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(54) Heating arrangement

(57) A heating arrangement such as for a domestic boiler uses a gas turbine 100 to provide heat to a heat exchanger 200 arranged perpendicular with respect to the direction of heated exit gases from the gas turbine. The turbine fan 130 has a relatively large clearance from the turbine housing 124 to generate maximum heat and minimal thrust.

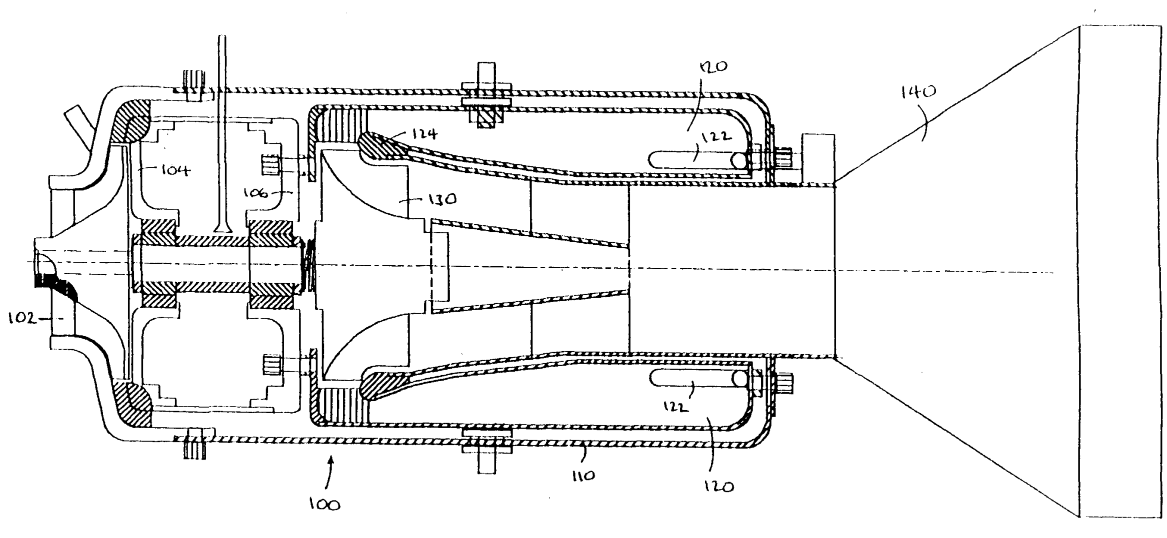

Fig. 1

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Description

[0001] The present invention relates to a heating arrangement and, in a preferred embodiment, to a heating arrangement for a domestic boiler.

[0002] In the example of a domestic boiler, having a capacity in the range of about 30,000 to 110,000 BTU, a heat exchanger is arranged over a heat source such as a gas burner in order to heat water (or other heat exchange fluid) passing through the heat exchanger. The heated water is then coupled to heat a hot water supply or a central heating system. Despite elements such as condensing boilers, known heating arrangements are inefficient and allow up to 65% of the input energy to be unrecovered.

[0003] GB-A-2273340 (British Gas) discloses a combined heat and power apparatus using a gas turbine to drive the shaft of an electrical power generator, and recovering heat from the exhaust gases of the turbine using a heat exchanger. However, this known apparatus is relatively large and cumbersome, and is not suited for use in a domestic environment. Further, a supplementary burner is required because the turbine is mainly intended to provide power rather than heat.

[0004] It is an aim of the present invention to provide a compact and efficient heating arrangement.

[0005] According to the present invention there is provided a heating arrangement for a domestic boiler, comprising: a gas turbine arrangement for generating a stream of heated exit gases; a heat exchanger for transferring heat energy from the heated exit gases to a heat exchange fluid; characterised in that the stream of heated exit gases is directed from the turbine arrangement along a longitudinal axis of the turbine arrangement; and a major plane of the heat exchanger lies substantially perpendicular to the axial direction of the heated exit gases.

[0006] The preferred turbine arrangement operates on the well known principle developed through the use of turbines in aircraft engines and large scale power generation. However, the aim of the prior art turbine arrangement is to output maximum thrust and minimum heat, whereas the preferred turbine arrangement outputs maximum heat and minimum thrust.

[0007] Preferably, the turbine arrangement comprises a turbine fan rotatably mounted within a housing. In contrast to the prior art turbine arrangements where the clearance between the turbine fan and the housing is usually desired to be as small as possible in order to generate maximum thrust, in the preferred embodiment of the present invention the clearance is relatively large, suitably of the order of 5mm, in order to provide maximum heat output. Preferably, the clearance is selected so that just sufficient thrust is generated to provide an operational turbine arrangement.

[0008] According to a second aspect of the present invention there is provided a boiler comprising a heat exchanger for transferring heat energy between a gas and a liquid, and a turbine arrangement for generating heated gas directed at the heat exchanger.

[0009] Preferably, the turbine arrangement runs on a dry fuel, preferably natural gas.

[0010] According to a further aspect of the present invention there is provided a heat exchanger having a plurality of layers arranged substantially co-planar.

[0011] Preferably, each layer comprises an elongate tube bent to form a plurality of parallel sections, and preferably the sections of each adjacent layer are offset with respect to each other. Further, the heat exchanger preferably comprises a plurality of fins for directing air through the heat exchanger. Each fin preferably comprises a planar sheet having parallel ribs formed laterally thereacross and holes therethrough for heat recovery and air scrubbing. Each fin preferably has a deflector arranged at around 45° to the plane thereof, for directing air across the fin. Ideally, up to around 80 fins are provided across the heat exchanger arranged parallel to the incoming air flow and perpendicular to the heat exchanger layers.

[0012] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic sectional view of a turbine arrangement;

Figure 2 is a plan view of a preferred heating arrangement;

Figure 3 is an expanded schematic view of a heat exchanger;

Figure 4 is a front view of a fin; and

Figure 5 is a side view of a fin.

[0013] Referring firstly to Figure 1, a turbine arrangement is shown as will be familiar to persons skilled in the art, having an inlet 102, a front vane carrier 104 and a rear vane carrier 106 carrying front and rear vanes, respectively, for drawing in cold air and compressing and slowing the air. The compressed air is passed to a combustion chamber 120 having gas injectors and atomisers 122 introducing a combustible fluid preferably natural gas from a mains supply. The gas and air mixture is ignited and expands and thus is forced past turbine wheel 130 toward an exit cone 140.

[0014] The turbine wheel has been developed to produce heat rather than thrust by allowing a relatively large tolerance between the turbine and the surrounding housing 124. If the gap is too great, between the tip of the turbine wheel and the housing, then insufficient energy will be passed to the turbine wheel to sustain the turbine cycle.

[0015] The shape of the exit cone 140 significantly affects the flame pattern produced from the turbine wheel 130. The exit cone 140 develops the flame pattern and guides it into the heat exchanger.

[0016] Referring to Figure 2, two turbine heat generators 100 are shown arranged side by side and directed toward a heat exchanger 200. A electric motor 300 having a centrifugal clutch is coupled to each of the turbine heat generators 100 to drive the turbine wheels up to operating speed of about 28,000 rpm at start up.

[0017] Operation of the heating arrangement and boiler system is suitably controlled by a central control means including interlocking sensors and temperature sensors. When demand for heat is established, such as from a central heating arrangement or a domestic hot water arrangement, the electric motor is engaged to run the or each turbine wheel up to operating speed of about 28,000 rpm. Operating speed is achieved after about 4 seconds, and a valve in the gas supply is opened to supply gas at a first predetermined rate to gas injectors 122 of Figure 1. Once a sustained flame is detected such as by a suitably placed thermocouple, the gas flow is increased to a second preset level. The speed of the turbine is dependent upon the volume of gas provided, and consequently increases in speed up to a maximum speed of around 80,000 rpm. In the preferred embodiment, full working system temperature is achieved within 4 to 5 minutes, and is continually monitored through heating control sensors. As the system attains working temperature, the volume of gas supplied is reduced to a rate between the first and second levels and the speed of the turbine consequently drops. Thus, the output of the heat generator can be easily varied to match demand.

[0018] In the preferred embodiment, a maximum desired operating output can be achieved within around 10 seconds from start up with the turbine running at around 85,000 rpm and producing an output of around 1010°C.

[0019] The heat exchanger will now be described in more detail with reference to Figures 3, 4 and 5. The heat exchanger 200 is suitably coupled to a central heating system or a hot water supply. The boiler can be set to operate on winter or summer settings according to variations in the incoming water temperature.

[0020] The heat exchanger 200 preferably comprises three layers to provide good thermal transfer efficiency. As may be seen in Figure 3, each layer comprises a tube 202, 203, 204 bent to form a plurality of parallel sections. The middle tube is offset with respect to the top and bottom tubes such that air passing through the heat exchanger must pass around the tube.

[0021] Referring now to Figures 4 and 5, a plurality of fins, preferably of the order of eighty fins, are provided across the heat exchanger. Each fin 220 has a plurality of holes 221 therethrough and lateral ribs 222, for good heat recovery. The fins are preferably set with a minimum amount of clearance. Relatively small gaps are required between the fins due to the relatively high velocity of the heated air exiting the turbine heat generator 100. As the air is moving over the fins at relatively high speed, the arrangement of holes 221, and ribs 222 increase friction to provide an air scrubbing effect which increases efficiency by around 5 to 7%. Each fin is provided with a deflector 223 arranged at around 45° for deflecting air across the fin, and for contributing to the air scrubbing effect.

[0022] The boiler and heat exchanger does not require a fan or other external venting source, because the residual velocity of the air exiting the heat exchanger is sufficient to ensure adequate venting. Also, relatively long runs of flue ducting may be installed.

[0023] The heating arrangement described herein has a number of advantages in that it is efficient and compact. In the preferred embodiment, a boiler is arranged to fit within the space available in a standard single wall unit of around 300 mm wide by 720 mm high by 280 mm deep. The heating arrangement is efficient with losses only in the region of 43%. Emissions from the heating arrangement are clean and well within current UK and EU standards.

[0024] Referring again to Figure 2, where two heat generators 100 are shown arranged side by side, further units may be provided according to the heat output desired. For example, four generators may be provided giving a total output of around 250,000 BTU. Further improvements in the efficiency of each unit and/or the provision of further units show that the heating arrangement described herein is generally applicable in providing an output up to around 500,000 BTU.

[0025] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0026] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0027] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0028] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A heating arrangement for a domestic boiler, comprising:

a gas turbine arrangement (100) for generating a stream of heated exit gases;

a heat exchanger (200) for transferring heat energy from the heated exit gases to a heat exchange fluid;

characterised in that

the stream of heated exit gases is directed from the turbine arrangement (100) along a longitudinal axis of the turbine arrangement; and

a major plane of the heat exchanger (200) lies substantially perpendicular to the axial direction of the heated exit gases.

2. A heating arrangement as claimed in claim 1, wherein the heat exchanger (200) is arranged to lie directly in the path of the heated exit gases produced by the turbine arrangement.

3. A heating arrangement as claimed in claim 2, wherein the stream of heated exit gases proceeds substantially linearly from the turbine arrangement (100) to the heat exchanger (200).

4. A heating arrangement as claimed in claim 1, wherein the turbine arrangement (100) comprises a turbine fan (130) rotatably mounted within a turbine housing (124), and wherein a clearance between the turbine fan (130) and the housing (124) is arranged to provide maximum heat output and minimal thrust.

5. A heating arrangement as claimed in claim 4, wherein the clearance is of the order of 5mm.

6. A heating arrangement as claimed in claim 5, wherein the turbine arrangement (100) comprises an exit cone (140) for defining a flame pattern of the heated exit gases from the turbine fan (100), the exit cone (140) for directing the flame pattern toward the heat exchanger (200).

7. A domestic boiler comprising:

a water circulation system;

a heat exchanger (200) for heating water in the water circulation unit using a heat exchanger fluid;

a turbine arrangement (100) for generating a stream of heated exit gases;

characterised in that:
a major plane of the heat exchanger (200) is arranged substantially perpendicular to the stream of heated exit gases.

8. A boiler as claimed in claim 7, wherein the heated exit gases leave the turbine arrangement (100) in a direction aligned with a longitudinal axis of the turbine arrangement.

9. A boiler as claimed in claim 8, wherein the heat exchanger (200) comprises a plurality of layers (202, 203, 204) arranged substantially co-planar, each layer comprising an elongate tube bent to form a plurality of parallel sections, and wherein the sections of each adjacent layer are offset with respect to each other.

10. A boiler as claimed in claim 9, wherein the heat exchanger comprises a plurality of fins for directing air through the heat exchanger, each fin comprising a planar sheet (222) having parallel ribs formed laterally thereacross and holes (221) therethrough for heat recovery and air scrubbing.

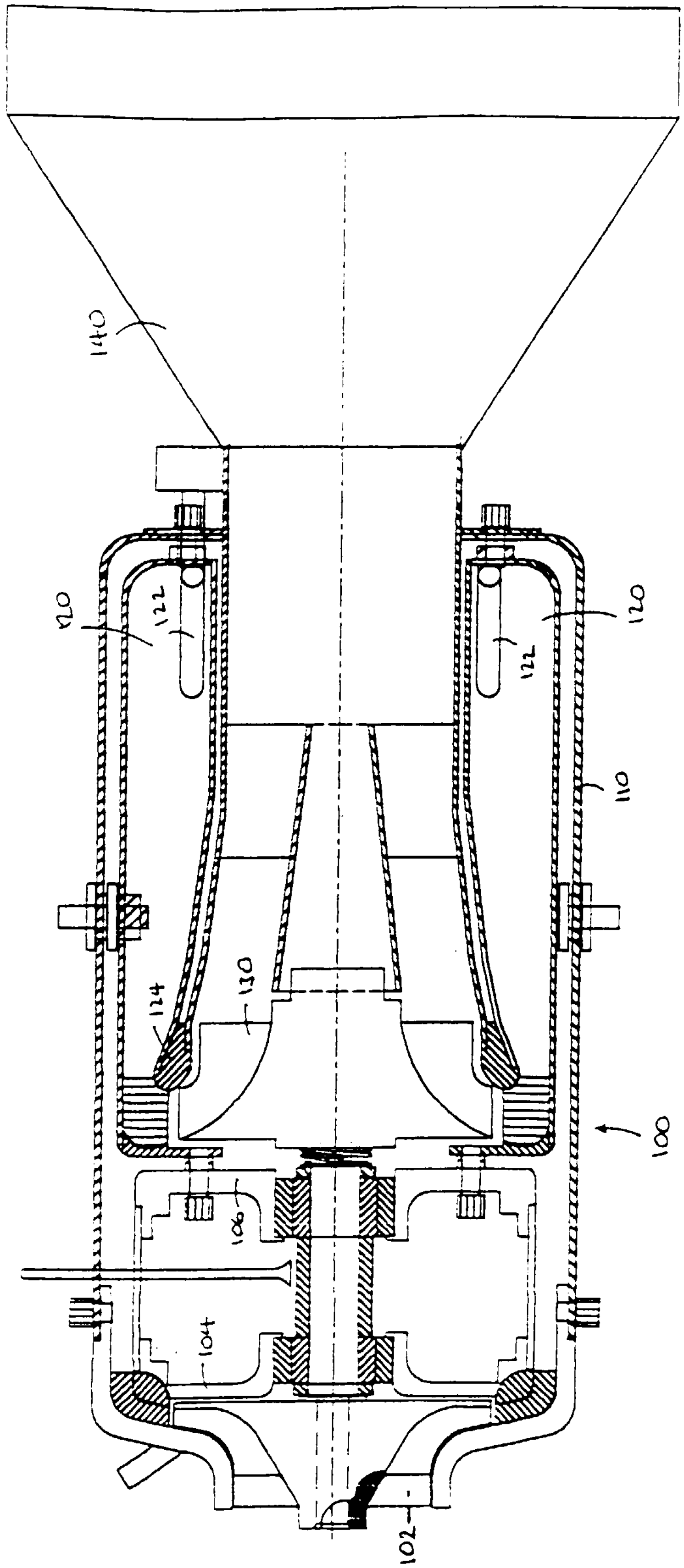

Fig. 1

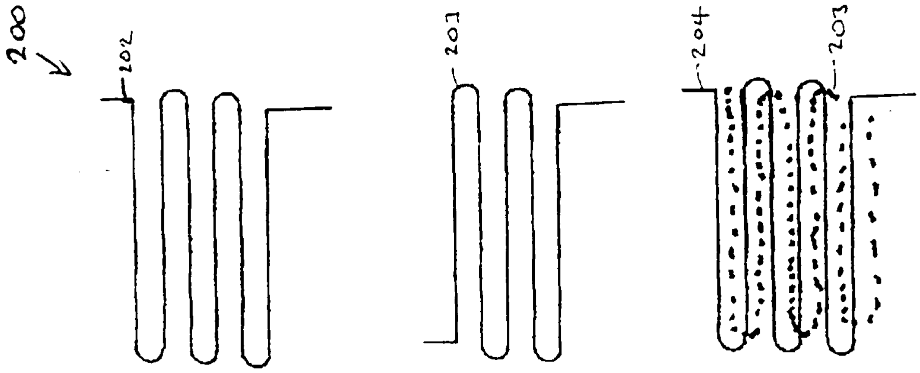

Fig. 3

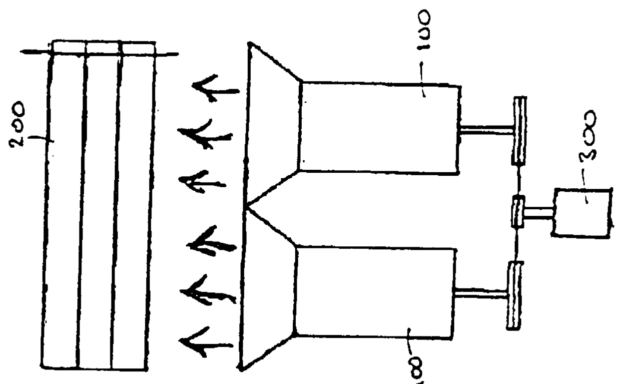

Fig. 2

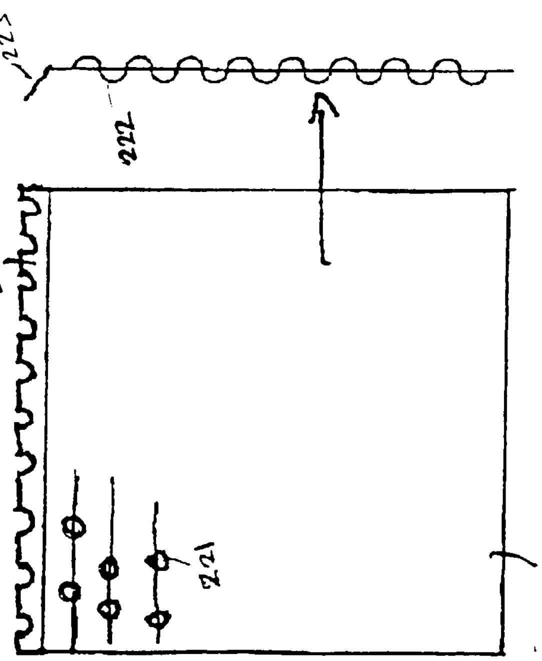

Fig. 5

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 5487

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)
X Y	US 4 002 157 A (TOESCA RENE A M) 11 January 1977 (1977-01-11) * column 3, line 27 - column 4, line 36 * * column 6, line 1 - line 12; figures 5,12 *	1-8 9,10	F23D14/36 F28D1/047 F28F1/22
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A	DE 27 39 655 A (WUTZ MAX PROF DR) 8 March 1979 (1979-03-08) * claims 1-3 *	1,7	
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F23D
F28D
F28F
F23L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 December 1999	Coli, E

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 5487

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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