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METHOD AND DEVICE FOR CONVERTING HEAT ENERGY
INTO MECHANICAL ENERGY

5 Field of Invention:

The present invention relates to a process of the conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium, primarily
10 gas in number of steps, and simultaneously relates to an apparatus for performing the process.

Background to the Invention:

15 There are known concepts of the conversion of heat energy into mechanical energy, where temperature and pressure is changed in the workspace with alternately changing volume. As the volume decreases, temperature and pressure increase both due to this volume change and primarily, in the last stage, due to
20 the volume decreasing, or optionally, in the first stage due to the volume reincreasing, by the additional supply of heat energy either from the exterior, or from the heat generation (e.g. combustion) inside the workspace. As the volume reincreases, the pressure (originated from the previous
25 workspace volume decreasing), after loss deduction, performs the work needed for consecutive volume decreasing. While the pressure, originated from the additional heat energy supply, after the loss deduction, performs the resulting mechanical work. At the permanently closed work space concept, the work
30 medium temperature (due to the additional heat energy supply) would be, at the end of the operating cycle, greater than the temperature at the beginning of the previous volume



G00002

--2--

increasing. So that, during an exterior heat supply, the medium temperature would reach the temperature, where the heat is supplied from the exterior and the temperature difference and also volume of the supplied heat would be, without a view
5 to the losses, zero. The heat supply, developed in the medium, would stop due to the lack of oxygen, at the permanently closed workspace. It is therefore necessary to open the workspace for the used medium exhaust and the fresh medium supply for a certain time, namely both at the beginning of the
10 volume decreasing, or before it and at the end of the volume increasing, or after it. The power cycle of the pressure and temperature variations, during the volume increasing and decreasing, proceeds in two stages. If there are other two stages added to the previous ones (i.e. volume increasing for
15 the used medium supply and volume decreasing for the used medium exhaust) then there is the four-cycle process of the conversion of heat energy into mechanical energy implemented. If the medium supply and exhaust take place at the beginning of the first stage, or respectively at the end of the second
20 stage, then the two-cycle process is implemented. All of these processes take place according to the known state of art in one workspace, exceptionally divided into two parts.

Summary of the Invention:

25 According to the present invention, work medium is sucked to the conversion of heat energy into mechanical energy by means of pressure and temperature change of the work medium into the first stage simultaneously with the volume increasing of this
30 stage, whereby it transfers into the second stage during the first stage volume decreasing, whereby it transfers (during the second stage volume decreasing) through the third stage,

--3--

simultaneously with the fourth stage heat supply and
simultaneously with this fourth stage volume increasing,
whereby it transfers from the fourth stage (during its stage
volume decreasing) into the fifth stage, where it is permitted
5 to expand. The concept according to the present invention is
described by the transfer of work medium through the third
stage simultaneously with the second stage decreasing,
simultaneously with warming, into the fifth stage, or can be
described by cooling during the transfer of the medium through
10 the first stage into the second one. Another aspect of the
present invention is that the work medium is transferred,
simultaneously with its cooling, from the fifth stage into the
first stage simultaneously with this first stage volume
increasing. The concept can be, according to the present
15 invention, modified so that the work medium is transferred
from the fifth stage, simultaneously with its volume
decreasing, into the third stage and is used for the warming
process, or that the fifth stage is joined with the first
stage and simultaneously with decreasing of the volume of this
20 joined stage is work medium (optionally with the simultaneous
cooling) transferred directly into the second stage,
simultaneously with increasing the volumes of this second
stage. The apparatus for a multistage conversion of heat
energy into mechanical energy by means of changing volume,
25 pressure and temperature of the work medium has the third
stage in form of a workspace with an invariable volume, while
the other stages are arranged as workspaces with variable
volume (particularly as piston machines with the revolving
piston) and are functionally, in a way of the work medium
30 transfer, arranged one behind the other, partly before the
third stage and partly behind the third stage. The apparatus
for performing the present invention is further adapted in a

--4--

way, so that the largest volume of the first stage is larger than the largest volume of the second stage, while the largest volume of the fifth stage is larger than the largest volume of the fourth stage, while the largest volume of the fifth stage is larger than the largest volume of the first stage or equal to the largest volume of the first stage. The apparatus, according to the present invention, can be furthermore arranged, so that the fifth stage concurrently forms the first one. According to another aspect of the present invention, the third stage is created as a combustion chamber and/or a heat exchanger. The present invention is furthermore expediently adapted so that the fifth stage is equipped by the inlet valve. According to this aspect of the present invention, the cooler is inserted between the first stage and the second stage, and also between the fifth stage and the first stage and also between the joined stage and the second stage.

Brief Description of the Drawings:

The present invention is readily understood from the Drawings, in which:

Figure 1 shows an apparatus of the present invention; Figure 2 shows a version with the cooler between the first stage and the second stage and also between the fifth stage and the first stage in accordance with the present invention; and

Figure 3 shows a concept with the first stage joined together with the fifth stage and a concept with the cooler between the fifth stage and the second stage in accordance with the present invention.

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Detailed Description:

Work medium is brought into the first stage 1 during the first stage volume increasing, as in Figuer 1, whereby it is, during
5 the first stage 1 volume decreasing, it is transferred into the stage 2, simultaneously with its volume increasing. It is then, during the second stage 2 volume decreasing, transferred into the third stage 3. While transferring through the third stage 3, heat is supplied into work medium either from inside
10 by fuel combustion, or from outside by the third stage heating e.g. by exterior combustion. Work medium is transferred from the third stage 3 into the fourth stage 4, whose volume simultaneously increases, whereon it is, from the fourth stage 4, concurrently with its volume decreasing, transferred into
15 the fifth stage 5. In this fifth stage 5, the work medium is allowed to expand within its volume increasing. Work medium is after its expansion, concurrently with the fifth stage 5 volume decreasing, either conducted outside, or inside back into the first stage 1. When using air as a work medium and
20 exterior combustion as a concept of the heat supply into the third stage, it is convenient to use expanded, but hot, air for the inside combustion. The present invention therefore presents five-cycle thermo dynamical cycle. These can be convenient, in some cases, to avoid the fourth stage 4 and to
25 transfer work medium into the fifth stage and allow it to expand in this stage. It is convenient, when work medium is cooled inside the interstage cooler 6, during its transfer from the stage 1 into the second stage 2 (see Picture 2). In the closed cycle, where the work medium is transferred from
30 the fifth stage 5 back into the first stage 1, it is convenient to insert other interstage cooler 7 between the fifth and the first stage. It is also convenient, in some

--6--

cases, according to the other invention concept, to join the fifth and the first stage into the joined stage 51 and to transfer (during this joined stage volume re-decreasing) work medium, expanded during the joined stage 51 volume increasing, into the second stage 2, simultaneously with this second stage increasing, optionally through the joined interstage cooler 76. The basic five-stroke cycle is, in this case, adapted into the three-stroke cycles.

10 The apparatus, as described above, performing the conversion of heat energy into mechanical energy is according to the invention, arranged in a way, so that the third stage 3 composes from, at least, one workspace with an invariable volume, while the other stages 1, 2, 4, 5, 51 are created as
15 workspaces with the variable volumes. It is convenient to create all the stages, excluding the third one, as piston machines with the revolving piston. Where the cusps edges join together during the piston revolution above each plane, the space volume may be enclosed by this area and the inclined
20 inside cylinder plane, where the piston revolves in, decreases. Here, the largest volume of the first stage 1 is larger than the largest volume of the second stage 2, and furthermore, the largest volume of the fifth stage 5 is larger than the largest volume of the fourth stage 4 and the largest
25 volume of the stage 5 is larger than the largest volume of the stage 1. The largest volume of the joined stage 51 is larger than the largest volume of the stage 4 and also larger than the largest volume of the stage 2. The third stage 3 is created as a combustion chamber and/or as a heat exchanger.
30 Work medium is firstly supplied (e.g. by sucking) into the increasing volume of the first stage 1. After reaching maximum, the volume of this stage begins to decrease and work

--7--

medium is exhausted into the increasing volume of the second stage 2. Because the largest volume of the second stage is many times smaller than the largest volume of the first stage 1, the state of work medium changes so that, after its shift
5 from the first stage 1 into the second stage 2, this medium has higher pressure and also higher temperature. If the temperature increase is not desirable, it is possible to insert the interstage cooler 6 between both of the stages according to the Figure 2. When the volume again decreases in
10 the second stage 2, work medium is transferred from it through the third stage 3 into the fourth stage 4, while increasing its volume. Heat is supplied into work medium in the third stage 3 either by inside combustion, where the stage is made as a heat exchanger, or by inside combustion in a way of the
15 combustion in the turbine's combustion chambers, but under considerably higher pressure. Because the largest volume of the fourth stage 4 is generally equal to the largest volume of the second stage 2, work medium has in the fourth stage 4, after warming in the third stage, in the final state, higher
20 pressure and also higher temperature contrary to the initial state in the second stage 2. Work medium expands from decreasing volume of the fourth stage 4 into increasing volume of the fifth stage 5, where it performs work. It is also possible to adapt this apparatus according to the present
25 invention, so that the largest volume of the fourth stage 4 is larger than the largest volume of the second stage 2, so that the partial isobaric to isothermal expansion between both of the stages will occur and this adaptation will reach Carnot's cycle concept. In an extreme case, it is possible to
30 completely avoid the fourth stage and to let work medium expand from the second stage 2, during warming in the third stage 3, into the fifth stage 5. The third stage has a nonzero

--8--

volume so that, if there is no heat supplied, the partial expansion occurs at the beginning of the work medium transfer and after transferring through the third stage into the fourth stage, work medium has lower pressure and also lower

5 temperature then in the second stage. However, due to this lower pressure, the fourth stage takes proportionally lower weighted quantity of work medium than it is supplied into the third stage from the second stage and the residual quantity generates, or optionally increases, the residual pressure in

10 the third stage. According to the size of the third stage, in this manner also without heat supply, the pressure in the third stage very quickly rises, so that expansion, within the work medium transfer from the second stage into the third stage, does not occur and it is possible to supply heat under

15 the pressure given by compressed work medium from the first stage into the second stage. It is therefore possible to dimension the third stage both as a combustion chamber with a small external area, so that needles heat leak does not occur, and as a heat exchanger with a large area, so that it is

20 possible to supply the largest heat quantity possible. In order to supply the largest possible heat quantity into the third stage and to decrease the work expended during the compressional stage of the cycle, it is, if possible, needed to decrease temperature during the transfer from the first

25 stage into the second one. It is, according to the present invention, enabled by inserting the interstage cooler 6

between the first stage 1 and the second stage 2. At the enclosed cycle, where work medium is transferred from the fifth stage 5 back into the first stage 1, it is appropriate

30 to insert an innerstage cooler 7 between these two stages. At the configuration according to the invention, it is possible to choose, independently upon the compression ratio, magnitude

--9--

of the expansion ratio, so that it is possible to expand
compressed to the pressure of the surrounding environment and
heated work medium, whereby a good cycle efficiency is
reached. At the given expansion ratio, the pressure at the end
5 of the expansion is given by magnitude of the pressure at its
beginning and this pressure, at the end of the expansion, can
therefore, at the smaller heat supply, drop under the
surrounding environment pressure. If this phenomenon is not
desirable, it is possible to incorporate other inventive
10 aspects i.e. additional work medium inlet through the inlet
valve 8 at the end of the expansion. The power cycle, realized
according to the present invention and apparatus, is therefore
five-stroke cycles. At certain expansion ratio magnitude in
the fifth stage 5 (i.e. the ratio between the largest volumes
15 of the fifth and fourth stages), not only the pressure at the
end of the expansion, but also the temperature drops to the
value of the surrounding environment. It is therefore possible
at the enclosed cycle and at the outside work medium warming,
which take place in the third stage 3, according to the other
20 invention character, to join the fifth stage 5 with the first
stage 1 according to Figure 3 and to transfer work medium
after expansion in the convenient way from the joined stage 51
through the interstage cooler 76 into the second stage 2
concurrently with its compression. In this case, it is also
25 desirable to equip the joined stage 51 by the inlet valve 8.
It is therefore possible, in some cases, within the invention,
to adapt the five-stroke cycle to the three-stroke cycle.

The present invention is, both according to the design
30 examples mentioned previously and in comparison to the other
known heat engines, more convenient especially by its
possibility to allow higher working pressure and temperature

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then turbine engines, longer warming of the compressed work medium and lower pressure and temperature at the end of the expansion than so far known piston engines. Higher cycle efficiency, lower emissions of the carbon and nitrogen oxides, 5 lower noise in the case of work medium warming by external or internal combustion is the outcome of the present invention. It is also possible to use the present invention for the conversion of solar energy into mechanical energy.

-- 11 --

Patent claims

1. A process of the multistage conversion of heat energy into mechanical energy by means of changing volume, pressure and
5 temperature of the work medium, primarily gas,

characterized in that

the work medium is sucked into the first stage, concurrently
with enlarging of the volume of the first stage, whereon the
work medium is transferred, concurrently with the decreasing
10 of the volume of the first stage into the second stage with
enlarging of the volume of the second stage whereon the work
medium is further transferred, concurrently with the second
stage volume decreasing and with the concurrent heat supply,
through the third stage into the fourth stage with this stage
15 volume increasing, whereon the work medium is furthermore
transferred, concurrently from the fourth stage into the fifth
stage with decreasing of the volume of the fourth stage and it
is finally allowed to expand in the fifth stage, concurrently
with its volume increasing.

20 2. The process according to Claim 1,
characterized in that

the work medium is transferred through the third stage
directly into the fifth stage concurrently with the second
25 stage volume decreasing and with concurrent warming.

3. The process according to Claims 1 or 2,
characterized by

-- 12 --

cooling of the work medium during the transfer from the first stage into the second stage.

4. A process according to any one of Claims 1, 2, or 3,

5 characterized by

transferring the work medium from the fifth stage into the first stage concurrently with cooling, with the volume decreasing of the fifth stage and with the volume increasing of the first stage.

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5. A process according to any one of Claims 1, 2, or 3,

characterized in that

the work medium is transferred from the fifth stage into the third stage concurrently with the volume decreasing of the

15 fifth stage and used for a warming process.

6. A process according to Claim 1,

characterized in that

the work medium is transferred from the fifth stage directly to the second stage concurrently with the volume decreasing of the fifth stage and/or cooling and second stage volume increasing.

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25 7. An apparatus for the multistage conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium according to any one of Claims 1, 2, 3, 4, 5, or 6,

-- 13 --

characterized in that

the third stage (3) is created as, at least, one working space with an invariable volume, while the other stages (1, 2, 4, 5) are created as workspaces with variable volumes, namely as

5 piston machines with the revolving piston, and are functionally (in sense of the work medium transfer) arranged one behind the other partly before the third stage (3) and partly behind this stage.

10 8. An apparatus according to Claim 7,
characterized in that

the largest volume of the first stage (1) is larger than the largest volume of the second stage (2), whereto the largest volume of the fifth stage (5) is larger than the largest
15 volume of the fourth stage (4), and whereto the largest volume of the fifth stage (5) is larger or equal to the largest volume of the first stage (1).

9. An apparatus according to Claim 7 or 8,
20 characterized in that

the fifth stage (5) is joined with the first stage (1).

10. An apparatus according to any one of Claims 7, 8, or 9,
characterized in that
25 the third stage (3) is created as a combustion chamber and/or as a heat exchanger.

-- 14 --

11. An apparatus according to any one of Claims 7, 8, 9, or 10,

characterized in that

the fifth stage (5) is provided with an inlet valve (8).

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12. An apparatus according to any one of Claims 7, 8, 9, 10, or 11,

characterized in that

10 the interstage cooler (6,7) is placed between the first stage (1) and the second stage (2) and between the fifth stage (5) and the first stage (1) as well and the cooler (76) is placed between joined stage (51) and the second stage (2).