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SPRUSON & FERGUSON

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

CONVENTION APPLICATION FOR A STANDARD PATENT
OR A PATENT OF ADDITION

We, KRAFTWERK UNION AKTIENGESELLSCHAFT, of Wiesenstrasse 35,
D-4330 Mülheim/Ruhr, Federal Republic of Germany hereby apply for
the grant of a standard patent for an invention entitled:

"COMBINED GAS AND STEAM TURBINE POWER STATION"

which is described in the accompanying complete specification.

DETAILS OF BASIC APPLICATION

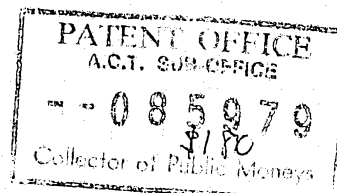
APPLICATION ACCEPTED AND AMENDMENTS

Number of Basic Application:-
P 35 31 305.6

ALLOWED 15.11.89

Name of Convention Country in which Basic
Application was filed:-
Federal Republic of Germany

Date of Basic application:-
2 September, 1985



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DATED this TWENTY-SECOND day of AUGUST 1986

KRAFTWERK UNION AKTIENGESELLSCHAFT

By:

[Signature]
Registered Patent Attorney.

LODGED AT SUB-OFFICE

- 1 SEP 1986

Sydney

TO: THE COMMISSIONER OF PATENTS
AUSTRALIA

SBR:eah 138F

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COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENTAUSTRALIA
CONVENTION
STANDARD
& PETTY PATENT
DECLARATIONIn support of the Convention Application made for a
patent for an invention entitled:

Title of Invention

"COMBINED GAS AND STEAM TURBINE POWER STATION"

Full name(s) and
address(es) of
Declarant(s)

I/We Hermann Renker
of Sophienstraße 102, D-8520 Erlangen
Federal Republic of Germany

do solemnly and sincerely declare as follows:--

Full name(s) of
Applicant(s)~~I am/We are the applicant(s) for the patent~~*(or, in the case of an application by a body corporate)*

1. I am/We are authorised by KRAFTWERK UNION AKTIENGESELLSCHAFT

the applicant(s) for the patent to make this declaration on
its/their behalf.2. The basic application(s) as defined by Section 141 of the
Act was/were made

Basic Country(ies)

in Federal Republic of Germany

Priority Date(s)

on 2 September, 1985

Basic Applicant(s)

by KRAFTWERK UNION AKTIENGESELLSCHAFT

Full name(s) and
address(es) of
inventor(s)~~3. I am/We are the actual inventor(s) of the invention referred
to in the basic application(s)~~*(or where a person other than the inventor is the applicant)*

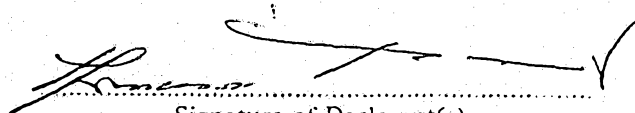
3. ULRICH SCHIFFERS

of Moritzbergstrasse 1, D-8501 Eckental
Federal Republic of Germany*(respectively)*is/are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/are entitled to make the application are
as follows:Set out how Applicant(s)
derive title from actual
inventor(s) e.g. The
Applicant(s) is/are the
assignee(s) of the
invention from the
inventor(s)The said applicant is the assignee
of the actual inventor.4. The basic application(s) referred to in paragraph 2 of this
Declaration was/were the first application(s) made in a Convention
country in respect of the invention(s) the subject of the application.

Declared at Erlangen this 15th day of May 1986

SFP4

To: The Commissioner of Patents


Signature of Declarant(s)
Hermann Renker

1/81

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(54) Title
COMBINED GAS-STEAM TURBINE POWER STATION

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(56) Prior Art Documents
US 4433065
US 3990229
DE 2345396

(57) Claim

1. A combined gas and steam turbine power station with a coal gasifier, a coal-preparation plant including a coal-grinding plant and a coal-drying plant, an air-separation plant upstream the coal gasifier, a first heat exchanger downstream on the gas side of the coal gasifier and with a gas purification unit a purified-gas line leading to the combustion chamber of the gas turbine and a waste heat boiler connected to the waste gas line of the gas turbine, wherein the sensible heat of the waste gas of the gas turbine is used to dry the ground coal, characterised in that the ground coal is dried by direct contact with an admixed gas having no, or only a very low, concentration of oxygen, in that the coal-preparation plant receives an admixture of the waste gas of the gas turbine and an inert gas, the admixture acting as a heating and drying medium when it directly contacts the ground coal.

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COMPLETE SPECIFICATION

(ORIGINAL)

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Complete Specification Lodged:

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This document contains the amendments made under Section 49 and is correct for printing.

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Complete Specification for the invention entitled:

"COMBINED GAS AND STEAM TURBINE POWER STATION"

The following statement is a full description of this invention,
including the best method of performing it known to us

SBR:eah 138F

ABSTRACT

In a combined gas and steam turbine power station (1) having a coal gasifier (4), having a coal preparation plant (22, 40), and having an air separation plant (5) connected upstream of the coal gasifier, the ^{sensible} ~~latent~~ heat of the waste of the gas turbine (11) is used for drying the milled coal.



COMBINED GAS AND STEAM TURBINE POWER STATION

The invention relates to a combined gas and steam turbine power station.

5 In DE-A-3319711, there is disclosed a combined gas and steam turbine power station to the combustion chamber of the gas turbine of which there is fed a purified gas produced in a coal gasifier associated with the power station. To the coal gasifier, there is supplied milled coal on the one hand and oxygen from an
10 air separation plant on the other hand. The ^{sensible}~~latent~~ heat of the crude gas leaving the coal gasifier is used, via heat exchange surfaces, both for heating the purified gas flowing to the combustion chamber of the gas turbine, as well as for steam generation.

15 Likewise, the waste gas of the gas turbine is piped through a waste heat steam generator. The steam turbine of the steam turbine power station is partly fed with the steam generated in the heat exchangers.

For the operation of coal gasifiers, it is known
20 to mill and dry the raw coal before piping it into the coal gasifier. A part of the purified gas produced in the coal gasifier is burned and the combustion gases are piped over the milled coal which is disposed in a finishing dust bunker. Such a milling-drying plant
25 impairs, however, the net efficiency of the total power station plant, because it uses up a part of the purified gas produced.

For making available the drying energy for the coal it is known to burn a part of the milled coal and thus to heat up the drawn-in gas circulating in the
30 drying plant. With this method too, the net efficiency of the total power station plant is reduced. What is more, with this way of making available the drying energy, the sulphur emission of the power station plant
35 is increased.

The underlying object of the present invention is



to make available the drying energy of the milling and drying plant in a way which produces no additional sulphur dioxide emission and, what is more, impairs the net efficiency of the total power station plant as little as possible.

5 According to one aspect of the present invention there is disclosed a combined gas and steam turbine power station with a coal gasifier, a coal-preparation plant including a coal-grinding plant and a coal-drying plant, an air-separation plant upstream the coal gasifier, a first heat exchanger downstream on the gas side of the coal gasifier and with a gas
10 purification unit a purified-gas line leading to the combustion chamber of the gas turbine and a waste heat boiler connected to the waste gas line of the gas turbine, wherein the sensible heat of the waste gas of the gas turbine is used to dry the ground coal, characterised in that the ground coal is dried by direct contact with an admixed gas having no, or only a
15 very low, concentration of oxygen, in that the coal-preparation plant receives an admixture of the waste gas of the gas turbine and an inert gas, the admixture acting as a heating and drying medium when it directly contacts the ground coal.

According to another aspect of the present invention there is
20 disclosed a combined gas and steam turbine power station with a coal gasifier, a coal-preparation plant including a coal-grinding plant and a coal-drying plant, an air-separation plant located upstream the coal gasifier, a first heat exchanger downstream on the gas side of the coal gasifier and with a gas purification unit, a purified-gas line leading to
25 the combustion chamber of the gas turbine and a waste heat boiler connected to the waste gas line of the gas turbine, wherein the sensible heat of the waste gas of the gas turbine is used to dry the ground coal, characterised in that the ground coal is dried by direct contact with an admixed gas having no, or only a very low, concentration of oxygen, wherein said
30 admixed gas is an admixture of the waste gas in that inert gas as a so-called return medium is conveyed into a circuit through a second heat exchanger to the grinding-drying plant and back again via the second heat exchanger.

35 In a preferred embodiment, the power station is constructed so that in use the drying medium can be circulated through the coal milling and drying plant, and so that in use a portion of the drying medium, laden with moisture, can be continuously removed and be replaced by fresh drying medium.



In another preferred embodiment, the power station is constructed so that in use the waste gas of the gas turbine can be passed directly to the coal milling and drying plant. Preferably, the power station is constructed so that in use inert gas can be added to the waste gas of the gas turbine. Preferably, the power station is constructed so that in use nitrogen, as the inert gas, from the air separation plant can be added to the waste gas of the gas turbine.

Preferably the power station is constructed so that in use inert gas can be conveyed in a circuit via

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a heat exchanger (through which a heating medium can flow) to the coal milling and drying plant and back again via the heat exchanger. Preferably, the power station is constructed so that in use a mixture of nitrogen and water vapour can be used as the inert gas. Preferably, the power station is constructed so that in use quantities of gas (e.g. exhaust-vapour-like leftover quantities of gas) can be removed upstream of the heat exchanger and replaced by fresh inert gas.

In a preferred embodiment, the power station is constructed so that in use the nitrogen to be added to the waste gas of the gas turbine can be heated in a heat exchanger through which flows compressed air flowing to the air separation plant.

In a preferred embodiment, the power station is constructed so that in use the nitrogen to be added to the waste gas of the gas turbine can be heated in a heat exchanger through which flows the waste gas to the gas turbine.

In a preferred embodiment, the power station is constructed so that in use the waste gas of the gas turbine, for use as the drying medium, can be heated by additional burning of part of the purified gas.

In a preferred embodiment, the power station is constructed so that in use hot combustion gases of the purified gas can be mixed directly with the drying medium.

In a preferred embodiment, the power station is constructed so that in use the waste gas of the gas turbine can flow through the heat exchanger.

In a preferred embodiment, the power station is constructed so that compressed air flowing to the air separation plant can flow through the heat exchanger.

In a preferred embodiment, the power station is constructed so that in use medium pressure steam can flow through the heat exchanger.

In a preferred embodiment, the power station is constructed so that at least part of the drying medium laded with moisture can be fed via a compressor to a fuel gas line of the gas turbine.

5 As a result of the exploitation of the latent heat of the waste gas of the gas turbine for drying the coal, there is used a heat source which is in any case present in the combined gas and steam turbine power station. Moreover, the emission of the gas and steam
10 turbine power station is thus not altered in any way either with regard to its quality or with regard to its quantity. In addition, with the recirculation of the drying medium, the consumption of the same is greatly lessened.

15 A minimising of the investment costs can be achieved, if, in a convenient refinement of the invention, the waste gas of the gas turbine is supplied to the milling and drying plant directly as a heating and drying medium. In this case, a connection from the
20 waste gas line of the gas turbine merely needs to be provided in the waste heat boiler and to be linked with the drawn-in gas line of the milling and drying plant.

The oxygen content of the waste gas of the gas turbine used as a drying medium can be reduced, if, in
25 convenient refinement of the invention, an inert gas is supplied to the gas turbine waste gas. In this way, the danger of fire can be effectively avoided. In addition, it is especially convenient to add nitrogen from the air separation plant to the gas turbine waste
30 gas by mixing. In a specially advantageous embodiment, an inert gas is conveyed in a circuit through a heat exchanger (through which flows the heating medium) to the milling and drying plant and back again through the heat exchanger. This type of heat supply avoids any
35 contact at all of the milled material with oxygen and thus all partial oxidation.

The invention will now be described, by way of example, with reference to the drawings in which:

Fig. 1 is a diagrammatic representation of the arrangement and mutual linking of the individual structural components of a combined gas and steam turbine power station including a coal preparation plant, according to the invention; and

Fig. 2 is a variation of the coal preparation plant of Fig. 1.

As Fig. 1 shows, the combined gas and steam turbine power station 1 consists of a gas turbine power station section 2, a steam turbine power station section 3, a coal gasifier 4 connected upstream of the gas turbine power station section 2, an air separation plant 5 connected upstream of the coal gasifier 4, a heat exchanger plant 6 connected downstream of the coal gasifier 4 on the crude gas side, and a gas purification plant 7 connected downstream of the heat exchanger plant 6 on the crude gas side. A purified gas line 8 heaving the gas purification plant 7 is connected, via a crude gas-purified gas heat exchanger 9 of the heat exchanger plant 6, to a combustion chamber 10 of a gas turbine 11. An air compressor 12 and a generator 13 are coupled to shaft 14 of the gas turbine 11. An air line 15 connected to the air compressor 12 leads both to the combustion chamber 10 of the gas turbine 11, as well as to the entrance of the air separation plant 5, via a heat exchanger 16 and a cooler 17. A waste gas line 18 of the gas turbine 11 is connected to a waste heat boiler 19. The steam generating heat-exchange surfaces 20 and 21 of the waste heat boiler 19 of the heat exchanger plant 6 are linked to the steam turbine power station section 3.

On the fuel side, a milling and drying plant 22, i.e. a coal preparation plant, is connected upstream of the coal gasifier 4. Through this milling and drying

plant, which contains several coal mills 23 and 24, a dust remover 25 and a finishing dust bunker (not shown), flows a drying medium, i.e. a so-called drawn-in gas, in a circuit. A recirculation line 26 thereof is connected, via a connection line 27, both to the waste gas line 18 of the gas turbine 11, as well as to a nitrogen line 28 of the air separation plant 5. The line 26 contains a circulation compressor 29 for circulating the drying medium. In the nitrogen line 28 leading to the recirculation line 26, there is disposed a heat exchanger 30 through which a heating medium flows. The heating medium flowing through this heat exchanger 30 can be crude gas branched off downstream of the crude gas-purified gas heat exchanger 9 or compressed air produced by the air compressor 12 and flowing to the air separation plant 5. In the flow direction of the drying medium and downstream of the milling and drying plant 22, the recirculation line 26 contains a gas outflow 32 leading to a chimney 31. In the gas outflow 32 as well as in the nitrogen line 28 and in the connection line 27 to the waste gas line 18 of the gas turbine 11, respective regulating valves 33, 34 and 35 are disposed.

When operating the gas and steam turbine power station 1, air is conveyed through the air compressor 12 on the shaft 14 of the gas turbine 11, into the combustion chamber 10 and into the air line 15 leading to the air separation plant 5. The oxygen produced in the air separation plant 5 is boosted by means of an oxygen compressor 36 to the pressure level of the coal gasifier 4, which is operated with over pressure, and is supplied to the coal gasifier 4. The crude gas leaving the coal gasifier 4 flows through the heat exchanger plant 6. In this heat exchanger plant 6, the crude gas gives up its heat both via steam generating heat-exchange surfaces 21, as well as via the crude

gas-purified gas heat exchanger 9. The extensively cooled crude gas leaving the heat exchanger plant 6 is freed, in the gas purification plant 7, both of dust-like impurities as well as of carbon dioxide, sulphur dioxide and halogen compounds. It then flows as purified gas into the crude gas-purified gas heat exchanger 9, from which it flows, in re-heated form, into the combustion chamber 10 of the gas turbine 11. To lessen NO_x-formation, nitrogen from the air separation plant 5, is added to this purified gas via a nitrogen compressor 37. The waste gas of the gas turbine 11 gives off its ~~latent~~^{Sensible} heat in the waste heat boiler 19 via steam generating heat-exchange surfaces 20, and then flows, at a temperature of 100 to 180°, into the chimney 31.

By means of a coal supply line 38, raw coal is passed into the milling and drying plant 22 and is milled in the coal mills 23 and 24 and is conveyed by means of a drying medium (in a preferred embodiment a mixture of nitrogen and waste gas of the gas turbine) via the dust remover 25 to the finishing dust bunker (not shown) of the milling and drying plant 22. From the finishing dust bunker, the finely milled and dried coal is piped, in a quantity corresponding to the consumption thereof, to the coal gasifier 4. Through the milling and drying plant 22, the previously mentioned hot drying medium flows. This drying medium is heated by the continuous addition of hot waste gas from the gas turbine 11, via the connection line 27 to the waste gas line 18 of the gas turbine 11. In order to lower the relatively high oxygen content of the gas turbine waste gas to a value considerably below 10 per cent by volume, nitrogen from the air separation plant 5, pre-heated in the heat exchanger 30, is constantly added to the waste gas of the gas turbine 11. A part of the surplus drying medium leaving the milling and



drying plant 22, enriched with moisture, is constantly released via the gas outflow 32 into the atmosphere, either directly or via the chimney 31. By means of the regulating valves 33, 34 and 35, the flow rate of the drying medium can be adapted to the moisture content of the coal.

It is a great advantage of this combined gas and steam turbine power station 1 that, for making available the drying energy, no additional combustion is required and thus no additional emission occurs either. Accordingly, the milling and drying plant 22 can be operated in a completely emission-neutral manner. Furthermore, for making available the drying energy, neither coal nor purified gas is burned (both being measures which would reduced the net efficiency of the gas and steam turbine power station) but rather the leftover heat of a part of the waste gas of the gas turbine is exploited.

Fig. 2 shows another milling and drying plant 30 which can be connected, instead of the milling and drying plant 22 shown in Fig. 1, to the otherwise unaltered gas and steam turbine power station 1 of Fig. 1. In the case of this milling and drying plant 40, the drying medium consists of pure nitrogen, which is fed from the air separation plant 5 into a recirculation line 41. Moreover, a circulation compressor 42, and a heat exchanger 43 having a heat-change surface 44 are disposed in this recirculation line. Through the heat exchanger 43, there flows either gas turbine waste gas, or air flowing to the air separation plant 5 and heated by compression, or medium pressure steam. In the case of this embodiment of the milling and drying plant, the milled material does not come into contact with any oxygen and the drying medium consists essentially of nitrogen and water vapour.

In the case of this embodiment as well, the drying

energy is made available in a way which is emission-neutral. With the supply of gas turbine waste gas or of finally compressed air into the heat exchanger 43, the net efficiency of the power station is also not
5 impaired. In the case of the connection of the heat exchanger 43 to a medium pressure steam tap, it is merely necessary for a slight worsening of the net efficiency of the power station to be taken into
10 account. This last-mentioned solution would, however, have the advantage that the heating capacity could be substantially raised in the event that very damp coal is to be dried. It would also be possible, in the case of the use of very damp coal or other damp fuels, to provide the increased drying energy by the additional
15 burning of purified gas or coal with the disadvantages outlined at the start.

Instead of releasing the damp drying medium via the gas outflow 32 or 45 into the atmosphere, it could also be compressed and then be added to and mixed with
20 the combustion gas flowing to the combustion chamber 10 of the gas turbine 11.

The claims defining the invention are as follows:

1. A combined gas and steam turbine power station with a coal gasifier, a coal-preparation plant including a coal-grinding plant and a coal-drying plant, an air-separation plant upstream the coal gasifier, a first heat exchanger downstream on the gas side of the coal gasifier and with a gas purification unit a purified-gas line leading to the combustion chamber of the gas turbine and a waste heat boiler connected to the waste gas line of the gas turbine, wherein the sensible heat of the waste gas of the gas turbine is used to dry the ground coal, characterised in that the ground coal is dried by direct contact with an admixed gas having no, or only a very low, concentration of oxygen, in that the coal-preparation plant receives an admixture of the waste gas of the gas turbine and an inert gas, the admixture acting as a heating and drying medium when it directly contacts the ground coal.

2. The combined gas and steam turbine power station according to claim 1, characterised in that nitrogen from the air-separation plant is admixed to the exhaust gas of the gas turbine.

3. The combined gas and steam turbine power station according to claim 1 or claim 2, characterised in that the heating and drying medium circulates as a co-called return gas through the coal-preparation plant wherein partial amounts charged with moisture flow away and are substituted by new heated heating and drying medium.

4. A combined gas and steam turbine power station with a coal gasifier, a coal-preparation plant including a coal-grinding plant and a coal-drying plant, an air-separation plant located upstream the coal gasifier, a first heat exchanger downstream on the gas side of the coal gasifier and with a gas purification unit, a purified-gas line leading to the combustion chamber of the gas turbine and a waste heat boiler connected to the waste gas line of the gas turbine, wherein the sensible heat of the waste gas of the gas turbine is used to dry the ground coal, characterised in that the ground coal is dried by direct contact with an admixed gas having no, or only a very low, concentration of oxygen, wherein said admixed gas is an admixture of the waste gas in that inert gas as a so-called return medium is conveyed into a circuit through a second heat exchanger to the grinding-drying plant and back again via the second heat exchanger.



5. The combined gas and steam turbine power station according to claim 4 characterised in that a mixture of nitrogen and water vapour is used as the inert gas.

5 6. The combined gas and steam turbine power station according to claim 4 or claim 5, characterised in that exhaust-vapour-like residual gas volumes can be removed upstream the second heat exchanger and substituted by new inert gas.

10 7. The combined gas and steam turbine power station according to claim 2 or claim 5, characterised in that the nitrogen to be admixed to the drying medium is able to be heated in a third heat exchanger through which flows compressed air flowing to the air-separation plant.

15 8. The combined gas and steam turbine power station according to claim 2 or claim 5, characterised in that the nitrogen admixed to the drying medium is able to be heated in a third heat exchanger through which the waste gas of the gas turbine flows.

20 9. The combined gas and steam turbine power station according to claim 3 or claim 4, characterised in that the return gas is able to be heated by additional combustion of a part of the purified gas.

20 10. The combined gas and steam turbine power station according to claim 9, characterised in that hot combustion gas of the purified gas is able to be directly admixed to the return gas.

11. The combined gas and steam turbine power station according to claim 4, characterised in that exhaust gas of the gas turbine flows through the second heat exchanger.

25 12. The combined gas and steam turbine power station according to claim 4, characterised in that fully compressed air flowing to the air-separation plant flows through a fourth heat exchanger.

30 13. The combined gas and steam turbine power station according to claim 4, characterised in that steam of medium pressure flows through the second heat exchanger.

14. The combined gas and steam turbine power station according to claim 3 or claim 6, characterised in that the humidified outflowing partial volumes of the drying medium is able to be piped in to the combustion gas line of the gas turbine via a compressor.

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15. A power station substantially as described with reference to the accompanying drawings.

DATED this THIRD day of NOVEMBER 1989

Kraftwerk Union Aktiengesellschaft

Patent Attorneys for the Applicant

SPRUSON & FERGUSON

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