About the possibility of operation of a four-stroke diesel engine according to the cycle of Otto

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Abstract

The possibility of improving diesel engines based on the reserves of thermodynamics is being considered.

Introduction

The diesel engine is very common because of its high efficiency. However, this engine has not exhausted all thermodynamic fuel efficiency improvements.

Problem

Three cycles of internal combustion engines are known from the thermodynamics course based on the heat supply process:

1. The constant pressure heating cycle is a diesel cycle.

The first diesels operated in this cycle with fuel supplied from an external high pressure compressor. Due to the high energy consumption of the compressor drive, these motors are not currently being built.

2. A cycle with a mixed supply of heat to an engine with compression ignition, namely with a constant volume and constant pressure - the so-called G. Trinkler cycle. All modern four-stroke and two-stroke diesel engines operate in this cycle.

3. Cycle with constant heat input, but only for positive ignition engines, this is the Otto cycle. For example, all modern carburetor engines work according to this cycle.

It is also known from thermodynamics that the most economical cycle for internal combustion engines is the supply of heat with a constant volume.

However, the efficiency of the Otto cycle is limited by the relatively low compression ratio of the working mixture due to the possible detonation.

It would be logical to suggest the operation of diesel engines, where the compression ratio is limited only by the strength of the parts, and heat is supplied only at a constant volume.

Unfortunately, it is impossible to instantly ignite the mixture on any diesel engine when the piston is in the UDP of the "classic" crank mechanism, as in Otto gasoline engines. Diesel engines take time to inject fuel, mix it with heated air in the combustion chamber, and ignite from contact with that air. Consequently, part of the fuel in a "classic" diesel engine burns when the piston moves to bottom dead center - at constant pressure, which, as you know, is a thermodynamically ineffective process.

Purpose

The purpose of this study is to solve an inventive problem of converting a four-stroke diesel engine to work according to the Otto cycle.

Research questions

It can be assumed that the situation can be corrected by ensuring the immobility of the piston at top dead center, and not stopping, as in a diesel engine, by replacing the crank mechanism with another mechanism.

These can be mechanisms for changing the compression ratio on the move of Otto engines or "half" rhombic mechanisms to ensure that the piston stops and stays, like in a Stirling engine. An analysis of the ideas of these mechanisms, known to the author, shows that they have the following irreparable fundamental drawback: an increase in gas pressure and mechanical forces when the piston is in these mechanisms requires an increase in the kinetic energy of the engine flywheel. what to hold a standing piston.

There is a technical contradiction - the piston must stop and stand during fuel combustion to improve efficiency, but with the existing crank mechanism, such retention of the piston will require additional kinetic energy from the engine flywheel.

Literature review

At the beginning, it is worth mentioning the existence of four-stroke internal combustion engines of the automobile company Mercedes-Benz AG - Daimler AG with a mechanical air boost compressor [1]. For the proposed work, the property of these engines is important - due to constant pressurization, the pressure inside the working chamber is always above atmospheric. By this indicator, they are close to two-stroke piston internal combustion engines.

It is already known that the considered technical contradiction for two-stroke diesel engines was previously solved [2].

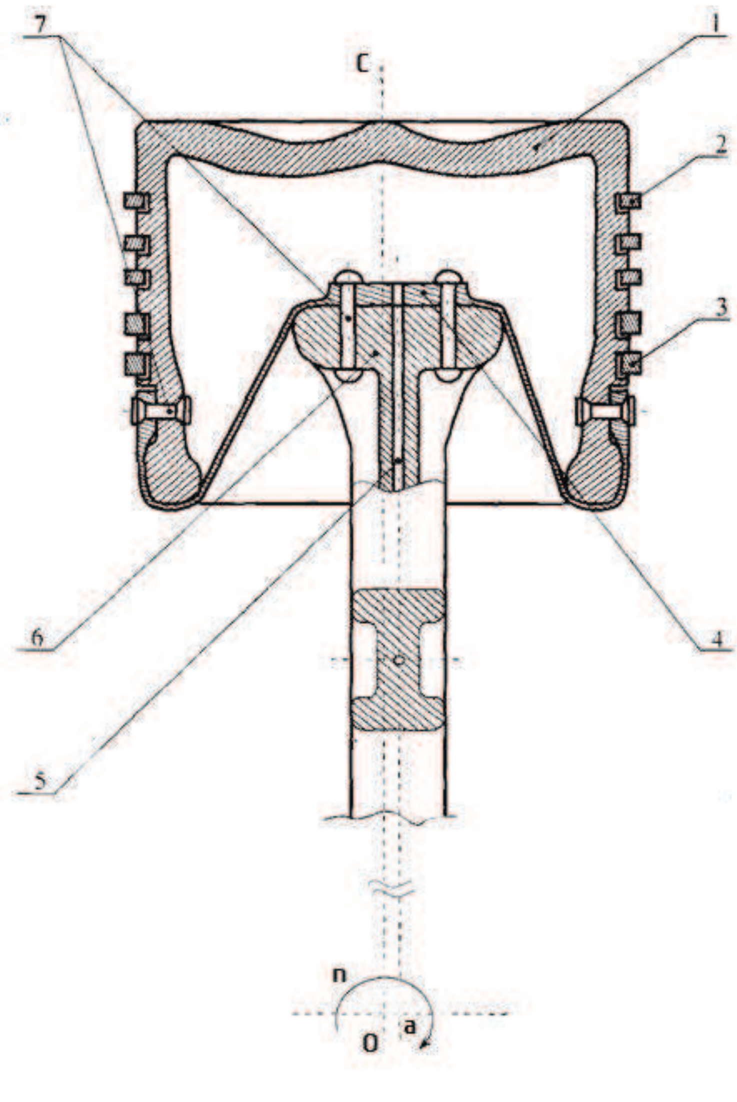

Fig.1 – Mechanism for a new cycle

Figure 1 shows the following positions of the mechanism for a new cycle:

1. piston;

2. compression rings;

3. oil scraper rings;

4. open trapezium made of spring steel;

5. oil supply channel (for cooling piston 1);

6. connecting rod;

7. cold forged rivets.

Point "O" corresponds to the center of rotation of the engine crankshaft. Axis "OS" is the vertical axis of the engine working cylinder.

The distance between the axis of rotation of the crankshaft and the axis 6 of the connecting rod, when the piston 1 is at top dead center (distance "O-a"), is the desection of the crank mechanism.

Arrow - n indicates the direction of rotation of the crankshaft.

The principle of implementing a new working cycle of a two-stroke diesel engine is clear from this diagram.

So, for example, it is clear that when the crankshaft rotates, the connecting rod will be wound around the profile of the T-shaped head on one or another branch of the elastic trapezoid. In this case, the desection of the motor will change - that is, the connecting rod pole, in addition to the usual movements along the working cylinder, can still move across the cylinder. The transfer of the connecting rod pole from one side of the wall of the working cylinder to the other and vice versa will lead to the fact that the piston will be stopped and standing at both dead points.

Staying at top dead center will allow you to move away from the G. Trinkler cycle and establish an economical heat supply - with a constant volume of the combustion chamber.

The diagram shows that piston stagnation will also be observed at bottom dead center.

This circumstance will make it possible to level the disadvantage of two-stroke diesel engines - a short time for cleaning and blowing out the working cylinder.

The diagram shows that the gas pressure of the piston acts on two branches of the trapezoid. But since the left branch of the trapezoid is steeper than the right one, the vertical force of gas pressure will tend to turn the crank in the direction of rotation of the crankshaft through the more loaded left shoulder of the T-shaped connecting rod.

Eliminated a technical contradiction - with increasing pressure at top dead center, this increase tends to push the connecting rod itself through the top dead center.

In principle, it would be possible to fasten the trapezoid with rivets from the inside in the piston, but additional girths are provided for the frictional forces that unload the rivets.

Analogue - keeping ships in the marina due to canals entwined at berths. The idea was patented UA89380C2 dated 12.03.2007.

Unfortunately, two-stroke diesel engines have poor cleaning of the working cylinders from exhaust gases. For this reason, four-stroke diesels are more economical and have better environmental performance.

Methodology

In fact, there is an inventive problem. It is necessary to adapt the piston retention mechanism of a two-stroke diesel engine to operate in a four-stroke diesel engine. The mechanism developed in the Ukrainian patent is not acceptable for a naturally aspirated four-stroke diesel engine. During the suction stroke, a vacuum is created in the cylinder - the vertical pressure on the piston disappears. And the mechanism under the patent for a two-stroke diesel engine works only at constant back pressure.

However, such back pressure is easily created by adding a mechanical air blower to the four-stroke diesel engine, as in the gasoline engines discussed above (Otto cycle) of Mercedes-Benz cars.

Conclusions

If in classical designs of four-stroke diesel engines a mechanical air blower (with a permanent mechanical drive from the engine crankshaft) and a piston stay mechanism from the Sevtsov's cycle for a two-stroke diesel engine are added, then four-stroke diesel engines can work according to the Otto cycle. This circumstance gives hope for an increase in the fuel efficiency of modern diesel engines.

Recommendations

The delay in fuel ignition at the piston height in new four-stroke diesel engines may allow solving the problem of multi-fuel consumption - modern diesel engines are difficult to convert to work with aviation kerosene.

References

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