



(12) **EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**03.02.2016 Bulletin 2016/05**

(51) Int Cl.:  
**F22B 1/18** (2006.01) **F01K 9/00** (2006.01)  
**F28B 1/02** (2006.01) **F28B 3/04** (2006.01)

(21) Application number: **14773797.7**

(86) International application number:  
**PCT/JP2014/056718**

(22) Date of filing: **13.03.2014**

(87) International publication number:  
**WO 2014/156686 (02.10.2014 Gazette 2014/40)**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

(71) Applicant: **Mitsubishi Hitachi Power Systems, Ltd.**  
**Yokohama 220-8401 (JP)**

(72) Inventor: **HOTTA Katsuhiro**  
**Tokyo 108-8215 (JP)**

(30) Priority: **27.03.2013 JP 2013065403**

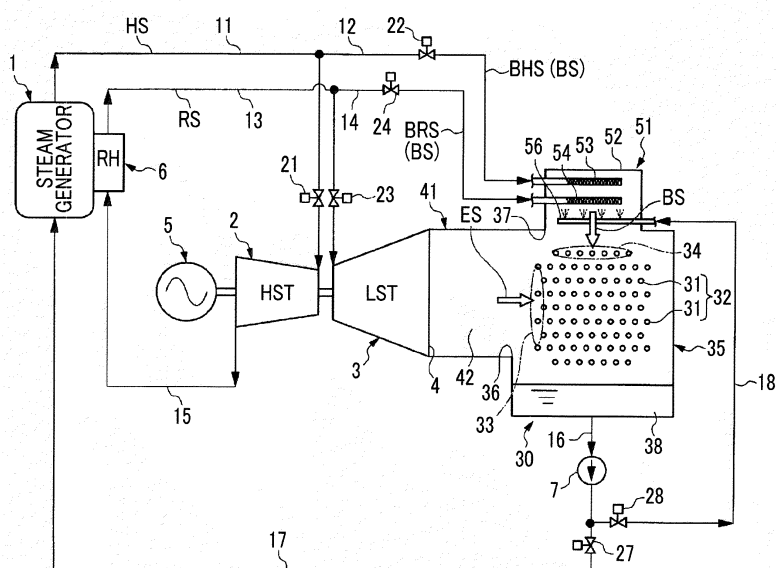
(74) Representative: **Hoffmann Eitle**  
**Patent- und Rechtsanwälte PartmbB**  
**Arabellastraße 30**  
**81925 München (DE)**

(54) **CONDENSER AND STEAM-TURBINE PLANT PROVIDED THEREWITH**

(57) This condenser (30) is provided with the following: a set of heat-transfer tubes (32); a main body (35) that covers the heat-transfer tubes; an intermediate body (41) that forms a primary steam passage (42) for guiding exhaust steam (ES) from a steam turbine (3) to the set of heat-transfer tubes in the main body; and a bypass steam receiving section (51) that receives bypass steam (BS), i.e. steam that has bypassed the steam turbine, and guides the bypass steam to the set of heat-transfer

tubes in the main body. The bypass steam receiving section (51) is located outside the primary steam passage (42), and an opening in the main body (35) that is opposite to the bypass steam receiving section (51) is formed at a position where the bypass steam (BS) flows into the set of heat-transfer tubes (32) mainly from a region (34) different from an inflow region (33) through which the exhaust steam (ES) mainly flows into the set of heat-transfer tubes via the primary steam passage.

FIG. 1



## Description

## Citation List

## Technical Field

## Patent Literature

**[0001]** The present invention relates to a condenser which condenses exhaust steam which is steam exhausted from a steam turbine and turns the exhaust steam back into water, and a steam turbine plant provided therewith. Priority is claimed on Japanese Patent Application No. 2013-065403, filed on March 27, 2013, the content of which is incorporated herein by reference.

5 **[0006]**

[PTL 1] Japanese Unexamined Patent Application Publication No. 2003-148111

[PTL 2] Japanese Unexamined Patent Application Publication No. 9-273875

[PTL 3] Japanese Unexamined Patent Application Publication No. 7-167571

## Background Art

## Summary of invention

**[0002]** Some steam turbine plants include a bypass steam line which guides steam bypassing a steam turbine to a condenser. Since the bypass steam which is the steam guided into the condenser from the bypass steam line has not operated the steam turbine, the bypass steam has a higher pressure and a higher temperature than exhaust steam which has operated the steam turbine.

15

## Technical Problem

**[0003]** As the above-described steam turbine plant, for example, there is a steam turbine plant disclosed in PTL 1 below. The steam turbine of this steam turbine plant is an axial exhaust type steam turbine which exhausts the steam in an axial direction in which a turbine rotor extends. A condenser is disposed in the position in the axial direction with respect to the steam turbine, that is, in the exhaust direction of the steam. A bypass steam line, through which bypass steam bypassing the steam turbine passes, is connected to the condenser.

20

**[0007]** In the steam turbine plant disclosed in PTL 1, since it is necessary to diffuse energy of the bypass steam having a higher temperature and a higher pressure than the exhaust steam to some extent, an end portion of the bypass steam line is connected into the intermediate body of the condenser. In this structure, to allow the bypass steam of which the energy has been diffused to some extent to flow into the main body, the length of the intermediate body is lengthened, so that it is not possible to effectively use an installation space of the steam turbine plant. Moreover, in this structure, there is a concern that the bypass steam which flows into the intermediate body and has a high temperature and a high pressure may reversely flow toward the steam turbine side and damage the turbine rotor, a bearing or a shaft seal thereof, or the like. In addition, since not only the exhaust steam from the steam turbine but also the bypass steam from the bypass steam line flows into the set of heat-transfer tubes in the main body via the intermediate body, there is another concern that a region opposing the intermediate body in the set of heat-transfer tubes may be significantly damaged compared with other portions.

25

30

35

**[0004]** In addition, for example, as the condenser of the axial exhaust type steam turbine, there is a condenser disclosed in PTL 2 below. The condenser includes a set of heat-transfer tubes configured of a plurality of heat-transfer tubes through the inner portions of which sea water or the like passes, a main body which covers the set of heat-transfer tubes, and an intermediate body which connects the steam turbine and the main body and guides the steam from the steam turbine to the set of heat-transfer tubes in the main body. The main body is disposed at a position in the axial direction with respect to the steam turbine, and the intermediate body is connected to the side portion of the main body.

40

**[0008]** Moreover, in the steam turbine plant of PTL 3, as described above, the steam receiving box is disposed below the communication body through which the upper portions of the bodies of the two condensers are connected with each other, and the bypass steam flows into the steam receiving box. Accordingly, in the steam turbine plant disclosed in PTL 3, it is not necessary to lengthen the length of the intermediate body among the bodies of the condenser which guides the exhaust steam from the steam turbine into the main body covering the set of heat-transfer tubes, as well as the possibility that the bypass steam having a high temperature and a high pressure reversely flows toward the steam turbine side is small. Also in this steam turbine plant, it is considered that the communication body is connected to the intermediate body of each condenser. Accordingly, not only the exhaust steam from the steam turbine but also the bypass steam from the bypass steam line flows into the set of heat-transfer tubes in the main body via the inter-

45

50

55

**[0005]** In addition, a steam turbine plant disclosed in PTL 3 includes two steam turbines. The two steam turbines are both downward exhaust type steam turbines which exhaust steam downward. A condenser is disposed at a position below each steam turbine. The bodies of the two condensers are connected to each other by a communication body on the upper portion. A steam receiving box is disposed below the communication body. A bypass steam line through which steam bypassing the steam turbine passes is connected to the steam receiving box. The steam flowing into the steam receiving box from the bypass steam line flows into the bodies of the two condensers via the communication body.

mediate body, and it is presumed that the region opposing the intermediate body in the set of heat-transfer tubes is significantly damaged compared with other portions.

**[0009]** That is, not only in the steam turbine plant disclosed in PTL 1 but also in the steam turbine plant disclosed in PTL 3, there are problems in that the set of heat-transfer tubes of the condenser are locally damaged.

**[0010]** Accordingly, an object of the present invention is to provide a condenser capable of preventing local damage of the set of heat-transfer tubes, and a steam turbine plant provided therewith.

#### Solution to Problem

**[0011]** In order to solve the above problem, according to an aspect of the present invention, there is provided a condenser including: a set of heat-transfer tubes which is configured of a plurality of heat-transfer tubes through the inner portions of which a medium which performs heat-exchange with exhaust steam exhausted from a steam turbine passes and which turns the exhaust steam back into water; a main body which covers the set of heat-transfer tubes; an intermediate body which is positioned between the steam turbine and the main body and connects both, and forms a primary steam passage for guiding the exhaust steam from the steam turbine to the set of heat-transfer tubes in the main body; and a bypass steam receiving section which receives bypass steam which has bypassed the steam turbine, and guides the bypass steam to the set of heat-transfer tubes in the main body via an opening formed in the main body, wherein the bypass steam receiving section is disposed outside the primary steam passage, and the opening of the main body is formed at a position at which the bypass steam mainly flows into the set of heat-transfer tubes from a region different from an inflow region through which the exhaust steam mainly flows into the set of heat-transfer tubes via the primary steam passage.

**[0012]** In the above, "mainly flows into" means that the most steam flows into the set of heat-transfer tubes from the region in the set of heat-transfer tubes.

**[0013]** In the condenser, the bypass steam flows into the set of heat-transfer tubes mainly from the region different from the inflow region through which the exhaust steam mainly flows into the set of heat-transfer tubes. Accordingly, in the condenser, since the region through which the steam flows into the set of heat-transfer tubes is distributed, it is possible to prevent local damage of the set of heat-transfer tubes.

**[0014]** Moreover, in the condenser, since the bypass steam receiving section is provided outside the primary steam passage, compared with a case where the bypass steam is guided to the intermediate body of the condenser, it is possible to decrease the length of the intermediate body, and to effectively use an installation space of the steam turbine plant. In addition, in the condenser, since the bypass steam does not directly flow into the primary

steam passage, the possibility that the bypass steam reversely flows toward the steam turbine side is extremely low, and it is possible to prevent damage of a turbine rotor of the steam turbine, a bearing or a shaft seal thereof, or the like. Moreover, in the condenser, since a steam injector or a water injector for injecting the bypass steam is not disposed in the intermediate body, it is possible to decrease resistance to the exhaust steam passing through the intermediate body.

**[0015]** The condenser may further include a flow suppression member which suppresses the flow of the bypass steam received by the bypass steam receiving section toward the set of heat-transfer tubes.

**[0016]** In the condenser, since it is possible to suppress the flow of the bypass steam toward the set of heat-transfer tubes, it is possible to further prevent damage of the set of heat-transfer tubes.

**[0017]** Any one of the above condensers may further include a water injection section which injects water into the bypass steam receiving section.

**[0018]** In the condenser, since it is possible to cool the bypass steam in the bypass steam receiving section, it is possible to prevent damage of the set of heat-transfer tubes.

**[0019]** In any one of the above condensers, the steam turbine may be a horizontal exhaust type which exhausts steam in an axial direction in which a rotor of the steam turbine extends, or to a side of the steam turbine; the intermediate body may be connected to a side portion of the main body; and the bypass steam receiving section may be provided on one of an upper portion of the main body, and a side portion of the main body which is opposite to a portion to which the intermediate body is connected based on the set of heat-transfer tubes.

**[0020]** In any one of the above condensers except for the condenser for the horizontal exhaust type steam turbine, the steam turbine may be a downward exhaust type which exhausts steam to a lower side of the steam turbine; the intermediate body may be connected to an upper portion of the main body, and the bypass steam receiving section may be provided at a position opposite to the set of heat-transfer tubes in a horizontal direction in a side portion of the main body.

**[0021]** In order to solve the above problem, according to another aspect of the present invention, there is provided a steam turbine plant including any one of the above condensers, the steam turbine, a steam supply device which supplies steam to the steam turbine, and a bypass steam line which guides the steam from the steam supply device, as the bypass steam, to the bypass steam receiving section so that the steam bypasses the steam turbine.

**[0022]** In order to solve the above problem, according to still another aspect of the present invention, there is provided a steam turbine plant including the condenser which includes the water injection section, the steam turbine, a steam supply device which supplies steam to the steam turbine, a feed water pump which returns water

obtained by condensation of the exhaust steam in the condenser to the steam supply device, a bypass steam line which guides the steam from the steam supply device, as the bypass steam, to the bypass steam receiving section so that the steam bypasses the steam turbine, and a water injection line which guides the water pressurized by the feed water pump to the water injection section.

**[0023]** Since the steam turbine plant also includes any one of the above-described condensers, it is possible to prevent local damage of the set of heat-transfer tubes. Advantageous Effects of Invention

**[0024]** According to an aspect of the present invention, since a region through which steam flows into a set of heat-transfer tubes is distributed, it is possible to prevent local damage of the set of heat-transfer tubes.

#### Brief Description of Drawings

#### **[0025]**

Fig. 1 is a system diagram of a steam turbine plant in a first embodiment according to the present invention.

Fig. 2 is a system diagram of a steam turbine plant in a second embodiment according to the present invention.

Fig. 3 is a system diagram of a steam turbine plant in a third embodiment according to the present invention.

Fig. 4 is a schematic sectional view of a condenser in a first modification example according to the present invention.

Fig. 5 is a schematic sectional view of a condenser in a second modification example according to the present invention.

Fig. 6 is a schematic sectional view of a condenser in a third modification example according to the present invention.

#### Description of Embodiments

**[0026]** Hereinafter, various embodiments and various modification examples of a steam turbine plant according to the present invention will be described with reference to the drawings.

#### First Embodiment

**[0027]** With reference to Fig. 1, a first embodiment of a steam turbine plant according to the present invention will be described.

**[0028]** The steam turbine plant of the present embodiment includes a steam generator (steam supply device) 1 such as a boiler, a high-pressure steam turbine 2 and a low-pressure steam turbine 3 which are driven through steam generated by the steam generator 1, a generator 5 which generates electricity by driving of each of the

steam turbines 2 and 3, a reheater (steam supply device) 6 which reheats the steam exhausted from the high-pressure steam turbine 2, a condenser 30 which condenses exhaust steam ES which is the steam exhausted from the low-pressure steam turbine 3 and turns the exhaust steam ES back into water, and a feed water pump 7 which returns the water in the condenser 30 to the steam generator 1.

**[0029]** Moreover, the steam turbine plant includes a high-pressure steam line 11 which guides high-pressure steam HS which is steam generated by the steam generator 1 to the high-pressure steam turbine 2, an exhaust high-pressure steam line 15 which guides steam exhausted from the high-pressure steam turbine 2 to the reheater 6, a reheat steam line 13 which guides reheat steam RS which is steam heated by the reheater 6 to the low-pressure steam turbine 3, a bypass high-pressure steam line 12 which is branched from the high-pressure steam line 11 and guides the high-pressure steam HS to the condenser 30, a bypass reheat steam line 14 which is branched from the reheat steam line 13 and guides the reheat steam RS to the condenser 30, a condensate line 16 which guides the water in the condenser 30 to the feed water pump 7, a feed water line 17 which guides the water from the feed water pump 7 to the steam generator 1, and an injection water line 18 which is branched from the feed water line 17 and guides the water to the condenser 30.

**[0030]** A high-pressure steam control valve 21, which controls a flow rate of the high-pressure steam HS flowing into the high-pressure steam turbine 2, is provided in the high-pressure steam line 11. A reheat steam control valve 23, which controls a flow rate of the reheat steam RS flowing into the low-pressure steam turbine 3, is provided in the reheat steam line 13. An on-off valve 22 is provided in the bypass high-pressure steam line 12. In addition, an on-off valve 24 is also provided in the bypass reheat steam line 14. In the feed water line 17, a feed water control valve 27, which controls a flow rate of the water flowing into the steam generator 1, is provided at a position closer to the steam generator 1 side than the position at which the injection water line 18 is branched. An injection water control valve 28 which controls a flow rate of the water injected into the condenser 30 is provided in the injection water line 18.

**[0031]** Each of the high-pressure steam turbine 2 and the low-pressure steam turbine 3 includes a turbine rotor which rotates about an axis line, and a casing which rotatably covers the turbine rotor. The turbine rotor of the high-pressure steam turbine 2 and the turbine rotor of the low-pressure steam turbine 3 rotate about the same axis line, and the turbine rotors are connected to each other. In addition, a generator rotor of the generator 5 is connected to the turbine rotor of the high-pressure steam turbine 2.

**[0032]** The low-pressure steam turbine 3 is an axial exhaust type steam turbine which exhausts steam in the axial direction in which the turbine rotor extends. Accord-

ingly, in the casing of the low-pressure steam turbine 3, the rear side opposite to the high-pressure steam turbine 2 in the axial direction is open as an exhaust port 4.

[0033] The condenser 30 is of a type corresponding to the axial exhaust type steam turbine, and is disposed on the rear side of the low-pressure steam turbine 3. The condenser 30 includes a set of heat-transfer tubes 32 which is configured of a plurality of heat-transfer tubes 31, a main body 35 which covers the set of heat-transfer tubes 32, an intermediate body 41 which is positioned between the low-pressure steam turbine 3 and the main body 35 and connects both, a bypass steam receiving section 51 which receives bypass high-pressure steam BHS which is the steam from the bypass high-pressure steam line 12 and bypass reheat steam BRS which is the steam from the bypass reheat steam line 14, and a water injector (water injection section) 56 which injects the water from the injection water line 18 into the condenser 30. In addition, hereinafter, one or both of the bypass high-pressure steam BHS and the bypass reheat steam BRS may be simply referred to as bypass steam BS.

[0034] The main body 35 is disposed at an interval on the rear side of the low-pressure steam turbine 3. The intermediate body 41 extends rearward from the exhaust port 4 of the low-pressure steam turbine 3 and connects the exhaust port 4 of the low-pressure steam turbine 3 and the main body 35. The portion of the main body 35 to which the intermediate body 41 is connected is a side portion of the main body 35 and is on a low-pressure steam turbine 3 side. A portion of the main body 35 which is connected to the intermediate body 41 is open. The exhaust steam ES, which is the steam exhausted from the low-pressure steam turbine 3, flows into the main body 35 from the opening (hereinafter, referred to as an exhaust steam inlet 36) via the intermediate body 41. Accordingly, the intermediate body 41 forms a portion of a primary steam passage 42 which guides the exhaust steam ES from the low-pressure steam turbine 3 to the set of heat-transfer tubes 32 in the main body 35. In addition, the primary steam passage 42 is configured of the internal space of the intermediate body 41, and a space between the exhaust steam inlet 36 of the main body 35 and the set of heat-transfer tubes 32 in the main body 35. For example, a cooling medium such as sea water flows to the plurality of heat-transfer tubes 31 configuring the set of heat-transfer tubes 32. In each heat-transfer tube 31, heat exchange is performed between the cooling medium flowing through the inner portion of the tube and the exhaust steam ES of the outer portion of the tube, and the exhaust steam ES is condensed and turned back into water. A hot well 38 in which the water obtained by the condensation of the exhaust steam ES is accumulated is formed at the lower portion of the inner portion of the main body 35. The condensate line 16 is connected to the lower portion of the main body 35.

[0035] The bypass steam receiving section 51 includes a bypass steam receiving box 52 in which a space for

receiving the bypass steam BS is formed in the inner portion, a high-pressure steam injector 53 which is connected to the bypass high-pressure steam line 12 and injects the bypass high-pressure steam BHS inside the bypass steam receiving box 52, and a reheat steam injector 54 which is connected to the bypass reheat steam line 14 and injects the bypass reheat steam BRS inside the bypass steam receiving box 52.

[0036] The bypass steam receiving box 52 is connected and fixed to the upper portion of the main body 35. A connection portion between the bypass steam receiving box 52 and the main body 35 is open, and from this opening (hereinafter, referred to as a bypass steam inlet 37) the bypass steam BS, which is injected into the bypass steam receiving box 52, flows into the main body 35. The high-pressure steam injector 53 and the reheat steam injector 54 are both porous tubes in which a large number of through-holes are formed in the tube. In addition, in the bypass steam receiving box 52, a water injector 56 is disposed at a position below the high-pressure steam injector 53 and the reheat steam injector 54, that is, a position on the set of heat-transfer tubes 32 side. The water injector 56 is a tube provided with a plurality of nozzles injecting water. The plurality of nozzles are provided in an upper part of the tube, and inject the water upward, that is, toward the side of the high-pressure steam injector 53 and the reheat steam injector 54.

[0037] Next, an operation of the above-described steam turbine plant will be described.

[0038] The steam generated by the steam generator 1 flows into the casing of the high-pressure steam turbine 2 via the high-pressure steam line 11 as the high-pressure steam HS, and drives the high-pressure steam turbine 2. Meanwhile, the high-pressure steam control valve 21 controls the flow rate of the high-pressure steam HS flowing into the casing of the high-pressure steam turbine 2. The on-off valve 22 provided in the bypass high-pressure steam line 12 is fully closed. The high-pressure steam HS exhausted from the high-pressure steam turbine 2 flows into the reheater 6 via the exhaust high-pressure steam line 15, and is reheated. The steam heated by the reheater 6 flows into the casing of the low-pressure steam turbine 3 via the reheat steam line 13 as the reheat steam RS, and drives the low-pressure steam turbine 3. Meanwhile, the reheat steam control valve 23 controls the flow rate of the reheat steam RS which flows into the casing of the low-pressure steam turbine 3. In addition, the on-off valve 24 provided in the bypass reheat steam line 14 is fully closed.

[0039] When the high-pressure steam turbine 2 and the low-pressure steam turbine 3 are driven, the generator 5 generates electricity.

[0040] The reheat steam RS which has driven the low-pressure steam turbine 3 is exhausted from the exhaust port 4 of the low-pressure steam turbine 3 as the exhaust steam ES, and flows into the set of heat-transfer tubes 32 in the main body 35 through the intermediate body 41 of the condenser 30. That is, the exhaust steam ES flows

into the set of heat-transfer tubes 32 through the primary steam passage 42 in the condenser 30 from the exhaust port 4 of the low-pressure steam turbine 3. In this case, the exhaust steam ES flows mainly from a region 33 of a side portion opposing the exhaust steam inlet 36 of the main body 35 in the set of heat-transfer tubes 32 into the set of heat-transfer tubes 32. In addition, here, "flows mainly" means that the most exhaust steam ES flows from the region 33 of the side portion opposing the exhaust steam inlet 36 of the main body 35 in the set of heat-transfer tubes 32 into the set of heat-transfer tubes 32.

**[0041]** The exhaust steam ES flowing into the set of heat-transfer tubes 32 or reaching the vicinity of the set of heat-transfer tubes 32 exchanges heat with the cooling medium flowing through the heat-transfer tubes 31 configuring the set of heat-transfer tubes 32, is condensed, and thus, becomes water. This water is accumulated in the hot well 38 positioned at the lower portion of the main body 35. The water accumulated in the hot well 38 returns to the steam generator 1 via the condensate line 16, the feed water pump 7, and the feed water line 17. Meanwhile, the feed water control valve 27 controls the flow rate of the water flowing into the steam generator 1. In addition, the injection water control valve 28 is fully closed.

**[0042]** During the above-described steady operation, for example, when the high-pressure steam turbine 2 and the low-pressure steam turbine 3 are stopped by an instruction of stop of a power supply from a power system connected to the generator 5, or the like, the high-pressure steam control valve 21 and the reheat steam control valve 23 are switched from an open state to a fully closed state. In addition, the on-off valves 22 and 24 provided in the bypass high-pressure steam line 12 and the bypass reheat steam line 14 are switched from a fully closed state to a fully open state. As a result, the high-pressure steam HS from the steam generator 1 is injected into the bypass steam receiving box 52 via the high-pressure steam line 11, the bypass high-pressure steam line 12, and the high-pressure steam injector 53 as the bypass high-pressure steam BHS. In addition, the reheat steam RS from the reheater 6 is injected into the bypass steam receiving box 52 via the reheat steam line 13, the bypass reheat steam line 14, and the reheat steam injector 54 as the bypass reheat steam BRS. Since the bypass high-pressure steam BHS injected into the bypass steam receiving box 52 has not operated the high-pressure steam turbine 2, the bypass high-pressure steam BHS has a higher temperature and a higher pressure than the high-pressure steam HS which has operated the high-pressure steam turbine 2. In addition, since the bypass reheat steam BRS injected into the bypass steam receiving box 52 has not operated the low-pressure steam turbine 3, the bypass reheat steam BRS has a higher temperature and a higher pressure than the reheat steam RS (exhaust steam ES) which has operated the low-pressure steam turbine 3. Accordingly, the bypass steam BS having a

higher temperature and a higher pressure than the exhaust steam ES flowing into the main body 35 via the intermediate body 41 flows into the bypass steam receiving box 52.

**[0043]** In this case, the injection water control valve 28 is opened, and a portion of the water from the feed water pump 7 is injected into the bypass steam receiving box 52 via the injection water line 18 and the water injector 56. The water injected into the bypass steam receiving box 52 exchanges heat with the bypass steam BS having a high temperature and a high pressure, and thus, the temperature of the bypass steam BS decreases. Moreover, the water injected into the bypass steam receiving box 52 functions as a curtain with respect to the bypass steam BS, and suppresses the flow of the bypass steam BS into the main body 35. Moreover, in this process, most water becomes steam.

**[0044]** The bypass steam BS and the water which becomes steam through the heat exchange with the bypass steam BS flow into the set of heat-transfer tubes 32. In this case, the bypass steam BS or the like flows into the set of heat-transfer tubes 32 mainly from a region 34 of the upper portion opposing the bypass steam inlet 37 of the main body 35 in the set of heat-transfer tubes 32. The bypass steam BS or the like flowing into the set of heat-transfer tubes 32 or reaching the vicinity of the set of heat-transfer tubes 32 exchanges heat with the cooling medium flowing through the heat-transfer tubes 31 configuring the set of heat-transfer tubes 32, is condensed, and becomes water. This water is accumulated in the hot well 38 positioned at the lower portion of the main body 35. A portion of the water accumulated in the hot well 38 returns to the steam generator 1 via the condensate line 16, the feed water pump 7, and the feed water line 17. In addition, the remaining water is injected into the bypass steam receiving box 52 via the injection water line 18 and the water injector 56.

**[0045]** Thus, in the present embodiment, the bypass steam BS flows into the set of heat-transfer tubes 32 mainly from the region 34 of the upper portion of the set of heat-transfer tubes 32 while the exhaust steam ES flows into the set of heat-transfer tubes 32 mainly from the region 33 opposing the exhaust steam inlet 36 of the main body 35 in the side portion of the set of heat-transfer tubes 32 via the primary steam passage 42. That is, in the present embodiment, the region 33 in the set of heat-transfer tubes 32 through which the exhaust steam ES flows into the set of heat-transfer tubes 32 is different from the region 34 in the set of heat-transfer tubes 32 through which the bypass steam BS flows into the set of heat-transfer tubes 32. Accordingly, in the present embodiment, it is possible to prevent local damage of the set of heat-transfer tubes 32.

**[0046]** When the bypass steam BS is guided to the intermediate body 41 of the condenser 30, since it is necessary to allow the bypass steam BS to flow into the main body 35 after energy of the bypass steam BS having a high temperature and a high pressure is diffused to some

extent, the length of the intermediate body 41 is lengthened. Moreover, in this case, there is a concern that the bypass steam BS, which flows into the intermediate body 41 and has a high temperature and a high pressure, may reversely flow toward the steam turbine side and damage the turbine rotor of the steam turbine, a bearing or a shaft seal thereof, or the like. In addition, in this case, since the steam injector for injecting the bypass steam BS or the water injector is disposed in the intermediate body 41, resistance to the exhaust steam ES passing through the intermediate body 41 increases.

**[0047]** However, in the present embodiment, since the bypass steam receiving section 51 is provided outside the primary steam passage 42, compared with the case where the bypass steam BS is guided to the intermediate body 41 of the condenser 30, it is possible to shorten the length of the intermediate body 41, and to effectively use an installation space of the steam turbine plant. In addition, in the present embodiment, since the bypass steam BS does not directly flow into the primary steam passage 42 in the intermediate body 41, the possibility that the bypass steam BS reversely flows toward the steam turbine side is extremely low, and it is possible to prevent damage of the turbine rotor of the steam turbine, the bearing or the shaft seal thereof, or the like. Moreover, in the present embodiment, since the steam injector which injects the bypass steam BS or the water injector is not disposed in the intermediate body 41, it is possible to decrease the resistance to the exhaust steam ES passing through the intermediate body 41.

## Second Embodiment

**[0048]** With reference to Fig. 2, a second embodiment of the steam turbine plant according to the present invention will be described.

**[0049]** The steam turbine plant of the present embodiment is substantially the same as the steam turbine plant of the first embodiment. However, the present embodiment is different from the first embodiment in that a bypass steam receiving section 51a of a condenser 30a is provided on a side portion of a main body 35a in the present embodiment.

**[0050]** Similarly to the bypass steam receiving section 51 of the first embodiment, the bypass steam receiving section 51a of the present embodiment also includes the bypass steam receiving box 52, the high-pressure steam injector 53, and the reheat steam injector 54. The bypass steam receiving box 52 is connected and fixed to a side opposite to the portion to which the intermediate body 41 is connected based on the set of heat-transfer tubes 32 in the side portion of the main body 35a. The connection portion between the bypass steam receiving box 52 and the main body 35a is open, and this opening forms a bypass steam inlet 37a through which the bypass steam BS from the bypass steam receiving box 52 flows into the main body 35a.

**[0051]** As described above, in the present embodi-

ment, the bypass steam BS flows into the set of heat-transfer tubes 32 mainly from a region 34a opposing the bypass steam inlet 37a opposite to the exhaust steam inlet 36 based on the set of heat-transfer tubes 32 while the exhaust steam ES flows into the set of heat-transfer tubes 32 mainly from the region 33 opposing the exhaust steam inlet 36 of the main body 35a in the side portion of the set of heat-transfer tubes 32 via the inner portion of the intermediate body 41. That is, similarly to the first embodiment, also in the present embodiment, the region 33 in the set of heat-transfer tubes 32 through which the exhaust steam ES flows into the set of heat-transfer tubes 32 is different from the region 34a in the set of heat-transfer tubes 32 through which the bypass steam BS flows into the set of heat-transfer tubes 32. In addition, similarly to the first embodiment, also in the present embodiment, the bypass steam receiving section 51a is provided outside the primary steam passage 42. Accordingly, also in the present embodiment, it is possible to obtain substantially the same effects as the first embodiment.

**[0052]** However, since the bypass steam receiving section 51a is provided on the side portion of the main body 35a in the present embodiment, compared to the first embodiment, the use efficiency of a planar installation space of the steam turbine plant is low in the present embodiment. On the other hand, in the present embodiment, since the bypass steam receiving section 51a is provided on the side opposite to the side to which the intermediate body 41 is connected based on the set of heat-transfer tubes 32, it is possible to further decrease the possibility of the bypass steam BS reversely flowing toward the steam turbine side than in the first embodiment.

**[0053]** In addition, in both the first embodiment and the second embodiment, the low-pressure steam turbine 3 is an axial exhaust type and the condensers 30 and 30a are types corresponding to the axial exhaust type. However, even when the low-pressure steam turbine is a side exhaust type and the condensers are types corresponding to the side exhaust type, similarly to the above-described embodiments, the present invention can be applied. In addition, when the steam turbine is the side exhaust type, the condenser is disposed on the side of the steam turbine.

## Third Embodiment

**[0054]** With reference to Fig. 3, a third embodiment of the steam turbine plant according to the present invention will be described.

**[0055]** Components of the steam turbine plant of the present embodiment are the same as the components of the steam turbine plants of the first and second embodiments. However, a low-pressure steam turbine 3b and a condenser 30b which are the components of the steam turbine plant of the present embodiment are different from the low-pressure steam turbines 3 and the condensers 30 and 30a of the steam turbine plants of

the first and second embodiments.

**[0056]** The low-pressure steam turbine 3b of the present embodiment is a downward exhaust type which exhausts steam downward. Accordingly, the lower side of the casing of the low-pressure steam turbine 3b of the present embodiment is open as an exhaust port 4b.

**[0057]** The condenser 30b is of a type corresponding to the downward exhaust type steam turbine, and is disposed below the low-pressure steam turbine 3b. Similarly to the condensers 30 and 30a of the first and second embodiments, the condenser 30b also includes the set of heat-transfer tubes 32, a main body 35b which covers the set of heat-transfer tubes 32, an intermediate body 41b which is disposed between the low-pressure steam turbine 3b and the main body 35b and connects both, a bypass steam receiving section 51b, and the water injector 56 (water injection section).

**[0058]** The main body 35b is disposed at an interval below the low-pressure steam turbine 3b. The intermediate body 41b extends downward from the exhaust port 4b of the low-pressure steam turbine 3b, and connects the exhaust port 4b of the low-pressure steam turbine 3b and the main body 35b. The portion of the main body 35 which is connected to the intermediate body 41b is the upper portion of the main body 35b. A portion of the main body 35b which is connected to the intermediate body 41b is open, and this opening forms an exhaust steam inlet 36b through which the exhaust steam ES flows into the main body 35b. Accordingly, also in the present embodiment, the intermediate body 41b forms a portion of a primary steam passage 42b which guides the exhaust steam ES from the low-pressure steam turbine 3b to the set of heat-transfer tubes 32 in the main body 35b. Moreover, also in the present embodiment, the hot well 38, in which the water obtained by the condensation of the exhaust steam ES is accumulated, is formed at the lower portion of the inner portion of the main body 35b.

**[0059]** Similarly to the above-described embodiments, the bypass steam receiving section 51b includes the bypass steam receiving box 52, the high-pressure steam injector 53 which injects the bypass high-pressure steam BHS, and the reheat steam injector 54 which injects the bypass reheat steam BRS.

**[0060]** The bypass steam receiving box 52 is connected and fixed to the side portion of the main body 35b. A connection portion between the bypass steam receiving box 52 and the main body 35b is open, and this opening forms a bypass steam inlet 37b through which the bypass steam BS flows into the main body 35b. Similarly to the first and second embodiments, both the high-pressure steam injector 53 and the reheat steam injector 54 are disposed inside the bypass steam receiving box 52. In addition, similarly to the first and second embodiments, the water injector 56 is also disposed at the position closer to the set of heat-transfer tubes 32 side than the high-pressure steam injector 53 and the reheat steam injector 54 in the bypass steam receiving box 52. The plurality of nozzles of the water injector 56 inject water to the side

of the high-pressure steam injector 53 and the reheat steam injector 54.

**[0061]** Thus, in the present embodiment, the bypass steam BS flows into the set of heat-transfer tubes 32 mainly from a region 34b of the side portion of the set of heat-transfer tubes 32 while the exhaust steam ES flows into the set of heat-transfer tubes 32 mainly from a region 33b of the upper portion in the set of heat-transfer tubes 32 via the intermediate body 41b. That is, similarly to the first and second embodiments, also in the present embodiment, the region 33b in the set of heat-transfer tubes 32 through which the exhaust steam ES flows into the set of heat-transfer tubes 32 is different from the region 34b in the set of heat-transfer tubes 32 through which the bypass steam BS flows into the set of heat-transfer tubes 32. Moreover, similarly to the first and second embodiments, also in the present embodiment, the bypass steam receiving section 51b is provided outside the primary steam passage 42b. Accordingly, also in the present embodiment, it is possible to obtain substantially the same effects as the first and second embodiments. That is, also in the present embodiment, it is possible to prevent local damage of the set of heat-transfer tubes 32. In addition, also in the present embodiment, compared with the case where the bypass steam BS is guided to the intermediate body 41b of the condenser 30b, it is possible to shorten the length of the intermediate body 41b. In addition, also in the present embodiment, it is possible to extremely decrease the possibility of the bypass steam BS reversely flowing toward the low-pressure steam turbine 3b side, and it is possible to decrease resistance to the exhaust steam ES passing through the intermediate body 41b.

**[0062]** Thus, as in the present embodiment, even when the low-pressure steam turbine 3b is the downward exhaust type and the condenser 30b is the type corresponding to the downward exhaust type, the present invention can be applied. That is, as described above, regardless of whether the steam turbine is the horizontal exhaust type, which is the axial exhaust type or the side exhaust type, or the steam turbine is the downward exhaust type, the present invention can be applied according to the exhaust type of the steam turbine.

#### First Modification Example of Condenser

**[0063]** With reference to Fig. 4, a first modification example of the condenser 30 in the first embodiment will be described.

**[0064]** In the condenser 30 in the first embodiment, the water injector 56 is disposed at the position closer to the set of heat-transfer tubes 32 side than the high-pressure steam injector 53 and the reheat steam injector 54 in the bypass steam receiving box 52. In a condenser 30c of the present modification example, the water injector 56 is disposed farther away from the set of heat-transfer tubes 32 side than the high-pressure steam injector 53 and the reheat steam injector 54 in the bypass steam



receiving box 52 of a bypass steam receiving section 51c. In other words, in the present modification example, the high-pressure steam injector 53 and the reheat steam injector 54 are disposed at positions on the set of heat-transfer tubes 32 side from the water injector 56. Similarly to the above-described embodiments, the nozzles of the water injector 56 inject water to the side of the high-pressure steam injector 53 and the reheat steam injector 54. Accordingly, also in the present modification example, the bypass steam BS, which is injected from the high-pressure steam injector 53 and the reheat steam injector 54 into the bypass steam receiving box 52, can be cooled by the water injected from the water injector 56.

**[0065]** In addition, the present modification example is the modification example of the condenser 30 in the first embodiment. However, the condensers 30a and 30b of the second and third embodiments can be similarly modified.

#### Second Modification Example of Condenser

**[0066]** With reference to Fig. 5, a second modification example which is a further modification example of the condenser 30c in the first modification example will be described.

**[0067]** In a condenser 30d of the present modification example, a flow suppression member, which suppresses the flow of the bypass steam BS received by the bypass steam receiving section 51c of the condenser 30c toward the set of heat-transfer tubes 32, is added to the condenser 30c of the first modification example. The flow suppression member is an impingement plate 58 which is disposed between a set of injectors 55, which is a collection of the high-pressure steam injector 53, the reheat steam injector 54, and the water injector 56 inside the bypass steam receiving box 52, and the set of heat-transfer tubes 32 in the main body 35. The impingement plate 58 spreads in a direction perpendicular to a receiving portion-tube set direction which is from the set of injectors 55 or the bypass steam receiving section 51c toward the set of heat-transfer tubes 32.

**[0068]** As in the present modification example, when the impingement plate 58 is disposed between the set of injectors 55 and the set of heat-transfer tubes 32, flow velocity of the steam flowing from the set of injectors 55 side into the set of heat-transfer tubes 32 decreases, and it is possible to further prevent the damage of the set of heat-transfer tubes 32.

#### Third Modification Example of Condenser

**[0069]** With reference to Fig. 6, a third modification example which is a further modification example of the condenser 30c in the first modification example will be described.

**[0070]** Similarly to the second modification example, also in a condenser 30e of the present modification example, a flow suppression member, which suppresses

the flow of the bypass steam BS received by the bypass steam receiving section 51c of the condenser 30c toward the set of heat-transfer tubes 32, is added to the condenser 30c of the first modification example. The flow suppression member of the present modification example is a plurality of impingement rods 59 which are disposed between the set of injectors 55 and the set of heat-transfer tubes 32 in the main body 35. The plurality of impingement rods 59 all extend in the direction perpendicular to the receiving portion-tube set direction which is from the set of injectors 55 or the bypass steam receiving section 51c toward the set of heat-transfer tubes 32, and are disposed at intervals in the direction perpendicular to the receiving portion-tube set direction and to the direction in which each impingement rod 59 extends.

**[0071]** Also in the present modification example, since the plurality of impingement rods 59 are disposed between the set of injectors 55 and the set of heat-transfer tubes 32, flow velocity of the steam flowing from the set of injectors 55 into the set of heat-transfer tubes 32 decreases, and it is possible to further prevent the damage of the set of heat-transfer tubes 32.

**[0072]** Moreover, in the second and third modification examples, each of the flow suppression members is disposed inside the main body 35. However, the flow suppression member may be disposed inside the bypass steam receiving box 52 as long as the flow suppression member is disposed between the set of injectors 55 and the set of heat-transfer tubes 32.

**[0073]** In addition, both the second and third modification examples are the modification examples of the condenser 30 in the first modification example. However, the condensers of the first to third embodiments can be similarly modified.

**[0074]** In the condenser 30c of the first modification example, the high-pressure steam injector 53 and the reheat steam injector 54 are disposed on the set of heat-transfer tubes 32 side from the water injector 56, and thus, it is not possible to expect the curtain effects of the flow of the bypass steam BS toward the set of heat-transfer tubes 32 being suppressed by the water injected from the water injector 56. Accordingly, it is more effective if the flow suppression member is provided in the condenser of the first modification example with respect to the first to third embodiments rather than the condensers of the first to third embodiments.

#### Other Modification Examples

**[0075]** In the above embodiments and modification examples, the present invention is applied to the steam turbine plant which includes the high-pressure steam turbine, the low-pressure steam turbine, and the condenser through which the exhaust steam from the low-pressure steam turbine is turned back into water. However, the present invention may also be applied to a steam turbine plant which includes a high-pressure steam turbine, an intermediate-pressure steam turbine, a low-pressure tur-

bine, and a condenser through which the exhaust steam ES from any one of these steam turbines is turned back into water. In addition, the present invention may also be applied to a steam turbine plant which includes one kind of steam turbine and a condenser through which the exhaust steam from the steam turbine is turned back into water. That is, as long as the steam turbine plant includes a steam turbine and a condenser for the steam turbine, the present invention may be applied to any steam turbine plant.

#### Industrial Applicability

**[0076]** According to an aspect of the present invention, it is possible to prevent local damage of the set of heat-transfer tubes.

#### Reference Signs List

**[0077]** 1: STEAM GENERATOR (STEAM SUPPLY DEVICE), 2: HIGH-PRESSURE STEAM TURBINE, 3, 3b: LOW-PRESSURE STEAM TURBINE (OR SIMPLY STEAM TURBINE), 5: GENERATOR, 6: REHEATER (STEAM SUPPLY DEVICE), 7: FEED WATER PUMP, 11: HIGH-PRESSURE STEAM LINE, 12: BYPASS HIGH-PRESSURE STEAM LINE, 13: REHEAT STEAM LINE, 14: BYPASS REHEAT STEAM LINE, 15: EXHAUST HIGH-PRESSURE STEAM LINE, 16: CONDENSATE LINE, 17: FEED WATER LINE, 18: INJECTION WATER LINE, 30, 30a, 30b, 30c, 30d, 30e: CONDENSER, 31: HEAT-TRANSFER TUBE, 32: SET OF HEAT-TRANSFER TUBES, 33, 33b, 34, 34a, 34b: REGION, 35, 35a, 35b: MAIN BODY, 36 36b: EXHAUST STEAM INLET (OPENING), 37, 37a, 37b: BYPASS STEAM INLET (OPENING), 41: INTERMEDIATE BODY, 42: PRIMARY STEAM PASSAGE, 51, 51a, 51b, 51c: BYPASS STEAM RECEIVING SECTION, 52: BYPASS STEAM RECEIVING BOX, 53: HIGH-PRESSURE STEAM INJECTOR, 54: REHEAT STEAM INJECTOR, 55: SET OF INJECTORS, 56: WATER INJECTOR (WATER INJECTION SECTION), 58: IMPINGEMENT PLATE, 59: IMPINGEMENT ROD

#### Claims

##### 1. A condenser, comprising:

a set of heat-transfer tubes which is configured of a plurality of heat-transfer tubes through the inner portions of which a medium which performs heat-exchange with exhaust steam exhausted from a steam turbine passes and which turns the exhaust steam back into water;  
a main body which covers the set of heat-transfer tubes;  
an intermediate body which is positioned between the steam turbine and the main body and

connects both, and forms a primary steam passage for guiding the exhaust steam from the steam turbine to the set of heat-transfer tubes in the main body; and

a bypass steam receiving section which receives bypass steam which has bypassed the steam turbine, and guides the bypass steam to the set of heat-transfer tubes in the main body via an opening formed in the main body, wherein the bypass steam receiving section is disposed outside the primary steam passage, and wherein the opening of the main body is formed at a position at which the bypass steam mainly flows into the set of heat-transfer tubes from a region different from an inflow region through which the exhaust steam mainly flows into the set of heat-transfer tubes via the primary steam passage.

##### 2. The condenser according to claim 1, further comprising:

a flow suppression member which suppresses a flow of the bypass steam received by the bypass steam receiving section toward the set of heat-transfer tubes.

##### 3. The condenser according to claim 1 or 2, further comprising:

a water injection section which injects water into the bypass steam receiving section.

##### 4. The condenser according to any one of claims 1 to 3, wherein the steam turbine is a horizontal exhaust type which exhausts steam in an axial direction in which a rotor of the steam turbine extends, or to a side of the steam turbine, wherein the intermediate body is connected to a side portion of the main body, and wherein the bypass steam receiving section is provided on one of an upper portion of the main body, and a side portion of the main body which is opposite to a portion to which the intermediate body is connected based on the set of heat-transfer tubes.

##### 5. The condenser according to any one of claims 1 to 3, wherein the steam turbine is a downward exhaust type which exhausts steam to a lower side of the steam turbine, wherein the intermediate body is connected to an upper portion of the main body, and wherein the bypass steam receiving section is provided at a position opposite to the set of heat-transfer tubes in a horizontal direction in a side portion of the main body.

6. A steam turbine plant, comprising:

the condenser according to any one of claims 1 to 5;  
the steam turbine; 5  
a steam supply device which supplies steam to the steam turbine; and  
a bypass steam line which guides the steam from the steam supply device, as the bypass steam, to the bypass steam receiving section so that the steam bypasses the steam turbine. 10

7. A steam turbine plant, comprising:

the condenser according to any one of claims 3 to 5; 15  
the steam turbine;  
a steam supply device which supplies steam to the steam turbine;  
a feed water pump which returns water obtained by condensation of the exhaust steam in the condenser to the steam supply device; 20  
a bypass steam line which guides the steam from the steam supply device, as the bypass steam, to the bypass steam receiving section so that the steam bypasses the steam turbine; and 25  
an injection water line which guides the water pressurized by the feed water pump to the water injection section.

30

35

40

45

50

55

**FIG. 1**

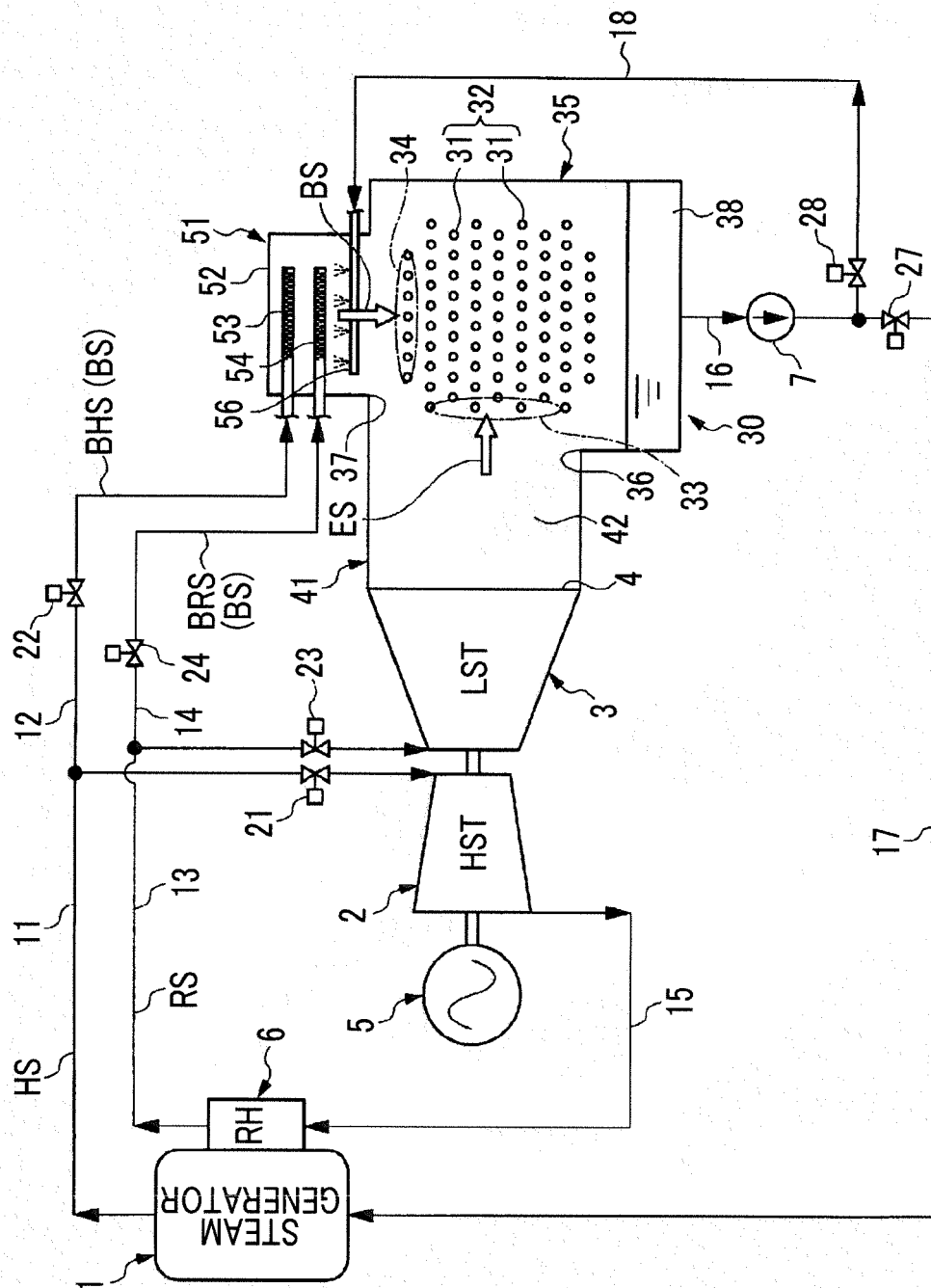


FIG. 2

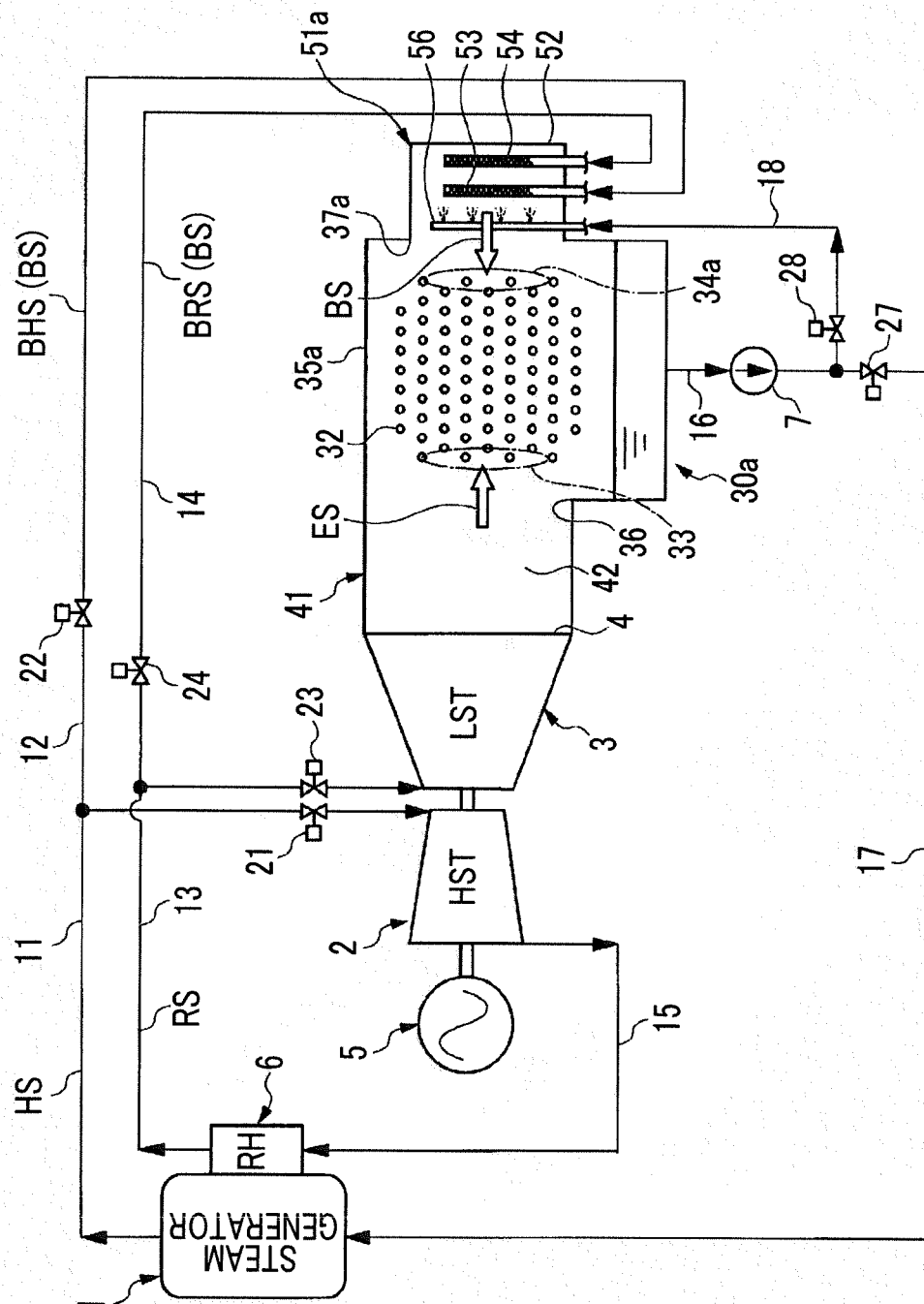


FIG. 3

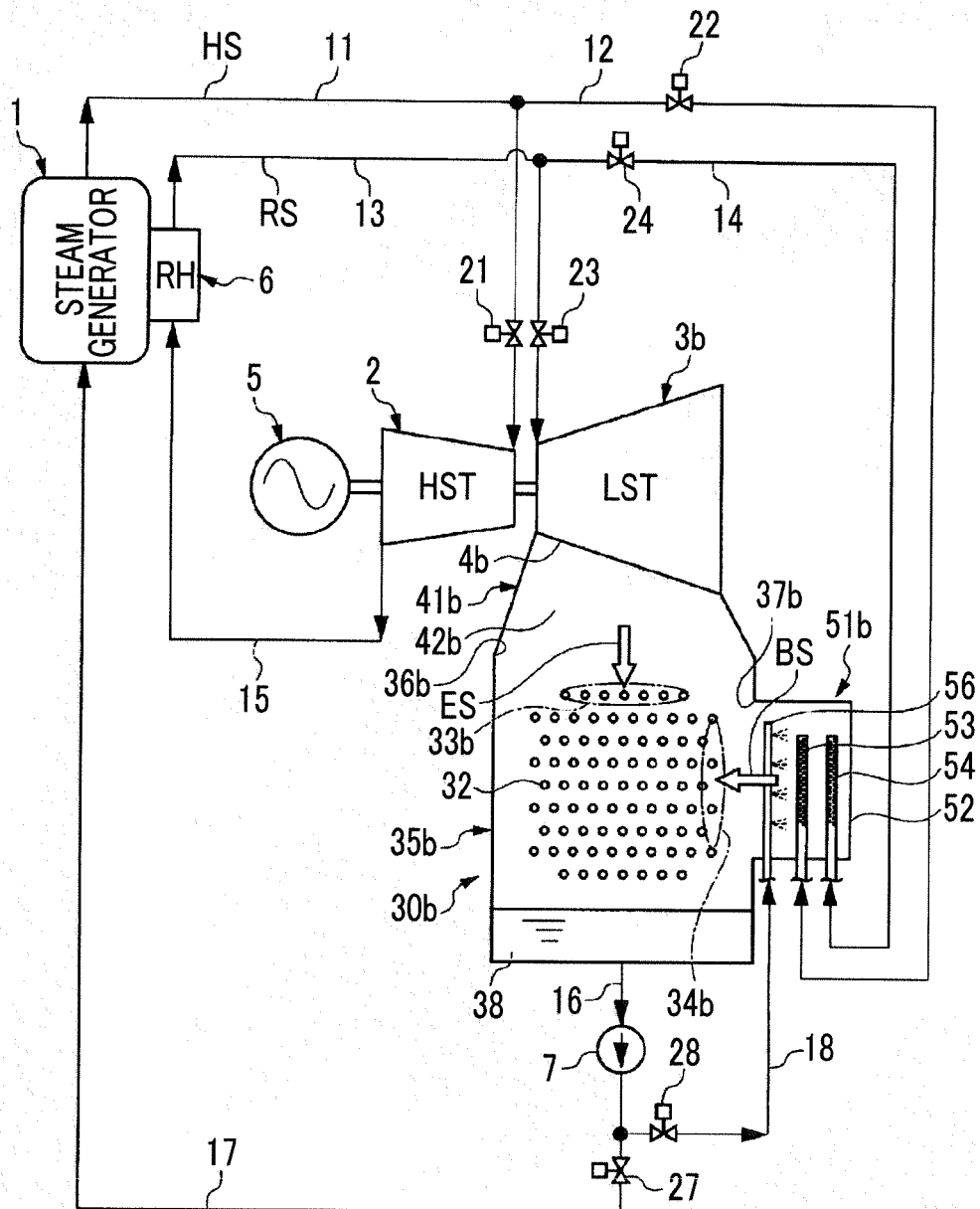


FIG. 4

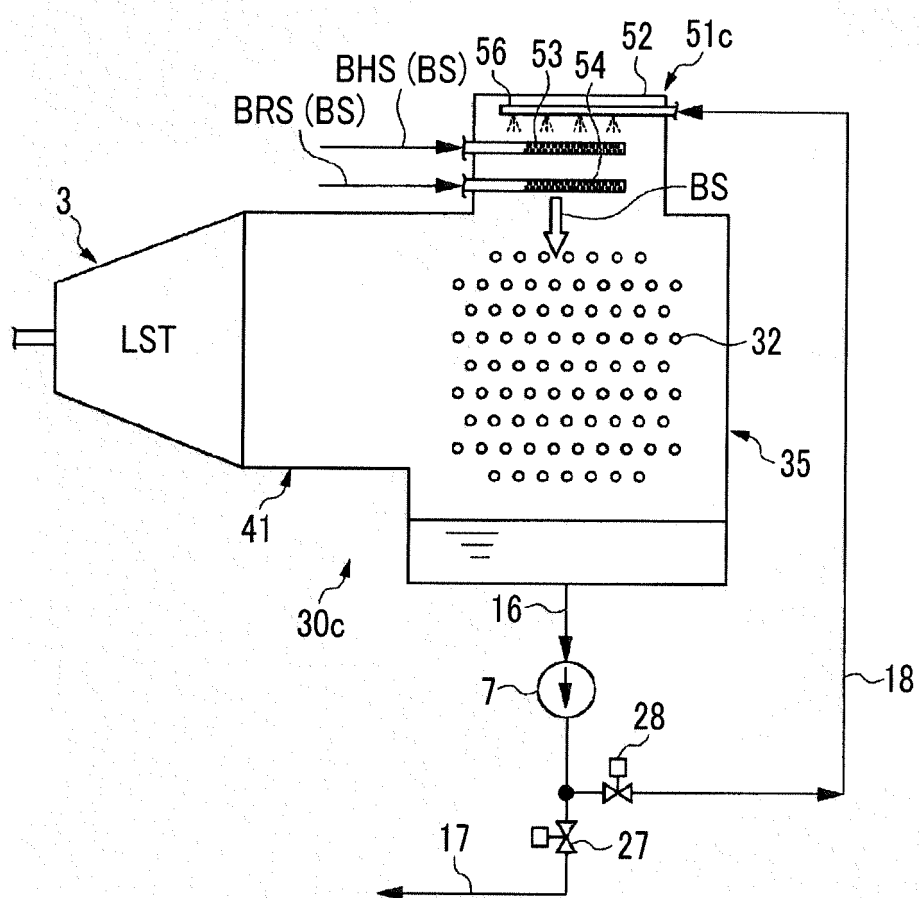


FIG. 5

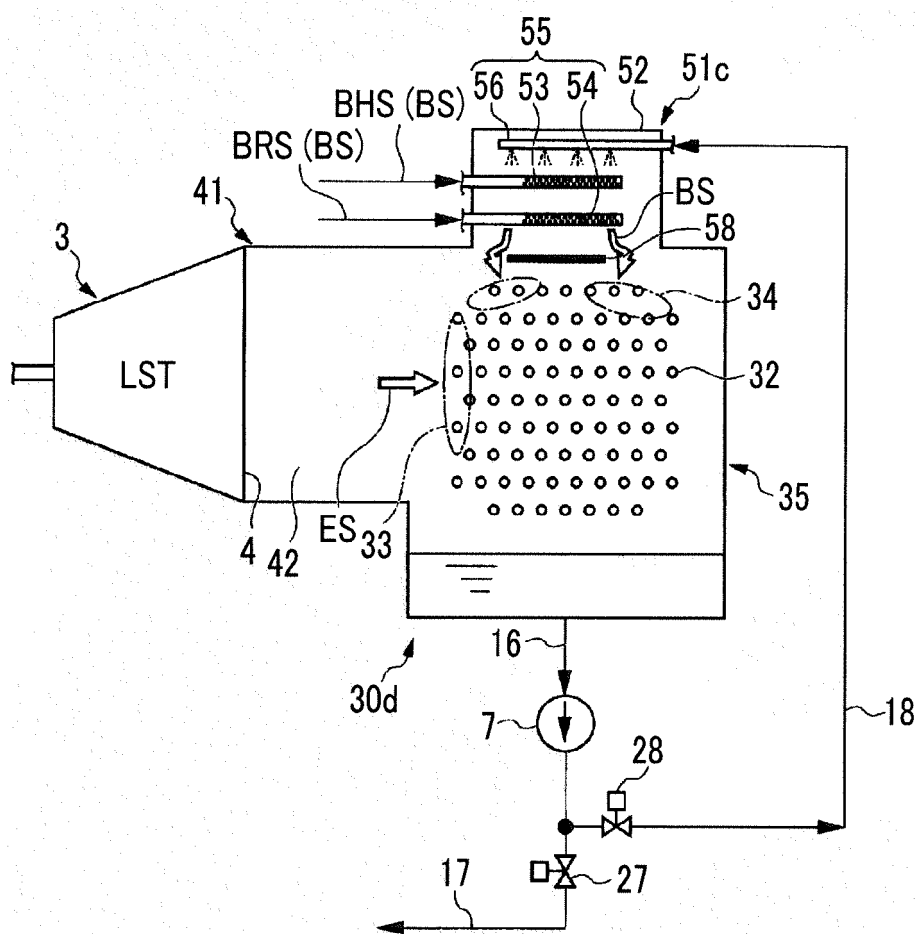
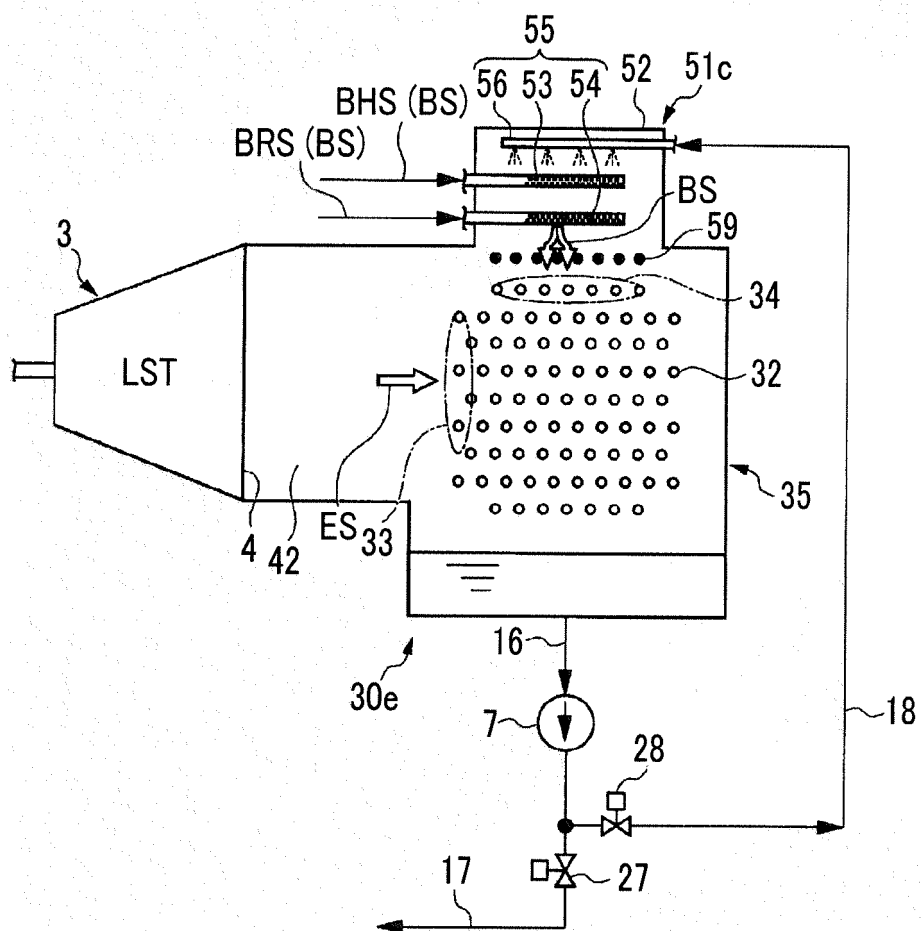




FIG. 6



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/056718

## A. CLASSIFICATION OF SUBJECT MATTER

F22B1/18(2006.01)i, F01K9/00(2006.01)i, F28B1/02(2006.01)i, F28B3/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F22B1/18, F01K9/00, F28B1/02, F28B3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014  
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                       | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y<br>A    | JP 62-108998 A (Hitachi, Ltd.),<br>20 May 1987 (20.05.1987),<br>page 3, lower left column, line 9 to page 4,<br>lower right column, line 15; fig. 1, 3<br>(Family: none) | 1-3, 5-7<br>4         |
| Y         | JP 7-151475 A (Toshiba Corp.),<br>16 June 1995 (16.06.1995),<br>paragraphs [0040] to [0046]; fig. 8, 9<br>(Family: none)                                                 | 1-3, 5-7              |
| Y         | JP 59-30993 B2 (Hitachi, Ltd.),<br>30 July 1984 (30.07.1984),<br>page 2, column 3, lines 28 to 39; fig. 7, 8<br>(Family: none)                                           | 1-3, 5-7              |

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search  
23 May, 2014 (23.05.14)

Date of mailing of the international search report  
03 June, 2014 (03.06.14)

Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/056718

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                              | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | JP 2006-329501 A (Toshiba Corp.),<br>07 December 2006 (07.12.2006),<br>paragraphs [0004] to [0005]; fig. 7<br>(Family: none)                                    | 6, 7                  |
| Y         | JP 63-201491 A (Hitachi, Ltd.),<br>19 August 1988 (19.08.1988),<br>page 2, lower left column, line 1 to lower<br>right column, line 1; fig. 1<br>(Family: none) | 6, 7                  |
| A         | US 2001/0011458 A1 (Ferenc KORONYA, Gunter<br>SCHMALZBAUER, Vaclav SVOBODA),<br>09 August 2001 (09.08.2001),<br>entire text; all drawings<br>& EP 1126227 A1    | 4                     |

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- JP 2013065403 A [0001]
- JP 2003148111 A [0006]
- JP 9273875 A [0006]
- JP 7167571 A [0006]