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Issue Article

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# ANALYSIS OF THE POWER CHARACTERISTICS OF THE INTERNAL COMBUSTION ENGINE OF THE CAR

***Abstract**: Parameters of the operation of the three-cylinder internal combustion engine of the car were discussed in the article. Characteristics of pressure in the cylinder, rotational speed of the crankshaft of the internal combustion engine and the braking power of the car in conditions of uniform motion were described. Dependences of the input and output powers of the internal combustion engine of the car on the angle of rotation of the crankshaft were determined.*

***Key words**: power, internal combustion engine, crankshaft, piston.*
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## Introduction

Any car consists of a number of interconnected units and mechanisms. The main unit of the car is an internal combustion engine, which provides the conversion of thermal energy into mechanical energy. During operation, complex thermomechanical processes occur in the internal combustion engine. They will not be described in this work. Reliable information about these processes is presented in the articles [1-6]. To analyze the processes occurring in internal combustion engines, they are modeled and then the overall dimensions, configuration, materials and other parameters of the parts included in the unit are optimized using special computer programs [7].

The power characteristics of the internal combustion engine are important for the speed and acceleration time of the car [8-10]. The input power at the end of the crankshaft of the internal combustion engine is transmitted to the car wheels through the flywheel and transmission. The power loss is defined as the sum of all resistances in the transfer mechanisms of the car. Determining the difference in input and output powers will allow you to expand knowledge about the physical processes taking place in the four-stroke internal combustion engine and their impact on the overall characteristics of the car.

## Materials and methods

The three-cylinder internal combustion engine of the car was subject to consideration. The power of the engine with an in-line arrangement of pistons was studied. The piston with a diameter of 80 mm made of structural steel is fixed on the steel connecting rod having a length of 200 mm. The connecting rod is fixed on the steel crankshaft with a diameter of 80 mm. Materials of the parts had the following properties: density – 7850 kg/m$^3$, Young's modulus – 200 × 10$^9$ Pa, Poisson's ratio – 0.33, heat capacity at constant pressure – 475 J/(kg × K), thermal conductivity – 44.5 W/(m × K), electrical conductivity – 4.032 × 10$^6$ S/m, coefficient of thermal expansion – 12.3 × 10$^{-6}$ K$^{-1}$, Murnaghan third-order elastic moduli – -3.0 × 10$^{11}$/-6.2 × 10$^{12}$/-7.2 × 10$^{11}$ Pa, Lamé parameter $\lambda$ – 1.5 × 10$^{11}$ Pa, Lamé parameter $\mu$ – 7.5 × 10$^{10}$ Pa. The properties of air in the cylinder have basic values at an initial temperature of 293.15 K. Ratio of specific heats is 1.4. The heat generated during the combustion of fuel in cylinders is 600 J.

## Results and discussion

The measurements were carried out on the time range of the internal combustion engine operation from 0 to 0.16 s. Initial rotation of the crankshaft was 50.25 degrees. Mechanical energy was -327.43 J in the middle of the time range.

The total pressure change from the volume in the system was measured: 9.8 bar at 20 m$^3$, 5 bar at 100 m$^3$, 2.5 bar at 200 m$^3$, 1.5 bar at 300 m$^3$ and 1.2 bar at 400 m$^3$. Thus, pressure increases sharply in conditions of the small volume in the system. The dependency changes inversely with large volumes in the system. Maximum pressure in the cylinder was determined when the crankshaft rotates 190-200 degrees around its axis, which corresponds to the compression stroke.

The initial speed of rotation of the crankshaft is 1400 rpm at the beginning of the first working cycle of rotation of the crankshaft. The speed of rotation of the crankshaft increases to 2600 rpm at the end of the fifth working cycle of rotation of the crankshaft.

Based on the measurements performed, we will determine the power characteristics of the internal combustion engine. The power generated from the third cylinder is the largest and was defined in the range from -50 to 180 hp. The braking power corresponds to the real indicator of the maximum possible power of the internal combustion engine. The power (in hp) is zero for one and a half working cycles of rotation of the crankshaft. Then there is a sharp increase in power to 40 hp. A slow oscillatory increase in power up to 51 hp was observed on subsequent working cycles.

The change in the input and output powers of the internal combustion engine from the angle of rotation of the crankshaft is presented in the Fig. 1.

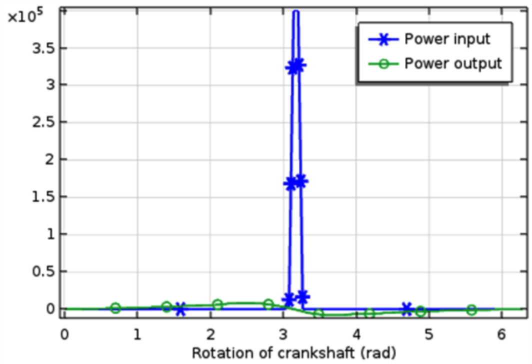


**Figure 1 – The change in the input and output powers (the values are given in J) of the internal combustion engine from the angle of rotation of the crankshaft.**

The input power varies from zero to 400,000 J per revolution of the crankshaft. The maximum value of the input power was determined in the compression stroke. The output power has a smooth change on each stroke. Negative values of the output power are losses caused by resistances.

**Conclusion**

Thus, the actual values of the crankshaft rotation speed, cylinder pressure and power characteristics of the three-cylinder internal combustion engine were obtained and conclusions were drawn about the relationship of these parameters to each other. It is determined that the input and output powers at the start of the compression stroke are equal to zero. A sharp increase in the input power in the compression stroke contributes to the loss of the output power. The input and output powers are balanced per a full revolution of the crankshaft.

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