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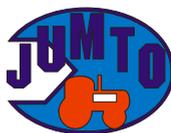
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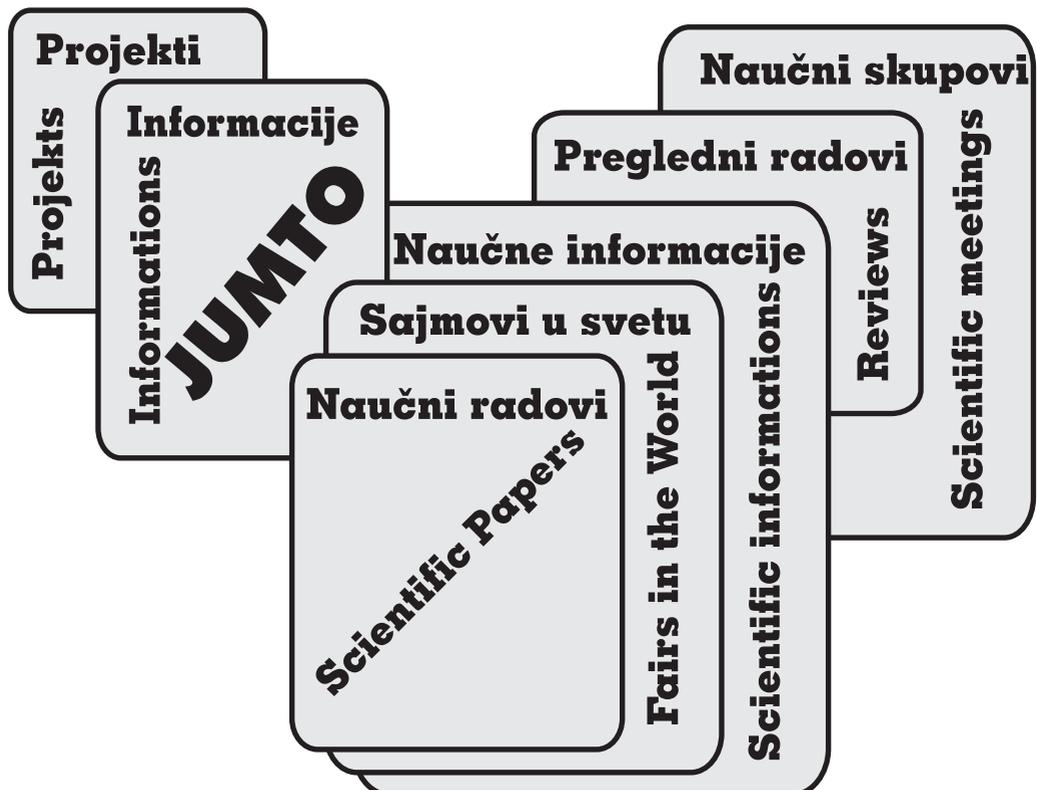
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THE ANALYSIS OF CONVENTIONAL AND NON CONVENTIONAL PISTON MECHANISM FROM ASPECT OF MECHANICAL STRESSES

Grujić, I.¹, Stojanović, N.², Dorić, J.³, Vasiljević, S.⁴, Pešić, R.⁵

SUMMARY

The IC engine represents vital part of every mobile system, as well for the agricultural machines. In difference from cars, where by production, life cycle is determined, agricultural machines presents different kind of mobile systems. From agricultural machines long life is expected, as well as the reliability during the life cycle. The development of IC engines with better performances as the consequence have the greater mechanical stresses, which have negative influence on life cycle of the engine, and with that on the life cycle of the mobile system. In the paper will be shown comparison of piston mechanism forces between conventional and nonconventional type of the piston mechanism, and on this way it will be performed comparison stresses, which occur in one and in other piston mechanism. On the basis of comparison, it will be determined, which piston mechanism is better from the aspect of the reliability.

Key words: IC engine, agricultural machines, long life, stresses, piston mechanism.

INTRODUCTION

IC engines have a rich history of technical development. From the beginning of their usage till today, IC engines didn't changed very much by their construction. However performances of first engines are drastically different in respect to today engines. This is the case how for the gasoline, as well as for the diesel engines. In order to improve the performances of the engine, it is necessary in some way to improve the working cycle. As the result of these improvement, almost always we have increasing in engine speed and/or cylinder pressure.

By increasing the cylinder pressure, the forces in piston mechanism are growing. As the result of increased forces, we have the higher stresses. One of the most dangerous forces, is the

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normal force. This force directly influence on the wear of the cylinder [1]. This can be a very bad, because this directly influence on the engine life cycle. In the case of working or more accurate agricultural machines, this is very important parameter, because from this kind of machines, reliability is expected. Besides the cylinder pressure, as well the speed can influence on stresses. As the nus product of piston speed, we have piston acceleration. The piston acceleration is main component of the inertial force that is very influential parameter in piston mechanism, which means that kinematic is also important, not only the dynamics [2].

One of the solutions for possible improvement in engines industry, in order to prolonger the life cycle of the IC engines, is the construction of new engines. One such research is performed by Kukuća P. et al. [3]. They have concluded in their research that the kinematic properties of the engine with FIK unconventional crank mechanism are comparable to the kinematic properties of the classical piston combustion engine with the same value of the piston stroke. This solution have the potential to reduce the wear of the cylinder and the noise caused by the tilting of the piston due to the small deflection of the connecting rod from the vertical axis of the piston.

The efficiency of a new internal combustion engine concept with variable piston motion was investigated by Dorić J., and Klinar I., [4]. They have expressed in their research, that represented engine have variable compression ratio, than with this concept it is possible to avoid classical approach for partial load operation via variable displacement. Finally presented concept is able to provide heat addition during constant volume. All of these mentioned advantages show that the potential to increase the efficiency of the SI engine conditions is not yet exhausted. As shown in the research results above, variable displacement methods have the best potential to increase the efficiency of the engine at part load conditions. To avoid engine operation below the unthrottled load limit, facilitate smooth mode changes and further improve the vehicle fuel economy. With the constant volume combustion cycle, the piston movement is significantly slower around TDC (Top Dead Centre) and BDC (Bottom Dead Centre), in fact piston actually stops for a while, this have significant impact on volumetric efficiency and engine efficiency.

The aim of this paper is to analyse the forces in the piston mechanism of simple nonconventional engine, as well as the comparison with the conventional engine, in order to determine, which engine is beater from the aspect of mechanical stresses.

3D MODEL AND THEORETICAL CONCEPT

The non-conventional piston mechanism engine is similar to the classic engine. As the base for the new conception, the experimental engine was taken. The characteristics of experimental engine are given in Table 1.

In order to compare the kinematic and dynamic characteristics of experimental and new engine, the 3D model is created, according to the geometrical parameters from table 1. The only difference, is that the new conception don't have the connecting rod, but all other geometrical parameters have stayed the same. The 3D model of new conception with main parts is given on

Tab. 1. Engine specifications

Engine capacity	454 cm ³
Number of cylinders	1
Bore/stroke	85 x 80 mm
Connecting rod length	145 mm
Compression ratio	17.5:1
Torque	28.5 Nm
Power	7.3 kW
Engine speed	3000 min ⁻¹

Figure1.

The 3D model of the new conception from Figure represents the section of the engine. The section is given on order for easier understanding the idea for new conception. As can be seen, this engine don't have connecting rod. This is replaced with the gear system inside the piston, as well as with the piston ring, which have the function to maintain the piston with the crankshaft in assembly.

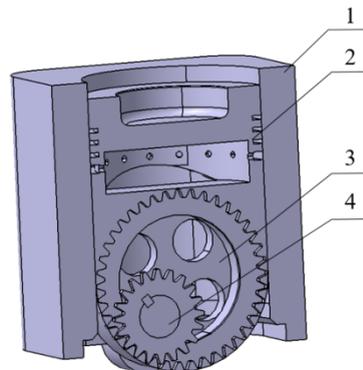


Fig. 1. New conception of IC engine
1 - cylinder 2 - piston
3 - crankshaft 4 - piston cap

COMPARISON BETWEEN CONVENTIONAL AND NON-CONVENTIONAL PISTON MECHANISM

In order to compare the conventional and non-conventional piston mechanism in stadium of development, it is not good to compare the concrete values, because the cylinder pressure can be different for one in respect to the other case. Because of this, only theoretical comparison will be performed. In order to compare this two mechanism the Figure 2 will be observed.

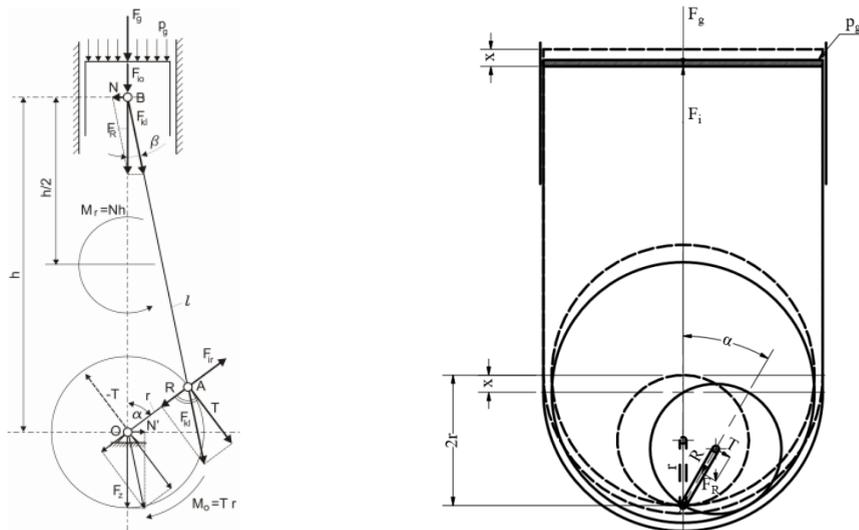


Fig. 2. Dynamic scheme of conventional piston mechanism (left), and non-conventional piston mechanism (right)

By compare dynamic schemes from Figure 2, it can be seen that there exist very important differences. The most difference that can be very usefully for analysis is the normal force (N). The normal force is one of the most harmfully forces in piston mechanism. The normal force is

main component in the friction force, which causes cylinder wear. In order of this it can be concluded that the non-conventional piston mechanism, will have smaller stresses, which will direct influence on the life cycle prolongation. Other harmful force is the radial force (R). This force appear in both mechanism. The only difference, which is also and convenience of the non-conventional piston mechanism, is application of the piston ring from Figure 3. By applying the piston ring, the radial force do not loads only the crank shaft. Also the piston ring is circular, which increase the power of carrying.

CONCLUSION AND REMARKS

The construction of IC engines wasn't changed very much during the time. The greatest accent was always placed on the equipment development in order to reduce the harmful exhaust emission. In this paper the application of the non-conventional piston mechanism from the aspect of stresses it was investigated. It was concluded, that the normal force is not appear in non-conventional piston mechanism. Because of this, the friction force, as well as the cylinder wear is reduced. This is very important, especially for the agricultural machines. It is a good known fact, that from the agricultural machines, the reliability is expected. With reduced cylinder wear, the reliability is increased, as well as the life cycle is prolonged. Also it was analysed the radial force, as harmful force. It is concluded that in the case of the non-conventional piston mechanism, this force do not loads just the crank shaft, because of the piston ring, which takes the load and increase the power of carrying. Based on the observed facts, the non-conventional piston mechanism have less stresses of his parts. The next step of the research is to calculate cylinder pressure, for the non-conventional piston mechanism, by usage of the mathematical models or the numerical analysis, and to apply the obtained pressure for the mechanical calculation. If those calculations give the satisfying results, the manufacturing of the engine prototype can be considered.

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REFERENCES

- [1.] Grujić, I., Stojanović, N., Doric, J., Glisović, J., Narayan, S., Davinic, A.: Engine load impact on maximum value of normal force in piston mechanism, Tractors and power machines, Vol.23, No.1/2, pp. 10-16, ISSN 0354-9496, 2018
- [2.] Grujić, I., Miloradović, D., Stojanović, N.: Nonlinear kinematics of engine crank-piston mechanism, The Ninth International Symposium KOD 2016, Machine and Industrial Design in Mechanical Engineering, Balatonfüred, Hungary, 9 - 12 June, pp. 93-98, ISBN 978-86-7892-821-5, 2016,
- [3.] Kukuća, P., Barta, D., Dižo, J., Caban, J.: Piston kinematics of a combustion engine with unconventional crank mechanism, MATEC Web of Conferences 244, 2018.
- [4.] Dorić, J., Klinar, I.: Efficiency of a new IC engine concept with variable piston motion, Thermal Science, Vol. 18, No 1, pp. 113-127, 2014.

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