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(54) COMBINED CYCLE POWER PLANT WITH CO2 CAPTURE PLANT

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(57) **ABSTRACT**

A combined cycle power plant includes a CO2 capture system operatively integrated with a liquefied natural gas LNG regasification system, where cold energy from the regasification process is used for cooling processes within the CO2 capture system or processes associated with it. These cooling systems include systems for cooling lean or rich absorption solutions for the CO2 capture or the cooling of flue gas. The LNG regasification system is arranged in one or more heat exchange stages having and one or more cold storage units. The power plant with CO2 capture can be operated at improved overall efficiencies.

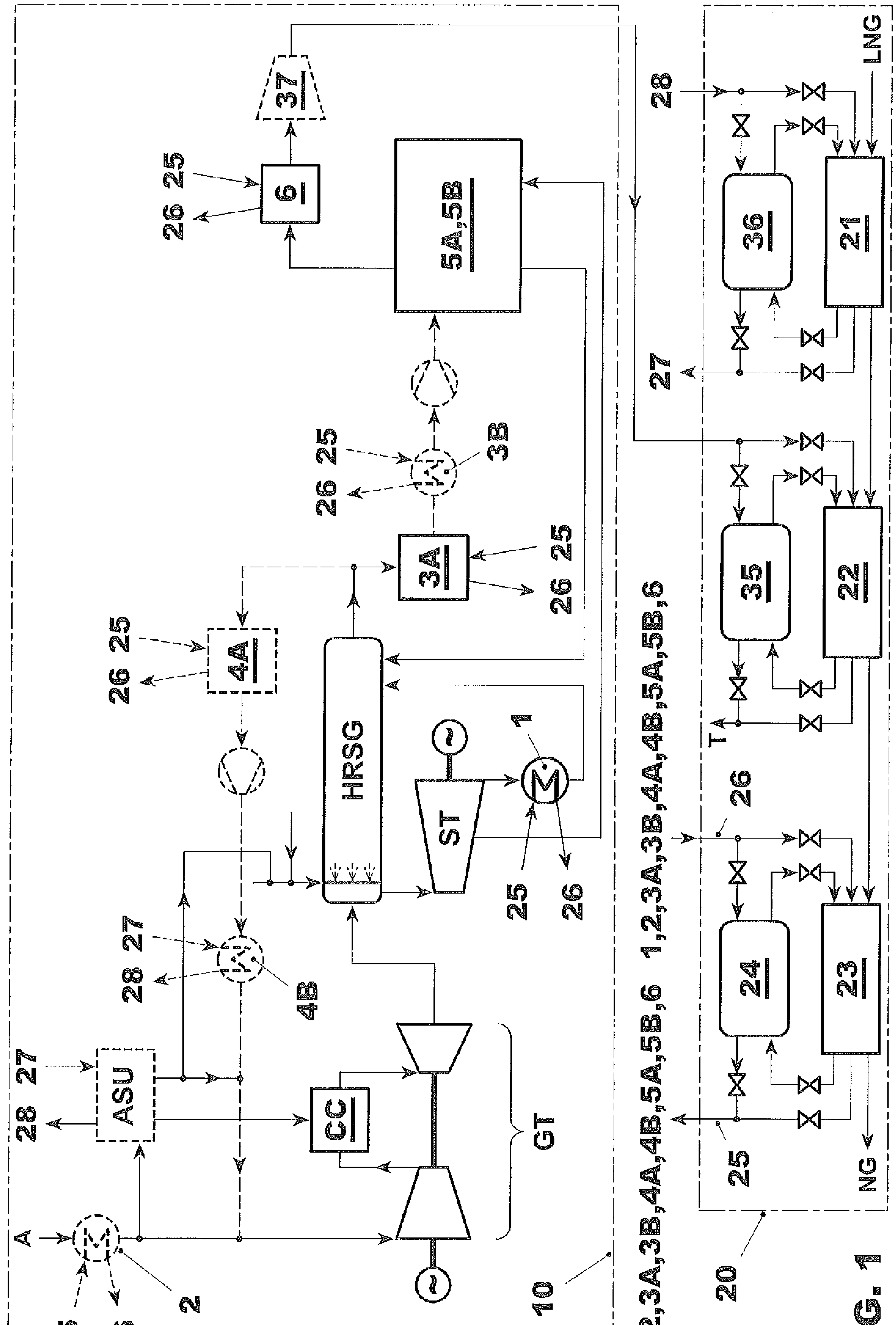

A
25
26
2
ASU
27
28
CC
GT
4B
4A
HRSG
ST
1
3A
3B
5A,5B
6
37
10
1,2,3A,3B,4A,4B,5A,5B,6
20
21
22
23
24
35
36
T
LNG
NG

FIG. 1

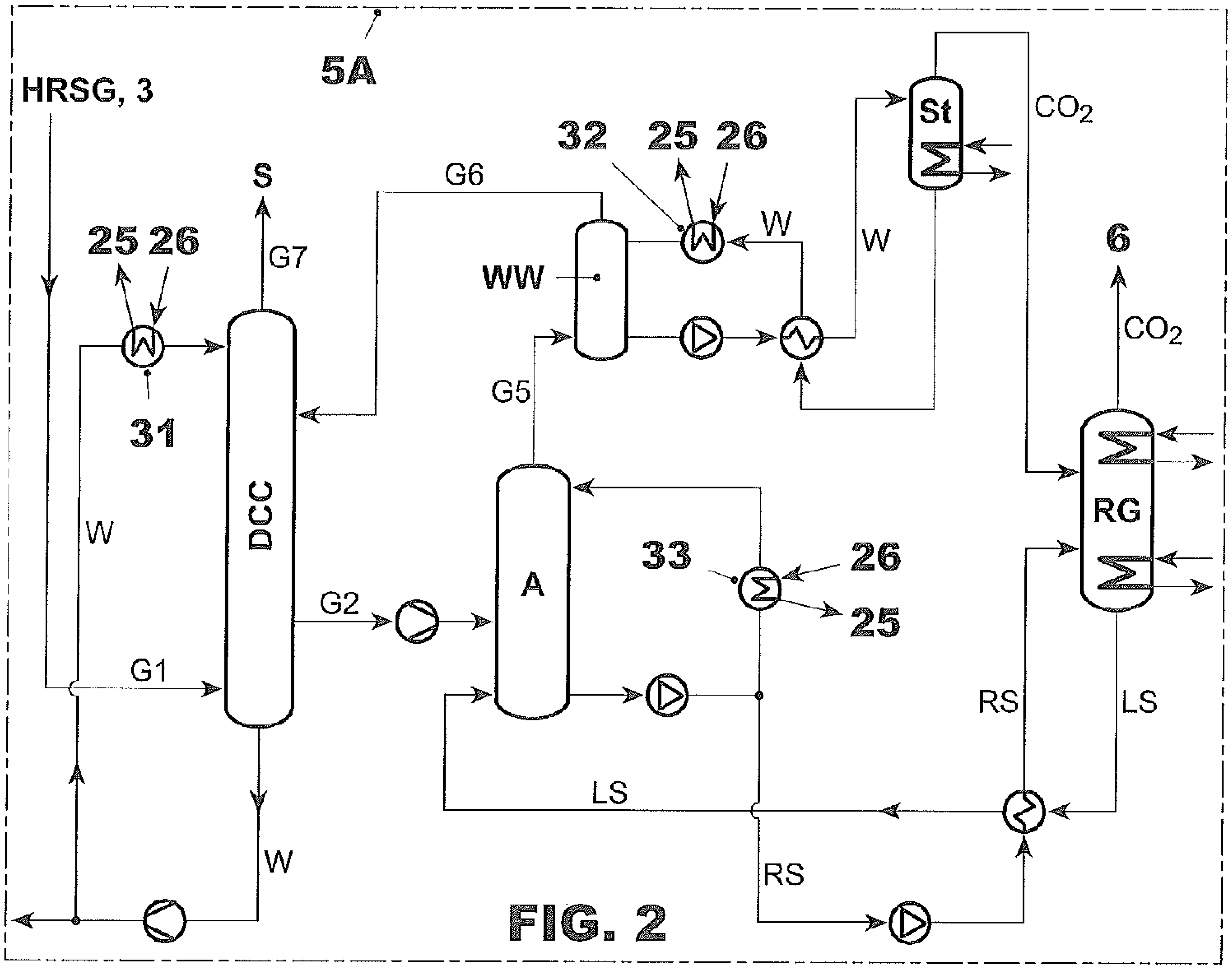

5A
HRSG, 3
S
G7
G6
G1
G2
G5
W
25 26
31
DCC
32
WW
St
CO2
6
A
33
26
25
RG
RS
LS


FIG. 2

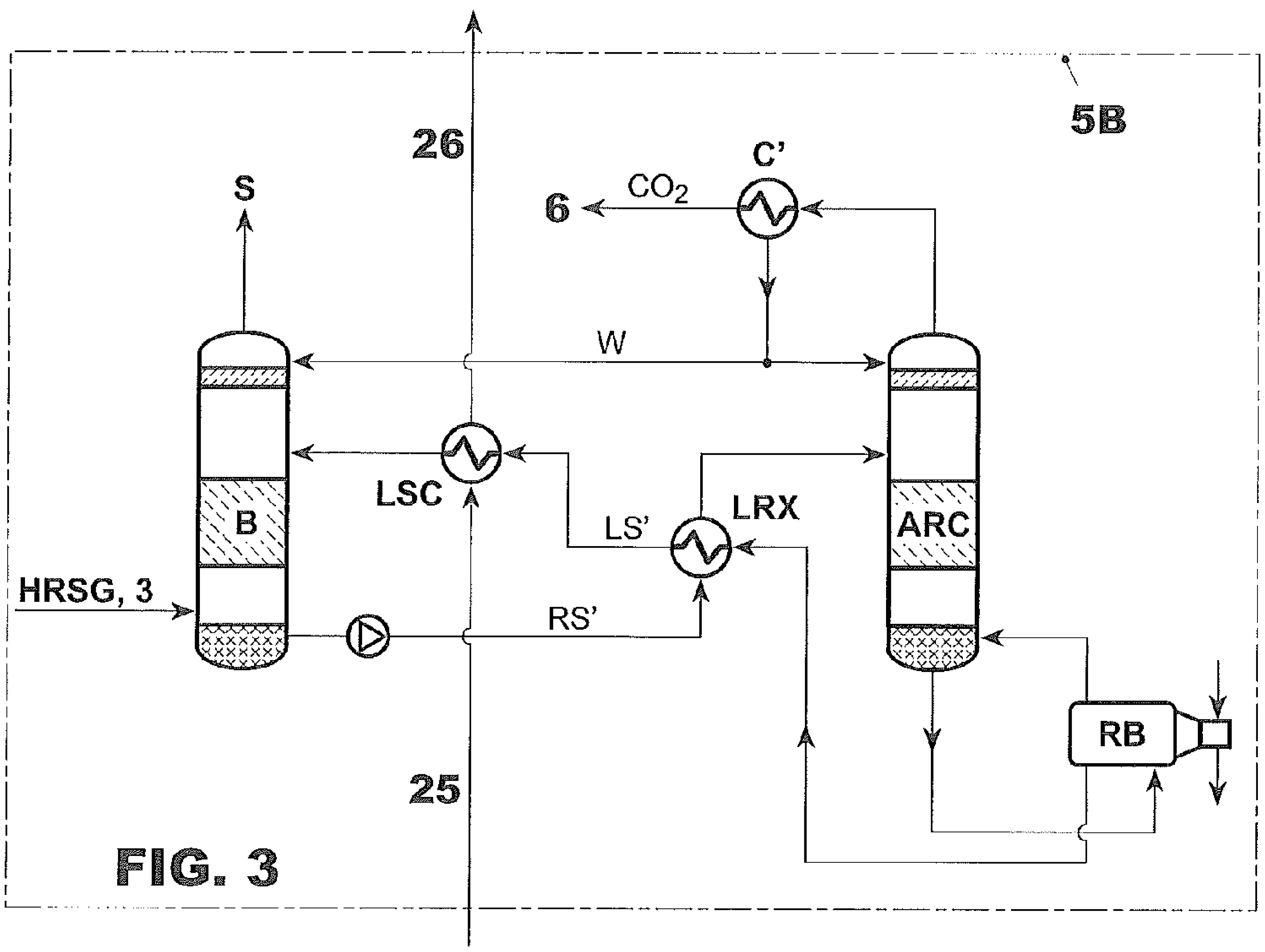
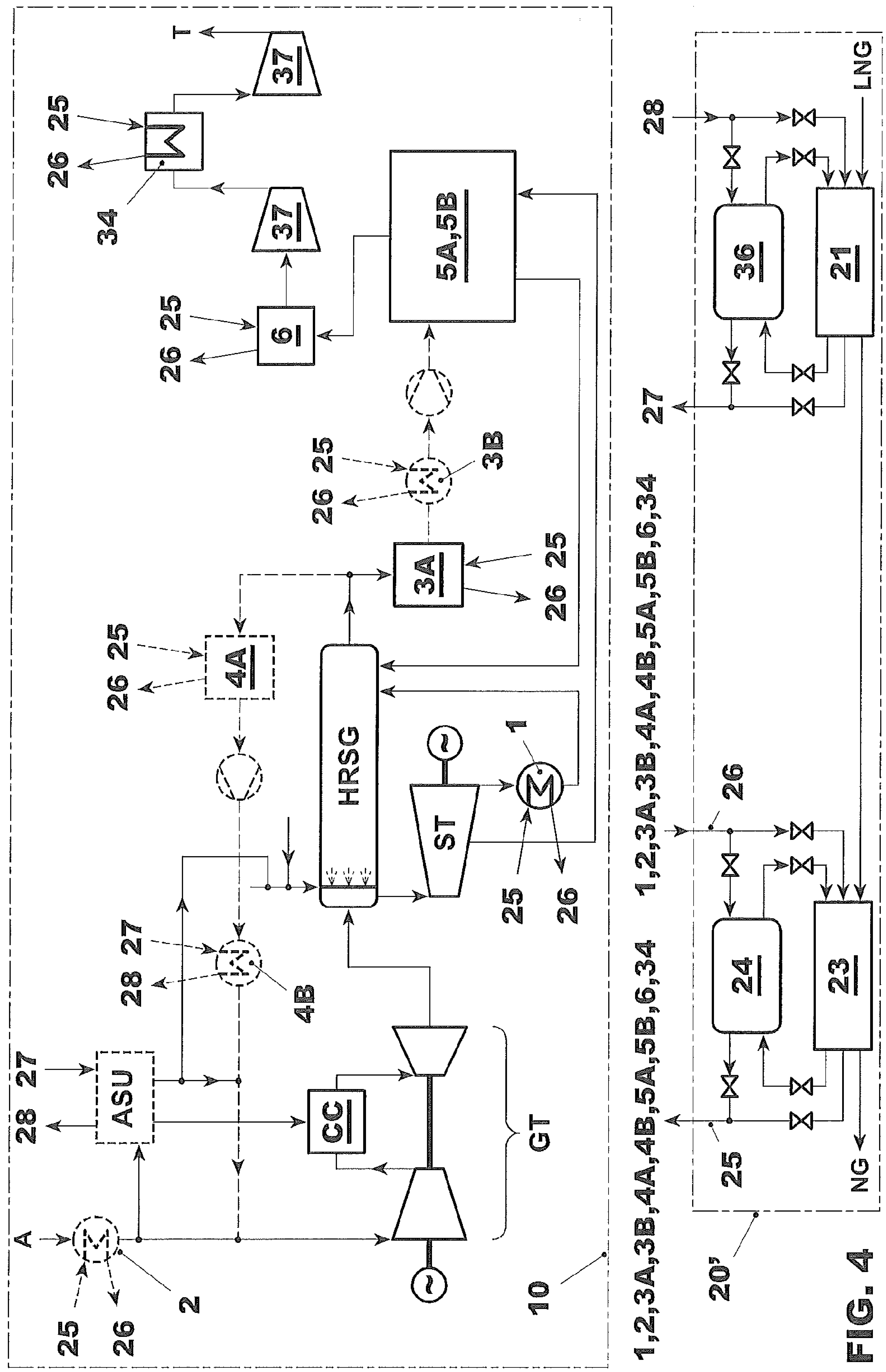

5B
26
C'
6
CO2
S
W
LSC
LS'
LRX
B
ARC
HRSG, 3
RS'
RB
25


FIG. 3



A
ASU
CC
GT
HRSG
ST
T
LNG
NG
1
2
3A
3B
4A
4B
5A,5B
6
10
20'
21
23
24
25
26
27
28
34
36
37
1,2,3A,3B,4A,4B,5A,5B,6,34


FIG. 4

# COMBINED CYCLE POWER PLANT WITH CO2 CAPTURE PLANT

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims priority to PCT/EP2012/051267 filed Jan. 26, 2012, which in turn claims priority to European Application 11152823.8 filed on Feb. 1, 2011, both of which are hereby incorporated in their entirety.

## TECHNICAL FIELD

**[0002]** The present invention pertains to a combined cycle power plant for the generation of electric power having a gas turbine, a steam turbine, and a heat recovery steam generator, and furthermore a plant for the capture and compression of carbon dioxide. The invention pertains in particular to an integration of a liquefied natural gas processing system with the power plant.

## BACKGROUND ART

**[0003]** Combined cycle power plants for the generation of electricity are known to include a gas turbine, a steam turbine, and a heat recovery steam generator utilizing the hot flue gases emitted by the gas turbine to generate steam to drive the steam turbine. In order to reduce emissions that contribute to the greenhouse effect, various measures have been proposed to minimize the amount of carbon dioxide emitted into the atmosphere. Such measures include the arrangement of systems in the power plant that capture and process CO2 contained in the flue gases exhausted by a heat recovery steam generator HRSG or a coal-fired boiler. Such CO2 capture processes operate for example on the basis of chilled ammonia or amine processes. In order to work effectively, both of these processes require that the flue gases are cooled to temperatures below 10° C. Furthermore, for the captured CO2 to be transported and stored economically, it is purified, separated from water, chilled, compressed, and liquefied. For this, among others, sufficiently cold heat exchange media need to be provided at economical conditions. A CO2 capture plant of this type requires a given amount of energy, which reduces the overall efficiency of the power plant. In order to design a combined cycle power plant with CO2 capture more energy efficiently, it has been proposed to use the cold energy from the LNG regasification for some power plant processes.

**[0004]** JP2000024454 discloses the use of vaporization heat of LNG to cool waste gases and solidify carbon dioxide contained in the waste gases. JP60636999 discloses the use of cold heat generated upon the evaporation of LNG to recover carbon dioxide from exhaust gas as liquefied carbon dioxide. WO 2008/009930 discloses the use of such cold energy in an air separation unit to produce nitrogen and oxygen.

**[0005]** U.S. Pat. No. 6,367,258 discloses the vaporization of liquefied natural gas for a combined cycle power plant, where the cold energy of the vaporization is utilized for the chilling of gas turbine intake air, steam turbine condenser cooling water, or a first heat transfer fluid intended to cool components in the gas turbine.

**[0006]** Velautham et al., <<Zero emission combined Power cycle using LNG cold>>, JSME International Journal, Series B, Vol. 44, No. 4, 2001, discloses the use of liquefied natural gas cold for cooling air in heat exchange with air in view of separating oxygen from the air for further use in a combined cycle power plant. The use of liquefied natural gas cold reduces the energy consumption of the oxygen-air-separation process. The use of liquefied natural gas cold energy in heat exchange with CO2 for its liquefication is also disclosed.

**[0007]** The WO2007/148984 discloses a LNG regasification plant in which natural gas is burned in pure oxygen. The plant also comprises a boiler and a steam turbine to generate electricity from the hot combustion gases. From the resulting flue gas CO2 is separated by condensation of water vapor. Further, CO2 is cooled against LNG for liquefaction.

**[0008]** The U.S. Pat. No. 5,467,722 discloses a combined cycle power plant with a subsequent CO2 capture system and a LNG regasification plant. The CO2 capture system comprises heat exchangers, which cool the flue gas for cryogenic CO2 capture using liquid LNG as a heat sink.

## SUMMARY

**[0009]** It is an object of the present invention to provide a combined cycle power plant operating with a CO2 capture plant having increased power plant efficiency over known power plants of this type.

**[0010]** A combined cycle power plant comprises a gas turbine, a steam turbine, and a heat recovery steam generator (HRSG), both turbines driving a generator. The power plant comprises furthermore a CO2 capture system operating on the basis of a chilled ammonia or an amine process and arranged to process exhaust gases from the HRSG. According to the invention the combined cycle power plant comprises a liquefied natural gas regasification system, which comprises heat exchangers operatively connected with one or more heat exchangers within the CO2 capture system.

**[0011]** The regasification of the liquefied natural gas LNG provides the cold energy necessary to operate cooling processes in the CO2 capture system. The heat gained by the heat exchange medium in that cooling process is in turn used to support the regasification process of the LNG. The LNG regasification system and the cooling systems of the CO2 capture system are integrated in a closed circuit system. This integration reduces the amount of energy needed to operate the CO2 capture system and LNG system, which otherwise would to be provided by other means, for example by steam extraction and electricity from the power plant. It therefore mitigates the efficiency reduction due to the CO2 capture process and LNG regasification processes.

**[0012]** In an embodiment of the invention, the LNG regasification system comprises one or more heat exchangers, configured for the operation at a specific temperature range of the natural gas in a cascaded arrangement, form a LNG inlet temperature up to ambient temperature, for heat exchange between the LNG on the cold stream side and a heat exchange medium on the hot stream side of the heat exchanger. The heat exchange medium on the hot stream side has cryogenic or chilling temperatures at the output of the heat exchanger depending on the cold requirements of the process. The chilling temperatures can be for example in the range from above a cryogenic temperature (cryogenic temperatures are temperatures below −150° C.) up to 10° C. or even up to ambient temperature, or in an embodiment in a range from 5° C. to 2° C. for chilled ammonia process applications.

**[0013]** In a further embodiment, the CO2 capture system is arranged for the chilled ammonia process. In order to support this process, the power plant comprises lines to direct the heat exchange medium from this regasification heat exchanger generating a medium having cryogenic or chilling temperatures to one or more refrigeration systems within the CO2 capture system, where the refrigeration systems are

[0014] a cooler in a cooling circuit of a flue gas direct contact cooler,

[0015] a water cooler arranged prior to a flue gas water wash apparatus,

[0016] a cooler for cooling part of a rich absorption solution flow for the purpose of regulating the temperature thereof.

[0017] In a further embodiment of the invention, the CO2 absorption system is a system for the removal of the CO2 from flue gases by means of an amine process and the system for the LNG regasification is operatively connected to cooling systems within this CO2 absorption system. This amine process system requires a heat exchange medium for cooling the absorption lean solution to temperatures of about 45° C. As is the case in the embodiments above, the use of cooling power from the LNG system mitigates the efficiency reduction due to the CO2 capture process. In a particular embodiment of the invention, lines lead from the heat exchanger of the LNG system to a cooler for amine process lean solution and back to the heat exchanger.

[0018] The heat exchangers are arranged in a cascaded way (the natural gas output temperature of a heat exchanges is the input temperature of the subsequent heat exchanger, and the natural gas is heated up form an LNG inlet cryogenic temperature up to −10° C. or more, preferably up to 0° C. or up to ambient temperature), and each of the heat exchangers of the LNG regasification system is configured and arranged for heat exchange within a specific temperature range based on load and temperature requirements of the cold utilities (such as an air separation unit, a CO2 liquefaction process, a chilled ammonia CO2 capture process, cooling requirements in combined cycle power plants, etc) optimized via process integration. More specifically in one exemplary embodiment the natural gas temperature range in the first heat exchanger is defined by the cryogenic inlet temperature of the LNG as well as the requirements of the cold utility and heat exchange medium on the hot stream side of this first heat exchanger. The boiling temperature of the LNG at the regasification pressure can be used as the natural gas outlet design temperature for this first heat exchanger. In order to reduce equipment size the natural gas outlet temperature of the first range can be higher, typically 10° C. to 50° C. higher that the LNG boiling temperature This first heat exchanger will provide cryogenic cold or very low temperature chilling power to the cold utility which requires extremely low temperature cold such as an air separation unit, etc. The natural gas inlet temperature of the second temperature range is the outlet temperature of the first range and the output temperature of the second range is the inlet temperature of the third range. This heat exchanger can be designed to provide very low temperature chilling power, at a temperature higher than the first heat exchanger.

[0019] The natural gas inlet temperature of the third temperature range is the outlet temperature of the second range. This heat exchanger can be designed to provide chilling power, which has a higher temperature than the second heat exchanger.

[0020] In such a cascaded arrangement, the energy losses of the LNG chilling power is minimized when providing cold to different cold utilizes.

[0021] Specifically the following temperature ranges are used in an exemplary embodiment: First natural gas temperature range: −165° C. to −120° C., second temperature range: −120° C. to −80° C., and third temperature range: −80° C. to 0° C.

[0022] Each one of these heat exchangers can comprise one or more heat exchange apparatuses, which can be arranged either in series or in parallel to one another. Such arrangements allow flexibility in flow and temperature control of the heat exchange medium and allow flexibility in control in different operation modes of the power plant.

[0023] In a further embodiment of the invention, the LNG regasification system comprises cold storage units for the storage of LNG, which are arranged for providing cold heat exchange media to the above-mentioned cooling systems within the power plant. In case of non-operation of LNG regasification or regasification, the cold energy contained in these cold storage units can be used for the CO2 liquefication process, thereby enabling reduction of power consumption of the CO2 absorption system.

[0024] In a further embodiment of the invention, the LNG regasification system, in particular a heat exchanger arranged for operation with a heat exchange medium having chilling temperatures at its output, is additionally operatively connected with a system for cooling the inlet air to the gas turbine of the combined cycle power plant. The chilling temperatures of the medium can be in a range of 10° C. or less, or in a range from 5° C. to 2° C.

[0025] In a further exemplary embodiment of the invention, the LNG regasification system is additionally operatively connected with one or more of the following systems associated with the process of the capture of CO2 from the flue gas from the combined cycle power plant:

[0026] a system for flue gas cooling and/or chilling prior to its entry to the CO2 capture system in order to fulfill temperature requirement for the CO2 capture process,

[0027] a system for the cooling of flue gas recirculated after the HRSG back to the gas turbine inlet,

[0028] a system for the chilling of flue gas recirculated after the HRSG back to the gas turbine inlet,

[0029] a system for cooling of CO2 extracted by the CO2 capture system.

[0030] a system for drying CO2 by means of chilling.

[0031] The recirculation of flue gas increases the CO2 concentration in the flue gas and thereby increases the CO2 capture process efficiency.

[0032] In a further exemplary embodiment of the invention, the LNG regasification system is additionally operatively connected with a cooling water system for the steam turbine condenser. This further increases the overall efficiency by effectively using the cold energy available for cooling and in turn using the low-level heat available from the condensation for the LNG regasification process.

[0033] From all of the above-mentioned cooling systems, the return heat exchange medium is directed back to the heat exchanger within the LNG regasification system.

[0034] The LNG regasification system can thereby be operated with the heat provided by the cooler and chiller systems of the combined cycle power plant. In return, the cooler and chiller systems can be operated with the cold energy provided by the LNG.

[0035] The use of the cold energy available from the LNG regasification system in any of the above cooling systems increases the overall power plant efficiency as these cooling systems no longer have to be operated with energy taken from other sources of the power plant. The heat taken back from the above-mentioned cooling systems on the other hand provide a heat source for the LNG regasification. Therefore, no or less steam extraction from the combined cycle power plant will be needed to operate the LNG regasification. The power plant's performance (efficiency and power output) can be improved.

**[0036]** In a further exemplary embodiment of the invention the system for LNG regasification comprises a heat exchanger configured and arranged for the liquefication of CO2 extracted by the CO2 capture system. The power plant with such LNG system requires no, or fewer, compressors for the liquefaction of the CO2. In addition, that heat exchanger of the LNG regasification system is provided with heat from the CO2 liquefaction process.

**[0037]** In a further embodiment, the power plant comprises lines to direct the heat exchange medium from the first heat exchanger of the liquefied natural gas regasification system to an air separation unit. The heat exchange medium has cryogenic temperatures (temperatures below −150° C.) at the output of that heat exchanger and is used for the operation of the air separation process thereby reducing the energy required to operate that unit. A further line for the return heat exchange medium from the air separation unit leads back to that first heat exchanger and provides its heat to the liquefied natural gas regasification process.

**[0038]** In an alternative embodiment the chilling power from the first heat exchanger of the liquefied natural gas regasification system is exchanged to the inlet air of the air separation unit and the chilling power from a second heat exchanger of the liquefied natural gas regasification system is used to cool the outlet air of the first compressor of the air separation unit.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0039]** FIG. **1** shows a schematic of the combined cycle power plant with CO2 capture system according to the invention and in particular the operative connections between the LNG regasification system and the cooling systems within the power plant.

**[0040]** FIG. **2** shows a detailed schematic of a CO2 capture system, in particular of chilled ammonia system and the operative connections between the LNG system and this CO2 capture system.

**[0041]** FIG. **3** shows a detailed schematic of a CO2 capture system, in particular of a system based on an amine process and the operative connections between the LNG system and this CO2 capture system.

**[0042]** FIG. **4** shows a schematic of the combined cycle power plant with CO2 capture system according to a further embodiment of the invention and in particular the operative connections between the LNG regasification system and the cooling systems within the power plant.

## DETAILED DESCRIPTION

**[0043]** FIG. **1** depicts a combined cycle power plant **10** for the generation of electricity with a gas turbine GT provided with ambient air A, a heat recovery steam generator HRSG, which generated steam using the hot exhaust gases from the gas turbine, and steam turbine ST driven by steam generated in the HRSG. A condenser **1** condenses the expanded steam and the condensate is directed as feedwater to the HRSG thereby completing the water/steam cycle of the steam turbine. The power plant furthermore comprises a CO2 capture system **5**A, **5**B, which can be either a system operating on the basis of a chilled ammonia process (as shown in as **5**A in FIG. **2**) or a system based on a amine process (as shown as **5**B in FIG. **3**).

**[0044]** The gas turbine of power plant **10** is operated with natural gas supplied by the liquefied natural gas LNG regasification plant **20**. The power plant **10** is operatively connected with a LNG processing system **20** having one more stages, which vaporizes cryogenic liquefied natural gas LNG for use in the gas turbine combustion chamber CC. According to the invention, the LNG regasification processes in system **20** is integrated with one or more cooling and chilling systems within the power plant **10** in order to optimize the overall power plant efficiency. For this, the LNG system **20** comprises several stages **21**-**23**, which are arranged in series, where each stage is dedicated to the regasification of the LNG within a range about a specific temperature level. In particular, the cooling or chilling systems within the CO2 capture system are integrated in closed heat exchange circuits with the LNG regasification system **20**.

**[0045]** A first embodiment comprises a power plant with a CO2 capture system **5***a*, which is a system operating on the basis of a chilled ammonia process, as shown in FIG. **2**. The system **5***a* comprises a CO2 absorption column A preceded by a direct contact cooler DCC, which cools the flue gas directed from the HRSG via line G**1** from a temperature in the range from 120° C. to 80° C. down to a temperature of 10° C. or less, as it is required to successfully operate the chilled ammonia process. A cooler **31** is arranged in cooling circuit of the direct contact cooler DCC and is configured to use the cold energy from heat exchanger **23** of the LNG regasification system **20**. The heat exchanger **23** generates a chilled flow medium of 10° C. or less, for example from 2-5° C., which is used in a cooler **33** to cool the flue gas to a temperature of less than 10° C.

**[0046]** Gas that is free of CO2 exits from the column A via line G**5** and is directed to a water wash WW, from which a gas line G**6** for cleaned flue gas extends to the direct contact cooler DCC**2**. Finally, the cleaned flue gas is directed from the direct contact cooler DCC via line G**7** to a stack S and the atmosphere.

**[0047]** The water wash W W is operatively connected to a stripper St and a water cooler **32** via water lines W. A line for a pure CO2 flow leads from the stripper St to a regenerator RG. The CO2 captured from the flue gas is finally released at the top of the regenerator RG, from where it is directed to further processing, for example compression, drying, or chilling.

**[0048]** The CO2 absorption column A is connected with a system for the regeneration of the chilled ammonia, its absorption solution. The CO2-rich absorption solution RS is reheated by means of a regenerator RG in order to release the CO2 and produce a CO2-lean solution LS to be reused in the absorption column A. The absorption solution regeneration system comprises additionally a cooler **33** for the rich solution RS.

**[0049]** Each of the above-mentioned coolers **31**, **32**, **33** within the chilled ammonia CO2 capture system **5**A require chilling water as cooling medium having temperatures of less than 10° C., which can be provided by the heat exchanger **23** of the LNG system **20**. Each of these coolers is connected in a closed circuit with heat exchanger **23** by means of lines **25** and **26**.

**[0050]** According to a further embodiment of the invention, the CO2 capture system can also be a system **5**B based on an amine process, as shown FIG. **3**. It includes a CO2 absorber B, which is provided with a flow of water via line W and lean absorption agent flow LS'. Flue gas from the HRSG is directed to the bottom of the absorber B and raises up through the apparatus in counter-current to the lean solution LS'. Clean flue gas exits at the top of the apparatus and is directed to the atmosphere via a stack S. The rich solution resulting from the absorption process is directed via line RS' and a heat exchanger LRX to an amine regenerator column ARC. There the CO2 is released from the solution and directed via a condenser C' to facilities for further processing or storing. The absorption column ARC is further connected with a circuit containing a reboiler RB, from which a lean solution flow is directed via line LS' to the heat exchanger LRX, where the lean solution LS' exchanges heat with the rich solution RS' thereby preheating the rich solution prior to its entry to the amine regenerator column ARC. The lean solution LS' needs to be further cooled prior to its use in the absorber column B. For this, it is directed through a heat exchanger LSC, which is configured to cool the lean solution by means of chilling water in line **25** from stage **23** of the LNG system. The heated water from the heat exchanger LSC is directed back to stage **23** for chilling again in stage **23**, thereby closing the circuit.

**[0051]** The CO2 extracted from the flue gas exits from the regenerator column ARC and is directed to further processing such as compression, drying, or chilling.

**[0052]** Depending on the type of CO2 capture system installed, the flue gas from the HRSG should be cooled to specific temperature ranges prior to its processing within that system. In the case of chilled ammonia process, the flue gas has a preferred temperature from of less than 10° C. prior to entering the absorber. In the case of an amine process, the flue gas should have a temperature of ca. 50° C. in order to assure optimal operation. For such flue gas cooling, the power plant comprises a flue gas cooler **3**A, or if necessary, additionally a flue gas chiller **3**B arranged in the flue gas line for cooling or chilling the flue gas prior to its processing in the CO2 capture processing. The cold energy therefore may be entirely drawn from the LNG system. The cooler/chiller system **3**A, **3**B in turn supports the LNG system with heat gained from the flue gas and directed to the LNG system via line **26**.

**[0053]** The power plant comprises several further cooling systems connected or associated with the CO2 capture system, which can be integrated with the LNG system, in addition to the cooling systems of the CO2 capture system itself.

**[0054]** The CO2 capture system **5**A, **5**B is connected to a CO2 drying and cooling system **6** for processing the captured CO2, which has been separated from the flue gas in the CO2 capture system. An optional compressor for CO2 compression may be arranged following the cooling system **6**.

**[0055]** In order to enhance the efficiency of the CO2 capture process by means of increasing the CO2 concentration in the flue gas, the power plant **10** can furthermore comprise a flue gas recirculation system, which can include a line branching off the exhaust line from the HRSG, which directs untreated flue gas back to the gas turbine inlet via a flue gas cooler **4***a* followed by an optional flue gas chiller **4***b*. Cooled or chilled flue gas exiting from the flue gas cooler or flue gas chiller respectively is directed and admixed to the inlet air flow A intended for the gas turbine compressor.

**[0056]** For a further power plant capacity increase, the power plant can comprise an inlet air chilling system **2**, which cools the inlet air for example in case of high ambient air temperatures using a chilled medium from heat exchanger **23** via line **25**. The heated medium is returned to heat exchanger **23** via line **26**.

**[0057]** The power plant is operatively connected with the liquefied natural gas processing system **20**, which vaporizes cryogenic liquefied natural gas LNG for use in the gas turbine combustion chamber CC and/or for export via a gas pipeline. The regasification processes and the various cooling and chilling systems within the power plant **10** are integrated in a manner to optimize the overall power plant efficiency. The LNG system **20** comprises for example several stages **21**-**23**, which are arranged in series, where each stage vaporizes the LNG to a different temperature level. A first stage **21** is configured and arranged to vaporize the LNG and is operatively connected in a closed circuit to an air separation unit ASU within power plant **10** via lines **27** and **28**. Line **27** directs cryogenic cold via a flow medium to operate the ASU, where a line **28** directs the heat generated in the ASU back to vaporizer stage **21** to vaporize the LNG.

**[0058]** The air separation unit ASU is arranged in a line for ambient air, which branches off the inlet airflow line A for the gas turbine compressor. Pure oxygen extracted from ambient air is directed either back to the ambient air line to the compressor, and/or the combustion chamber CC of the gas turbine, and/or the heat recovery steam generator HRSG to support supplementary firing.

**[0059]** A second heat exchanger **22** of the LNG system **20**, as shown in FIG. **1**, is operatively connected with the CO2 drying and cooling system **6**. The cold energy of the LNG heat exchanger **22** is used to liquefy the CO2 captured from the gas turbine exhaust gas after the CO2 has been compressed sufficiently in a compressor **37**. The liquefied CO2 may be directed to a transportation facility T or any other facility for processing or storing CO2.

**[0060]** The integration of the second heat exchanger **22** of the LNG vaporizer into the CO2 processing of the power plant allows a liquefaction of the CO2 without the need of additional CO2 compressors and intercoolers to compress the CO2 to higher pressures. This arrangement allows a significant savings in investment and operating cost as well as plant efficiency.

**[0061]** The third heat exchanger **23** of the LNG regasification system **20** is operatively connected by means of lines **25** and **26** with cooler systems of the CO2 capture system **5**A or **5**B. In order to additionally optimize the overall power plant efficiency, further cooling systems within the power plant **10** can be integrated in similar manner. These systems include for example the cooling system for the steam turbine condenser **1**.

**[0062]** Each one of the heat exchangers **21**-**23** may in themselves comprise one or more vaporizer units, where in the case of several units, the units can be arranged in series or in parallel. Such arrangements allow for flexible control of the LNG and heat exchange flows and the respective temperatures.

**[0063]** Additionally, the last heat exchanger **23** may be combined with a cold storage unit **24**, which is also connected by lines to lines **25** and **26**. Also heat exchanger **22** may be connected with a cold storage unit **35**, which is connected with lines to compressor **37** and the transport facility T. Similarly, the heat exchanger **21** may be combined with a cold storage unit **36**, which is connected via lines to lines **27** and **28**. This configuration allows the operation of the cooling and chilling systems within the power plant during a shut-down of the LNG regasification process or insufficient cold available from the process.

**[0064]** FIG. **4** shows a further exemplary embodiment of the power plant **10** with a variant of the LNG regasification plant **20'**. This variant comprises two heat exchangers **21** and **23** for LNG regasification with optional cold storage units **24** and **36**. Instead of having a heat exchanger **22** used for CO2 liquefaction, the power plant comprises a system of compressors **37** with an intercooler **34** arranged after the drying and chilling system **6**. The intercooler is supplied with cold via line **25** from heat exchanger **23**.

What is claimed is:

**1**. A combined cycle power plant comprising a gas turbine (GT), a steam turbine (ST), a heat recovery steam generator (HRSG), a liquefied natural gas (LNG) regasification system, and a CO2 capture system arranged to process exhaust gases exhausted by the heat recovery steam generator (HRSG) wherein

the liquefied natural gas regasification system comprises heat exchangers operatively connected with heat exchangers within the CO2 capture system,

wherein one or more heat exchangers arranged in a cascaded way, configured for the operation at temperatures of the natural gas form an LNG inlet temperature up to at least −10° C. and of which at least one heat exchanger is configured and arranged for heat exchange between the liquefied natural gas and a heat exchange medium, where that heat exchange medium has cryogenic temperatures or chilling temperatures at the output from that at least one heat exchanger.

**2**. The combined cycle power plant according to claim **1** wherein

the CO2 capture system is a system arranged for a chilled ammonia process and the power plant comprises lines to direct the heat exchange medium from this regasification heat exchanger to one or more of the following refrigeration systems within the CO2 capture system

a cooler integrated in a cooling circuit of a flue gas direct contact cooler (DCC),

a water cooler prior to a flue gas water wash apparatus (WW),

a cooler for the cooling of CO2 rich absorption solution within the CO2 capture system.

**3**. The combined cycle power plant according to claim **1** wherein

the CO2 capture system is a system arranged for an amine process for the removal of CO2 from flue gases and the liquefied natural gas regasification system comprises one or more heat exchangers arranged in a cascaded way, configured for the operation of the natural gas from an LNG inlet temperature up to at least 0° C. and of which at least one heat exchanger is configured and arranged for heat exchange between the liquefied natural gas and a heat exchange medium, where that heat exchange medium has cryogenic temperature or chilling temperatures at the output from that at least one heat exchanger.

**4**. The combined cycle power plant according to claim **3** wherein

the power plant comprises lines to direct the heat exchange medium from this regasification heat exchanger to a system (LSC) for cooling a CO2 lean solution within the CO2 capture amine process system.

**5**. The combined cycle power plant according to claim **1** wherein

the at least one heat exchanger, which is configured and arranged for heat exchange between the liquefied natural gas and a heat exchange medium that has a cryogenic temperature or a chilling temperature at the output from the heat exchanger, is operatively connected to a system for cooling the inlet air to the gas turbine (GT) of the combined cycle power plant.

**6**. The combined cycle power plant according to claim **5** wherein

the one or more heat exchangers of the liquefied natural gas regasification system are additionally operatively connected to one or more of the following systems of the combined cycle power plant:

a system for flue gas cooling prior to its entry to the CO2 capture system,

a system for flue gas chilling prior to its entry to the CO2 capture system.

a cooling water system for the steam turbine condenser,

a system for the cooling of flue gas recirculated after the HRSG back to the gas turbine inlet,

a system for the chilling of flue gas recirculated after the HRSG back to the gas turbine inlet,

a system for cooling of CO2 extracted by the CO2 capture system.

a system for drying CO2 by means of chilling.

**7**. The combined cycle power plant according to claim **1** wherein

the heat exchangers of the liquefied natural gas regasification system are arranged either in series or in parallel.

**8**. The combined cycle power plant according to claim **7** wherein

each of the heat exchangers of the LNG regasification system are configured and arranged for heat exchange within a given temperature range, where each one of the heat exchangers can comprise one or more heat exchange apparatuses, which can be arranged either in series or in parallel to one another.

**9**. The combined cycle power plant according to claim **5** wherein

the liquefied natural gas regasification system comprises one or more cold storage units for the storage of liquefied natural gas arranged in parallel to its heat exchangers.

**10**. The combined cycle power plant according to claim **1** wherein

the system for liquefied natural gas regasification comprises a heat exchanger configured and arranged for the liquefaction of CO2 extracted by the CO2 capture system.

**11**. The combined cycle power plant according to claim **6** wherein

a line leads from the system for drying and cooling CO2 to the heat exchanger for CO2 liquefaction and a line for liquefied CO2 leads from this heat exchanger to a transport facility (T) or pump.

**12**. The combined cycle power plant according to claim **1** wherein

the liquefied natural gas regasification system comprises a heat exchanger configured and arranged for heat exchange between liquefied natural gas and a medium having cryogenic temperatures at the output of said heat exchanger and a line for said heat exchange medium that leads to an air separation unit, and a line leads from said air separation unit (ASU) back to said heat exchanger.

**13**. The combined cycle power plant according to claim **5** wherein

the liquefied natural gas regasification system is additionally operatively connected to the cooling system for the steam turbine (ST) condenser.

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