

AMBIENT HEAT ENGINE

[0001] The present application relates to one or more ambient heat engines that are independently operated or connected together. The application also relates to methods of making, assembling, installing, repairing, upgrading, modifying and using the one or more ambient heat engines.

[0002] The present application claims earlier priority dates of following two Singapore patent applications with the same title, consisting of following serial numbers:

- 10201406579W filed on 13 October 2014; and
- 10201503915P filed on 19 May 2015.

[0003] World living standards have been improved drastically over the last century by consuming escalating amount of energy. Main sources of the energy are fossil fuels, such as crude oil and coal. However, current practices of consuming the fossil fuels inevitably generate carbon dioxide gas and other pollutants that are damaging to the Earth's eco-system. For example, Internal Combustion Engines (ICE) that rely on refined petrol (gasoline) or diesel have been used since year 1859, which emit carbon dioxide, soot (particular matter), nitrogen oxides and sulfur when combusting these carbonaceous fuel.

[0004] To avoid the degradation and eventual destruction of the Earth's ecosystem, various solutions have been developed for harnessing renewable energy from sunlight, wind, ocean wave, and biomass. Unfortunately, cost of making use of these forms of renewable energy sources is prohibitively high, in addition to disadvantages of fluctuation of their power production and insufficient supply of raw materials for producing these renewable energy sources. Accordingly, technologies of using these renewable energy sources remain heavily subsidized, thus making the renewable energy to be experimental and supplementary, not feasible to replace the existing fossil fuels.

[0005] Essential features are provided by one or more independent claims, whilst advantageous features are presented by their dependent claims.

[0006] According to a first aspect of the invention, the present application provides
5 an ambient heat engine that comprises a high pressure heat exchanger connecting to an expander for reducing pressure and temperature of a fluid to a low pressure; an optional low pressure heat exchanger further connected to the expander for absorbing external heat to warm up the fluid so that the fluid will not become solid block form obstructing fluid flow; and a hydraulic motor further connected to the low
10 pressure heat exchanger for converting hydraulic pressure, possibly being further raised by hydraulic motor housing by absorbing external heat, into mechanical displacement, and return the fluid to a high pressure at the high pressure heat exchanger. The high pressure heat exchanger, the expander and the hydraulic motor are connected together in forming a closed loop for circulating the fluid,
15 known as heat transfer medium or refrigerant. The low pressure exchanger is optional because it is used to prevent the fluid from forming big solid blocks. The low pressure heat exchanger can be integrated with the expander as one unit. Since rotary motor can absorb heat from ambient, the rotary motor may also be known as heat exchanger, being independent or as a part of other heat
20 exchangers. In short, the ambient heat engine also called low grade heat engine uses a colder than ambient working fluid (e.g. liquid) which enters into a heat to mechanical conversion device where the working fluid absorbs heat, increase volume and pressure of the working fluid, performs work before exiting at high pressure and gets warm up further to expand to cold liquid again before entering
25 into the heat to mechanical conversion device in a closed loop cycle.

[0007] The expander is configured to increase volume of the fluid for reducing its temperature in the process of volume expansion. The process of volume expansion may be adiabatic or diabatic, resulting the fluid becoming denser and
30 form into liquid or solid if it is too cold. The fluid acts as a heat transfer medium of the ambient heat engine, which has a closed and hermetically sealed loop. The fluid is propelled through components of the ambient heat engine for converting heat which can be of low temperature like ambient heat, into displacement, also known as mechanical movement as energy output. Particularly, the fluid at

entering the hydraulic motor is colder than ambient environment of the ambient heat engine (e.g. lower than ambient temperature of -5°C) such that the fluid absorbs ambient heat via the hydraulic motor housing. The hydraulic motor is driven by the fluid such that the heat absorbed from the ambient environment is partially or fully converted to kinetic energy in the form of mechanical motion, for numerous industrial applications. The hydraulic motor comprises following types, such as rotary vane motors, generator motors, axial plunger motors, radial piston motors, turbomachines, impulse turbines and reaction turbines.

[0008] Energy and fresh water are everywhere. To harness them is simple, just create a very cold working medium (cold liquid CO_2) on the spot and warm the very cold working medium up in a rotary motor where pressure of the very cold working medium increases and drives the shaft of the rotary motor to power generator. After performing work, the cold working medium remains cold and needs to be warmed up to room or ambient temperature before the cold working fluid can be used again in a closed loop cycle. The warming process can be achieved by condensing water vapor in the air or freezing fresh water out from waste water or seawater. Thereafter the coldness can still be used for air-conditioning.

[0009] Incorporating a high temperature reactor which can dispose wet waste, will add more power to g-EN CO_2 engine (i.e. ambient heat engine) as no heat is wasted. You get additional energy and fresh water in hot temperature suitable for heating in cold area. Hence, you get abundant, clean, affordable energy, fresh cold and hot water with waste disposal without depending on a particular fine weather or specific fuel and creating pollution. g-EN CO_2 engine will change the world with abundant energy and fresh water for better living for every people.

[0010] The ambient heat engine comprises a high pressure heat exchanger that is connected between the hydraulic motor and the expander for heating the fluid to a temperature where when the fluid expands and temperature of the fluid becomes at least low enough to form liquid. The high pressure heat exchanger is designed or configured to operate within an ambient environment with a predetermined temperature range that is substantially higher than that of the low pressure heat

exchanger. The high pressure heat exchanger is alternatively known as a high temperature heat exchanger, whilst the low pressure heat exchanger may also be termed as a low temperature heat exchanger. One or more of the high and low pressure heat exchanger can absorb heat (i.e. thermal energy) surrounding the ambient heat engine such that the ambient heat engine receives the (ambient) heat, and converts the ambient heat to other forms of energies, such as rotary motion, linear displacement or electricity. In the ambient heat engine, the expander reduces temperature of the fluid to be lower than that of the ambient environment such that the fluid is able to intake heat from the ambient environment.

[0011] The fluid comprises carbon dioxide, ammonia or a combination of both. The carbon dioxide may be operated in gas phase, liquid phase, supercritical phase, solid phase or a mixture of any of these phases. For example, when using carbon dioxide, the expander may discharge a mixture of liquid, powder and gaseous carbon dioxide for heat absorption in the hydraulic motor. In practice, the carbon dioxide mixture of different phases is sprayed by the expander at about 0°C, 25 bar or lower but above the triple points when entering the hydraulic motor. The carbon dioxide and ammonia are environmentally friendly refrigerants (also known as heat transfer media) with abundant supply and low cost. Carbon dioxide and ammonia cause no damage to health or environment even when discharged to environment.

[0012] The expander can comprise a Joule–Thomson device that has one or more throttles. The Joule–Thomson device is alternatively known as Joule–Kelvin device, Kelvin–Joule device, or Joule–Thomson expansion device because the device causes temperature change of a gas or liquid when the liquid or gas is forced through a valve or porous plug while kept insulated so that no heat is exchanged with the environment. The expansion of gas to liquid undergoes an adiabatic expansion process such that the gas or liquid has no heat exchange with the ambient environment of the expander. Alternatively, the heat exchange between the expander and the ambient environment is not sufficient (e.g. negligible) to maintain temperature of the gas or liquid during the expansion. In practice, one or more of the Joule–Thomson devices of different sizes can be connected in serial or parallel such that the one or more Joule–Thomson devices have multiple valves or porous plugs for expansion under force or pressure.

[0013] The hydraulic motor may comprise an extendable vanes rotary motor. When in use, the plurality of vanes divide an enclosed chamber of the rotary vane motor into several compartments such that these vanes may individually receive pressure by expansion of the fluid for exporting torque. The rotary vane motor may include several rotary vane motors connected in serial or parallel so that output of the torque or speed may be adjusted depending situation or requirements.

[0014] The rotary vane motor can have a constant gap for providing separate two or more compartments of substantially similar volumes divided by the plurality of movable vanes from inlet to outlet of the rotary motor. These compartments hold the same volume and mass of the fluid providing higher pressure when heated by the ambient environment, giving rotary vane motor more power.

[0015] The ambient heat engine may further comprise an inlet and an outlet that are connected to opposite ends of the constant gap. The inlet and outlet provides smooth transition of the fluid into and out of the ambient heat engine such that the ambient heat engine does not experience vibration, leakage or explosion when operating under high pressure (e.g. 25~120 bar).

[0016] One or more of the movable vanes can comprise a biasing means for extending the one or more of the movable vanes radially to ceiling or wall of the rotary motor. When rotating, the biasing means keeps pushing the one or more movable vanes against a wall of the rotary vane motor such that individually sealed compartments are maintained during operation of the rotary vane motor. Stability and structural integrity of the rotary vane motor is maintained for long-term operation under extreme high pressure.

[0017] The biasing means may comprise a spring that is pushed against the one or more movable vanes. The spring may take one or more forms, either separately or integrated with the movable vanes. For example, the spring includes a tension/extension spring, compression spring, torsion spring, constant spring, variable spring, coil spring, flat spring, machined spring, cantilever spring, coil

spring or helical spring, hairspring or balance spring, leaf spring, v-spring and gas spring. The spring is low cost and reliable tool for biasing the movable vanes.

[0018] A pin rod may be inserted to help extending the vane reaching the wall of the rotary motor. The pin rod is pushed down by a vane that is moving closer to the wall of the rotary motor and the direct opposite vane receives the pin rod extended length to raise its extent to reach the wall which is further away. This action is known to those in the art of rotary vane motor or pump application. However in a constant gap height design from inlet to outlet of the rotary motor, the internal diameter of the rotary motor cylinder may not be constant all round. The length of pin rod has to make the vanes reach the wall at the rotary motor cylinder largest diameter, but will be too long and cause it to jam at the smaller diameter point. To compensate for the different internal cylinder diameter requires the vanes to have recessed bottom so that the extended movement of the spring contraction goes into the recessed bottom when the vane is at the rotary motor cylinder smaller internal diameter, thus preventing the pin rod jamming the movement.

[0019] The low pressure heat exchanger is configured to ensure the fluid is from 6 bar to 25 bar depending on the final low pressure temperature which has to be preferably 40 degree C lower than the ambient temperature but not lower than the freezing point of the fluid. When using carbon dioxide, the right pressure and temperature must be selected to avoid generation of big solid blocks of carbon dioxide, allowing fluidic transportation through the ambient heat engine ensuring reliable performance of the ambient heat engine.

[0020] The high pressure heat exchanger is configured to operate the fluid at a temperature and a high pressure range that when the fluid is expanded in the expander, the carbon dioxide remains fluidic (e.g. gas, liquid or fine powder), avoiding becoming big solid chunk. The high pressure heat exchanger absorbs heat from the ambient to achieve the temperature range. The ambient heat engine with the high pressure heat exchanger, thus also works as a fresh water generator and or a chiller without electricity input. In practice, the high pressure heat exchanger, the low pressure heat exchanger, the hydraulic motor or any other components of the ambient heat exchanger can operate below freezing point of

water such that contaminated water may be frozen as pure ice, free from contaminants. Otherwise, the coolness can condense water from air. The ambient heat generator thus becomes the freshwater generator by using the fluid.

5 [0021] The high pressure heat exchanger may be replaced with a connecting tube to another rotary vane motor if the high pressure carbon dioxide is still very cold liquid form. This cascading can be repeated until the high pressure carbon dioxide is close to 0 (zero) degree Celsius. This configuration gives more work power but less coldness for cooling application.

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[0022] The ambient heat engine can further comprise one or more non-return valves that are connected to the hydraulic motor for preventing backflow of the fluid. The non-return valve is also known as a check valve, clack valve, or one-way valve that normally allows fluid (liquid or gas) to flow through it in only one
15 direction. Hence, the one or more non-return valves prevent the hydraulic motor from reversing as the backward is a lower pressure zone. The fluid in hydraulic motor must absorb enough heat to overcome the forward pressure and creates the forward flow. Since the ambient heat engine operates at pressure values substantially higher than its ambient environment, the one or more non-return
20 valves can insulate or separate parts of the ambient heat engine for fault isolation or maintenance. The non-return valves may be connected in parallel to allow higher flowrate. Such many non-return valves in parallel can be housed in one compact block thus reducing the physical size. The one or more non-return valves can also be connected to the low pressure heat exchanger, the high pressure heat
25 exchanger, the Joule-Thomson device or a combination of any of these for directing flow of the fluid.

[0023] According to a second aspect of the invention, the application provides a method for using an ambient heat engine that comprises a step of reducing
30 temperature of a heat transfer fluid to be lower than ambient temperature of the ambient heat engine; another step of absorbing heat by the heat transfer fluid from ambient environment of the ambient heat engine; and a further step of converting one or more portions of the heat to displacement as output. Some of these steps

may be changed in sequence, whilst all of these steps can be cyclically or continuously repeated for operating the ambient heat engine.

[0024] The method can further comprise a step of increasing temperature of the heat transfer fluid after the converting the one or more portions of the heat to displacement as output. In other words, the fluid (i.e. heat transfer medium) can absorb thermal energy from waste heat, sunlight, furnace, plasma gasifying devices, hot spring or any other natural or industrial heat sources for converting the thermal energy to desired energy (e.g. electrical, mechanical). The method can be applied in diverse types of the industries, and further adapted to individual needs or specification.

[0025] The step of increasing temperature of the heat transfer fluid additionally may comprise a step of absorbing thermal energy by the heat transfer fluid from the ambient environment. Since ambient environment provides an almost inexhaustible source of energy, the ambient heat engine does not require transportation of "fuel" to the ambient engine, or cause environmental damage. Instead, the ambient heat engine reduces temperature of its ambient environment, and provides an air-conditioner at almost no running cost.

[0026] The method can further comprise a step of preventing backflow of the heat transfer fluid. Since the backflow can interrupt steady operation of the ambient heat engine, the ambient heat engine that has a closed loop can be divided into segments for avoiding collapse of the entire ambient heat engine when facing issue at one particular segment.

[0027] The method may further comprise a step of regulating pressure of the heat transfer fluid for controlling its temperature to be lower than the ambient temperature. Pressure values of the ambient heat engine may be adjusted at individual segments, or according to specific requirements. For example, the low pressure heat exchanger and the high pressure heat exchanger may operate at dissimilar pressure values so that the fluid can progressively pass through the two heat exchangers for absorbing ambient heat. In cold countries or winter season,

the pressure of the heat transfer fluid may be further regulated for heat absorption at suitable temperature and rate.

[0028] Heat is the main source of energy for work. The Sun and burning of hydrocarbon compounds are the main fuel source of heat. In ICE (Internal Combustion Engine) concept, it uses the heat to cause rapid expansion of pressure of air in its engine cylinder to push the piston causing it to move in rotating action to perform work. Similarly for a boiler, the heat is used to increase the fluid pressure and the pressurized fluid then performs work.

[0029] According to present application, the heat is not necessary directly from standard hydrocarbon fuels. The heat energy source is the ambient heat which is mostly leftover by the Sun or human activities. The ambient heat is most abundant energy source which should be harnessed for performing work.

[0030] Ambient heat alone and or waste heat from industrial sources can be recovered to increase the volume or pressure of a working fluid like CO₂. The increased volume of a pressurized fluid in a cylinder of a piston-driven reciprocating engine or a spindle rotary device will perform mechanical works. The exhausted working fluid of low pressure is passed through a cryogenic chamber to condense back to higher density state and then pumped back to working fluid storage cylinder to the same input pressure by the return stroke of the piston or a separate transfer pump. Thus completes the closed loop of performing works.

[0031] Liquid CO₂ when confined to a sealed cell and when the sealed volumetric cell is allowed to suddenly expand its original size, the pressure on the confined liquid CO₂ will suddenly become lower to below its critical point, the liquid CO₂ will become gaseous as it cannot exist in liquid state below its triple point. This expansion of CO₂ to gaseous volume with the same mass and some heat absorption results in higher pressure that can perform work.

[0032] The work performed by the pressurized fluid can drive an electric generator. A portion of the electricity will provide the electrical power to maintain the system operation.

[0033] A portion of the return cryogenic liquid working fluid can go through a heat exchange to transfer the chilled energy out for other chilling applications.

- 5 [0034] The Ambient Heat Engine is scalable for use as battery charger in an electric vehicle to distributed power plant.

[0035] According to a third aspect of the invention, the present application provides an ambient heat engine that comprises a motor with heat exchanger for increasing
10 the temperature of the cryogenic working fluid and exhausts out of a lesser density to a cryogenic condenser which is chilled by a portion of the cryogenic working fluid not flowing through the motor. The cryogenic condenser connects to a compressor for receiving and compressing a cryogenic working medium to a higher pressure. The cryogenic working medium is configured to be circulated
15 around the motor, the cryogenic condenser and the compressor forming a closed loop.

[0036] The heat exchanger which is attached to the motor will absorb the ambient heat or other heat source. The Ambient Heat Engine does not generate waste
20 heat. Both cryogenic condenser and motor chamber of the Ambient Heat Engine have their body temperature lower than ambient temperature such that the working medium chills its environment.

[0037] The ambient heat engine can further comprise a working medium that
25 comprises carbon dioxide, air, ammonia or a combination of both. In particular, phase diagram of the carbon dioxide shows a critical point of 31.1°C and 73.8bar that the carbon dioxide can exist in a supercritical region, as a supercritical fluid. The carbon dioxide has a triple point of 518 kPa at -56.6°C. Since carbon dioxide is a naturally occurring medium, industrial application of carbon dioxide is
30 inherently safe. Refrigeration experiments of carbon dioxide gives good indication of efficiency, as compared to other refrigerants, such as R11 (Trichlorofluoromethane) and R121 (1,1,2,2-Tetrachloro-1-fluoroethane).

[0038] The motor may comprise a turbine that is configured to produce mechanical movement. The turbine is a highly efficient mechanical device that expanding volume of a fluid/gas can provide for mechanical or rotary movement. Some types of turbine can operate at high pressure, which especially suitable for application with carbon dioxide.

[0039] The ambient heat engine can include an electric generator that is connected to the motor for converting the mechanical movement into electricity. The Ambient Heat Engine may further include a transformer, a power inverter, rectifier or other electric devices for providing electricity of predetermined voltage value, current parameter or frequency. The electricity generated may be used for driving electric motors or disassociating water.

[0040] The motor can further comprise a compressor, a reciprocate engine or both. Since the working fluid increase its volume after passing the motor, the process of expansion can propel the reciprocate engine, the compressor or other mechanical devices, which produces useful work for fully utilizing the energy.

[0041] The reciprocate engine may comprise a piston for achieving reciprocating movement within a chamber of the reciprocate engine.

[0042] The reciprocate engine can comprise a control valve that is configured to cooperate with the piston for injecting or discharging the working medium into or from the chamber. The control valve may be synchronized with the movement of the piston such that the reciprocate engine can suck the working medium and expel the working medium of lower pressure for providing continuously revolution.

[0043] The reciprocate engine may further comprise a cam connected to the piston for activating the control valve. The cam is simple and reliable when design and installed properly for linking the movements of the control valve and the piston.

[0044] According to a fourth aspect of the invention, the present application provides a method of using an Ambient Heat Engine. The method comprises a step of injecting a working medium into the Ambient Heat Engine. Since the

Ambient Heat Engine can accept more than one type of working medium, the Ambient Heat Engine may be discharged or filled different types of working medium repeatedly, periodically or progressively. For example, carbon dioxide can be introduced into the Ambient Heat Engine.

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[0045] The method can further include a step of compressing the working medium by the compressor such that pressure of the working fluid is raised to be equal or higher than a critical point of the working fluid in forming a highly compressed fluid. When equal or beyond the critical point, the carbon dioxide can be converted to gas, liquid or even solid instantly or directly with sudden decrease of pressure, temperature or both. Such rapid phase transformation is beneficial circulating the carbon dioxide and exchanging heat using the working medium.

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[0046] The method may further comprise a step of expanding the working medium rapidly for reducing temperature of the working medium. With the rapid or sudden expansion, the working medium (e.g. carbon dioxide) will drastically lower its temperature, and be converted into liquid or solid forms.

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[0047] The method can further comprise a step of absorbing heat from ambient of the Ambient Heat Engine. Since the temperature of the working medium can be reduced below the ambient temperature, a container of the expanded working medium can absorb heat from the ambient, thereby providing a cool engine.

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[0048] The method may further comprise a step of heating the working medium by an artificial heat source. The artificial heat source includes an oven, blast furnace, an Internal Combustion Engine, a nuclear reactor, or any other manmade devices that can give away heat.

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[0049] The step of heating of the working medium can comprise a step of removing heat from waste water, room air, sea water or any other heat generators. In other words, the working medium can reduce temperature of coolants that passes through it. Such application in large scale may be known as waste heat recycle.

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[0050] The method may further comprise a step of raising temperature of the working medium by beyond its critical point. Alternatively speaking, the working medium/fluid can transit between supercritical fluid, liquid, gas or solid such that heat exchange of different phases can be flexible adopted various parts of the

5 Ambient Heat Engine.

[0051] The method further can comprise a step of changing temperature of the working medium beyond or below its triple point. The triple point provides an alternative point of operating with the working medium (carbon dioxide) at lower

10 temperature or pressure.

[0052] According to a fifth aspect of the invention, the present application provides an ambient heat engine system that comprises of a cylinder, motor cum compressor, pump, heat exchangers and electric generator which a high pressure

15 cryogenic working fluid flows in a closed loop. The working fluid absorbs heat from ambient and waste heat from other process to expand its volume and pressure to perform work. The Ambient Heat Engine works as a freezer. The Ambient Heat Engine uses like a high temperature reactor. The Ambient Heat Engine uses as to perform mechanical work. The Ambient Heat Engine works as a clean water

20 generation. The Ambient Heat Engine performs all or combination of the freezer, the high temperature reactor for performing waste disposal, the mechanical work and generating clean water. An ambient heat engine provides a reactor with a HHO heating source. The heating element of the HHO heating has narrow through cavities. The heating element narrow through cavities can have spiral design.

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[0053] According to a sixth aspect of the invention, the application provides a cool Ambient Heat Engine operates by a very cold fluid absorbing ambient or low grade heat to turn a mechanical load as well as produce a freezing thermal source; and the exhausted fluid return in a close loop chilled back by a cryogenic condenser

30 and pump to high pressure by a transfer pump The fluid may be carbon dioxide. In other words, the application provides an Ambient Heat Engine that has carbon dioxide working under high pressure and around 40 degrees C below the critical point to liquid state for absorbing heat from ambient or unwanted heat sources which can be of low grade.

[0054] According to a seventh aspect of the invention, the present application provides an engine that deliver mechanical energy and freezing thermal energy with power source from ambient thermal energy and or thermal energy from other energy sources that have higher temperature than the freezing thermal output.

[0055] The cryogenic condenser is maintained at temperature minus 40 deg. C by feeding in with dry ice made on the spot. The Dry Ice making section of the cryogenic condenser has a different pressure level to the cryogenic condenser chamber where the exhaust of the motor enters. The dry ice is transferred to the cryogenic chamber by a mean (known to person with the skill to build) to maintain the pressure difference. If 1 kg of CO₂ from the expander will exhaust to 40% liquid and 60% vapor at -20 deg. C, 1 kg of dry ice would be more than enough to condense the 0.6kg of vapor to liquid at -40 deg. C.

[0056] The liquid CO₂ collected in cryogenic condenser is distributed back to the motor and another portion through a transfer pump or compressor for higher pressure before discharging back to the dry ice section of the cryogenic condenser to form dry ice.

[0057] In another embodiment, the dry ice is separated from the working fluid in the cryogenic condenser chamber. Through a heat exchanger in the cryogenic condenser chamber, the dry ice becomes liquid and is circulated back through a pump to higher pressure before discharging back. The exhausted CO₂ from expander become liquid again in the cryogenic condenser chamber and feed back to the expander.

[0058] The liquid CO₂ pumped back to be discharged again for making dry ice can go through a heat exchanger with ambient heat and the coldness is transferred for other application. A working fluid of the similar PH features may be able to substitute CO₂ if it has the same no liquid state below its triple points.

[0059] Fig. 1 illustrates a first ambient heat engine;

- Fig. 2 illustrates a side view of a rotary vane motor with a constant volume chamber;
- Fig. 3 illustrates the vane of rotary vane motor having a recessed bottom;
- Fig. 4 illustrates the compact block of many non-returning valves;
- 5 Fig. 5 illustrates a second Ambient Heat Engine;
- Fig. 6 illustrates the second Ambient Heat Engine with a heat exchanger;
- Fig. 7 illustrates a first cryogenic condenser that is connected to a first regulator; and
- Fig. 8 illustrates a second cryogenic condenser having a second regulator.

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[0060] Figs. 1 to 4 relates an embodiment of the invention. Particularly, Fig. 1 illustrates a first ambient heat engine 20. The first ambient heat engine 20 comprises a low pressure heat exchanger 22, a first non-return valve 24, an rotary vane motor 26, a second non-return valve 28, a high pressure heat exchanger 30,

15 a third non-return valve 32 and a Joule-Thomson device 34, which are sequentially connected together clockwise (CW).

[0061] These components 20, 22, 24, 26, 28, 30, 32, 34 are connected to each other by thermally insulated tubes in forming a closed loop 36. The first ambient

20 heat engine 20 contains carbon dioxide (CO₂) 38 of various phases in the loop, which is also hermetically sealed. The non-return valves 24, 28, 32 control directions of mass flow such that the carbon dioxide 38 is allowed to flow in one direction, in this illustration clockwise direction, within the closed loop 36.

25 [0062] The Joule-Thomson device 34 comprises a throttle in the form of a porous baffle, which is concealed by a casing of the Joule-Thomson device 34. The throttle is configured to cause pressure difference between two sides of the throttle when experiencing gaseous flow. The rotary vane motor 26 is also known as a hydraulic motor. The rotary vane motor 26 is rotary mechanical device that extracts

30 kinetic energy from a fluid flow and converts the kinetic energy into rotation movement as useful work. The housing 48 of the rotary vane motor 26 can have fins (not shown) for absorbing heat from its ambient environment. Other mean of heat transfer can be a medium like water flowing through the housing 48. The Joule-Thomson device 34 comprises a pressure regulator (not shown) that keeps

pressure of the carbon dioxide 38 in the expander cum low pressure heat exchanger 22 to be low and cold.

[0063] The carbon dioxide 38 has diverse temperature, pressure, and mass flow rates at different positions of the first ambient engine 20. Specifically, at the low pressure heat exchanger (also known as low pressure coil), the carbon dioxide 38 exists as a mixture of dense vapor, liquid and solid in the form of power. The carbon dioxide 38 at the low pressure heat exchanger 22 is about 10 bar (about 9.87 atmospheric pressure) and -50°C (i.e. 323.15K). The low pressure heat exchanger 22 receives the carbon dioxide 38 in gaseous form at high speed and get very cold to become liquid form at its exit near the first non-return valve 24. In contrast, the carbon dioxide at the high temperature heat exchanger 30 is about 70 bar and 30°C (ambient temperature in tropical countries) in the form of high density gas.

[0064] Fig. 2 illustrates a side view of the rotary vane motor 26 with a constant volume chamber 40. The rotary vane motor 26 has many movable vanes 42. The rotary vane motor 26 has a drive shaft 44, a rotor 46, the movable vanes 42 and a housing 48. The drive shaft 44 is an elongated cylindrical bar, although only an end portion 50 is visible in Fig. 2. The drive shaft 44 incorporates a ratchet featuring gear and a pawl mounted on a base for preventing the driving shaft 44 from rotating backward. The drive shaft 44 is fixed into the rotor 46 with interference and a locking key 50 such that the two parts 44, 46 become unitary and can rotate together. Depending on design, in this case there are eight movable vanes 42 that are equally distributed around rotor 46. Additionally, the eight movable vanes 42 are held by eight radial slots 50 with comparable sizes such that each of the eight movable vanes 42 can radially slide along the radial slots 52. The housing 48 has an inlet 54 and an outlet 56 that are placed at opposite sides of the housing 48. A lower portion 58 of the housing 48 is circular, but have a larger radius than that of the rotor 46, although the rotor 46 and the lower portion 58 are concentric. Hence, a gap 60 between the rotor 46 and the lower portion 58 is substantially constant. In contrast, the rotor 46 touches an upper portion 62 of the housing 48 such that the

movable vanes 42 are completely pushed into their respective radial slots 52 at a ceiling 64 of the upper portion 62.

[0065] Fig. 3 illustrates a movable vane 66 of the rotary vane motor 26 having a recessed bottom 68. The movable vane 66 is one of the eight movable vanes 42 of identical shapes, sizes and material. The recessed bottom 68 has a rectangular pocket 68 that extends from a middle position of the movable vane 66. Fig. 3 further shows a spring mechanism 72 that includes a leaf spring 74 and a pin 76. The pin 76 length extends from one leaf spring through the rotor 46 and drive shaft 44 to the direct opposite movable vane 66 and its leaf spring 74 at bottom of a radial slot 52. When one movable vane 66 is at the upper portion 66, the movable vane 66 is pressed into the radial slot 52 and pushes the pin 76 which further pushes against the leaf spring 74 of the direct opposite movable vane 66 out of its radial slot 52 to reach the lower portion 58 of the housing 48. The spring mechanism 72 drives the movable vane 66 radially outward towards the housing 48 such that tips of the movable vanes 42 are constantly contiguous with the housing 48, thereby providing sealed compartments between the movable vanes 42. If the distance length of the 2 direct opposite movable vanes 66 touching wall of the housing 48 varies a lot, the pin 76 will be too long when distance length is at the shortest. The recessed bottom 68 in the movable vane 66 provides extra room for the pin 76 to move in to offset the unwanted length of pin 76. If difference of the distance length of the 2 direct opposite movable vanes 66 at various points is designed to be small, the recessed bottom 68 may not be required.

[0066] Before usage, interior of the first ambient heat engine 20 is vacuumed so that no gas, liquid or solid matter exists inside the first ambient heat engine 20. The high pressure heat exchanger 30 is subsequently filled with carbon dioxide 38 in the form of liquid or gas from a cylinder (not shown). A stop valve (not shown) at the Joule-Thompson device 34 is turned off and the high pressure heat exchanger 30 keeps the carbon dioxide 38 inside in thermal equilibrium, having pressure about 70 bar and temperature around 30°C or other high pressure value depending on the ambient temperature at the application site, which is known as high temperature carbon dioxide 39.

[0067] When the stop valve is opened, carbon dioxide 38 moves around in the loop 20 clockwise. Particularly, since the non-return valves 24, 28, 32 only permit mass flow clockwise, the carbon dioxide 38 cannot flow from the high pressure heat exchanger 30 to the rotary vane motor 26 via the second non-return valve 28.

5 Instead, the carbon dioxide 38 runs from the high pressure heat exchanger 30 to the Joule-Thomson device 34 via the third non-return valve 32.

[0068] During initial starting, while the stop valve is opened, a second stop valve (not shown) at the outlet 56 of the rotary vane motor 26 is opened to allow carbon
10 dioxide 38 to flow out into the atmosphere momentary to start the rotation of the rotary vane motor. The second stop valve is then closed and the carbon dioxide 38 flows into high pressure heat exchanger to complete the loop.

[0069] Pressure may drop in the high pressure heat exchanger. A mean can be
15 built in to refurnish back with an external source like topping up the refrigerant to an air-conditioner unit.

[0070] At the Joule-Thomson device 34, the carbon dioxide 38 passes through several serially spaced baffle plates (also known as throttle, not shown) or
20 basically through a small orifice between the high and low pressure regions, such that the carbon dioxide 38 changes to about 10 bar and -50°C at an outlet of the Joule-Thomson device 34, known as low temperature carbon dioxide 41 as cold dense vapor mixed with liquid and some solid powder carbon dioxide 38. Coefficient of the Joule-Thomson device 34 for carbon dioxide 38 at 30 degree
25 Celsius ($^{\circ}\text{C}$) is about 1 degree C of temperature reduction (decrease or drop) for every 1 bar of pressure drop.

[0071] Since both heat exchangers 22, 30 can have numerous tubes and fins (not shown) depending on design, they 22, 30 transfer heat efficiently. The low
30 temperature carbon dioxide 41 which is formed by the Joule-Thompson device 34 and received by the low pressure heat exchanger 22, progresses by passing through the first non-return valve 24, and enters the rotary vane motor 26. Here, the low temperature carbon dioxide 41 is also known as low pressure carbon

dioxide 38, whilst the high temperature carbon dioxide 39 is alternatively known as high pressure carbon dioxide 39.

[0072] At the rotary vane motor 26, the low temperature carbon dioxide 38
5 between the movable vanes 42 absorbs heat from the ambient environment through the housing 48 because the low temperature carbon dioxide 38 has substantially lower temperature than the ambient temperature of 30°C. Both the first non-return valve 24 and the second non-return valve 28 prevent the low temperature carbon dioxide 38 flowing backwards in the counterclockwise (CCW)
10 or anticlockwise direction (ACW). Accordingly, the low temperature carbon dioxide 38 with the pressure raised by absorbing the heat in the housing 48, pushes the movable vanes 42 and causes the drive shaft 44 to rotate clockwise, producing rotary motion and exporting kinetic energy. A ratchet and pawl mechanism (not shown) is attached to the drive shaft 44 to prevent the backward rotation as the
15 pressure at inlet 54 is lower than outlet 56. In the rotary vane motor 26, volumes between the movable vanes 42 remain substantially the same at the lower portion 58, between the inlet 54 and the outlet 56.

[0073] The low temperature carbon dioxide 38 flows out of the rotary vane motor
20 26 to the high pressure heat exchanger 30, receive more heating and become high temperature carbon dioxide 41. The heating can be done by condensing water from air, or freezing water from waste water or seawater or other direct heat sources.

25 [0074] A safety relief valve (not shown) is attached in the high pressure heat exchanger to ensure pressure is within the operating range.

[0075] Fig. 4 shows a compact non-return block 80 housing many non-return
30 devices 81. The compact non-return block 80 can be any shape to suit in the connection and can contain as many non-return devices 81 required to achieving the fluid flowrate. The non-return device 81 comprises blocking inlet 82, flow through inlet 83, retainer 85, spring coil 84, and shutter ball 86. All blocking inlets 82 are on the same side of the compact non-return block 80 and all flow through

inlets 83 on the other side. Compact non-return blocks 80 can easily integrate into the rotary vane motor housing 48.

[0076] Heat energy source for heating the carbon dioxide 38 in the housing 48 can be direct exposure of the housing 48 to the ambient heat which can be assisted by a fan. For higher power output, heat energy source can be pumped around or through the housing 48 with a medium like water which can be at temperature just below boiling point. Hot water can come from waste heat sources like thermal waste disposal process, spent nuclear waste, industrial process or purposely generated to boost the power.

[0077] Figs. 5 to 7 provides a second embodiment of the invention. The second embodiment comprises parts or objects that are similar or identical to those of other embodiments. The similar or identical parts or objects are labelled with similar or identical reference numerals. Description of the similar or identical parts of objects is hereby incorporated by reference wherever appropriate.

[0078] Particularly, Fig. 5 illustrates a second ambient heat engine 101. The second ambient heat engine system 101 has a closed loop 101 that comprises a heat exchanger 110, an accumulator cylinder 102, a motor 107, a cryogenic condenser 105 and a transfer pump 106. The accumulator cylinder 102 contains a working fluid 38 of ambient temperature, high pressurized carbon dioxide 39 close to its critical points or above. The high pressurized CO₂ 39 is released when a stop valve 103 is opened to the dry ice maker 104 similar to the first embodiment where the expander 34 makes CO₂ becomes liquid except here, it makes colder until CO₂ becomes solid. Dry ice (i.e. solid carbon dioxide) from the dry ice maker 104 is transported out to the cryogenic condenser 105 chamber by a transport device 114 as shown in Fig. 6. In Fig. 7, the dry ice maker 104 is inside the cryogenic condenser 105 chamber and the dry ice splash onto the wall of the dry ice maker 104 and the heat is transferred through the wall to cryogenic condenser 105 chamber condensing the exhaust CO₂ to liquid. The temperature of low pressure CO₂ 41 in the cryogenic condenser 105 chamber can be around -40 degrees Celsius. The cryogenic condenser 105 chamber internal is thermal insulated. The dry ice maker 104 inside the cryogenic condenser 105 is designed with material

and shape that can transfer cold heat out easily. Some of the cryogenic CO₂ from point 112 goes to the motor 107 input while remaining goes back to the accumulator cylinder 102 through transfer pump (compressor) 106 the cryogenic CO₂ pressure becomes higher. Alternatively, the cryogenic CO₂ can go to the motor 107 input after the transfer pump 106 at the expense of lowering the capacity for the chilling purpose. The cryogenic CO₂ 38 that enters motor 107 chamber come in contact with the warm surface of the motor 107 chamber which has a high temperature maintained by the heat source 108 which can be just ambient heat. The cryogenic CO₂ volume expands together with pressure increase as its temperature rises.. Depending on the type of motor 107, the volume expansion or pressure increase causes the vanes or piston of the motor 107 to rotate and perform work 109. The work 109 can be turning a generator (not shown in the diagram) or other mechanical function. The CO₂ 38 becomes low pressure and warmer but still cold below water freezing point. It exhausts out into the cryogenic condenser 105 at exhaust input point 113. The exhausted CO₂ gets colder with increasing density by the cryogenic condenser 105 extra freezing temperature. The cryogenic CO₂ splits into two paths, one for chilling in the cryogenic condenser 105 and the other to motor 107 for performing work 109 and all return back before the transfer pump 106 to complete the closed loop cycle. The second stop valve 116 is used for starting or stopping the motor 107 operation.

[0079] Fig. 8 provides a third embodiment of the invention. The third embodiment comprises parts or objects that are similar or identical to those of other embodiments. The similar or identical parts or objects are labelled with similar or identical reference numerals. Description of the similar or identical parts of objects is hereby incorporated by reference wherever appropriate.

[0080] According to Fig. 8, a third ambient heat engine 120 comprises of a heat exchanger 110, an accumulator cylinder 102, a cryogenic condenser 105, a transfer pump 106 and another closed loop comprises the motor 107, a cryogenic condenser 105. A dry ice maker 104 is inside the cryogenic condenser 105. In a closed loop, the cryogenic CO₂ 38 feed into the motor 107 from the cryogenic condenser 105, and the exhausted CO₂ 38 from the motor 107 is returned to cryogenic condenser 105 via an input point 113. When the exhausted CO₂ 38

enters into the cryogenic condenser 105, it 38 gets colder and denser into cryogenic liquid where it is fed back to the motor 107. The input point 113 and output point 112 each has a check valve (not shown) to hold the CO₂ 38 inside the cryogenic condenser 105 when motor 107 is not operation. CO₂ 38 can only
5 circulate around motor 107 and cryogenic condenser 105 in one direction. The cryogenic condenser 105 is chilled by the high pressure CO₂ 39 discharged via point 11 to low pressure forming dry ice in the dry ice maker 104 with transfer pump 106 pumping back to high pressure forming another closed loop.

10 [0081] The heat source 108 comes directly from ambient heat. For producing a larger power by the motor 107, a high temperature reactor (not shown in the diagram) can be incorporated to reduce the size of heat exchanging surface of the motor 107. The high temperature reactor is be powered by HHO gas (i.e. oxyhydrogen as a mixture of hydrogen and oxygen gases) and use for gasification
15 of waste and create more heat energy. This is particular helpful for a very power generation and for area where the ambient temperature is too low for a generating a good power level.

[0082] The heat exchanger 110 in both ambient heat engines 100, 120 acts the
20 same as the high pressure heat exchanger 30. If the heat exchanger 110 can maintain enough high pressure CO₂ 39 for the closed loop cycle, accumulator cylinder 102 can be removed. The high pressure cryogenic CO₂ 38 before returning to the accumulator cylinder 102 passes through a heat exchanger 110 where its cold temperature is transferred out for other application. In the reactor,
25 HHO is generating on the spot and on-demand. The heat generated by the HHO generation is recovered as component of the heat source 108.

Claims

1. Ambient heat engine comprising:

- a high pressure heat exchanger for exchanging heat by using a fluid;
- an expander connected to the high pressure heat exchanger for receiving the fluid and reducing temperature of the fluid and;
- a hydraulic motor further connected to the expander for converting hydraulic pressure of the fluid to displacement;

wherein the high pressure heat exchanger, the expander, and the hydraulic motor are connected together serially in forming a closed loop for circulating the fluid inside the ambient heat exchanger.

2. Ambient heat engine of Claim 1 further comprising:

a low pressure heat exchanger that is connected between the hydraulic motor and the expander for heating the fluid.

3. Ambient heat engine of Claim 1 or 2, wherein

the fluid comprises carbon dioxide, ammonia or a combination of both.

4. Ambient heat engine of any of the preceding claims, wherein

the expander comprises a Joule–Thomson device having at least one throttle.

5. Ambient heat engine of any of the preceding claims, wherein

the expander comprises a pressure regulator.

6. Ambient heat engine of any of the preceding claims, wherein

the hydraulic motor comprises an rotary vane motor having a constant gap of plurality of radially movable vanes between inlet to outlet.

7. Ambient heat engine of any of the preceding claims, wherein
The rotary vane motor comprises a constant volume in the compartments
formed by the movable vanes between the inlet and outlet..
- 5 8. Ambient heat engine of claim 7, wherein
the rotary vane motor further comprises an inlet and an outlet that are
connected to opposite ends of the constant gap.
- 10 9. Ambient heat engine of any of the preceding Claim 6 to 8, wherein
at least one of the movable vanes comprises a biasing means for extending
the at least one of the movable vanes radially.
- 15 10. Ambient heat engine of Claim 9, wherein
the biasing means comprises a spring that is pushed against the at least
one of the movable vanes.
- 20 11. Ambient heat engine of Claim 10, wherein
the at least one of the movable vanes comprises a recessed bottom for
accommodating movement of the spring.
12. Ambient heat engine of any of the preceding claims,
the low pressure heat exchanger is configured to operate the fluid
substantially from 6 bar to 25 bar.
- 25 13. Ambient heat engine of any of the preceding claims,
the low pressure heat exchanger is configured to operate the fluid
substantially from zero degree Celsius or lower.
- 30 14. Ambient heat engine of any preceding claims, wherein
The ambient heat engine is configured to provide freshwater by condensing,
chilling or freezing.

15. Ambient heat engine of any of the preceding claims,
the high pressure heat exchanger is configured to operate the fluid
substantially from 50 bar or higher.
- 5 16. Ambient heat engine of any of the preceding claims comprising
a non-return valve that is connected to the hydraulic motor for preventing
backflow of the fluid.
- 10 17. Ambient heat engine of any of the preceding claims comprising
a block housing with a plurality of non-return valves integrated in the block
housing.
- 15 18. Ambient heat engine of any of the preceding claims comprising
At least one non-return valve that is connected to the low pressure heat
exchanger, the high pressure heat exchanger, the expander or a
combination of any of these for directing flow of the fluid.
- 20 19. Ambient heat engine of any of the preceding claims further comprising
a ratchet and pawl device that is connected to the hydraulic motor for
preventing backward rotation.
- 25 20. Method of using an ambient heat engine comprising:
– reducing temperature of a heat transfer fluid to be lower than ambient
temperature of the ambient heat engine;
– absorbing heat by the heat transfer fluid from ambient environment of
the ambient heat engine; and
– converting at least a portion of absorbed ambient heat to
displacement as output.
- 30 21. Method of Claim 20 further comprising:
increasing temperature of the heat transfer fluid after the converting the at
least a portion of the absorbed heat to displacement as output.

22. Method of Claim 21, wherein
the increasing temperature of the heat transfer fluid comprises absorbing
thermal energy by the heat transfer fluid from the ambient environment.
- 5 23. Method of any of the preceding Claims 20 to 22 further comprising:
preventing backflow of the heat transfer fluid.
24. Method of any of the preceding Claims 20 to 23 further comprising
regulating pressure of the heat transfer fluid for controlling its temperature to
10 be lower than the ambient temperature.
25. Ambient heat engine comprising:
- a motor receiving a liquid work medium and expands to perform
work and exhaust to a cryogenic condenser where work medium is
15 chilled back to higher density and deliver back to motor, and
 - a compressor connects to the cryogenic condenser for receiving and
compressing a working medium to higher pressure and delivers the
working medium to the cryogenic condenser,
20 wherein the cryogenic working medium is configured to be circulated
around the motor, cryogenic condenser and the compressor in
forming a closed loop.
26. Ambient heat engine of Claim 25 further comprising
a working medium that comprises carbon dioxide, ammonia or a
25 combination of both.
27. Ambient heat engine of Claim 25 or 26, wherein
the motor comprises a rotary device that is configured to produce
mechanical movement.
- 30 28. Ambient heat engine of Claim 27 further comprising
An electric generator that is connected to the motor for converting the
mechanical movement into electricity.

29. Ambient heat engine of any of the preceding Claims 25 to 28, wherein the motor comprises an accumulator cylinder for collecting the working medium.

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30. Ambient heat engine of any of the preceding Claims 25 to 29, wherein the motor further comprises a compressor, a reciprocate engine or both.

31. Ambient heat engine of Claim 30, wherein
10 the reciprocate engine comprises a piston for achieving reciprocating movement with a chamber of the reciprocate engine.

32. Ambient heat engine of Claim 30 or 31, wherein
15 the reciprocate engine comprises a control valve that is configured to cooperate with the piston for injecting or discharging the working medium into or from the chamber.

33. Ambient heat engine of Claim 31 or 32, wherein
20 the reciprocate engine further comprises a cam connected to the piston for activating the control valve.

34. Ambient heat engine of any of the preceding Claims 25 to 33, wherein the at least one heat exchanger having direct contact with the motor comprises parts that are exposed to ambient for absorbing ambient heat.

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35. Ambient heat engine of any of the preceding Claims 25 to 34, wherein the at least one heat exchanger comprises a reactor that is configured to disassociate feedstock into gases.

30 36. Ambient heat engine of Claim 35, wherein
The reactor comprises electrodes for generating HHO gas.

37. Ambient heat engine of Claim 35 or 36, wherein
the reactor comprises a burner of high refractory index, a high melting point
or both.
- 5 38. Ambient heat engine of Claim 37, wherein
The burner comprises spiral passages for conveying the feedstock in fluidic
form.
- 10 39. Ambient heat engine of any of the preceding Claims 25 to 38, wherein
The at least one heat exchanger comprises a freezer module for chilling
water or forming ice.