

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
12 February 2004 (12.02.2004)

PCT

(10) International Publication Number
WO 2004/013473 A2

(51) International Patent Classification⁷: **F02C**

(21) International Application Number:
PCT/US2003/021732

(22) International Filing Date: 14 July 2003 (14.07.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/202,421 23 July 2002 (23.07.2002) US

(71) Applicant: **THE REGENTS OF THE UNIVERSITY OF CALIFORNIA** [US/US]; Los Alamos National Laboratory, LC/IP, MS A 187, Los Alamos, NM 87545 (US).

(72) Inventor: **PLATTS, David, A.**; 932 B 42nd Street, Los Alamos, NM 87544 (US).

(74) Agents: **WYRICK, Milton, D.** et al.; Los Alamos National Laboratory, LC/IP, MS A 187, Los Alamos, NM 87545 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

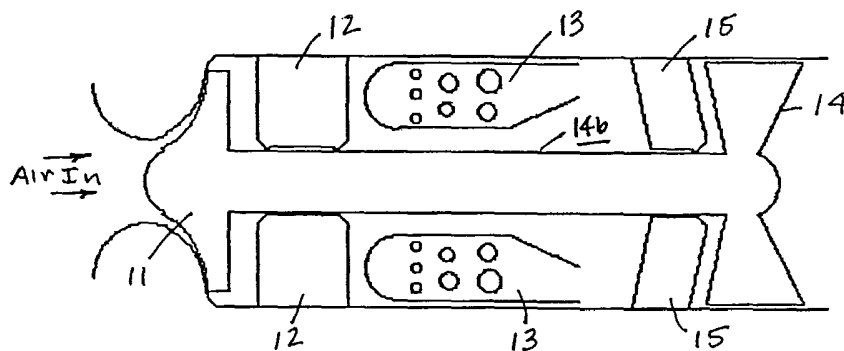
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: VORTEX TURBINE ENGINE



(57) Abstract: A turbine engine having greater efficiency and fewer parts in which an engine housing defines a longitudinal axis, and a centrifugal compressor rotor is mounted to a shaft in the housing along the longitudinal axis for creating a vortex flow of air flowing through the housing that defines a low pressure area along the longitudinal axis. At least one fuel inlet is in the engine housing for inserting fuel into the vortex flow of air and creating a flame front along the low pressure area to heat the vortex flow of air and a turbine rotor mounted to the shaft for receiving the vortex flow of heated air and spinning.

WO 2004/013473 A2

VORTEX TURBINE ENGINE

The present invention generally relates to turbine engines, and, more specifically, relates to an improved vortex flow turbine engine. This invention was made with Government support under Contract No. W-7405-ENG-36 awarded by the U.S. Department of Energy. The Government has certain rights in the invention.

BACKGROUND OF THE INVENTION

Turbine engines are in use in many fields, but are particularly applicable where light, compact, low maintenance power sources are needed. Aircraft engines, and electricity generation are prominent uses of gas turbine engines. Gas turbines and related systems have been in use and described in the literature for a number of years. Such systems include a compressor for compressing ambient air, a diffuser to convert some of the remaining kinetic energy from the compressor to pressure, a combustor to heat the compressed air, a device to lower the temperature of the combustion gasses, a set of nozzle guide vanes to add kinetic energy to the gasses before introduction to the turbine in which the heated gasses from the combustor are expanded to produce mechanical power. Some of this power is used to drive the compressor. Power is extracted from the engine by using the turbine exhaust gases directly to produce thrust or to drive a turbine which produces mechanical power. Mechanical power can also be extracted directly from the engine shaft, or obtained from the engine in other ways. In electricity generation the mechanical power is used to turn a generator.

Because of current limitations on the materials used in the turbine section of engines, particularly the highly stressed turbine blades, the gases from the combustor section must be lowered in temperature from the temperature at which the gas has burned. This lowering of temperature is usually accomplished in the rear portion of the combustion chamber by admitting unheated air from the compressor.

The combustion chambers of conventional turbine engines have been developed to provide good combustion efficiency with recent efforts being devoted to reducing the production of NO_x. Many of these combustion chambers use some swirl or vortex action to achieve these results. However, they generate this swirl by using vanes to reaccelerate the flow after it has been decelerated coming out of the compressor. These acceleration processes lose energy and are not needed when the natural swirl from a centrifugal compressor can be used to create the vortex. In the combustion chamber of the present invention, the strong vortex provides a kinetic radial pressure gradient as opposed to the largely static pressure of conventional designs. The methods used to provide good combustion efficiency and low NO_x production in conventional combustion chambers can still be used in the vortex chamber. In fact even more kinetic energy is available to accomplish these goals. The vortex chamber also has the option of controlling the vortex rotation and recirculation by simply changing the diameter of the chamber along its length.

The present invention provides apparatus and method for improving the efficiency of turbines. One way that it does this is by the elimination of certain components. This elimination of components eliminates the losses associated with those components, making it more efficient, lighter, and less expensive to manufacture.

It is therefore an object of the present invention to provide a vortex turbine engine that improves the efficiency of conventional turbine engines.

It is a further object of the invention to eliminate some of the parts used in traditional turbine engines.

It is a further object of the present invention to provide a vortex engine that allows energetic controlled mixing, combustion, and subsequent dilution of the fuel and air for good combustion efficiency and pollution control.

Additional objects, advantages and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by

practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

SUMMARY OF THE INVENTION

To achieve the foregoing and other objects, and in accordance with the purposes of the present invention, as embodied and broadly described herein, a turbine engine having increased efficiency and fewer components comprises a generally cylindrical engine housing defining a longitudinal axis with a centrifugal compressor rotor mounted to a shaft in the engine housing along the longitudinal axis for creating a vortex flow of air flowing through the engine housing and defining a low pressure area along the longitudinal axis. At least one fuel inlet in the engine housing inserts fuel into the vortex flow of air and creates a flame front along the low pressure area to heat the vortex flow of air; and a turbine rotor is mounted to the shaft for receiving the vortex flow of heated air and spinning.

In a further aspect of the present invention and in accordance with its objectives and purposes a turbine engine having increased efficiency and fewer components comprises an engine housing defining a longitudinal axis with a centrifugal compressor rotor mounted to a shaft in the engine housing along the longitudinal axis for creating a vortex flow of air flowing through the engine housing and defining a low pressure area along the longitudinal axis. At least one fuel inlet in the engine housing inserts fuel into the low pressure area of the vortex flow of air and creates a flame front along the low pressure area to heat the vortex flow of air and a turbine rotor mounted to the shaft for receiving the vortex flow of heated air and spinning.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

FIGURE 1 is a cross-sectional side view of a prior art turbine.

FIGURE 2 is a cross-sectional side view of a turbine engine according to the present invention.

DETAILED DESCRIPTION

5 The present invention provides turbine engines that feature more efficient operation, lighter weight, reduced parts count, and no backpressure for the fuel to overcome through the use of a vortex flow of air. The invention is understood most easily through reference to the drawings.

Turning first to Figure 1, there can be seen a cross-sectional side view of
10 a conventional prior art turbine engine with a radial compressor. As shown, air is entering centrifugal compressor rotor 11, where it is compressed and given a velocity that is tangential to the longitudinal axis of the engine. The compressed air then enters diffuser 12 where its pressure is further increased by way of conversion of the tangential velocity into pressure. The pressurized air then
15 enters combustion chamber 13 where it is combined with fuel and burned and then combined with more air to reduce its temperature to a level that will not melt turbine blades 14. The hot gas is then spun up by nozzle guide vanes 15 and used to spin turbine blades 14, which powers centrifugal compressor rotor 11 via shaft 14b. The exhaust gases then are used for thrust or spin another turbine for
20 mechanical power. In the type of turbine engine illustrated in Figure 1, the input air is pressurized and then slowed down in order to allow it sufficient time to burn in the relatively low turbulence region of combustion burner 13. Unfortunately, this slowing wastes energy as do the flow of air into the combustion chamber, and the respinning of the air by the nozzle guide vanes.

25 Reference should now be directed to Figure 2, where a cross-sectional side view of the vortex turbine engine using the present invention is illustrated. Here, turbine engine housing 31 defines an air inlet 31a, a combustion chamber wall 31b and an exhaust 31c. Inside turbine engine housing 31 is centrifugal compressor 32 connected by shaft 34 to turbine rotor 35. In this embodiment,
30 centrifugal compressor 32 creates a vortical flow of air that defines low pressure area 32a. The vortical flow of air from centrifugal compressor 32 encounters fuel

introduced from fuel inlet 32b and is heated as the fuel burns in vortex combustion chamber 33. The vortical flow of combustion gasses passes through turbine rotor 35, causing it to turn. As in the above-described combustor, the ignited fuel burns along the interface with low-pressure area 32a.

5 The air from radial compressor 32 is introduced directly to the vortex combustion chamber 33 without use of a diffuser, a lossy component used by the prior art to convert kinetic energy to pressure energy. The profile of radial compressor 32 is designed to produce a highly kinetic swirl flow unlike many present designs that have severely backswept blades whose output has more
10 pressure energy and less kinetic energy. In general, radial compressor blades are stronger and more efficient than the backswept blades.

In vortex combustion chamber 33, the trapped swirling flow of air produces a radial pressure gradient, which can range from sub atmospheric in the center of low-pressure region 32a to high pressure next to the wall of turbine engine
15 housing 31. The fuel is introduced into low-pressure region 32a, thus eliminating the need for a fuel pump when used with low pressure gaseous fuel, one fuel available in most homes. The rotational velocity of the air in vortex combustion chamber 33 is controlled by the diameter of the combustion chamber wall 31b. Thus variations in the diameter produce pressure variations and flows along the
20 axis of turbine engine housing 31. In this manner flow reversals for fuel mixing and burning can be created in the combustion chamber.

The interior diameter of combustion chamber wall 31b is varied in this embodiment by vortex control structures 36. Although shown in Figure 3 as convex vortex control structures 36, narrowing the diameter of combustion
25 chamber wall 31b, vortex control structures 36 could as well be concave, increasing the diameter of combustion chamber wall 31b at predetermined locations, or any desired combination of convex and concave vortex control structures 36 located at desired positions.

Additional vanes and blockages 37 can be used to produce faster mixing
30 and combustion, but these can be in the low velocity low pressure flow close to the axis extending out into high velocity flow only enough to provide the energy

needed for mixing, combustion, and dilution. The combustion chamber wall 31b of vortex combustion chamber 33 is protected and cooled by the high velocity air flow on the outside of the vortex. The losses caused by having to force all the air through holes in a conventional combustion chamber are eliminated by the present invention.

Between vortex combustion chamber 33 and turbine 35, no lossy nozzle guide vanes are needed since the air is already swirling and its swirl velocity can be controlled by the diameter of the combustion chamber wall 31b. Some baffling may be used to select which airflow goes to turbine rotor 35. It is also possible that a double walled vortex combustion chamber 33 may be needed since an inner wall would be heated by radiation and may need additional cooling on the back side.

The compressor in this design needs to provide considerable rotation to the flow of air so it should be a radial or a mixed flow unit. Turbine rotor 35 can be axial, radial, or anything in between.

The undulations introduced by vortex control structures 36, if used, serve to control the vortex burning and increase the spin of the vortex before it encounters turbine 35. Placing vortex control structures 37 near fuel inlet 31b could be used to trip the turbulent burning layer, if needed. Use of any vortex control structures 37 may not be required. It is necessary that a determination be made in practice of the present invention as to whether application of vortex control structures 37 is advantageous.

One of the important benefits of the present invention is the rapid fuel burning brought about by the vortical flow of air which can provide energy for highly turbulent mixing. Turbulent mixing can also be used to quickly lower the temperature of the combustion products to reduce NOx generation, thereby reducing the pollution from operation of the present invention. The invention also creates a low-pressure area for the introduction of fuel, eliminating the need high-pressure introduction of fuel. These features of the invention make it ideal for use in distributed energy systems.

The foregoing description of the embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching.

- 5 The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended
- 10 hereto.

What is claimed is:

1. A turbine engine having increased efficiency and fewer components comprising:

a generally cylindrical engine housing defining a longitudinal axis;

5 a centrifugal compressor rotor mounted to a shaft in said housing along said longitudinal axis for creating a vortex flow of air flowing through said housing, defining a low pressure area along said longitudinal axis;

at least one fuel inlet in said engine housing for inserting fuel into said vortex flow of air and creating a flame front along said low pressure area to heat
10 said vortex flow of air and;

a turbine rotor mounted to said shaft for receiving said vortex flow of heated air and spinning.

2. The turbine engine as described in Claim 1 wherein said engine housing defines vortex control structures for modifying said vortex flow of air as it passes through said engine housing.

3. The turbine engine as described in Claim 1 wherein said fuel inlet inserts fuel directly into said low pressure area.

4. The turbine engine as described in Claim 1 wherein said fuel is natural gas.

5. A turbine engine having increased efficiency and fewer components comprising:

an engine housing defining a longitudinal axis;

5 a centrifugal compressor rotor mounted to a shaft in said engine housing along said longitudinal axis for creating a vortex flow of air flowing through said engine housing, defining a low pressure area along said longitudinal axis;

at least one fuel inlet in said engine housing for inserting fuel into said low pressure area of said vortex flow of air and creating a flame front along said low pressure area to heat said vortex flow of air and;

10

a turbine rotor mounted to said shaft for receiving said vortex flow of heated air and spinning.

6. The turbine engine as described in Claim 5 wherein said engine housing defines vortex control structures for modifying said vortex flow of air as it passes through said engine housing.

7. The turbine engine as described in Claim 5 wherein said fuel is natural gas.

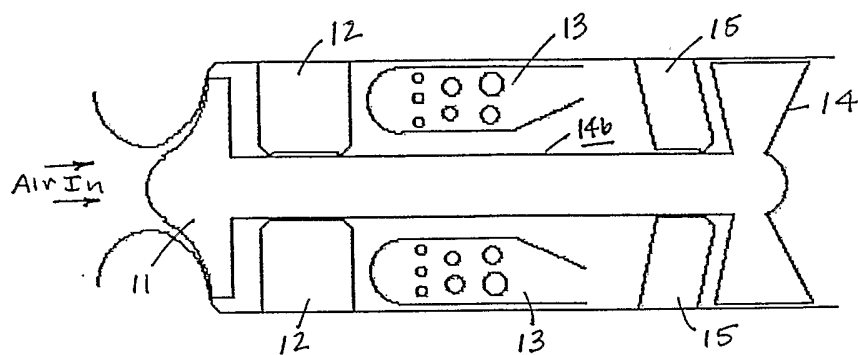


FIG. 1 (Prior Art)

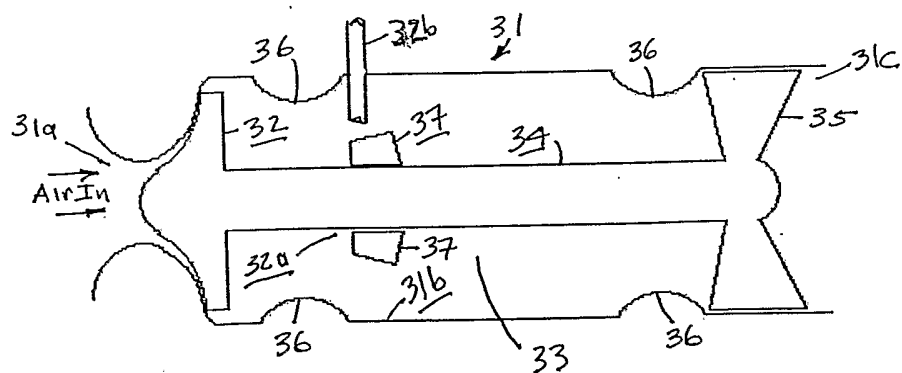


FIG. 2