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A THERMO-VOLUMETRIC MOTOR**FIELD OF THE INVENTION**

The present invention relates generally to a thermo-volumetric motor and relates particularly, though not
5 exclusively, to a thermo-volumetric motor which is activated by a phase change substance having a relatively high latent heat of fusion. Typically, the phase change substance is a hydrate salt which is heated from an external heat source, such as sunlight. The present
10 invention further relates generally to a method for producing motive power.

BACKGROUND TO THE INVENTION

Motive power can be produced in a variety of known ways. For example, turbines in a hydro-electric plant are driven
15 by water and each turbine is operatively connected to a generator which produces electricity. The motive power is produced by the flow of water within a turbine. A steam engine produces motive power by boiling water to create steam which then drives a piston in a reciprocating motion
20 within a cylinder. The reciprocating motion can then be adapted to produce rotary motion for driving a vehicle, or alternatively driving a generator to produce electricity.

Hydro-electricity has environmental drawbacks. For example, the flow of water from a lake can detrimentally
25 affect the ecosystem in and around the lake. To this extent the water is a limited resource.

The production of steam from water requires heat and generally combustion. Combustion results in both combustion products, such as carbon dioxide, and unburnt
30 fuel which are harmful to the environment. The treatment of these harmful products can be expensive and processes which scrub an exhaust gas or promote complete combustion of unburnt fuel are rarely totally efficient. This is an

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inherent problem with most combustion engines.

Another drawback with a large number of engines or motors is their efficiency. The energy input relative to the power output is relatively large due to losses associated with friction, heat and pressure losses, incomplete combustion, and other similar factors. Particularly with geared motors frictional losses can substantially detract from the overall efficiency of the motor. With combustion engines pressure losses which generally increase with the age of the motor are also a problem and often require complex and expensive mechanical sealing.

SUMMARY OF THE INVENTION

An intention of the present invention is to provide a thermo-volumetric motor which can produce motive power both efficiently and environmentally safely.

According to a first aspect of the present invention there is provided a thermo-volumetric motor comprising:

a continuous fluid path adapted to carry a substantially compressible fluid, said continuous fluid path having heat transfer means and flow converting means in fluid communication with each other, said flow converting means being adapted to convert a flow of the compressible fluid in the fluid path to a motive power and said heat transfer means containing a first phase change substance having a relatively high latent heat of fusion and adapted to absorb heat from an external heat source whereby, in use, the first phase change substance can absorb heat from the external heat source thus fusing a portion of said phase change substance, and thereafter said portion of the phase change substance can solidify thus releasing latent heat which is absorbed by the compressible fluid thereby expanding and thus effecting a flow of the compressible fluid through the flow converting means to provide motive power.

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Typically, the continuous fluid path further comprises cooling means in fluid communication with the heat transfer means and the flow converting means so that the compressible fluid can be cooled by the cooling means before said compressible fluid is heated by the heat transfer means.

Preferably, the continuous fluid path further comprises a pump operatively coupled to the flow converting means and in fluid communication with the heat transfer means, the flow converting means, and the cooling means whereby, in use, movement of the flow converting means drives the pump thereby pumping the compressible fluid through the continuous fluid path.

Typically, the cooling means is a first accumulator containing a second phase change substance having a relatively high latent heat of fusion and a relatively low melting-point whereby, in use, heat from the compressible fluid can be absorbed by the second phase change substance thus fusing a portion of said phase change substance which cools the compressible fluid passing through the cooling means.

Typically, the thermo-volumetric motor further comprises a collector adapted to absorb heat from the external heat source, the collector being in heat conductive communication with the heat transfer means so that, in use, heat absorbed by the collector can be transferred to the first phase change substance contained in the heat transfer means wherein a portion of the phase change substance fuses.

Typically, the flow converting means comprises:
a chamber adapted to receive the compressible fluid and in fluid communication with the heat transfer means; and

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a flow structure movably coupled to the chamber wherein the flow of compressible fluid in the chamber forces the flow structure to move so as to provide motive power.

5 Preferably, the flow structure comprises a pair of axially spaced apart rotors connected to a shaft wherein the flow converting means comprises a turbine in fluid communication with the heat transfer means. Typically, the pair of spaced apart rotors defines a substantially sealed portion
10 of the chamber therebetween such that, in use, the compressible fluid is injected into said portion of the chamber, and said compressible fluid frictionally engages and thus rotates the rotors.

Alternatively, the flow converting means comprises:

15 a resilient tube adapted to carry the compressible fluid and in fluid communication with the heat transfer means; and

engaging means configured to operatively engage the flexible tube wherein the flow of compressible fluid
20 through the flexible tube moves the engaging means so as to provide motive power.

In one embodiment, the engaging means comprises a rotational structure having at least one roller coupled to a coaxial shaft so that, in use, said at least one roller
25 can engage the flexible tube and the flow of compressible fluid through the flexible tube causes said at least one roller to move and rotate the rotational structure which can then provide motive power.

Preferably, said rotational structure has more than one
30 roller rotationally coupled to and disposed about the coaxial shaft so that, in use, at least one of said rollers engages the resilient tube at any one time wherein the flow of compressible fluid through the flexible tube ensures

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rotation of the rotational structure at all times.

In an alternative embodiment, the engaging means comprises a pair of rotational structures connected by a common coaxial shaft, each rotational structure having at least one roller used to engage a flexible tube of a pair of flexible tubes, respectively, wherein at least one of said rollers engages one of said flexible tubes at any one time.

Typically, the heat transfer means comprises:

a first tube adapted to carry the compressible fluid through the heat transfer means; and

a shell surrounding a portion of the first tube, said shell containing the first phase change substance which is in contact with the first tube whereby, in use, latent heat can be transferred from the first phase change substance to the compressible fluid via the first tube of the heat transfer means.

Typically, the heat transfer means further comprises a jacket surrounding the shell and adapted to carry a heat transfer fluid whereby, in use, heat from the heat transfer fluid can be transferred to the first phase change substance thereby melting the first phase change substance and storing latent heat.

In one example, the jacket is in fluid communication with the collector wherein heat absorbed by the collector can be transferred to the first phase change substance via the heat transfer fluid.

In another embodiment the heat transfer means further comprises a second accumulator containing a third phase change substance having a relatively high latent heat of fusion, said second accumulator in heat conductive communication with the collector and in fluid communication with the jacket, so that, in use, the heat transfer fluid

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can be preheated by the latent heat of the third phase change substance before said heat transfer fluid flows to the jacket.

According to a second aspect of the present invention there is provided a method for producing motive power comprising the steps of:

5 absorbing heat, from an external heat source, on a first phase change substance contained in heat transfer means wherein a portion of the first phase change substance fuses, said first phase change substance having a
10 relatively high latent heat of fusion;

 transferring latent heat from said portion of the first phase change substance, upon solidification thereof, to a compressible fluid provided in a continuous fluid path
15 thereby expanding the compressible fluid and effecting a flow of the compressible fluid in the fluid path; and

 converting the flow of compressible fluid through the fluid path so as to produce motive power.

Preferably, the method further comprises the step of
20 cooling the compressible fluid and returning said compressible fluid to the heat transfer means.

Typically, the step of cooling the compressible fluid involves absorbing heat from the compressible fluid by exchanging heat with a second phase change substance,
25 having a relatively high latent heat of fusion and a relatively low melting-point, wherein the compressible fluid is cooled.

Typically, the method further comprises the step of driving a pump operatively coupled to the flow converting means
30 wherein compressible fluid is pumped to the heat transfer means using the pump.

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Preferably, the method further comprises the step of absorbing heat from the external heat source onto a collector which is in heat conductive communication with the heat transfer means, wherein absorbed heat can be transferred from the collector to the first phase change substance of the heat transfer means.

In one example the method further comprises the step of preheating a heat transfer fluid circulating between the heat transfer means and an accumulator containing a third phase change substance having a relatively high latent heat of fusion, wherein the preheated heat transfer fluid can transfer heat to the first phase change substance of the heat transfer means.

Typically the first, second and/or third phase change substances are first, second and/or third hydrate salts respectively, each having a high latent heat of fusion.

Preferably the first hydrate salt and the third hydrate salt each have a melting-point of between 0°C to 100°C.

Preferably the first hydrate salt and the third hydrate salt each have a latent heat of fusion of greater than 50 kilocalories/litre (kcal/l).

In one example the first hydrate salt and the third hydrate salt comprises sodium acetate trihydrate or a derivative thereof.

Preferably, the second hydrate salt has a melting-point of less than 0°C.

In one example the second hydrate salt comprises of a stoichiometric mixture of sodium chloride, calcium chloride, and demineralised water or a derivative thereof.

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Typically, the compressible fluid comprises a refrigerant such as methane, chloro-difluoro or a derivative thereof.

Typically, the collector is a solar collector adapted to absorb sunlight.

- 5 Preferably, the refrigerant does not contain a halogen element.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to achieve a better understanding of the nature of the present invention a preferred embodiment of a thermo-volumetric motor according to the present invention will
10 now be described in some detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic of an embodiment of a thermo-volumetric motor;

15 Figure 2 is a cross-sectional view taken axially through one embodiment of flow converting means;

Figure 3 is a detailed plan view of an alternative embodiment of flow converting means; and

20 Figure 4 is a detailed perspective view of some of the components of the flow converting means shown in Figure 3.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in Figure 1, this embodiment of a thermo-volumetric motor 10 comprises a continuous fluid path in the form of a refrigerant path 12, and a solar collector 14. The refrigerant path 12 is adapted to carry a refrigerant fluid in this example methane, chloro-difluoro or a derivative thereof. However, it is preferable for environmental reasons that the refrigerant is not a
25 halogenated hydrocarbon.
30

The continuous refrigerant path 12 includes heat transfer means, in this example a first heat exchanger 16, flow

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converting means shown generally as 18, a pump 19, and cooling means, in this example a first accumulator or condenser 20. In a downstream direction the refrigerant can flow through the flow converting means 18, the
5 condenser 20, the pump 19 and the first heat exchanger 16. A throttle valve 21 is located upstream of the flow converting means 18 to control flow thereto.

The first heat exchanger 16 comprises a shell and tube arrangement (not shown) wherein the refrigerant is passed
10 through a first tube formed in the shape of a triple-helix. The shell contains a first phase change substance, in this example a first hydrate salt sodium acetate trihydrate, having a relatively high latent heat of fusion and a melting-point of approximately 58°C. The first heat
15 exchanger 16 is housed in a sealed jacket 22 surrounding the shell and adapted to carry a heat transfer fluid, in this example water. The jacket 22 has an inlet 24 for receiving water, and an outlet 26 for discharging water.

The first heat exchanger 16 further includes a second
20 accumulator 28 containing a third phase change substance. In this example the third phase change substance is a third hydrate salt, sodium acetate trihydrate. The third hydrate salt is contained within a vessel 30, the vessel 30 being coupled to the jacket 22 of the first heat exchanger 16 via
25 a first recirculation tube 32 adapted to circulate the heat transfer fluid, in this example water. The vessel 30 is similarly coupled to the solar collector 14 via a second recirculation tube 34 adapted to circulate water.

In this embodiment the solar collector 14 has an upper
30 surface (not shown) exposed to sunlight, the upper surface constructed of a material having relatively low reflectivity and radiation. The upper surface is coated with a composite bitumen/latex product marketed and sold under a trade mark IMPERSPRAY. The collector 14 has a base

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layer constructed of a high density polystyrene material having relatively high thermal insulation. The coating of IMPERSPRAY covers an upper surface of the base layer. A corrugated sheet, constructed of a polycarbonate material being substantially transparent to sunlight, rests on the coating of IMPERSPRAY. A series of adjacent channels are thus defined between a lower surface of the corrugated sheet and the coating of IMPERSPRAY. It is believed that a greenhouse heating effect occurs in the adjacent channels such that the efficiency of the collector 14 is increased.

The water circulating through the second recirculation tube 34 flows through a corrugated tube (not shown) connected at each end thereof to the recirculation tube 34. The corrugated tube is laid in a serpentine arrangement immediately adjacent the upper surface of the solar collector 14.

Heat from sunlight absorbed on the solar collector 14 is transferred to the third hydrate salt contained in the second accumulator 28 via the water circulating through the second recirculation tube 34. The first hydrate salt contained in the shell is then heated via the water circulating between the second accumulator 28 and the jacket 22 of the first heat exchanger 16.

The condenser 20 can take a variety of forms. In this embodiment the condenser 20 comprises a refrigerant tube (not shown) formed in the shape of a helix, the tube housed in a shell 36 of the condenser 20. The shell 36 contains a second phase change substance, in this embodiment a second hydrate salt being a stoichiometric mixture of sodium chloride, calcium chloride, and demineralised water or a derivative of such a mixture. The second hydrate salt has a relatively high latent heat of fusion and a relatively low melting-point, in this example approximately -21°C .

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The pump 19 is operatively coupled to the flow converting means 18 via an endless belt (not shown). Alternatively, the pump 19 can be driven by electricity produced from an electrical generator operatively coupled to the flow converting means 18. Rotation of the flow converting means 18 thus causes the pump 19 to rotate and pump refrigerant through the refrigerant path 12. The pump 19, in this example, is of a positive displacement type. Advantageously refrigerant can only flow in one direction through the positive displacement pump 19.

The throttle valve 21 is used to control flow of refrigerant to the flow converting means 18. The valve 21 is manually controlled such that there is an upstream pressure of approximately 15 Bar and a downstream pressure of approximately 8 Bar, depending largely on the rotational or linear speed required of the flow converting means 18. This pressure differential will also depend on the compressible fluid used, the first phase change substance used, and other related factors.

The flow converting means 18 can take a variety of configurations.

In one preferred embodiment, as shown in Figure 2, the flow converting means comprises a sealed turbine shown generally as 40. The sealed turbine 40 has a coaxial shaft 42 rotationally mounted within a shaft housing 44 via a pair of bearings 46. At one end the shaft 42 is axially fixed to a pair of rotors 48A, 48B. A nut 50 threadingly engages the end of the shaft 42 and fixes the pair of rotors 48A, 48B to the shaft 42 with a spacer 50 located therebetween. The rotors 48a, 48B are housed in a turbine casing 54 which is connected to the shaft housing 44.

An opposing pair of seals 56A, 56B is located within the turbine casing 54, disposed about the shaft 42 to prevent

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the ingress of refrigerant into and egress of lubricant from the shaft housing 44. A pair of seal retainers 58A, 58B also locates within the turbine casing 54 about the shaft 42 so as to hold each of the seals 56A, 56B in place.

5 A similar seal arrangement is used at the opposite end of the shaft 42 to prevent the egress of lubricant from the shaft housing 44.

A turbine casing cover 60 connects to the turbine casing 54 and seals the pair of rotors 48A, 48B within the casing 54.

10 A housing end plate 62 connects to the shaft housing 44 and retains the seal arrangement at the opposite end of the shaft 42. A nozzle (not shown) is connected to the turbine casing 54 and is designed to inject refrigerant into a substantially sealed chamber 61 defined between the rotors

15 48A, 48B.

As shown in Figures 3 and 4 an alternative embodiment of the flow converting means 18 comprises a resilient tube 138 and engaging means, in this example a rotational structure or rotor 140. The resilient tube 138 is coupled at each

20 end to a housing 142. The housing 142 is substantially cylindrical in shape. The tube 138 is adapted to carry the refrigerant and is in fluid communication with the first heat exchanger 16.

The rotor 140 comprises a coaxial shaft 144 connected to a

25 pair of axially spaced triangular-shaped plates 146. A roller 148 is rotationally coupled between opposing apexes of the pair of plates 146. Three rollers 148A, 148B, 148C are thus disposed about the pair of plates 146 with an angle of approximately 120° between adjacent rollers 148.

30 The axis of rotation of each roller 148 is substantially parallel to the axis of the coaxial shaft 144.

The rotor 140 is rotationally supported in the housing 142 so that at least one of the rollers 148 contacts and

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resiliently deforms the resilient tube 138. A flow of refrigerant through the tube 138 forces the roller 148 to move relative to the housing 142 and hence a motive force is applied to the rotor 140. The coaxial shaft 144 can be
5 connected to a pulley (not shown), the pulley operatively coupled to the pump 19 via the endless belt. The rotor 140 can be used to provide motive power, for example, to drive a generator (not shown) and produce electricity.

Operation of the thermo-volumetric motor 10 exemplified
10 above will now be described in detail.

The solar collector 14 is exposed to sunlight and the upper IMPERSPRAY surface absorbs heat from the sunlight. Water in the corrugated tube, connected to the second recirculation tube 34, is thus heated and heat therefrom
15 transferred to the third hydrate salt sodium acetate trihydrate, contained within the vessel 30 of the second accumulator 28. When the third hydrate salt fuses latent heat is stored in the second accumulator 28.

Water recirculating through the first recirculation tube 32
20 cools the third hydrate salt and, upon solidification of the hydrate salt, absorbs heat in the form of latent heat. The heated water then exchanges heat with the first hydrate salt contained in the shell of the first heat exchanger 16. A portion of the first hydrate salt then fuses and stores
25 latent heat.

The refrigerant path 12 has been charged with the refrigerant fluid, in this example methane, chloro-difluoro. The refrigerant in the first tube of the heat exchanger 16 cools the first hydrate salt causing it to
30 solidify and the refrigerant then absorbs the latent heat of the first hydrate salt. The refrigerant thereby expands and a flow of refrigerant through the refrigerant path 12 is effected. The pump 19 upstream of the heat exchanger 16

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is unidirectional, as described above, and therefore the refrigerant flows from the heat exchanger 16 to the flow converting means 18.

5 In the preferred form of the flow converting means illustrated in figure 2 the refrigerant is injected into the sealed chamber 61 between the rotors 48A, 48B via the nozzle (not shown). The refrigerant frictionally engages the rotors 48A, 48B and thus effects rotation of the rotors 48A, 48B and the coaxial shaft 42.

10 In the alternative form of the flow converting means depicted in figures 3 and 4 the refrigerant is injected into the resilient tube 138. The flow of refrigerant through the resilient tube 138 forces one of the rollers 148 to move relative to the housing 142. The shaft 144 of
15 the rotor 140 is thus rotated. As best shown in Figure 3 the rollers 148 and tube 138 are arranged such that at least one roller 148 presses against or engages the tube 138 at any one time. Hence, the transfer of motive power to rotor 140 is maintained substantially continuously
20 during rotation of the rotor 140.

The pump 19 is operatively coupled to the shaft 42 or 144 and also rotates thereby pumping refrigerant through the refrigerant path 12.

25 The throttle valve 21 is adjusted so that a selected flow of refrigerant passes through the flow converting means 18. This will vary depending on the factors described above.

Refrigerant then flows to the condenser 20 through an enlarged diameter tube wherein the refrigerant expands and cools. The refrigerant is at this stage at a temperature
30 greater than the melting-point of the second hydrate salt. Consequently the refrigerant transfers heat to the second hydrate salt fusing the salt, and therefore the refrigerant

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cools and preferably changes phase from a gas to a liquid. The liquid refrigerant is then pumped via the pump 19 to the first heat exchanger 16. The liquid refrigerant absorbs heat from the first hydrate salt and upon
5 solidification of the salt is heated, changing phase back to a gas, and expands. The expanded refrigerant gas thereafter flows to the flow converting means 18 via the throttle valve 21 thus providing motive power.

Now that preferred embodiments of the present invention
10 have been described it will be apparent to persons skilled in the relevant arts that the thermo-volumetric motor has the following advantages over the admitted prior art:

- (1) the thermo-volumetric motor has no environmentally unsafe combustion products;
- 15 (2) the thermo-volumetric motor can be adapted to utilise heat from sunlight absorbed on a solar collector;
- (3) the thermo-volumetric motor uses phase change substances to store energy in the form of latent heat which can then be used to provide motive power;
- 20 (4) the thermo-volumetric motor can be adapted to use energy such as solar or waste energy which is generally not a limited resource such as, for example, is the case with mineral fuels;
- (5) the thermo-volumetric motor is cold running and
25 therefore does not require cooling which may detract from its efficiency; and,
- (6) the thermo-volumetric motor operates without combustion noise.

It will be apparent to persons skilled in the relevant arts
30 that numerous variations and modifications can be made to the thermo-volumetric motor and method for providing motive power in addition to those already mentioned without departing from the basic inventive concepts of the present invention. For example, the flow converting means may
35 comprise a turbine means which is adapted to be driven by

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the compressed fluid wherein motive power is provided. The invention is not limited to the phase change substances herein described but rather may include any phase change substance which can exchange latent heat with a compressed fluid as described above. Furthermore, the first heat exchanger need not include a second accumulator as described. The second accumulator in the example described advantageously provides for a large storage bank of latent heat when, for example, heat cannot be provided to fuse or charge the phase change substance. The heat transfer means and the condenser described herein are not limited to those specific arrangements described. All such variations and modifications are to be considered within the scope of the present invention the nature of which is to be determined from the foregoing description.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A thermo-volumetric motor comprising:
a continuous fluid path adapted to carry a substantially compressible fluid, said continuous fluid path having heat transfer means and flow converting means in fluid communication with each other, said flow converting means being adapted to convert a flow of the compressible fluid in the fluid path to a motive power and said heat transfer means containing a first phase change substance having a relatively high latent heat of fusion and adapted to absorb heat from an external heat source whereby, in use, the first phase change substance can absorb heat from the external heat source thus fusing a portion of said phase change substance, and thereafter said portion of the phase change substance can solidify thus releasing latent heat which is absorbed by the compressible fluid thereby expanding and thus effecting a flow of the compressible fluid through the flow converting means to provide motive power.
2. A thermo-volumetric motor as defined in claim 1 further comprising cooling means in fluid communication with the heat transfer means and the flow converting means so that the compressible fluid can be cooled by the cooling means before said compressible fluid is heated by the heat transfer means.
3. A thermo-volumetric motor as defined in claim 2 further comprising a pump operatively coupled to the flow converting means and in fluid communication with the heat transfer means, the flow converting means, and the cooling means whereby, in use, movement of the flow converting means drives the pump thereby pumping the compressible fluid through the continuous fluid path.



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4. A thermo-volumetric motor as defined in either claim 2 or 3 wherein the cooling means is a first accumulator containing a second phase change substance having a relatively high latent heat of fusion and a
5 relatively low melting-point whereby, in use, heat from the compressible fluid can be absorbed by the second phase change substance thus fusing a portion of said phase change substance which cools.

10 5. A thermo-volumetric motor as defined in any one of the preceding claims further comprising a collector adapted to absorb heat from the external heat source, the collector being in heat conductive communication with the heat transfer means so that, in use, heat absorbed by the collector can be transferred to the first phase change
15 substance contained in the heat transfer means wherein a portion of the phase change substance fuses.

6. A thermo-volumetric motor as defined in any one of the preceding claims wherein the flow converting means comprises:

20 a chamber adapted to receive the compressible fluid and in fluid communication with the heat transfer means; and

a flow structure movably coupled to the chamber wherein the flow of compressible fluid in the chamber
25 forces the flow structure to move so as to provide motive power.

7. A thermo-volumetric motor as defined in claim 6 wherein the flow structure comprises a pair of axially spaced apart rotors connected to a shaft wherein the flow
30 converting means comprises a turbine in fluid communication with the heat transfer means.

8. A thermo-volumetric motor as defined in claim 7 wherein the pair of spaced apart rotors define a



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substantially sealed portion of the chamber therebetween such that, in use, the compressible fluid is injected into said portion of the chamber, and said compressible fluid frictionally engages and thus rotates the rotors.

5 9. A thermo-volumetric motor as defined in any one of claims 1 to 5 wherein the flow converting means comprises:

10 a resilient tube adapted to carry the compressible fluid and in fluid communication with the heat transfer means; and

engaging means configured to operatively engage the flexible tube wherein the flow of compressible fluid through the flexible tube moves the engaging means so as to provide motive power.

15 10. A thermo-volumetric motor as defined in claim 9 wherein the engaging means comprises a rotational structure having at least one roller coupled to a coaxial shaft so that, in use, said at least one roller can engage the flexible tube and the flow of compressible fluid through
20 the flexible tube causes said at least one roller to move and rotate the rotational structure which can then provide motive power.

11. A thermo-volumetric motor as defined in claim 10 wherein said rotational structure has more than one roller
25 rotationally coupled to and disposed about the coaxial shaft so that, in use, at least one of said rollers engages the resilient tube at any one time wherein the flow of compressible fluid through the flexible tube ensures rotation of the rotational structure at all times.

30 12. A thermo-volumetric motor as defined in claim 9 wherein the engaging means comprises a pair of rotational structures connected by a common coaxial shaft, each rotational structure having at least one roller used to



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engage a flexible tube of a pair of flexible tubes, respectively, wherein at least one of said rollers engages one of said flexible tubes at any one time.

13. A thermo-volumetric motor as defined in any one
5 of the preceding claims wherein the heat transfer means comprises:

a first tube adapted to carry the compressible fluid through the heat transfer means; and

10 a shell surrounding a portion of the first tube, said shell containing the first phase change substance which is in contact with the first tube whereby, in use, latent heat can be transferred from the first phase change substance to the compressible fluid via the first tube of the heat transfer means.

15 14. A thermo-volumetric motor as defined in claim 13 wherein the heat transfer means further comprises a jacket surrounding the shell and adapted to carry a heat transfer fluid whereby, in use, heat from the heat transfer fluid can be transferred to the first phase change substance
20 thereby melting the first phase change substance and storing latent heat.

15. A thermo-volumetric motor as defined in claim 14 wherein the jacket is in fluid communication with the collector wherein heat absorbed by the collector can be
25 transferred to the first phase change substance via the heat transfer fluid.

16. A thermo-volumetric motor as defined in claim 15 wherein the heat transfer means further comprises a second accumulator containing a third phase change substance
30 having a relatively high latent heat of fusion, said second accumulator in heat conductive communication with the collector and in fluid communication with the jacket, so that, in use, the heat transfer fluid can be preheated by



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the latent heat of the third phase change substance before said heat transfer fluid flows to the jacket.

17. A method for producing motive power comprising the steps of:

5 absorbing heat, from an external heat source, on a first phase change substance contained in heat transfer means wherein a portion of the first phase change substance fuses, said first phase change substance having a relatively high latent heat of fusion;

10 transferring latent heat from said portion of the first phase change substance, upon solidification thereof, to a compressible fluid provided in a continuous fluid path thereby expanding the compressible fluid and effecting a flow of the compressible fluid in the fluid path; and

15 converting the flow of compressible fluid through the fluid path so as to produce motive power.

18. A method for producing motive power as defined in claim 17 further comprising the step of cooling the compressible fluid and returning said compressible fluid to
20 the heat transfer means.

19. A method for producing motive power as defined in claim 18 wherein the step of cooling the compressible fluid involves absorbing heat from the compressible fluid by exchanging heat with a second phase change substance,
25 having a relatively high latent heat of fusion and a relatively low melting-point, wherein the compressible fluid is cooled.

20. A method for producing motive power as defined in any one of claims 17 or 19 further comprising the step of
30 driving a pump operatively coupled to the flow converting means wherein compressible fluid is pumped to the heat transfer means using the pump.



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21. A method for producing motive power as defined in any one of claims 17 to 20 further comprising the step of absorbing heat from the external heat source onto a collector which is in heat conductive communication with the heat transfer means, wherein absorbed heat can be transferred from the collector to the first phase change substance of the heat transfer means.
22. A thermo-volumetric motor as defined in any one of claims 17 to 21 further comprising the step of preheating a heat transfer fluid circulating between the heat transfer means and an accumulator containing a third phase change substance having a relatively high latent heat of fusion, wherein the preheated heat transfer fluid can transfer heat to the first phase change substance of the heat transfer means.
23. A thermo-volumetric motor or a method for producing motive power as defined in any one of the preceding claims wherein the first, second and/or third phase change substances are first, second and/or third hydrate salts respectively, each having a high latent heat of fusion.
24. A thermo-volumetric motor or a method for producing motive power as defined in claim 23 wherein the first hydrate salt and the third hydrate salt each have a melting-point of between 0°C to 100°C.
25. A thermo-volumetric motor or a method for producing motive power as defined in claim 23 wherein the first hydrate salt and the third hydrate salt each have a latent heat of fusion of greater than 50 kilocalories/litre (kcal/l).
26. A thermo-volumetric motor or a method for producing motive power as defined in claim 23 wherein the



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first hydrate salt and the third hydrate salt comprises sodium acetate trihydrate or a derivative thereof.

27. A thermo-volumetric motor or a method for producing motive power as defined in claim 23 wherein the
5 second hydrate salt has a melting-point of less than 0°C.

28. A thermo-volumetric motor or a method for producing motive power as defined in claim 23 wherein the second hydrate salt comprises of a stoichiometric mixture of sodium chloride, calcium chloride, and demineralised
10 water or a derivative thereof.

29. A thermo-volumetric motor or a method for producing motive power as defined in any one of the preceding claims wherein the compressible fluid comprises a refrigerant such as methane, chloro-difluoro or a
15 derivative thereof