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(54) Method of repowering boiler turbine generator plants and repowered boiler turbine generator plants

(57) A repowered boiler turbine generator plant is provided, which plant comprises one or more boilers (1) and one or more gas turbines or internal combustion engines (5), each of which being connected with a generator (6) and each of which supplying the boiler (1) with exhaust gas; and wherein

- all the exhaust gas from gas turbine(s) or internal combustion engine(s) (5) is supplied to the windbox (7) of the boiler (1); and
- a controller of fuel (17) fired in the boiler (1) ensures a content of oxygen in the flue gas from the boiler (1) being either between approximately 1 % and approximately 6 % by volume as a dry gas, or generating approximately 100 ppm to approximately 1000 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

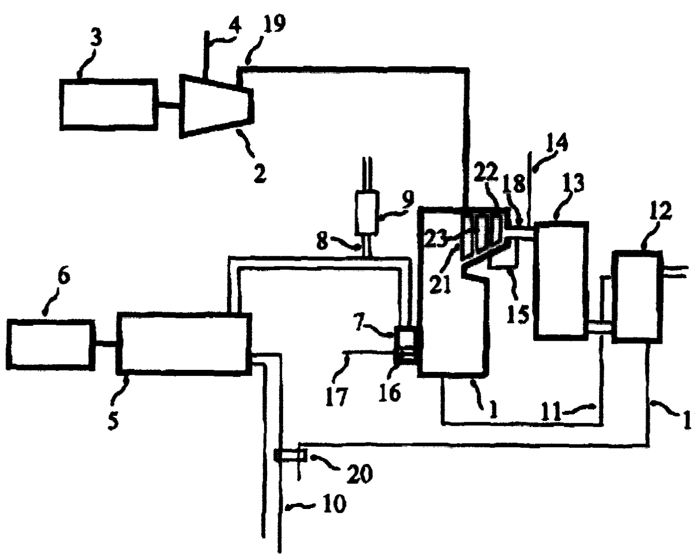

Fig. 1

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Description

Technical Field

[0001] The present invention relates to a method of repowering existing boiler turbine generator plants and achieving the optimum cost-efficient output as well as such repowered plants per se.

Background Art

[0002] It is well known that the thermal efficiency of a boiler turbine generator plant (BTG) may be increased by repowering the BTG plant with an internal combustion engine or a gas turbine. Repowering entails that the power output and thermal efficiency of the BTG system are increased by combining the BTG system with a gas turbine or an internal combustion engine using the energy in the exhaust gas of the engine by introducing the exhaust gas into the boiler space as described in U.S. patent No. 4,928,635 and the PCT publication WO 99/23360 disclosing that the thermal efficiency can be further increased by carefully optimising the introduction of the engine exhaust gas into the boiler space. Hereby is also obtained a staged combustion leading to a NO_x-reduction as previously disclosed in the Japanese patent JP 64-22328 (89). The background of the latter method is described in greater detail in a paper from Mitsubishi Heavy Industry Vol 26. No. 4 (1989).

[0003] In the Japanese patent application JP 07-239977 a method is described for repowering with a two-stroke diesel engine and it is shown that the economy of the repowering is improved compared to conventional repowering by converting the diesel engine as well as the refurbished boiler for operation on residual oil.

[0004] Further experiments have shown that the best operational economy for the repowering is not obtained by the configuration having the highest thermal efficiency.

[0005] It is therefore an object of the invention to provide a method of repowering boiler turbine generator plants to improve the operational economy (defined as the highest net present value) in comparison with the above prior art.

Brief Description of the Invention

[0006] In accordance with the above object there is provided a repowered boiler turbine generator plant comprising one or more oil-fired or pulverised coal-fired boilers, each boiler generating steam supplied through a steam piping to one or more steam turbines, each of which being connected with a power generator; one or more gas turbines or internal combustion engines, each of which being connected with a generator and each of which supplying the boiler with exhaust gas; a wind-box for the boiler having a burner being supplied with fuel; a superheater and optionally a reheater and a hot economiser upstream of an outlet piping for flue gas from the boiler; a steam piping for passing steam from the boiler through the superheater to the steam turbine(s); optionally a catalyst downstream of the hot economiser for reducing the content of NO_x in the flue gas; means for adding ammonia or urea upstream of the catalyst, if present; and optionally a bypass for flue gas from the boiler to the catalyst; which plant further comprises

- an exhaust gas piping supplying all the exhaust gas from the gas turbine(s) or internal combustion engine(s) to the wind-box of the boiler and optionally a piping for adding heated air to said exhaust gas; and

- a controller of fuel fired in the boiler ensuring a content of oxygen in the flue gas from the boiler being either approximately between 1 % and approximately 6%, preferably approximately between 1 % and approximately 4 %, and especially 3 % by volume as a dry gas, or generating approximately between 100 ppm and approximately 1000 ppm, preferably between 100 ppm and approximately 500 ppm, and especially 100 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

[0007] According to a further embodiment of the invention the plant may further comprise a cold economiser downstream of the superheater and the catalyst, if present, for cooling the flue gas to a temperature normally used to prevent sulphuric acid corrosion at the cold end of the economiser and for preheating said boiler feed water.

[0008] In addition the plant according to the invention may further comprise a heat exchanger using the heat from engine cooling medium, if available, for additional preheating of said boiler feed water.

[0009] In accordance with the above object there has also been provided a method of repowering boiler turbine generator plants comprising one or more oil-fired or pulverized coal-fired boilers, each boiler generating steam supplied through a steam piping to one or more steam turbines, each of which being connected with a power generator; one or more gas turbines or internal combustion engines, each of which being connected with a generator and each of which supplying the boiler with exhaust gas; a wind-box for the boiler having a burner being supplied with fuel; the flue gas of said boiler being passed to an outlet piping for flue gas through a superheater and optionally a reheater and a hot

economiser for said steam being passed through the steam piping; said flue gas optionally being passed through a catalyst for reducing the content of NO_x in the flue gas, in which case ammonia or urea is added upstream of the catalyst; and the temperature at the inlet to the catalyst, if necessary, being maintained at the required level by bypassing the superheater with flue gas;
said method comprising the steps of:

(i) supplying all the exhaust gas from the gas turbine(s) or internal combustion engine(s) to the wind-box of the boiler and optionally adding heated air to said exhaust gas so as to obtain a composition of exhaust gas and air with the oxygen content required for obtaining stable combustion in the boiler; and

(ii) regulating the amount of fuel fed into in the boiler to obtain a flue gas from the boiler having an oxygen content, which is either approximately between 1 % and approximately 6% by volume as a dry gas, or having such a content of oxygen, which generates approximately between 100 ppm and approximately 1000 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

[0010] Preferably the method according to the invention further comprises the step of controlling the amount of fuel to obtain a flue gas having a minimum content of oxygen between approximately 1 % and approximately 4% by volume as a dry gas, or having such a content of oxygen which generates approximately between 100 ppm and approximately 500 ppm by volume as a dry gas of CO, whichever oxygen content is the highest, and more preferably the method according to the invention further comprises the step of controlling the amount of fuel to obtain a flue gas having a content of oxygen of approximately 3 % by volume as a dry gas, or having such a content of oxygen generating approximately at least 100 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

[0011] According to a further embodiment of the method according to the invention the size of the gas turbine(s) or the internal combustion engine(s) is selected so that the exhaust gas with the optionally added heated air provides said stable combustion in the boiler with the amount of fuel to produce steam in an amount required to generate 95 to 100 % of the output of the power generator in comparison with the use of heated air alone for the combustion at full load.

[0012] According to an yet another embodiment of the method according to the invention a prior-art boiler turbine generator plant pre-heater of air for the combustion in the boiler is replaced by a cold economiser cooling the flue gas to a temperature normally used to prevent sulphuric acid corrosion at the cold end of the economiser, and the heat from said economiser used to heat boiler feed water.

[0013] According to an additional embodiment of the method according to the invention the heat from engine cooling medium, if available, is used for additional preheating of said boiler feed water.

[0014] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

Brief Description of the Drawing

[0015] Fig. 1 shows a schematic diagram of a boiler turbine generator plant being repowered by an embodiment of the method according to the invention.

Best Mode for Carrying Out the Invention

[0016] All exhaust gas from the gas turbines or internal combustion engines 5 is supplied to the wind-box 7 of the boiler 1 and the boiler 1 is fired to achieve normal maximum output of the steam turbine generator(s) 2. The exhaust gas from the gas turbine(s) or internal combustion engine(s) 5 is optionally mixed with the preheated air necessary to achieve stable combustion in the boiler. The amount of exhaust gas used (optionally mixed with heated air) corresponds to the minimum requirement for combustion in the boiler 1 and to the maximum requirement for generating a fluegas from the boiler 1 with either an oxygen (O_2) content generating in the flue gas a CO content of maximum approximately 100 ppm to approximately 1000 ppm, more preferred approximately 100 to approximately 500 ppm, and especially approximately at least 100 ppm by volume as a dry gas or other maximum values acceptable to the plant owner and authorities, or alternatively approximately 1 % to approximately 6%, more preferred approximately 1 % to approximately 4%, and especially 1 % O_2 by volume as a dry gas, whichever oxygen content is the highest. The pre-heater of air for the combustion existing in prior-art plants is replaced by a cold economiser 12 generating heat for heating boiler feed water 11 and any heat from engine cooling is also used for heating boiler feed water. This novel boiler feed water heating replaces otherwise necessary extraction of steam from the steam turbine 2 for feed water preheating and thereby increases the steam turbine output and compensates together with the increased combustion gas temperature and amount for the lower furnace temperature because of the reduced oxygen-content in the boiler combustion gas. Under the preferred operation conditions the NO_x-emission is minimal and may be reduced further by selective catalytic NO_x-reduction with the catalyst 13 located between the boiler and the new economiser. Similarly the specific CO_2-emission is minimal at the preferred operational conditions. Surprisingly it has been found that the maximum thermal efficiency is obtained at operational conditions differing from the preferred operational conditions of the method according to the invention.

[0017] The specific gas and oil prices in equal units are assumed to vary in the range: $0.6 < Gas/Oil < 1.17$

[0018] The repowering process as schematically shown in Fig. 1 comprises the following elements:

I. A steam-generating oil-fired boiler 1 with a steam piping 19 for supplying a steam turbine 2, powering a generator 3. Steam may be extracted 4 for process or other use.

II. One or more internal combustion engines or gas turbines (in the following denoted as the "engine") 5, each powering a generator 6.

III. All of the exhaust gas from the engine 5 is passed to the wind-box of the boiler (1), and, if necessary, air is added 8. The air is preheated with steam 9.

IV. If the engine 5 requires cooling, the heat from the cooling medium 10 is used for heating the feed water 11 for the boiler 1.

V. A cold economiser 12 replacing the conventional air pre-heater is used for heating of boiler feed water 11.

VI. If required, the NO_x in the flue gas from the boiler may be reduced further by incorporating of a catalyst 13 between the boiler 1 and the cold economiser 12. The NO_x is reduced to the required level by an introduction 14 of ammonia or urea upstream the catalyst 13.

VII. The temperature upstream from the catalyst 13 is kept at the required level by use of a flue gas bypass 15.

[0019] Fig. 1 shows the basic elements of a boiler turbine generator (BTG) plant repowered by use of the method according to the invention. The principle is described for a system with one boiler 1. The steam produced in the boiler 1 is supplied to a steam turbine 2. Steam is extracted from the turbine 4 for internal use in the boiler plant or for use as process steam outside the boiler plant. The steam turbine 2 is powering a generator 3. The boiler steam turbine cycle may be a simple cycle system or a reheat type cycle. The engine 5 may be formed of one or more gas turbines powered by gas or an internal combustion engine powered by heavy fuel oil or residual oil (i.e. an oil with a viscosity up to 10,000 cSt at 100 C).

[0020] All of the exhaust gas from the engines is supplied to the wind-box 7 of the boiler 1. If necessary, air 8 is added to the exhaust gas. The air 8 is heated by steam 9. The oxygen content in the gas used for combustion, if necessary with addition of air 8, corresponds to the minimum required amount for securing stable combustion in the boiler 1. Existing burners in the boiler are preferably changed to a type 16 with two gas inlet chambers of which one can be closed with a damper for operation of the boiler on fresh air only. The fuel 17 fed into the boiler 1 might be heavy fuel oil, residual oil or coal.

[0021] The minimum oxygen content in the combustion gas is in the range of 13.5-13.8 % O_2 by volume on dry basis. The amount of gas used by the combustion for a given amount of fuel 17 fed into the boiler 1 at full load condition for the steam turbine generator is controlled by the oxygen content and the CO-content in the flue gas discharged from the boiler 1 through the piping 18.

[0022] Under the preferably optimum condition the amount of gas used by the combustion corresponds to an amount leaving an oxygen content in the flue gas discharged through piping 18, which generate an CO content of maximum approximately 100 ppm by volume on dry basis or other maximum values acceptable to the plant owner and authorities. However, the oxygen content has to be at least 1 % by volume on dry basis to ensure stable boiler operation.

[0023] At steam turbine generator full-load conditions the engines 5, in case of gas turbines, operate at 95-100% of full-load conditions at given ambient conditions, whereas, if the engines 5 are internal combustion engines, the engines 5 may operate in the range 85-100 % of full-load conditions. One or more engines 5 may be used for each boiler 1 depending on the amount of exhaust gas at full load for each engine and for required part load operation conditions.

[0024] Because of the reduced oxygen content in the present boiler combustion gas compared with air, the combustion temperature is reduced. The mass flow of gas through the boiler 1 is however increased, whereby the transfer of heat in the boiler part from the superheater 21 to the hot economiser 22 is increased. Further the apparent boiler efficiency is increased, because the higher temperature of the combustion gas compared with air compensates for the reduced combustion temperature.

[0025] The heat energy from the cold economiser 12 is used for heating of boiler feed water 11. If internal combustion engines are used, the heat energy in the cooling water 10 is also used for heating of the boiler feed water 11 by means of the heat exchanger 20. The heating of the boiler feed water by means of waste heat reduces the amount of extracted steam 4, whereby the steam turbine generator output is increased for same steam supply conditions through steam piping 19. In any case the output from the steam turbine generator 3 after repowering can be kept at full load at 95-100 % of the maximum output when using air for the combustion.

[0026] The temperature at the inlet to the superheater 21 is also reduced and it should therefore be checked, if the wall temperature comes near the ash sticking temperature. This is even more necessary, if the fuel 17 for the boiler 1 is replaced with residual oil, which with its higher content of vanadium has a reduced ash sticking temperature. If critical, the first superheater should be replaced with another design coping with this problem.

[0027] Operating with an oxygen content of 11 to 15 % in the gas used by the combustion in the boiler 1 corresponds to operating a stand alone boiler with a large degree of flue gas recirculation leading to a reduced NO_x-emission from the boiler. In fact the preferred operation conditions as described leads to the lowest thermal NO_x production under the given conditions. An additional portion of the NO_x introduced into the boiler 1 from the engine 5 with the exhaust gas is converted into N_2 and H_2O in the furnace. Under the preferred operation conditions 40-60% of the NO_x introduced is converted. Consequently, under the preferred optimum condition the NO_x emission from the boiler 1 is minimal.

[0028] If the NO_x level is to be further reduced, a catalyst 13 is placed between the boiler 1 and the cold economiser 12. The catalyst 13 is used for selective catalytic NO_x reduction. For that purpose, urea or ammonia 14 is injected upstream the catalyst 13.

[0029] The temperature of the flue gas at the inlet of the catalyst 13 is kept at the required high level by bypassing 15 flue gas.

[0030] If oil is used for powering the engine 5 and/or for firing the boiler 1, a filter is installed downstream of the economiser 12 to reduce the particulate content to the required level and a desulphurisation system is installed after the filter. The flue gas after the desulphurisation system is heated by use of a gas/gas heat exchanger using the heat of exhaust gas at the inlet of the desulphurisation system.

[0031] Further, the specific CO_2 emission is minimal at the preferred operational conditions.

Examples

[0032] The method according to the invention is described with reference to a system comprising of a 250 MW reheat type boiler steam turbine generator plant repowered with one to four GTX 100 gas turbines operating on natural gas and the boiler converted into operating on residual oil having a viscosity up to 10,000 cSt at 100°C. The natural gas has a lower heat of combustion of 45,130 kJ/kg and the residual oil a lower heat of combustion of 39,800 kJ/kg. The ambient temperature is 25 °C and 60 % RH at sea level.

[0033] The gas/power cost level in equal units is 0.266 and the residual oil cost to the power cost level in equal units is similar 0.266.

[0034] The oxygen content after the boiler generating 100 ppm CO by volume on dry basis is 3%.

[0035] Operating parameters are indicated in the following Table. In Case 2.9, the gas turbine size is assumed adjusted geometrically to the preferred operational conditions:

	Case 1	Case 2	Case 2.9	Case 3	Case 4
Total power/steam turbine power	116 %	132 %	146 %	148 %	164 %
Engine Exhaust O_2 % Vol Dry	11.8	11.8	11.8	11.8	11.8
Engine Exhaust temperature °C	550	550	550	550	550
Economiser Outlet temp. °C	170	170	170	170	170
Boiler Flue gas O_2 % Vol Dry	3.0	3.0	3.0	3.6	7.0
Total Flue gas kg/kWs Gross	986	946	919	945	1120
Boiler Added Air/Total Flue Gas	59.5 %	31.8 %	11.3 %	11.3 %	11.4 %
Net Power Efficiency %	41.1 %	44.0 %	46.3 %	46.6 %	48.0%
Power /Ref. Power	100%	114 %	126 %	128 %	141 %

(continued)

	Case 1	Case 2	Case 2.9	Case 3	Case 4
Power Income*	1.000	1.141	1.263	1.281	1.412
Engine Fuel	0.104	0.208	0.299	0.312	0.417
Boiler Fuel	0.555	0.505	0.461	0.456	0.415
	0.341	0.428	0.503	0.513	0.580
O&M New Equipment	0.029	0.045	0.058	0.061	0.079
Capital Cost	0.195	0.258	0.295	0.308	0.409
Surplus	0.117	0.125	0.150	0.144	0.092
Relatively	78 %	83 %	100 %	96 %	61 %
CO_2 kg/MWh 3 % O_2 Vol-Dry	115 %	106 %	100 %	103 %	120 %

* Power Income = (power capacity) • (full load operation hours per year) • (power price/MWh)

[0036] For a given boiler steam turbine generator system the optimum economy is achieved, where the existing steam turbine after repowering may be operated in the range of 95-100 % of the normal maximum output, when using air by the combustion and gas turbines are operated at full load at given ambient conditions and only either marginal extra air is needed at inlet of the boiler or a marginal higher oxygen content at the outlet boiler compared to the optimum condition.

[0037] The main differences between Case 4 and Case 2.9 are that the specific flue gas amount is 22 % higher in Case 4 compared to Case 2.9. The flue gas mass flow itself is 37% higher in Case 4 compared to Case 2.9.

[0038] The ratio between the specific gas cost and the specific oil cost at equal metric units is assumed to be: 0.6 < gas cost/oil cost < 1.17.

[0039] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. Repowered boiler turbine generator plant comprising one or more oil-fired or pulverized coal-fired boilers, each boiler (1) generating steam supplied through a steam piping (19) to one or more steam turbines (2), each of which being connected with a power generator (3); one or more gas turbines or internal combustion engines, (5) each of which being connected with a generator (6) and each of which supplying the boiler (1) with exhaust gas; a wind-box (7) for the boiler (1) having a burner (16) being supplied with fuel (17); a superheater (21) and optionally a reheater (23) and a hot economiser (22) upstream of an outlet piping (18) for flue gas from the boiler (1); a steam piping (19) for passing steam from the boiler (1) through the superheater (21) to the steam turbine(s) (2); optionally a catalyst (13) downstream of the hot economiser (22) for reducing the content of NO_x in the flue gas; means for adding ammonia or urea (14) upstream of the catalyst (13), if present; and optionally a bypass (15) for flue gas from the boiler (1) to the catalyst (13);
said plant further comprising:

    - an exhaust gas piping supplying all the exhaust gas from the gas turbine(s) or internal combustion engine(s) (5) to the wind-box (7) of the boiler (1) and optionally a piping (8) for adding heated air to said exhaust gas; and

    - a controller of fuel (17) fired in the boiler (1) ensuring a content of oxygen in the flue gas from the boiler (1) being either approximately between 1% and approximately 6%, preferably approximately between 1 % and approximately 4%, and especially 3 % by volume as a dry gas, or generating approximately 100 ppm to approximately 1000 ppm, preferably 100 ppm to approximately 500 ppm, and especially 100 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

2. The plant of claim 1, further comprising:

- a cold economiser (12) downstream of the superheater (21) and optional reheater (23), hot economiser (22) and catalyst (13), if present, for cooling the flue gas to a temperature normally used to prevent sulphuric acid corrosion at the cold end of the economiser (12) and for preheating said boiler feed water (11).

3. The plant of claims 1 to 2, further comprising:

- a heat exchanger using the heat from engine cooling medium, if available, for additional preheating of said boiler feed water (11).

4. A method of repowering boiler turbine generator plants comprising one or more oil-fired or pulverized coal-fired boilers, each boiler (1) generating steam supplied through a steam piping (19) to one or more steam turbines (2), each of which being connected with a power generator (3); one or more gas turbines or internal combustion engines (5), each of which being connected with a generator (6) and each of which supplying the boiler (1) with exhaust gas; a wind-box (7) for the boiler (1) having a burner (16) being supplied with fuel (17); the flue gas of said boiler (1) being passed to an outlet piping (18) for flue gas through a superheater (21) and optionally a reheater (23) and a hot economiser (22) for said steam being passed through the steam piping (19); said flue gas optionally being passed through a catalyst (13) for reducing the content of NO_x in the flue gas, in which case ammonia or urea (14) is added upstream of the catalyst (13); and the temperature at the inlet to the catalyst (13), if necessary, being maintained at the required level by bypassing the superheater (21) with flue gas (15);
said method comprising the steps of:

- supplying all the exhaust gas from gas turbine(s) or internal combustion engine(s) (5) to the wind-box (7) of the boiler (1) and optionally adding heated air to said exhaust gas so as to obtain a composition of exhaust gas and air with the oxygen content required for obtaining stable combustion in the boiler (1); and

- regulating the amount of fuel (17) fired in the boiler (1) to obtain a flue gas after the boiler (1) having a content of oxygen, which is either between approximately 1 % and approximately 6% by volume as a dry gas, or having such a content of oxygen generating approximately 100 ppm to approximately 1000 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

5. The method of claim 4, further comprising the step of :

- regulating the amount of fuel (17) to obtain a flue gas having a minimum content of oxygen of between approximately 1 % and approximately 4 % by volume as a dry gas, or having such a content of oxygen, which generates approximately 100 ppm to approximately 500 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

6. The method of claims 4 to 5, further comprising the step of:

- regulating the amount of fuel to obtain a flue gas having a minimum content of oxygen of approximately 1 % by volume as a dry gas, or having such a content of oxygen, which generates approximately at least 100 ppm by volume as a dry gas of CO, whichever oxygen content is the highest.

7. The method of claims 4 to 6, further comprising the step of:

- selecting the size of the gas turbine(s) or internal combustion engine(s) (5) so that the exhaust gas with the optionally added heated air provides said stable combustion in the boiler (1) with the amount of fuel (17) so as to produce steam in an amount required to generate 95 to 100 % of the output of the power generator (3) in comparison with the use of heated air alone for the combustion at full load.

8. The method of claims 4 to 7, further comprising the steps of:

- replacing a prior-art boiler turbine generator plant pre-heater of air for the combustion in the boiler (1) with a cold economiser (12) cooling the flue gas to a temperature normally used to prevent sulphuric acid corrosion at the cold end of the economiser (12); and

- using the heat from said economiser (12) to heat boiler feed water (11).

9. The method of claims 4 to 8, further comprising the step of:

- using the heat from engine cooling medium, if available, for additional preheating of said boiler feed water (11).

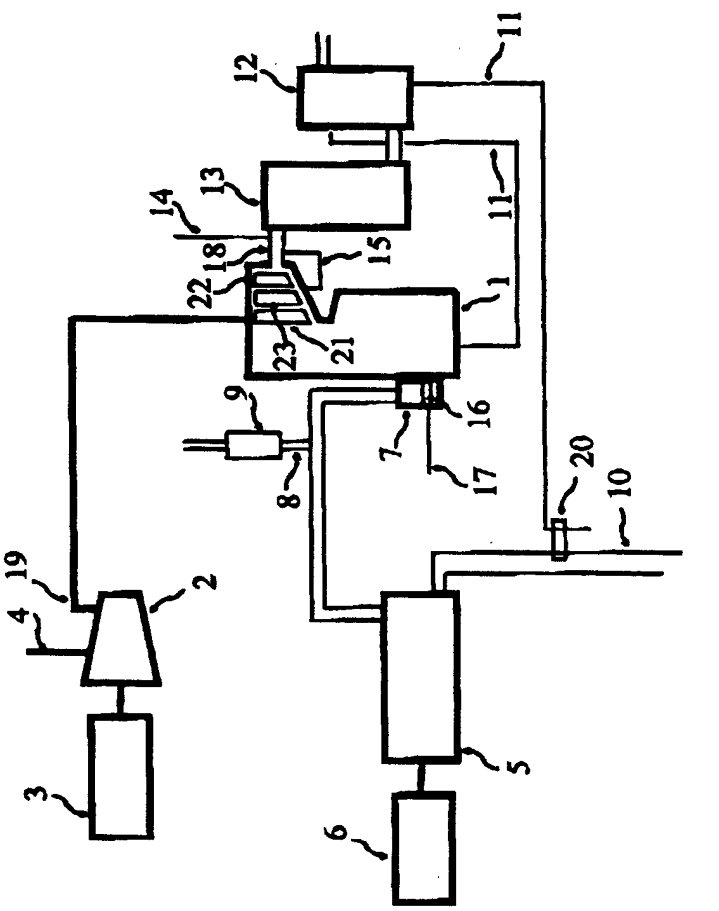

Fig. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 61 0072

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	HOELY F - J: "LEISTUNGSSTEIGERUNG FOSSILBEFEUERTER DAMPFTKRAFTWERKE DURCH UMBAU ZU KOMBINIERTEN ANLAGEN" BWK BRENNSTOFF WARME KRAFT,DE,VDI VERLAG GMBH. DUSSELDORF, vol. 48, no. 10, 1 October 1996 (1996-10-01), pages 44-48, XP000633032 ISSN: 0006-9612 * page 44, left-hand column, line 1 - page 46, left-hand column, paragraph 1 * ---	1,4	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 061 (M-671), 24 February 1988 (1988-02-24) & JP 62 206320 A (NIPPON STEEL CORP), 10 September 1987 (1987-09-10) * abstract * ---	1,4	F01K F23N F22B
A	US 4 492 559 A (POCOCK ROBERT E) 8 January 1985 (1985-01-08) * column 3, line 23 - line 61; figures * --- -/--	1,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 December 2000	Van Gheel, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	GARCIA R F: "FUZZY RULE-BASED COMBUSTION CONTROL ON AIR ADJUSTMENT APPLIED TO A COAL FIRED POWER PLANT" , PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SYSTEMS, MAN, AND CYBERNETICS,US,NEW YORK, IEEE, PAGE(S) 408-412 XP000530705 ISBN: 0-7803-2130-8 * page 411, right-hand column, paragraph 5; figure 4 * -----	1,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

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THE HAGUE	18 December 2000	Van Gheel, J

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O : non-written disclosure
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 61 0072

This annex lists the patent family membersrelating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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