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(54) APPARATUS FOR GENERATING HEAT ENERGY FOR HEATING PURPOSES BY MEANS OF A FUEL-AIR MIXTURE

(71) I, UTE-URSULA THIMM of Landwehrstrasse 31, 8000 Munchen 2, West Germany, a citizen of the Federal Republic of Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for generating heat energy for heating purposes by means of a fuel-air mixture.

Known heat-generating plants, such as plants fired with fuel oil, coal or gas, have the disadvantage that the heat energy of the primary fuel is only poorly utilized. The reasons for this poor utilization are generally known and will be briefly stated.

When a flame is produced in a combustion chamber, conditions which result in complete combustion with full utilization of the calorific value of the fuel will be obtained only for relatively short periods of operation and only after careful adjustment. When the flame is ignited, the walls or lining defining the combustion chamber must first assume a sufficient temperature at which complete combustion is effected and there is no quenching of the flame; since such quenching could result in formation of carbon monoxide.

Even when the conditions required for satisfactory flame formation exist in the combustion chamber, the originally selected, desired setting of the burner may change as a result of deposition of soot, wear, and the like that the burner efficiency (quotient of energy supplied in the form of fuel, on a annual average, based on the net calorific value, on the one hand, and of heat energy which becomes available at the outlet of the burner, on the other hand) does not rise above values of 50% in practice on an annual average. Specifically, a burner will be highly susceptible to changes of flow conditions in the air supply line as a result of a deposition of soot, of flow conditions in the combustion chamber, which changes may also be due to deposits on the lining of the combustion chamber, and of changes of flow conditions in the flue or chimney.

A decrease of the overall efficiency of a plant, with increase in fuel consumption, may also be due to difficulties involved in the heat transfer from the hot combustion products through a heat transfer partition to the heat transfer fluid circulating in the heating system. Such difficulties are observed particularly in relatively small plants, which do not permit of adjustment of the burner flame for power control but are generally arranged for ON/OFF control so that the efficiency of the boiler decreases with its duty cycle because the entire boiler and the combustion chamber lining have a considerable thermal capacity and after a prolonged inoperative period must be heated up from the cold.

It has been attempted to improve the utilization of fuel in the generation of heat for heating purposes in that the fuel is used to operate a heat pump installation in which primary energy is used, possibly after an energy conversion stage, to drive a compressor which is included in the heat pump cycle, and an evaporator-heat exchanger is included which precedes the compressor and is used to extract heat energy from the environment, as well as an output heat exchanger for delivering heat energy for heating purposes. Such plant is very advantageous and suitable for high heat powers. They permit of a decrease of fuel consumption or of primary energy consumption of up to 30% compared to a heating system using a conventional furnace.

Particularly when generating small power ouputs, heat pump installations for heating purposes have the disadvantage that their prime cost is considerable owing to the considerable cost of a refrigerant compressor, the evaporator-heat exchanger and the sealed pipe system filled with refrigerant. Furthermore, heat pump installations cannot be used where heat cannot be extracted from the environment, e.g., in regions in which the temperature often drops far below the freezing point.

It is an object of the invention to provide apparatus for generating heat energy for heating purposes in such a manner that the prime cost of the plant is low, the plant can easily be controlled and the fuel consumption is considerably decreased particularly in plant of lower power output, e.g., for domestic heating.

In accordance with the invention apparatus for generating heat energy comprises a heat engine having combustion chamber means in which compressed air is burned with a fuel to operate the heat engine, engine retardation means coupled to the engine, and a heat transfer circuit in which a heat transfer medium flows for cooling both the engine and the retardation means, the heat transfer circuit including one or more output heat exchangers for enabling all the heat of the heat transfer medium to be utilised for heating purposes.

It will be understood that the term fuel used in the present specification and in the claims refers to a chemical fuel. The apparatus described here may be operated with solid fuel, such as powderized coal, but it will more likely be operated with liquid or gaseous fuels.

It is apparent that part of the mechanical energy of the engine is not used to drive the compressor but is converted into heat energy by the engine retardation means and the resulting heat energy is supplied to the heat transfer medium.

The retardation means may comprise a water-swirling brake, which may be speed-controlled and may supply heat to the heat transfer medium either directly or through a heat exchanger.

Alternatively the retardation means may comprise a centrifugal pump which may be incorporated in a controlled shunt path of the heat transfer circuit. Preferably the pump serves to circulate the heat transfer medium round the heat transfer circuit. Control may be exercised by flow control means situated in the shunt path and in that part of the heat transfer circuit shunted by the shunt path.

Before a discussion of details of apparatus embodying the invention, a short explanation will be given of the fact that up to 50% fuel can be saved by the use of the present invention. This can be proved by practical experiments.

The compression of combustion air results in high gas velocities in the combustion chamber so that the fuel and air are intimately blended and are completely burned. The high gas velocities result in a good heat transfer through the heat transfer partition. As there is no need for a liner on the partition, the plant has only a low thermal capacity and after a short time of operation will assume the state in which the highest utilization of fuel is ensured. In addition, the required size of the combustion chamber is much smaller than in heating systems having a conventional combustion chamber.

The invention will now be explained more fully by a description of illustrative embodiments shown on the accompanying drawings, in which

Fig. 1 is a diagrammatic view showing a heat-generating plant, and

Fig. 2 shows a preferred embodiment of a heat-generating plant including a diesel engine.

The heat energy-generating plant shown in Fig. 1 includes a compressor 1, which is driven by means of shafts and interposed couplings 2 from an engine, such as a piston engine or a turbine 3. The compressor 1 takes in fresh air through an intake passage 4 and delivers compressed air under a superatmospheric pressure greater than 11 bars and of, say 21 bars, through a compressed air passage 5 to a combustion chamber 6. In the combustion chamber 6, the compressed air is mixed with fuel, such as fuel oil, which is supplied through a conduit 7. The fuel-air mixture is burned in the combustion chamber so that a stream of hot combustion products under a pressure of 21 bars is delivered through a passage 8 to the engine 3, in which the heat content of the combustion products is utilized and is converted into mechanical energy in dependence on the efficiency of the engine. That mechanical energy is used in part to drive the compressor and in part to drive fuel supply pumps or fuel injection pumps. The latter use is not shown in Fig. 1 for the sake of simplicity. A further part of the mechanical energy delivered by the engine 3 is diverted and is converted back into heat energy in engine retardation means which may comprise a brake 9.

A heat transfer fluid circuit 10 includes a heat exchange arrangement 11, which takes up the heat dissipated by the engine 3, and another heat exchange arrangement 12, which is associated with the brake 9 and supplies the heat transfer fluid with the heat energy which has been derived from the mechanical energy that has been produced by the engine 3 and diverted through the brake 9. It will be understood that the brake 9 and the associated further heat exchanger arrangement 12 may be used in various forms. This will be discussed more in detail hereinafter.

The heat transfer fluid circuit 10 also includes output heat exchangers 13 such as radiators used to heat dwelling rooms,

The heat exchange arrangement 11 comprises a section for utilizing residual heat contained in the exhaust gas from the engine 3 and a section which is included in the cooling water cycle of the engine 3. In certain gases, the cooling water cycle of the engine 3 may be directly included in the heat transfer fluid circuit 10.

In the embodiment shown in Fig. 1, the

compressor 1 and the engine 3 are separate units. In the embodiment shown in Fig. 2, the compressor and the engine 3 are combined in one machine. The latter consists of a piston engine, specifically a diesel engine, which sucks combustion air through a fresh air passage 14 and compresses the air in a compression stroke in the cylinder chambers, which also constitute combustion chambers. Fuel is injected into and ignited in said combustion chambers, preferably after the compression stroke. The fuel is fed through a fuel conduit 15. The diesel engine 16 has a cooling circuit, which is connected by conduits 17 and 18 to the heat transfer fluid circuit 10, which includes the output heat exchanger 13 as well as a heat exchanger 19 for utilizing the residual heat contained in the exhaust gases from the diesel engine 16.

It is apparent that part of the mechanical energy which is generated in the diesel engine 16 during the combustion and expansion stroke is used to compress the fresh air within the cylinder chambers of the diesel engine itself. Surplus mechanical energy from the diesel engine 16 is used to drive a brake 20, which constitutes a water-handling centrifugal pump. That pump is coupled to the shaft of the diesel engine 16 and included in a shunt path of the heat transfer fluid circuit 10. Flow control means in the form of control valves 21, 22 and 23 permit control of the flow rate in the heat transfer fluid circuit 10. The valves 21 and 22 also permit control of the mechanical power which is dissipated by the brake 20. The water-handling centrifugal pump 20 circulates the heat transfer fluid in the circuit 10 and owing to the resistance to flow causes a temperature rise of the water being handled so that the water-handling centrifugal pump 20 supplies heat to the heat transfer fluid circuit 10.

Fig. 2 shows also a starting motor 24, by which the diesel engine 16 can be started by means of a vee belt drive 25 and an overrunning clutch 26.

When a certain value of braking power of the water-handling centrifugal pump 29 has been adjusted at the valve 22, a disturbing noise may be generated during operation but may be avoided if the passage leading from the outlet of the water-handling centrifugal pump has a greatly enlarged portion, which includes throttling means consisting of a multi-orifice plate, which divides the initially compact stream of water into a large number of fine partial streams. Such constricting means operate substantially without noise.

The mechanical energy diverted from the engine 3 may be converted to heat by means of a brake in a desirable manner in that an electric generator is coupled to the engine and the heat energy derived from the electric energy supplied via an electric heater to the heat transfer fluid circuit 10.

The brake 20 may alternatively consist of a water-swirling brake; in that case, the braking power may be controlled by speed control. If an eddy current brake is used to convert the diverted mechanical energy to heat energy, it will also be suitable to control the brake power by speed control. In any case, arrangements of the two kinds mentioned last will also comprise heat exchangers by which the heat energy derived from the diverted mechanical energy can be supplied to the heat transfer fluid circuit 10.

A water-handling centrifugal pump used as a brake may circulate the heating fluid. This will be desirable not only in room-heating systems, because a separately driven circulating pump is no longer required, but also for other heating purposes, e.g., in swimming pool water-heating systems, whether or not they include a countercurrent unit.

WHAT I CLAIM IS:—

1. Apparatus for generating heat energy comprising a heat engine having combustion chamber means in which compressed air is burned with a fuel to operate the heat engine, engine retardation means coupled to the engine, and a heat transfer circuit in which a heat transfer medium flows for cooling both the engine and the retardation means, the heat transfer circuit including one or more output heat exchangers for enabling all the heat of the heat transfer medium to be utilised for heating purposes.

2. Apparatus as claimed in claim 1 in which the said retardation means comprises a water-swirling brake.

3. Apparatus as claimed in claim 2 in which the said brake is speed-controlled.

4. Apparatus as claimed in claim 2 or claim 3 in which the said brake supplies heat directly to the heat transfer medium.

5. Apparatus as claimed in claim 2 or claim 3 in which the said brake supplies heat to the heat transfer medium through a heat exchanger.

6. Apparatus as claimed in claim 1 in which the said retardation means comprises a centrifugal pump.

7. Apparatus as claimed in claim 6 in which the said pump is included in a shunt path of the heat transfer circuit.

8. Apparatus as claimed in claim 7 in which flow control means is provided in that part of the heat transfer circuit which is shunted by the shunt path.

9. Apparatus as claimed in any one of claims 6 to 8 in which throttle means are included in the output side of the said pump.

10. Apparatus as claimed in claim 9 in which the throttle means comprises a multi-orifice plate positioned in a portion of the flowpath of the heat transfer medium which has an enlarged cross-section.

11. Apparatus as claimed in any one of

claims 6 to 10 in which flow control means is provided in series with the said pump.

12. Apparatus as claimed in any one of claims 6 to 11 in which the said pump serves to circulate the heat transfer medium round the heat transfer circuit.

13. Apparatus for generating heat energy substantially as described herein with reference to the accompanying drawings.

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1596069 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

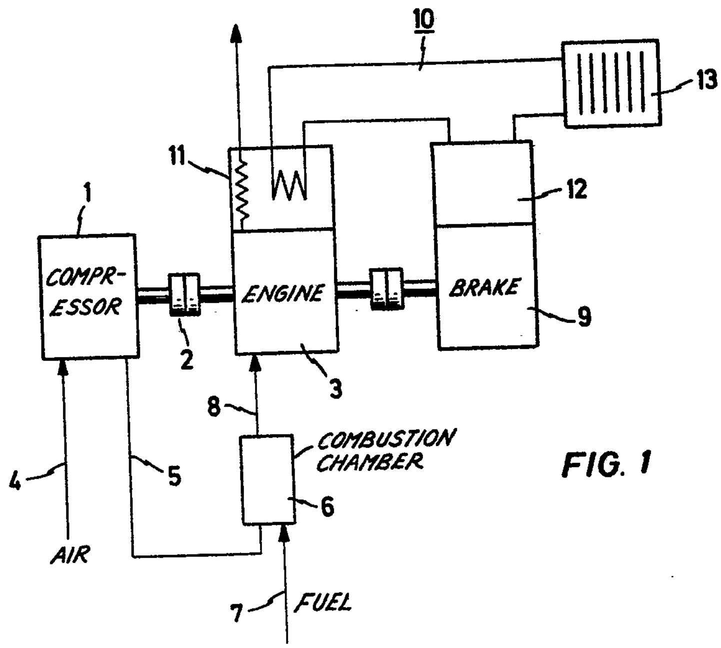

FIG. 1

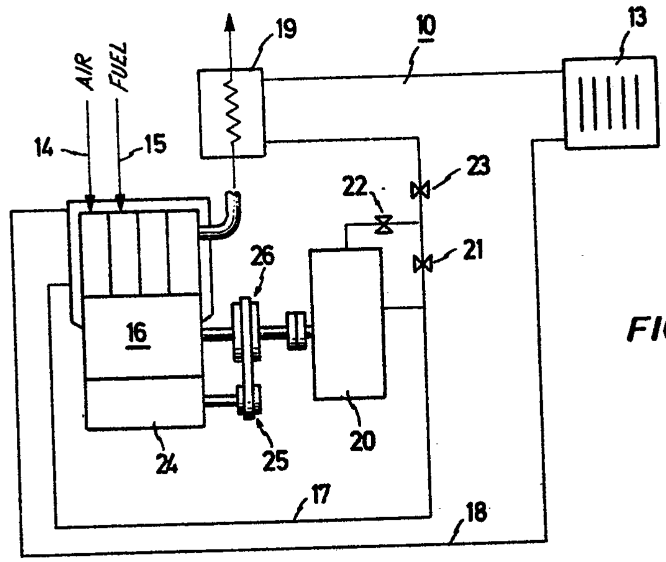

FIG. 2