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Stirling Engine and Principle of Operation

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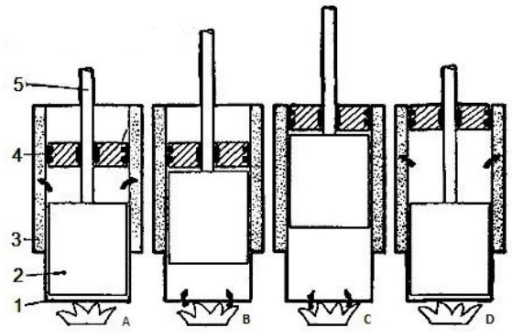
Annotation. The internal combustion engine has supplanted other types of power plants, however, work aimed at abandoning the use of these units suggests an imminent change in leading positions.
Since the beginning of technological progress, when the use of engines that burn fuel inside was just beginning, their superiority was not obvious. The steam engine, as a competitor, contains a lot of advantages: along with traction parameters, it is silent, omnivorous, easy to control and configure. But lightness, reliability and efficiency allowed the internal combustion engine to take over the steam [1-2].

Keywords: Stirling engine, rotary stirling engine, thermoacoustic stirling engine, circuit, position

Today, issues of ecology, economy, and safety are at the forefront. This forces engineers to throw their forces on serial units operating on renewable fuel sources. In the year 16 of the nineteenth century, Robert Stirling registered an engine powered by external heat sources. Engineers believe that this unit is able to change the modern leader. The Stirling engine combines efficiency, reliability, runs quietly, on any fuel, this makes the product a player in the automotive market [3].

The principle of the engine

In order to understand how the Stirling engine works, let's look at the device and the frequency of the phenomena of the unit. The mechanism converts the heat received from the heater located outside the product into a force on the body. The whole process occurs due to the temperature difference, in the working substance, which is in a closed circuit.



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The principle of the engine

The principle of operation of the mechanism is based on expansion due to heat. Immediately prior to expansion, the substance in the closed-circuit heats up. Accordingly, before being compressed, the substance is cooled. The cylinder itself (1) is wrapped in a water jacket (3), heat is supplied to the bottom. The piston that does the work (4) is placed in a sleeve and sealed with rings. Between the piston and the bottom there is a displacement mechanism (2), which has significant gaps and is freely moving [4]. The substance in a closed circuit moves through the volume of the chamber due to the displacer. The movement of matter is limited to two directions: the bottom of the piston, the bottom of the cylinder. The movement of the displacer is provided by a rod (5) which passes through the piston and is operated by an eccentric 90° late compared to the piston drive [5].

Position "A":

The piston is located in the lowest position, the substance is cooled by the walls.

Position "B":

The displacer occupies the upper position, moving, passes the substance through the end slots to the bottom, and cools itself. The piston is stationary.

Position "C":

The substance receives heat, under the action of heat it increases in volume and raises the expander with the piston up. Work is done, after which the displacer sinks to the bottom, pushing out the substance and cooling.

Position "D":

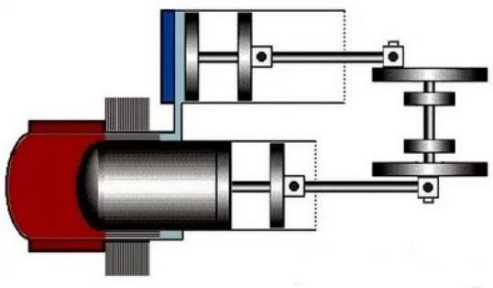
The piston goes down, compresses the cooled substance, useful work is done. The flywheel serves as an energy accumulator in the design.

The considered model is without a regenerator, so the efficiency of the mechanism is not high. The heat of the substance after work is removed into the coolant using the walls. The temperature does not have time to decrease by the required amount, so the cooling time is extended, the motor speed is low.

Types of engines

Structurally, there are several options using the Stirling principle, the main types are:

Engine "α - Stirling":

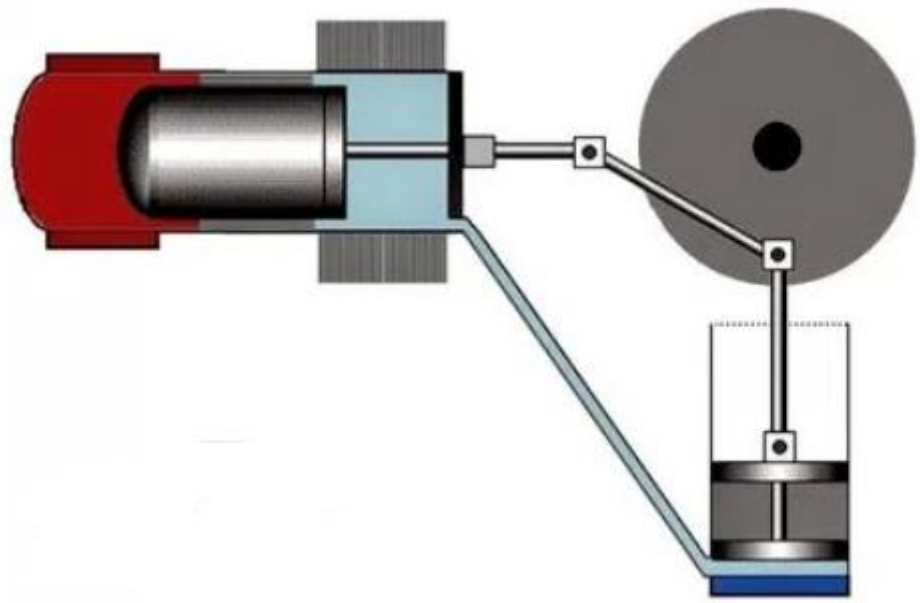


The design uses two different pistons placed in different contours. The first circuit is used for heating, the second circuit is used for cooling. Accordingly, each piston has its own regenerator (hot and cold). The device has a good power to volume ratio. The disadvantage is that the temperature of the hot regenerator creates design difficulties [6].

Engine "β - Stirling":

The design uses one closed circuit, with different temperatures at the ends (cold, hot). A piston with a displacer is located in the cavity. The displacer divides the space into cold and hot zones. The exchange of cold and heat occurs by pumping a substance through a heat exchanger. Structurally, the heat exchanger is made in two versions: external, combined with a displacer.

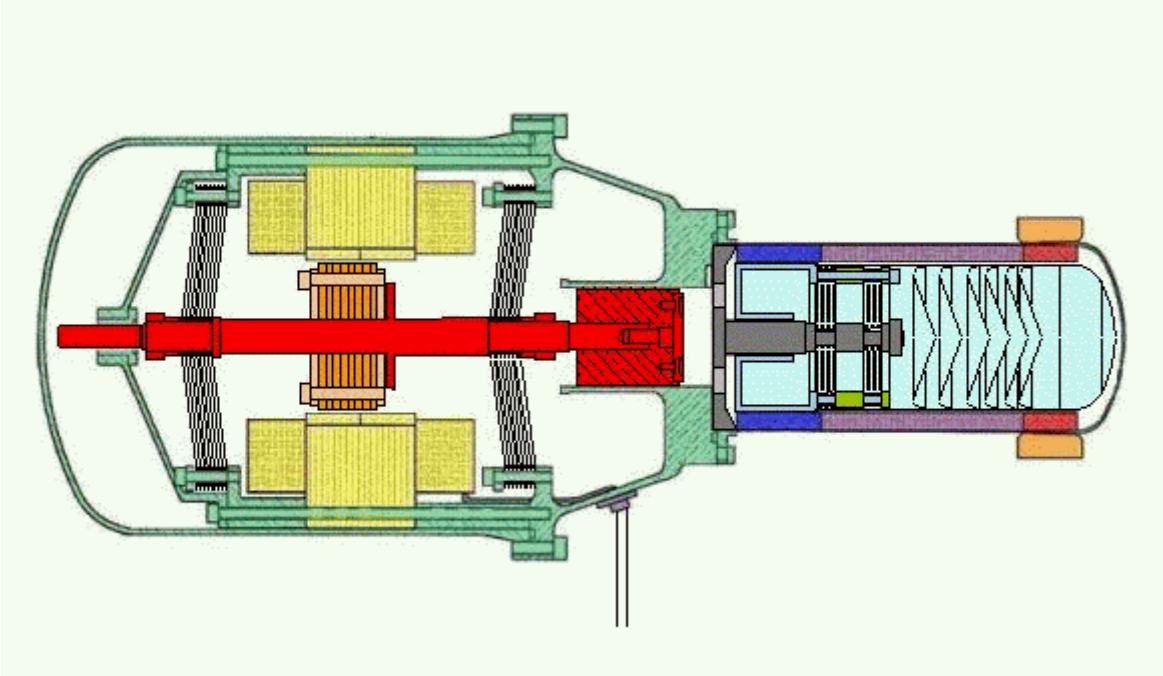
Engine "γ - Stirling":



The piston mechanism provides for the use of two closed circuits: cold and with a displacer. Power is taken off a cold piston. The displacer piston is hot on one side and cold on the other. The heat exchanger is located both inside and outside the structure.

Some power plants are not similar to the main types of engines:

Rotary Stirling engine.



Structurally, the invention with two rotors on the shaft. The part performs rotational movements in a closed cylindrical space. A synergistic approach to the implementation of the cycle has been laid. The body contains radial slots. Blades with a certain profile are inserted into the recesses. The plates are put on the rotor and can move along the axis when the mechanism rotates. All the details create changing volumes with phenomena taking place in them. The volumes of the various rotors are connected by channels. Channel arrangements are offset by 90° to each other. The shift of the rotors relative to each other is 180°.

Thermoacoustic Stirling engine.

The engine uses acoustic resonance to carry out processes. The principle is based on the movement of matter between a hot and a cold cavity. The circuit reduces the number of moving parts, the difficulty in removing the received power and maintaining resonance. The design refers to the free-piston type of motor.

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