US 20080047272A1

(19) **United States**

(12) **Patent Application Publication**

Schoell

(10) **Pub. No.: US 2008/0047272 A1**

(43) **Pub. Date: Feb. 28, 2008**

(54) **HEAT REGENERATIVE MINI-TURBINE GENERATOR**

(76) Inventor: **Harry Schoell**, Pompano Beach, FL (US)

Correspondence Address:
Robert M. Downey, P.A.
Ste. 300, 6751 N. Federal Hwy.
Boca Raton, FL 33487

(21) Appl. No.: **11/895,667**

(22) Filed: **Aug. 27, 2007**

Related U.S. Application Data

(60) Provisional application No. 60/840,786, filed on Aug. 28, 2006.

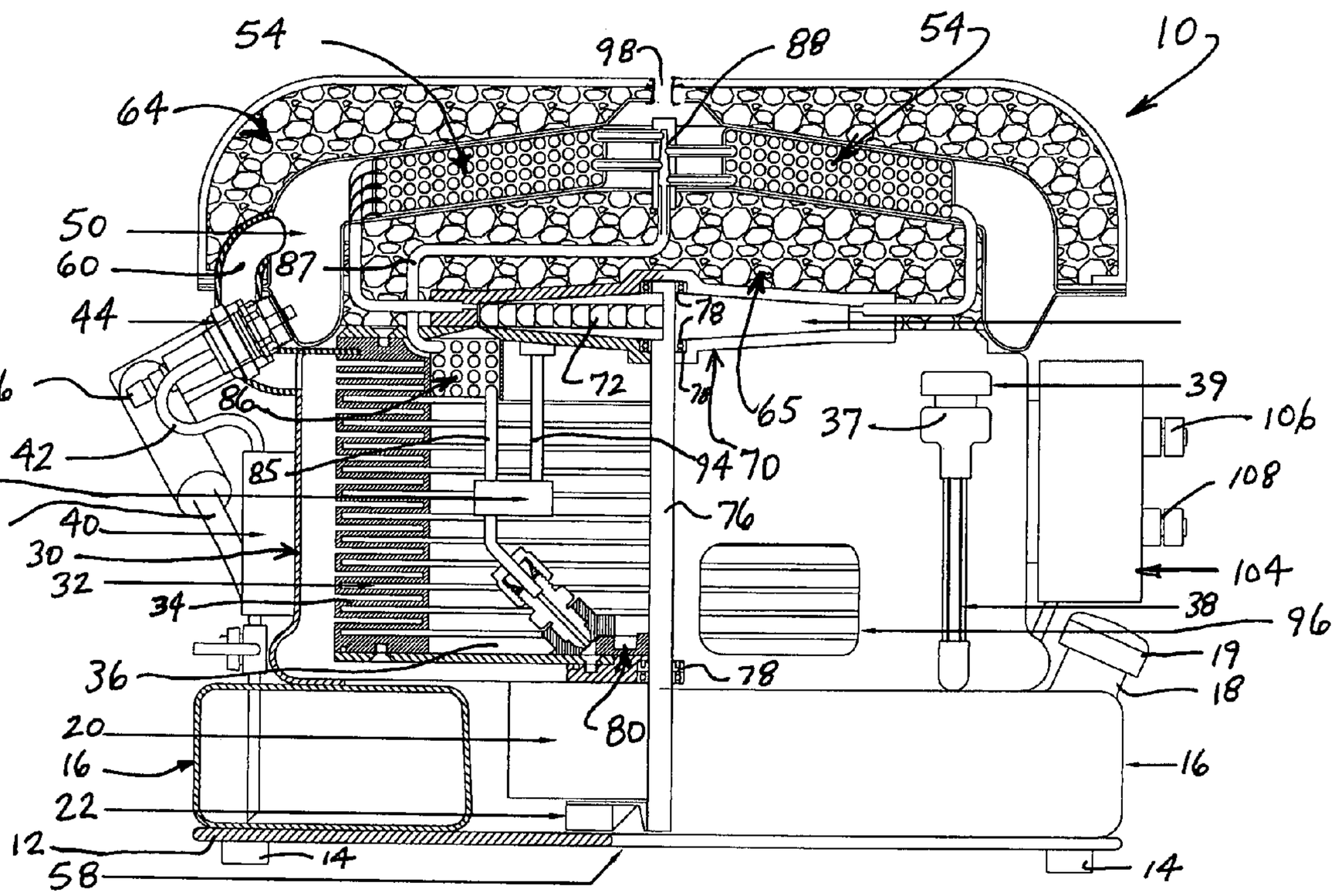
Publication Classification

(51) **Int. Cl.**
F01K 17/04 (2006.01)

(52) **U.S. Cl.** **60/648**; 60/670

(57) **ABSTRACT**

A compact, lightweight steam turbine is connected to a central shaft that drives a high pressure pump, a high efficiency generator and a blower. An igniter burns fuel exiting a fuel injector to generate heat in a cyclone combustion chamber. Water pumped through coils is heated in the combustion chamber to produce steam energy to drive the turbine. Exhaust steam is directed through a centrifugal condenser having an arrangement of flat plates to condense the steam to a liquid state. The turbine drives the generator at a high rpm, through the connected shaft, to generate electric power.



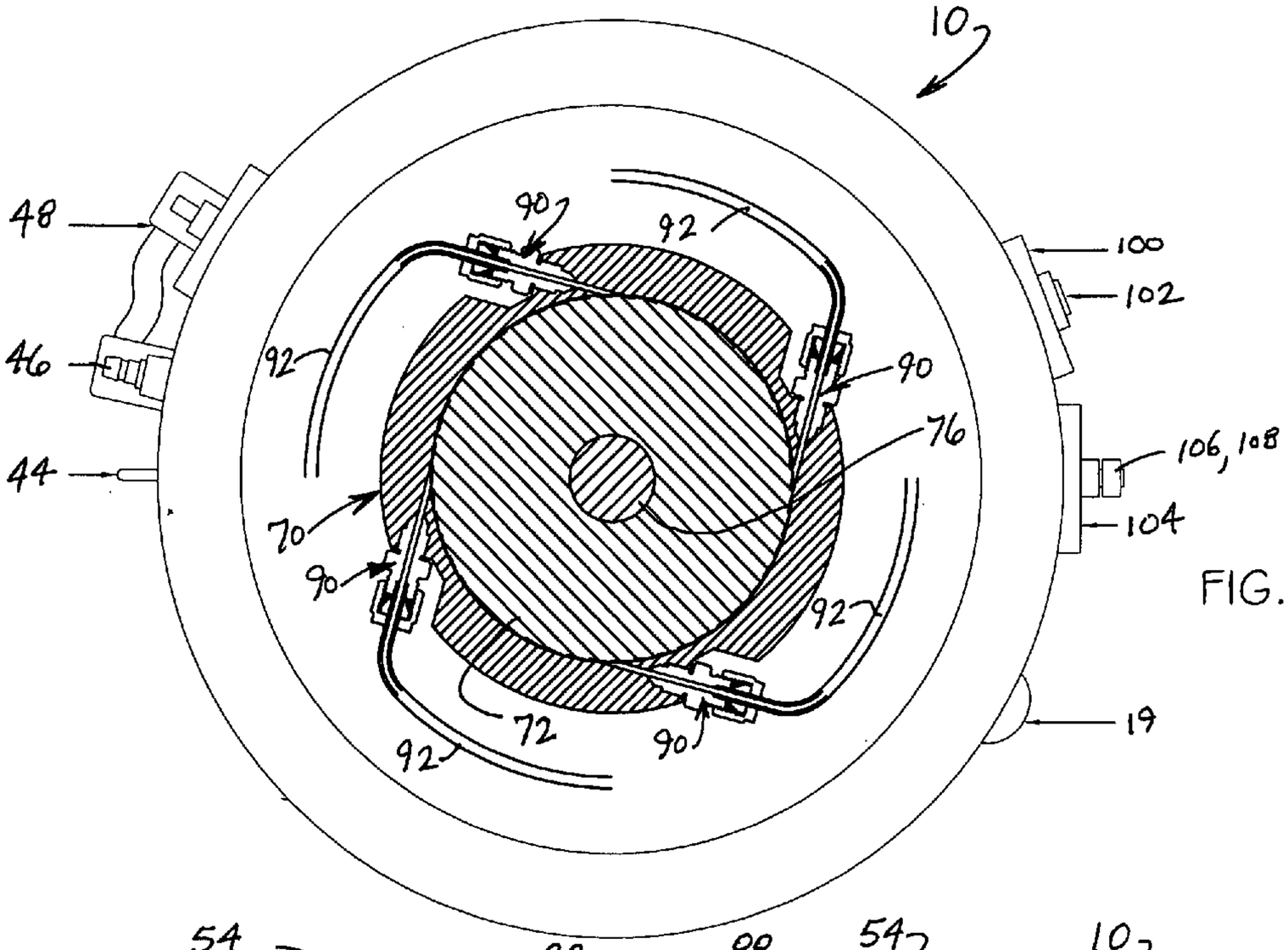

10
48
90
92
100
102
46
92
90
76
44
106, 108
70
90
104
92
72
90
92
19

FIG. 1

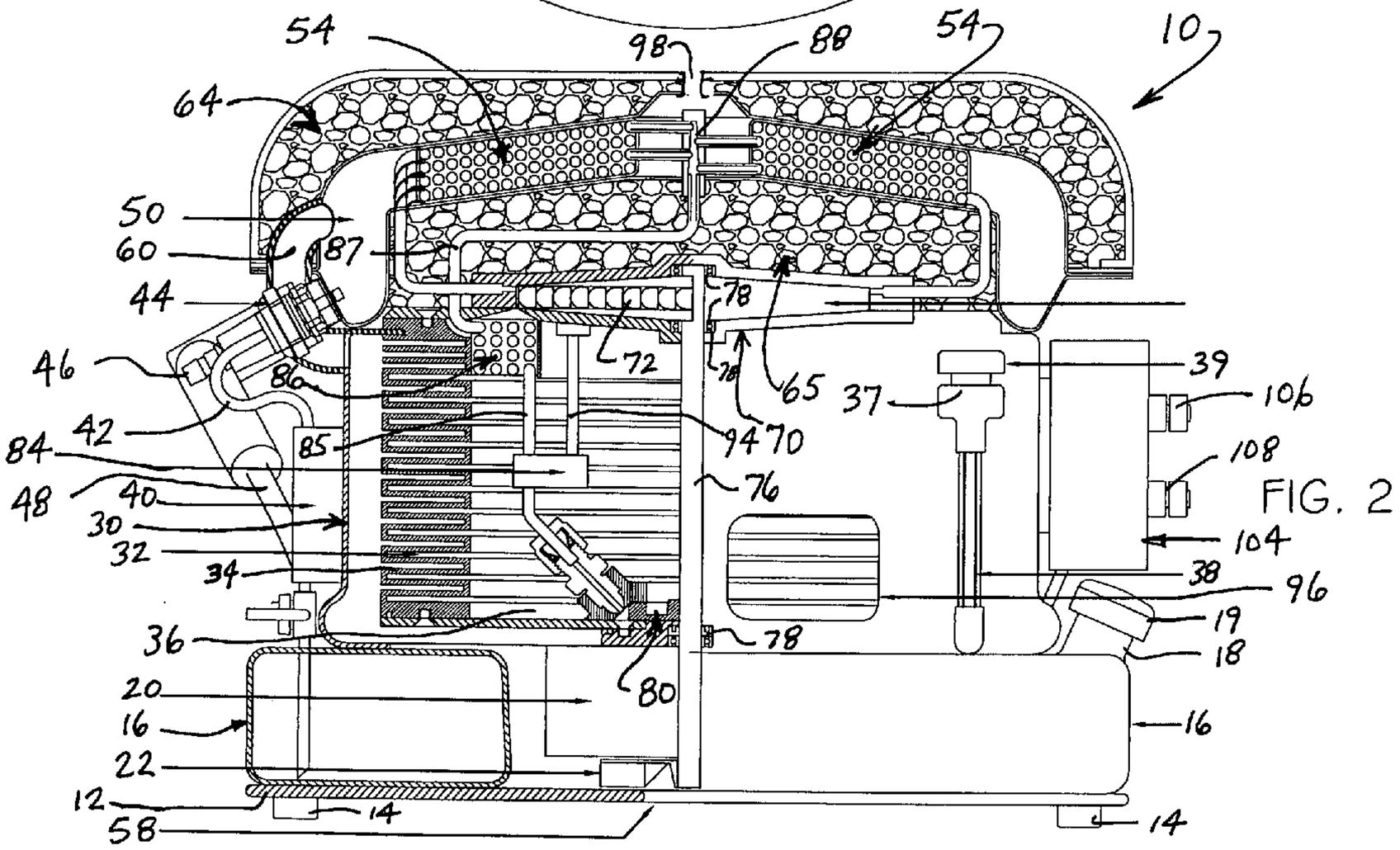
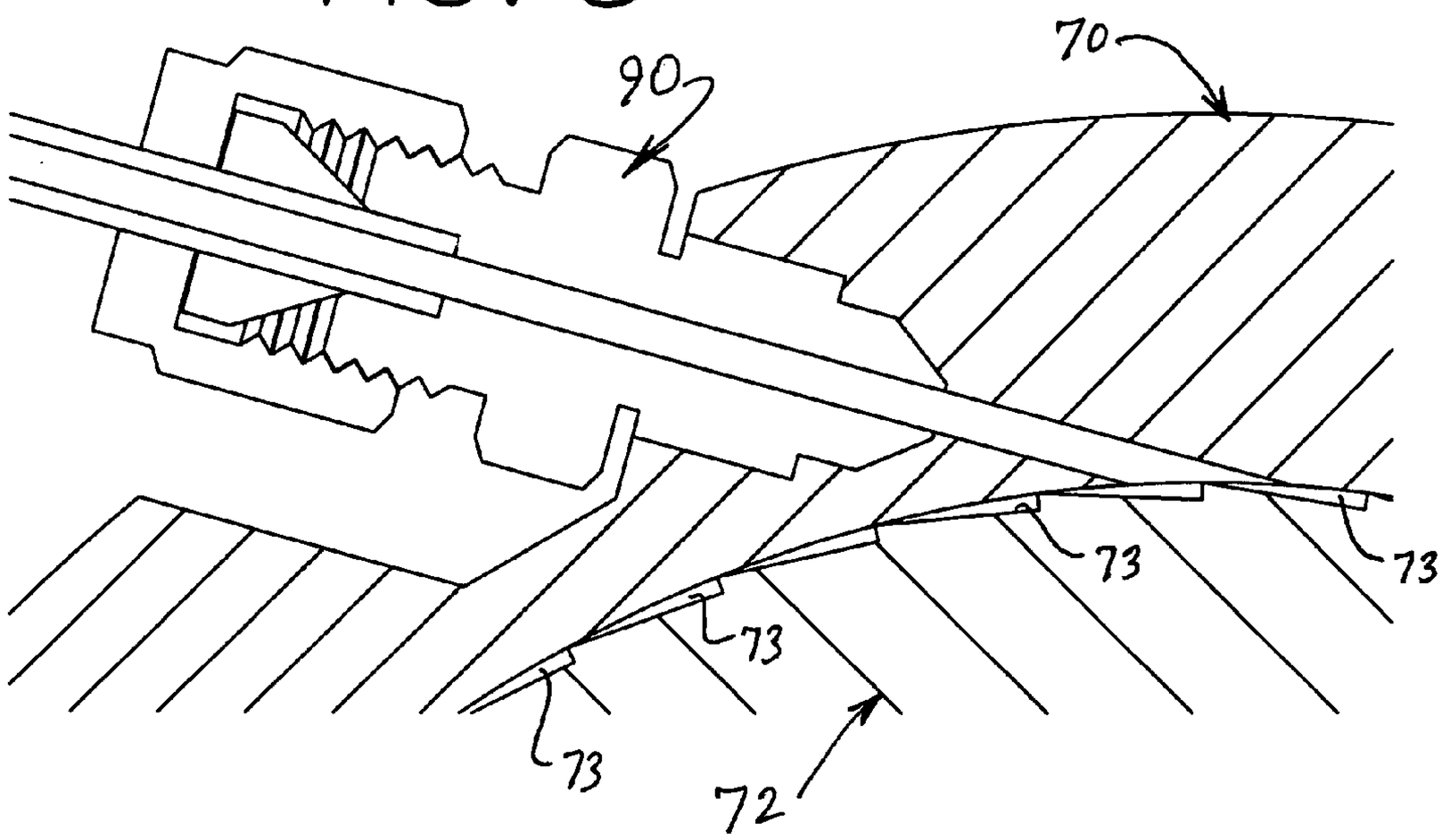

54
98
88
54
10
64
50
60
87
44
78
46
72
39
86
65
37
106
42
85
94
70
108
84
76
48
40
104
30
38
96
32
19
34
78
18
36
80
20
16
16
22
12
14
14
58

FIG. 2

FIG. 3



HEAT REGENERATIVE MINI-TURBINE GENERATOR

BACKGROUND OF THE INVENTION

[0001] This non-provisional patent application is based on provisional patent application Ser. No. 60/840,786 filed on Oct. 28, 2006.

DISCUSSION OF THE RELATED ART

[0002] Portable generators for producing electricity are typically powered by combustion engines fueled by gasoline or diesel. Combustion engine powered portable generators are known to be noisy (i.e. loud) and are not fuel efficient. For this reason, portable generators powered by combustion engines are primarily used for emergency power situations when more efficient conventional power sources are unavailable. Additionally, gasoline and diesel powered combustion engines are considerably heavy and bulky. This adds to the overall size and weight of portable generators, making them difficult to transport when used in mobile field operations.

[0003] Accordingly, there remains an urgent need for a fuel efficient portable generator that is relatively quiet, compact in size, lightweight and easy to transport. Further, there is a need for a portable, fuel efficient generator that operates on multiple fuel types, including a mixture of different fuel types. Finally, there is a need for a portable, fuel efficient generator that uses heat regeneration for greater efficiency.

SUMMARY OF THE INVENTION

[0004] The present invention provides a heat regenerative mini-turbine generator in a compact, lightweight unit. The unit includes a steam turbine connected to a central shaft that drives a high pressure pump, a high efficiency generator and a blower. An igniter burns fuel exiting a fuel injector to generate heat in a cyclone combustion chamber. Water pumped through coils is heated in the combustion chamber to produce steam energy to drive the turbine. Exhaust steam is directed through a centrifugal condenser having an arrangement of flat plates to condense the steam to a liquid state. The turbine drives the generator, through the connected shaft, to generate electric power. It is necessary to drive the generator at a high rpm to achieve the lightweight and small size. However, it is known that turbines in small sizes have poor efficiency. The use of heat regeneration helps this deficiency. The turbine heat exchanger, condenser and re-heaters are all contained in one small package. The unit is water lubricated and operates in a closed loop system. According to several preferred embodiments, the generator unit operates in a compact envelope at weight of approximately 10-25 lbs. The unit size can be scaled up or down to accommodate different power output requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a fuller understanding of the nature of the present invention, reference should be made to the following detailed description taken in conjunction with the accompanying drawings in which:

[0006] FIG. **1** is a top plan view, shown in partial phantom lines, illustrating the heat regenerative mini-turbine generator of the present invention;

[0007] FIG. **2** is a side elevational view, in partial cross-section, showing the main component parts of the heat regenerative mini-turbine generator; and

[0008] FIG. **3** is an isolated view of a steam ejector nozzle fitted to a turbine housing for ejecting a pressurized flow of steam against a cupped perimeter of a turbine wheel to forcibly drive rotation of the turbine wheel and a central shaft.

[0009] Like reference numerals refer to like parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring to the several views of the drawings, and initially FIG. **2**, the heat regenerative mini-turbine generator is shown and is generally indicated a **10**.

[0011] The generator **10** is supported on a base **12** that may include feet **14** on the bottom for supported engagement on a floor, ground or counter surface. A fuel tank **16** rests on the top of the base. In a preferred embodiment, the fuel tank **16** is circular (i.e. donut shaped) to provide an open central area above the base that accommodates a centrifugal blower **22** and an alternator **20**. A fill spout **18** with a cap **19** extends upwardly from the fuel tank to facilitate refilling of fuel.

[0012] A condenser chamber **30** sits above the fuel tank **16** and alternator **20** and contains a centrifugal condenser **32** and a condensate collection pan **36** at the bottom of the condenser chamber. The centrifugal condenser has a spaced arrangement of condenser plates **34** that present a large surface area for maximizing heat transfer within a relatively compact space. A sight gauge **38** on the exterior of the condenser chamber indicates a working fluid level (i.e. water level) within the condensate collection pan **36**. Water can be added through a fill spout **37** at the top of the site gauge by removing a pressure relief cap **39**. When a desired working fluid level is indicated in the sight gauge **38**, the pressure relief cap **39** is replaced on the fill spout **37**.

[0013] A fuel pump **40** pulls fuel from the fuel tank **16** and directs a supply of fuel through hose **42** leading to fuel injector **44**. The fuel injector **44** directs a spray of fuel past an igniter **46** to burn the sprayed fuel. The burning fuel is directed into a cyclone combustion chamber **50** that surrounds a tube bundle **54**. An igniter coil **48** connects to the igniter **46** and is powered by a battery (not shown). The blower **22** directs air flow from air intake **58** on the base **12** of the generator through the condenser chamber **30**, about the exterior of the centrifugal condenser plates **34**. A portion of the air flow (approximately 20%) from the blower **22** is directed to air duct **60** leading to the cyclone combustion chamber **50**, thereby providing sufficient airflow to promote combustion of the fuel. The directed airflow into the cyclone combustion chamber **50** helps to circulate the heat around the circular combustion chamber so that hot gases from combustion circulate around and over the tube bundle **54**. The cyclone combustion chamber **50** is surrounded by an insulated wall structure, including an insulated cover **64** and an insulated central section **65** partially surrounding a turbine housing **70**. The turbine housing **70** is centrally positioned above the centrifugal condenser **32** and contains a turbine wheel **72**. The central shaft **76** is fixed to the center of the turbine wheel **72** and is supported on bearings **78**. The shaft **76** extends downwardly from the turbine wheel **72** and into driven engagement with the alternator **20** and blower **22** at the lower end. Rotation of the shaft **76** drives the blower

22, the alternator **20** and a centrifugal water pump **80** in the bottom of the condensate collection pan **36**. The water pump **80** directs a flow of water to bypass governor **84**. At normal operating pressure, water flow is directed to heat exchanger **86** at the top of the centrifugal condenser **32** for pre-heating the water. From the heat exchanger **86**, the water flow is directed to a conduit **87** leading to a splitter valve **88** at the top center of the combustion chamber. The splitter valve **88** directs the water flow through the tube bundle **54** leading to multiple steam ejector nozzles **90**. In a preferred embodiment, the splitter valve splits into four separate tubes **92** in the tube bundle **54**, with each tube **92** leading to one of four steam ejector nozzles **90**. In the tube bundle **54**, within the cyclone combustion chamber **50**, the pre-heated water is heated to produce steam which is directed to each of the steam ejector nozzles **90**. The steam ejector nozzles **90** are fitted to the turbine housing **70** and are arranged at an optimal angle and position to direct the ejected steam into cup shaped members **73** about the periphery of the turbine wheel **72**. The force from the ejected steam drives the turbine wheel **72** to rotate the shaft **76**. When the turbine wheel RPMs get above normal operating speed (i.e. too high), the increasing pressure of water flow from the water pump **80** causes a valve member in the bypass governor **84** to be operated to a bypass position, causing water flow to bypass the normal passage **85** leading to the heat exchanger **86** and, instead, going to a conduit **94** leading to the turbine housing **70**. In the bypass position, the pressurized water flow is directed into the turbine housing and against the turbine wheel **72**, with the impinging force of the pressurized water flow against the flat face of the turbine wheel **72** having the effect of slowing the turbine wheel, and, thereby, slowing the RPMs to a normal operating speed.

[0014] Air flow through the condenser chamber **30** from blower **22** is exhausted through cooling exhaust port **96**. Combustion gases within the cyclone combustion chamber are exhausted through exhaust port **98** on the top of the cover.

[0015] An electric control panel **100** includes an ON/OFF switch **102** to start and stop operation of the generator. Upon initial start up, the ON/OFF switch **102** is operated to energize the alternator **20**. During startup, the alternator **20** is motorized, using power from the battery (not shown) to turn the shaft **76** and turbine wheel **72**. This allows for initial operation of the blower **22**, water pump **80** and fuel pump **40**. The fuel pump **40** then directs the fuel supply to the injector **44** and igniter **46** assembly to generate hot gases in the cyclone combustion chamber **50**, while the water pump **80** directs water flow to the tube bundle **54**. Once steam is produced, the turbine wheel **72** is driven by the ejected steam and the alternator **20** switches from start up mode to normal alternator operation.

[0016] A voltage regulator **104** on the side of the unit connects to the alternator **20**. The voltage regulator **104** provides DC voltage at connection terminals **106**,**108**.

[0017] While the present invention has been shown and described in accordance with a preferred and practical embodiment, it is recognized that departures from the instant disclosure are contemplated within the spirit and scope of the invention which, therefore, is not to be limited except as defined in the following claims, as interpreted under the doctrine of equivalence.

What is claimed is:

1. A generator for producing electric power comprising:
a combustion chamber;
a fuel burner for burning fuel to generate heat in said combustion chamber and including a fuel injector communicating with said combustion chamber and an igniter for burning fuel exiting said fuel injector;
a blower for directing air flow into said combustion chamber to promote burning of the fuel and for circulating the heat from the burning fuel through said combustion chamber;
at least one steam tube coil in said combustion chamber;
at least one steam ejection nozzle connected to said at least one steam tube coil;
a water pump for pumping water from a collection reservoir through said at least one steam tube coil, wherein the water is heated by the heat in said combustion chamber to produce steam for release from said at least one steam ejection nozzle;
a steam driven turbine;
said at least one steam ejection nozzle being structured and disposed to direct a flow of pressurized steam into said turbine to cause driven rotation of said turbine;
a central shaft connected to said turbine and rotatable with said turbine;
an alternator driven by rotation of said central shaft for generating electric current;
a condenser for condensing exhaust steam exiting said turbine to produce liquid condensate, and said condenser being structured to direct the liquid condensate into the collection reservoir; and
an electric power output connected to said alternator.

2. The generator as recited in claim **1** further comprising:
a plurality of said steam tube coils in said combustion chamber; and
a plurality of said steam ejection nozzles, with each of said plurality of steam ejection nozzles connected to a respective one of said plurality of steam tube coils, and said plurality of steam ejection nozzles being structured, disposed and arranged to direct the flow of pressurized steam into said turbine to cause driven rotation of said turbine.

3. The generator as recited in claim **1** wherein said combustion chamber surrounds said at least one steam tube coil.

4. The generator as recited in claim **2** wherein said combustion chamber is structured and disposed to surround said plurality of steam tube coils.

5. The generator as recited in claim **1** wherein said water pump is driven by rotation of said central shaft.

6. The generator as recited in claim **1** wherein said blower is driven by rotation of said central shaft.

7. The generator as recited in claim **1** wherein said blower is structured and disposed for directing the air flow around said condenser for cooling the exhaust steam.

8. The generator as recited in claim **1** wherein said electric power output includes a voltage regulator.

9. The generator as recited in claim **8** wherein said electric power output includes at least one pair of connection terminals.

10. The generator as recited in claim **1** further comprising:
a fuel tank for holding a supply of fuel; and
a fuel pump for directing fuel from said fuel tank to said fuel burner.

11. A generator for producing electric power comprising:

a combustion chamber;

a fuel burner connected to a fuel supply, and said fuel burner being structured for burning fuel to generate heat in said combustion chamber;

a blower for directing air flow into said combustion chamber to promote burning of the fuel and for circulating the heat from the burning fuel through said combustion chamber;

at least one steam tube coil in said combustion chamber;

at least one steam ejection nozzle connected to said at least one steam tube coil;

a water pump for pumping water from a collection reservoir through said at least one steam tube coil, wherein the water is heated by the heat in said combustion chamber to produce steam for release from said at least one steam ejection nozzle;

a steam driven turbine;

said at least one steam ejection nozzle being structured and disposed to direct a flow of pressurized steam into said turbine to cause driven rotation of said turbine;

a central shaft connected to said turbine and rotatable with said turbine;

an alternator driven by rotation of said central shaft for generating electric current;

a condenser for condensing exhaust steam exiting said turbine to produce liquid condensate, and said condenser being structured to direct the liquid condensate into the collection reservoir; and

an electric power output connected to said alternator.

12. The generator as recited in claim **11** further comprising:

a plurality of steam tube coils in said combustion chamber; and

a plurality of said steam ejection nozzles, with each of said plurality of steam ejection nozzles connected to a respective one of said plurality of steam tube coils, and said plurality of steam ejection nozzles being structured, disposed and arranged to direct the flow of pressurized steam into said turbine to cause driven rotation of said turbine.

13. The generator as recited in claim **11** wherein said combustion chamber surrounds said at least one steam tube coil.

14. The generator as recited in claim **12** wherein said combustion chamber is structured and disposed to surround said plurality of steam tube coils.

15. The generator as recited in claim **11** wherein said water pump is driven by rotation of said central shaft.

16. The generator as recited in claim **11** wherein said blower is driven by rotation of said central shaft.

17. The generator as recited in claim **11** wherein said blower is structured and disposed for directing the air flow around said condenser for cooling the exhaust steam.

18. The generator as recited in claim **11** wherein said electric power output includes a voltage regulator.

19. The generator as recited in claim **18** wherein said electric power output includes at least one pair of connection terminals.

20. The generator as recited in claim **11** further comprising:

a fuel tank for holding the supply of fuel; and

a fuel pump for directing fuel from said fuel tank to said fuel burner.

* * * * *