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(54) **Title**: POWER GENERATION PLANT HAVING INERT GAS DEAERATOR AND ASSOCIATED METHODS

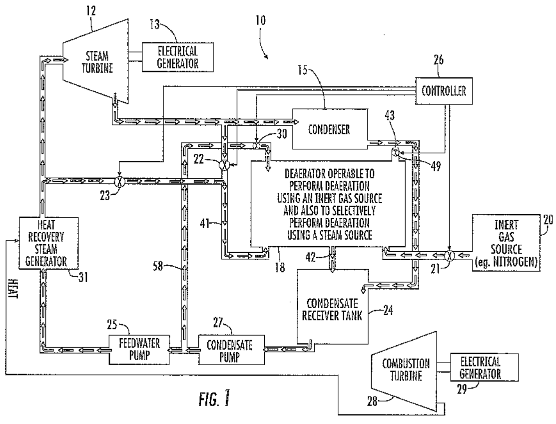

FIG. 1

(57) **Abstract**: A power generation plant includes a steam turbine and an electrical generator driven thereby. A condenser is downstream from the steam turbine. Moreover, the power generation plant includes a steam source and an inert gas source. A deaerator downstream from the condenser and is operable to perform deaeration using the inert gas source and is also selectively operable to perform deaeration using the steam source.

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POWER GENERATION PLANT HAVING INERT GAS DEAERATOR AND ASSOCIATED METHODS

Field of the Invention

[0001] The present invention relates to the field of power plants, and, more particularly, to deaerators for power plants and related methods.

Background of the Invention

[0002] A power generation plant typically includes a source of feedwater, a steam generator or boiler to heat the feedwater until the feedwater becomes steam, and a steam turbine to be rotated by a flow of steam from the steam generator. The steam turbine is coupled to an electrical generator by a rotatable driveshaft to thereby generate electricity as the steam turbine rotates.

[0003] After the flow of steam exits the steam turbine, it is directed into a condenser. The condenser cools the flow of steam until the flow of steam condenses back into liquid water, commonly called the condensate. The condensate may contain dissolved gasses. The dissolved gasses may be corrosive and corrode various metallic components of the power generation plant. Similarly, solid corrosion products may deposit on the surfaces of various components of the power generation plant, which may lead to localized overheating of some components and eventual component failure.

[0004] To reduce the amount of such dissolved gasses in the condensate, a dearator may be used. The deaerator removes the dissolved gasses from the condensate. The deaerated water is then fed back into the steam generator to be re-used to power the steam turbine.

[0005] |A condenser with a built in deaerator is described in U.S. Pat. No. 5,921,085 to Kawano. The condenser of Kawano includes a condenser tank to receive a flow of steam discharged from a steam turbine. A coolant tube bank carrying a flow of cold water runs through the condenser tank. The steam flows across the coolant tube bank and condenses. An inert gas injection valve in the condenser tank sparges the condensate with a flow of inert gas that flows from an inert gas supply. The sparging deaerates the condensate.

[0006] U.S. Pat. No. 4,896,500 to Pavel et al. discloses a deaeration system for a power generation plant including a deaerator and a storage tank coupled thereto. The deaerator includes a deaerator tank having spray nozzles inside. The spray nozzles spray condensate onto a series of deaeration trays. The deaeration has a steam inlet to receive steam from a steam source. The steam flows upward through the deaeration trays and deaerates the water as it flows over the trays. When the deaeration system is to be shut off, the water is drained from the deaeration system and nitrogen is pumped through the steam inlet into the deaeration tank from a nitrogen tank.

[0007] U.S. Pat. App. 2006/0010869 to Blangetti et al. discloses a deaerator for a power generation plant. A mixture of steam and non-condensable gasses are suctioned from a condenser and fed through a direct contact condensation device. Similarly, water from the condenser is pumped into the direct contact condensation device. The mixture of steam and non-condensable gasses flow through the direct contact condensation device in a countercurrent to water from the condenser to deaerate the water.

[0008] The aforementioned deaerators, however, may not remove as much dissolved gasses from the condensate as may be desired. In addition, such deaerators may remove the dissolved gasses from the condensate more slowly than may be desirable, such as after a maintenance outage.

Summary of the Invention

[0009] In view of the foregoing background, it is therefore an object of the present invention to provide a deaerator for a power generation plant.

[0010] This and other objects, features, and advantages in accordance with the present invention are provided by a power generation plant comprising a steam turbine and an electrical generator driven thereby. A condenser may be downstream from the steam turbine. In addition, there may be a steam source and an inert gas source. A deaerator may be downstream from the condenser and may be operable to perform deaeration using the inert gas source. The deaerator may also be selectively operable to perform deaeration using the steam source. The use of inert gas may help to remove dissolved gases, such as carbon dioxide and oxygen, from condensed water. This may help to extend the lifetime and service intervals of components of the power generation plant.

[0011] Furthermore, the use of inert gas is particularly advantageous when the power generation plant is being started after a maintenance outage and may quickly remove non-condensable gasses from the deaerator and dissolved gases from the condensate. After such a maintenance outage, the condensate may be saturated with dissolved gasses, such as carbon dioxide. Since the steam to run the steam turbine is generated from the condensate, it will likewise be saturated with undesired impurity gases at the thermodynamic conditions of the deaerator and will not be as effective as inert gas at deaerating the condensate in the deaerator.

[0012] The inert gas source may comprise a nitrogen gas source and the deaerator may comprise a deaerator tank. Nitrogen from the nitrogen gas source may be introduced into a bottom of the deaerator tank. There may be at least one spray nozzle in the deaerator tank and coupled to the condenser to receive a flow of water therefrom. Additionally, there may be at least one distributor trough in the deaerator tank below the at least one spray nozzle. Furthermore, there may be at least one deaeration tray in the deaerator tank below the at least one distributor trough. Also, the deaerator tank may have a vent opening.

[0013] Moreover, a controller may be coupled to at least one of the steam source and the inert gas source, the controller to selectively control a fluid flow from at least one of the steam source and the inert gas source. The controller may select whether to use inert gas only, or a combination of both inert gas and steam to the deaerator to optimize deaeration for different operating conditions of the power generation plant. In addition, the controller can control the vent opening and the amount of steam or inert gas that is vented to the atmosphere.

[0014] The power generation plant may also include a combustion turbine and an electrical generator driven thereby. The steam turbine may operate based upon waste heat from the combustion turbine. Such a power generation plant configuration is known as a combined-cycle power generation plant and is more efficient than a power generation plant running on a steam turbine alone or a power generation plant running on a combustion turbine alone.

[0015] Another aspect is directed to a deaerator for a power generation plant comprising a steam turbine and an electrical generator driven thereby, a condenser downstream from the steam turbine, and an inert gas source. The deaerator may comprise a deaerator tank and at least one spray nozzle positioned in the deaerator tank and coupled to a condenser to receive a flow of water therefrom. At least one deaeration tray is in the deaerator tank below the at least one spray nozzle. The deaerator tank is coupled to the inert gas source to receive a flow of inert gas therefrom, the flow of inert gas to deaerate the flow of water.

[0016] A method aspect is directed to a method of operating a power generation plant comprising driving an electrical generator with a steam turbine and condensing steam from the steam turbine into water with a condenser downstream of the steam turbine. The method includes operating a deaerator downstream from the condenser to deaerate the water using an inert gas source and to selectively deaerate the water using a steam source. The steam may come from the turbine exhaust, a higher pressure extraction port, or directly from the heat recovery steam generator, as appropriate to the operating conditions.

Brief Description of the Drawings

[0017] FIG. 1 is a schematic block diagram of a power generation plant in accordance with the present invention.

[0018] FIG. 2 is a schematic cross sectional view of the deaerator of the power generation plant of FIG. 1.

[0019] FIG. 3 is a schematic block diagram of an alternative embodiment of a power generation plant in accordance with the present invention.

[0020] FIG. 4 is a flowchart of a method of operating a power generation plant in accordance with the present invention.

Detailed Description of the Preferred Embodiments

[0021] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout, and prime notation is used to indicate similar elements in alternative embodiments.

[0022] Referring initially to FIGS 1-2, a power generation plant **10** is now described. The power generation plant **10** includes a steam turbine **12** and an electrical generator **13** driven thereby. A condenser **15** is coupled to the steam turbine **12** and receives a flow of steam therefrom. The condenser is illustratively an air-cooled heat exchanger in which the steam flows into tubes and is cooled by air on the outside. As the flow of steam enters the condenser **15** and flows through the cooling tubes, it is cooled thereby and condenses into liquid water (e.g. the condensate).

[0023] The condenser **15** is coupled to a condensate receiver tank **24** that receives the condensate. A condensate pump **27** pumps the condensate out of the condensate receiver tank **24** to a feedwater pump **25.** A condensate pipe **58** between the condensate pump **27** and the feedwater pump **25** is coupled to the deaerator **18** to provide a flow of condensate thereto. An adjustable valve **30** regulates the flow of condensate into the deaerator **18**.

[0024] The deaerator **18** comprises a deaerator tank **32** having a vent **43** defined therein. A valve **49** is coupled to the vent to control a fluid flow therethrough. The deaerator tank **32** also has a condensate inlet **33** defined therein to receive the condensate pumped thereto by the condensate pump **27** and through the valve **30**. The deaerator tank **32** also has a deaeration fluid inlet **39** defined therein. The deaeration fluid inlet **39** is illustratively coupled to both an inert gas source **20** and a steam source **41**, although of course, in some applications, the deaeration fluid inlet **39** may be coupled only to the inert gas source **20,** or in other cases, only to the steam source. The inert gas source **20** may be a nitrogen storage tank, for example. Other inert gas sources **20,** such as an argon gas tank, may also be used, as will be appreciated by those of skill in the art. The steam source **41** is illustratively a steam conduit carrying steam from a heat recovery steam generator **31** or an inlet or outlet of the steam turbine **12** to the deaeration fluid inlet **39**, although other steam sources, such as a boiler may also be used. Those skilled in the art will recognize that the deaeration fluid inlet **39** may be within the deaerator tank **32** and that the steam and inert gas pipes penetrate the deaerator tank **32.**

[0025] Valves **22, 23** are coupled between the ultimate steam source, the steam turbine **12** or the HRSG **31,** and the steam source **41** and the deaeration fluid inlet **39** to selectively deliver the flow of steam thereto. Similarly, a valve **21** is coupled between the inert gas source **20** and the deaeration fluid inlet **39** to selectively deliver the flow of inert gas thereto. The valves **21, 22, 23** may be suitable valves as known to those of skill in the art, and may be mechanically operated, electrically operated, or pneumatically operated.

[0026] A distribution pipe **34** is positioned at the top of the deaerator tank **32** and coupled to the condensate inlet **33** to receive the condensate therefrom and to distribute the condensate to a plurality of spray nozzles **35**. There may be a single spray nozzle **35** rather than a plurality of spray nozzles. The spray nozzles **35** may be conventional spray nozzles **35** as known to those of skill in the art.

[0027] A distributor trough **36** is in the deaerator tank **32** and under the spray nozzles **35**. A plurality of deaeration trays **37** are under the distributor trough **36**. Those of skill in the art will appreciate that there may be a plurality of distributor troughs **36**, each of a suitable shape. Likewise, there may be a single deaeration tray **37** rather than a plurality thereof. Tray support rods **38** securely locate the distributor trough **36** and deaeration trays **37** in the deaerator tank **32**.

[0028] The spray nozzles **35** spray the condensate onto the distributor trough **36**. The distributor trough **36** may uniformly spill the condensate onto the uppermost deaeration tray **37**. The condensate then cascades down through the series of deaeration trays **37** and may form a pool **40** at the bottom of the deaeration tank **32**.

[0029] The deaerator trays **37** create a large surface area for the condensate to flow over, so that liquid-vapor equilibria may be achieved for the gasses dissolved in the condensate. During operation of the deaerator **18** and the power generation plant **10**, inert gas and possibly steam flows into the deaeration tank **32** through the deaeration fluid inlet **39**. This deaeration fluid flows upward through the deaeration trays **37** and sweeps away non-condensable gasses from the surface of the condensate water as it flows over the deaeration trays **37**. In addition, the flow of deaeration fluid agitates the condensate and causes dissolved gases to separate therefrom. The deaerated water flows from an outlet **42** in the deaerator **18** to the condensate receiver tank **24** where it mixes with the non-deaerated condensate to form feedwater. Those skilled in the art will recognize that in conventional power plants, the deaerator **18** may drain to a deaerator storage tank, which may provide suction for the feedwater pump **25**.

[0030] In the illustrated embodiment, there is an additional deaeration fluid manifold **44** located at the bottom of the deaerator **18**. This deaeration fluid manifold **44** may bubble or sparge steam and/or inert gas through the pool **40** of condensate at the bottom of the deaeration tank **32** to deaerate the condensate. Likewise, the deaeration fluid inlet **39** may include an upper outlet **45** through which the deaeration fluid may flow above the deaeration trays **37** and through the condensate as it is sprayed by the spray nozzles **35**.

[0031] The use of inert gas instead of, or in addition to steam for deaeration provides a variety of advantages. For example, when the power generation plant **10** is being started after a maintenance outage, the condensate and therefore the feedwater may be saturated with dissolved gasses, such as carbon dioxide. The steam to run the steam turbine **12** will be generated from the feedwater and may be similarly saturated. Since the steam and condensate will be similarly saturated with the dissolved gases, there will be a small concentration gradient for degassing if steam and not inert gas is used as the deaeration fluid. Consequently, it may take an undesirable period of time for the levels of carbon dioxide and other dissolved gases to fall to below a threshold level.

[0032] The use of an inert gas, for example nitrogen, as a deaeration fluid allows for quicker deaeration because there will be a much larger concentration gradient (as the inert gas may not include carbon dioxide or other undesirable gases). Since an excess amount of dissolved gases in the feedwater may lead to corrosion of components of the power generation plant **10**, the ability to quickly remove such dissolved gases after a maintenance outage is particularly advantageous.

[0033] Furthermore, during normal operation of the power generation plant **10**, if steam alone is used as the deaeration fluid, an equilibrium point will be reached between the dissolved gas concentrations in the steam and the condensate. The deaerator **18** may be unable to reduce the amount of dissolved gases in the condensate below this equilibrium level, as there will be no concentration gradient between the incoming steam and the condensate. The use of the inert gas in the deaerator **18** as the deaeration fluid allows the amount of dissolved gases in the condensate to be reduced below this equilibrium level, thereby reducing the corrosion done by those dissolved gases to the components of the power generation plant **10**. In addition, when steam is used as the deaeration fluid, some of the steam may escape from the vent **43** in the deaerator tank **32**. Such a loss of steam may be undesirable.

[0034] An optional controller **26** is illustratively coupled to each of the valves **21, 22, 23** to selectively regulate the flow of steam and/or inert gas to the deaeration fluid inlet **39**. Likewise, the controller **26** is coupled to valve **30** to regulate the flow of condensate into the deaerator **18.** The controller **26** is also coupled to valve **49** to regulate the flow is fluid through the vent **43**.

[0035] The controller **26** may electrically operate the valves **21, 22, 23, 30, 49** or, alternatively, may pneumatically operate the valves. In addition, the valves **21, 22, 23, 30, 49** may be operated manually rather than by the controller. The controller **26** may select whether inert gas only, or a combination of steam and inert gas flows into the deaeration fluid inlet **39** to deaerate the condensate. In addition, the controller **26** may operate the valves **21, 22, 23** to provide differing amounts of steam and/or inert gas to the deaerator **18** to match an operating condition of the power generation plant **10**. For example, as explained above, after a maintenance outage, it is particularly helpful for nitrogen to be used as a deaeration fluid during deaeration. Indeed, it may be desirable for only inert gas to be used as a deaeration fluid for a period of time after a maintenance outage.

[0036] The controller **26** may control valve **49** coupled to the vent **43** to maintain a positive pressure in the deaerator **18**. The valve **49** limits the flow of steam or inert gas out of the vent **43**, and thereby the total quantity used. When the condensate is very contaminated, the controller **26** may control the valve **49** to be open. When the condensate is close to the desired composition, the valve **49** may be nearly closed. Intermediate positions are of course possible, as appropriate. If neither steam nor inert gas is flowing to the deaerator, the valve **49** may be entirely closed.

[0037] There may be one or more sensors (not shown) in a component of the power generation plant **10**, for example the heat recovery steam generator, and the controller **26** may selectively provide steam and/or inert gas to the deaerator **18** based upon readings of the sensors. For example, if the sensors sense that the concentration of carbon dioxide in the steam is higher than a threshold value, the controller **26** may increase the flow of inert gas to the deaerator **18**. Likewise, if the sensors sense that the concentration of carbon dioxide in the steam is lower than a threshold value, the controller **26** may decrease the flow of inert gas to the deaerator **18** and may increase the flow of steam thereto.

[0038] Those of skill in the art will recognize that the type of deaerator **18** disclosed described in detail herein is a spray-tray deaerator. The spray-tray deaerator **18** is effective because it incorporates three deaerating mechanisms (e.g. spraying the condensate, spilling the condensate over a series of deaeration trays **37**, and sparging a deaeration fluid through the pool **40** of condensate). It is to be understood, however, that other types of deaerators **18** may be utilized by the present invention, such as spray, tray, and spray-scrubber.

[0039] The power generation plant **10** illustratively includes an optional combustion turbine **28** and an electrical generator **29** coupled thereto. The combustion turbine **28** may be of a type known to those of skill in the art and may burn natural gas, oil, gassified coal, or other fuels. Waste heat from the combustion turbine **28** is fed to the heat recovery steam generator **31** coupled thereto. The heat recovery steam generator **31** generates steam by heating feedwater provided thereto by the feedwater pump **25** with the waste heat from the combustion turbine **38**. Those of skill in the art will recognize that the heat recovery steam generator **31** may also have an internal or external heater to heat the feedwater in the heat recovery steam generator **31**. The steam from the heat recovery steam generator **31** drives the steam turbine **12**.

[0040] Those of skill in the art will understand that a boiler may be used to generate steam to run the steam turbine **12** instead of the heat recovery steam generator **31.** Accordingly, the combustion turbine **28** is therefore optional.

[0041] With reference to FIG. 3, an alternative embodiment of a power generation plant **10'** is now described. In this embodiment, the condenser **15'** is a water-cooled heat exchanger and comprises a condenser tank **15'** through which a series of coolant tubes run. A coolant, typically water from a cooling tower, is pumped through the coolant tubes. As the flow of steam enters the condenser **15'** and flows across the coolant tubes, it is cooled thereby and condenses into liquid water (e.g. the condensate). The condensate flows from the condenser **15'** into a hotwell **48'**. A condensate pump **27'** pumps the condensate out of the hotwell **48'**. Those other elements not specifically mentioned are indicated with prime notation and are similar to the elements described above with reference to FIGS. 1-2. Accordingly, those other elements require no further description herein.

[0042] With reference to FIGS. 1-2, a method of starting a power generation plant 10 is now described. If the condensate contains more undesirable dissolved gases than are desired, the condensate is sprayed into the deaerator **18**. No steam is available because the power generation plant **10** has not been started, but inert gas may be used in the deaerator **18** to remove the undesired gases. When the undesirable gases are reduced to a desired concentration, the power plant **10** may then be started. This method protects the power plant **10** from an initial surge of undesirable dissolved gases while steam is first being generated.

[0043] With reference to the flowchart **50** of FIG. 4, a method of operating a power generation plant **10** is now described. After the start (Block **52**), at Block **54**, an electrical generator **13** is driven by a steam turbine **12.** At Block **56**, steam from the steam turbine **12** is condensed into water by a condenser **15** downsteam of the steam turbine. At Block **58**, a deaerator **18** is operated downstream from the condenser **15** to deaerate the water using an inert gas source **20** and to selectively deaerate the water using a steam source **41.** Block **60** indicates the end of the method.

[0044] Although the deaerator **18** has been described with reference to its use in a power generation plant **10**, those skilled in the art will recognize that the deaerator may also be used in other applications, such as a steam plant.

[0045] Many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that the invention is not to be limited to the specific embodiments disclosed, and that modifications and embodiments are intended to be included within the scope of the appended claims.

THAT WHICH IS CLAIMED IS:

1. A power generation plant comprising:

a steam turbine and an electrical generator driven thereby;

a condenser downstream from said steam turbine;

a steam source;

an inert gas source; and

a deaerator downstream from said condenser and being operable to perform deaeration using said inert gas source and also being selectively operable to perform deaeration using said steam source.

2. The power generation plant of Claim 1 wherein said inert gas source comprises a nitrogen gas source; wherein said deaerator comprises a deaerator tank; and wherein *nitrogen from the nitrogen gas source* is introduced into a bottom of said deaerator tank

3. The power generation plant of Claim 1 wherein said deaerator comprises a deaerator tank; and further comprising at least one spray nozzle in said deaerator tank and coupled to the condenser to receive a flow of water therefrom.

4. The power generation plant of Claim 3 further comprising at least one distributor trough in said deaerator tank below said at least one spray nozzle.

5. The power generation plant of Claim 4 further comprising at least one deaeration tray in said deaerator tank below said at least one distributor trough.

6. The power generation plant of Claim 1 further comprising a controller coupled to at least one of said steam source and said inert gas source, said controller to selectively control a fluid flow from at least one of said steam source and said inert gas source.

7. The power generation plant of Claim 6 wherein said deaerator comprises a deaerator tank and a vent therein; and wherein the controller is also coupled to said vent to selectively control a fluid flow therethrough.

8. The power generation plant of Claim 1 further comprising a combustion turbine and an electrical generator driven thereby; and wherein said steam turbine operates based upon waste heat from said combustion turbine.

9. The power generation plant of Claim 1 further comprising a condensate receiver tank coupled to said condenser; wherein a first amount of water flows from said condenser to said deaerator; and wherein a second amount of water flows from said deaerator to said condensate receiver tank, the second amount being greater than the first amount.

10. A deaerator comprising:

a deaerator tank;

at least one spray nozzle positioned in said deaerator tank to be coupled to a condenser to receive a flow of water therefrom; and

at least one deaeration tray positioned in said deaerator tank below said at least one spray nozzle;

said deaerator tank to be coupled to an inert gas source to receive a flow of inert gas therefrom, the flow of inert gas to deaerate the flow of water.

11. The deaerator of Claim 10 wherein said inert gas source comprises a nitrogen gas source; and wherein nitrogen from the nitrogen gas source is introduced into a bottom of said deaerator tank.

12. The deaerator of Claim 10 further comprising at least one distributor trough in said deaerator tank above said at least one deaeration tray.

13. A method of operating a power generation plant comprising:

driving an electrical generator with a steam turbine;

condensing steam from the steam turbine into water with a condenser downstream of the steam turbine; and

operating a deaerator downstream from the condenser to deaerate the water using an inert gas source and to selectively deaerate the water using a steam source.

14. The method of Claim 13 wherein the inert gas source comprises a nitrogen gas source.

15. The method of Claim 13 further comprising selectively controlling a fluid flow from at least one of the steam source and the inert gas source using a controller coupled to at least one of the steam source and the inert gas source.

16. The method of Claim 13 wherein the fluid flow is selectively controlled based upon at least one operating condition of the power generation plant.

17. The method of Claim 13 wherein the deaerator comprises a deaerator tank and a vent therein; and further comprising selectively controlling a fluid flow from the vent using a controller coupled thereto.

18. The method of Claim 13 wherein the deaerator comprises a deaerator tank; and wherein the deaerator further comprises at least one spray nozzle in the deaerator tank and coupled to the condenser to receive a flow of water therefrom.

19. The method of Claim 18 wherein the deaerator further comprises at least one distributor trough in the deaerator tank below the at least one spray nozzle.

20. The method of Claim 19 wherein the deaerator further comprises at least one deaeration tray in the deaerator tank below the at least one distributor trough.

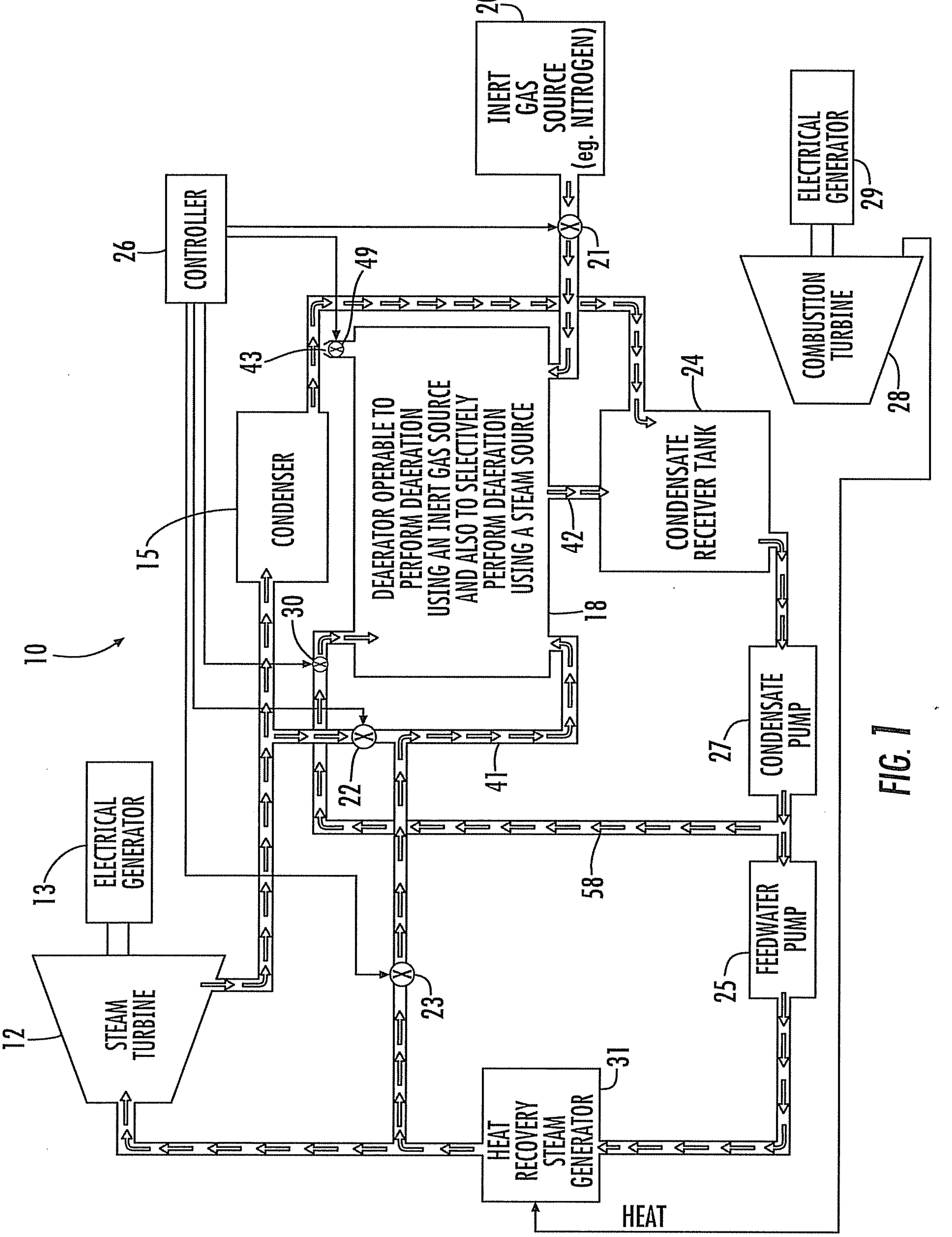
INERT GAS SOURCE (eg. NITROGEN)
20
CONTROLLER
26
21
49
43
ELECTRICAL GENERATOR
29
COMBUSTION TURBINE
28
DEAERATOR OPERABLE TO PERFORM DEAERATION USING AN INERT GAS SOURCE AND ALSO TO SELECTIVELY PERFORM DEAERATION USING A STEAM SOURCE
18
CONDENSER
15
24
CONDENSATE RECEIVER TANK
42
30
10
22
41
CONDENSATE PUMP
27
58
ELECTRICAL GENERATOR
13
FEEDWATER PUMP
25
STEAM TURBINE
12
23
HEAT RECOVERY STEAM GENERATOR
31
HEAT

FIG. 1

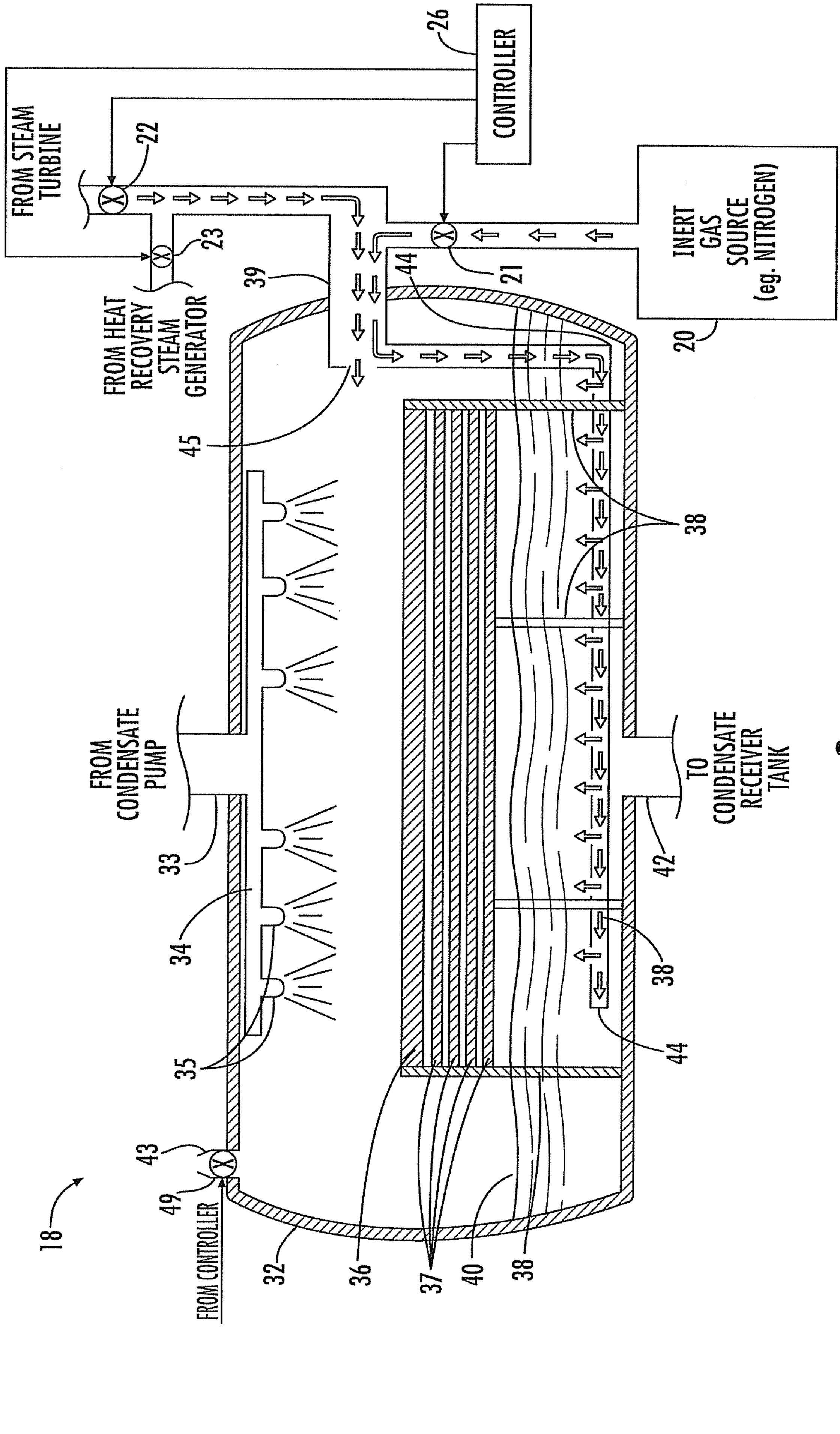
CONTROLLER
26
FROM STEAM TURBINE
22
23
FROM HEAT RECOVERY STEAM GENERATOR
21
INERT GAS SOURCE (eg. NITROGEN)
20
39
44
45
38
FROM CONDENSATE PUMP
33
34
35
TO CONDENSATE RECEIVER TANK
42
44
43
49
FROM CONTROLLER
18
32
36
37
40
38

FIG. 2

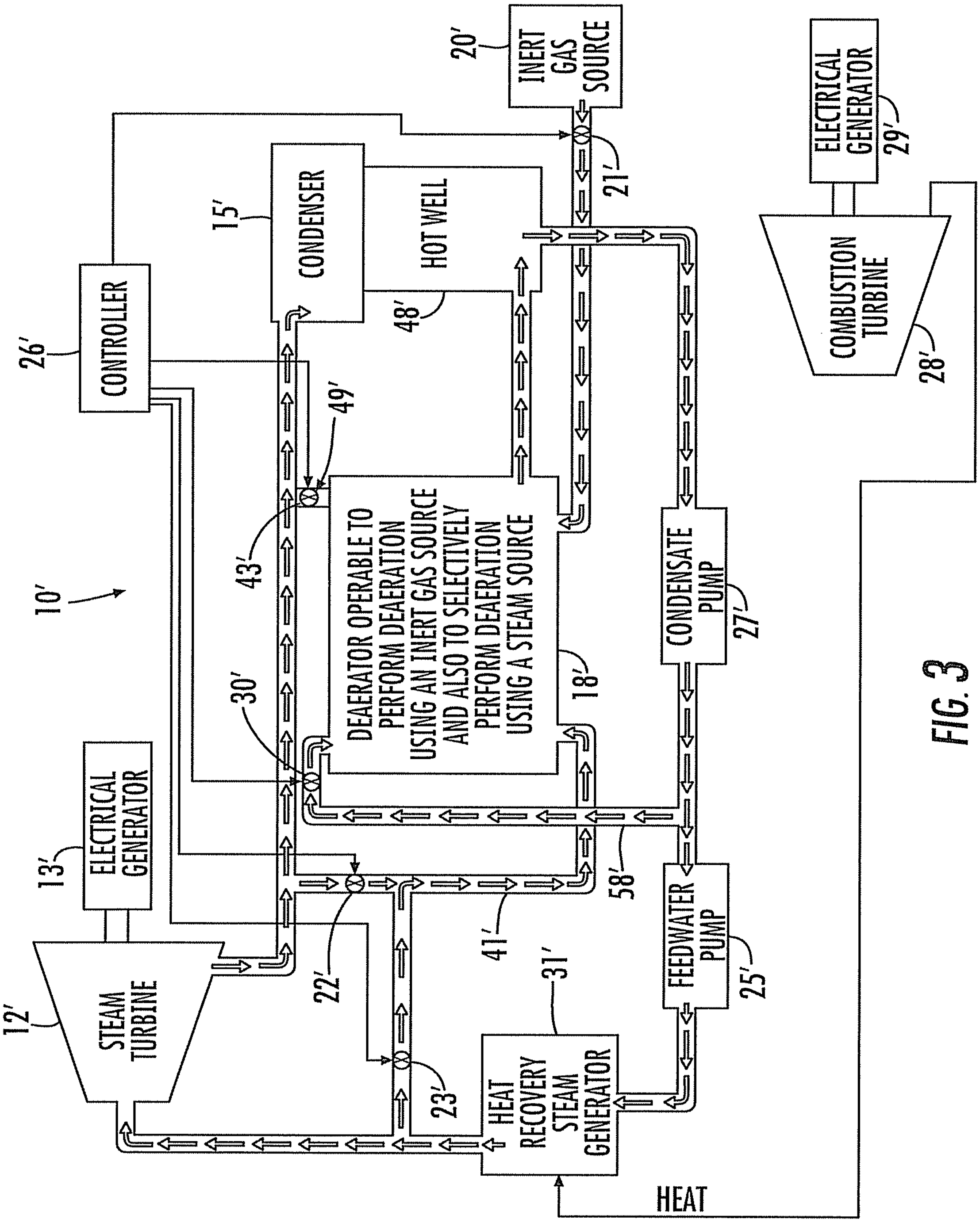
10'
20'
INERT GAS SOURCE
21'
ELECTRICAL GENERATOR
29'
COMBUSTION TURBINE
28'
CONTROLLER
26'
CONDENSER
15'
HOT WELL
48'
49'
43'
DEAERATOR OPERABLE TO PERFORM DEAERATION USING AN INERT GAS SOURCE AND ALSO TO SELECTIVELY PERFORM DEAERATION USING A STEAM SOURCE
18'
CONDENSATE PUMP
27'
30'
58'
ELECTRICAL GENERATOR
13'
STEAM TURBINE
12'
22'
41'
31'
FEEDWATER PUMP
25'
23'
HEAT RECOVERY STEAM GENERATOR
HEAT

FIG. 3

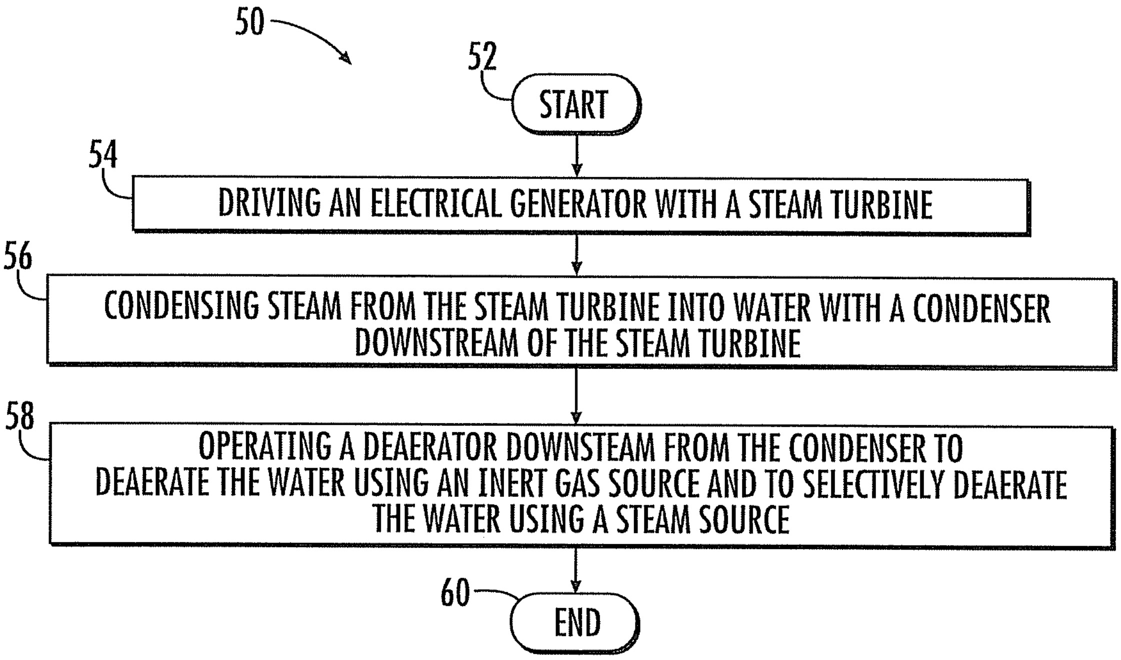
50
52
START
54
DRIVING AN ELECTRICAL GENERATOR WITH A STEAM TURBINE
56
CONDENSING STEAM FROM THE STEAM TURBINE INTO WATER WITH A CONDENSER DOWNSTREAM OF THE STEAM TURBINE
58
OPERATING A DEAERATOR DOWNSTEAM FROM THE CONDENSER TO DEAERATE THE WATER USING AN INERT GAS SOURCE AND TO SELECTIVELY DEAERATE THE WATER USING A STEAM SOURCE
60
END

FIG. 4