(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 429 074 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.02.2007 Bulletin 2007/09

(51) Int Cl.:
F22D 1/32 *(2006.01)* ***F01K 7/38*** *(2006.01)*

(21) Application number: **03028207.3**

(22) Date of filing: **09.12.2003**

(54) **System and method for feeding water for steam turbine plant**

Anordnung und Methode für die Wasserspeisung einer Dampfturbinenanlage

Système et procédé pour alimenter en eau une installation à turbines à vapeur

(84) Designated Contracting States:
DE FR GB

(30) Priority: **10.12.2002 JP 2002358221**

(43) Date of publication of application:
16.06.2004 Bulletin 2004/25

(73) Proprietor: **KABUSHIKI KAISHA TOSHIBA**
Tokyo (JP)

(72) Inventor: **Nonaka, Toshiaki,**
Intellectual Property Division
Minato-ku
Tokyo (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(56) References cited:
EP-A- 1 241 323
DE-A- 2 164 631
DE-A- 2 727 185

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 429 074 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention is related generally to a system and a method for feeding water to a steam generator or a boiler in a thermal or a nuclear power generation plant. The present invention is more specifically related to such a system and a method that has a heating line including a heat exchanger and a bypass line for bypassing the heat exchanger by switching valves.

[0002] A typical prior art feed water system for a steam turbine plant has a heat exchanger as a feed water heater as well as a bypass line for feed water to bypass the heat exchanger. The prior art feed water system also has an inlet bypass valve and an outlet bypass valve to switch between the line through the heat exchanger (or the heating line) and the bypass line.

[0003] The inlet bypass valve is typically a two-way switching valve disposed at the branch point between the heating line and the bypass line. The inlet bypass valve is used to select one of the two directions -- the heating line or the bypass line. The outlet bypass valve is an isolating valve disposed downstream of the heat exchanger and upstream of the connecting point to the bypass line in the heating line.

[0004] The inlet and outlet bypass valves each has a piston in a piston chamber for activation of the valve. When pressure is accumulated in the piston chambers, the pistons are pushed so that the inlet bypass valve can switch over from the bypass line side to the heating line side, and the outlet bypass valve can open. At that time, the water on the other sides of the pistons in the piston chambers is drained out of the systems. Thus, the valves are operated quickly utilizing self-water-pressure as a driving source without any other activation source.

[0005] The prior art inlet and outlet valves described above are advantageous in simple structure because self-pressure is utilized as an activation source. However, those inlet and outlet valves cannot be activated, when the required pressure is not available due to the pressure drop across the control valve, for example.

[0006] DE 27 27 185 A1 describes a feed water system for a steam generator of a steam power plant. A preheater for supply water is described, and a bypass line for bypassing the preheater. A valve is provided for selectively letting water flow through the preheater or the bypass line. The valve is activated by a piston that is driven by water pressure.

BRIEF SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the present invention to provide an improved system and an improved method for feeding water to a steam generator where the inlet and outlet bypass valves can be activated even when the pressure in the pipes upstream of the valves is not adequately high.

[0008] There has been provided, in accordance with an aspect of the present invention, a feed water system for feeding water from a condenser to a steam generator in a steam turbine plant, the feed water system comprising: a feed water/condensate water pump for pumping up water from a condenser; a control valve disposed downstream of the feed water/condensate water pump; a heating line disposed downstream of the control valve, the heating line including a heat exchanger for heating water; a bypass line for bypassing the heating line downstream of the control valve: and inlet and outlet bypass valves for water selectively flowing through either the heating line or the bypass line, wherein the inlet and/or outlet bypass valves are activated by pistons which are driven by water pressure, wherein a valve-activation line for providing water pressure to the pistons to activate the pistons is branched from a point between the feed water/condensate water pump and the control valve.

[0009] There has also been provided, in accordance with another aspect of the present invention, a method for feeding water from a condenser to a steam generator in a steam turbine plant using a feed water system, the feed water system comprising: a feed water/condensate water pump for pumping up water from a condenser; a control valve disposed downstream of the feed water/condensate water pump; a heating line disposed downstream of the control valve, the heating line including a heat exchanger for heating water; a bypass line for bypassing the heating line downstream of the control valve: and inlet and outlet bypass valves for water selectively flowing through either the heating line or the bypass line, the method comprising: branching part of pressurized water from the feed water/condensate water pump upstream of the control valve; supplying the branched part of the pressurized water to one side of each of pistons in piston chambers of the inlet and outlet bypass valves to drive the pistons to activate the valves; and draining water on the opposite side of the pistons in the piston chambers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The above and other features and advantages of the present invention will become apparent from the discussion hereinbelow of specific, illustrative embodiments thereof presented in conjunction with the accompanying drawings, in which:

Figure 1 is a flow diagram showing a first embodiment of a feed water system in a steam turbine plant according to the present invention;

Figure 2 is a flow diagram showing a second embodiment of a feed water system in a steam turbine plant according to the present invention; and

Figure 3 is a flow diagram showing a third embodiment of a feed water system in a steam turbine plant according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0011] In the following description and also in the above description of background of the invention, like reference numerals represent like elements, and redundant description may be omitted.

[0012] Now, a first embodiment of a feed water system in a steam turbine plant according to the present invention is described referring to Figure 1. Steam drives a steam turbine (not shown) rotate, and condenses into condensate water in a condenser (not shown). The condensate water is pumped up by a feed water/condensate water pump 2 before the water returns back to a steam generator (not shown). Typically, a condensate water pump, a heat exchanger and a feed water pump are connected in series in this order. Since the present invention can be applied to both portions related to the condensate water pump and the feed water pump, those pumps are called a feed water/condensate water pump collectively. A control valve 4 is disposed downstream of the feed water/condensate water pump 2 in order to control the flow rate. The control valve 4 causes a pressure drop.

[0013] An inlet bypass valve 6 is disposed downstream of the control valve 4. The inlet bypass valve 6 is a two-way switching valve and can be switched to form selectively a flow path through a heating line 8 or through a bypass line 10. The heating line 8 has a heat exchanger or a heater 12. Part of the steam generated in the steam generator is extracted into the heat exchanger 12 where the feed water (or the condensate water) is heated.

[0014] An outlet bypass valve 14 is disposed downstream of the heat exchanger 12. Downstream of the heat exchanger 12 is combined to the bypass line 10, and then, to the steam generator to which the feed water is supplied. In some embodiments, there may be multiple stages in series, each stage including a combination of a feed water/condensate water pump 2 and a heating line 8. In such a case, downstream of the combining point of the heating line 8 and the bypass line 10 may be connected to another feed water/condensate water pump 2 of the next stage.

[0015] Inlet and outlet bypass-valve piston chambers 24 and 26, respectively, are attached to the inlet and outlet bypass valves 6 and 14, respectively. Inlet and outlet bypass-valve pistons 28 and 30, respectively, are disposed and can be moved reciprocally in the piston chambers 24 and 26, respectively. The pistons 28 and 30 divide the space in their respective piston chambers 24 and 26. The pistons 28 and 30 move together with the valve bodies (not shown) of the inlet and outlet bypass valves 6 and 14, respectively.

[0016] First and second spaces divided by the inlet bypass-valve piston 28 in the inlet bypass-valve piston chamber 24 have first and second ports 32 and 34, respectively. Likewise, third and fourth spaces divided by the outlet bypass-valve piston 30 in the outlet bypass-valve piston chamber 26 have third and fourth ports 36 and 38, respectively.

[0017] The first and third ports 32 and 36, respectively, are commonly connected to a first valve-activation line 44. The first valve-activation line 44 can be drained through a first drain valve 40. Likewise, the second and fourth ports 34 and 38, respectively, are commonly connected to a second valve-activation line 46. The second valve-activation line 46 can be drained through a second drain valve 42.

[0018] A third valve-activation line 48 is branched from a point between the feed water/condensate water pump 2 and the control valve 4. An isolating valve 50 is disposed in the third valve-activation line 48. The third valve-activation line 48 is branched downstream of the isolating valve 50. One of the branched lines is connected to a first valve-activation line 44 via a first high-pressure activation-water supply valve 52, and the other of the branched lines is connected to a second valve-activation line 46 via a second high-pressure activation-water supply valve 54.

[0019] A water-filling line 16 is branched from a point between the control valve 4 and the inlet bypass valve 6. The water-filling line 16 is connected to a point upstream of the heat exchanger 12 in the heating line 8. A drain line 20 is branched from a point downstream of the connecting point of the water-filling line 16 of the heating line 8 and upstream of the heat exchanger 12. The drain line 20 has a drain valve 22.

[0020] Operation of the embodiment is now described. When water flows through the bypass line 10, the inlet bypass valve 6 is switched over to the bypass line side. At the same time, the outlet bypass valve 14, the water-filling valve 18, the first drain valve 40, the second drain valve 42, the third drain valve 22, the first high-pressure activation-water supply valve 52 and the second high-pressure activation-water supply valve 54 are closed.

[0021] When the flow path is changed to the heating line 8 side, the water-filling valve 18 is opened and water is guided to the heating line 8, which causes the heating line 8 pressurized. Thus, when the pressure difference across the valve body of the inlet bypass valve 6 is minimized, the first high-pressure activation-water supply valve 52 is opened. Then, comparatively high pressure activation water which does not pass through the control valve 4 is supplied to the first port 32 of the inlet bypass-valve piston chamber 24 and to the third port 36 of the outlet bypass-valve piston chamber 26 through the third valve-activation line 48, the first high-pressure activation-water supply valve 52 and the first valve-activation line 44.

[0022] Immediately after that, the second drain valve 42 is opened, which creates the differential pressures across the pistons 28 and 30. Thus, the pistons 28 and 30 move toward the sides of the ports 34 and 38, respectively. Then, the inlet bypass valve 6 is turned to the heating line 8 side, and the outlet bypass valve 14 is opened.

[0023] When the flow path changes from the heating line 8 to the bypass line 10, the first high-pressure activation-water supply valve 52 and the second drain valve

42 are closed first. The first drain valve 40 and the second high-pressure activation-water supply valve 54 remain closed. Then, the second high-pressure activation-water supply valve 54 is opened. Thus, the relatively high-pressure activation water which does not flow through the control valve 4 is supplied to the second port 34 of the inlet bypass-valve piston chamber 24 and the fourth port 38 of the outlet bypass-valve piston chamber 26.

[0024] Immediately after that, the first drain valve 40 is opened, which creates the differential pressures across the pistons 28 and 30. Thus, the pistons 28 and 30 move toward the sides of the ports 32 and 36, respectively. Then, the inlet bypass valve 6 is turned to the bypass line 10 side, and the outlet bypass valve 14 is closed. The third drain valve 22 is opened to ensure the switch-over.

[0025] When all of the activation is completed, the water-filling valve 18, the third drain valve 22, the first drain valve 40, the second drain valve 42, the first high-pressure activation-water supply valve 52 and the second high-pressure activation-water supply valve 54 are closed.

[0026] According to the first embodiment described above, the inlet bypass valve 6 and the outlet bypass valve 14 can be activated even when the pressure in the pipe is lower than the pressure needed to valve activation.

[0027] Now, a second embodiment of a feed water system in a steam turbine plant according to the present invention is described referring to Figure 2. In this embodiment, a valve activation pump 60 is disposed upstream of the isolating valve 50 on the third valve-activation line 48. Thus, the water pressure supplied to the first and second valve-activation lines 44 and 46 can be enhanced more.

[0028] When the valve activation pump 60 is disposed upstream of the isolating valve 50 on the third valve-activation line 48, the third valve-activation line 48 may be alternatively branched at a point downstream of the control valve 4.

[0029] Now, a third embodiment of a feed water system in a steam turbine plant according to the present invention is described referring to Figure 3. In this embodiment, the third valve-activation line 48 is connected to a high pressure source (not shown) other than the feed water/condensate water pump 2.

[0030] Numerous modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that, within the scope of the appended claims, the present invention can be practiced in a manner other than as specifically described herein.

Claims

1. A feed water system for feeding water from a condenser to a steam generator in a steam turbine plant, the feed water system comprising:

a feed water/condensate water pump (2) for pumping up water from a condenser;
a control valve (4) disposed downstream of the feed water/condensate water pump (2);
a heating line (8) disposed downstream of the control valve (4), the heating line (8) including a heat exchanger (12) for heating water;
a bypass line (10) for bypassing the heating line (8) downstream of the control valve (4); and
inlet and outlet bypass valves (6, 14) for water selectively flowing through either the heating line (8) or the bypass line (10),

wherein the inlet and/or outlet bypass valves (6, 14) are activated by pistons (28, 30) which are driven by water pressure,
characterized in that a valve-activation line (48) for providing water pressure to the pistons (28, 30) to activate the pistons (28, 30) is branched from a point between the feed water/condensate water pump (2) and the control valve (4).

2. The feed water system according to claim 1, wherein the inlet bypass valve (6) includes a two-way switching valve disposed at a branch point between the heating line (8) and the bypass line (10), wherein the outlet bypass valve (14) includes an isolating valve (50) disposed downstream of the heat exchanger (12) in the heating line (8).

3. The feed water system according to claim 2, wherein the inlet bypass valve (6) is activated by a piston (28) which is driven by water pressure, the feed water system further comprising:

a water-filling line (16) which is branched from a point between the control valve (4) and the inlet bypass valve (6) and which is connected to the heating line (8) at a point between the inlet bypass valve (6) and the heat exchanger (12); and
a water-filling valve (18) on the water-filling line (16).

4. A method for feeding water from a condenser to a steam generator in a steam turbine plant using a feed water system, the feed water system comprising:

a feed water/condensate water pump (2) for pumping up water from a condenser;
a control valve (4) disposed downstream of the feed water/condensate water pump (2);
a heating line (8) disposed downstream of the control valve (4), the heating line (8) including a heat exchanger (12) for heating water;

a bypass line (10) for bypassing the heating line (8) downstream of the control valve (4); and inlet and outlet bypass valves (6, 14) for water selectively flowing through either the heating line (8) or the bypass line (10), the method comprising:

branching part of pressurized water from the feed water/condensate water pump (2) upstream of the control valve (4);
supplying the branched part of the pressurized water to one side of each of pistons (28, 30) in piston chambers (24, 26) of the inlet and outlet bypass valves (6, 14) to drive the pistons (28, 30) to activate the valves; and
draining water on the opposite side of the pistons (28, 30) in the piston chambers (24, 26).

Patentansprüche

1. Wasserspeisesystem zum Speisen von Wasser von einem Kondensator an einen Dampfgenerator in einer Dampfturbinenanlage, wobei das Wasserspeisesystem enthält:

eine Speisewasser-/Kondenswasser-Pumpe (2) zum Pumpen von Wasser von einem Kondensator;
ein Steuerventil (4), welches stromabwärts der Speisewasser-/Kondenswasser-Pumpe (2) angeordnet ist;
eine Wärmeleitung (8), welche stromabwärts des Steuerventils (4) angeordnet ist, wobei die Wärmeleitung (8) einen Wärmetauscher (12) zum Erwärmen von Wasser enthält;
eine Überbrückungsleitung (10) zum Überbrükken der Wärmeleitung (8) stromabwärts des Steuerventils (4); und
Einlass- und Auslass-Überbrückungsventile (6, 14), damit Wasser selektiv entweder durch die Wärmeleitung (8) oder durch die Überbrükkungsleitung (10) fließt,

wobei die Einlass- und/oder Auslass-Überbrükkungsventile (6, 14) durch Kolben (28, 30) aktiviert werden, welche durch Wasserdruck angetrieben werden,
dadurch gekennzeichnet, dass eine Ventilaktivierungsleitung (48) zum Bereitstellen von Wasserdruck an die Kolben (28, 30), um die Kolben (28, 30) zu aktivieren, an einem Punkt zwischen der Speisewasser-/Kondenswasser-Pumpe (2) und dem Steuerventil (4) abzweigt.

2. Wasserspeisesystem nach Anspruch 1, bei welchem das Einlass-Überbrückungsventil (6) ein Zweiwege-Umschaltventil enthält, welches an einem Abzweigpunkt zwischen der Wärmeleitung (8) und der Überbrückungsleitung (10) angeordnet ist, wobei das Auslass-Überbrückungsventil (14) ein Isolierventil (50) enthält, welches stromabwärts des Wärmetauschers (12) in der Wärmeleitung (8) angeordnet ist.

3. Wasserspeisesystem nach Anspruch 2, bei welchem das Einlass-Überbrückungsventil (6) durch einen Kolben (28) aktiviert wird, welcher durch Wasserdruck angetrieben wird, wobei das Wasserspeisesystem ferner enthält:

eine Wasserfüllleitung (16), welche an einem Punkt zwischen dem Steuerventil (4) und dem Einlass-Überbrückungsventil (6) abzweigt, und welche an einem Punkt zwischen dem Einlass-Überbrückungsventil (6) und dem Wärmetauscher (12) mit der Wärmeleitung (8) verbunden ist; und
ein Wasserfüllventil (18) an der Wasserfüllleitung (16).

4. Verfahren zur Wasserspeisung von einem Kondensator an einen Dampfgenerator in einer Dampfturbinenanlage unter Verwendung eines Wasserspeisesystems, wobei das Wasserspeisesystem enthält:

eine Speisewasser-/Kondenswasser-Pumpe (2) zum Pumpen von Wasser von einem Kondensator;
ein Steuerventil (4), welches stromabwärts der Speisewasser-/Kondenswasser-Pumpe (2) angeordnet ist;
eine Wärmeleitung (8), welche stromabwärts des Steuerventils (4) angeordnet ist, wobei die Wärmeleitung (8) einen Wärmetauscher (12) zum Erwärmen von Wasser enthält;
eine Überbrückungsleitung (10) zum Überbrükken der Wärmeleitung (8) stromabwärts des Steuerventils (4); und
Einlass- und Auslass-Überbrückungsventile (6, 14), damit Wasser selektiv entweder durch die Wärmeleitung (8) oder durch die Überbrükkungsleitung (10) fließt, wobei das Verfahren enthält:

Abzweigen eines Teils von mit Druck beaufschlagtem Wasser von der Speisewasser-/Kondenswasser-Pumpe (2) stromaufwärts des Steuerventils (4);
Zuführen des abgezweigten Teils des mit Druck beaufschlagten Wassers an eine Seite von jedem der Kolben (28, 30) in Kolbenkammern (24, 26) der Einlass- und Auslass-Überbrückungsventile (6, 14), um die Kol-

ben (28, 30) anzutreiben, um die Ventile zu aktivieren; und
Entwässern von Wasser an der gegenüberliegenden Seite der Kolben (28, 30) in den Kolbenkammern (24, 26).

Revendications

1. Système d'eau d'alimentation pour fournir de l'eau d'un condenseur à un générateur de vapeur dans une installation de turbines à vapeur, le système d'eau d'alimentation comprenant :

une pompe à eau d'alimentation/eau de condensat (2) pour pomper de l'eau à partir d'un condenseur ;
une vanne de commande (4) disposée en aval de la pompe à eau d'alimentation/eau de condensat (2) ;
une conduite de chauffage (8) disposée en aval de la vanne de commande (4), la conduite de chauffage (8) comprenant un échangeur de chaleur (12) pour chauffer l'eau ;
une conduite de dérivation (10) pour contourner la conduite de chauffage (8) en aval de la vanne de commande (4) ; et
des vannes de dérivation d'entrée et de sortie (6, 14) pour que l'eau circule sélectivement à travers la conduite de chauffage (8) ou la conduite de dérivation (10),

dans lequel les vannes de dérivation d'entrée et/ou de sortie (6, 14) sont activées par des pistons (28, 30) qui sont entraînés par une pression d'eau, **caractérisé en ce qu'**une conduite d'activation de vannes (48) pour fournir une pression d'eau aux pistons (28, 30) pour activer les pistons (28, 30) bifurque à partir d'un point entre la pompe à eau d'alimentation/eau de condensat (2) et la vanne de commande (4).

2. Système d'eau d'alimentation selon la revendication 1, dans lequel la vanne de dérivation d'entrée (6) comprend une vanne de commutation à deux voies disposée à un point de bifurcation entre la conduite de chauffage (8) et la conduite de dérivation (10), dans lequel la vanne de dérivation de sortie (14) comprend une vanne d'isolement (50) disposée en aval de l'échangeur de chaleur (12) dans la conduite de chauffage (8).

3. Système d'eau d'alimentation selon la revendication 2, dans lequel la vanne de dérivation d'entrée (6) est activée par un piston (28) qui est entraîné par une pression d'eau, le système d'eau d'alimentation comprenant en outre :

une conduite de remplissage d'eau (16) qui bifurque à partir d'un point entre la vanne de commande (4) et la vanne de dérivation d'entrée (6) et qui est connectée à la conduite de chauffage (8) à un point entre la vanne de dérivation d'entrée (6) et l'échangeur de chaleur (12) ; et
une vanne de remplissage d'eau (18) sur la conduite de remplissage d'eau (16).

4. Procédé pour fournir de l'eau d'un condenseur à un générateur de vapeur dans une installation de turbines à vapeur utilisant un système d'eau d'alimentation, le système d'eau d'alimentation comprenant :

une pompe à eau d'alimentation/eau de condensat (2) pour pomper de l'eau à partir d'un condenseur ;
une vanne de commande (4) disposée en aval de la pompe à eau d'alimentation/eau de condensat (2) ;
une conduite de chauffage (8) disposée en aval de la vanne de commande (4), la conduite de chauffage (8) comprenant un échangeur de chaleur (12) pour chauffer l'eau ;
une conduite de dérivation (10) pour contourner la conduite de chauffage (8) en aval de la vanne de commande (4) ; et
des vannes de dérivation d'entrée et de sortie (6, 14) pour que l'eau circule sélectivement à travers la conduite de chauffage (8) ou la conduite de dérivation (10), le procédé comprenant :

la bifurcation d'une partie de l'eau sous pression de la pompe à eau d'alimentation/eau de condensat (2) en amont de la vanne de commande (4) ;
la fourniture de la partie bifurquée de l'eau sous pression sur un côté de chacun des pistons (28, 30) dans des chambres de piston (24, 26) des vannes de dérivation d'entrée et de sortie (6, 14) pour entraîner les pistons (28, 30) pour activer les vannes ; et
l'évacuation de l'eau sur le côté opposé des pistons (28, 30) dans les chambres de piston (24, 26).

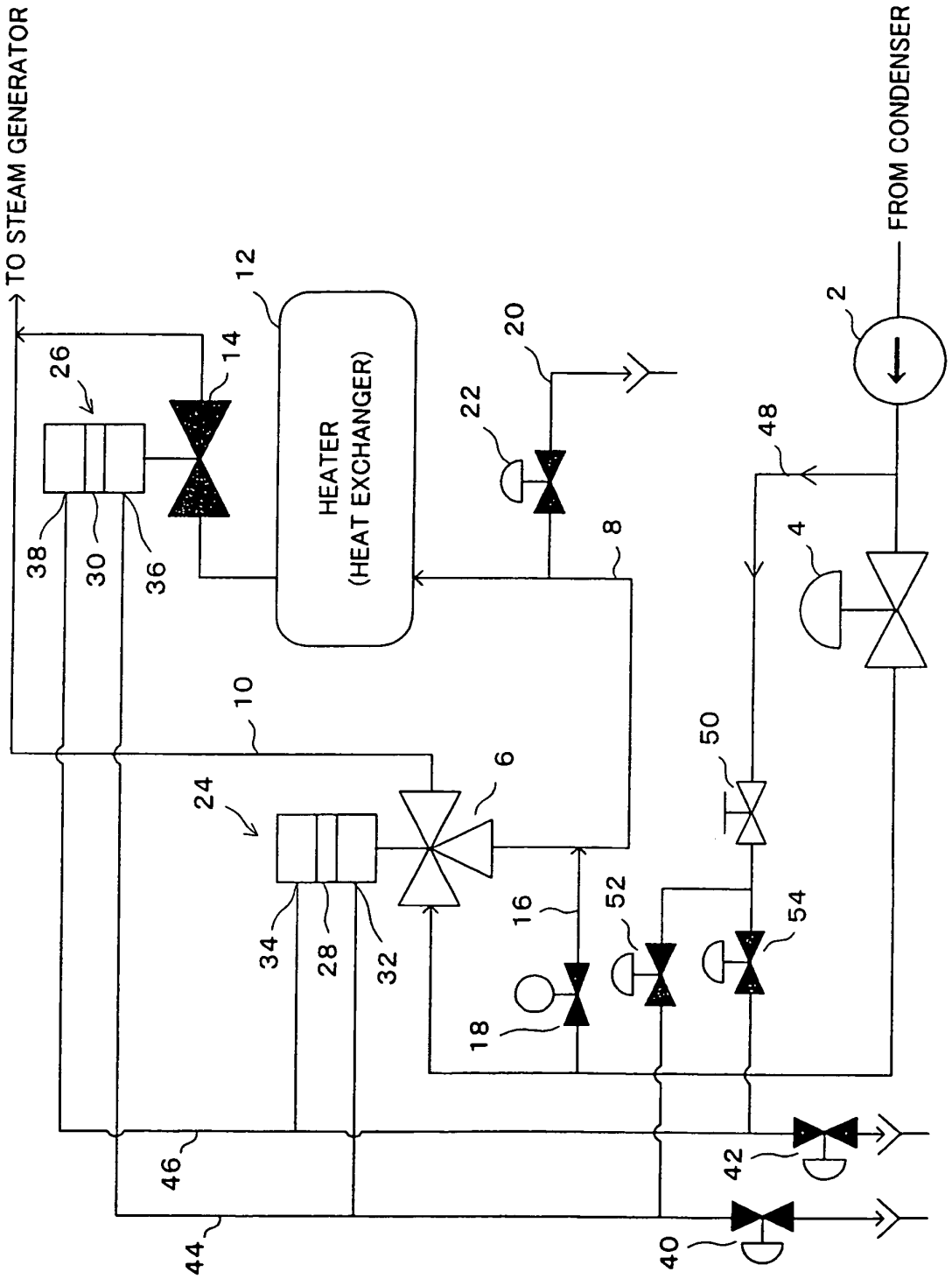

TO STEAM GENERATOR
FROM CONDENSER
HEATER
(HEAT EXCHANGER)
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54

FIG. 1

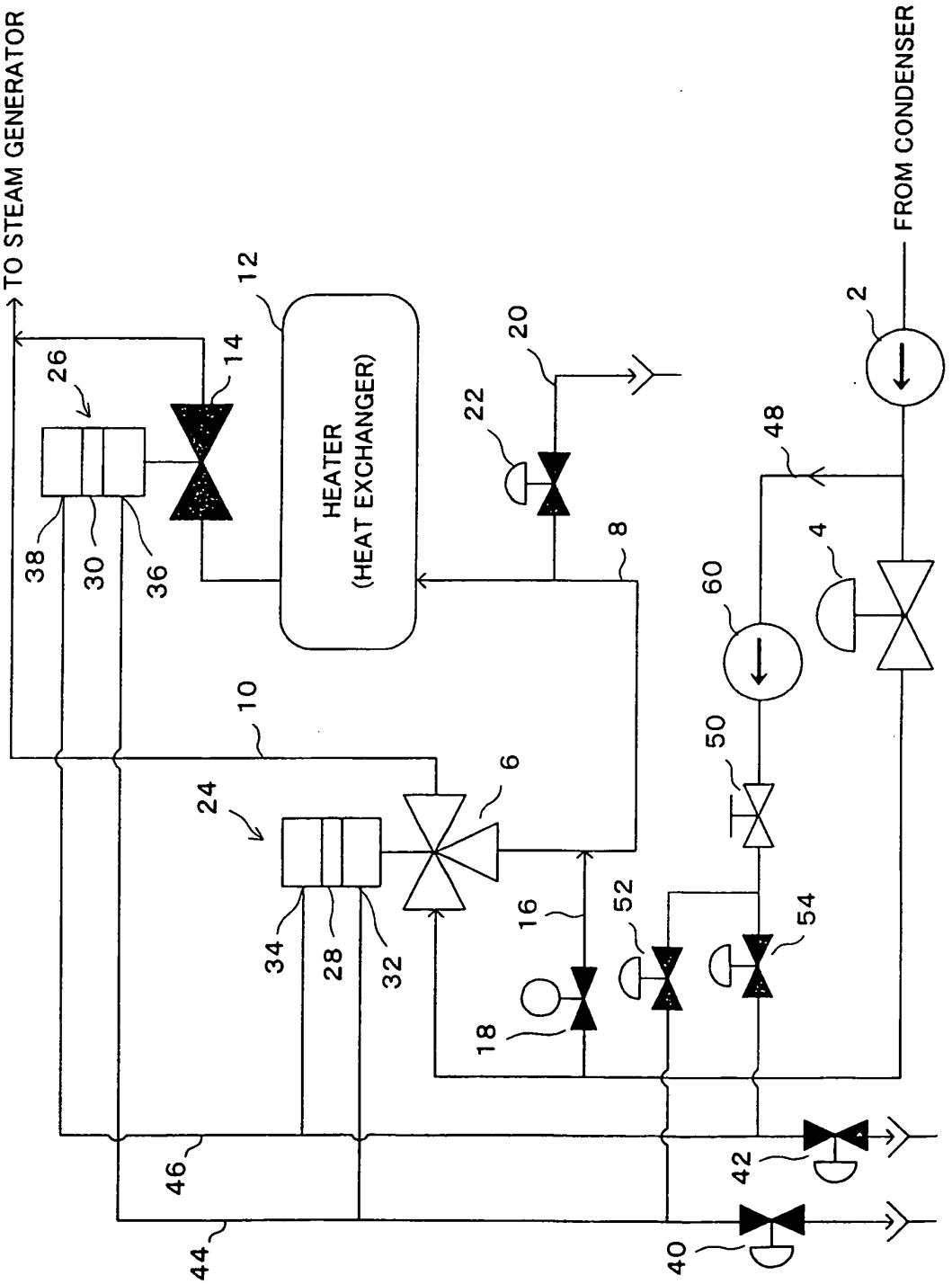

TO STEAM GENERATOR
FROM CONDENSER
HEATER
(HEAT EXCHANGER)
12
14
26
38
30
36
20
22
8
2
48
4
60
10
6
24
34
28
32
50
16
52
54
18
46
44
42
40

FIG. 2

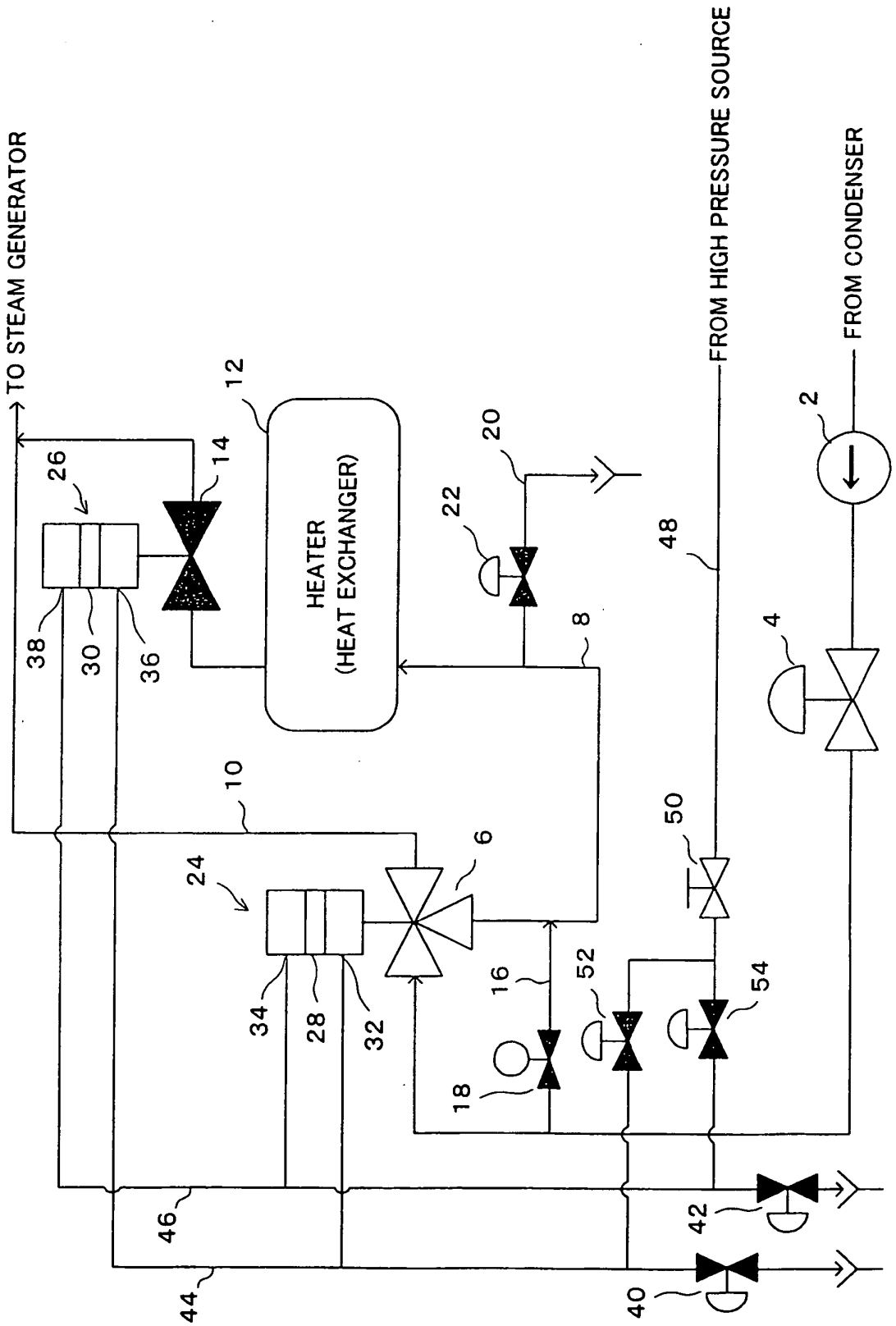

TO STEAM GENERATOR
FROM HIGH PRESSURE SOURCE
FROM CONDENSER
HEATER
(HEAT EXCHANGER)
12
14
26
38
30
36
20
22
8
48
2
4
10
6
24
50
34
28
32
16
52
54
18
46
42
44
40

FIG. 3