Preface

The main aim of the book is to present development in heat air engines. We attempt to apply an idea of external heating to the piston engine manufactured with well known technology for internal combustion engines. External heating, i.e., delivery of energy from outside in order to create mechanical energy inside the engine, is an extensively developed range of engineering applications, especially in the light of a possibility to use a much wider scope of potential "fuels" than those which can only be burnt inside the engine cylinder. In fact, we intend to use any kind of heat from solar, through burning different fuels to heat generated in the nuclear process. On the other hand, externally heated engines still developing since 1800s exhibit a very complicated and difficult mechanical construction in exploitation, with many wear problems. We propose to employ the standard internal combustion piston engine design which is fed with heat from an external heater to warm up the working fluid which, in turn, employs simple thermodynamic laws interchanging its potential energy into the mechanical one. As in internal combustion piston engines, the working fluid expanding over the moving piston triggers mechanical rotations with torque in the rotating crankshaft, providing thus drive for any machinery.

The idea of air engine which originates from the original Stirling design is entirely different from it. It combines the proven technology of internal combustion engines together with their lubrication system and can be an effective solution not only in the future when most mineral fuels run out but even nowadays as it eliminates problems with lubrication of the mechanism, the main disadvantage of present solutions. Additionally, it can use the cheapest working fluid, the atmospheric air, instead of costly helium or hydrogen. Stability of the heat generation process outside the engine is another advantage of the proposed engine. The work is generated by expansion of hot and compressed air in a cylinder located between two heat exchangers, having extreme temperature and pressure values. A compression ratio considered is about 1:10 although higher values can be reached.

The idea comes back to 1995 and was invented by Lech Brzeski and Zbyszko Kazimierski. An engine, in both 2-stroke and 4-stroke cycles, working in a closed

heat cycle is in some way equivalent to internal combustion engines as energy is generated in similar working loops although heat cycles are different. The idea was confirmed by an experimental model in early 2000s when further development of another prototype stopped due to a lack of financial support. Thus, all our efforts were directed to increase theoretically the heat exchange level which was the main problem detected during tests. We present some ideas which can increase dramatically an amount of heat delivered to the working fluid in the work cycle. In parallel, we have also developed new versions of the engine which have yielded even higher performance characteristics in our simulations and remain within feasible engineering solutions even if some devices are added.

The 4-stroke version of the engine appears to be a very attractive proposition as it applies only a single cylinder. Even such a solution is able to realize a complete thermodynamic cycle. When expanded to a multicylinder design, the advantages are obvious. All proposed 2-stroke versions apply either 2 separate cylinders or a design with double-action pistons. The simulation results show impressive numbers of the power and efficiency generated by the engine – it can reach 50 kW per 1 liter of the working volume at the efficiency equal to about 40 %.

Therefore, we compare these numbers with those available for other, effectively working externally heated engines, where a choice of installations of modern Stirling devices is obvious. The results are promising, especially if air and not helium is applied.

We can expect many possible applications of such a source of mechanical energy worldwide and not only, as space applications are possible as well. In the future, when availability of mineral fuels is limited, such engines can replace internal combustion solutions.

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