(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 October 2025 (30.10.2025)

WIPO | PCT

(10) International Publication Number
WO 2025/224471 A1

(51) International Patent Classification:
F03G 7/10 (2006.01)

(21) International Application Number:
PCT/HU2025/050020

(22) International Filing Date:
10 April 2025 (10.04.2025)

(25) Filing Language: Hungarian

(26) Publication Language: English

(30) Priority Data:

P2400235	25 April 2024 (25.04.2024)	HU
P2500094	28 March 2025 (28.03.2025)	HU

(72) Inventor; and
(71) Applicant: MARCZ, Henrik [HU/HU]; Szeder utca 46., 8000 Székesfehérvár (HU).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UY, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

(54) Title: PROCESS FOR COOLING AND FOR THE USE OF ENVIRONMENTAL HEAT

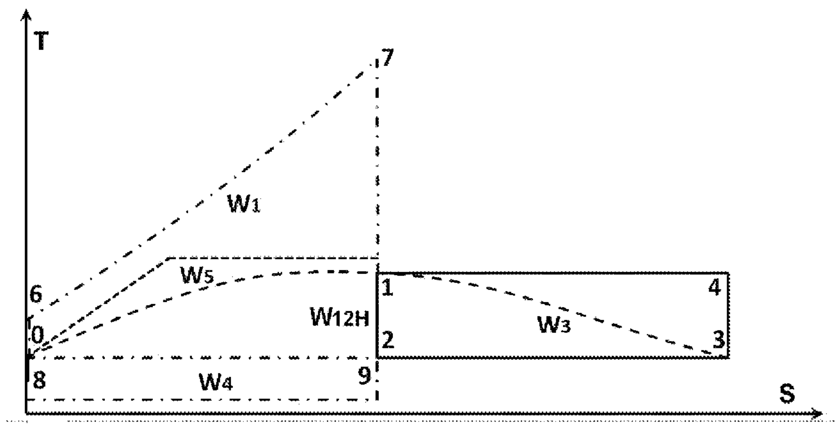

Figure 1

(57) Abstract: The present invention relates to a process for cooling and for the use of environmental heat, where the following steps are carried out, implemented in a thermodynamic machine: a) the working fluid being in steam state is adiabatically expanded (1-2), b) the working fluid being in wet-steam state is separated according to state into liquid (0) and steam (3) components, c) the temperature of the working fluid being in steam state (3) is increased by adiabatic compression (3-4), d) the working fluids of liquid (0) and steam (4) are compressed (4-1) and mixed at the same time, keeping the temperature of the steam (4) at a constant level by means of the compression, and generating steam (1) of stable state through the evaporation of the liquid (0), e) the process is repeated periodically.

WO 2025/224471 A1

Process for cooling and for the use of environmental heat

The present invention relates to a process for cooling and for the use of environmental heat, such process being able to perform cooling economically even at cryogenic temperatures when implemented in a thermodynamic machine designed for that specific purpose. Its essence is that it converts the thermal energy absorbed by it during cooling into work.

Nowadays, the vast majority of the energy demand of our society is generated by means of heat engines and internal combustion engines, and their operation requires the use of large quantities of harmful and expensive fuels like coal, gas, petrol etc. This situation has led to the generation of the demand for the use of a lot of waste and environmental heat (hereinafter collectively: environmental heat) to produce mechanical and/or electric energy in a clean and cost-efficient manner.

Refrigeration machines known today work at temperatures close to the ambient temperature, since the working fluid heated over the ambient temperature by the compressor can only release the thermal energy absorbed by it during the cooling process in this manner to the environment. This conventional process is the only cooling method accepted widely at the present time. This process forms a basis for the assumption that no machine with periodic operation can be created to produce useful energy by using environmental heat.

A solution similar to the present invention is described in the patent document with Publication No JP 2003336573 A about a new energy production system and equipment maintaining a heat - pressure cycle, where the environmental heat of the soil is intended to be utilised for mechanical work. During the process, the working fluid being in the state of saturated steam is expanded adiabatically; the generated working fluid being in the state of wet steam is separated into the components of liquid and saturated steam; then the liquid is compressed and heated by environmental heat, causing it to return to its initial state; the saturated steam is heated by environmental heat in a constant-volume process and returned to its initial state by compressing it at a constant temperature; finally, the generated steam-steam components are mixed together and the process is repeated periodically. We think that then the mixture contains about 5% liquid, the rest being steam. If this fluid is expanded, no liquid that can be used freely will be generated in the next cycle, and so the cycle will not be closed and the system will stop. It is a difficulty that if the liquid is evaporated in a heat exchanger, there will be no opportunity for returning to the original state by means of the boiling heat demand. Consequently, the cycle will not be closed, so this method is not suitable for generating a cyclic process.

In consideration of the state-of-the art technology, our set objective was to develop a process for cooling and for the use of environmental heat where the thermal energy absorbed during cooling is used for the thermal energy required for the evaporation of the liquid-state working fluid; so this process is independent of the environmental temperature and is able to perform cooling cost-efficiently at any temperature, while the energy absorbed by it is transformed to work.

Since thermal energy flows from the warmer place to the colder one, the heat engine has to implement the process at a temperature below the ambient temperature. During the conventional process of a thermal power plant, exhaust steam is cooled by environmental heat and compressed by pressure to the highest possible density, that is until reaching the liquid state. This process cannot be taken into account in the case of a heat engine operating below the ambient temperature, since a classical refrigeration machine would consume more energy than the produced energy. Therefore, the heat engine must solve the cooling independent of the environmental heat.

It is the source of the liquid working fluid - the heat of vaporisation - that can generate the highest cooling effect. Figure 1 shows the following things:

- the gas of high temperature and high pressure expands, losing its temperature and pressure thereby, while getting from point 1 to 2. A part of the working fluid condensates during this process, while the remaining steam cools and expands. At the end of this stage, the energy of the liquid is reduced to the same extent as the energy of the steam increases, but as a whole it will be reduced by the generated work. The role of the liquid being at low energy level is to ensure the cooling effect for the recompression of the steam;
- if the liquid and the steam compressed to higher temperature are loaded into a mixing cylinder in pre-determined amounts, an unstable state will occur. The liquid starts to vaporise and extracts heat equal to its boiling heat from the steam. The vaporised liquid gets mixed with the steam, increasing the density of the steam thereby, but, first of all, the liquid cools the working fluid being in steam state.

We have recognised that if the decrease in temperature is prevented by compression, the working fluid starts to get denser for two reasons: due to compression on the one side, and due to the increase in volume of the vaporised and expanded liquid on the other side. This way a cooling cycle is created where the steam-state working fluid is restored to its original condition. For this process, there is no need for adding all the liquid to the mixture to recompress the steam-state working fluid into its original condition, and the rest of the liquid can be used freely.

The expressed objectives are implemented by means of a thermodynamic process suitable for cooling and for the use of environmental heat, and this process is carried out by a thermodynamic machine in the following steps:

a) the steam is expanded in the mixed-phase field,
b) the working fluid being in wet-steam state is separated according to state into liquid and steam components,
c) the temperature of the steam is increased,
d) the steam and the liquid are mixed together and compressed at the same time,
e) the cycle a)-d) is repeated periodically.

The scope of the invention includes an integrated cooler power plant (CoolerPowerplant) using the present thermodynamic process suitable for cooling and for the use of environment heat to operate a small or a large power station.

The inventive process for cooling and for the use of environmental heat consumes a part of the produced work, but the rest (see Drawing A in Figure 3) can be used as useful energy. This is the direct CoolerPowerplant Co/Pp or CoPp.

In the case of the inventive cooling process, the thermal energy absorbed during the cooling stage is consumed by the thermal energy demand of the liquid-state working fluid, id est the process is independent of the environmental temperature and is able to perform cooling economically at any temperature. To sum up, one could say that the absorbed energy is converted into work.

Another important purpose of the cooling process is to achieve the utilisation of environmental heat in a manner where the CoolerPowerplant CoPp (see Drawing B in Figure 3) makes the conventional power plant process Pp operational at a temperature below the ambient temperature as a result of cooling the working fluid from exhaust steam state back to liquid state. An advantage of the power plant below the ambient temperature is that the conversion of the working fluid into high-pressure saturated steam is not made by a conventional boiler but by a heat exchanger that gets energy from the environmental heat. This is another type of the process for the use of environmental heat. By the application of the present CoolerPowerplant as basic machine, the utilisation of environmental heat by Pp can be achieved by means of known technical solutions.

The cooler power plant Co/Pp or CoPp shown in Figure 3 is the equivalent Carnot rectangle of the process shown in Figures 1 and 4,

while Pp is a rectangle illustrating the work that can be produced by the integrated heat engines.

Drawing A shows a high-temperature CoPp (CoolerPowerplant), Drawing B shows CoPp+Pp = a medium-level integrated CoolerPowerplant with an integrated heat engine, and Drawing C shows Co/Pp+2*Pp = CoolerPowerplant with 2 integrated heat engines.

It must be noted that the second law of thermodynamics is generally misunderstood, assuming that it is not possible to create a machine with continuous operation that can generate useful energy from environmental heat. This is usually illustrated in a T-s diagram. It is shown in the drawing Pp+Co in Figure 3. The smaller rectangle Pp in the foreground represents the Carnot cycle of the heat engine, while the larger rectangle Co behind it is the cycle of the cooler. The areas of the rectangles are proportional to the quantity of work. This means that the cooler requires more work than the work that can be produced by the heat engine, which is unreasonable, making loss.

The set objectives of the invention can be achieved by means of the processes characterised in Claims 1, 2 and 6, the preferred embodiments of which being described in the sub-claims.

The invention is described in detail with reference to the attached drawings, where

- Figure 1 shows the T-S diagram of the thermodynamic process suitable for cooling and for the use of environmental heat,
- Figure 2 is the schematic drawing of the machine implementing the process,
- Figure 3 illustrates the CoolerPowerplant implementing the process according to Figure 1, using state-of-the-art technology,
- Figure 4 shows the T-S diagram of Example 1,
- Figure 5 is the schematic drawing of Example 1,
- Figure 6 shows the T-S diagram of Example 2,
- Figure 7 is the schematic drawing of Example 2,
- Figure 8 shows the T-S diagram of Example 3, and
- Figure 9 is the schematic drawing of Example 3.

In the description hereunder, the following expressions and symbols are used:

- Thermodynamic process (hereinafter: basic process), represented by the symbol W3;
- Basic machine: a machine implementing the combination of the basic process and the process that carries out the utilisation of the liquid generated by the basic process. Symbol: Co/Pp or CoPp.
- Example 1: CoolerPowerplant. It only consists of the basic machine; symbol: CoPp.
- Example 2: Basic machine + power plant process; symbol: CoPp+Pp
- Example 3: Basic machine + power plant processes; symbol: Co/Pp+2*Pp

The rectangle drawn with continuous line in Figure 1 illustrates the inventive thermodynamic process as basic process. Numbers 1 - 11 in the description indicate the places of status change.

I. The basic process W3

The cycle indicated by the points 1-2-3-4-1 in Figure 1 is one of the basic processes W3.

a) 1-->2: the working fluid is expanded.

b) The expansion 1-2 is necessary to separate the working fluid into the phases of liquid and ~~saturated~~ steam; the heat is converted into work in this stage. In the process 1-2, the working fluid passes along the saturation curve between 1-0 and 1-3, and decomposes into liquid 0 and ~~saturated~~ steam 3.

c) The temperature of the steam 3 is increased by compression up to the specified temperature 4.

d) 4-->1: the working fluid consisting of liquid 0 and steam 4 is compressed and mixed together at the same time. In this step of the process, the temperature fall of the steam 4 can be prevented by loading liquid 0 and steam 4 in adequate quantities into the cylinder C401 and pushing the piston forward, causing the steam get denser. The steam 4 of higher temperature and the liquid 0 of lower temperature create an instable condition where the saturated steam 4 would cool and the liquid 0 would vaporise. If compression is carried out by means of the piston to keep the temperature at a constant level, id est the instable condition is maintained during the vaporisation process, the mixture can reach the point 1. If the mass ratio of liquid 0 and steam 4 is set properly, all liquid vaporises and homogenous steam 1 of stable state is generated thereby. It is important to note that not the entire quantity of the liquid 0 is required for this process.

It must be noted that the basic process W3 is included in each basic machine.

In summary:

Process for cooling and for the use of environmental heat, implemented in a thermodynamic engine,

characterised in that

a) the steam is expanded in the mixed-phase field,

b) the working fluid being in wet-steam state is separated according to state into liquid and steam components,

c) the temperature of the steam is increased,

d) the steam and the liquid are mixed together and compressed at the same time,

e) the cycle a)-d) is repeated periodically.

II. Basic machine Co/Pp

The cycle indicated by the points 1-2-3-4-1 in Figure 1 is the basic process W3. For the process shown in Figure 1, 2 kg working fluid is used: it is separated in the stage a) into 1 kg liquid and 1 kg steam, very similar to a T-s diagram of 1 KJ/kg*K. The rectangle illustrated in Figure 1 has a form of rectangle due to better traceability, but it can also be polytropic except for the line section 2-3.

The characteristics of the cycle illustrated in Figure 1 are as follows:

- there is no need for the entire amount of liquid to return the steam 4 to point 1. This is essential to cooling effect and power source as well;
- no cooling effect is generated during the process, since it will be created by the residual liquid 0;
- the quantity of working fluid is 1 kg in the stage 2-3-4. At the end of the stage 4-1, there will be much more working fluid in the cylinder, but, consequently, its density will also be higher. It can be proved that the calculation of work must be based on the compression of 1 kg working fluid, independent of the fact that the mass of steam working fluid is continuously increasing,
- by reaching the point 1, the mass of the steam working fluid 1 will be increased by the mass of the liquid 0 mixed to it, but it can be shared for the calculation of work. It is reasonable to divide it into 1 kg and the residual W12H, so the section 1-2 of the rectangle also relates to a mass of 1 kg, and the product $W3=\Delta T*\Delta s$ that represents its area clearly gives the value of the work required for the process. The mass-proportional residual work W12H of the adiabatic expansion must be deducted from this value, and so the amount of work to be invested can be determined accurately. If Z is the mass of the added liquid, then $W12H = \Delta H(12)*Z(kg)$.

Characteristics of the cooling effect:

Cooling and the production of useful energy is carried out by the non-mixed residue of the liquid-state working fluid 0. The methods of utilisation of the cooling effect are illustrated by dashed lines in Figure 1.

- the simplest method is middle-level cooling ("Cool-middle"). Then the liquid 0 vaporises along the line 0-2. This process takes place practically in a heat exchanger until reaching the state of steam, but only half of the mass flows through it. The rest of the liquid 0 remains in the collecting tank, maintaining the mass ratio according to the state 2 thereby. In this case, the cooling requires the work W3-W12H shown by continuous line and described for the operation of the cooler;

- low-level cooling ("Cool-low") is carried out when the working fluid passes along the line 0-8-9-2 in the same way as mentioned above. Then the cooling is performed at a lower temperature than in the above case, but its work requirement is W4+W3-W12H, that is higher;
- in the case of high-level cooling (Co/Pp-high) the liquid 0 passes along the line 0-6-7-2. Then the process generates work amounting to W1-W3+W12H, since the mass-proportional area W1 is higher than the work demand W3-W12H. This is called cooler power plant (CoolerPowerplant), which is a commonly accepted process in power plants. In Figure 2, it is indicated by Pp and separated from the basic process Co by a dashed line;
- for the mobile cooler: W3- W12H =W5. This process neither consumes nor produces extra energy. It uses the generated work for its own operation. By choosing suitable working fluid, the system can be operated in a temperature range below the ambient temperature. By repeating the process periodically, cooling and useful energy can be provided continuously.

This process relates to static operation, since it can be followed better when the process is described. In practice, the liquid 0 must be loaded into the mixing cylinder most likely by injection in order to accelerate the process and decrease the cycle time; or, for example, C34 and C401 in Figure 2 can be combined in one component. The piston compresses the steam 4 rapidly, and continues to compress it to the state 1 during the injection of the liquid.

Environmental heat can be any heat suitable for utilisation, including the waste heat of rivers, sea, power stations, firing furnaces, municipal waste etc.

The volume of the liquid was not taken into account in the description or even for the calculations, since its quantity is negligible as compared to that of the steam. In addition, it does not occupy any space in the cylinder in the case of injection-based operation.

Steps of the cooling and CoolerPowerplant process

The cyclic cooling process can be followed in the T-s diagram shown in Figure 1 and in the schematic drawing in Figure 2. Of the units separated by a dashed line in Figure 2, Pp is a traditional power plant, while Co carries out the resetting of the steam back to stage 1.

a) The working fluid being in its initial state in point 1 in Figure 2 is adiabatically expanded in the expansion machine E12 until reaching the required pressure and temperature; then the working fluid gets into the mixed-phase state 2, i.e. it decomposes into liquid 0 and steam 3.

b) The working fluid of liquid state 0 is separated from that of steam state 3 in a settling tank 230.

c) The steam 3 is heated by adiabatic compression in a compression machine C34 until reaching the specified temperature and pressure (point 4).

d) The steam 4 and the liquid 0' pressed by the compression machine C00' to the same pressure are loaded - preferably by injection - in appropriate ratio of mass into the cylinder of the compression machine C401 where the mixing process starts. In the course of mixing, the mixed-state working fluid is compressed by the compression machine C401 so that the temperature of the steam 4 remains constant.

In the case of parameters given hereunder, the steam working fluid 4 with increased mass returns to the high-pressure steam state 1 in the cylinder C401 with decreasing volume due to the double effect. The cylinder C401 works most likely slower than the other machine components, so it is expected that several cylinders will be required within one system. This is why it is reasonable to integrate the buffer tanks P.

The cycle indicated by the points 1-2-3-4-1 in Figure 1 is the basic process W3. Its essence is that in this case it is not the environment but the liquid-state working fluid vaporising in the cylinder C401 that performs cooling during the recompression of the steam-state working fluid.

e) As mentioned before, there is no need for all the liquid to return the expanded steam working fluid 3 back to its original state. The residue of the liquid 0 can be utilised in several ways. Figure 2 shows a generally accepted power plant process.

The working fluid can be expanded further in an expansion machine or through a throttle valve, and then led through a heat exchanger. Thus, it will be able to perform cooling at a lower temperature.

f) The rest of the 0-state liquid goes after adiabatic compression C06 from state 6 at constant pressure in the heat exchanger Q67 with external thermal energy input into state 7. The expansion machine E72 converts the energy of the high-pressure saturated steam 7 into work, and loads it as mixed-phase fluid being in state 2 into the tank 230. This is the cycle W1 where the useful energy is generated. This is a generally accepted power plant process even now.

g) The process is repeated periodically.

In the stage between 6-7 of each cycle of the periodically repeated process, thermal energy is withdrawn from the environment - i.e. cooling is carried out - through the heat exchanger Q67. According to theoretical calculations based on parahydrogen as working fluid, 0.22 kg liquid of 1 kg working fluid has to be added to recompress 0.5 kg steam 4 back into state 1. The remaining 0.28 kg liquid can be used freely. Its cooling effect is S=3 kJ/kg.K, and, depending the utilisation of the liquid, it is able to perform useful work in the amount of W = 0-35 kJ/kg.cycle. Figure 1 shows such a process of W1 with useful work performance of 31 kJ/kg.cycle. If 1 cycle is completed per second, the power will be 31 kW and the energy production 31 kW/h. The following table gives the operating points for the given example. Based on this, the machine can be built and improved by taking the losses into account.

CoolerPowerplant		W_{eff}	31	kJ/kg.cycle	S_{cool}	3	kJ/kg.K.cycle	**Wh by area calculation**		
	T	P	d	v/%	u	h	s	W1		148.477
1	32.799	1.2598	24.738	0.0404	289.08	340.01	11.004	W(1-2)		51.458
2	20.271	0.1013	2.627	0.5%	184.5	223.06	11.004	W3		137.821
3	20.271	0.1013	1.339	0.7471	370.37	446.06	22.005	2	kg	62.1142
4	32.799	0.3329	2.710	0.3690	438.89	561.73	22.005	1	Wh	31.0571
0	20.271	0.1013	70.828	0.0141	-1.433	0.00	0			31
6	25.78	15	79.347	0.0126	8.4182	197.46	0	**Cooling effect**		
7	64.5	15	50	0.02	380.6	680.60	11.004	S6-7	3.08112	
Masses in kg	total	2		Added liquid	0.44	Useful	0.56		3	240 K

The data of the table have been taken from the database of NIST:
https://webbook.nist.gov/chemistry/fluid/ „Thermophysical Properties of Fluid Systems"
According to preliminary calculations, the system can also be operated by means of the solution with expansion valve as used in cooling technology instead of the expansion machine 1-2, but its efficiency is far below that of the process described here. Its use may only be reasonable for household refrigerators produced in large quantities, due to reasons of production technology.
The above sections include the description of the basic process and the cooling method. The following examples describe configurations that can meet various user demands to illustrate the versatility of the process. The basic process can be detected in each example, and it is indicated by the symbol W3.

Examples for the utilisation of the invention

The purpose of these examples is to illustrate the applicability of the basic process.

Example A: Integrated CoolerPowerplant CoPp (Figures 4 and 5)

Example A shows an advanced integrated cooler power plant (symbol: CoPp). It is important that the cooler power plant should possibly be a simple startable/stoppable system without the need of qualified personnel. This is achieved by the fact that is works at a temperature close to the ambient temperate, and so the working fluid of the stopped equipment - e.g. R13 - can also be stored under normal temperature conditions.

The process is shown in the T-S diagram in Figure 4 as well as in the schematic drawing in Figure 5.

It is a principal characteristic of the process that it does not use the residual liquid directly for work operation, but the steam working fluid performs work and the liquid only performs the reduction of entropy in the stage 6-1. It is reasonable to examine the cycle from the point 2 in the following sections. The steam 3 goes through the status changes 3-4-5-6-1-2. The liquid 0 only plays a role in the section 6-1 as one of the components of the mixing process. Regarding work, the section 6-X should be included in the cycle W1, and so the rectangle is closed and the area W1 determines the amount of useful work. Accordingly, the section X-1 should be included in the cycle W3. According to calculations, about 20% liquid is sufficient for the recompression of the exhaust steam 6.

The schematic drawing in Figure 5 shows a machine implementing the above-described process. The compression machine C34 compresses the saturated steam 3 of the working fluid being state 2 in the settling tank 230 to the required temperature and pressure 4. The isothermal expansion machine E45 expands 4-5 the high-pressure steam 4 and performs useful work thereby. The thermal energy necessary for the isothermal process is ensured by environmental heat through a heat exchanger Q, cooling the environment thereby, i.e. it works as a refrigerating machine as well. In the next stage, the expansion machine E56 expands the working fluid from state 5 to state 6 by means of adiabatic expansion. Useful work is generated thereby as well. The recompression from state 6 to state 1 is implemented by mixing, combined with the above-mentioned compression E016. Finally, the working fluid gets from state 1 to state 2 through the adiabatic expansion machine E12 back to the settling tank 230.

Since Figure 5 and the above description are true for Example B as well, they are not described there again.

The adaptation of the process to the ambient temperature lies in the fact that the process can be adjusted to the temperature of the environment by changing the temperature of the stage 4-5.

The machine set to 240 K as shown in Figure 4 can still operate at 100% performance at an ambient temperature of 24 °C, depending on the heat exchanger. It may be required to utilise waste heat of higher temperature. For example, if the exhaust steam coming from a classical power station with a temperature of 60 °C is to be utilised, the process should go along the status changes 3-4’-5’-6 at a higher temperature. In this case, a CoolerPowerplant with much higher efficiency is achieved.

Considering the control opportunities, the system may be optimised for cooling or for energy production mainly by changing the liquid-steam ratio. This can be solved practically along the limiting curve of saturated steam 3 in Figure 4 by changing the point C of the stage 1.

This system is also capable of low-cooling by offsetting the section 1-2 to 1’-2’ at a higher temperature. In the case of the new configuration, the generated reserve liquid is sufficient for implementing low-cooling 10-11. From energetic point of view, this may be necessary if a cooler power plant operating at a lower temperature is to be put into operation, like in the following example, or when the machine is stopped. In this case the control system regulates the process down to the maximum of low-cooling, and as much as possible liquid working fluid is stored in a double-wall tank with good insulation.

Example B: Small power station (Figures 6 and 7)

A small power station uses the oxygen-operated basic machine similar to the one described in Example A, but in cooperation with the power plant process shown in Figure 5; so the sum of the processes CoPp and Pp in drawing B of Figure 3 gives the total power. The cooling effect of the basic machine makes the power plant process applicable by performing the re-liquefaction of the exhaust steam in the stage M-N of the Pp process using R22 as working fluid by means of the cooling effect of the basic machine M-N (see Figure 6). In this way a heat exchanger can implement the production of high-pressure saturated steam instead of a boiler. This is another type of the process for the use of environmental heat.

Example C: Large power station

Both Co/Pp and CoPp described above can be the basic machine of a large power station. In this example we can see a Co/Pp basic machine with parahydrogen as working fluid (Figure 2) and conventional Pp power station processes implemented with nitrogen and oxygen as working fluids. The ratio of the working fluids is similar to the composition of ambient air. The main task of the basic machine is the re-condensation of nitrogen and oxygen. It is reasonable to operate the large power station with the basic machine Co/Pp shown in Figure 1, since it can also condense the heating air; if the heat supply of the system is ensured with air, the heating air will be cooled due to the counter-effect. The -13 °C temperature of the "hot" heating air will be reduced to -186 °C. Using another Co/Pp basic machine, the heating air can also be condensed from this point, and the generated liquefied air can be used by a secondary power station. And this can be repeated several times. If there is no need for the entire power of a power station, the condensed air can be used for storing energy in cold-storage tanks, cooling it by means of a basic machine.

Since in the examples presented here isothermal process was chosen for the stage of compression combined with mixing, the control system must monitor the temperature in the cylinder, which is rather difficult, since mixing takes place not at the level of molecules and local temperature differences may occur. Therefore, it is reasonable to determine the pressure curve and to regulate the displacement of the piston depending on the pressure.

The processes have rectangular form as far as possible, since the generated work can be calculated and understood easily in this way.

The above descriptions show that the invention is capable of achieving the set objectives, since it

- can perform cooling at any temperature;
- is also capable of storing energy indirectly;
- is suitable for liquefying gases and storing them in liquefied state;
- is also suitable for the fractioning distillation of gases;
- can be used as cooler of technologies requiring household or industrial cooling;
- can be the basic machine of power stations, and;
- can also be a power source.

Claims

1. Process for cooling and for the use of environmental heat, implemented in a thermodynamic engine, characterised in that
a) the steam is expanded in the field of mixed-phase state,
b) the working fluid being in wet-steam state is separated according to state into liquid and steam components,
c) the temperature of the steam is increased,
d) the steam and the liquid are mixed and compressed at the same time,
e) the cycle a)-d) is repeated periodically.

2. A process according to claim 1, characterised in that
a) the working fluid being in wet-steam state is expanded (1-2),
b) the working fluid being in wet-steam state is separated according to state into liquid (0) and steam (3) components,
c) the temperature of the working fluid being in steam state (4) is increased by adiabatic compression (3-4), generating an instable condition,
d) the working fluids of liquid (0) and steam (4) are compressed (4-1) and mixed at the same time, keeping the temperature of the steam (4) at a constant level by means of the compression, and generating steam (1) of stable state through the evaporation of the liquid (0),
e) the rest of the liquid (0) is utilised, and
f) the process is repeated periodically.

3. A process according to Claim 2, characterised in that the operation of cooling machine is set by evaporating the rest of the liquid (0) in a heat exchanger until reaching the state of wet steam (2).

4. A process according to Claim 2, characterised in that in step e) the residual liquid (0) is expanded through an expansion machine or a throttle valve, and it is evaporated through a heat exchanger to the state of wet steam (2), then it is returned to its initial pressure (2) by compression.

5. A process according to Claim 2, characterised in that in step e) the residual liquid (0) is loaded into a heat exchanger (6) by a compressor (C06); it is converted into overheated steam

(7) of higher temperature and pressure by external heat input; the overheated steam (7) is used to generate work in an expander (E72); then the wet steam (2) is led into a tank (230) for the purpose of further use.

6. Process to operate an integrated CoolerPowerplant by implementing the process according to Claim 1, characterised in that
a) the steam (4) of the working fluid (2) is compressed until reaching a specified temperature and pressure,
b) the steam (4) is isothermally expanded (4-5) through the input of environmental thermal energy,
c) the working fluid (5) is adiabatically expanded (5-6),
d) the working fluid (6) is compressed and mixed at the same time (6-1), and
e) the working fluid (1) is adiabatically expanded (1-2).

7. Process to operate a small power station by implementing the process according to Claim 6, characterised in that the exhaust steam of the integrated power plant process (M-N) is condensed by means of the cooling effect of the heat exchanger (Q).

8. Process to operate a large power station by implementing the process according to Claim 2, characterised in that the exhaust steam of the integrated power plant process is performed by means of a Co/Pp CoolerPowerplant.

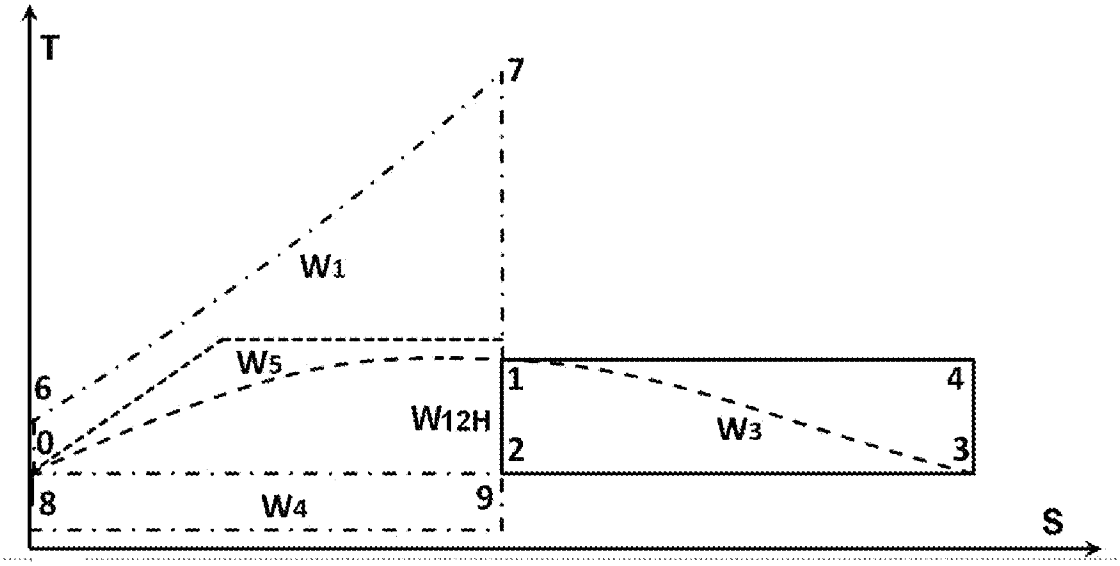

Figure 1

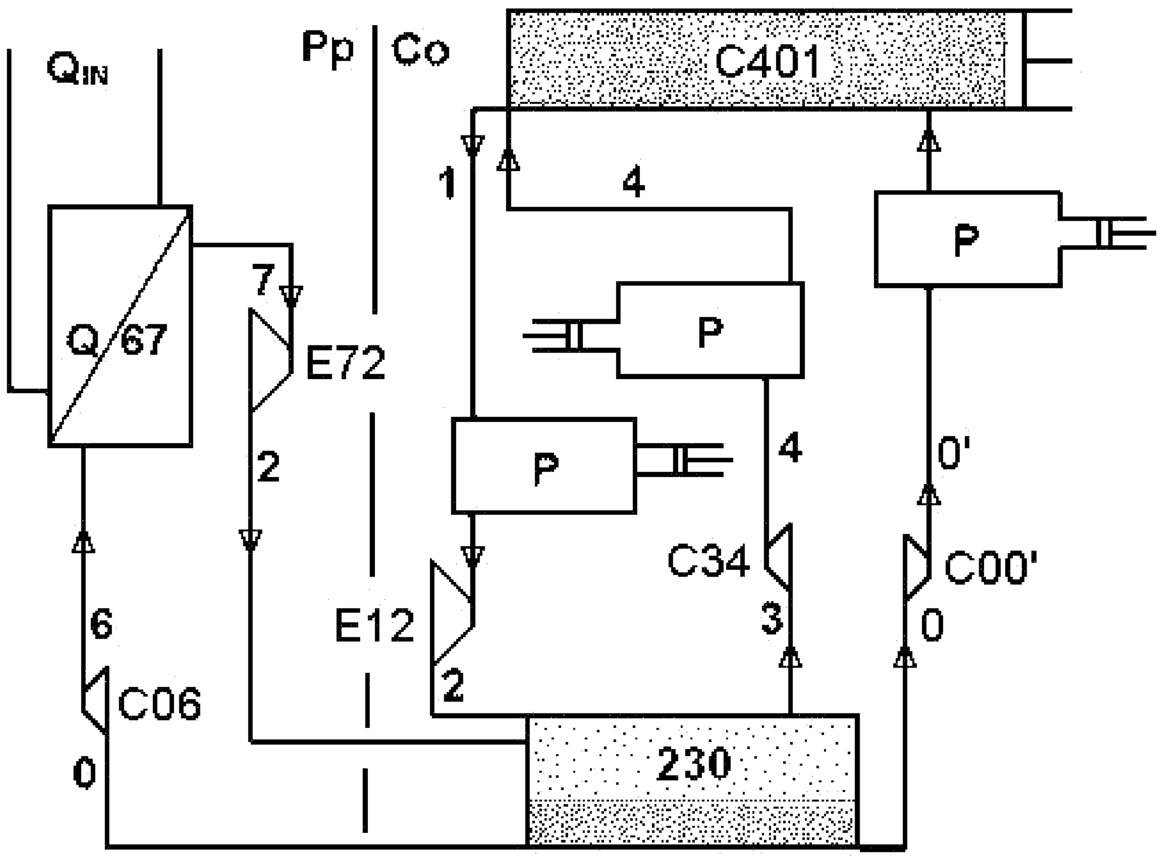

Figure 2

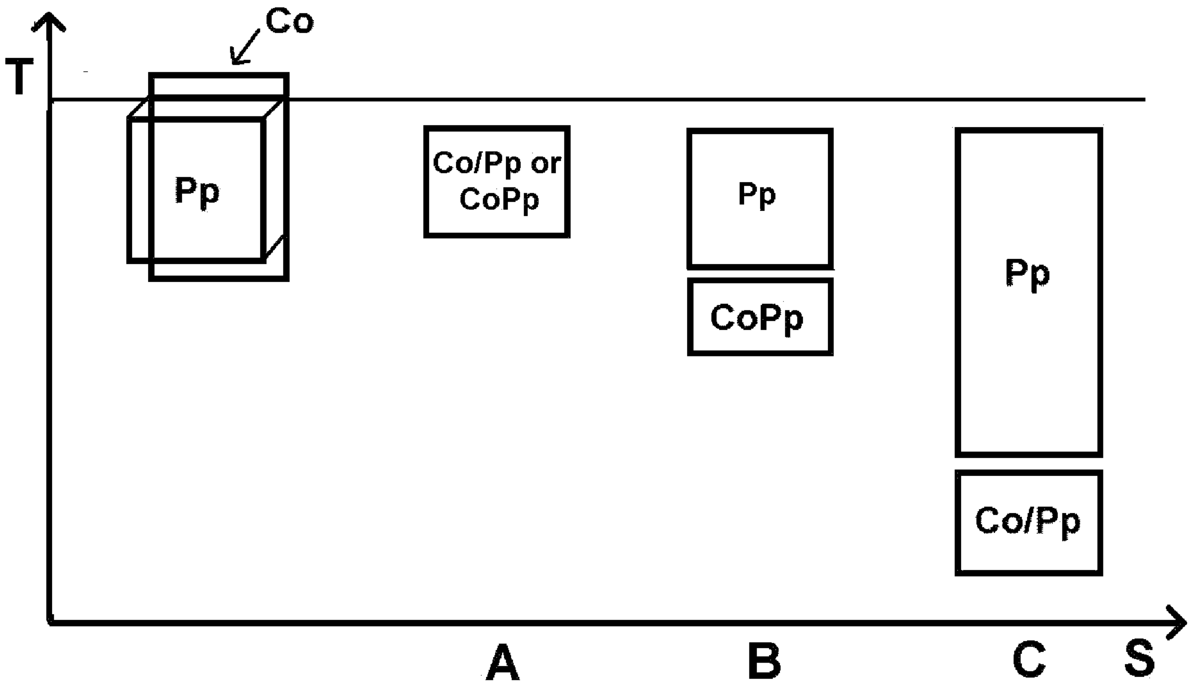

Figure 3

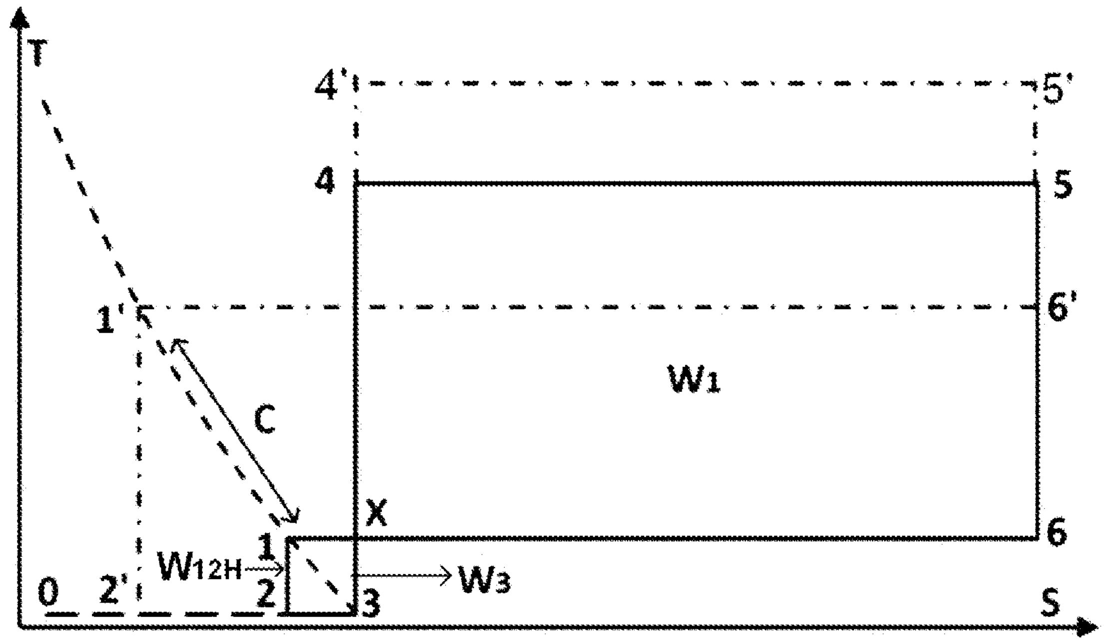

Figure 4

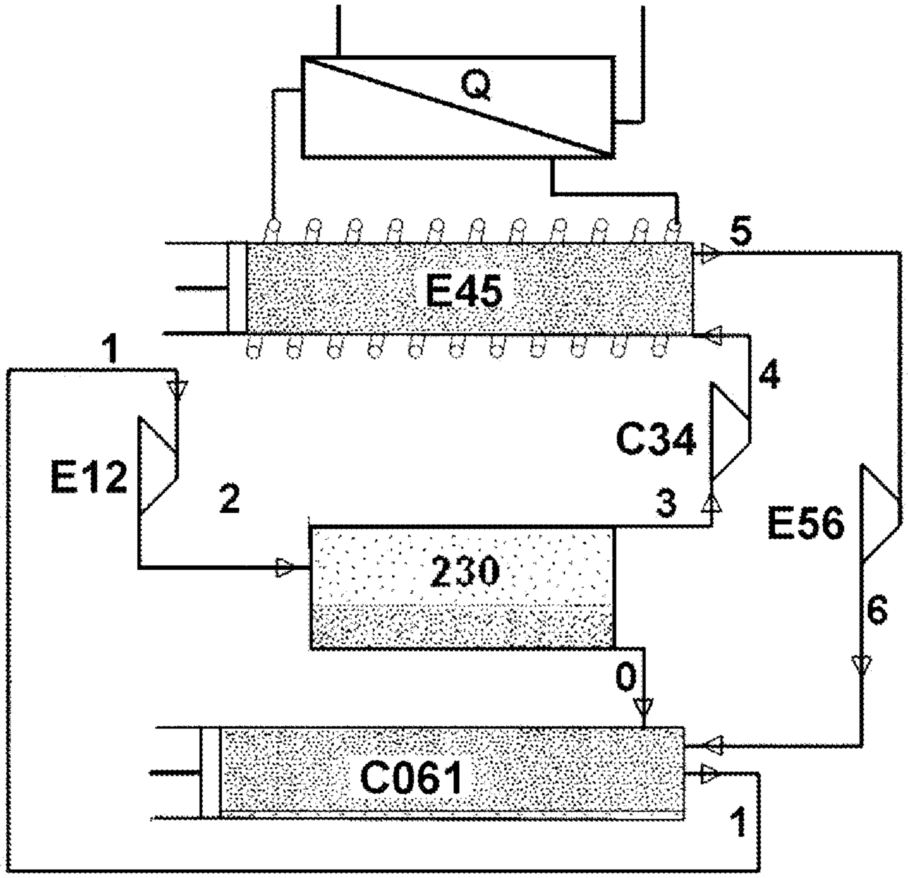

Figure 5

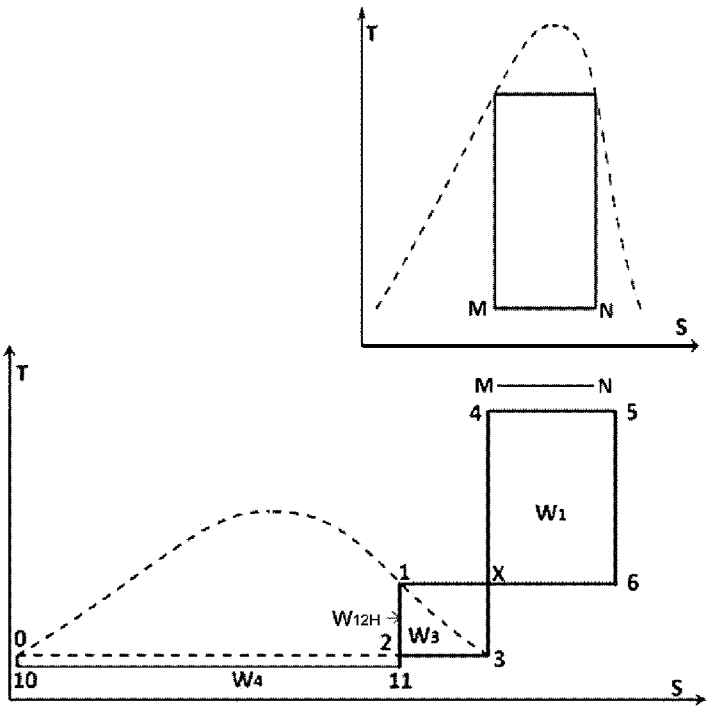

Figure 6

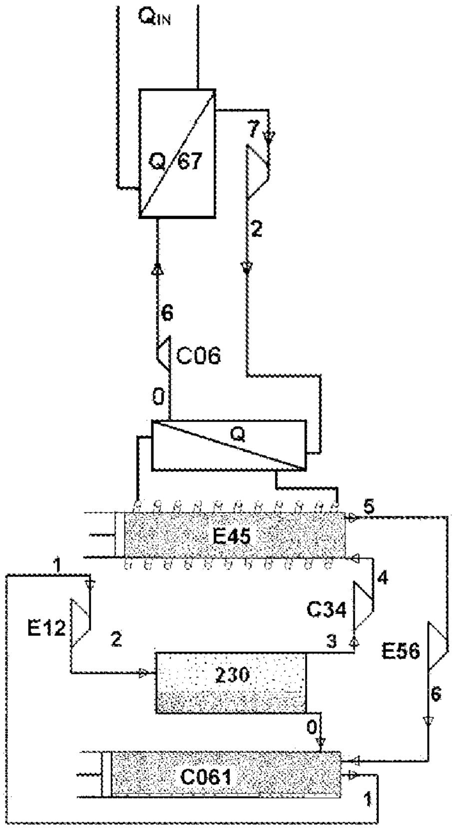

Figure 7

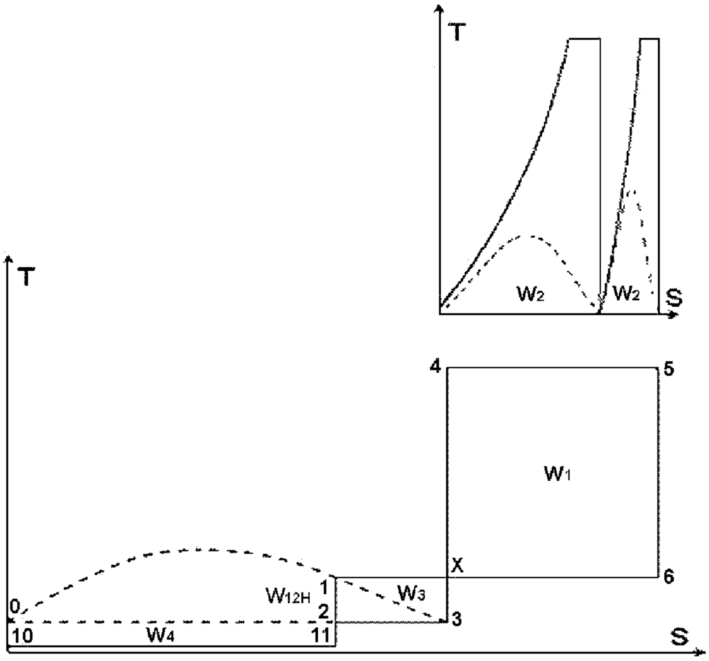

Figure 8

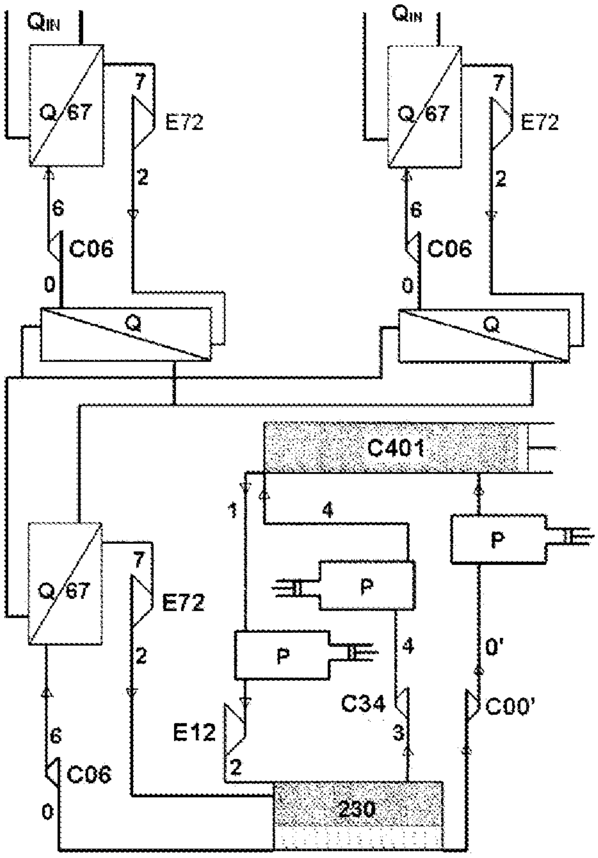
QIN
Q/67
7
E72
2
6
C06
0
Q
QIN
Q/67
7
E72
2
6
C06
0
Q
C401
1
4
P
P
Q/67
7
E72
2
P
4
0'
E12
C34
3
C00'
2
6
C06
0
230

Figure 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/HU2025/050020

A. CLASSIFICATION OF SUBJECT MATTER
F03G 7/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: F03G, F01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
---

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, X-FULL (Full Text Patent Databases), MINESOFT ORIGIN, E-KUTATÁS (Hungarian National Patent Database)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Second law of thermodynamics. *Wikipedia (old version),* 29 February 2024 (29.02.2024) [online encyclopedia], [retrieved on 29.05.2025] Retrieved using Internet <https://en.wikipedia.org/w/index.php?title=Second_law_of_thermodynamics&oldid=1210991248> Chapter Various statements of the law, paragraph Relation between Kelvin's statement and Planck's proposition	1-8
A, D	JP 2003336573 A (MAEDA YUTAKA) 28 November 2003 (28.11.2003) Paragraphs [0013]-[0015], Fig. 2	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
13 June 2025 (13.06.2025)

Date of mailing of the international search report
01 July 2025 (01.07.2025)

Name and mailing address of the ISA/
Visegrad Patent Institute / Branch Office HU
H-1081 Budapest, II. János Pál pápa tér 7., Hungary
Facsimile No. +36-1-331 2596

Authorized officer
REMÉNYI, Péter

Telephone No. +36-1-474-5858

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/HU2025/050020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2003336573 A	28-11-2003	NONE	