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(54) UTILIZATION OF EXHAUST OF LOW PRESSURE CONDENSING STEAM TURBINE AS HEAT INPUT TO SILICA GEL-WATER WORKING PAIR ADSORPTION CHILLER

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(57) **ABSTRACT**

A device and method for utilizing waste heat from the exhaust of a low pressure condensing steam turbine. An adsorption chiller is driven by heat recovered from the exhaust steam by incorporating a heat exchanger between the low pressure condensing steam turbine and the condenser of the steam turbine. The heat exchanger provides heated fluid which is then utilized as the hot water for the adsorption chiller. The adsorption chiller outputs chilled water which may be beneficially used for many purposes in the power plant.

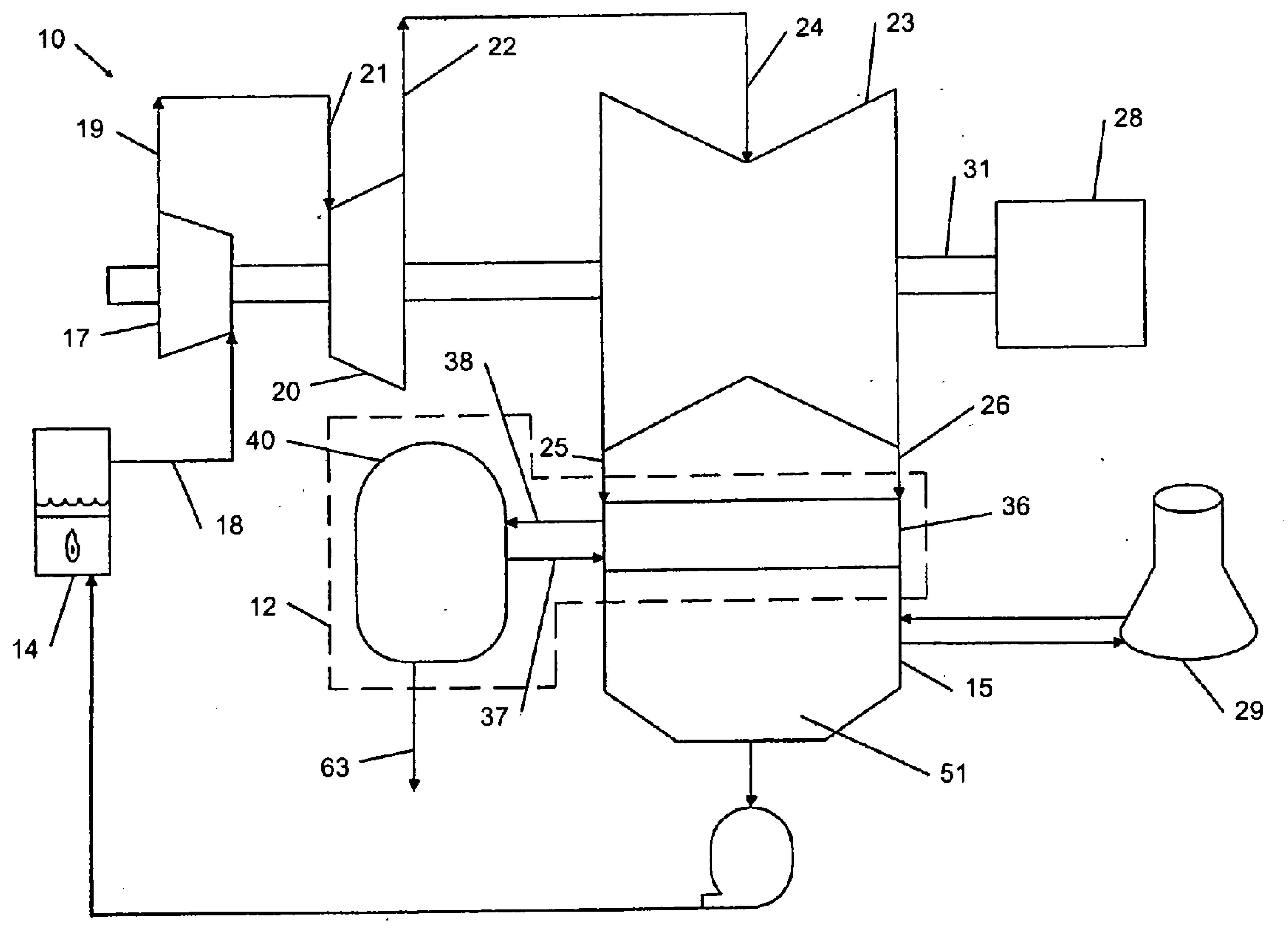


FIG. 1

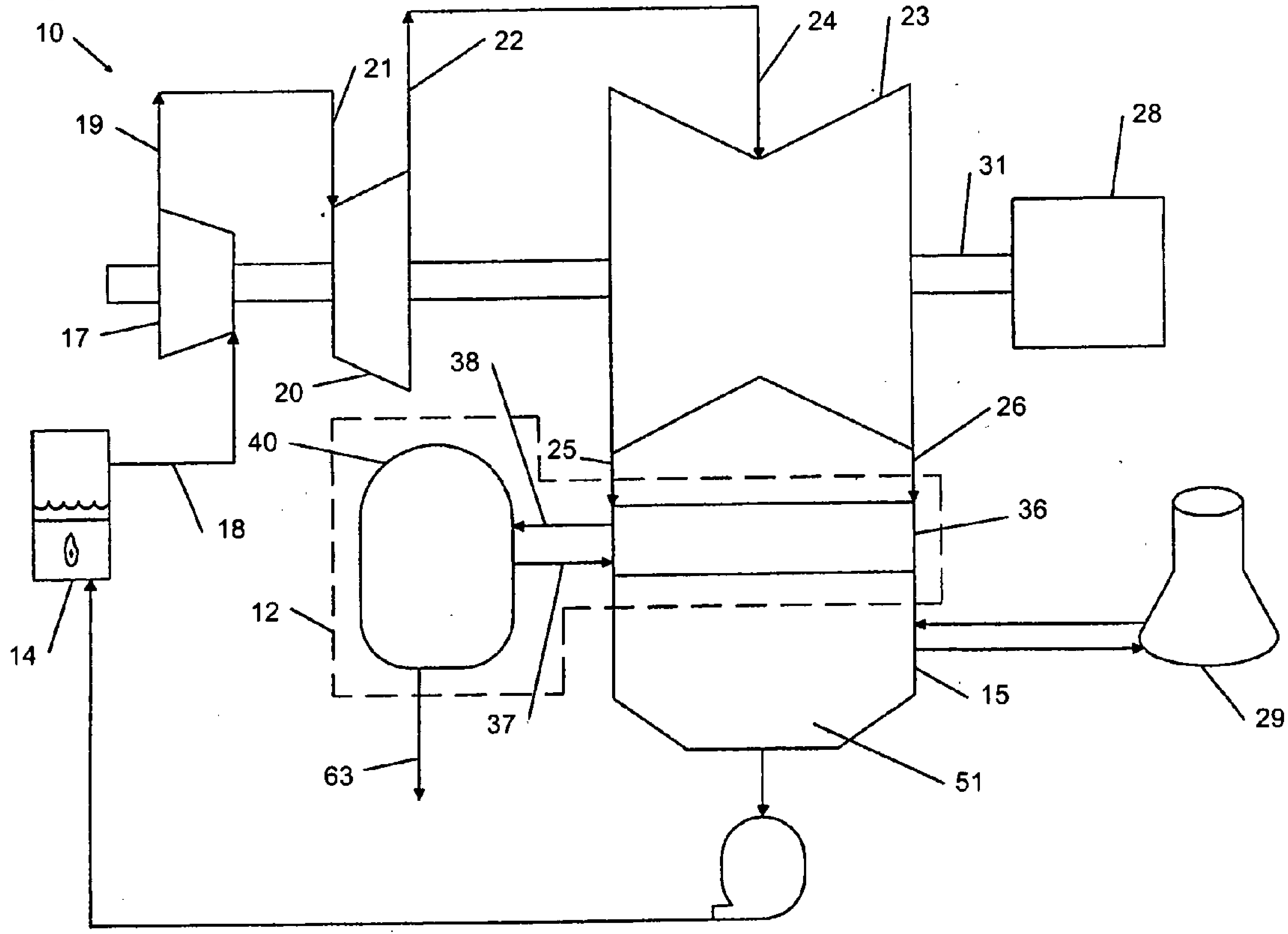
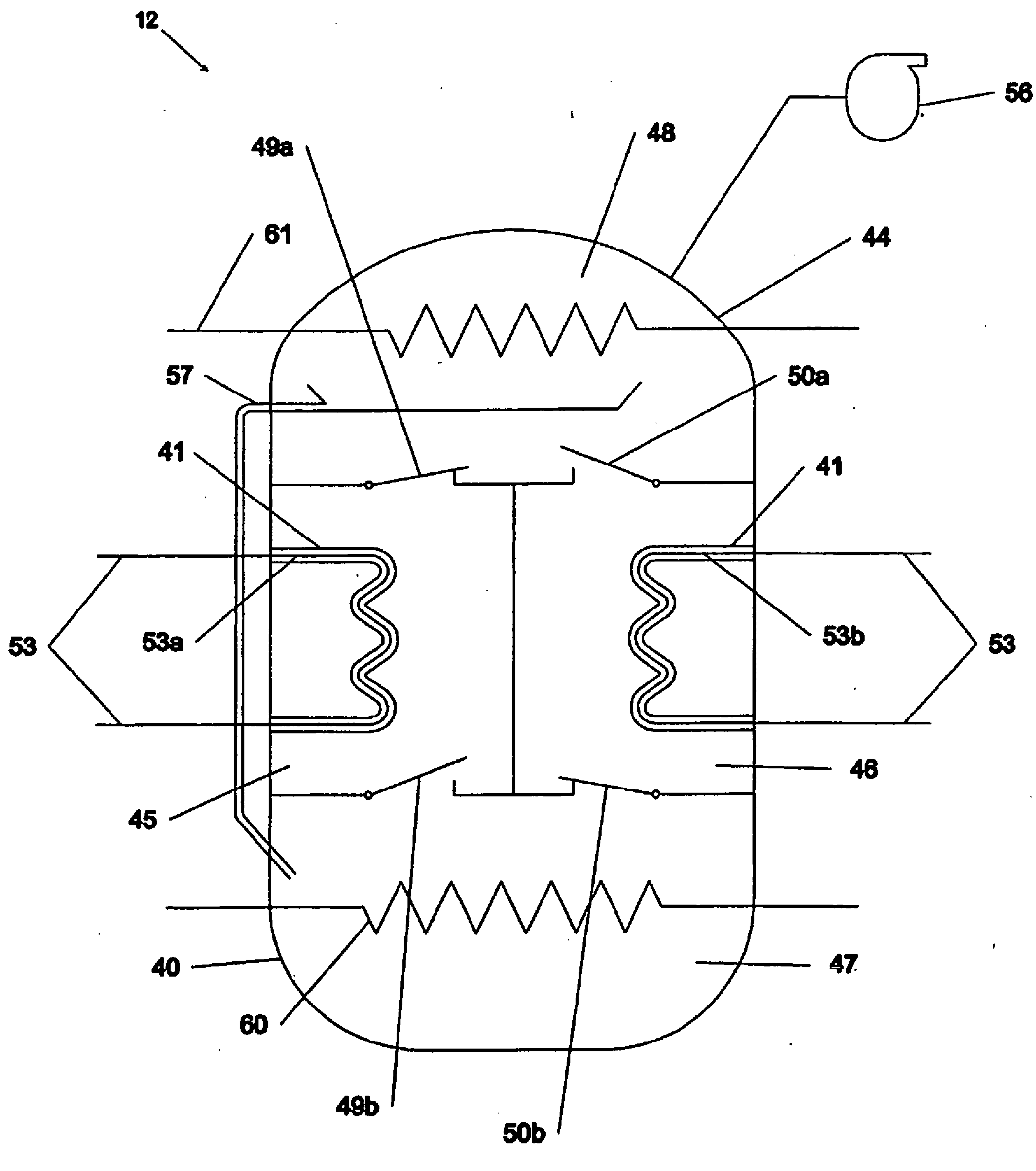


FIG. 2



UTILIZATION OF EXHAUST OF LOW PRESSURE CONDENSING STEAM TURBINE AS HEAT INPUT TO SILICA GEL-WATER WORKING PAIR ADSORPTION CHILLER

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to steam turbines. A steam turbine is a mechanical device that converts thermal energy in pressurized steam into useful mechanical work. The steam turbine derives much of its thermodynamic efficiency through the use of multiple stages in the expansion of the steam.

[0002] Specifically, this invention relates to the utilization of low quality heat from the exhaust of a low pressure condensing steam turbine as the heat input to a silica gel-water working pair adsorption chiller to further improve the efficiency of the heat utilization of simple steam turbines and/or a combined cycle power plant.

[0003] This invention relates to a means of using a portion or all of the exhausted saturated steam that is currently expelled as waste from a steam turbine as the heat input to an adsorption chiller, preferably a silica gel-water working pair adsorption chiller. The product of the adsorption chiller (cold water) can be used for a variety of useful purposes such as industrial process cooling, air conditioning or gas turbine inlet cooling in a combined cycle plant.

[0004] The source of the steam for the steam turbine may come from a combined cycle plant consisting of one or more gas turbines matched to a steam turbine or from another other boiler process fired by fuel choices such as coal, oil, natural gas or nuclear power.

BRIEF SUMMARY OF THE INVENTION

[0005] The exhaust of a low pressure condensing steam turbine is a mixture of water and steam. It is at a temperature and pressure that are considered too low to provide any further value as steam for the turbine. The normal design of current turbine systems dumps this exhaust to a water-cooled surface condenser as waste heat. The condenser converts the exhaust back to water and, in doing so, the condensation of the steam and the change of state of the steam from a vapor to water creates a partial vacuum that helps pull the exhaust through the last stages of the low pressure turbine. The temperature of the exhaust as it exits the turbine is normally in the range of about 111°-125° C. (about 231°-257° F.). At that temperature in a partial vacuum, the exhaust is difficult to use effectively because it is a mixture of saturated steam and water at very low enthalpy. The resulting condensate in the "hot well" of the condenser is collected as condensate water for recirculation. The temperature of the condensate water has been reduced to about 40.5° C. (about 105° F.), a little above ambient temperature. During condensation, the heat is captured by the water tubes in the condenser and is transferred to a heat rejection device, often an evaporative (wet) cooling tower or simple circulation through river water. A cooling tower will transfer the heat a second time from the water to the surrounding atmosphere in the form of higher air temperature and higher humidity. Alternately, circulating the heated water from the condenser through lines through river water will transfer the heat a second time from the water in the water tubes to the surrounding river water in the form of higher water temperature.

[0006] The present invention provides a method and device to make use of the exhaust steam previously considered waste. The temperature of the exhaust steam is just above an ideal starting temperature for an adsorption chiller. This disclosure describes a method of extracting the heat in this exhaust steam and using it as one of the drivers for an adsorption chiller.

[0007] Adsorption chillers are ideally matched to a hot water source that is just below boiling temperature, at approximately 194° F./90° C. Hence the exhaust from a low-pressure turbine has the potential to provide for one more purpose, driving an adsorption chiller.

[0008] It is therefore an object of the present invention to improve the efficiency of conventional steam turbine plants by making more efficient use of the heat of the exhaust steam.

[0009] It is another object of the present invention to utilize one or more of the condenser's waterboxes to provide hot water for circulation through an adsorption chiller.

[0010] It is another object of the present invention to provide a heat exchanger intermediate to the low-pressure steam turbine and the condenser to capture heat from the exhaust steam to provide hot water to be circulated through an adsorption chiller.

[0011] It is another object of the present invention to provide a steam turbine having an adsorption chiller system intermediate to the low pressure turbine and the condenser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The particular features and advantages of the invention as well as other objects will become apparent from the following description taken in connection with the accompanying drawings in which:

[0013] FIG. **1** is a block diagram of a condensing steam turbine including the adsorption chiller system of the present invention.

[0014] FIG. **2** is a schematic of an adsorption chiller system suitable for use in the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] FIG. **1** is a block diagram of a conventional condensing steam turbine **10** which includes an adsorption chiller system **12** for usefully capturing the waste heat of the exhaust steam. Condensing steam turbines **10** are most commonly found in electrical power plants. A steam turbine plant consists of one or more steam turbines **10** operating in a Rankine cycle. The exhaust steam exiting such turbines **10** is in a partially condensed state, typically of a quality near 95%, at a pressure well below atmospheric. Steam quality is the proportion of saturated steam in a saturated water/steam mixture.

[0016] With the exception of the adsorption chiller system **12**, steam turbines **10** are known in the art and include, in serial flow relationship, a source of high pressure steam **14**, one or more steam turbines, such as high-pressure turbine **17**, intermediate-pressure turbine **20**, and low-pressure turbine **23**. Low-pressure turbine **23** is typically double ended as illustrated in FIG. **1**, with steam flow going in both axial directions. High-pressure turbine **17** and intermediate-pressure turbine **20** are non-condensing while low-pressure turbine **23** is condensing.

[0017] The source **14** of the steam may come from a combined cycle plant consisting of one or more gas turbines matched to a steam turbine **10** or from another boiler process fired by fuel choices such as coal, oil, natural gas or nuclear.

[0018] High-pressure turbine **17**, intermediate-pressure turbine **20** and low-pressure turbine **23** are operatively connected to a rotor shaft **31** to turn a generator **28**. All turbines **17**, **20**, **23** of a steam turbine **10** are typically coupled in series to jointly drive rotor shaft **31** to drive the generator **28**, though alternate configurations are within the contemplation of this invention. High-pressure turbine **17** includes an inlet **18** and an outlet **19**. Intermediate-pressure turbine **20** includes an inlet **21** and an outlet **22**. Low-pressure turbine **23** includes an inlet **24** and one or more outlets **25**, **26**.

[0019] High-pressure steam enters the inlet **18** of high-pressure turbine **17**. Higher pressure in front of the turbine and lower pressure behind the turbine creates a pressure gradient, which the steam follows through the impellers of the turbine, delivering kinetic energy to the impellers to turn the turbine and cooling down in the process. Intermediate pressure steam exits through outlet **19** and is channeled to the inlet **21** of intermediate-pressure turbine **20**. Again, a pressure gradient is formed across the impellers of the turbine **20**, and the impellers are turned as the steam travels through, exiting the intermediate-pressure turbine at outlet **22** as lower pressure steam and being channeled to the inlet **24** of low-pressure turbine **23**. The low pressure steam travels through the low-pressure turbine or turbines **23** and exits as exhaust steam through outlets **25**, **26**. As it travels through the condensing steam turbine **10**, the steam crosses the saturation line and becomes saturated steam with ever decreasing quality as the steam flows.

[0020] In the present invention, all or a portion of the exhaust steam is directed from the outlets **25**, **26** of the low-pressure turbine **23** to a chiller heat exchanger **36** for providing or producing a heated fluid, such as water, to adsorption chiller **40**. Chiller heat exchanger **36** may be any type of conventional heat exchanger, such a shell and tube heat exchanger, a plate heat exchanger, or any other suitable means for extracting heat from steam and outputting a flow of hot fluid that can be directed to an adsorption chiller **40**.

[0021] In a preferred embodiment of the present invention, the chiller heat exchanger **36** comprises a water-cooled surface condenser such as those typically used as the condenser **15** of the steam turbine **10** in present steam turbine plants. The present invention may be practiced by adding one or more additional water-cooled surface condensers connected via an isolated or isolatable inlet **37** and outlet **38** to the adsorption chiller **40** intermediate or between the low-pressure turbine **23** and the condenser **15** of the steam turbine **10**, or, alternatively, the heated fluid from one or more existing portions of the existing steam turbine condenser **15** may be redirected to provide hot water to the adsorption chiller **40**.

[0022] As will be explained in greater detail below, the adsorption chiller system **12** utilizes the hot water or other heated fluid generated by the chiller heat exchanger **36** to drive an adsorption chiller **40**, preferably a silica gel-water working pair adsorption chiller **40**. Adsorption chillers may also utilize other substances as the working pair, such as water and zeolite, ammonia and water, hydrogen and certain metal hydrides, activated carbon and a number of fluids, are a few of the available working pairs. While each type of working pair could theoretically be used, the silica gel-water working pair has been found to be preferable for the present invention based upon its range of working temperatures and the simplicity of its chemistry.

[0023] The adsorption chiller **40** produces as its output **63** chilled or cold water what can be put to beneficial use, such as industrial process cooling, air conditioning or gas turbine inlet cooling in a combined-cycle plant. The adsorption chiller system **12** utilizes the exhaust steam to extract additional work from the latent waste heat before the exhaust steam is finally directed into the condenser **15** of the steam turbine **10**. The exhaust steam itself cannot be channeled directly into the adsorption chiller system **12** as it is not a liquid and too hot. The temperatures inside the adsorption section of the chiller must be limited to lower ranges than the temperatures reached by the exhaust steam. Additionally, it would not be desirable to have to design the adsorption chiller to accommodate the high pressures reached by the exhaust steam.

[0024] Condensation from the chiller heat exchanger **36** is passed or channeled to the hotwell **51** of the condenser **15** for collection, but instead of merely rejecting all of the heat captured from the condensing steam to a cooling tower **29** or other heat sink as waste, the chiller heat exchanger **36** utilizes some of the heat captured from the steam as the heat source for driving the adsorption chiller **40**.

[0025] Exhaust steam not condensed at the chiller heat exchanger **36** is directed to the connected steam turbine condenser **15** which condenses and reclaims the water from the exhaust steam while rejecting waste heat from the exhaust steam and transferring it to the cooling tower **29**.

[0026] The exhaust of a low pressure condensing steam turbine **23** is a mixture of water and steam. The temperature of the exhaust as it exits the turbine is normally in the range of about 111°-125° C. (about 231°-257° F.). Adsorption chillers are ideally matched to a heated fluid or hot water source that is just below boiling temperature, having a temperature of about 85° C. to about 92° C., preferably at approximately 90° C. (194° F.) but may also make use of a hot water source having a temperature as low as about 50° C. (122° F.). At temperatures below about 50° C., the desorption phase become too long to be useful. Chiller heat exchanger **36** will produce hot water in the desired temperature range in the presence of exhaust steam in the range of about 90° C.

[0027] FIG. **2** is a schematic of an adsorption chiller system **12** suitable for use in the present invention. Numerous known designs of adsorption chillers are also within the contemplation of the present invention. An adsorption chiller system **12** uses an adsorbent **41** which can be regenerated. The presently preferred adsorbent is a silica gel.

[0028] An adsorption chiller **40** comprises in principle a pressure vessel **44** divided into a plurality of chambers, at least two or more adsorbent heat exchanger chambers **45**, **46** located between a lower evaporator chamber **47** (also referred to as simply an evaporator) and an upper condenser chamber **48** (also referred to as simply a condenser). The adsorbent heat exchanger chambers **45**, **46** are each connected to the condenser **48** and evaporator **47** by one or more valves **49***a*, **49***b* and **50***a*, **50***b*.

[0029] Each adsorbent heat exchanger chamber **45**, **46** contains a portion **53***a*, **53***b* of adsorption heat exchanger circuit **53** comprising tubing to carry fluid. Adsorption heat exchanger circuit **53** is a reversible circuit operatively connected to the chiller heat exchanger **36** (shown in FIG. **1**) and a pumping means for moving the fluid through the circuit. The portions **53***a*, **53***b* of adsorption heat exchanger circuit **53** within adsorbent heat exchanger chambers **45**, **46** are packed with an adsorbent **41**, preferably silica gel.

[0030] A chilling-water circuit **60**, comprising tubing to carry fluid, passes through the evaporator **47**. A cooling-water circuit **61**, comprising tubing to carry fluid, passes through the condenser **48**. Many alternative plumbing layouts with various configurations of tubing and valves are well known in the adsorption chiller art, and their use is within the contemplation of the present invention. All that is necessary is for hot water to be directed through one of the adsorption heat exchanger chambers **45** or **46** while running cooling water through the other adsorption heat exchanger chamber **45** or **46** and the condenser chamber **48**. The condenser **48** and evaporator **47** are connected by a return **57** for returning condensed water from the condenser **48** to the evaporator **47**.

[0031] When the adsorption chiller system **12** is first started, the pressure vessel **44** is evacuated using an evacuation pump **56**. Once started, an adsorption chiller **40** operates automatically on a four step cycle. First, hot water is introduced into one adsorption heat exchanger chamber **45** through the heat exchanger circuit portion **53***a*. This de-adsorbs (or desorbs or dries) the silica gel **41** in this chamber **45**. This forces the water vapor to open valve **49***a* and enter the condenser chamber **48**. Water vapor in the condenser contacts the cooling water circuit **61** where it condenses back into water. The water is then returned to the evaporator by way of the return **57**. When the drying of the adsorption heat exchanger chamber **45** is complete, the water flowing through the adsorption heat exchanger circuit **53***a* is switched from hot water to cooling water by means of external piping not described here. Cool, dry silica gel **41** has a large affinity to capture water vapor and will capture all of the available water vapor from the adsorption heat exchanger chamber **45**, reducing the pressure in this chamber, closing valve **49***a* and allowing the valve **49***b* to open.

[0032] Water evaporates in a vacuum at room temperature and thereby extracts heat from its surroundings. The evaporation of water introduced into in the evaporator chamber **47** chills the water flowing through the tubes in the chilling circuit **60**. The output of this useful cold water in the chilling circuit **60** is the product of the adsorption chiller system **12** and may be put to use for many desirable purposes.

[0033] The evaporated water passes through an opened valve **49***b* into adsorbent heat exchanger chamber **45** and is adsorbed into the adsorbent silica gel **41**. Cool water is circulated in this chamber through the adsorption heat exchanger circuit **53***a* to remove the heat deposited in this chamber **45** by the adsorption process. The adsorption process creates a slight decrease in pressure, creating a small vacuum differential between the evaporator chamber **47** and adsorbent heat exchanger chamber **45** that pulls evaporated water from the evaporator **47** through valve **49***b* and into the adsorbent heat exchanger chamber **45**.

[0034] When adsorbent heat exchanger chamber **45** is in the adsorption cycle, adsorbent heat exchanger chamber **46** is in the de-adsorption cycle; water in chamber **46** that has been adsorbed into the adsorbent **41** is driven from the adsorbent **41** by the circulation of hot water through the portion **53***b* of adsorbent heat exchanger circuit **53** running through chamber **46**. The de-adsorbed water vapor rises and exits adsorbent heat exchanger chamber **46** through opened valve **50***a*, entering the condenser **48** where it is condensed by the cool water circulating through the cooling water circuit **61**. The cool water in the cooling water circuit **61** gains heat through the condensing process, which excess heat is transferred to the heat sink **29** (shown in FIG. **1**) of the plant, thereby adding to the total heat load to be dissipated through the heat sink **29**. The condensed water collects in the condenser **48** and is recycled through return **57** to the evaporator **47** where it is available for reuse in the adsorption process.

[0035] When an adsorbent heat exchanger chamber **45** is in the adsorption cycle, the pressure in that chamber **45** is slightly lower than in the evaporator chamber **47**, accordingly, a portion of the refrigerant, water, evaporates and is pulled into the adsorbent heat exchanger chamber **45**. At the same time, the pressure in the other adsorbent heat exchanger chamber **46** in the de-adsorption cycle, is slightly elevated as the water vapor is driven from the silica gel. That de-adsorbed water vapor in pulled into the condenser chamber **48** which has a lower pressure.

[0036] When the silica gel in the adsorption cycle chamber **45** is saturated with water and the silica gel in the de-adsorption cycle chamber **46** is dry, the adsorption chiller **40** automatically switches the adsorbent heat exchanger chambers **45** and **46** between adsorbing and desorbing by exchanging the flow of hot and cool water. The flow of hot water through the adsorption heat exchanger circuit **53** is switched from flowing through the portion **53***b* of the adsorption heat exchanger chamber **46** to flowing through the portion **53***a* to begin the de-adsorption process in adsorption heat exchanger chamber **45**. Cool water that was running through the portion **53***a* of the adsorption heat exchanger chamber **45** is switched to flow through portion **53***b* of adsorption heat exchanger **46** to begin the adsorption process. Valves **49***a*, **49***b*, **50***a* and **50***b* are preferably one-way valves which are actuated to their opposite condition (i.e., opened or closed) based upon changes in the air pressure differentials in the chambers on opposing sides of the valves. For example, when heat exchanger chamber **46** is in the de-adsorption cycle, valve **50***a* is pushed open by the increase in air pressure within heat exchanger chamber **46** due to the de-adsorption of water from the gel **41**, but valve **50***b* is held closed by this same pressure. As an adsorption cycle begins in heat exchanger **46**, the adsorption of water from the vapor creates a partial vacuum which pulls closed the valve **50***a* between the adsorption cycle chamber and the condenser chamber **48** but pulls open the valve **50***b* between the evaporator chamber **47** and heat exchanger chamber **46**, thereby allowing for the proper flow of vapor through the adsorption chiller **12**. Thus it can be seen that the adsorption chiller **12** requires only the switching of the flow of hot and cool water to function, but does not otherwise require the application of any power to properly function.

[0037] An adsorption chiller **40** is capable of operating with a wide range of temperatures for the hot, the cool and the cold water. Cycles are generally run for pre-determined amounts of time, depending on the conditions presented. In a presently preferred embodiment, peak performance is obtained when the hot water is about 90° C. (194 F), the cool water about 29.4° C. (85° F.) and the output cold water at about 3.3°-4.4° C. (about 38°-40° F.).

[0038] The utilization of some or all of the heat from the top of the condenser **15** of the steam turbine **10** to drive the adsorption chiller **40** changes neither the eventual temperature of the output of the condenser **15**, nor the condensate water at the bottom. The condensate water will still be slightly above ambient air temperature. The exhaust steam will still be fully condensed, so the partial vacuum created in the condenser **15** will remain the same. The use of some of the heat for the adsorption chiller **40** will neither impact the performance of the condenser **15**, nor the low pressure turbine **23**, nor the steam turbine as a whole.

[0039] When the adsorption chiller system **12** of the present invention is initially engaged, the thermal load on the cooling tower **29** is initially reduced because of the heat load transferred to the adsorption chiller **40** through the chiller heat exchanger **36**. However, all of the heat extracted for the adsorption chiller **40**, plus the heat extracted from the chilled water generated by the adsorption chiller **40** is returned back to the cooling tower **29** from the adsorption chiller **40**.

[0040] The cold chilled water output from the adsorption chiller **40** may be used in a variety of applications inside and outside the power plant. If the power plant is a combined cycle power plant, then it includes one or more gas turbines that are paired with the steam turbine. In a combined cycle plant, the exhaust from one or more gas turbines is captured in a heat recovery steam generator (HRSG) and is used to provide the heat into the Rankine cycle of a steam generator. The heat is transferred to the steam turbines as high pressure, high temperature steam. The steam produced in the HRSG is sent directly to the high pressure non-condensing steam turbine **17**. By utilizing the present invention in a combined cycle plant, the chilled water output from the adsorption chiller system **12** can be used to beneficially reduce the temperature of the inlet air entering the gas turbine. It is well known that chilling the air at the inlet of a gas turbine increases its density and hence the mass of air entering into the turbine compressor. This increased air mass allows more fuel to be burned in the gas turbine combustion chamber, increasing the output of the gas turbine and hence the connected generator. The increased heat flow from the turbine power section also increases the amount of heat available for the HRSG. This reduces the need for supplemental heating (duct firing or duct burning or bulk burning) within the HRSG to produce the desired steam flow rates for the steam turbine. The increased air mass has been demonstrated to add 15-30% to the output and has proven also to increase the heat rate and the cycle efficiency of the gas turbine. Accomplishing this air inlet chilling without having to resort to externally driven refrigerants will greatly increase the overall efficiency of the plant.

[0041] Another alternative in-process application of the chilled water is its use to provide intercooling of the air as it passes through the compressor stages of the gas turbine. Intercooling is extracting a portion of the air flow from near the center of the compressor, cooling it and reinjecting it into the air flow. This cooled air increases the density in a fashion similar to cooling the inlet air.

[0042] The chilled water may also be used for other out-of-process or auxiliary applications within the power plant. The generators for the steam turbine and the gas turbine need cooling for their windings and bearings. Using the chilled water for this purpose may further enhance the efficiency of the combined plant.

[0043] Additionally the chilled water can be used for cooling the components of the generator assembly cabinet from such heat loads as from the SCR's (silicon controlled rectifiers) and the generator structural legs.

[0044] The chilled water may also be used to cool the glands and sample valves in the steam and gas turbines. Keeping these elements cool prevents expensive and dangerous steam leaks in the steam turbines and similar gas leaks in the gas turbines.

[0045] The chilled water may also be used to cool the bearings and windings of the feedwater pumps. The main feedwater pump(s) in particular requires extensive cooling to control the buildup of heat in the pump as it pressurizes the water and moves it back into the HRSG from the condenser. The temperature rise of these critical pumps may limit the output of the combined plant if the temperatures are not controlled effectively.

[0046] Beyond the power plant itself, the chilled water can be used for an endless number of other uses including air conditioning, process cooling for industrial or food preparation processes or machine cooling. Examples of out-of-process auxiliary heat loads in a combined cycle or steam cycle plant that may be cooled using the chilled water include, but are not limited to, generator windings, bearings, supports and control cabinet loads, feedwater pump winding and bearing loads, and turbine bearings, supports, glands, packings and sample valves.

[0047] Although this invention has been disclosed and described in its preferred forms with a certain degree of particularity, it is understood that the present disclosure of the preferred forms is only by way of example and that numerous changes in the details of operation and in the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

We claim:

1. A low pressure condensing steam turbine of the type directing exhaust steam to a steam turbine condenser comprising a heat exchanger intermediate to the low pressure condensing steam turbine and the steam turbine condenser, said heat exchanger providing a flow of heated fluid to drive an adsorption chiller system.

2. The low pressure condensing steam turbine of claim **1** wherein the heated fluid produced by said heat exchanger comprises water having a temperature of about 85° C. to about 90° C.

3. The low pressure condensing steam turbine of claim **1** wherein the exhaust steam utilized comprises a mixture of water and water vapor having a temperature in the range of about 111° C. to about 125° C.

4. The low pressure condensing steam turbine of claim **1** wherein the adsorption chiller system comprises a silica gel-water working pair adsorption chiller operatively connected to said heat exchanger.

5. The low pressure condensing steam turbine of claim **1** wherein said low pressure condensing steam turbine comprises a steam turbine of a power plant having a heat sink for the dissipation of waste heat, and wherein the condenser transfers the heat captured from the condensing steam to the heat sink of the plant as waste heat, and wherein the adsorption chiller system also transfers the heat gained from its operation to the heat sink of the plant as waste heat, thereby increasing the total heat load on the heat sink of the plant without having increased the heat load input into the plant.

6. The low pressure condensing steam turbine of claim **1** wherein the adsorption chiller outputs chilled water.

7. The low pressure condensing steam turbine of claim **6** wherein the chilled water is used to reduce the temperature of the inlet air entering a gas turbine of a combined cycle power plant.

8. The low pressure condensing steam turbine of claim **6** wherein the chilled water is used to provide intercooling of the air as it passes through one or more compressor stages of a gas turbine of a combined cycle power plant.

9. A method of extracting additional work from the waste heat of a steam turbine of a power plant comprising:

(a) incorporating a heat exchanger for outputting a flow of heated fluid between an exhaust outlet of a low pressure steam turbine of said power plant and a condenser of said steam turbine;

(b) directing the heated fluid to an adsorption chiller; and

(c) outputting chilled water from the adsorption chiller.

10. The method of claim **9** wherein the power plant further comprises a combined cycle plant having a gas turbine, and wherein the efficiency of the plant is increased by using the chilled water to reduce the temperature of the inlet air entering the gas turbine.

11. The method of claim **9** wherein the power plant further comprises a combined cycle plant having a gas turbine having one or more compressor stages, and wherein the efficiency of the plant is increased by using the chilled water to provide intercooling of the air as it passes through one or more the compressor stages of the gas turbine.

12. The method of claim **9** wherein the incorporating step comprises adding one or more water-cooled surface condensers to between the exhaust outlet and the condenser of an existing steam turbine.

13. The method of claim **9** wherein the incorporating step comprises redirecting one or more portions of the existing condenser to output the flow of heated fluid to the adsorption chiller.

14. The method of claim **9** wherein the directing step further comprises connecting the flow of heated fluid from the heat exchanger to the adsorption heat exchanger circuit, a portion of which is contained within an adsorbent heat exchanger chamber of the adsorption chiller.

15. The method of claim **9** wherein the heated fluid produced by said heat exchanger comprises water having a temperature of about 85° to about 90° C.

16. The method of claim **9** wherein the waste heat of the steam turbine comprises exhaust steam from a low pressure condensing steam turbine, said exhaust steam comprising a mixture of water and water vapor having a temperature in the range of about 111° C. to about 125° C.

17. The method of claim **9** wherein the adsorption chiller comprises a silica gel-water working pair adsorption chiller.

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