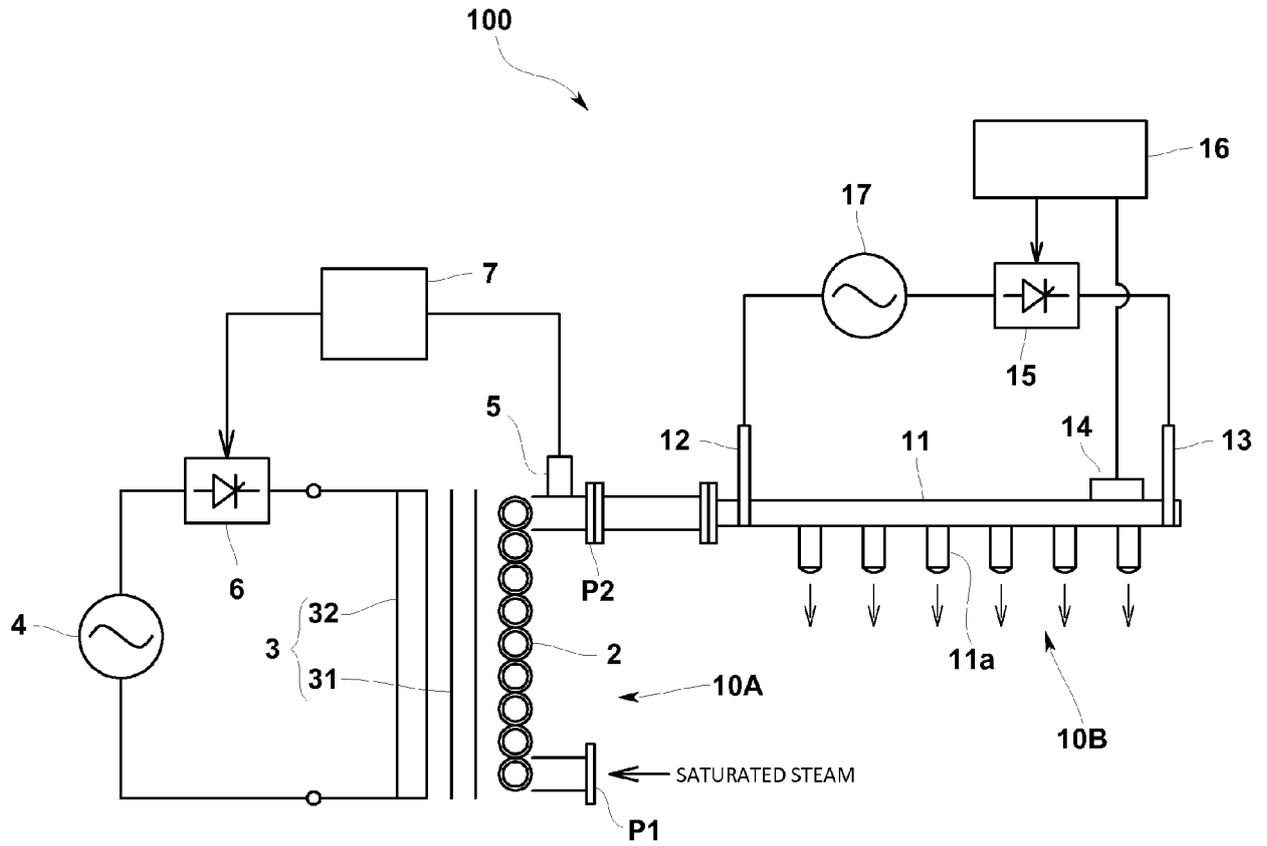


FIG. 4



EUROPEAN SEARCH REPORT

Application Number
EP 18 21 4119

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 April 2019	Examiner Varelas, Dimitrios
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.02 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 18 21 4119

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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