(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 426 905 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.08.2021 Bulletin 2021/31

(21) Application number: **17763658.6**

(22) Date of filing: **07.03.2017**

(51) Int Cl.:
F02G 1/044 *(2006.01)* ***F01K 27/00*** *(2006.01)*

(86) International application number:
PCT/SE2017/050209

(87) International publication number:
WO 2017/155452 (14.09.2017 Gazette 2017/37)

(54) STIRLING ENGINE TYPE ENERGY GENERATING SYSTEM

STIRLINGMOTOR-ENERGIEERZEUGUNGSSYSTEM

SYSTÈME DE GÉNÉRATION D’ÉNERGIE DU TYPE À MOTEUR STIRLING

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **07.03.2016 SE 1650297**

(43) Date of publication of application:
16.01.2019 Bulletin 2019/03

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Description

Technical field

[0001] The present invention relates generally to an energy generating system for generating energy from temperature differences of fluids.

Background art

[0002] It is known to use energy generating system for generating energy from temperature differences. US2007/186553 shows a thermo-driven engine including cylinders each cylinder containing an air chamber and a hydraulic chamber with a piston disposed between the chambers, and at least one hydraulic motor. US2006/059912 shows a power plant with at least two pressure vessels containing a hydraulic fluid and a heat exchanging assembly being in heat transferring association with the pressure vessels. US2008/307785 shows a system for driving a turbine, comprising two chambers each having a piston dividing each chamber into two enclosures, a conduit defining a fluid flow path between the two chambers and a turbine arranged in the conduit.

[0003] A drawback of known solutions is their limited ability and feasibility to sufficiently capture surplus of energy in temperature intervals for instance provided by waste heat in industrial processes or natural temperature difference in the environment.

Summary of invention

[0004] An object of the present invention is to alleviate some of the disadvantages of the prior art and to provide an energy generating system which transforms low temperature energy to kinetic energy based on temperature differences. A further object of the present invention is to provide an energy generating system which transforms energy from temperature differences wherein the warm side of the temperature difference exist below zero degrees Celsius. A further object of the present invention is to provide an energy generating system having a modular design adaptable to need and requirements.

[0005] According to one embodiment of the invention, an energy generating system is provided, as defined in claim 1.

[0006] According to one embodiment, the second and fourth variable spaces of the main piston system, via the fluid lines are in fluid connection with a first cylinder of the further piston system via a valve device, and wherein the second and fourth variable spaces of the main piston system, via the fluid lines are in fluid connection with a second cylinder of the further piston system via a valve device, wherein the valve devices are controlled by a valve control unit.

[0007] According to one embodiment, the first cylinder of the further piston system comprises a reciprocatable piston, sealably dividing the cylinder into a first and second variable space, wherein the first space comprises a fluid medium, and the second space comprises a fluid medium, wherein the second cylinder of the further piston system comprises a reciprocatable piston, sealably dividing the second cylinder into a third and fourth variable space, wherein the third space comprises a fluid medium, and the fourth space comprises a fluid medium, wherein the second space is in fluid connection with the fourth space, wherein the second and fourth variable spaces of the main piston system, via the fluid lines, are in fluid connection with the first and third variable spaces of the further piston system.

[0008] According to one embodiment, the second and fourth spaces of the main piston system are in fluid connection with a plurality of further pistons systems, comprising at least a first and second further piston system, in a similar arrangement as described in claims 2-4.

[0009] According to one embodiment, a movement cycle of the reciprocation of the pistons of the further piston system is time shifted in relation to the cycle time of at least one of the plurality of further piston systems.

[0010] According to one embodiment, the energy generating system further comprising a second main piston system similar to the first piston system wherein the second main piston system is arranged to the further piston system according to claims 2-4, whereby the first and second energy transfer devices of the second main piston system transfer the kinetic energy from the reciprocating movement of the reciprocatable pistons to the energy generating device arranged for being in an energy-transfer connection to the first and second reciprocatable pistons, wherein a movement cycle of the reciprocation of the pistons of the second main piston system is time shifted in relation to the movement cycle of the pistons of the first main piston system.

[0011] According to one embodiment, the energy generating system further comprising a second main piston system similar to the first main piston system according to any of the embodiments described herein, wherein the second main piston system is arranged to the second further piston system, according to any of the embodiments described herein, wherein a movement cycle of the reciprocation of the pistons of the second main piston system is time shifted in relation to the movement cycle of the pistons of the first main piston system.

[0012] According to one embodiment, a preload cylinder, similar to the first cylinder of the further piston system as described in any of the embodiments herein, is arranged in fluid connection with the second space and the fourth variable space of the first cylinder of the further piston system for generating a preload to the fluid of the second space and the fourth variable space.

[0013] According to one embodiment, the first energy transfer device is connected to the first reciprocatable piston, and the second energy transfer device is connected to the second reciprocatable piston, wherein the second space is in fluid connection with the fourth space, whereby during expansion movement of the first piston the fluid medium is forced out of the second space into the fourth space aiding a compression movement of the second piston so that the third space is decreased, and whereby during expansion movement of the second piston the fluid medium is forced out of the fourth space into the second space aiding a compression movement of the first piston so that the first space is decreased.

[0014] According to one embodiment, the first heat exchanging system comprises a first heat exchanger, comprising a first valve to which a line for a hot medium and a line for cold medium is connected for selectively receiving a hot medium and a cold medium into the first heat exchanger, wherein the second heat exchanging system comprises a second heat exchanger comprising a second valve to which a line for a hot medium and a line for a cold medium is connected for selectively receiving a hot medium and a cold medium into the second heat exchanger, wherein the first and second valves are controlled by a valve control unit.

[0015] According to one example, the first heat exchanger is in fluid connection with the cylinder via a third valve, and the second heat exchanger is in fluid connection with the cylinder via a fourth valve, wherein the opening and closing of valves are controllable by the valve control unit.

[0016] According to one embodiment, the first heat exchanging system and the second heat exchanging system comprises two separate heat exchangers respectively, wherein a first heat exchanger of the first system is adapted to heat the first fluid medium, and a first heat exchanger of the second system is adapted to heat the second fluid medium, and a second heat exchanger of the first system is adapted to cool the first medium, and a second heat exchanger of the second system is adapted to cool the second fluid medium.

[0017] According to one example, the first heat exchanging system is arranged within the first variable space of the cylinder, and/or the second heat exchanging system is arranged within the third variable space of the cylinder.

[0018] According to one example, the first heat exchanging system is arranged externally of the cylinder, and/or the second heat exchanging system is arranged externally of the cylinder.

[0019] According to one example, the fluid medium of the second space and the fluid medium of the fourth space is an incompressible liquid.

[0020] According to one example, the fluid medium of the first space and the fluid medium of the third space is an incompressible liquid.

[0021] According to one example, the fluid medium of the second space and the fluid medium of the fourth space is an incompressible liquid.

[0022] According to one example, the liquid is oil.

[0023] According to one example, the fluid medium, is propane or R410A.

[0024] According to one embodiment, the fluid medium, undergoes a phase transfer from a gaseous phase into a liquid phase during the compression movement and back into a gaseous phase during the expansion movement.

[0025] According to one example, the fluid medium is a gaseous medium, e.g. nitrogen.

[0026] According to one example, the fluid medium comprises a gaseous medium.

[0027] According to one example, the hot medium is hot water and the cold medium is cold water.

[0028] According to one example, the energy transfer devices comprises one of a mechanical transfer device such as a crank-link mechanism, magnets or coils.

[0029] According to one example, the energy generating device comprises one of a rotating shaft in a crank-link mechanism, magnets, coils, and a generator.

[0030] According to one embodiment, the energy generating system is adapted to control heating of the first fluid medium substantially simultaneously with cooling of the second fluid medium and conversely cooling of the first fluid medium substantially simultaneously heating of the second fluid medium,

Brief description of drawings

[0031] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 shows a side view of an energy generating system according to the invention.

Fig. 2 shows a side view of an energy generating system.

Fig. 3a shows a side view of an energy generating system.

Fig. 3b shows a side view of a check valve.

Fig. 3c shows a side of the check valve of Fig. 3b..

Fig. 3d shows a side view of the check valve of Fig. 3b.

Fig. 3e shows a side view of an energy generating system.

Fig. 4a shows a side view of an energy generating system.

Fig. 4b shows a side view of an energy generating system.

Fig. 5a shows a side view of an energy generating system.

Fig. 5b shows a side view of an energy generating system.

Fig. 6 shows a side view of an energy generating system.

Fig. 7 shows a side view of an energy generating system.

Description of embodiments

[0032] In the following, a detailed description of the invention will be given. In the drawing figures, like reference numerals designate identical or corresponding elements throughout the several figures. It will be appreciated that these figures are for illustration only and are not in any way restricting the scope of the invention.

[0033] Fig. 1 shows a side view of an energy generating system 1 for generating energy from temperature differences of fluids. According to one embodiment, the energy generating system 1 comprises a first cylinder 14 comprising a first reciprocatable piston 15, wherein the first piston 15 sealably divides the first cylinder 14 into a first 14a and second 14b variable space, wherein the first space 14a comprises a first fluid medium 140 and the second space 14b comprises a fluid medium 145. Further, the energy generating system 1 comprises a first energy transfer device 30a connected to the first cylinder 14.

[0034] The energy generating system 1 further comprises a first heat exchanging system 11 in fluid connection with the first space 14a, wherein the first heat exchanging system 11 is adapted to alternately heat and cool the first fluid medium 140, whereby pressure in the first space 14a is increased and reduced respectively, a second cylinder 24 comprising a reciprocatable piston 25, wherein the second piston 25 sealably divides the second cylinder 24 into a third 24a and fourth 24b variable space, wherein the third space 24a comprises a second fluid medium 240 and the fourth space 24b comprises a fluid medium 245. The energy generating system 1 further comprises a second energy transfer device 30b connected to the second cylinder 24, and a second heat exchanging system 21 in fluid connection with the third space 24a, wherein the second heat exchanging system 21 is adapted to alternately heat and cool the second fluid medium 240, whereby pressure in the third space 24a is increased and reduced respectively, wherein the energy generating system 1 is adapted to control heating of the first fluid medium 140 and cooling of the second fluid medium 240 and conversely cooling of the first fluid medium 140 and heating of the second fluid medium 240, whereby the resulting pressure increase from heating and pressure reduction from cooling in the first space 14a and the third space 24a respectively, causes the first piston 15 and the second piston 25 to reciprocate between an expansion movement during heating wherein the first and third variable spaces 14a, 24a increases, and a compression movement during cooling wherein the first and third variable spaces 14a, 24a decreases, whereby the first and second energy transfer devices 30a, 30b transfer the kinetic energy from the reciprocating movement of the reciprocatable pistons 15, 25 to an energy generating device 30 arranged for being in an energy-transfer connection to the first and second reciprocatable pistons 15, 25. According to one embodiment, during the expansion movement of the first piston 15 the fluid medium 145, 245 is forced out of the second space 14b as well as into the fourth space 24b aiding the compression movement of the second piston 25, and whereby during the expansion movement of the second piston 25 the fluid medium 145, 245 is forced out of the fourth space 24b as well as into the second space 14b aiding the compression movement of the first piston 15.According to one embodiment, the energy generating system 1 is adapted to control heating of the first fluid medium 140 substantially simultaneously with cooling of the second fluid medium 240 and conversely cooling of the first fluid medium 140 substantially simultaneously with heating of the second fluid medium 240.

[0035] According to one embodiment, the energy generating system 1 is adapted to synchronize heating of the first fluid medium 140 with cooling of the second fluid medium 240 and conversely cooling of the first fluid medium 140 with heating of the second fluid medium 240, whereby the resulting pressure increase from heating and pressure reduction from cooling in the first space 14a and the third space 24a respectively, causes the first piston 15 and the second piston 25 to reciprocate between an expansion movement during heating wherein the first and third variable spaces 14a, 24a increases, and a compression movement during cooling wherein the first and third variable spaces 14a, 24a decreases, whereby the first and second energy transfer devices 30a, 30b transfer the kinetic energy from the reciprocating movement of the reciprocatable pistons 15, 25 to an energy generating device 30 arranged for being in an energy-transfer connection to the first and second reciprocatable pistons 15, 25.

[0036] According to one embodiment, the stroke length of the reciprocatable pistons 15, 25 are 50-70cm.

[0037] According to one embodiment, the first and second fluid medium 140, 240 is propane or R410A. According to one embodiment, the selection of the fluid medium is dependent on the temperature range of the mediums of the heat exchanging systems, 11, 21. According to one embodiment, the first fluid medium 140 and second fluid medium 240 is a first gaseous medium 140 and second gaseous medium 240 respectively. According to one embodiment, the fluid medium 140, 240 undergoes a phase transfer from a gaseous phase into a liquid phase during the compression movement and back into a gaseous phase during the expansion movement.

[0038] According to one embodiment, the pressure of the first and second fluid medium during heating, i.e. as a result of the pressure increase, is 15-16 Bar or 1,5-1,6 MPa when using propane. According to one embodiment, the pressure of the fluid medium during heating, i.e. as a result of the pressure increase, is 30-40 Bar or

3-4 MPa when using propane. According to one embodiment, the pressure of the fluid medium during cooling, i.e. as a result of the pressure reduction, is 2-4 Bar or 0,2-0,4 MPa when using propane. According to one embodiment, the pressure of the fluid medium during cooling, i.e. as a result of the pressure reduction, is 2-4 Bar or 0,2-0,4 MPa when using propane.

[0039] According to one embodiment, the fluid medium 145 of the second space 14b and the fluid medium 245 of the fourth space 24b is an incompressible liquid. According to one embodiment, the liquid is oil. According to one embodiment, the fluid medium 145, 245 comprises a gaseous medium.

[0040] According to one embodiment, the energy transfer devices 30a, 30b, 30c, 30d comprises one of a mechanical transfer device such as a crank-link mechanism, magnets or coils. According to one embodiment, the energy generating device 30 comprises one of a rotating shaft in a crank-link mechanism, magnets, coils, and a generator, for generating energy from the movement of the reciprocatable pistons 15, 25,35, 45.

[0041] According to one embodiment, the first energy transfer device 30a is connected to the first reciprocatable piston 15, and the second energy transfer device 30b is connected to the second reciprocatable piston 25, wherein the second space 14b is in fluid connection with the fourth space 24b, whereby during expansion movement of the first piston 15 the fluid medium is forced out of the second space 14b into the fourth space aiding a compression movement of the second piston 25 so that the third space is decreased, and whereby during expansion movement of the second piston 25 the fluid medium is forced out of the fourth space 24b into the second space 14b aiding a compression movement of the first piston 15 so that the first space is decreased. According to one embodiment, an expansion tank 75 is adapted to be in fluid connection with the second space 14b and the fourth space 24b. According to one embodiment, the expansion tank 75 is provided between the second space 14b and the fourth space 24b. According to one embodiment, the expansion tank 75 provides for the fluid medium 145, 245 to enter the expansion tank 75 during an expansion movement of either the first piston 15 or the second piston 25. According to one embodiment, the expansion tank may be closed and comprising a gaseous medium such as e.g. air, having a bias pressure, wherein during entering of the fluid medium 145, 245, the gaseous medium is compressed further. According to one embodiment, this provides for a delaying of aiding a compression movement of the second piston or the first piston 15 respectively after the expansion movement has been initiated by the first piston 15 or the second piston 25 respectively. This enables the further cooling of the fluid medium 240 and 140 respectively before aiding of the compression movement may take place. According to one embodiment, this provides for a more energy efficient process wherein the compression movement does not provide an unwanted and unnecessary counteraction to the expansion movement. According to one embodiment, this further enables the movement of the pistons 15 and 25 respectively to be asynchronous.

[0042] According to one embodiment, the first heat exchanging system 11 comprises a first heat exchanger 11a, comprising a first valve 12 to which a line 12a for a hot medium and a line 12b for cold medium is connected for selectively receiving a hot medium, such as e.g. a fluid, and a cold medium, such as e.g. a fluid, into the first heat exchanger 11, wherein the second heat exchanging system 21 comprises a second heat exchanger 21a comprising a second valve 22 to which a line 22a for a hot medium and a line 22b for a cold medium is connected for selectively receiving a hot medium and a cold medium into the second heat exchanger 21. According to one embodiment, the first and second valves 12, 22 are controlled by a valve control unit 50. According to one embodiment, the hot medium is hot water and the cold medium is cold water. According to one embodiment, the cold medium has a temperature of 4°-10°. According to one embodiment, the hot medium has a temperature of 15°-40°. According to one embodiment, the temperature difference between the hot medium and cold medium, ΔT, is in the range of 20°C-5°C difference. According to one embodiment, the warm side if the temperature difference exist below zero degrees Celsius. According to one embodiment, the cold water is ground water. According to one embodiment, the hot water is waste water or water heated by being exposed to solar energy or more specifically by means of solar collectors.#According to one embodiment, the cold medium has a temperature down to 4°C to -10°C. According to one embodiment, the hot medium has a temperature that are sufficient to realize a temperature difference between the hot medium and cold medium, ΔT, in the range of 10°C or more.

[0043] According to one embodiment, as seen in Fig. 1, the first heat exchanger 11 is in fluid connection with the cylinder 14 via a third valve 13, and the second heat exchanger 21 is in fluid connection with the cylinder 24 via a fourth valve 23, wherein the opening and closing of valves 13, 23 are controllable by the valve control unit 50.

[0044] Fig. 2 discloses the energy generating system 1 of Fig. 1, wherein the third valve 13 and the fourth valve 23 have been removed and the first heat exchanger 11 is in direct fluid connection with the cylinder 14, and the second heat exchanger 21 is in direct fluid connection with the cylinder 24.

[0045] Fig. 1 and Fig. 2 discloses the energy generating system 1 wherein the first heat exchanging system 11 is arranged externally of the cylinder 14, and/or the second heat exchanging system 21 is arranged externally of the cylinder 24.

[0046] According to one embodiment, the first heat exchanging system 11 and the second heat exchanging system 21 comprises two separate heat exchangers respectively (not shown), wherein a first heat exchanger of the first system 11 is adapted to heat the first 140 fluid medium, and a first heat exchanger of the second system 21 is adapted to heat the second 240 fluid medium, and a second heat exchanger of the first system 11 is adapted to cool the first medium 140, and a second heat exchanger of the second system 21 is adapted to cool the second 240 fluid medium.

[0047] Fig. 3a discloses the energy generating system of Fig. 1, wherein the first heat exchanging system 11 is arranged within the first variable space 14a of the cylinder 14, and/or the second heat exchanging system 21 is arranged within the third variable space 24b of the cylinder 24. According to one embodiment, a control valve 76a or 76b is provided and arranged in the fluid connection between the second space 14b and the fourth space 24b, for instance as described in the energy generating systems of Fig. 2 and 3, wherein the third valve 13 and the fourth valve 23 have been removed and the first heat exchanger 11 is in direct fluid connection with the cylinder 14, and the second heat exchanger 21 is in direct fluid connection with the cylinder 24. According to one embodiment, a valve control unit 50 is adapted to control the opening and closing of the control valve 76a, 76b. According to one embodiment, the control valve 76 when closed provides for a buildup of pressure of the first fluid medium 140 resulting from the heating of the first fluid medium 140 and prior to the expansion movement of the first piston 15. After sufficient reduction of the temperature of the second fluid medium 240, the control valve 76 may be opened to give a boost to the compression movement of the second piston 25 sufficient to compress the second fluid medium to undergo a phase transfer and provide for even further compression movement resulting from the sudden reduction in volume of the third variable space 24a. Naturally, an analogous process is occurring during the expansion movement of the second piston 25 instead. According to one embodiment, as shown in Fig. 3a, a first control valve 76a and a second control valve 76b are provided and arranged in the fluid connection between the second space 14b and the fourth space 24b, for instance as described in the energy generating systems of Fig. 2 and 3. According to one embodiment, a valve control unit 50 is adapted to control the opening and closing of the control valve 76a and 76b. According to one embodiment, the first valve 76a and second valve 76b are arranged on either side of a expansion tank 75 or on either side of a common connection line to an expansion tank 75 as shown in Fig. 3a.. According to one embodiment, the first cylinder 14 comprises a first check valve 141, and the second cylinder 24 comprises a second check valve 241, arranged between the first piston 15 and the heat exchanging system 11 and the second piston 25 and the heat exchanging system 21 respectively. According to one embodiment the first 141 and second 241 check valves are adapted to lower the pressure and temperature of the first medium 140 and second medium 240 respectively when the fluid mediums 140, 240 pass through the check valves 141, 241 in an unfolded position. According to one embodiment, the first check valve 141 is in a folded position, and the second check valve 241 is in an unfolded position in Fig. 3a. According to one embodiment, the first and second check valves 141, 241 are arranged in the cylinders 14, 24 just below the lowermost position of the pistons 15, 25 in their lowermost compressed positions.

[0048] Fig. 3b shows a check valve such as a first and second check valve 141, 241 in an unfolded position, seen in a direction from the piston 15, 15 towards the heat exchanging systems 11, 21. According to one embodiment, the first and second check valves 141, 241 are essentially circular to fit snugly inside the cylinders 14, 24 cross section and are separate into two portions 141a, 241a, 141b, 241b connected by a hinge device 142, 242 which enables the check valve 141, 241 by its first portions 141a, 242a and second portions 141b, 241b, to swing in relation to each other between an unfolded position and a folded position. According to one embodiment, the hinge device 142, 242 comprises two separate hinges 142a, 242a, 142b, 242b. According to one embodiment, the check valves 141, 241 are provided with holes 143, 243. According to one embodiment, the holes have a larger entry diameter 143a, 243a than exit diameter 143b, 243b seen in a direction from the piston 15, 15 towards the heat exchanging systems 11, 21, wherein the holes form passages in the form of restrictions or throttles. According to one embodiment, the circumference of the portions 141a, 241a are tapered wherein a slit formed between the portions 141a, 241a is provided with a larger entry area than exit area, and wherein the circumference of the portions 141a, 241 a facing the inner wall of the cylinders 14, 24 is provided with a larger entry area than exit area. These passages form restrictions or throttles.

[0049] Fig 3c shows a side view of the check valve 141, 241 of Fig. 3b in an unfolded position.

[0050] Fig. 3d shows a side view of the check valve 141, 241 of Fig. 3b in a folded position. According to one embodiment, a process of use may be described as follows: When the first and second fluid mediums 140, 240 expands and move upwards in the respective cylinder 14, 24, the check valve 141, 241 is swung from an unfolded towards a folded position wherein the fluid mediums 140, 240 may pass unhindered. When the fluid mediums 140, 240 shrinks the check valve 141, 241 falls down to an unfolded position and becomes essentially planar wherein the fluid medium 140, 240 is forced to pass through all restrictions towards the heat exchanging systems 11, 21. During passage of the restrictions the temperature and pressure of the fluid mediums 140, 240 is reduced. According to one embodiment, the use of check valves 141, 241 reduces the requirement of the temperature of the cold medium. According to one embodiment, no cold medium is required, only a hot medium, for the energy generating system 1. Herein, the first heat exchanging system 11 also comprises the first check valve 141 adapted to cool the first fluid medium 140, and further comprises the second check valve 241 adapted to cool the second fluid medium 240. According to one embodiment, a process of the energy generating device 1 comprising the control first valve 76a and second control valve 76b and the expansion tank 75 may be described as follows: In a starting position, the first piston 15 is in its lowermost and compressed position in the first cylinder 14. The second piston 25 is in its uppermost, expanded position, in the second cylinder 25. The first control valve 76a and second control valve 76b are closed. The first valve 12 is open to the line 12a wherein the first heat exchanging system 11 receives a hot medium, heating the first medium 140. The second valve 22 is open to a line 22b wherein the second heat exchanging system 21 receives a cold medium, colder than the hot medium, cooling the second medium 240. Essentially, the pressure of the first space 14a is at its highest level, and the pressure of the third space 24a is at its lowest level. According to one embodiment, a first and second check valve 141, 241 are provided, wherein the check valves 141, 241 are in an unfolded position. Hereafter, the first and second control valves 76a and 76b are opened simultaneously. The first check valve 141 is automatically opened, i.e. folded by the aid of the expansion of the first fluid medium 140. The first piston 15 is pressed upwards in an expansion movement, where the first energy transfer device 30a transfers the kinetic energy from the movement of the first piston 15 to the energy generating device 30. During this movement, the first piston 15 also presses the fluid medium 145 into the fourth space 24b where an overpressure is created pressing the second piston 25 downwards in a compression movement. The second piston 25 then simultaneously generates a higher pressure on the second medium 240 in the third space 24a than it adopted during cooling wherein the second fluid medium may undergo a phase change into liquid form which further reduces the volume of the second fluid medium 240 which, in turn, enables the compression movement of the second piston 25 to its lowermost position in the cylinder 24. When the second fluid medium 240 is pressed or forced through the unfolded check valve 241, the cooling of the second medium 240 is enhanced, whereby the phase change of the fluid medium from gaseous state to a liquid state is accelerated. The pressure, driving the first piston 15 upwards during the expansion movement can be counteracted by that the shrinking process taking place in the third space 24a, and consequently the compression movement of the second piston 25 towards the lowermost position in cylinder 24, is a slower process. This may be overcome by the aid of the expansion tank 75 and/or the proper selection of the fluid medium 145, 245 allowing these fluid mediums to be compressed. When the first piston 15 reaches its uppermost expanded position, the first control valve 76a is closed, and the first valve 12 is opened towards the line 12b wherein a cold medium is received in the heat exchanging system 11. When the second piston 25 reaches its lowermost position during the compression movement, the second control valve 76b is closed and the second valve 22 is opened towards the line 22a wherein hot medium is received in the heat exchanging system 21. According to one embodiment, when the first and second mediums 140 and 240 has reached the temperature corresponding to the temperature of the hot and cold mediums flowing into and through the heat exchanging systems 11 and 21 respectively, the above process is repeated in the opposite direction, i.e. wherein the second piston 25 carry out the expansion movement and the first piston carry out the compression movement, with required controlling of the valves 12, 22, 76a and 76b. According to one embodiment, the energy transfer devices 30a, 30b transfer the kinetic energy into a rotating movement of the energy generating device 30. According to one embodiment, the energy transfer devices 30a, 30b are adapted to rotate the energy generating device during both their expansion movement and compression movement by e.g. a gear device. According to one embodiment, a plurality of further main piston systems 1" as shown in Fig. 5, 6, 7 adapted to carry out the above process in an alternating manner, are provided and connected to the energy generating device 1 via energy transfer devices 30a, 30b in order to provide a continuous rotating movement of the energy generating device 1.

[0051] Fig. 3e shows the energy generating system 1 according to one embodiment, wherein a respective cooling circuit 90a, 90b is provided to cool the first cylinder 14 and the second cylinder 24 respectively. According to one embodiment, the same source of cooling medium provided to the heat exchanging systems 11 and 21 are also provided to the cooling circuits 90a, 90b. According to one embodiment, the cooling circuits 90a, 90b are adapted to continuously cool the first cylinder 14 and the second cylinder 24 respectively. According to one embodiment, the cooling circuits are arranged to the cylinders 14, 24 whereby cooling of the portions of the cylinders covering the first space 14a and third space 24a in the most compressed position of the respective first and second piston 15 and 25 are avoided. As a result, the negative effect of unwanted cooling of these spaces 14a, 24a during the initial part of the expansion movement when the first and second fluid mediums 140 and 240 are heated by the hot medium is avoided. As a result, the process of compression movement of the first and second pistons 15 and 25 respectively is improved in that the time for lowering the temperature of the first and second fluid mediums 140 and 240 respectively and achieving a phase change of the same mediums is reduced. According to one embodiment, the process of compression and phase change from a gaseous state to a liquid state is more time consuming than the process of expansion and phase change from a liquid state to a gaseous state. According to one embodiment, the process of compression and phase change from a gaseous state to a liquid state is more time consuming than the process of expansion and phase change from a liquid state to a gaseous depending on the actual temperature of the hot medium, cold medium and the first and second fluid mediums.

[0052] Fig. 4a shows the energy generating system 1 according to one embodiment, wherein the first 30a and second 30b energy transfer devices comprises a first 30a, 30a1, 30a2 and second 30b, 30b1, 30b2 fluid line respectively, respectively connecting the second variable space 14b and fourth variable space 24b with a further piston system 2, whereby the fluid lines 30a1, 30b1, 30a2, 30b2 transfers the kinetic energy of the reciprocatable pistons 15, 25 via the further piston system 2, to the energy generating device 30.

[0053] Thus, according to one embodiment, again as seen in Fig. 4a, the energy generating system 1 comprises a further piston system 2. wherein the further piston system 2 comprises: a first cylinder 34 comprising a first reciprocatable piston 35, wherein the first piston 35 sealably divides the first cylinder 34 into a first 34a and second 34b variable space, wherein the first space 34a comprises a fluid medium 340 and the second space 34b comprises a fluid medium 345, a first energy transfer device 30c connected to the first cylinder 34, a second cylinder 44 comprising a reciprocatable piston 45, wherein the second piston 45 sealably divides the second cylinder 44 into a third 44a and fourth 44b variable space, wherein the third space 44a comprises a fluid medium 440 and the fourth space 44b comprises a fluid medium 445, a second energy transfer device 30d connected to the second cylinder 44, wherein the first 30a and second 30b energy transfer devices of the main piston system 1' comprises a first 30a, 30a1, 30a2 and second 30b, 30b1, 30b2 fluid line respectively, whereby the second variable space 14b of the main piston system 1' is connected to the first variable space 34a of the further piston system 2 via the first fluid line 30a, 30a1, and further connected to the third variable space 44a of the further piston system 2 via the first fluid line 30a, 30a2, whereby the fourth variable space 24b of the main piston system 1' is connected to the first variable space 34a of the further piston system 2 via the second fluid line 30b, 30b1, and further connected to the third variable space 44a of the further piston system 2 via a second fluid line 30b, 30b2, whereby the fluid lines 30a1, 30b1, 30a2, 30b2 transfers the kinetic energy of the reciprocatable pistons 15, 25 via the further piston system 2, to the energy generating device 30.

[0054] According to one embodiment, the second and fourth variable spaces 14b, 24b of the main piston system 1', via the fluid lines 30a1, 30b1 are in fluid connection with a first cylinder 34 of the further piston system 2 via a valve device 33 comprising a respective valve 33a1, 33b1 for the respective fluid line 30a1 and 30b1, and wherein the second and fourth variable spaces 14b, 24 of the main piston system 1', via the fluid lines 30a2, 30b2 are in fluid connection with a second cylinder 44 of the further piston system 2 via a valve device 43 comprising a respective valve 43a1, 43b1 for the respective fluid line 30a2, and 30b2. According to one embodiment, the valve devices 33 and 43 are controlled by a valve control unit 50.

[0055] According to one embodiment, the fluid medium 340 of the first space 34a and the fluid medium 440 of the second space 44a is an incompressible liquid. According to one embodiment, the liquid is oil. According to one embodiment, the fluid medium 340 of the first space 34a and the fluid medium 440 of the second space 44a is the same fluid medium 145 of the second space 14b and the fluid medium 245 of the fourth space 24b.

[0056] According to one embodiment, the fluid medium 345 of the second space 34b and the fluid medium 445 of the fourth space 44b is an incompressible liquid. According to one embodiment, the liquid is oil. According to one embodiment, the fluid mediums 345, 445 is a gaseous medium, wherein the gaseous medium is nitrogen.

[0057] According to one embodiment, the first cylinder 34 of the further piston system 2 comprises a reciprocatable piston 35, sealably dividing the cylinder 34 into a first 34a and second 34b variable space, wherein the first space 34a comprises a fluid medium 340, and the second space 34b comprises a gaseous medium 345, wherein the second cylinder 44 of the further piston system 2 comprises a reciprocatable piston 45, sealably dividing the second cylinder 44 into a third 44a and fourth 44b variable space, wherein the third space 44a comprises a fluid medium 440, and the fourth space 44b comprises a gaseous medium 445, wherein the second space 34b is in fluid connection with the fourth space 44b, wherein the second 14b and fourth 24b variable spaces of the main piston system 1', via the fluid lines 30a1, 30a2, 30b1, 30b2, are in fluid connection with the first 34a and third 44a variable spaces of the further piston system 2. According to one embodiment, during the expansion movement of the first piston 15 the fluid medium 145, 245 is forced out of the second space 14b as well as into the fourth space 24b aiding the compression movement of the second piston 25, and whereby during the expansion movement of the second piston 25 the fluid medium 145, 245 is forced out of the fourth space 24b as well as into the second space 14b aiding the compression movement of the first piston 25.

[0058] Fig. 4b discloses the energy generating system 1, according to one embodiment, wherein the energy generating system 1 similar to the embodiment of Fig. 4a comprises a main piston system 1' and a further piston system 2. However, in the embodiment of Fig. 4b, the second space 34b is not in a direct fluid connection with the fourth space 44b. Instead, the first 30a and second energy transfer devices 30b , comprises respectively further first and second fluid lines 30a3, 30a4 and 30b3, 30b4 The second variable space 14b of the main piston system 1' is connected to the second variable space 34b of the further piston system 2 via the first fluid line 30a3,, and further connected to the fourth variable space 44b of the further piston system 2 via a the first fluid line 30a4.The fourth variable space 24b of the main piston system 1' is connected to the second variable space 34b of the further piston system 2 via the second fluid line

30b3, and further connected to the fourth variable space 44b of the further piston system 2 via second fluid line 30b4.The fluid lines 30a3, 30b3, 30a4, 30b4 hereby transfers the kinetic energy of the reciprocatable pistons 15, 25 via the further piston system 2, to the energy generating device 30. Thus, according to one embodiment, the second variable space 34b and the fourth variable space 44b comprise the same fluid medium as in the first and third variable spaces 34a, 44a respectively. According to one embodiment, respective valve devices 53 and 63 are comprising valves 53a1, 53b1 and 63a1, 63b1 respectively connects the fluid lines 30a3, 30b3 and 30a4, 30b4 to the second variable space 34b and 44b as similarly described for the valve devices 33 and 43 above. According to one embodiment, the valve control unit 50 is adapted to control the valve devices 53, 63 such as e.g. the opening and closing of the valve devices. According to one embodiment, the first and second energy transfer devices 30a, 30b transfer kinetic energy from the reciprocating movement of the reciprocatable pistons 15, 25 to an energy generating device 30 arranged for being in an energy-transfer connection to the first and second reciprocatable pistons 15, 25.

[0059] Thus, the relationship and dependency between the expansion movement of the first piston 15 and the compression movement of the second piston 25 respectively the expansion movement of the second piston 25 and the compression movement of the first piston 25 has been shown in the embodiments related to Fig. 1-3, as well as Fig. 4a, 4b and later Fig. 5. Again, in Fig. 1-3 according to one embodiment, this is provided by the aid of a fluid connection directly between the second space 14b, and the fourth space 14b of the main piston system 1'. Again, in Fig. 4a, and later Fig. 5, according to one embodiment this is provided by the aid of the second space 34b being in fluid connection with the fourth space 44b, i.e. in an indirect manner via these spaces of the further piston system 2. In Fig. 4b this is provided by that the second and fourth space 14b and 24b of the main piston system 1' are respectively connected to all spaces 34a, 34b, 44a, 44b of the further piston system 2.

[0060] According to one embodiment, an expansion tank 85 (not shown) is adapted to be in fluid connection with the second space 34b and the fourth space 44b. The function of the expansion tank 85 for the further piston system 2 is analogous to the function of the expansion tank 75 for the main piston system 1' described above. According to one embodiment, a valve 86 is provided in the fluid connection between the second space 34b and the fourth space 44b. According to one embodiment, the valve control unit 50 is adapted to control the opening and closing of the valve 86. According to one embodiment, the function of the valve 86 for the further piston system 2 is analogous to the function of the valve 76 for the main piston system 1' described above. According to one embodiment, a first valve 86a and a second valve 86b are provided and arranged in the fluid connection between the second space 34b and the fourth space 44b, for instance as described in a similar manner in the energy generating systems of Fig. 2 and 3. According to one embodiment, a valve control unit 50 is adapted to control the opening and closing of the valve 86a and 86b. According to one embodiment, the first valve 86a and second valve 86b are arranged on a either side of a expansion tank 85, i.e. wherein the first valve 86a controls the flow of the fluid medium from the second space 34b into the expansion tank 85 during expansion movement of the first piston 35 and the second valve 86b controls the flow of the fluid medium from the fourth space 44b into the expansion tank 85 during expansion movement of the second piston 45. According to one embodiment, the function of the first and second valves 86a and 86b respectively for the further piston system 2 is analogous to the function of the first and second valves 76a and 76b for the main piston system 1' described above.

[0061] According to one embodiment, the first cylinder 14 and the second cylinder 24 of the main piston system 1' are selected to have a larger volume than the first cylinder 3 and the second cylinder 44 of the further piston system 2. According to one embodiment, the expansion and compression movement cycle time of the further piston system 2, i.e. time required for both the first piston 35 and second piston 45 to respectively carry out an expansion and compression movement, is shorter than the expansion and compression movement cycle time of the corresponding first piston 15 and second piston 25 of the main piston system 1'. Thus, as a result, the frequency of the further piston system 2 is higher than the frequency of the main piston system 1.

[0062] According to one embodiment, the second and fourth spaces 14b, 24b of the main piston system 1' are in fluid connection with a plurality of further pistons systems 2, 2', comprising at least a first and second further piston system 2, 2' in a similar arrangement as described above (not shown).

[0063] According to one embodiment, a movement cycle of the reciprocation of the pistons of the further piston system 2 is time shifted in relation to the cycle time of at least one of the plurality of further piston systems 2'. According to one embodiment, the time shifted movement cycle between further pistons systems 2, 2' is achieved by means of controlling of the valve devices 33, 43 by the control unit 50.

[0064] According to one embodiment, an energy generating system 1 is provided , wherein the energy generating system 1 comprises a second main piston system 1" similar to the first piston system 1' as described above, wherein the second main piston system 1" is arranged to the further piston system 2, in a similar manner as the first main piston system 1' is arranged to the first further piston system 2 as described above, whereby the first and second energy transfer devices 30a", 30b" of the second main piston system 1" transfer the kinetic energy from the reciprocating movement of the reciprocatable pistons 15", 25" to the energy generating device 30 arranged for being in an energy-transfer connection to the first and second reciprocatable pistons 15", 25".

[0065] According to one embodiment, a movement cycle of the reciprocation of the pistons of the second main piston system 1" is time shifted in relation to the movement cycle of the pistons of the first main piston system 1'.

[0066] Fig. 5a discloses the energy generating system 1, according to one embodiment, wherein the energy generating system 1 comprises a second main piston system 1" similar to the first main piston system 1' as described above, wherein the second main piston system 1" is arranged to the second further piston systems 2', in a similar manner as the first main piston system 1' is arranged to the first further piston system 2 as described above, wherein a movement cycle of the reciprocation of the pistons of the second main piston system 1" is time shifted in relation to the movement cycle of the pistons of the first main piston system 1'.

[0067] According to one embodiment as described in Fig. 5a, the first 30a and second 30b energy transfer devices of the main piston system 1' further comprises a first 30a, 30a1, 30a2, and second 30b, 30b1, 30b2, fluid line respectively, whereby the second variable space 14b of the main piston system 1' is further connected to the first variable space 54a of the second further piston system 2 via the first fluid line 30a, 30a1, and further connected to the third variable space 64a of the second further piston system 2' via a the first fluid line 30a, 30a2, whereby the fourth variable space 24b of the main piston system 1' is connected to the first variable space 54a of the first further piston system 2 via the second fluid line 30b, 30b1, and further connected to the third variable space 64a of the second further piston system 2' via a second fluid line 30b, 30b2, whereby the fluid lines 30a1, 30b1, 30a2, 30b2 transfers the kinetic energy of the reciprocatable pistons 15, 25 via the second further piston system 2', to the energy generating device 30. According to one embodiment, the valve devices 33 and 43 of the second main piston system 1" comprises additional valves 33a1, 33b1 and 43a1, 43b1 respectively for connecting the respective fluid lines 30a1, 30b1 and 30a2, 30b2 to the first variable space 54a and third variable space 64a. Additionally, an analogous set up can be provided between the second main piston system 1" and the first further pistons system 2 as described.

[0068] Fig. 5b discloses the energy generating system 1, according to one embodiment, wherein the energy generating system 1 comprises a first main piston system 1' according to any of the described main piston systems 1', and a second main piston system 1" similar to the first main piston system 1', wherein the second main piston system 1" is arranged to a second further piston system 2', in a similar manner as the first main piston system 1' is arranged to the first further piston system 2. The overall structure is thus similar to what is described in Fig. 5a, however, the plurality of further piston systems 2, 2' comprises or essentially comprises the features of the further pistons system 2 as described in Fig. 4b above. The energy generating system 1 further comprises a high pressure line HP and a low pressure line LP, wherein the high pressure line HP connects the first energy transfer device 30a comprising the first 30a, 30a1, 30a2, 30a3, 30a4 fluid lines as described in Fig. 4b to the second variable space 14b via a valve 73a1 of valve device 73, and to the fourth variable space 24b via a valve 73b1 of the valve device 73, and the low pressure line LP connects the second energy transfer device 30b comprising the second 30b, 30b1, 30b2, 30b3, 30b4 fluid lines as described in Fig. 4b, to the second variable space 24b via a valve 83a1 of a valve device 83, and to the fourth variable space 24b via a valve 83b1 of the valve device 83. Thus, the pistons 34, 44 and 54, 64 of the further piston systems 2, 2' respectively have two valves in both ends wherein on each end, one valve is connected to the high pressure line HP and the other valve is connected to the low pressure line LP, and the variable spaces 14b, 24b of the main piston systems 1', 1" each have two valves, wherein one valve is connected to the high pressure line HP and the other valve is connected to the low pressure line LP. According to one embodiment, the high pressure line HP and low pressure line LP and all fluid lines comprise a common fluid medium. According to one embodiment, the fluid medium is hydraulic oil. According to one embodiment, an expansion tank 95, similar to the expansion tanks 75, 85 described above, is arranged in connection to the low pressure line LP as seen in Fig. 5b. According to one embodiment, a respective cooling circuit 90a, 90b as described in Fig. 3e is provided to cool the first 14 and second cylinder 24 respectively in a manner further described in relation to Fig. 3e. According to one embodiment, a first 141 and second check valve 241 as described in relation to Fig. 3a-3d are provided in the first 14 and second 24 cylinders respectively. According to the embodiment, shown in Fig. 5b, the energy generating system 1 comprises four main piston system cylinders and four further piston system cylinders, however the use of a common high pressure line HP and low pressure line LP enables the connection and addition of any suitable number of main piston system cylinders and further piston system cylinders to the energy generating system 1. According to one embodiment, a possible process of the energy generating system 1 may be described as follows: In the cylinders of the main piston systems 1', 1", e.g. the first cylinder 14, wherein the first fluid medium 140 is heated by the aid of the first heat exchanging system 11, wherein the first fluid medium 140 carry out an expansion movement after sufficient heating of the first fluid medium 140, wherein the fluid medium in the second space 14b is pressed through an open valve 73a1 to the high pressure line HP. This may be carried out with the check valves swung to a folded position. In the cylinders of the main piston systems 1', 1", e.g. the second cylinder 24, wherein the second fluid medium 240 is cooled by the aid of the second heat exchanging system 21 as well as the cooling circuit 90b, the pressure of the second fluid medium 240 is reduced. A valve 83b1 is opened whereby fluid medium from the low pressure line

LP is allowed to enter the fourth space 24b whereby pressure is increased on the second piston 25, whereby the pressure of the second fluid medium 240 is increased to a higher pressure than if it only been exposed to cooling which enables the phase change into a liquid phase whereby the volume of the second fluid medium is reduced further enabling the second piston to reach its lowest most compressed position. The check valve 241 in an unfolded state further accelerates the cooling of the second fluid medium 240, which increases the speed of the process. When any of the cylinders of the main piston systems 1', 1" reaches an end position, the valves 73, 83 at the upper end are closed and the heat exchanging process shifts from heating to cooling or the opposite. When the heat exchanging process is finalized, and the fluid medium 140, 240 has reached the similar temperature as the heat exchanging system, the correct valve 73, 83 is opened and the piston 15, 25 forces the fluid medium of the second or fourth space 14, 24 to the high pressure line HP if the fluid medium 140, 240 was heated or the piston 15, 25 is pressed downwards from the low pressure line LP if the fluid medium 140, 240 was cooled. In parallel to the above described process, the cylinders 34, 44 of the further piston systems 2, 2' works independently of the cylinders of the main piston systems 1', 1". The cylinders 34, 44 of the further piston systems 2, 2' also work independently of each other. When a piston 35, 45 of the respective cylinders 34, 44 has reached an end position, the valve in that end opens to the high pressure line HP and a valve in the opposite end of the cylinder 34, 44 opens to the low pressure line LP. The piston 35, 45 is then forced/pressed by fluid medium in the high pressure line HP and forces/presses fluid medium in the cylinder 34, 44 to the low pressure line LP, at the same as the kinetic energy of the piston 35, 45 is transferred to the energy generating device 30, for instance by rotating a drive shaft. The piston 35, 45 as well as the energy transfer device is adapted to rotate the drive shaft in the same direction irregardless if the piston 35, 45 carry out an expansion or a compression movement. The expansion 95 is adapted to take up the over pressure that may be generated when the cylinders of the main piston systems 1', 1" that are being cooled are not able to receive all fluid medium from the low pressure line LP at the same time since the expansion movemement and compression movement of the pistons 15, 15 of the main piston systems 1', 1" are not synchronous. According to one embodiment, the use of an expansion tank 95 enables the asynchronous movement of the pistons 15, 25. According to one embodiment, the use of a fluid medium in the second and fourth variable spaces 14b, 24, and thus in the high pressure line HP and low pressure line LP, which is compressible enables the asynchronous movement of the pistons 15, 25 even though the expansion tank 95 has been removed, i.e. is not comprised in the energy generating system 1. According one embodiment, the cylinders of the energy generating system 1 comprises limit switches adapted to sense when the piston 15, 25, 35, 45, has reached its end position. According to one embodiment, the first and second energy transfer devices 30a, 30b transfer kinetic energy from the reciprocating movement of the reciprocatable pistons 15, 25 to an energy generating device 30 arranged for being in an energy-transfer connection to the first and second reciprocatable pistons 15, 25.

[0069] Fig. 6 discloses the energy generating system 1, according to one embodiment, wherein a preload cylinder 74, similar to the first cylinder 34 of the further piston system 2 as described above, is arranged in fluid connection with the second space 34b and the fourth variable space 44b of the first cylinder 34 and second cylinder 44 of the further piston system 2 for generating a preload to the fluid of the second space 34b and the fourth variable space 44b. According to one embodiment, the preload cylinder 74, is arranged in fluid connection with the second space 54b and the fourth variable space 64b of the first cylinder 54 and the second cylinder 64 of the second further piston system 2' for generating a preload to the fluid of the second space 34b and the fourth variable space 44b. According to one embodiment, a valve device (not shown) is arranged in the lines connecting the first and second cylinder 34, 44 and first and second cylinder 54, 64 respectively. According to one embodiment, the preload is a slight overpressure compared to the pressure in the first and second variable spaces 14a, 24a. According to one embodiment, the overpressure is in the range of 1-2 Bar. According to one embodiment, the preload cylinder 74 provides a similar effect as the above described expansion tanks, 75, 85, 95, i.e. wherein an asynchronous movement of the first 35 and second piston 45 are enabled.

[0070] Fig. 7 discloses the energy generating system 1, according to one embodiment of the invention. The main pistons 5, 6, 7, 8 compressing first and second fluid mediums such as e.g. gaseous medium causing a phase transfer of the gas by cooling or expanding gas by heating, which alternately is provided to heat exchanging systems arranged in fluid connection with each main piston 5, 6, 7, 8. The gaseous medium is housed in the lower part of the main pistons as well as in each heat exchanging system. Cooling and heating in liquid form is provided and returned from the heat exchanging systems via two 3-way valves arranged to each heat exchanging system. The upper part of each main piston and the fluid lines connected to the lower parts of the piston pairs 1, 2, 3, 4 is filled with e.g. hydraulic oil. The main pistons work in pairs, wherein main piston 5 is heated and has a relatively higher pressure than main piston 7 having a low pressure, connected to fluid line 56 and 78 respectively. Piston pairs 1-4 is connected in sequence via valves to fluid lines 56 and 78 so that at least one piston pair drives and rotates the drive shaft, or, transfers energy to the energy generating device by any other means. In Fig. 7, a fluid line is connected to the fluid line 56 and presses one piston in the piston pair to an upper end position, while the other piston of the piston pair is pressed back to a lower end position and hydraulic oil back via fluid line 78 to main piston 7. Pressurization line connected to the upper part in the piston pairs has a slight overpressure compared to the lowest pressure obtainable by heat exchanging by cooling in the main pistons. This overpressure allows in this case the transfer of gas into liquid phase in the heat exchanging system and the lower part of main piston 7 where the pressure as a result decreases rapidly. Eventually, the main pistons 5 and 7 have reached their end positions. At this point, the valves V56 and V78 switch over to main piston 6 and 8 and the process starts over. While main piston 6 and 8 work toward their end positions, main piston 5 and 7 are undergoing a heat exchange wherein the piston previously heated is now cooled (5) and the piston previously cooled is now heated (7) so that they are ready to start when main piston 6 and 8 are ready. According to one embodiment, as seen in Fig. 7 a valve device V51, V61, V71, V81. is provided on the inlet side to each heat exchanging device, 11, 21 etc, corresponding to the above described first valve 12, wherein a heat supply and cold supply is connected said valve devices. Fig. 7 also discloses a valve devices V52, V62, V72, V82 arranged on the outlet side of the heat exchanging devices. The valve devices V52, V62, V72, V82 are connected to a heat return and a cold return wherein the heat and cold may be reused in the process. According to one embodiment, the valve control unit 50 controls the valves V51, V61, V71, V81, V52, V62, V72, V82. In order to avoid that cold medium is returned via the heat return and hot medium is returned via the cold return, which reduces the efficiency of the process, the valve devices V52, V62, V72, V82 on the outlet side are adapted to be switched between the heat and cold return with a slight delay after the heat exchanging system has stopped either the heating and cooling process of the fluid medium in the cylinders. Hot and cold medium still in the heat exchanging system are thereby allowed to exit the system, emptying the same, before switching the valve devices V52, V62, V72, V82.

[0071] A preferred embodiment of an energy generating system 1 according to the invention has been described. However, the person skilled in the art realizes that this can be varied within the scope of the appended claims without departing from the inventive idea.

Claims

1. An energy generating system (1) comprising:

a main piston system (1'), further comprising,
a first cylinder (14) comprising a first reciprocatable piston (15), wherein the first piston (15) sealably divides the first cylinder (14) into a first (14a) and second (14b) variable space, wherein the first space (14a) comprises a first fluid medium (140) and the second space (14b) comprises a fluid medium (145),
a first energy transfer device (30a) connected to the first cylinder (14),
a first heat exchanging system (11) in fluid connection with the first space (14a), wherein the first heat exchanging system (11) is adapted to alternately heat and
cool the first fluid medium (140), whereby pressure in the first space (14a) is increased and reduced respectively,
a second cylinder (24) comprising a reciprocatable piston (25), wherein the second piston (25) sealably divides the second cylinder (24) into a third (24a) and fourth (24b) variable space, wherein the third space (24a) comprises a second fluid medium (240) and the fourth space (24b) comprises a fluid medium (245),
a second energy transfer device (30b) connected to the second cylinder (24),
a second heat exchanging system (21) in fluid connection with the third space (24a), wherein the second heat exchanging system (21) is adapted to alternately heat and cool the second fluid medium (240), whereby pressure in the third space (24a) is increased and reduced respectively,
wherein the energy generating system (1) is adapted to control heating of the first fluid medium (140) and cooling of the second fluid medium (240) and conversely cooling of the first fluid medium (140) and heating of the second fluid medium (240), whereby the resulting pressure increase from heating and pressure reduction from cooling in the first space (14a) and the third space (24a) respectively, causes the first piston (15) and the second piston (25) to reciprocate between an expansion movement during heating wherein the first and third variable spaces (14a, 24a) increases, and a compression movement during cooling wherein the first and third variable spaces (14a, 24a) decreases, whereby the first and second energy transfer devices (30a, 30b) transfer kinetic energy from the reciprocating movement of the reciprocatable pistons (15, 25) to an energy generating device (30) arranged for being in an energy-transfer connection to the first and second reciprocatable pistons (15, 25)
whereby during the expansion movement of the first piston (15) the fluid medium (145, 245) is forced out of the second space (14b) as well as into the fourth space (24b) aiding the compression movement of the second piston (25), and whereby during the expansion movement of the second piston (25) the fluid medium (145, 245) is forced out of the fourth space (24b) as well as into the second space (14b) aiding the compression movement of the first piston (25), **characterised in that** the first (30a) and second (30b)

energy transfer devices comprise a first (30a1, 30b1) and second (30a2, 30b2) fluid line respectively, respectively connecting the second variable space (14b) and fourth variable space (24b) with a further piston system (2), whereby the first and second fluid lines (30a1, 30b1, 30a2, 30b2) transfer the kinetic energy of the reciprocatable pistons (15, 25) via the further piston system (2), to the energy generating device (30).

2. Energy generating system (1) according to claim 1, wherein the second and fourth variable spaces (14b, 24b) of the main piston system (1'), via the fluid lines (30a1, 30b1) are in fluid connection with a first cylinder (34) of the further piston system (2) via a valve device (33), and wherein the second and fourth variable spaces (14b, 24) of the main piston system (1'), via the fluid lines (30a2, 30b2) are in fluid connection with a second cylinder (44) of the further piston system (2) via a valve device (43),
wherein the valve devices (33) and (43) are controlled by a valve control unit (50).

3. Energy generating system (1) according to claim 2, wherein the first cylinder (34) of the further piston system (2) comprises a reciprocatable piston (35), sealably dividing the cylinder (34) into a first (34a) and second (34b) variable space, wherein the first space (34a) comprises a fluid medium (340), and the second space (34b) comprises a fluid medium (345), wherein the second cylinder (44) of the further piston system (2) comprises a reciprocatable piston (45), sealably dividing the second cylinder (44) into a third (44a) and fourth (44b) variable space, wherein the third space (44a) comprises a fluid medium (440), and the fourth space (44b) comprises a fluid medium (445), wherein the second space (34b) is in fluid connection with the fourth space (44b), wherein the second (14b) and fourth (24b) variable spaces of the main piston system (1'), via the fluid lines (30a1, 30a2, 30b1, 30b2), are in fluid connection with the first (34a) and third (44a) variable spaces of the further piston system (2).

4. Energy generating system (1) according to any of claims 1-3, wherein the second and fourth spaces (14b, 24b) of the main piston system (1') are in fluid connection with a plurality of further pistons systems (2, 2'), comprising at least a first and second further piston system (2, 2'), in a similar arrangement as described in claims 2-4.

5. Energy generating system (1) according to claim 4, wherein a movement cycle of the reciprocation of the pistons of the further piston system (2) is time shifted in relation to the cycle time of at least one of the plurality of further piston systems (2').

6. Energy generating system (1) according to any of claims 1-5, comprising a second main piston system (1") similar to the main piston system (1') according to any of claims 1-5 wherein the second main piston system (1") is arranged to the further piston system (2),
whereby the first and second energy transfer devices (30a", 30b") of the second main piston system (1") transfer the kinetic energy from the reciprocating movement of the reciprocatable pistons (15", 25") to the energy generating device (30) arranged for being in an energy-transfer connection to the first and second reciprocatable pistons (15", 25"),
wherein a movement cycle of the reciprocation of the pistons of the second main piston system (1") is time shifted in relation to the movement cycle of the pistons of the main piston system (1').

7. Energy generating system (1) according to any of claims 4-6, wherein the second main piston system (1") is arranged to the second further piston system (2'), according to any of claims 4-6,
wherein a movement cycle of the reciprocation of the pistons of the second main piston system (1") is time shifted in relation to the movement cycle of the pistons of the first main piston system (1').

8. Energy generating system (1) according to any of claims 2-7, wherein a preload cylinder (74), similar to the first cylinder (34) of the further piston system (2) as described in any of claims 3-7 is arranged in fluid connection with the second space (34b) and the fourth variable space (44b) of the first cylinder (34) of the further piston system (2) for generating a preload to the fluid of the second space (34b) and the fourth variable space (44b).

9. Energy generating system (1) according to claim 1, wherein the first energy transfer device (30a) is connected to the first reciprocatable piston (15), and the second energy transfer device (30b) is connected to the second reciprocatable piston (25), wherein the second space (14b) is in fluid connection with the fourth space (24b), whereby during expansion movement of the first piston (15) the fluid medium is forced out of the second space (14b) into the fourth space aiding a compression movement of the second piston (25) so that the third space is decreased, and whereby during expansion movement of the second piston (25) the fluid medium is forced out of the fourth space (24b) into the second space (14b) aiding a compression movement of the first piston (25) so that the first space is decreased.

10. Energy generating system (1) according to any of the preceding claims, wherein the first heat exchanging system (11) comprises a first heat exchanger, comprising a first valve (12) to which a line (12a) for a hot medium and a line (12b) for cold medium is connected for selectively receiving a hot medium and a cold medium into the first heat exchanger (11), wherein the second heat exchanging system (21) comprises a second heat exchanger comprising a second valve (22) to which a line (22a) for a hot medium and a line (22b) for a cold medium is connected for selectively receiving a hot medium and a cold medium into the second heat exchanger (21), wherein the first and second valves (12, 22) are controlled by a valve control unit (50).

11. Energy generating system (1) according to any of the preceding claims, wherein the first heat exchanging system (11) is in fluid connection with the first cylinder (14) via a third valve (13), and the second heat exchanging system (21) is in fluid connection with the second cylinder (24) via a fourth valve (23), wherein the opening and closing of valves (13, 23) are controllable by the valve control unit (50).

12. Energy generating system (1) according to any of the preceding claims, wherein the first heat exchanging system (11) and the second heat exchanging system (21) comprises two separate heat exchangers respectively, wherein a first heat exchanger of the first system (11) is adapted to heat the first (140) fluid medium, and a first heat exchanger of the second system (21) is adapted to heat the second (240) fluid medium, and a second heat exchanger of the first system (11) is adapted to cool the first medium (140), and a second heat exchanger of the second system (21) is adapted to cool the second (240) fluid medium.

13. Energy generating system (1) according to any of the preceding claims, wherein the first heat exchanging system (11) is arranged within the first variable space (14a) of the first cylinder (14), and/or the second heat exchanging system (21) is arranged within the third variable space (24b) of the second cylinder (24).

14. Energy generating system (1) according to any of the preceding claims, wherein the first heat exchanging system (11) is arranged externally of the first cylinder (14), and/or the second heat exchanging system (21) is arranged externally of the second cylinder (24).

15. Energy generating system (1) according to any of the previous claims, wherein the fluid medium (140, 240) undergoes a phase transfer from a gaseous phase into a liquid phase during the compression movement and back into a gaseous phase during the expansion movement.

16. Energy generating system (1) according to any of the preceding claims, wherein the energy generating system (1) is adapted to control heating of the first fluid medium (140) substantially simultaneously with cooling of the second fluid medium (240) and conversely cooling of the first fluid medium (140) substantially simultaneously with heating of the second fluid medium (240).

Patentansprüche

1. Energieerzeugungssystem (1), umfassend:

ein Hauptkolbensystem (1'), ferner umfassend, einen ersten Zylinder (14), der einen ersten hin- und herbewegbaren Kolben (15) umfasst, wobei der erste Kolben (15) abdichtbar den ersten Zylinder (14) in einen ersten (14a) und zweiten (14b) variablen Raum teilt, wobei der erste Raum (14a) ein erstes fluides Medium (140) umfasst und der zweite Raum (14b) ein fluides Medium (145) umfasst,
eine erste Energieübertragungsvorrichtung (30a), die mit dem ersten Zylinder (14) verbunden ist,
ein erstes Wärmetauschsystem (11) in Fluidverbindung mit dem ersten Raum (14a), wobei das erste Wärmetauschsystem (11) ausgelegt ist, das erste fluide Medium (140) abwechselnd zu erwärmen und zu kühlen, wodurch ein Druck in dem ersten Raum (14a) erhöht bzw. reduziert wird,
einen zweiten Zylinder (24), der einen hin- und herbewegbaren Kolben (25) umfasst, wobei der zweite Kolben (25) abdichtbar den zweiten Zylinder (24) in einen dritten (24a) und vierten (24b) variablen Raum teilt, wobei der dritte Raum (24a) ein zweites fluides Medium (240) umfasst und der vierte Raum (24b) ein fluides Medium (245) umfasst,
eine zweite Energieübertragungsvorrichtung (30b), die mit dem zweiten Zylinder (24) verbunden ist,
ein zweites Wärmetauschsystem (21) in Fluidverbindung mit dem dritten Raum (24a), wobei das zweite Wärmetauschsystem (21) ausgelegt ist, das zweite fluide Medium (240) abwechselnd zu erwärmen und zu kühlen, wodurch ein Druck in dem dritten Raum (24a) erhöht bzw. reduziert wird,
wobei das Energieerzeugungssystem (1) ausgelegt ist, ein Erwärmen des ersten fluiden Mediums (140) und ein Kühlen des zweiten fluiden Mediums (240) und umgekehrt ein Kühlen des ersten fluiden Mediums (140) und ein Erwärmen des zweiten fluiden Mediums (240) zu steuern, wodurch die resultierende Druckerhöhung aus dem Erwärmen und Druckreduzierung aus dem

Kühlen in dem ersten Raum (14a) bzw. dem dritten Raum (24a) den ersten Kolben (15) und den zweiten Kolben (25) veranlasst, sich zwischen einer Expansionsbewegung während des Erwärmens, bei der sich die ersten und dritten variablen Räume (14a, 24a) erhöhen, und einer Kompressionsbewegung während des Kühlens, bei der sich die ersten und dritten variablen Räume (14a, 24a) verringern, hin- und herzubewegen, wodurch die ersten und zweiten Energieübertragungsvorrichtungen (30a, 30b) kinetische Energie aus der hin- und hergehenden Bewegung der hin- und herbewegbaren Kolben (15, 25) zu einer Energieerzeugungsvorrichtung (30) übertragen, die angeordnet ist, in einer Energieübertragungsverbindung mit den ersten und zweiten hin- und herbewegbaren Kolben (15, 25) zu sein,
wobei während der Expansionsbewegung des ersten Kolbens (15) das fluide Medium (145, 245) aus dem zweiten Raum (14b) sowie in den vierten Raum (24b) gedrückt wird, was die Kompressionsbewegung des zweiten Kolbens (25) unterstützt, und wobei während der Expansionsbewegung des zweiten Kolbens (25) das fluide Medium (145, 245) aus dem vierten Raum (24b) sowie in den zweiten Raum (14b) gedrückt wird, was die Kompressionsbewegung des ersten Kolbens (25) unterstützt, **dadurch gekennzeichnet, dass** die ersten (30a) und zweiten (30b) Energieübertragungsvorrichtungen eine erste (30a1, 30b1) bzw. zweite (30a2, 30b2) Fluidleitung umfassen, die den zweiten variablen Raum (14b) bzw. den vierten variablen Raum (24b) mit einem weiteren Kolbensystem (2) verbinden, wobei die ersten und zweiten Fluidleitungen (30a1, 30b1, 30a2, 30b2) die kinetische Energie der hin- und herbewegbaren Kolben (15, 25) über das weitere Kolbensystem (2) zu der Energieerzeugungsvorrichtung (30) übertragen.

2. Energieerzeugungssystem (1) nach Anspruch 1, wobei die zweiten und vierten variablen Räume (14b, 24b) des Hauptkolbensystems (1') über die Fluidleitungen (30a1, 30b1) in Fluidverbindung mit einem ersten Zylinder (34) des weiteren Kolbensystems (2) über eine Ventilvorrichtung (33) sind, und wobei die zweiten und vierten variablen Räume (14b, 24) des Hauptkolbensystems (1') über die Fluidleitungen (30a2, 30b2) in Fluidverbindung mit einem zweiten Zylinder (44) des weiteren Kolbensystems (2) über eine Ventilvorrichtung (43) sind,
wobei die Ventilvorrichtungen (33) und (43) durch eine Ventilsteuereinheit (50) gesteuert werden.

3. Energieerzeugungssystem (1) nach Anspruch 2, wobei der erste Zylinder (34) des weiteren Kolbensystems (2) einen hin- und herbewegbaren Kolben (35) umfasst, der den Zylinder (34) abdichtbar in einen ersten (34a) und zweiten (34b) variablen Raum teilt, wobei der erste Raum (34a) ein fluides Medium (340) umfasst und der zweite Raum (34b) ein fluides Medium (345) umfasst, wobei der zweite Zylinder (44) des weiteren Kolbensystems (2) einen hin- und herbewegbaren Kolben (45) umfasst, der den zweiten Zylinder (44) abdichtbar in einen dritten (44a) und vierten (44b) variablen Raum teilt, wobei der dritte Raum (44a) ein fluides Medium (440) umfasst und der vierte Raum (44b) ein fluides Medium (445) umfasst, wobei der zweite Raum (34b) in Fluidverbindung mit dem vierten Raum (44b) ist, wobei die zweiten (14b) und vierten (24b) variablen Räume des Hauptkolbensystems (1') über die Fluidleitungen (30a1, 30a2, 30b1, 30b2) in Fluidverbindung mit den ersten (34a) und dritten (44a) variablen Räumen des weiteren Kolbensystems (2) sind.

4. Energieerzeugungssystem (1) nach einem der Ansprüche 1-3, wobei die zweiten und vierten Räume (14b, 24b) des Hauptkolbensystems (1') in Fluidverbindung mit einer Mehrzahl von weiteren Kolbensystemen (2, 2'), die mindestens ein erstes und zweites weiteres Kolbensystem (2, 2') umfassen, in einer ähnlichen Anordnung wie in den Ansprüchen 2-4 beschrieben sind.

5. Energieerzeugungssystem (1) nach Anspruch 4, wobei ein Bewegungszyklus des Hin- und Hergehens der Kolben des weiteren Kolbensystems (2) in Relation zu der Zykluszeit mindestens eines der Mehrzahl von weiteren Kolbensystemen (2') zeitversetzt ist.

6. Energieerzeugungssystem (1) nach einem der Ansprüche 1-5, umfassend ein zweites Hauptkolbensystem (1") ähnlich zu dem Hauptkolbensystem (1') nach einem der Ansprüche 1-5, wobei das zweite Hauptkolbensystem (1") zu dem weiteren Kolbensystem (2) angeordnet ist,
wobei die ersten und zweiten Energieübertragungsvorrichtungen (30a", 30b") des zweiten Hauptkolbensystems (1") die kinetische Energie aus der hin- und hergehenden Bewegung der hin- und herbewegbaren Kolben (15", 25") zu der Energieerzeugungsvorrichtung (30) übertragen, die angeordnet ist, in einer Energieübertragungsverbindung zu den ersten und zweiten hin- und herbewegbaren Kolben (15", 25") zu sein,
wobei ein Bewegungszyklus des Hin- und Hergehens der Kolben des zweiten Hauptkolbensystems (1") in Relation zu dem Bewegungszyklus der Kolben des Hauptkolbensystems (1') zeitversetzt ist.

7. Energieerzeugungssystem (1) nach einem der Ansprüche 4-6,

wobei das zweite Hauptkolbensystem (1") zu dem zweiten weiteren Kolbensystem (2’) nach einem der Ansprüche 4-6 angeordnet ist,
wobei ein Bewegungszyklus des Hin- und Hergehens der Kolben des zweiten Hauptkolbensystems (1") in Relation zu dem Bewegungszyklus der Kolben des ersten Hauptkolbensystems (1’) zeitversetzt ist.

8. Energieerzeugungssystem (1) nach einem der Ansprüche 2-7, wobei ein Vorspannzylinder (74), ähnlich zu dem ersten Zylinder (34) des weiteren Kolbensystems (2) wie in einem der Ansprüche 3-7 beschrieben, in Fluidverbindung mit dem zweiten Raum (34b) und dem vierten variablen Raum (44b) des ersten Zylinders (34) des weiteren Kolbensystems (2) zum Erzeugen einer Vorspannung auf das Fluid des zweiten Raums (34b) und des vierten variablen Raums (44b) angeordnet ist.

9. Energieerzeugungssystem (1) nach Anspruch 1, wobei die erste Energieübertragungsvorrichtung (30a) mit dem ersten hin- und herbewegbaren Kolben (15) verbunden ist, und die zweite Energieübertragungsvorrichtung (30b) mit dem zweiten hin- und herbewegbaren Kolben (25) verbunden ist, wobei der zweite Raum (14b) in Fluidverbindung mit dem vierten Raum (24b) ist, wobei während einer Expansionsbewegung des ersten Kolbens (15) das fluide Medium aus dem zweiten Raum (14b) in den vierten Raum gedrückt wird, was eine Kompressionsbewegung des zweiten Kolbens (25) unterstützt, so dass der dritte Raum verringert wird, und wobei während einer Expansionsbewegung des zweiten Kolbens (25) das fluide Medium aus dem vierten Raum (24b) in den zweiten Raum (14b) gedrückt wird, was eine Kompressionsbewegung des ersten Kolbens (25) unterstützt, so dass der erste Raum verringert wird.

10. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche,
wobei das erste Wärmetauschsystem (11) einen ersten Wärmetauscher umfasst, der ein erstes Ventil (12) umfasst, mit dem eine Leitung (12a) für ein heißes Medium und eine Leitung (12b) für ein kaltes Medium zum gezielten Aufnehmen eines heißen Mediums und eines kalten Mediums in den ersten Wärmetauscher (11) verbunden ist,
wobei das zweite Wärmetauschsystem (21) einen zweiten Wärmetauscher umfasst, der ein zweites Ventil (22) umfasst, mit dem eine Leitung (22a) für ein heißes Medium und eine Leitung (22b) für ein kaltes Medium zum gezielten Aufnehmen eines heißen Mediums und eines kalten Mediums in den zweiten Wärmetauscher (21) verbunden ist, wobei die ersten und zweiten Ventile (12, 22) durch eine Ventilsteuereinheit (50) gesteuert werden.

11. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das erste Wärmetauschsystem (11) in Fluidverbindung mit dem ersten Zylinder (14) über ein drittes Ventil (13) ist, und das zweite Wärmetauschsystem (21) in Fluidverbindung mit dem zweiten Zylinder (24) über ein viertes Ventil (23) ist, wobei das Öffnen und Schließen der Ventile (13, 23) durch die Ventilsteuereinheit (50) steuerbar sind.

12. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das erste Wärmetauschsystem (11) und das zweite Wärmetauschsystem (21) jeweils zwei separate Wärmetauscher umfassen, wobei ein erster Wärmetauscher des erste Systems (11) ausgelegt ist, das erste (140) fluide Medium zu erwärmen, und ein erster Wärmetauscher des zweiten Systems (21) ausgelegt ist, das zweite (240) fluide Medium zu erwärmen, und ein zweiter Wärmetauscher des ersten Systems (11) ausgelegt ist, das erste Medium (140) zu kühlen, und ein zweiter Wärmetauscher des zweiten Systems (21) ausgelegt ist, das zweite (240) fluide Medium zu kühlen.

13. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das erste Wärmetauschsystem (11) in dem ersten variablen Raum (14a) des ersten Zylinders (14) angeordnet ist und/oder das zweite Wärmetauschsystem (21) in dem dritten variablen Raum (24b) des zweiten Zylinders (24) angeordnet ist.

14. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das erste Wärmetauschsystem (11) extern von dem ersten Zylinder (14) angeordnet ist und/oder das zweite Wärmetauschsystem (21) extern von dem zweiten Zylinder (24) angeordnet ist.

15. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das fluide Medium (140, 240) einen Phasenübergang von einer gasförmigen Phase in eine flüssige Phase während der Kompressionsbewegung und zurück in eine gasförmige Phase während der Expansionsbewegung unterläuft.

16. Energieerzeugungssystem (1) nach einem der vorhergehenden Ansprüche, wobei das Energieerzeugungssystem (1) ausgelegt ist, ein Erwärmen des ersten fluiden Mediums (140) im Wesentlichen gleichzeitig mit einem Kühlen des zweiten fluiden Mediums (240) und umgekehrt ein Kühlen des ersten fluiden Mediums (140) im Wesentlichen gleichzeitig mit einem Erwärmen des zweiten fluiden Mediums (240) zu steuern.

Revendications

1. Système de génération d'énergie (1), comprenant :

un système de piston principal (1'), comprenant en outre, un premier cylindre (14) comprenant un premier piston déplaçable en va-et-vient (15), dans lequel le premier piston (15) divise de façon étanchéifiable le premier cylindre (14) en un premier (14a) et un deuxième (14b) espace variable, dans lequel le premier espace (14a) comprend un premier milieu fluide (140) et le deuxième espace (14b) comprend un milieu fluide (145),
un premier dispositif de transfert d'énergie (30a) raccordé au premier cylindre (14),
un premier système d'échange de chaleur (11) en raccordement fluidique avec le premier espace (14a), dans lequel le premier système d'échange de chaleur (11) est adapté pour chauffer et refroidir de façon alternée le premier milieu fluide (140), moyennant quoi la pression dans le premier espace (14a) est augmentée et réduite respectivement,
un second cylindre (24) comprenant un piston déplaçable en va-et-vient (25), dans lequel le second piston (25) divise de façon étanchéifiable le second cylindre (24) en un troisième (24a) et un quatrième (24b) espace variable, dans lequel le troisième espace (24a) comprend un second milieu fluide (240) et le quatrième espace (24b) comprend un milieu fluide (245),
un second dispositif de transfert d'énergie (30b) raccordé au second cylindre (24),
un second système d'échange de chaleur (21) en raccordement fluidique avec le troisième espace (24a), dans lequel le second système d'échange de chaleur (21) est adapté pour chauffer et refroidir de façon alternée le second milieu fluide (240), moyennant quoi la pression dans le troisième espace (24a) est augmentée et réduite respectivement,
dans lequel le système de génération d'énergie (1) est adapté pour commander le chauffage du premier milieu fluide (140) et le refroidissement du second milieu fluide (240) et inversement le refroidissement du premier milieu fluide (140) et le chauffage du second milieu fluide (240), moyennant quoi les résultantes augmentation de pression due au chauffage et réduction de pression due au refroidissement dans le premier espace (14a) et le troisième espace (24a), respectivement, font en sorte que le premier piston (15) et le second piston (25) se déplacent en va-et-vient entre un mouvement d'expansion durant le chauffage, dans lequel les premier et troisième espaces variables (14a, 24a) augmentent, et un mouvement de compression durant le refroidissement, dans lequel les premier et troisième espaces variables (14a, 24a) se réduisent, moyennant quoi les premier et second dispositifs de transfert d'énergie (30a, 30b) transfèrent de l'énergie cinétique du mouvement en va-et-vient des pistons déplaçables en va-et-vient (15, 25) à un dispositif de génération d'énergie (30) agencé pour être en raccordement de transfert d'énergie avec les premier et second pistons déplaçables en va-et-vient (15, 25)
moyennant quoi, durant le mouvement d'expansion du premier piston (15), le milieu fluide (145, 245) est forcé hors du deuxième espace (14b) ainsi que dans le quatrième espace (24b), aidant le mouvement de compression du second piston (25), et moyennant quoi, durant le mouvement d'expansion du second piston (25), le milieu fluide (145, 245) est forcé hors du quatrième espace (24b) ainsi que dans le deuxième espace (14b), aidant le mouvement de compression du premier piston (25), **caractérisé en ce que** les premier (30a) et second (30b) dispositifs de transfert d'énergie comprennent une première (30a1, 30b1) et une seconde (30a2, 30b2) conduite de fluide respectivement, raccordant respectivement le deuxième espace variable (14b) et le quatrième espace variable (24b) à un système de piston supplémentaire (2), moyennant quoi les première et seconde conduites de fluide (30a1, 30b1, 30a2, 30b2) transfèrent l'énergie cinétique des pistons déplaçables en va-et-vient (15, 25), par l'intermédiaire du système de piston supplémentaire (2), au dispositif de génération d'énergie (30).

2. Système de génération d'énergie (1) selon la revendication 1, dans lequel les deuxième et quatrième espaces variables (14b, 24b) du système de piston principal (1'), par l'intermédiaire des conduites de fluide (30a1, 30b1), sont en raccordement fluidique avec un premier cylindre (34) du système de piston supplémentaire (2), par l'intermédiaire d'un dispositif de soupape (33), et dans lequel les deuxième et quatrième espaces variables (14b, 24) du système de piston principal (1'), par l'intermédiaire des conduites de fluide (30a2, 30b2), sont en raccordement fluidique avec un second cylindre (44) du système de piston supplémentaire (2), par l'intermédiaire d'un dispositif de soupape (43),
dans lequel les dispositifs de soupape (33) et (43) sont commandés par une unité de commande de soupape (50).

3. Système de génération d'énergie (1) selon la revendication 2, dans lequel le premier cylindre (34) du système de piston supplémentaire (2) comprend un piston déplaçable en va-et-vient (35), divisant de façon étanchéifiable le cylindre (34) en un premier (34a) et un deuxième (34b) espace variable, dans lequel le premier espace (34a) comprend un milieu fluide (340), et le deuxième espace (34b) comprend un milieu fluide (345), dans lequel le second cylindre (44) du système de piston supplémentaire (2) comprend un piston déplaçable en va-et-vient (45), divisant de façon étanchéifiable le second cylindre (44) en un troisième (44a) et un quatrième (44b) espace variable, dans lequel le troisième espace (44a) comprend un milieu fluide (440), et le quatrième espace (44b) comprend un milieu fluide (445), dans lequel le deuxième espace (34b) est en raccordement fluidique avec le quatrième espace (44b), dans lequel les deuxième (14b) et quatrième (24b) espaces variables du système de piston principal (1'), par l'intermédiaire des conduites de fluide (30a1, 30a2, 30b1, 30b2), sont en raccordement fluidique avec les premier (34a) et troisième (44a) espaces variables du système de piston supplémentaire (2).

4. Système de génération d'énergie (1) selon l'une quelconque des revendications 1 à 3, dans lequel les deuxième et quatrième espaces (14b, 24b) du système de piston principal (1') sont en raccordement fluidique avec une pluralité de systèmes de pistons supplémentaires (2, 2'), comprenant au moins un premier et un second système de piston supplémentaire (2, 2'), dans un agencement similaire tel que décrit dans les revendications 2 à 4.

5. Système de génération d'énergie (1) selon la revendication 4, dans lequel un cycle de mouvement du mouvement en va-et-vient des pistons du système de piston supplémentaire (2) est décalé en temps par rapport au temps de cycle d'au moins un de la pluralité de système de piston supplémentaires (2').

6. Système de génération d'énergie (1) selon l'une quelconque des revendications 1 à 5, comprenant un second système de piston principal (1") similaire au système de piston principal (1') selon l'une quelconque des revendications 1 à 5, dans lequel le second système de piston principal (1") est agencé sur le système de piston supplémentaire (2),
moyennant quoi les premier et second dispositifs de transfert d'énergie (30a", 30b") du second système de piston principal (1") transfèrent l'énergie cinétique du mouvement en va-et-vient des pistons déplaçables en va-et-vient (15", 25") au dispositif de génération d'énergie (30) agencé pour être en raccordement de transfert d'énergie avec les premier et second pistons déplaçables en va-et-vient (15", 25"),
dans lequel un cycle de mouvement du mouvement en va-et-vient des pistons du second système de piston principal (1") est décalé en temps par rapport au cycle de mouvement des pistons du système de piston principal (1').

7. Système de génération d'énergie (1) selon l'une quelconque des revendications 4 à 6, dans lequel le second système de piston principal (1") est agencé sur le second système de piston supplémentaire (2'), selon l'une quelconque des revendications 4 à 6,
dans lequel un cycle de mouvement du mouvement en va-et-vient des pistons du second système de piston principal (1") est décalé en temps par rapport au cycle de mouvement des pistons du premier système de piston principal (1').

8. Système de génération d'énergie (1) selon l'une quelconque des revendications 2 à 7, dans lequel un cylindre de précharge (74), similaire au premier cylindre (34) du système de piston supplémentaire (2) tel que décrit dans l'une quelconque des revendications 3 à 7, est agencé en raccordement fluidique avec le deuxième espace (34b) et le quatrième espace variable (44b) du premier cylindre (34) du système de piston supplémentaire (2) pour générer une précharge sur le fluide du deuxième espace (34b) et du quatrième espace variable (44b).

9. Système de génération d'énergie (1) selon la revendication 1, dans lequel le premier dispositif de transfert d'énergie (30a) est raccordé au premier piston déplaçable en va-et-vient (15), et le second dispositif de transfert d'énergie (30b) est raccordé au second piston déplaçable en va-et-vient (25), dans lequel le deuxième espace (14b) est en raccordement fluidique avec le quatrième espace (24b), moyennant quoi, durant un mouvement d'expansion du premier piston (15), le milieu fluide est forcé, hors du deuxième espace (14b), dans le quatrième espace, aidant un mouvement de compression du second piston (25), pour que le troisième espace soit réduit, et moyennant quoi, durant le mouvement d'expansion du second piston (25), le milieu fluide est forcé, hors du quatrième espace (24b), dans le deuxième espace (14b), aidant un mouvement de compression du premier piston (25) pour que le premier espace soit réduit.

10. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes,
dans lequel le premier système d'échange de chaleur (11) comprend un premier échangeur de chaleur, comprenant une première soupape (12) à laquelle une conduite (12a) pour un milieu chaud et une conduite (12b) pour un milieu froid sont raccordées pour sélectivement recevoir un milieu chaud et un milieu froid dans le premier échangeur de chaleur (11),
dans lequel le second système d'échange de chaleur (21) comprend un second échangeur de chaleur comprenant une deuxième soupape (22) à laquelle une conduite (22a) pour un milieu chaud et une conduite (22b) pour un milieu froid sont raccordées pour

sélectivement recevoir un milieu chaud et un milieu froid dans le second échangeur de chaleur (21). dans lequel les première et deuxième soupapes (12, 22) sont commandés par une unité de commande de soupape (50) .

11. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le premier système d'échange de chaleur (11) est en raccordement fluidique avec le premier cylindre (14) par l'intermédiaire d'une troisième soupape (13), et le second système d'échange de chaleur (21) est en raccordement fluidique avec le second cylindre (24) par l'intermédiaire d'une quatrième soupape (23), dans lequel l'ouverture et la fermeture des soupapes (13, 23) sont commandables par l'unité de commande de soupape (50).

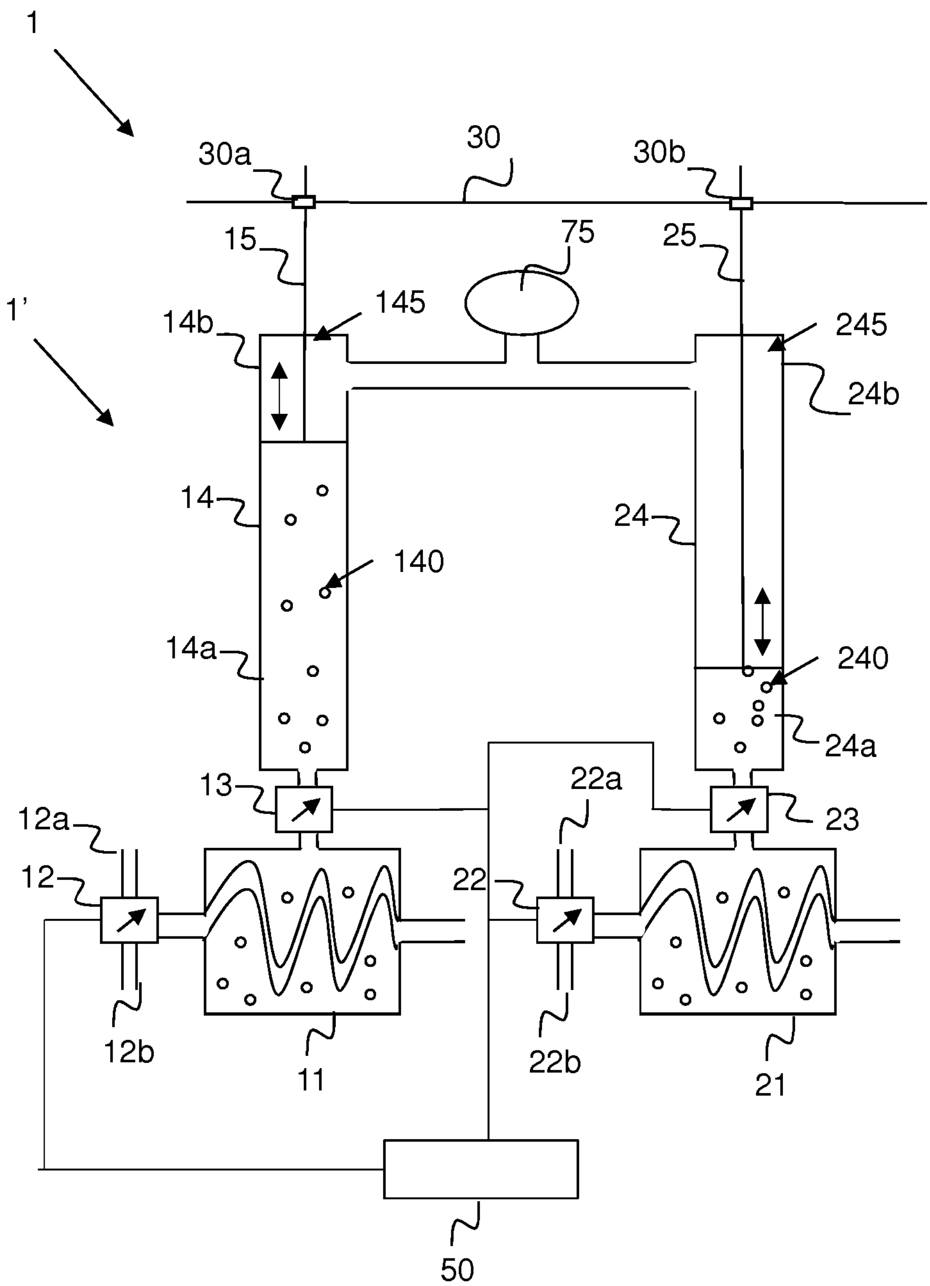
12. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le premier système d'échange de chaleur (11) et le second système d'échange de chaleur (21) comprennent deux échangeurs de chaleur séparés respectivement, dans lequel un premier échangeur de chaleur du premier système (11) est adapté pour chauffer le premier (140) milieu fluide, et un premier échangeur de chaleur du second système (21) est adapté pour chauffer le second (240) milieu fluide, et un second échangeur de chaleur du premier système (11) est adapté pour refroidir le premier milieu (140), et un second échangeur de chaleur du second système (21) est adapté pour refroidir le second (240) milieu fluide.

13. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le premier système d'échange de chaleur (11) est agencé à l'intérieur du premier espace variable (14a) du premier cylindre (14), et/ou le second système d'échange de chaleur (21) est agencé à l'intérieur du troisième espace variable (24b) du second cylindre (24).

14. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le premier système d'échange de chaleur (11) est agencé de façon externe au premier cylindre (14), et/ou le second système d'échange de chaleur (21) est agencé de façon externe au second cylindre (24).

15. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le milieu fluide (140, 240) subit un transfert de phase depuis une phase gazeuse en une phase liquide durant le mouvement de compression et de retour en phase gazeuse durant le mouvement d'expansion.

16. Système de génération d'énergie (1) selon l'une quelconque des revendications précédentes, dans lequel le système de génération d'énergie (1) est adapté pour commander le chauffage du premier milieu fluide (140) sensiblement simultanément avec le refroidissement du second milieu fluide (240) et inversement le refroidissement du premier milieu fluide (140) sensiblement simultanément avec le chauffage du second milieu fluide (240).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30b
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14b
245
24b
14
24
140
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240
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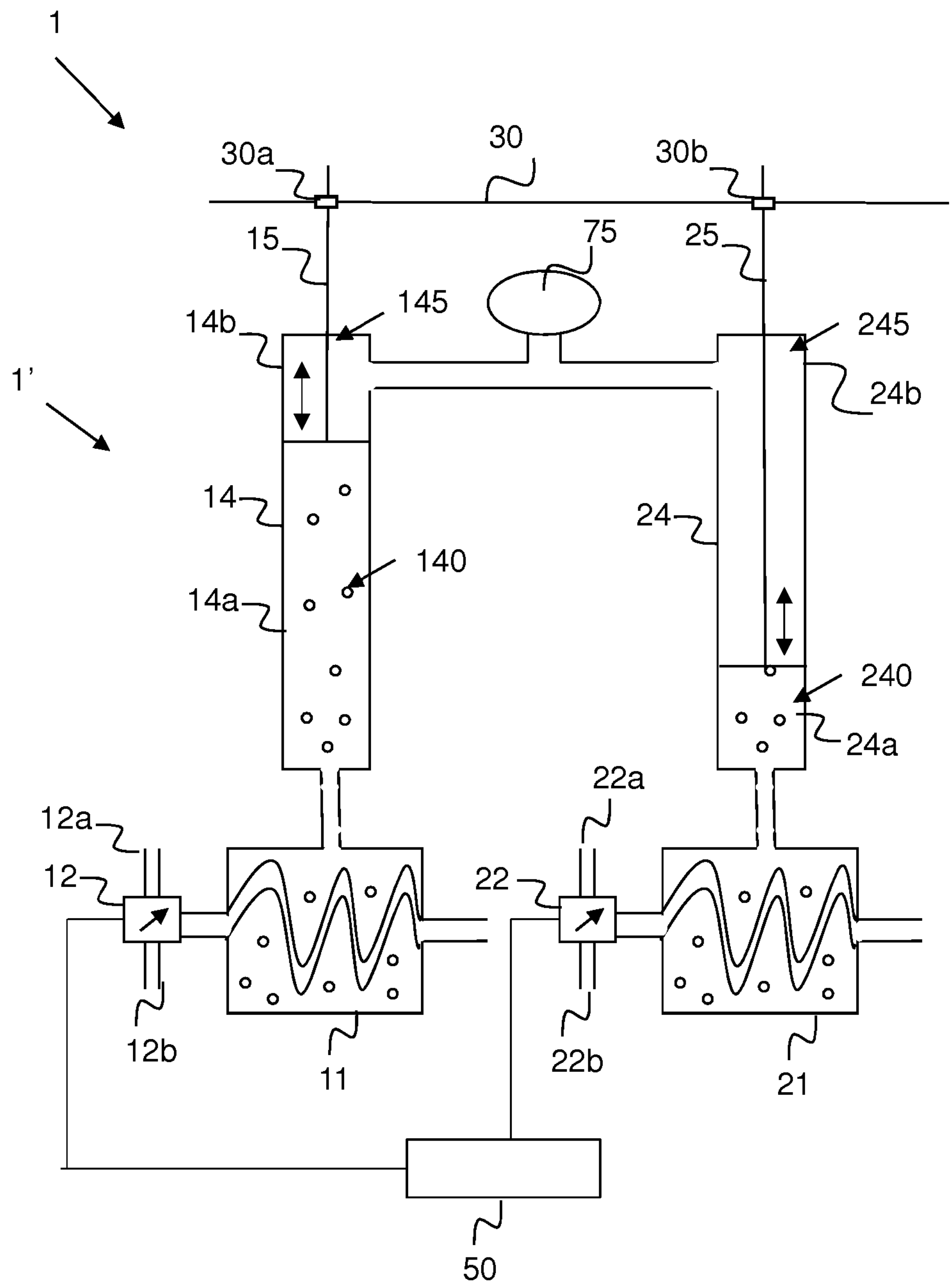
13
22a
23
12a
12
22
12b
11
22b
21
50

Fig. 1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30
30b
15
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25
14b
145
245
24b
14
24
140
14a
240
24a
22a
12a
12
22
12b
11
22b
21
50

Fig. 2

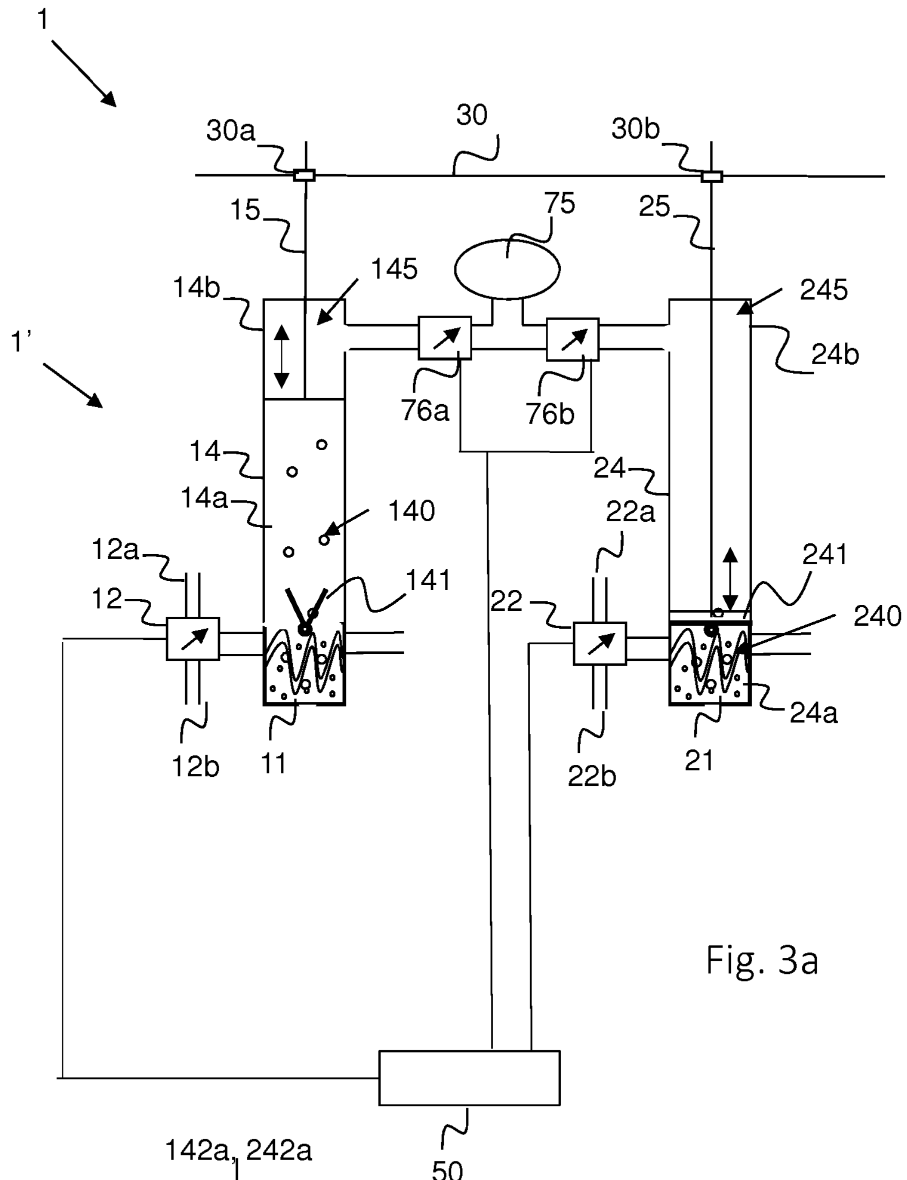


Fig. 3a

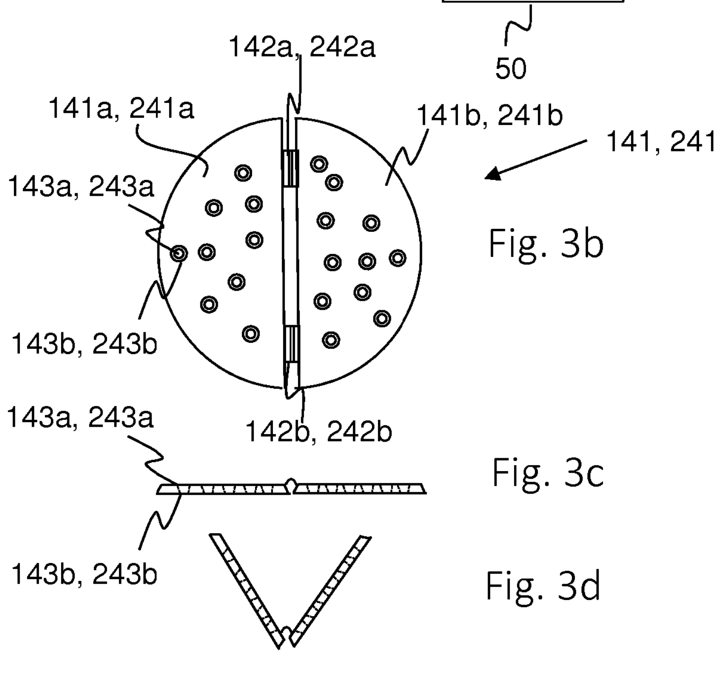
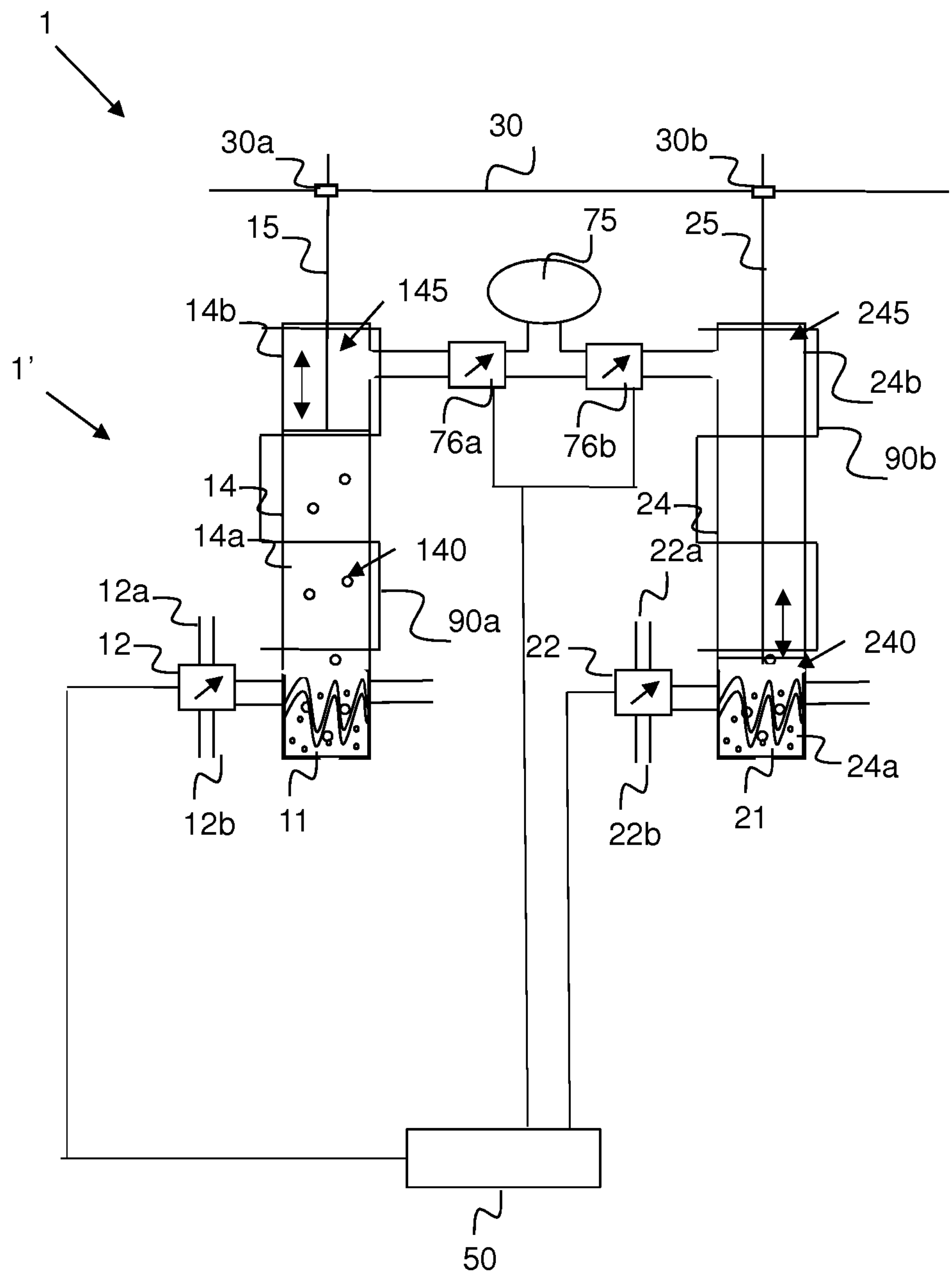


Fig. 3b

Fig. 3c

Fig. 3d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14
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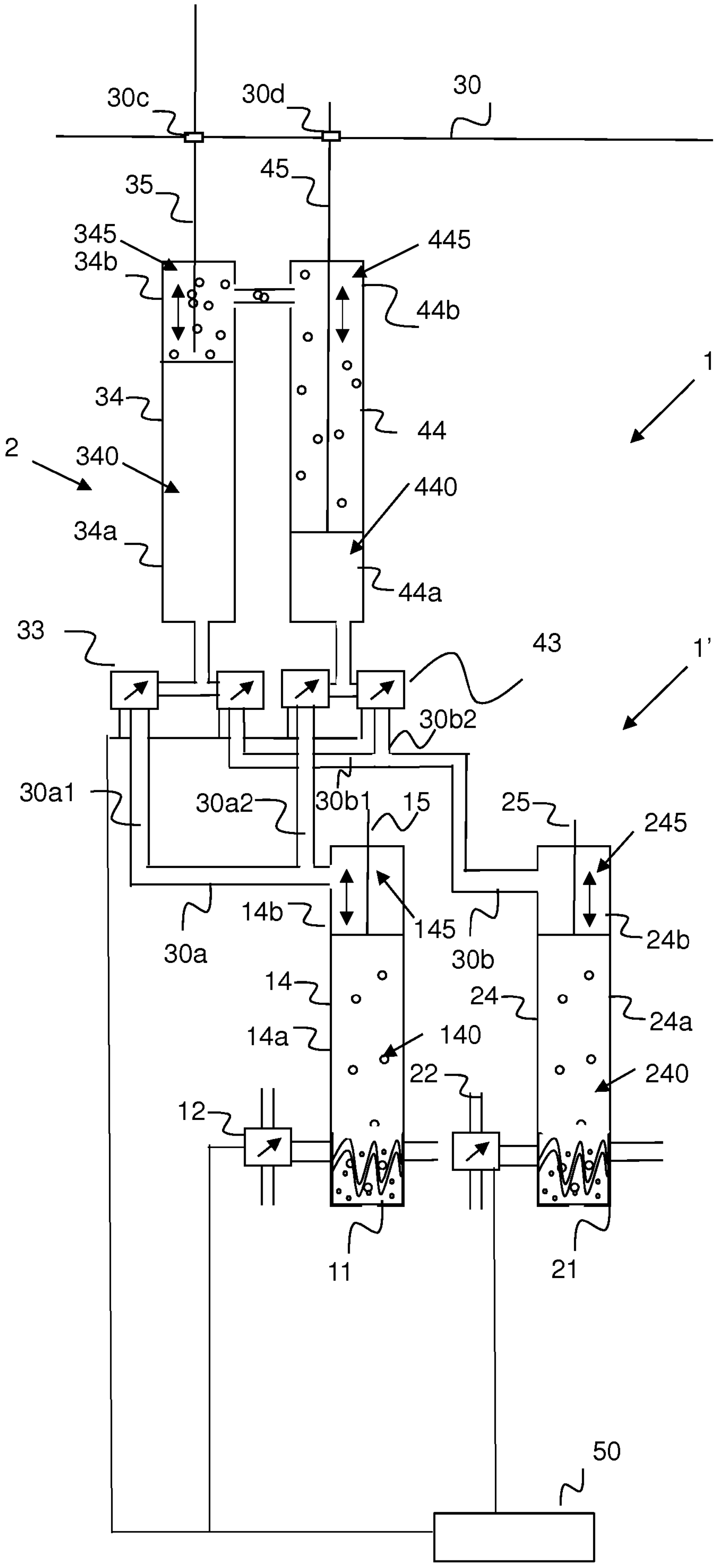
22a
12a
90a
22
240
12
24a
12b
11
22b
21
50

Fig. 3e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34b
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44b
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1'
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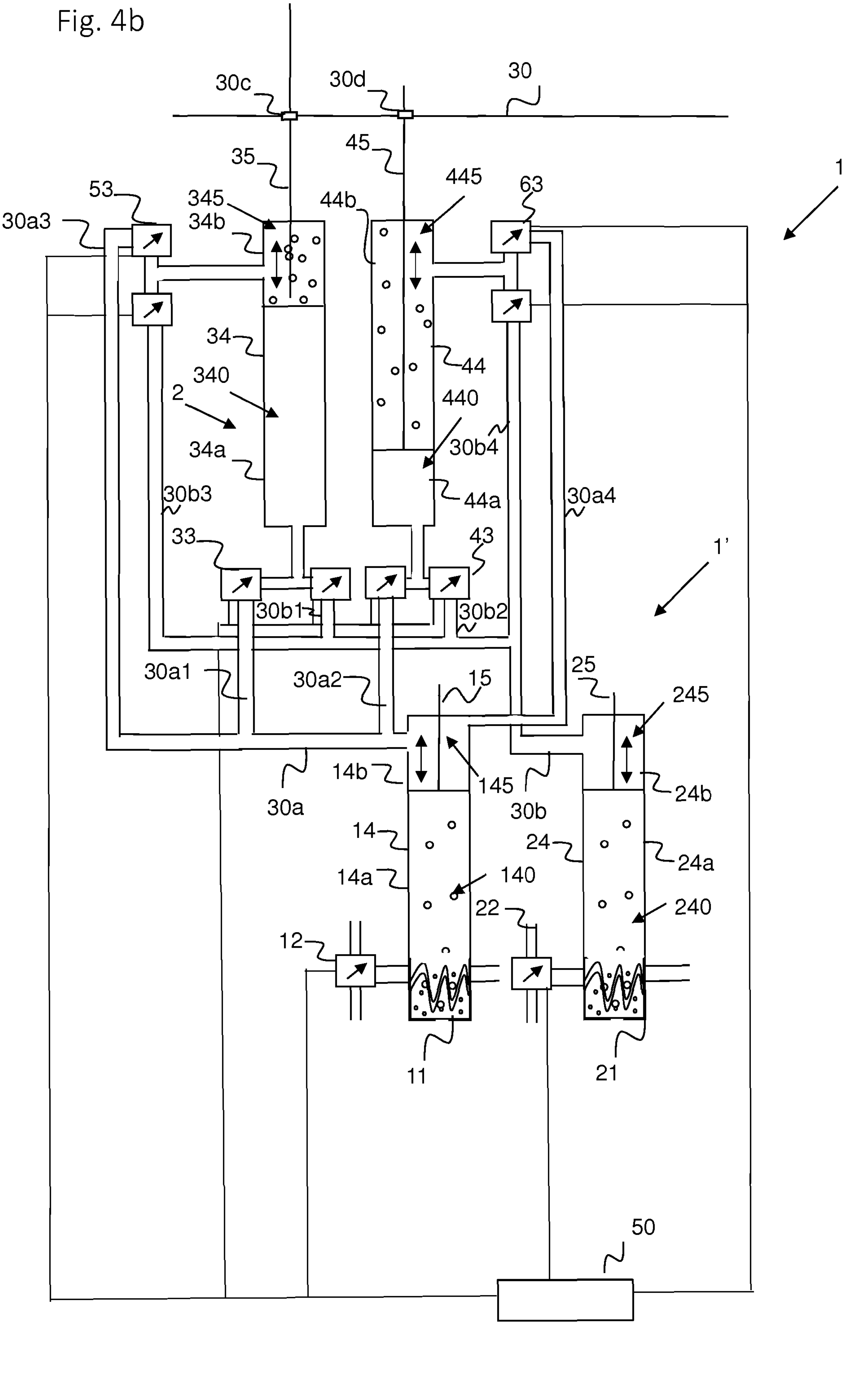
30a1
30a2
30b1
15
25
245
14b
145
24b
30a
30b
14
24
24a
14a
140
22
240
12
11
21
50

Fig. 4a

Fig. 4b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44a
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33
43
1'
30b1
30b2
30a1
30a2
15
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30b
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24
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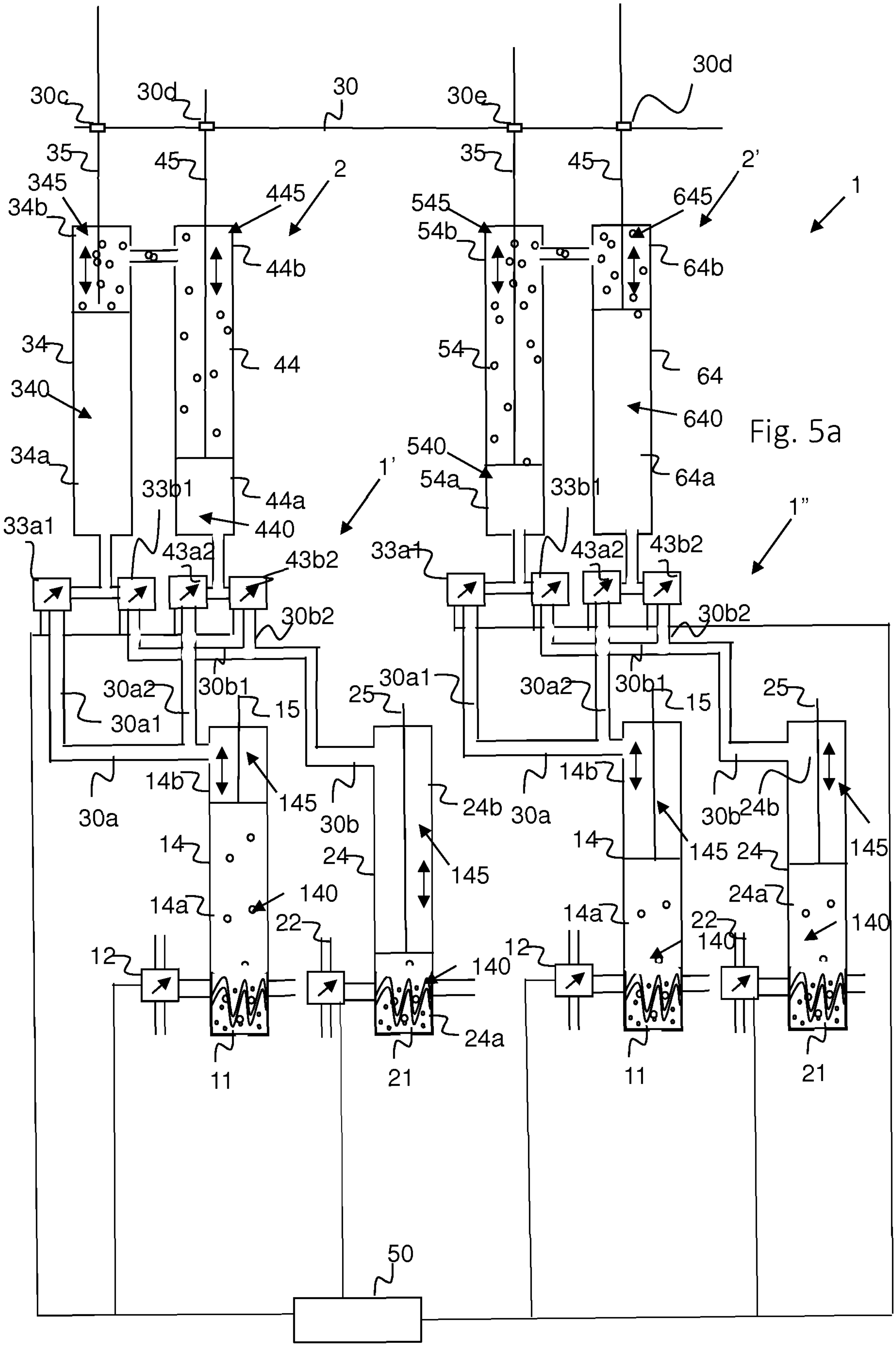
14a
140
240
22
12
11
21
50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30
30e
30d
35
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35
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345
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445
2
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645
2'
1
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64b
34
44
54
64
340
640
540
54a
34a
64a
33b1
44a
33b1
33a1
440
1'
1"
43a2
43b2
33a1
43a2
43b2
30b2
30b2
30a2
30b1
30a1
30a2
30b1
25
15
25
30a1
15
14b
14b
30a
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24b
30a
30b
24b
14
24
145
145
24
145
14a
140
14a
22
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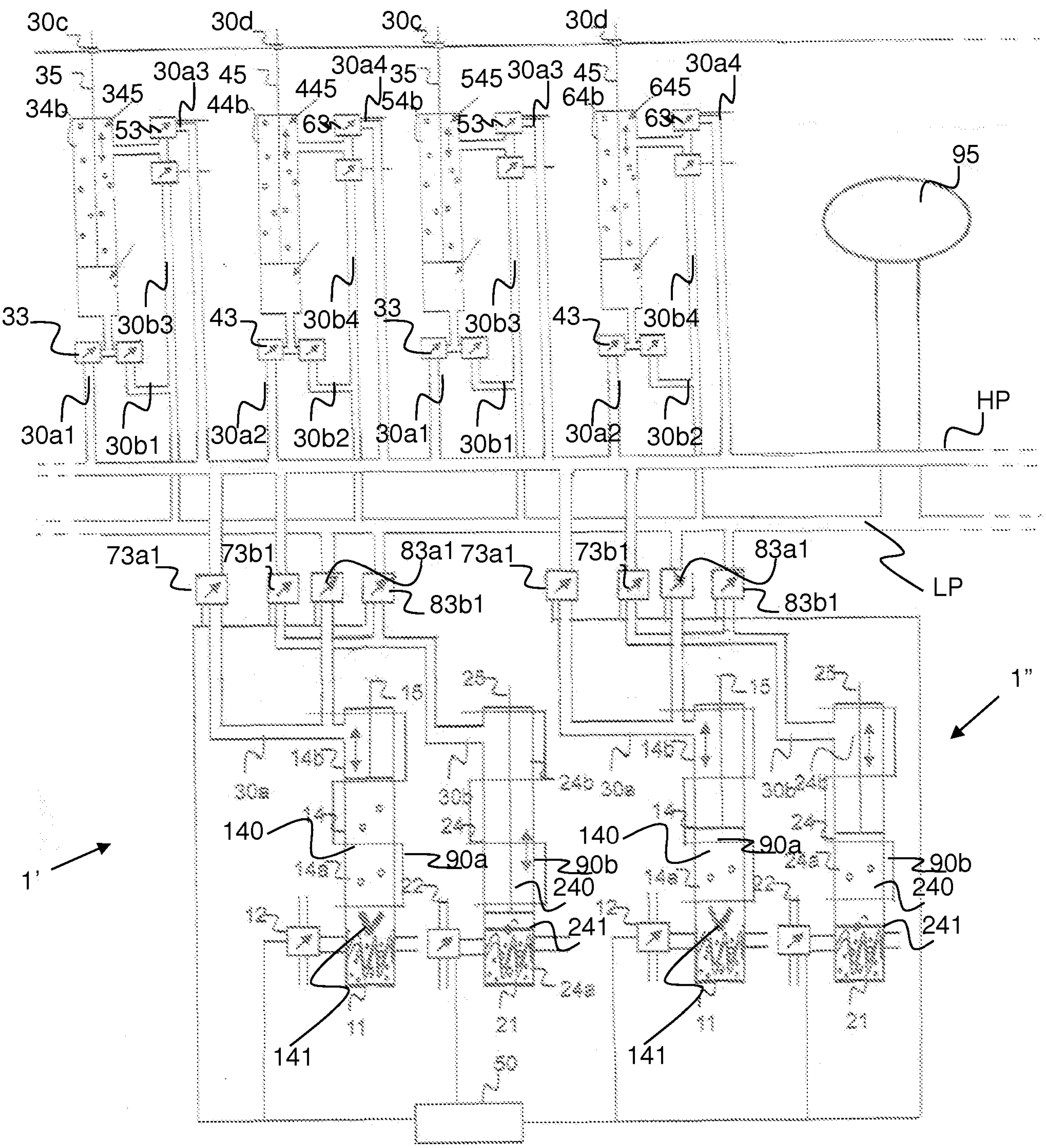
12
140
24a
11
21
11
21
50
Fig. 5a

Fig. 5b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64b
53
63
53
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95
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30b3
43
30b4
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30a2
30b2
30a1
30b1
30a2
30b2
HP
73a1
73b1
83a1
83b1
73a1
73b1
83a1
83b1
LP
1"
15
25
15
25
14b
24b
14b
24b
30a
30b
30a
30b
140
90a
90b
240
140
90a
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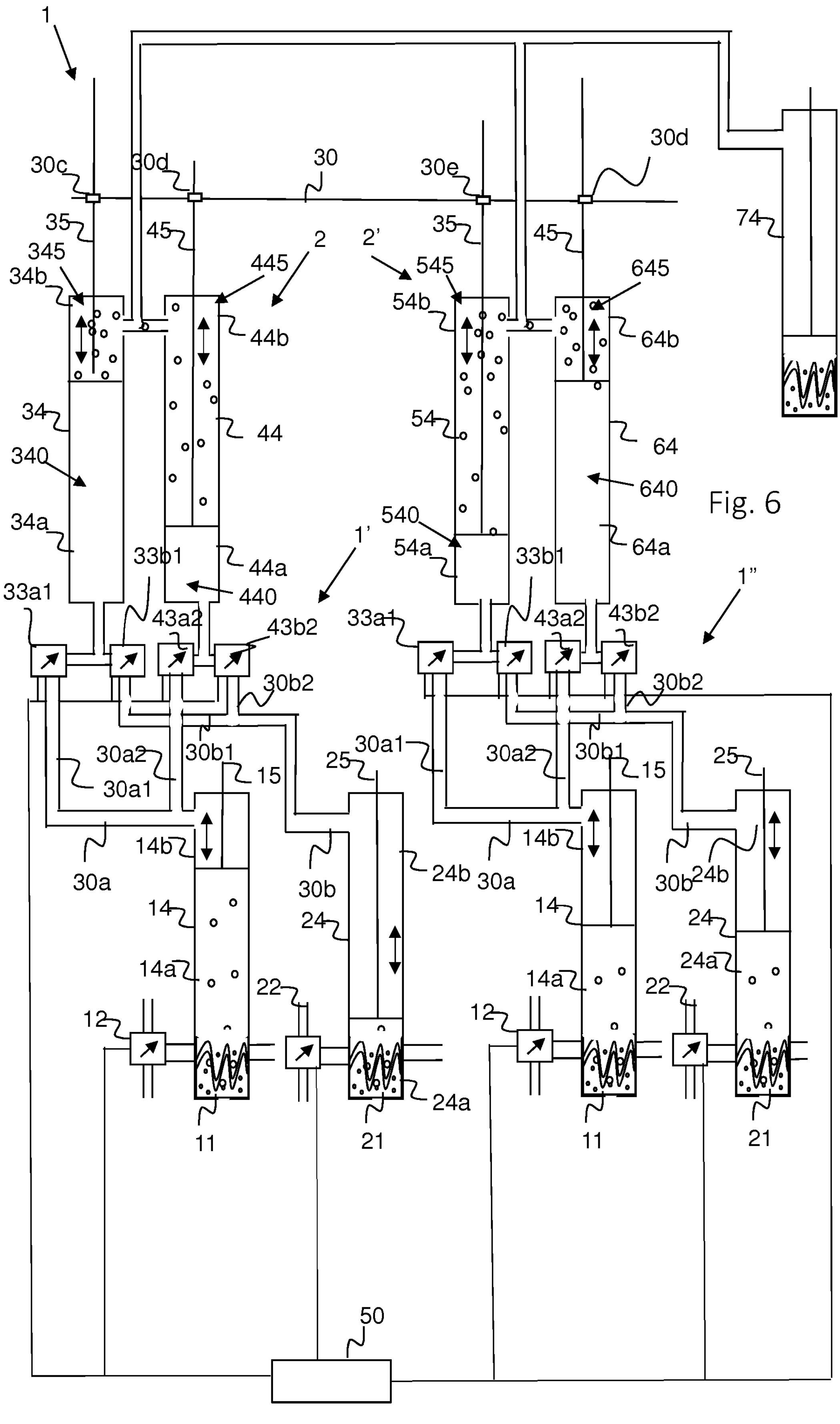
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640
34a
540
54a
64a
33b1
44a
1'
33b1
33a1
440
1"
43a2
43b2
33a1
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43b2
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30b2
30a2
30b1
30a1
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24b
30a
30b
24b
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24a
22
14a
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12
24a
11
21
11
21
50

Fig. 6

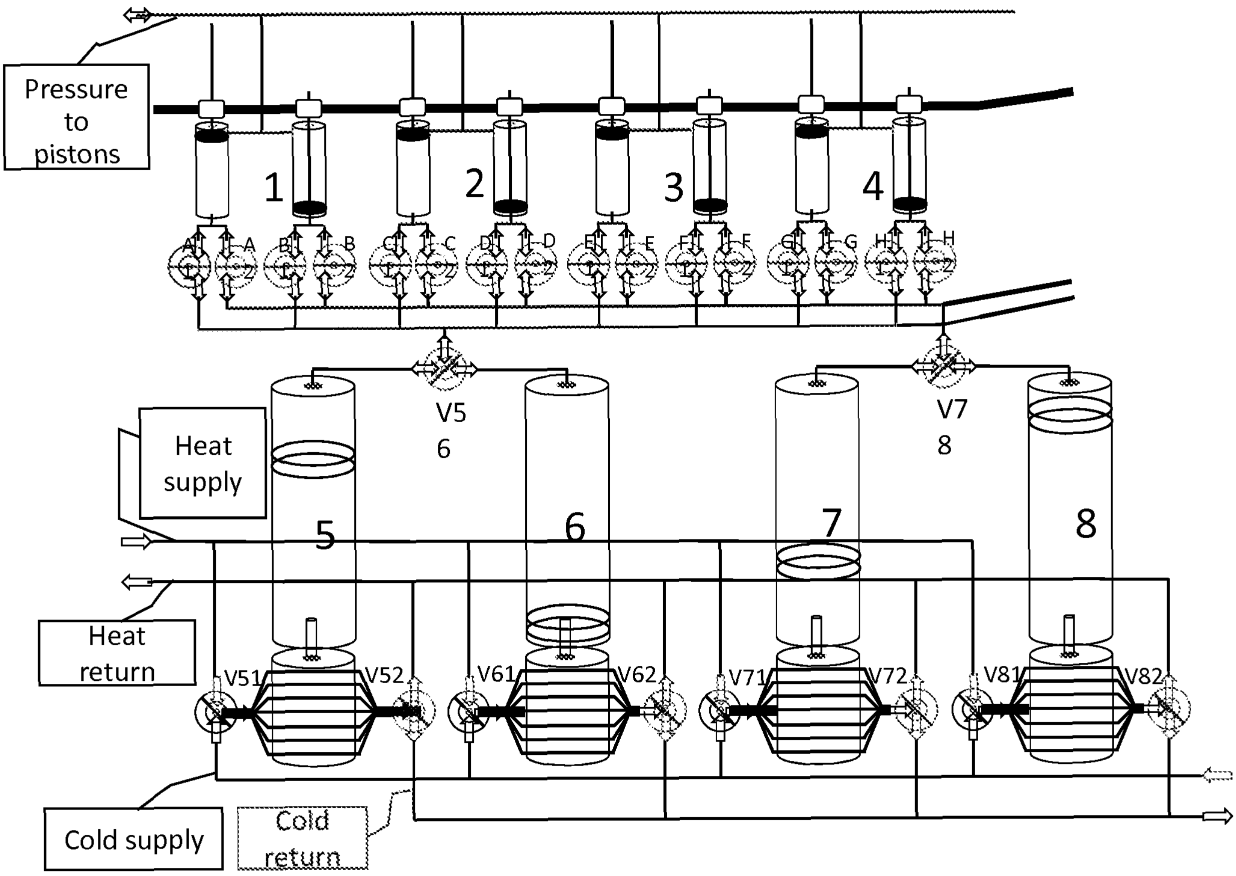
Pressure to pistons
1
2
3
4
A
A
B
B
C
C
D
D
E
E
F
F
G
G
H
H
V5 6
V7 8
Heat supply
Heat return
5
6
7
8
V51
V52
V61
V62
V71
V72
V81
V82
Cold supply
Cold return

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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- US 2008307785 A **[0002]**