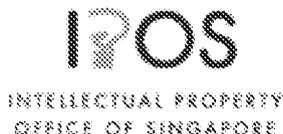


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**ENERGY CHANGER**

(57) **Abstract:**

A self contained energy converter, suitable for powering a vehicle for example, includes an assembly for gasification of a liquid fuel to produce a combustible gas. A number of burners are provided burn the combustible gas in order to heat a heat exchanger for heating water from a tank to produce wet steam. A superheated steam generator is provided in communication with the heat exchanger and includes a number of heating assemblies arranged to heat cylindrical surfaces for converting the wet steam into a superheated steam. Nozzles are provided to direct the superheated steam to a turbine to produce mechanical motion.

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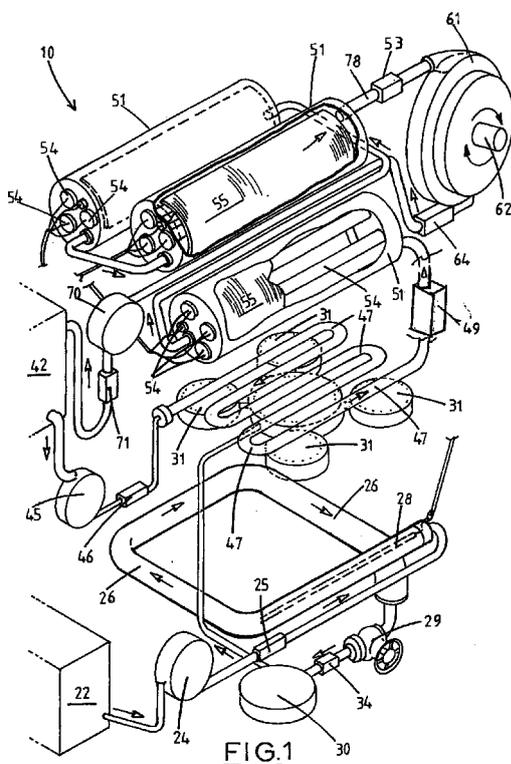
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[Continued on next page]

(54) Title: ENERGY CHANGER



(57) Abstract: A self contained energy converter, suitable for powering a vehicle for example, includes an assembly for gasification of a liquid fuel to produce a combustible gas. A number of burners are provided burn the combustible gas in order to heat a heat exchanger for heating water from a tank to produce wet steam. A superheated steam generator is provided in communication with the heat exchanger and includes a number of heating assemblies arranged to heat cylindrical surfaces for converting the wet steam into a superheated steam. Nozzles are provided to direct the superheated steam to a turbine to produce mechanical motion.

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## **ENERGY CHANGER**

### **FIELD OF THE INVENTION**

5 This invention relates to an energy changer and to a method of changing energy. The invention relates particularly but not exclusively to the conversion of thermal energy into mechanical motion or electrical energy.

### **BACKGROUND TO THE INVENTION**

10

The reference to any prior art in this specification is not and should not be taken as an acknowledgement or any form of suggestion that the referenced prior art forms part of the common general knowledge in any place in the world.

15

It has been known to create devices which utilize a temperature differential to create mechanical motion. Some of these devices have been referred to as "heat engines" or "thermal engines." A heat engine is a physical device that converts thermal energy to mechanical output. The mechanical output is called work, and the thermal energy input is called heat. Heat engines typically run on a specific thermodynamic cycle, as such a heat engine performs the conversion of heat energy to mechanical work by exploiting the temperature gradient between a hot "source" and a cold "sink".

25 Over the past one hundred years, Internal Combustion Engine ("ICE" or "IC engine") has been the major power source for motorised vehicles. A typical IC engine comprises of a plurality of piston-and-cylinder assemblies. An air-fuel mixture is forced into the cylinder during the intake stroke cycle, compressed and subsequently ignited and generates high pressure to produce motion energy and waste heat. Recent attempts have been made in the automotive industries to incorporate alternative power sources such as an electric motor, known as a hybrid vehicle. These types of vehicles

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convert wasted mechanical work during brake or deceleration into electricity for later driving.

5 With the world-wide depletion of fossil fuels, utilization of other energy sources has become critical. Fossil fuels are generally such fuels as oil, natural petroleum and coal. These materials were derived from the fossilized remains of plants and animals. As the years go on, the sources of these fuels have become less and less. The problem with fossil fuels is they will someday run out. It takes time for these energy sources to develop within  
10 the crust of the earth. At the current rate of consumption, there is no way that these fuels can develop naturally and not be used up.

More efficient uses of these types of energy are being produced and experimented with. Cars with better gas mileage are being manufactured.  
15 Hybrid cars which use electricity as well as gas are just one of the many products which have been developed to sustain the use of fossil fuels. Still these fuels are being depleted. Another problem with the use of fossil fuels is no matter how safely and efficiently these fuels are being used, they still have an impact on the environment. The combustion of these fuels  
20 contributes pollutants to the atmosphere and contributes to the greenhouse effect. Fossil fuels are not considered a renewable energy source and aside from the environmental impact, the cost of retrieving and converting them is beginning to demand notice.

25 These environmental concerns have prompted costly, complex technological proposals in engine design. For instance, fuel cell technology provides the benefit of running on clean burning hydrogen. However, the expense and size of fuel cell engines, as well as the cost of creating, storing, and delivering fuel grade hydrogen disproportionately offsets the environmental  
30 benefits. As a further example, clean running electric vehicles are limited to very short ranges, and must be regularly recharged by electricity generated from coal, diesel or nuclear fuelled power plants. And, while gas turbines are

clean, they operate at constant speed. In small sizes, gas turbines are costly to build, run and overhaul. Diesel and gas internal combustion engines are efficient, lightweight and relatively inexpensive to manufacture, but they produce a significant level of pollutants that are hazardous to the environment and the health of the general population and are fuel specific.

Steam engines which have previously been developed have suffered the long-term endemic problems that have led to the demise of steam power in a commercial environment; these include excessive pollution, maintenance costs, labor intensive operation, low power/weight ratio, low overall thermal efficiency. This applies particularly to medium and small-scale installations where steam power has generally now been superseded by the internal combustion engine or by electrical power drawn from the National Grid.

Clearly it would be advantageous if a contrivance could be devised that helped to at least ameliorate some of the shortcomings described above. In particular it would be desirable if an apparatus or a method could be devised for converting energy that was cost effective and reduced the depletion of fossil fuels.

20

## **SUMMARY OF THE INVENTION**

According to a first aspect, the present invention provides an apparatus for converting thermal energy to mechanical motion, comprising: a heat exchanger configured to produce wet steam comprising: a combustibile fluid reservoir and a combustibile fluid pump to circulate a combustibile fluid from the combustibile fluid reservoir to a gas generator; a first heater means to heat the combustibile fluid in the gas generator to produce gasification of the combustibile fluid; an ignition source and burner to burn the combustibile gas; a water reservoir and a water pump to circulate a supply of water from the water reservoir to the heat exchanger; a second heater means to heat the water in the steam generator; a superheated steam generator comprising: at

least one steam separator to separate water droplets from the wet steam produced in the heat exchanger; a cylindrical surface within the superheated steam generator, the surface of which is heated by at least one heater element such that when the steam contacts the cylindrical surface a  
5 superheated steam with a higher temperature and no water is produced; and wherein the gas from the gas generator is ignited to provide a heat source to heat the water in the heat exchanger, wherein the heat exchanger provides the wet steam source for the superheated 4 steam generator and the superheated steam generator provides a superheated steam which is  
10 directed to a turbine to produce mechanical motion.

The present invention does not suffer from the endemic problems that have led to the demise of steam power in a commercial environment to date. There is little or no pollution, due to the recycling of the water and t e small  
15 number of moving parts means maintenance costs have been significantly reduced. Due to the adaptability and relative small size of the present invention means that the energy converter may be used as part of a hybrid renewable energy vehicle, for example an electric car. This means that the drawback of having to regularly recharge an electric car can be reduced due  
20 to the adaptability of the steam energy converter which can be used to recharge the batteries while the car is still in use thereby extending the time between charges of the batteries.

The above application of the present invention to a hybrid renewable energy  
25 vehicle is but one possible use of the present invention and will be used throughout the description of this invention. However, the use of the present invention for a hybrid vehicle should not be limited to only this use and a person skilled in the art would be expected to apply this invention to many possible uses.

30

Preferably, the apparatus for converting thermal energy to mechanical motion may further comprises a condenser placed between the turbine and

the water chamber to condense the steam to a liquid state and provide a closed loop system. The apparatus may comprise three superheated steam generators connected in an end-to-end arrangement and each generator comprises three heater elements to produce a dry superheated steam for driving the turbine. Each said superheated steam generator may comprise a separator vessel presenting a substantially cylindrical inside surface; an inlet for directing incoming wet steam containing a mixture of steam and water into the vessel in a manner to effect a swirling motion of the wet steam around said cylindrical inside surface; a steam chamber in the upper portion of the separator vessel for receiving the separated dry steam which rises above the water; a generally cylindrical baffle plate mounted in the steam chamber at a location spaced apart from the cylindrical inside surface of the separator vessel to form a partition which provides a surface which is heated by the three heater elements to produce a superheated steam; and a steam outlet conduit extending from the steam chamber for discharging superheated steam.

Preferably, the outlet of the first superheated steam generator may be fed to the inlet of the second superheated steam generator and the outlet of the second said superheated steam generator may be fed to the inlet of the third superheated steam generator and the outlet of the third superheated steam generator provides the superheated steam at a higher temperature and with no water to the turbine to produce the mechanical motion.

Preferably, the baffle plate and cylindrical inside surface of the separator vessel may be constructed from copper.

Preferably, the combustible fluid may comprise any one of the group consisting of ethanol, methylated spirits or LP gas.

Preferably, the apparatus may further comprise an electrical source to power the heater means and heater elements and the ignition source. The

mechanical motion produced by the energy converter may be used as a power source for any one of the group comprising: a generator; a house, an automobile; a boat; a pump; or any steam driven vehicle.

- 5 Preferably, the saturated steam may be directed by nozzles onto a rotor of the turbine to cause the rotor to turn and produce mechanical motion.

10 Preferably, the heat exchanger, the gas generator, the at least one superheated steam generator and the turbine may further comprise a pressure relief valve to control or limit the pressure at each stage of the apparatus. The gas generator may further comprise a gas regulator valve to automatically control the flow of a gas at a pre-determined pressure.

15 Preferably, the apparatus may further comprise a one way valve between each stage of the apparatus to allow a liquid or gas to flow through it in only one direction.

20 According to a further aspect, the present invention provides a method of converting thermal energy to mechanical motion, the method comprising: heating a combustible fluid to produce a combustible gas; igniting the combustible fluid to heat water in the heat exchanger to produce a wet steam; separating water droplets from the wet steam produced by the heat exchanger using a steam separator; heating the separated dry steam in a superheated steam generator to produce a superheated steam; and using  
25 the superheated steam to turn a turbine to produce mechanical motion.

Preferably, the method may comprise any of the features of the apparatus according to the first aspect.

30 According to a further aspect, the present invention provides a self contained energy converter comprising: a gas generator housed within a first container and comprising: a combustible fluid reservoir and a

combustible fluid pump to circulate a combustible fluid from the combustible fluid reservoir to the gas generator; a first heater means to heat the combustible fluid in the gas generator to produce gasification of the combustible fluid; and an ignition source to ignite and burn the combustible gas; a heat exchanger housed within a second container comprising: a water reservoir and a water pump to circulate a supply of water from the water reservoir to the heat exchanger; and a second heater means to heat the water in the steam generator to produce a wet steam; a superheated steam generator housed in a third container and comprising: at least one steam separator to separate water droplets from the wet steam produced in the heat exchanger; and a cylindrical surface within the at least one steam separator the surface of which is heated by at least one heater element such that when the steam contacts the cylindrical surface a superheated steam with a higher temperature and containing no water is produced; wherein the gas generator provides the gas and when ignited provides a heat source to heat the water in the heat exchanger, wherein the heat exchanger provides the wet steam source for the superheated steam generator and the superheated steam generator provides a superheated steam which is directed to a turbine to produce mechanical motion.

Preferably, the self contained energy converter may comprise any of the features of the apparatus according to the first aspect.

According to a further aspect of the present invention there is provided an energy converter including: an assembly for delivery of a combustible gas; at least one burner to burn the combustible gas; a heat exchanger in communication with a water reservoir for producing wet steam therefrom, said heat exchanger located to be heated by the at least one burner; a superheated steam generator in communication with the heat exchanger including: at least one heating assembly arranged to heat at least one cylindrical surface for converting said wet steam into a superheated steam;

and an arrangement for directing the superheated steam to a turbine to produce mechanical motion.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

5

The present invention will be understood more fully from the detailed description given hereinafter and from the accompanying drawings of the preferred embodiment of the present invention, which, however, should not be taken to be limitative to the invention, but are for explanation and understanding only.

10

Figure 1 shows a perspective view of an energy converter in accordance with an embodiment of the present invention;

Figure 2 shows a line diagram of the process of converting a combustible fluid to a heating source in accordance with an embodiment of the present invention;

15

Figure 3 shows a line diagram of the heat exchanger and the superheated steam generator in accordance with an embodiment of the present invention;

Figure 4 shows an exploded perspective view of the superheated steam generator in accordance with an embodiment of the present invention; and

20

Figure 5 shows an exemplary use of the energy converter in accordance with an embodiment of the present invention.

## **25 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

An apparatus for converting thermal energy to mechanical motion and a method of converting thermal energy to mechanical motion in accordance with this invention may manifest itself in a variety of forms. It will be convenient to hereinafter describe several embodiments of the invention in detail with reference to the accompanying drawings. The purpose of providing this detailed description is to instruct persons having an interest in

30

the subject matter of the invention how to carry 7 8 the invention into practical effect. However it is to be clearly understood that the specific nature of this detailed description does not supersede the generality of the preceding broad description.

5

In figures 1 to 5, reference numeral 10 generally designates an embodiment of an apparatus for converting thermal energy to mechanical motion.

The apparatus 10 includes a combustible gas producer and burner system  
10 20, in the form of an ethanol combustible fluid 21 and a heater element 28 which heats the ethanol fluid 21 to produce gasification of the ethanol fluid 21 in a gas generator 26 to provide ethanol gas for the burners 31. The gas is then burnt in the burners 31 to produce a heat source for the steam producing system 40. Water 41 is heated by the burners 31 in the heat  
15 exchanger 47 to produce a wet steam which is then heated further in the superheated steam system 50 to produce super heated steam at the output of the superheated steam system 50. The superheated steam is then utilized to drive a turbine system 60 in which the superheated steam is directed by nozzles onto a rotor of the turbine 61 to cause the rotor to turn  
20 and produce mechanical motion which is transmitted to a drive shaft 62.

Each of the above systems of the energy converter 10 will be described in more detail below.

25 The combustible gas producer and burner system 20 includes a storage tank 22 for storing the combustible fluid 21. The combustible fluid may include any fluid 21 which is capable of igniting and burning. For example, ethanol, methylated spirits or LP gas may be used. The invention relates particularly but not exclusively to an energy converter that is suited to  
30 producing and burning gaseous ethanol for use in heating water 41 in a heat exchanger 47. It will therefore be convenient to hereinafter describe the

invention with reference to this application. However it is to be understood that it is capable of broader application.

5 The ethanol 21 is stored in a tank 22 and when required to provide an ignition source for the burners 31 is drawn out of the tank 22 by pump 24 and passes through a one-way valve 25 and into the gas generator 26. The ethanol 21 is poured into the tank 22 through the filler point 23 and may be topped up as required. A oneway valve or check valve is a mechanical device which allows fluid (liquid or gas) to flow through it in only one  
10 direction. A number of one-way valves are used in the energy converter 10 to prevent either a gas or liquid from being fed back into the previous process. One-way valves are typically two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave.

15

The ethanol 21 is then heated in the gas generator 26 by heating element 28. The heating element 28 may be a nichrome 80/20 (80% nickel, 20% chromium) wire, ribbon, or strip. A heating element converts electricity from the battery 33 into heat through the process of Joule heating. Electric  
20 current through the element encounters resistance, resulting in heating of the element. The ethanol fluid 21 undergoes the gasification process in a gas generator 26 in which the ethanol or the carbonaceous material undergoes several different processes.

25 Gasification is a process that converts carbonaceous materials, such as coal, petroleum, or biofuel such as ethanol, into carbon monoxide and hydrogen by reacting the raw material, at high temperatures with a controlled amount of oxygen. The resulting gas mixture is called synthesis gas or syngas.

30

The ethanol undergoes a pyrolysis (or devolatilization) process which occurs as the carbonaceous particles heat up. Volatiles are released and char is

produced, resulting in up to 70% weight loss of the carbonaceous material. The process is dependent on the properties of the carbonaceous material and determines the structure and composition of the char, which will then undergo gasification reactions. The combustion process occurs as the  
5 volatile products and some of the char reacts with oxygen to form carbon dioxide and carbon monoxide, which provides heat for the subsequent gasification reactions. Finally the gasification process occurs as the char reacts with carbon dioxide and steam to produce carbon monoxide and hydrogen, via the reaction.

10

In essence, a limited amount of oxygen or air is introduced into the reactor to allow some of the organic material to be "burned" to produce carbon monoxide and energy, which drives a second reaction that converts further organic material to hydrogen and additional carbon dioxide. Further  
15 reactions occur when the formed carbon monoxide and residual water from the organic material react to form methane and excess carbon dioxide. This third reaction occurs more abundantly in reactors that increase the residence time of the reactive gases and organic materials, as well as heat and pressure. Catalysts are used in more sophisticated reactors to improve  
20 reaction rates, thus moving the system closer to the reaction equilibrium for a fixed residence time.

The ethanol gas or combined carbon dioxide, carbon monoxide and methane gas are used in the burners 31. The gas in the burners 31 is  
25 ignited by the igniter 32 which may be an electric or electronic igniter or a piezo igniter. Electronic ignition works when the electronic module receives a signal from a switch or gas knob. The module then outputs a series of sparks igniting the gas burner. When the switch or gas knob is released, the ignition stops. The electronic igniter is powered by a battery 33 or a power  
30 supply (not shown).

Piezo ignition is a type of ignition that is used in portable camping stoves, gas grills and some lighters. It consists of a small, spring-loaded hammer which, when a button is pressed, hits a crystal of lead zirconate titanate (PZT) or quartz crystal. Lead zirconate titanate, also called PZT, is a ceramic perovskite material that shows a marked piezoelectric effect. Quartz or PZT are piezoelectric, which means that it creates a voltage when deformed. This sudden forceful deformation produces a high voltage and subsequent electrical discharge, which ignites the gas.

10 A pressure relief valve 27 or relief valve (RV) is used to control or limit the pressure in the gas generator 26. The pressure may build up by a process upset, instrument or equipment failure, or fire and the pressure relief valve 27 is used to limit the amount of pressure which can build up in the gas generator 26. The gas which flows out of the gas generator 26 passes through a one-way valve 34 and may 11 be switched on or off by open/close valve 29. A pressure regulator 30 is used to automatically cut off the flow of gas at a certain pressure. The gas is ignited in the burners 31 and the heat source is used to heat the water 41 in the heat exchanger 47 to produce the wet steam which passes from the heat exchanger 47 and into the first tank 20 51 of the superheated steam system 50.

The steam producing system 40 includes a tank 42 for storing the water 41 which may be poured into the tank 42 through filler point 43. A pressure relief valve 44 is used to limit and control the pressure within the tank 42. 25 The water 41 is drawn out of the tank 42 by pump 45. The pump 45 is simply a device used to move fluids, such as water 41 by displacing a volume by physical or mechanical action. The water 41 then passes through a one-way valve 46 and into the heat exchanger 47 where the water 41 is heated by the burners 31.

30

As the temperature increases and the water 41 approaches its boiling condition, some molecules attain enough kinetic energy to reach velocities

that allow them to momentarily escape from the liquid into the space above the surface, before falling back into the liquid. Further heating causes greater excitation and the number of molecules with enough energy to leave the liquid increases. As the water 41 is heated by the burners 31 to its  
5 boiling point, bubbles of steam form within it and rise to break through the surface. Considering the molecular structure of liquids and vapours, it is logical that the density of steam is much less than that of water, because the steam molecules are further apart from one another. The space immediately above the water surface thus becomes filled with less dense steam  
10 molecules. When the number of molecules leaving the liquid surface is more than those re-entering, the water freely evaporates. At this point it has reached boiling point or its saturation temperature, as it is saturated with heat energy.

15 The heat exchanger 47 in its very basic form is a device built for efficient heat transfer from one medium to another and in this case from liquid to gas. The heat exchanger 47 in accordance with this invention may manifest itself in a variety of forms. One such form is a shell and tube heat exchangers 47 which consist of a series of tubes. One set of these tubes contains the fluid  
20 that must be heated by the burners 31. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned, etc. However it is to be clearly understood that other types of 5 heat exchanger  
25 47 may be used, for example, a plate heat exchanger or an adiabatic wheel heat exchanger may be used without departing from the scope of the invention.

The heat exchanger 47 also includes a pressure relief valve 48 to limit and  
30 control the pressure within the heat exchanger 47. If the pressure within the heat exchanger 47 remains constant, adding more heat does not cause the temperature to rise any further but causes the water to form saturated steam

or wet steam. The temperature of the boiling water and wet steam within the same system is the same, but the heat energy per unit mass is much greater in the wet steam. Therefore the steam that leaves the heat exchanger 47 is a wet steam which is steam that contains water droplets in suspension. The wet steam passes through a one-way valve 49 before further processing in the superheated steam system 50.

The superheated steam system 50 consists of three steam generator chambers 51 connected in an end-to-end arrangement, separated and isolated from each other by three one-way valves 53. Each steam generator chamber 51 comprises three heater elements 54 and a pressure relief valve 52 to control and limit the steam in the generators 51.

Superheated steam is steam at a temperature higher than water's boiling point. If wet or saturated steam is heated at constant pressure, its temperature will rise, producing superheated steam. This will occur if saturated steam contacts a surface with a higher temperature. The steam is then described as superheated by the number of degrees through which it has been heated above saturation 30 temperature, put another way the temperature above saturation temperature is called the degree of superheat of the steam.

As each steam generator chamber 51 is identical in construction we will only describe one unit and also describe how each of the units interact to produce an output of superheated steam for the turbine system 70. The steam generator is substantially cylindrical in structure with end caps 58, 76 on either end of the steam generator chamber 51. End cap 58 is connected to an inlet 77 and end cap 76 is connected to the outlet 78. The inlet 77 into the first steam generator chamber 51 receives the wet steam from the steam producing system 40. Each steam generator chamber 51 is connected in series with the other steam generator chambers 51, that is the outlet 78 of the first steam generator chamber 51 is connected to the inlet 77 of the

second steam generator 51 and subsequently the output 78 of the second steam generator chamber 51 is connected to the input 77 of the third steam generator chamber 51 and the outlet 78 of the third steam generator 51 is connected to the input of the turbine system 60. Each steam generator 51  
5 has a pressure relief valve 52 for controlling and limiting the pressure within each of the steam generator chambers 51. In between each outlet 78 and inlet 77 a one-way valve 53 is positioned to prevent the feedback of the steam to the previous steam generator chamber 51.

10 Each steam generator chamber 51 is designed in such a way as to ensure that no water or wet steam is transmitted to the turbine system 60. Also, superheat cannot be imparted to the steam whilst it is still in the presence of water, as any additional heat simply evaporates more water. The saturated steam must be passed through a heat exchanger or water separator. In this  
15 case each steam generator 51 is designed with an internal cylindrical surface. The wet steam containing a mixture of steam and water enters the steam generator chamber 51 via the inlet 77 in a manner to effect a swirling motion of the wet steam around said cylindrical inside surface. This ensures that the water or water droplets are thrown outwards separating the water  
20 from the steam.

A generally open cylindrical baffle plate 55 mounted in the steam generator chamber 51 at a location spaced apart from the cylindrical inside surface of the steam generator chamber 51 to form a partition which provides a surface  
25 which is heated by the three heater elements 54 to produce a superheated steam.

The baffle plate 55 has two ends 56, 57 which are located within the end caps 75, 76. The baffle plate 55 does not form a complete cylinder as there  
30 is an open slot in the surface which allows any further moisture to drop to the bottom of the steam generator chamber 51. A steam outlet conduit 78 extends from the steam generator chamber 51 for discharging superheated

steam. The steam generator chamber has a separate steam chamber in the upper portion of the steam generator chamber 51 for receiving the separated dry steam which rises above the water and the dry steam has the characteristics of a dry gas.

5

As described above the outlet of the first superheated steam generator chamber 51 is fed to the inlet of the second superheated steam generator chamber 51 and the outlet of the second said superheated steam generator chamber 51 is fed to the inlet of the third superheated steam generator chamber 51 and the outlet of the third superheated steam generator chamber 51 provides the superheated steam at a higher temperature and with no water to the turbine system 60 to produce the mechanical motion. The process of passing the superheated steam from one steam generator chamber 51 to a next steam generator chamber 51 provides a superheated steam at the output of the final steam generator chamber 51 which is more efficient and with more energy due to the molecules having more kinetic energy. Given that the superheated steam receives no further moisture, but receives further heat energy from each of the heater elements 54 in the steam generator chambers 51, it is considered to be a 'dry' steam.

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Having a dry superheated steam is important because wet steam reduces the thermal efficiency of the energy converter. It is also important because water droplets in high velocity steam being fed to the nozzles (or vanes) in a steam turbine system 60 can impinge on and erode turbine internals such as turbine blades.

25

The baffle plate 55 and cylindrical heaters 54 in the steam generator chambers 51 are constructed from copper but may be constructed from any other material which allows for the transfer of heat from the heater elements 54 to the baffle plate 55.

30

The steam is now in the form of a dry superheated steam which is directed to the turbine system 60. In between the turbine system 60 and the final stage of the superheated steam system 50 is a one-way valve which prevents the feedback of dry superheated steam to the final stage of the superheated steam system 50. The turbine system 60 comprises a turbine 61 having a drive shaft 62 and a pressure relief valve 63. The turbine 61 is for example, a turbine 61 where the superheated steam is directed by nozzles onto a rotor. This causes the rotor to turn. The energy to make this happen can only have come from the steam, so logically the steam has less energy after it has gone through the turbine rotor. Turbines typically have a number of stages; the exhaust steam from the first rotor will be directed to a second rotor on the same drive shaft 62. This means that the superheated steam could by the time it reached the output of the turbine 61 have slightly condensed and may have returned to a saturated or wet steam due to it passing through the successive stages.

If the steam was not at a superheated stage and was only a wet steam it could not only promote water hammer, but the water particles would cause severe erosion within the turbine 61. Water hammer is a pressure surge or wave resulting when a fluid (usually a liquid but sometimes also a gas) in motion is forced to stop or change direction suddenly. The solution as identified by the applicant is to supply the turbine with superheated steam at the inlet, and use the energy in the superheated portion to drive the rotor until the temperature/pressure conditions are close to saturation; and then exhaust the steam. At the output of turbine system 60 is a one-way valve 64 which prevents the steam at the output of the turbine feeding back into the turbine system 60.

In order to return the steam back to the system and to be able to re-use a significant part of the steam, the steam is passed through a condenser 70 and via a one-way valve 71 and back into the water tank 42 for re-use. The energy converter 10 is formed substantially as a closed loop system such

that the water used to convert to steam in the steam producing system 40 and then converted to superheated steam in the superheated steam system 50 is fed back into the water tank 42. The condenser 70 is a device or unit used to condense a substance from its gaseous state to its liquid state, typically by cooling it. In so doing, the latent heat is given up by the substance, and will transfer to the condenser coolant.

In the example illustrated in figure 5, the energy converter 10 may be stored in three separate containers and installed in a motor vehicle 90. In this example the motor vehicle 90 has a turbine system 60 which is connected to impart the mechanical motion derived from the energy converter 10 to the front wheels 92 of the motor vehicle 90. Alternatively, the energy converter 10 may be used to charge a set of storage batteries 91 an electric motor (not shown) to operate the vehicle 90 as a hybrid vehicle combining the energy converter 10 with an electric motor. The energy converter 10 may be used to charge the batteries 91 while the vehicle running on an electric motor (not shown). Obviously this is but one possible use of many which may use the energy converter 10. For example, the energy converter may be used to drive machinery which would normally be driven by either a motor or electricity.

As described above the energy converter 10 is conveniently stored in three separate containers. The combustible gas producer and burner system 20 is stored in the bottom or first container, the steam producing system 40 is stored in the second or middle container and finally the superheated steam generator 50 is stored in the top container. Behind the containers the combustible fluid tank 22 and the water tank 42 are conveniently placed to allow easy access for refilling the tanks 22, 42 with their respective fluids. The turbine system 60 and turbine 61 are located to the rear and to one side of the three containers and conveniently attached to drive the wheel 92 of the vehicle 90.

The present invention may also be used as a power source for devices such as a boat, a motorcycle or a scooter. The size of the present invention is dictated by the amount of mechanical energy that is needed to power the individual devices. For example the energy converter for a scooter is much smaller and is sized to fit conveniently within the frame of a scooter, whereas the energy converter for a boat can be significantly larger due to the extra power required to drive a boat. The boat may be direct driven or may be configured such that the energy converter is 17 connected to a direct drive or shaft driven motor. The present invention is also useful for powering a house in which the energy converter may power a alternator or inverter device which uses the mechanical motion from the energy converter to drive the inverter or alternator to produce the electrical energy required to power a house or the like. Another use of the energy converter may be to use the mechanical motion developed by the energy converter to drive a pump or motor for a number of uses. For example a water pump may be driven by the energy converter for pumping water from a water tank or for irrigation or any other similar use. The present invention is not limited to only the above uses and a skilled person would easily be able to devise many other suitable uses for the energy converter of the present invention.

The present invention is also directed to a method of converting thermal energy to mechanical motion. The method comprises heating a combustible fluid 21 to produce a combustible gas using the combustible gas producer and burner system 20. The combustible fluid, in this case ethanol 21 is ignited using the igniter 32 and the gas is burnt in the burners 31 and used to heat water 41 in the heat exchanger 47 to produce a wet steam in the steam producing system 40. In order to produce the superheated steam the water droplets in the wet steam must be separated from the steam using the superheated steam system 50 and a steam separator. The wet steam once separated is heated further by the steam generator 51 to produce a superheated steam which is used to drive a turbine 61 in a turbine system 60 to produce the mechanical motion or drive the drive shaft 62.

The applicant has found that the energy converter 10 has an improved thermal efficiency over the prior art systems. The efficiency of the best prior art heat engines is low; usually below 50% and often far below. So the energy lost to the environment by heat engines is a major waste of energy resources. The present invention has improved the thermal efficiency by using a closed loop system which recycles some of the steam which is condensed and fed back to the start of the process in the steam producing system 40.

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The present invention advantageously allows the energy converter 10 to be used in modern cogeneration, combined cycle and energy recycling schemes which all provide an environmentally friendly option using heat engines. By utilizing superheated steam which is fed to a turbine system 60 the applicant is avoiding causing blade erosion of the turbine 61.

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The present invention does not suffer from the endemic problems that have led to the demise of steam power in a commercial environment to date. There is little or no pollution, due to the recycling of the water and the small number of moving parts means maintenance costs have been significantly reduced. Due to the adaptability and relative small size of the present invention means that the energy converter may be used as part of a hybrid renewable energy vehicle, for example an electric car. This means that the drawback of having to regularly recharge an electric car can be reduced due to the adaptability of the steam energy converter which can be used to recharge the batteries while the car is still in use thereby extending the time between charges of the batteries.

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In the specification the term "comprising" shall be understood to have a broad meaning similar to the term "including" and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

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This definition also applies to variations on the term "comprising" such as "comprise" and "comprises".

Although the present invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without departing from the scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the feature set out in the appended claims.

**Claims**

1. An apparatus for converting thermal energy to mechanical motion, comprising:
  - a heat exchanger configured to produce wet steam comprising:
    - a combustible fluid reservoir and a combustible fluid pump to circulate a combustible fluid from the combustible fluid reservoir to a gas generator;
    - a first heater means to heat the combustible fluid in the gas generator to produce gasification of the combustible fluid;
    - an ignition source and burner to burn the combustible gas;
    - a water reservoir and a water pump to circulate a supply of water from the water reservoir to the heat exchanger;
    - a second heater means to heat the water in the steam generator;
    - a superheated steam generator comprising:
      - at least one steam separator to separate water droplets from the wet steam produced in the heat exchanger;
      - a cylindrical surface within the superheated steam generator, the surface of which is heated by at least one heater element such that when the steam contacts the cylindrical surface a superheated steam with a higher temperature and no water is produced; and
  - wherein the gas from the gas generator is ignited to provide a heat source to heat the water in the heat exchanger, wherein the heat exchanger provides the wet steam source for the superheated steam generator and the superheated steam generator provides a superheated steam which is directed to a turbine to produce mechanical motion.
2. An apparatus according to claim 1, further comprising a condenser placed between the turbine and the water chamber to condense the steam to a liquid state and provide a closed loop system.

3. An apparatus according to claim 2, wherein the apparatus comprises three superheated steam generators connected in an end-to-end arrangement and each generator comprises three heater elements to produce a dry superheated steam for driving the turbine.

4. An apparatus according to claim 3, wherein each said superheated steam generator comprises:

a separator vessel presenting a substantially cylindrical inside surface;

an inlet for directing incoming wet steam containing a mixture of steam and water into the vessel in a manner to effect a swirling motion of the wet steam around said cylindrical inside surface;

a steam chamber in the upper portion of the separator vessel for receiving the separated dry steam which rises above the water;

a generally cylindrical baffle plate mounted in the steam chamber at a location spaced apart from the cylindrical inside surface of the separator vessel to form a partition which provides a surface which is heated by the three heater elements to produce a superheated steam; and

a steam outlet conduit extending from the steam chamber for discharging superheated steam.

5. An apparatus according to claim 3 or claim 4, wherein the outlet of the first superheated steam generator is fed to the inlet of the second superheated steam generator and the outlet of the second said superheated steam generator is fed to the inlet of the third superheated steam generator and the outlet of the third superheated steam generator provides the superheated steam at a higher temperature and with no water to the turbine to produce the mechanical motion.

6. An apparatus according to any one of claims 3 to 5, wherein the baffle plate and cylindrical inside surface of the separator vessel are constructed from copper.

7. An apparatus according to any one of the preceding claims, wherein the combustible fluid comprises any one of the group consisting of ethanol, methylated spirits or LP gas.
8. An apparatus according to any one of the preceding claims, further comprising an electrical source to power the heater means and heater elements and the ignition source.
9. An apparatus according to any one of the preceding claims, wherein the mechanical motion produced by the energy converter can be used as a power source for any one of the group comprising:
  - a generator;
  - a house;
  - an automobile;
  - a boat;
  - a pump;
  - or any steam driven vehicle.
10. An apparatus according to claim 1, wherein the saturated steam is directed by nozzles onto a rotor of the turbine to cause the rotor to turn and produce mechanical motion.
11. An apparatus according to claim 1, wherein the heat exchanger, the gas generator, the at least one superheated steam generator and the turbine further comprise a pressure relief valve to control or limit the pressure at each stage of the apparatus.
12. An apparatus according to claim 1, wherein the gas generator further comprises a gas regulator valve to automatically control the flow of a gas at a pre-determined pressure.

13. An apparatus according to any one of the preceding claims, wherein the apparatus further comprises a one way valve between each stage of the apparatus to allow a liquid or gas to flow through it in only one direction.

14. A method of converting thermal energy to mechanical motion, the method comprising:

heating a combustible fluid to produce a combustible gas;

igniting the combustible fluid to heat water in the heat exchanger to produce a wet steam;

separating water droplets from the wet steam produced by the heat exchanger using a steam separator;

heating the separated dry steam in a superheated steam generator to produce a superheated steam;

and using the superheated steam to turn a turbine to produce mechanical motion.

15. A method according to claim 14 performed with the apparatus of claim 1.

16. A self contained energy converter comprising:

a gas generator housed within a first container and comprising:

a combustible fluid reservoir and a combustible fluid pump to circulate a combustible fluid from the combustible fluid reservoir to the gas generator;

a first heater means to heat the combustible fluid in the gas generator to produce gasification of the combustible fluid;

and an ignition source to ignite and burn the combustible gas;

a heat exchanger housed within a second container comprising: a water reservoir and a water pump to circulate a supply of water from the water reservoir to the heat exchanger;

and a second heater means to heat the water in the steam generator to produce a wet steam;

a superheated steam generator housed in a third container and comprising: at least one steam separator to separate water droplets from the wet steam produced in the heat exchanger;

and a cylindrical surface within the at least one steam separator the surface of which is heated by at least one heater element such that when the steam contacts the cylindrical surface a superheated steam with a higher temperature and containing no water is produced;

wherein the gas generator provides the gas and when ignited provides a heat source to heat the water in the heat exchanger, wherein the heat exchanger provides the wet steam source for the superheated steam generator and the superheated steam generator provides a superheated steam which is directed to a turbine to produce mechanical motion.

17. A self contained energy converter according to claim 16 performed with the apparatus of claim 1.

18. An energy converter including:

an assembly for delivery of a combustible gas;

at least one burner to burn the combustible gas;

a heat exchanger in communication with a water reservoir for producing wet steam therefrom, said heat exchanger located to be heated by the at least one burner;

a superheated steam generator in communication with the heat exchanger including:

at least one heating assembly arranged to heat at least one cylindrical surface for converting said wet steam into a superheated steam; and

an arrangement for directing the superheated steam to a turbine to produce mechanical motion.