NEW MOTOR AND TRIZ EVALUATION

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Abstract
The article presents use of TRIZ methodology for understanding and evaluation of significant invention. New solution of a motor presented in the article – based on invention of the nonlinear rotating screw mechanism - can be characterized from a TRIZ point of view: as an interesting combination of preferences and partial elimination of weak points of the two alternative systems (piston motor and a gas turbine), as a combination of the system and the anti-system (compressor and expander), as a system, bi-system and poly-system (motor with one, two, three or more shafts), as a cases of total nonlinearity of shapes (lines, surfaces, spaces), as a case of trimming (of classical combustion engine), as a case of radical innovations, etc. Generally, the new motor is a complex invention with numerous variable applications and a good case of increasing ideality of the system. For example the propeller is one of the possible applications of the base invention – the screw mechanism. This could also be a challenge for students and teachers to observe and study use of TRIZ tools in one specific invention.
Keywords: motor, propeller, contradictions, trends, TRIZ evaluation

1. Introduction

Existing principles of combustion engines are based on reciprocating motion of pistons and power transmission through a crank mechanism, eccentric transmission or cam. The most common piston motors from the mechanical point of view are having a number of imperfections:

- impact combustion process and cyclic power loading of mechanism,
- identical space for compression and expansion leading to the expansion limit and a necessity of removal unused thermal energy by cooling,
- losses caused by rubbing and necessity of lubrication (of the combustion space walls),
- many exact components (crank shaft, connecting rod, bearings, distribution mechanism, cams, valves, regulating elements, etc.),
- operating mechanisms (fuel and injection preparation, regulation, cooling, cycle), etc.

On the other hand existing gas turbine with shaft and numerous blades are designed usually for higher performance, working as a same-pressured or operating on a constant volume.

New motor can be described shortly as combination of two alternative systems: piston motor and a gas turbine, as well as a combination of the two opposite systems: compressor and expander - see Fig.1.

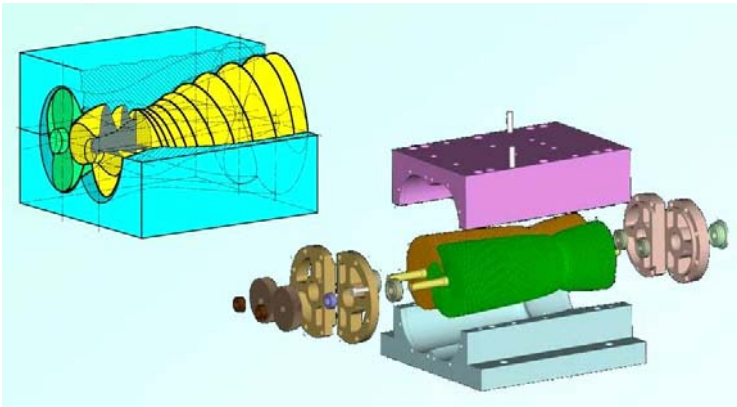

Fig. 1 Schematic arrangement of the new motor [5]

2. New motor benefits an differences

Benefits and differences of something new are always desirable to show by comparison of something old and comparable. For example, new motor can be considered by comparison of systems such as classical combustion engine, screwed pump/compressor or partial turbine. Fundamental differences and benefits of the new motor (as on principle shown in Fig.2.) are as follows:

- during the calculation of the shape of the rotor for the most efficient operation, it is possible to follow the type of the chosen fuel (gaseous: propane-butane, natural gas, biomass, hydrogen or liquid – petrol, kerosene, petroleum, spirit or their mixtures or combinations for multi-fuel motors),
- new motor allows a wide-range variability of design (small for high-speed and large for low-speed motors),
- motor has a compression space divided „in space" according to its expansion space and to a variant which could have a differently shaped „running and dividing parts" of combustion cell,
- spiral rotors are shaped differently in spiral rotors of standard screw compressors,
- spiral teethes („pistons") performs only rotary motion,
- motor has a continuous injection and continuous fuel combustion,
- output on rotors is relatively stable (there is no-cyclic change a course of revolution),
- moving parts are very well dynamically balanced,
- according to balance and continuous combustion, it has very quiet running and has consequently very low value of air pollution,
- non-touching transmission of motion of rotors (from the sight of stator) means that a friction and lubrication is only limited to bearings (which are placed away from combustion working area),
- new motor has only partial cooling which decreases outlet of unused thermal energy,
- theoretically it is possible to count with less fuel consumption, good thermal and high general efficiency,
- favorable is non-cyclic course of powers in working areas, a balance of resulting powers and of a torque without undesirable side effects,
- motor is made from a small amount of parts, only the rotors are more complicated to produce,
- necessary peripheral mechanisms are starter, hot plug, regulated continuous-injection pump and cooling course
- motor is relatively low and light with a long life and minimum maintenance.

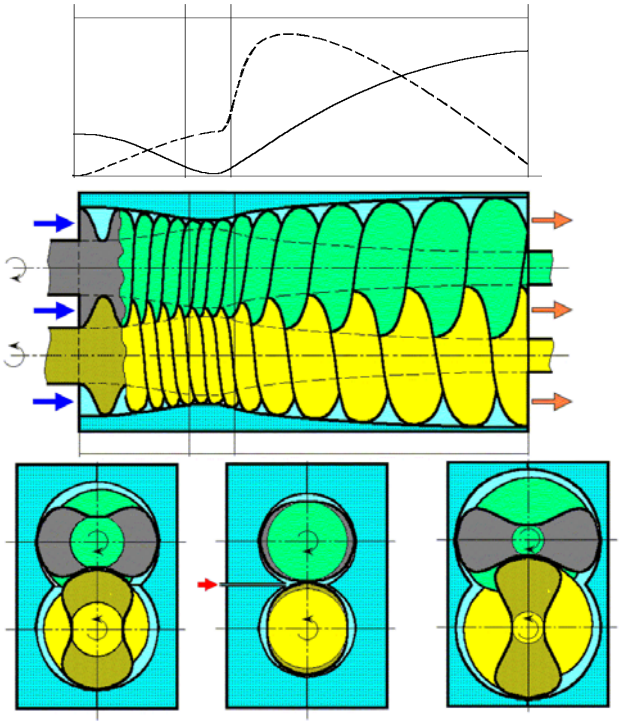

Fig. 2 Principe of the new motor: suction with compression in left part, ignition in the middle, expansion with exhaust on the right part [5].

3. Motor variants and other principles of applications:

Except of motor variants with parallel axis of rotors, it is also possible to construct motor variants with convergent or off-tracking axe of rotors. Except two rotors, variant showed above is possible to use more divided rotors or arrangements with one main rotor as shown in Fig. 3. It is possible to choose from many different profiles of teeth on rotors as well as different direction of motion interacting rotors (counter-rotating or parallel rotating).

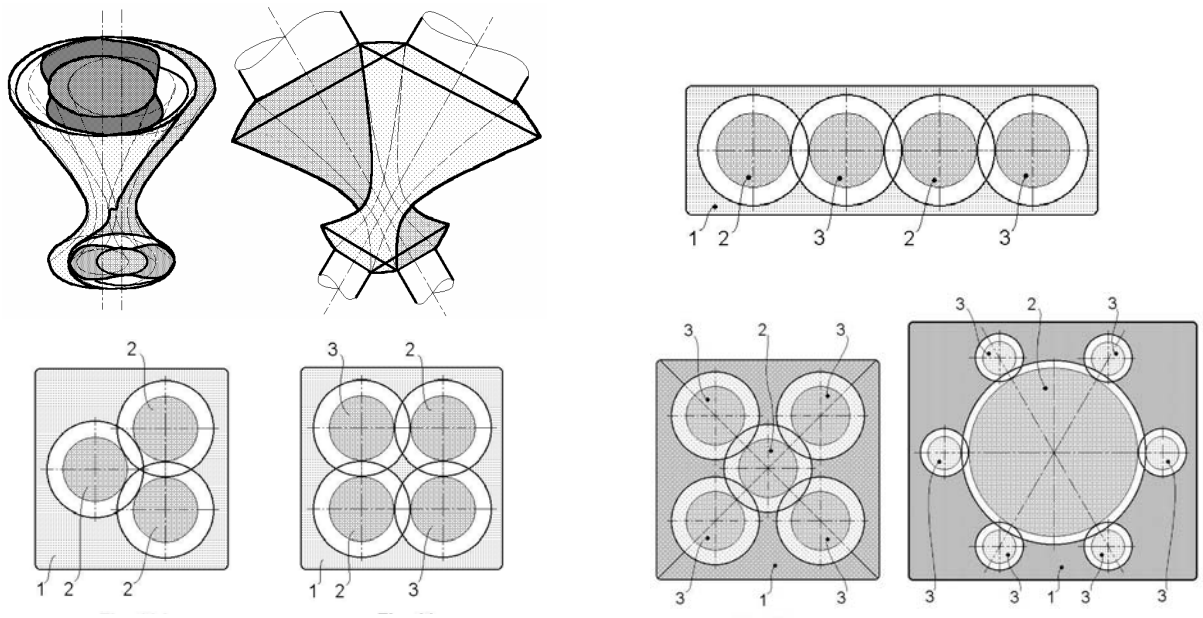

Fig. 3. Axis, shafts and their variability [5] according to trends: bi-poly systems with similar or different parts [2]. Description: 1- stator, 2 and 3 – shafts with opposite moving direction

Except mentioned motors, another application can be: a screw-shaped compressor, ventilator fans, vacuum pumps, pumps, marine drive (propeller) etc.

4. Contradictions and evolution trends of new motor

As we know, one of the possible indicators of improvement of the classical combustion engine is ratio of discharge to mass. Improvement of this indicator usually deteriorates other indices. For instance, the increased discharge at identical dimensions and mass can generate bigger heat losses - it is necessary to cool intensively, etc.

Formulating a few variants of technical contradictions and inspirations by numerous heuristic principles can be useful. However, conception of this engine has numerous limits and is close to depletion of possibility of further development (S-curve). Thousands of designers have "digged" on this place for more than a century. It is time and necessity to “dig“ deeper or elsewhere... TRIZ offers specific mining tools.

Formulation of physical contradiction leads human to deeper understanding of the matter of the problem and brings human closer to finding a new concept. Separation processes recommend several guide directions to find best solutions (in time, in space, C-antiC, etc ..). Trends of technical development can recommend more general perspective directions.

Where is it possible to see the physical contradiction solved by invention of a new engine?

Classical reciprocating „4 cycle“ internal combustion engine includes 4 processes (suction, compression, expansion, exhaust) in a one space (symmetrical – cylindrical space among cylinder and piston) and these processes are serial and impulsive.

New engine with the 4 spiral teethes on the two shafts separates 2 compatible processes (suction and compression) into the space in the left part of engine (segmented - unsymmetrical - spiral along shaft - convergent) and other 2 compatible processes (expansion and exhaust) into the space in the right part of engine (segmented - unsymmetrical - spiral along shaft - divergent). All these actions are parallel and less impulsive.

Physical contradiction: combustion space has to be huge to increase discharge; on the other hand combustion space has to be small to avoid worse volume, mass, heat loss, etc.

Inventor solved contradiction “in space” and by principle C-antiC. New engine has many small segmented spaces along the axe which are integrated into one big space.

It is possible to see many other applications of TRIZ tools (heuristics, separations, trends) in this radical innovation as well. Novelty and potentional benefits of the new motor can be illustrated by so-called evolution radar. On Fig.4. are shown benefits of the new propeller in comparison with classical screw and according to the evolution trends.

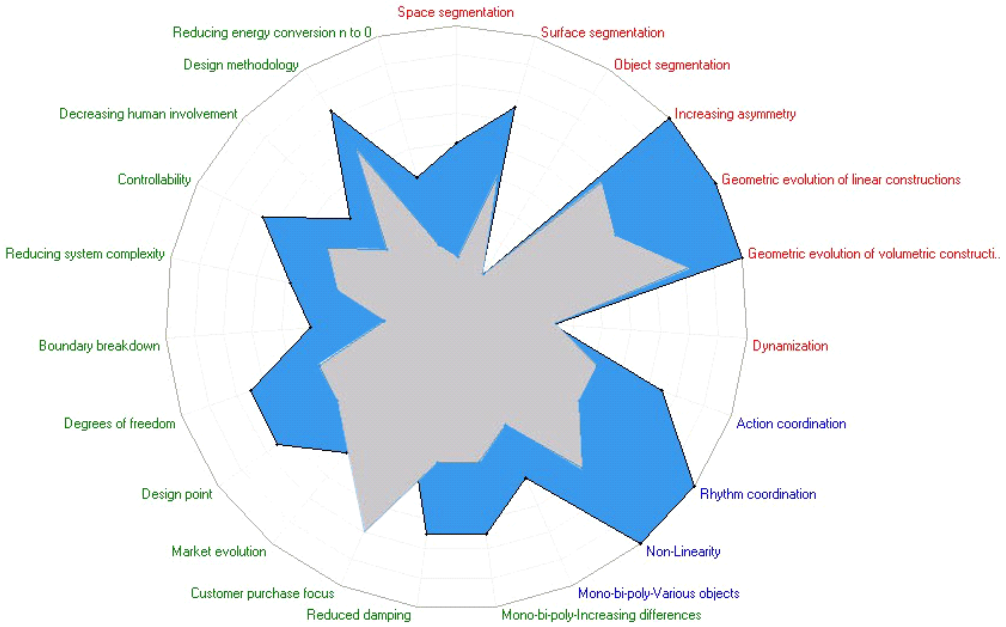

Fig. 4 Evolution trends radar of classical screw (grey) and the new propeller (blue) [7].

5. New Propeller

Propeller, as one possible application of the base invention, consists of the "stator" and two rotors inside. Every rotor has two teethes winded up along the rotor in a screw line shape; both rotors with spiral teethes interact with each other. These rotors, together with the stator, create a segmented workplace along the axis, with pumping on the input and with propeller's media extrusion on the output – see. Fig. 5.

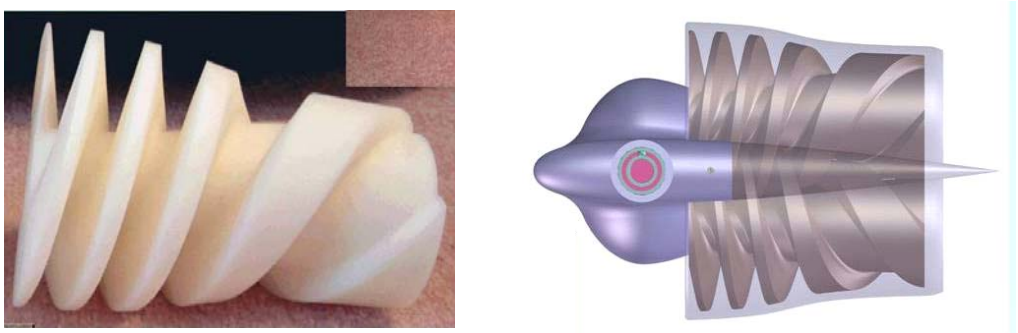

Fig. 5. One spiral shaft and model of the new propeller

The propeller generates an isochoric flow of the uncompressible media, but the medium velocity inside the segmented space is continuously and significantly increasing because the pitch of the spiral teethes increases nonlinearly and the profile (high and form of the section) of the spiral teeth changes also nonlinearly (first is decreasing, second is increasing).

These nonlinearities generate the relative increases of the media momentum inside the segmented workplace along of the propeller.

Moreover, these teethes can be even hollow. In this case, the medium can pass continuously not just through segmented workplace outside, but also through inner hollow spiral teeth.

All previously known solutions of similar equipments allow changes of the pitch and of the profile of the spiral teeth only in limited range, and do not comply with exact demands on working characteristics of the equipment.

6. Propeller integrated with the rudder.

The rotors of the new propeller are driven by worm gear built in the front of the stator and having a rudder shape. The vertical driving shaft of the engine is placed in the hollow peg, that allows turning the rudder over 360 degrees; this improves control over the ship (in all directions, with sufficient power). Both the accuracy and sensitivity is also increased, and thus the security of the ship navigation.

The propeller, presented in Fig. 6, has been designed to have ratio 3:1 between media acceleration on the output and the media velocity on the input and for the media volume pumping 2 liters per one rotor's revolution. It means that in 300 revs per minute, it is possible to have outflow of the media more than 600 liter/minute at the velocity of approx.140 km/h.

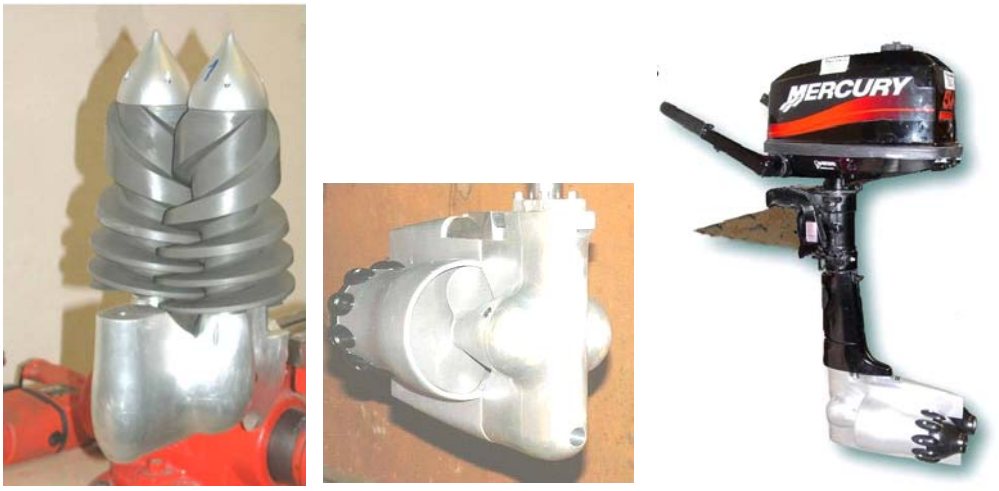

Fig. 6. Functional prototype

The new propeller differs from the common propeller by many advantages. It works already from very low revs up to the maximum, the transmitted power continuously increases (limited by the material strength). Propeller rotors inside the stator are also protected from the contact with the foreign bodies (fishes, nets, ropes, swimmers). Counter-rotation of the rotor's bi-system eliminates undesirable careenage, which is characteristic for classic screw-propellers rotating only in one direction. The cavitations and vibrations are considerably smaller due to limited turbulences.

The new propeller could be realized only with use of sophisticated computational and experimental methods, design tools (CAD), technological processes (Rapid Prototyping, NC machining, precise casting), materials, etc.

7. Conclusion

On the basis of the previous case were illustrated practical usability of TRIZ analytic-synthetic instruments for effective study and for objective evaluation of presented invention/innovation.

Authentic Conclusion by inventor **" ...**even first verbal information about TRIZ methodology impressed me a lot. As an active inventor, I was very curious, what is about, but the truth overcame my expectations. I was fairly dragged into the systematic methodology of creative work even though we used it only partly for evaluating an invention (engine) and innovation (propeller). I assured myself, that knowledge of methodic processes fastens thinking and searching procedures and reduce random steps of improper solutions. As an author of an invention being evaluated, I must say, that my concern of the methodology is not at the end, but in the beginning because a next ideas during evaluation arised"

8. References

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