MODERN DESIGN ROTARY ENGINE AltSTU

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Abstract: *Modern design of turbo-compressor type of internal-combustion rotary engine (TIRE) was made by Altai State Technical University (TIRE-3, AltSTU). The analysis of shortcomings of the first option of the rotor TIRE-1 engine is made. The main shortcoming – at a compression timing period not all fuel and air mixture arrives in a combustion chamber because of existence of "nonoperating" volumes. It reduces all technical and economic indicators of the rotor engine.*
In an advanced engine make change of a design of the compressor is made. The compressor of new model has a ledge and the gate which slides at rotation of a shaft of the engine on an external surface of a rotor of the compressor. At the maximum conveyance the gate enters into the special deepening made in a working ring. The fulcrum pin of a rotor of the compressor coincides with a shaft of an internal surface of a working ring of the engine. It allows to exclude existence of "nonoperating" volumes in working cavities of the compressor of the engine The physical model of engine is made and tested. Tests showed increase in compression pressure in a combustion chamber at the TIRE-3 model, in comparison with the TIRE-1 model.
KEY WORDS: ROTARY ENGINE, COMPRESSOR, TURBINE, GAS-DISTRIBUTING BUCKET, COMBUSTION CHAMBER, PHASES OF VALVE TIMING, WORKING DUMPER PLATE OF COMPRESSOR, INTAKE AND OUTLET PORTS, VALVE, WORKING STROKES OF THE ENGINE.

At the Altai state technical university of I.I.Polzunov (Russia) the design of a rotor internal combustion engine of turbocompressor type (RDT AltSTU) is developed. As for a design the engine reminds the gas turbine since it has the compressor, the turbine and a combustion chamber, and as for principle of operation – the piston engine since it has traditional working strokes: intake, compression, power and exhaust. The design is protected by several patents and described in detail literature [1,2,3,4].

Described in literature the design of the engine has some constructive shortcomings. One of the most essential shortcomings of the engine is that at the overflowing of a working mixture from a working cavity of the compressor the combustion chamber the part of it remains in the working cavity of the compressor and isn't used when burning a working mixture. It influences on the compression ratio, and finally all technical and economic indicators of the engine.

Besides there are problems with sealings between condensing gate of a rotor of the compressor and an internal cylindrical surface of a working ring. It is caused by that the rotor axis of the compressor and an axis of the internal cylindrical surface of a working ring are displaced relative to each other at a certain size that doesn't allow condensing plates of a rotor of the compressor to press its face surface to the internal cylindrical surface of a working ring at rotation of a rotor of the compressor.

For elimination of these shortcomings the modernized design of the rotor engine AltSTU was developed and patented by RDT-3. The essence of modernization consists, mainly in changing of a design of the compressor engine.

The general device of the modernized engine. The principle of a design of RDT-3 consists that, as well as at the gas turbine, on one shaft the rotor of the compressor 1 and a turbine rotor 2 (see fig. 1) are established and rigidly fixed. The case of the engine is the working ring 3 in which the compressor rotor, and lateral cheeks are rotated.

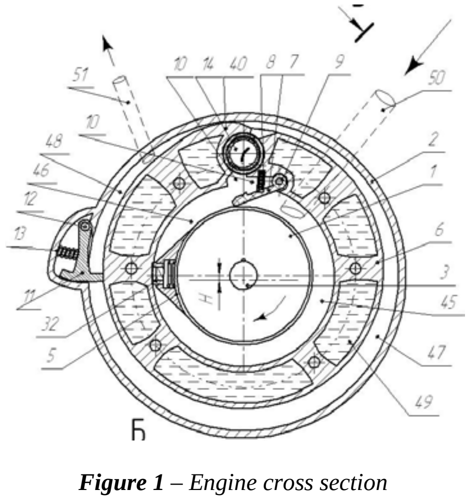

***Figure 1** – Engine cross section*

1 rotor of the compressor, 2 – turbine rotor, 3 – engine shaft, 4 – engine case, 5 – the working ring, 6 –combustion chamber, 7 –outer face of the case , 8 – incher face of the case, 9 - spark plug, 10 - reduction gear, 11 - a ledge of a rotor of the compressor, 12 - working gate of the compressor, 13 - groove, 14 - L-shaped turbine gate, 15 - intake passage, 16 - exhaust passage, 17 - intake chamber, 18 - preliminary compression chamber, 19 - power stroke chamber, 20 - exhaust chamber, 21 - sealing ledge.

The rotor of the compressor 1 is made in the form of a disk on the external surface of which there is a ledge 4. The ledge 4 has the smooth thickening going from an external surface of a rotor of the compressor 1 up to the maximum height, and smoothly decreasing to its external surface. The surface of a ledge 4 with the maximum height is made according to diameter allowing a rotor of the compressor freely to rotate in a working ring 3 without adjoining to its internal surface. Width of a ledge 4 is equal to width of a rotor of the compressor 1. On the external surface of a ledge 4, in a zone of its maximum height, the cross chase 8 is done for installation condensing plates in it. The rotor axle of the compressor and axle the engine shaft coincide.

In the working ring 3 the sprung working gate 5 is fitted in the form of a plate with possibility of reciprocating rotary motion round axis 6, fixed in a body of a working ring. On an internal cylindrical surface of a working ring there is a deepening 7 intended for placing working gate at its maximum shift. The free end of the gate, under the influence of spring, presses to the external surface of a rotor of the compressor. The turbine rotor, combustion chamber and gas distribution mechanism in new design didn't undergo essential changes in comparison with earlier described design of the rotor engine.

Compressor sealings. For sealing of a working volume of the compressor created by an external surface of a rotor of the compressor 1 and the internal surface of working ring, on the external surface of the ledge 2 of the rotor compressor the chase 3, is done for installation in it condensing plates 4 and 5 (see rice 2). The condensing plates 4 and 5 established in a chase 3, owing spring 6 densely adjoin to the internal surface of a working ring and have possibility of reciprocating motion in a chase 3. The condensing plate 4 is done for moving apart, under the influence of a spring, to eliminate gap between butts of a plate and a side face of a working ring.

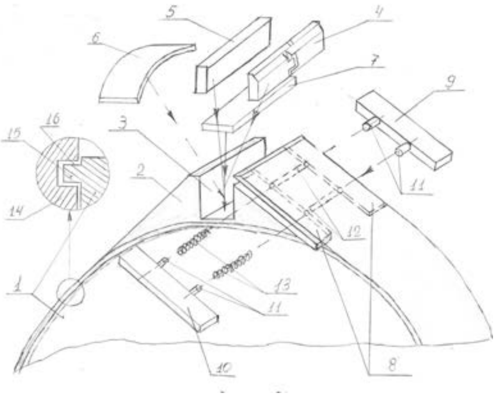

Figure 2 *– Sealings of a rotor of the compressor*

1 – compressor rotor, 2 – a ledge of a compressor rotor, 3 – a cross chase of a compressor rotor, 4 – a movable condensing plate, 5 – a sealing back plate, 6 – a leaf spring, 7 supporting plate, 8 – chases for lateral condensing plates, 9,10 – lateral condensing plates, 11 – cylindrical ledges, 12 – bores, 13 – springs, 14 – a lateral cheek of the engine, 15 – a ledge of a rotor of the compressor, 16 – a chase in a lateral cheek of the engine

For sealing of gaps between side faces of a ledge 2 rotor of the compressor on side faces of a ledge 2 chases 8 are made into which lateral condensing plates 9 and 10 are entered. Condensing plates 9 and 10 have cylindrical ledges 11 entering into bores 12. For pressing of these plates to side faces of cheeks of the engine in bores 12 there are springs 13. These springs work with a certain effort to cylindrical ledges 11 of the condensing plates 9 and 10 and press them to side faces of the engine cheeks.

Sealing of a working volume of the compressor between lateral cheeks 14 of the engine and a rotor 1 of compressor is carried out due to the existence from each side on lateral faces of a rotor 1 ledges 15 turned towards lateral cheeks of the engine. These ledges have rectangular section and are located on radius in the top part of a circle of a rotor 1 and entering into the corresponding reciprocal deepenings 16 full filled in lateral cheeks of the engine. Ledges 15 on a rotor 1 of the compressor and deepening 16 in cheeks 14 of the engine carry out function of labyrinth sealings.

Sealing of the working damper plate of the compressor. Working damper plate 5 of compressor is the most complicated element of engine construction (ref. to fig. 3). It is a plate of a complicated configuration and it is the configuration that ensures its fitting flush into its cave 7, made in bead working ring 3 under combustion chamber 9.

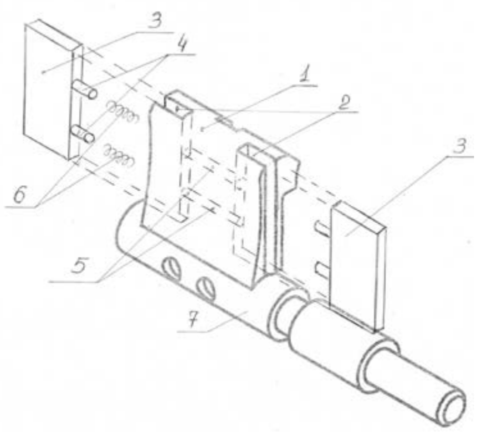

Figure 3 *- Sealing of the working damper plate of compressor*

1 - working damper plate, 2 - chases, 3 - sealing plates, 4 - cylindrical spigots, 5 - holes, 6 - springs, 7 - damper plate shaft

In order to seal the working capacity of the compressor, chases 2 are made between engine side plates and the working damper plate 1, in the side faces of the working damper plate, so that sealing plates 3 would le fitted into chases 2 for reciprocating motion in these chases (ref. to fig. 3). Sealing plates have cylindrical spigots 4, fitting into holes 5 of the working damper plate 1. Springs 6 are fitted inside holes 5, pressing the gasket plates to side faces of engine side plates. These springs apply certain force to cylindrical spigots 4 of gasket plates 3, thus pressing them to the side faces of engine side plates.

Operating principle of the engine. Operating principle of the rotary engine designed at Altai State Technical University is described in literature in detail [2,3]. We would remind you that the intake stroke and the compression stroke of the engine in question occur in the compressor rotor, while the combustion stroke and the exhaust stroke occur in the turbine rotor. The overall schematic of engine operation is illustrated in figure 4.

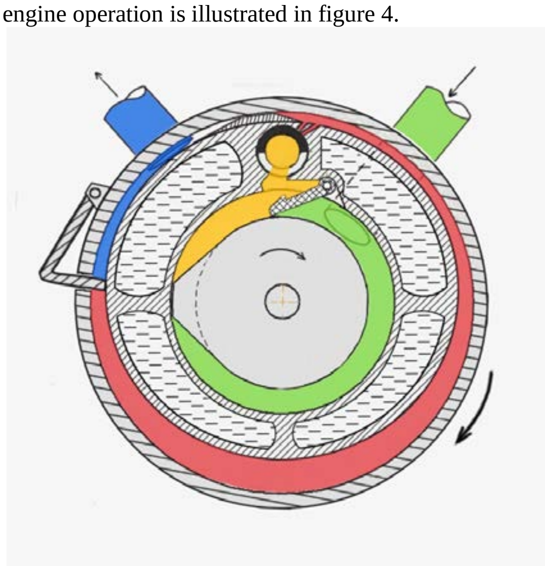

Figure 4 *– Schematic of operating principle of TIRE-3*

The working principle of the engine is as follows: while the rotors rotate within the range of 0 to 360 degrees, the compression of the working mixture occurs in the preliminary compression chamber, on the one side of the working damper plate of the compressor in its working space, while at the same time, the intake of the working mixture occurs in the intake chamber, on the other side of the working damper plate of the compressor in its working space.

In the working space of the turbine rotor, a combustion stroke occurs in combustion chamber on the one side of the L-shaped turbine plate, while an exhaust of waste gases from exhaust chamber occurs on the other side of the plate. Thus, the full circle of engine operation is accomplished at 360 degrees rotation angle of engine shaft.

The development of the engine working model. While developing the working model of the RDT-3 it was assumed that the working capacity of the compressor is 0.1 liters, while the compression ratio is 8. The engine power was estimated within the range of 3 to 6 kW. On the basis of this data, overall dimensions of the major engine components were calculated as follows: diameter of compressor - 56 mm, diameter of turbine - 260 mm, width of compressor rotor - 34 mm. The overall dimensions of the working model are as follows: outer diameter - 280 mm, width - 90 mm (excluding the length of the engine shaft).

Conventional feed and ignition systems for piston engines are used in the working model of RDT-3. The engine is cooled using either air or a liquid. The lubrication of engine parts is carried out by adding some oil to the fuel.

The tests conducted on the working model demonstrated that the engine is efficient, but requires further development. From our point of view, the invented rotary internal combustion engine has some advantages in comparison with a traditional piston engine. Namely:

- the engine has higher efficiency by reducing losses due to the reciprocating motion of the main parts of the engine;
- as all four strokes of the engine occur simultaneously in one revolution of the engine shaft, that is at 360 degrees rotation angle of the engine shaft, it has the right to speak about less "useless" costs of the engine;
- the engine has almost "ideal" engine balance as all major parts of the engine perform rotary motion;
- all major parts of the engine, being of a revolutional shape, are characterized by technological effectiveness;
- the engine design allows to have different working volumes of the compressor and the turbine, resulting the increase of the power-to-weight ratio, decrease in fuel consumption and improving the environment;
- engine of any power can be designed by increasing its size or the number of rotors and turbines.

The above advantages allow us to speak about the high potential of the rotary engine designed at Altai State Technical University.

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