# The Possibility of Almost Complete Transformation of Thermal Energy into Mechanical One

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*There is a description of thermodynamic cycle of a heat motor with heterogeneous working body. This cycle allows completely transforming a thermal energy into mechanical one. The proof of existence of the cycle and its characteristics is a logic consequence of the first law of thermodynamics. By means of realizing of the cycle it will be possible to create new types of heat motors, which have qualitative advantages in comparison with the known ones. The said advantages are possibilities either to almost completely transform high-temperature heat, which appears as a result of combustion of fuel, to the useful work or to do such work by transforming free heat, which is taken off the matter of environment.*

## Introduction

The main method to transform thermal energy into energy of other types is using of heat motors (engines), which implement any of closed thermodynamic processes (cycles). For functioning of such devices the presence of two thermal vessels with different temperatures of the heater and the cooler of a working body of a heat motor is required.

In all known heat motors ambient matter is used as a cooler. Therefore the doing of a useful work by known methods is possible only as a result of transformation of high-temperature heat which is created by combustion of fuel.

The main features of known thermodynamic processes, used for the transformation of heat into other types of energy are as follows:

- efficiency of these processes is less than that of Carno cycle for a used temperature interval;
- these processes can not be applied for transformation of free heat, which is contained in the ambient matter.

Use of the invention under the Russian Federation patent [1] will allow to implement the process of transformation of heat, which is free from specified restriction. Federal Institute of the industrial property (FIIP) has included the invention in the list of prospective Russian projects [2].

There is offered the method to do useful work by means of realization of the closed thermodynamic cycle, wherein at some stages matter of the working body changes its aggregative state creating heterogeneous system, consisting of equilibrium of liquid phases and saturated vapor.

In the offered method the working body does useful work in the process of adiabatic expansion from initial state in the cycle at temperature of the heater up to achieving the state with minimum temperature of the cycle (at this temperature density of the liquid phase of a working body is equal to initial one). The processes of return of some parts of the working body into an initial thermodynamic state are various for matter of each phase:

- The matter of liquid phase has to be returned in an initial state in the process of isochoric heating, by transferring heat from the heater to the matter;

- The matter of vapor phase has to be returned in an initial state by the adiabatic compression up to achievement an initial temperature, by restitution the heat exchange between compressed matter and the heater, by the isothermal compression up to an initial density at transferring of heat from the matter to the heater.

Such realization of the cycle excludes any contact of working body with the cooler (with environment) as well as transferring heat from the working body to it. Due to that, the complete quantity of heat, received in the described cycle by working body from the heater, equals the done work and is non-zero. Thus realization of this cycle will ensure transformation of heat into mechanical work with some output which is theoretically equals 1.

The offered cycle can be realized in a temperature interval, which upper bound will be in the region of temperatures, which are lower than temperature of matter of the environment. It will take place, if some matter of low critical temperature is used as a working body. In this case matter of environment can serve as heater and be a source of thermal energy, which will be conversed into useful mechanical work.

Thus there are qualitatively new results which will be got by using this invention. Among these results we can mention possibility to converse thermal energy into mechanical work with high efficiency as well as possibility to use thermal energy taken off the matter of environment for doing useful mechanical work. The proof of these possibilities is a consequence of the first law of thermodynamics.

Let us note that this proof reveals the contradiction which exists between the first law of thermodynamics and some known formulations of the second law. At that there is revealed the logical incompatibility between both laws and necessity to explain this incompatibility. As the first law of thermodynamics, being the law of conservation of energy, should not be called in question (as well as all its consequences), then there is a conclusion on the necessity to improve some formulations of the second law and to accept the fact that these formulations have the restricted domain of applicability. The question how to resolve the contradiction remains unclosed and does not concern the essence of the invention (the offered method).

Realization of the possibility to make the device which can do useful work by using (conversion) heat energy taken off the matter of environment will allow to create new kind of sources of free mechanical energy which are the most economical and ecologically safe.

The advantages of such devices before other known sources of free energy (hydraulic, wind, solar, geothermal etc.) are as follows:

- greater specific power (per unit of volume);

- working capacity does not depend on external conditions (geographical, weather, time etc.).

The obtained estimations of achievable useful power give the reason to consider it appropriate to use the offered devices in different fields of engineering. Each user by using these devices to satisfy demand for energy or heat will get the possibility either to reduce consumption of energy carriers in 2-3 times or totally remove such consumption.

Mass application of the invented devices can several times reduce requirements of economics in natural energy carriers and therefore to create the possibilities for radical solving of problems which appear because of scantiness of fuel-energy resources and nonecology of the general used heat sources.

The construction diagram of the simplest pattern of the said engine is shown in Fig.1.

The parts of the drawing present: 1 and 2 working

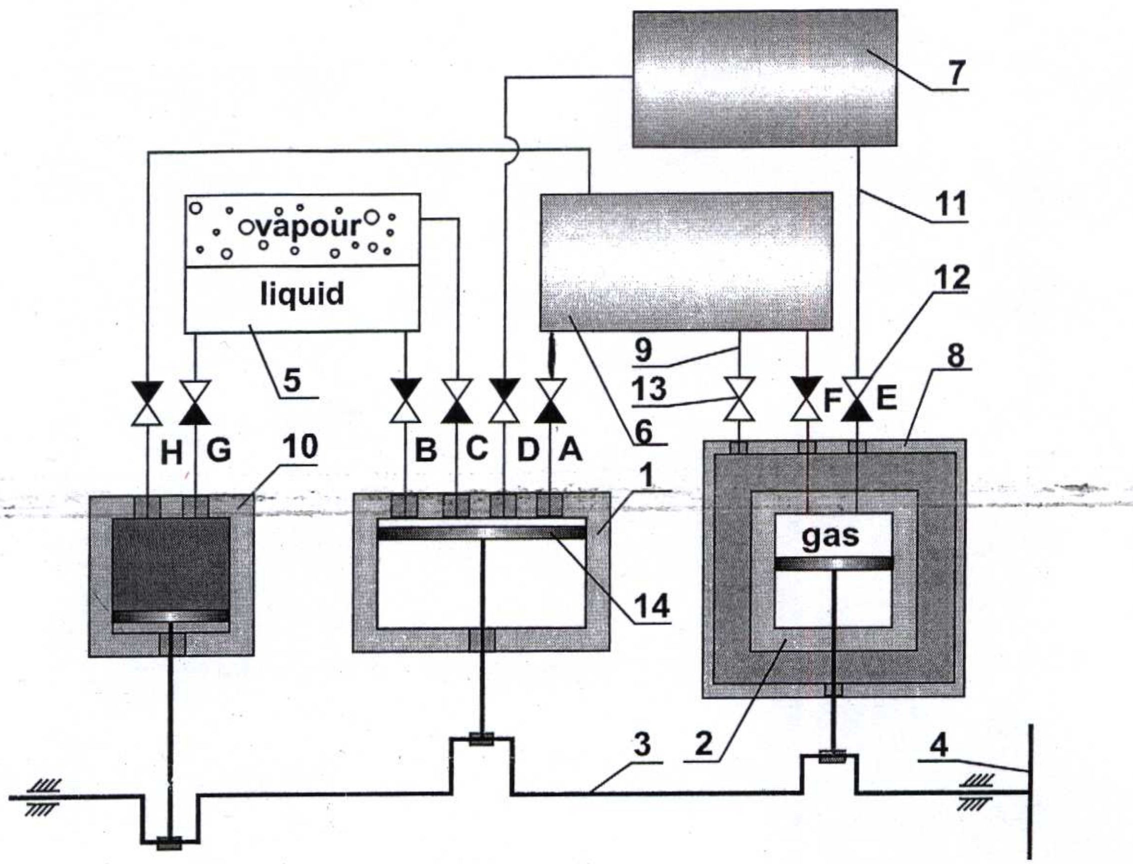


*Fig. 1*

cylinders wherein movable pistons 14 are placed. The pistons are connected by the crank shaft 3 with the fly-wheel 4. 5, 6, 7 are reservoirs filled with matter of the working body. 8 is the reservoir filled with matter of the heater. 9 is the heat conductor transferring heat from the heater to the matter of the working body, which is placed in the reservoir 6. 10 is the pump, which is set in motion by the shaft 3 and is used for swapping of matter of the liquid phase of the working body from reservoir 5 to the reservoir 6. 11 are pipelines. 12 are the valves (they are marked on the figure by letters), which provide one direction movement of matter of the working body along the pipelines. 13 is the valve, which regulates the size of heat flow through the heat conductor 9.

The reservoir 5 contains heterogeneous matter of the working body at the chosen minimum temperature of the realized thermodynamic cycle. The reservoir 6 contains a homogeneous matter of the working body with initial values of thermodynamic characteristics. The reservoir 7 contains a homogeneous matter of the working body. This matter has temperature of the heater and intermediate density.

The matter in housing 2 is in the state of thermal equilibrium with matter of the heater which is in the reservoir 8. All details of the device have adiabatic heat insulation which provides keeping of required temperature conditions.

The thermodynamic cycle begins when piston of the housing 1 is in the uppermost point. The valve A is opening in this moment and matter of the working body from the reservoir 6 begins to fill the working volume of the cylinder.

Some time later the valve A closes and after this in the cylinder there takes place the process of adiabatic expansion of the working body from the initial thermodynamic state. The process results in separating of the expanding matter into equilibrium phases of liquid and saturated vapour. The process continues until the piston reaches the lowermost point. The valve B opens in this moment and the heterogeneous matter with minimal temperature in the cycle is displaced in the reservoir 5 while the piston moves back. The displacement continues until the piston reaches the uppermost position and valve B closes. At the repeated motion of the piston from the uppermost point the saturated vapour is absorbed into the working volume of the cylinder from the reservoir 5 through the valve C. When the piston reaches the uppermost point the valve C closes and when the piston moves back there is the process of adiabatic compression of the matter of vapor phase.

When the temperature of the compressed matter becomes equal to that of the heater, the valve D opens and compressed matter is displaced in the reservoir 7. The displacement is over when the piston is in the uppermost position. At that valve D closes and the cycle of working processes repeats in the housing 1.

The processes in housing 2 are organized in a like manner: the working volume is filled through the valve E when the piston of the cylinder is in the uppermost point. While the piston moves the matter is absorbed into the working volume from the reservoir 7. The absorption is over when the piston is in the lowermost position, then the valve E closes. At that the backward movement of the piston is accompanied by isothermal compression of the matter in the working volume. When density of the compressed matter is equal to the initial one the valve E opens and compressed matter is displaced into the reservoir 6. The displacement continues until the piston reaches the uppermost point. After that the valve F closes and the cycle of the processes repeats in the cylinder 2.

Stability of the device is provided by swapping the matter of the liquid phase of the working body from the reservoir 5 into reservoir 6 by means of the pump 10 and valves G and H. By means of movement of the pump piston from the uppermost point the working volume is filled with liquid from the reservoir 5 through the valve G. At the backward movement of the piston the liquid is displaced through the valve H into the reservoir 6.

The initial temperature of the working body in the working cycle of the described device can be chosen either greater or less than temperature of the environment. If we choose the first variant then it is necessary to hold temperature of the matter of the heater at rather high level. It can be achieved by use of high-temperature heat, which is produced as a result of fuel combustion and is transferred to the heater by means of some known heating apparatus.

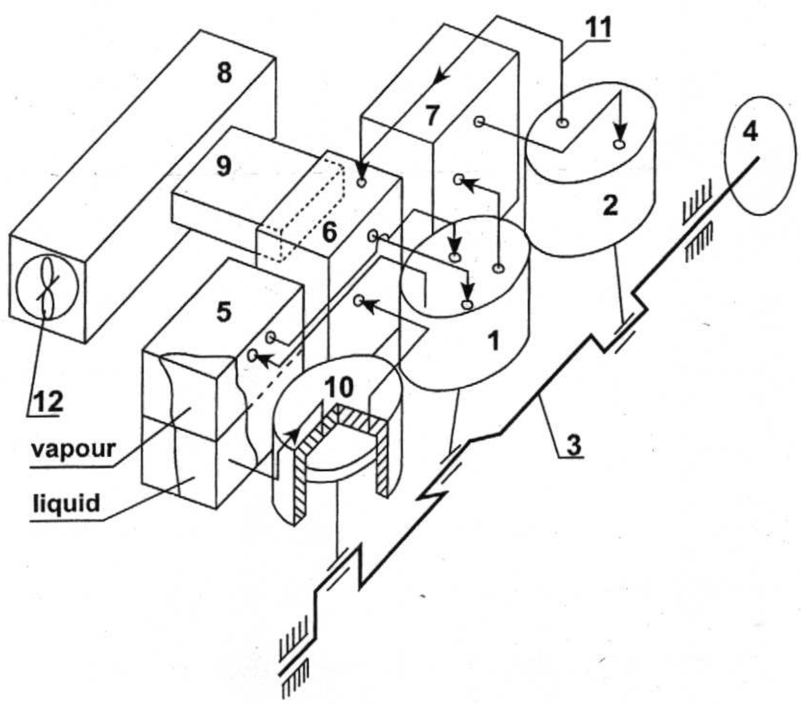


*Fig.2*

The main qualitative advantage of the device is its greater efficiency (achievable output), which can not be achieved in the processes of functioning of known heat engines.

The realization of the second case, wherein the initial temperature of the working body is less (or equal) than that of the environment, will allow to use the matter of environment as a heater and to convert the heat, which is partaken from it, into useful work. In that case the described device will represent a new kind of early unknown sources of free mechanical energy. The possible variant of such source is represented in the Fig. 2.

The heater 8 is made as heat exchanger, which is connected with the end of the heat conductor 9. The ambient matter is pumped through the heat exchanger by means of propeller 12. The cylinder 2 and the reservoir 7 can be in the state of thermal equilibrium with the environment.

Below there are some estimates of parameters of the concrete variant of proposed thermodynamic cycle to illustrate technical capabilities of the described heat engine:

- nitrogen ($N_2$) is chosen as a matter of the working body;
- the minimum and the initial temperatures of the working body are taken equal;
- 73 °C and -123°C (100 and 150°K);
- the initial pressure of the working body is taken equal to ~ 500 bar;
- the temperature of the heater is supposed to be ~7 °C (the value is close to average temperature of environment);
- the specific quantity of heat (which the working body gets from environment matter in the cycle and which is converted into useful work) is equal to ~ 63 cal/mole;
- if the working volume of the cylinder 1 and duration of the cycle are taken equal to V ~1 litre and t ~0.02 sec, then achievable power capacity of the device is ~130 kWt.

The achievable power capacity of the device represented in Fig. 2 is defined by two parameters:

- by cross-sectional area S of the heat exchanger, through which environment matter is pumped;
- by temperature difference in a flow of environment matter at the inlet and outlet of the heat exchanger.

Let us accept the values equal to S = 0.25 m² and "T = 10° C for these parameters, then we get an estimation of power capacity equal to ~ 107 kWt.

## Conclusions

1. There are received the estimations of an achievable useful power capacity of the devices which are designed for effective conversion of heat into work. These estimations allow to suppose wide use of these devices in different fields of technique as possible and expedient.

2. Each user by using these devices to satisfy demand for energy or heat will get the possibility either to reduce consumption of energy carriers in 2-3 times or totally remove such consumption.

3. The economy, which can be achieved as a result of reduction of systematic coasts on purchasing of fuel, will quickly cover a cost of the invented devices.

4. The qualities of the devices (high efficiency, autonomy, ecological compatibility) will ensure high and stable income to those businessmen who will organize sufficiently considerable production and realization of these devices.

The investors are invited to participate in realization and commercial use of the invention.

### References


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