INTEGRATION OF HYDRAULIC CONVERTER AS VARIABLE FLOW PUMP IN THE HYDRAULIC-HYBRID PROPULSION SYSTEM

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ABSTRACT – The objective of the paper is the implementation of hydraulic converter as pump with variable flow as applied to hydraulic-hybrid propulsion system with application to vehicles.

Currently, the main requirements imposed on the propulsion systems for motor vehicles related emissions that contribute to global warming and other energy use than petroleum because they are limited and growing consumer needs. To resolve issues of limited resources and pollution, have developed a series of technical solutions which means radical changes in propulsion systems.

Hydraulic-hybrid propulsion system has in his building, components made from relatively simple and well-tuned processes of common materials with relatively low cost compared with other components of hybrid vehicles. A disadvantage of the hydraulic-hybrid propulsion systems is bound to efficiency less than mechanical transmissions. For this reason it is investigating ways to increase the hydraulic efficiency for example hydraulic pumps and motors with variable flow, that allow internal combustion engines to operate at constant speed system leading to an operation with low consumption and pollution. Conventional solution pump with variable flow is affected by a variable yield and constructive complexity. Solution considered in the paper is the hydraulic converter.

In this paper, is done a simulation of hydraulic converter which generates the necessary hydraulic energy for hydraulic-hybrid propulsion system and then are compared with variable flow hydraulic pump efficiency to that of hydraulic converter.

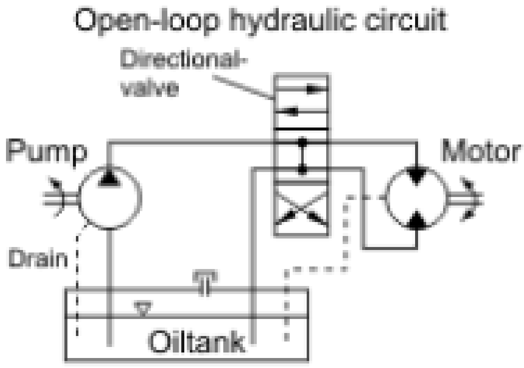
The method of analysis used in the simulation achieve hydraulic converter is AMESIM. The analysis in this paper is the hydraulic converter.

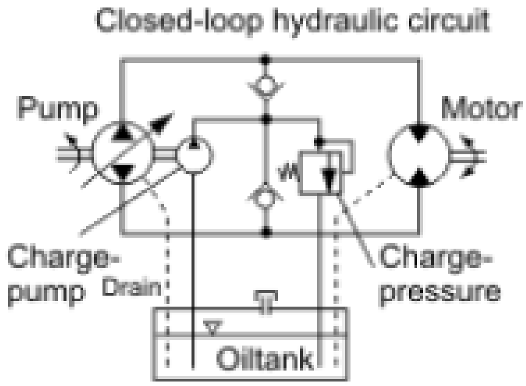
The work presents the hydraulic converter for various constructive variants and operating modes.

INTRODUCTION

A hydraulic drive system is a transmission that uses pressurized hydraulic fluid to drive hydraulic machinery. The term hydrostatic refers to the transfer of energy at high pressures and low flow speed.

A hydraulic drive system consists of three parts: The generator (e.g. a hydraulic pump), driven by an electric motor, a combustion engine); valves, filters, piping assembly (to guide and control the flow); the motor to drive thevehicle.





Mechanical transmissions are simple but the transmission ratio is discontinuous.Automatic versions have made it more easy to use but with loss of efficiency and power.Electrical transmissions have a constant ratio and are highly efficient but their elevated cost makes them unaffordable. Hydraulic transmissions have a constant ratio and a large variation domain but because of their low efficiency, they are not widely used

HYDRAULIC CONVERTER

Hydraulic pump hydraulic converter is based on fluid movement through oscillating piston is in motion. Hydraulic converter is particularity contact oscillating liquid column masses. Dynamic mass oscillation system influences the pump pumping qualities respectively, peculiarity that makes the result a variable flow at constant racing pistons.

Technical solution, as shown in Figure 1 is based on a double-acting piston or pistons on two independent and simultaneously operable disposed opposite (180 º). By moving the piston the liquid is absorbed by overrunning valves h and l in front of the piston and the valves a, prepressed the fluid to the outlet 24.

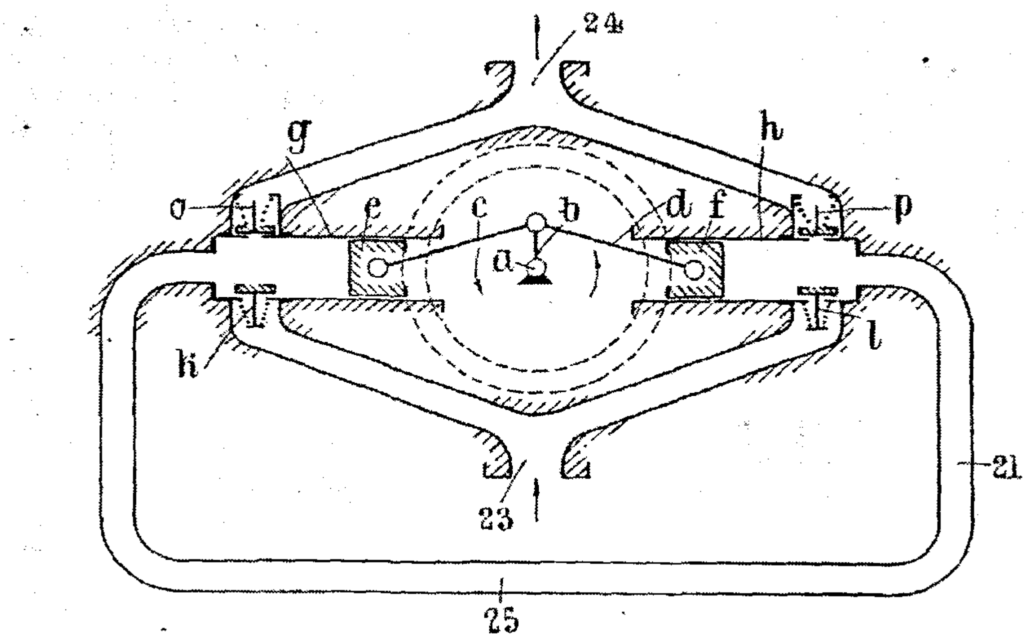


Fig.1: Schematic diagram of the hydraulic pump with double acting piston

Inertia effect to this solution is achieved by placing a pipeline linking the two workspaces opposed cylinders, liquid column contained in the pipe being moved in reciprocating motion during operation, moved with inertial effects. To enter the inertia effect using a concentrated mass, pump schematized in Figure 1, make a set of two cylinders working pistons, which implies a mass oscillatory motion. Working space of pump cylinders and the mass of the oscillating actuator cylinders are connected as shown in Figure 2. Through the auxiliary cylinders,the main liquid column of pump is connected to the oscillating mass.

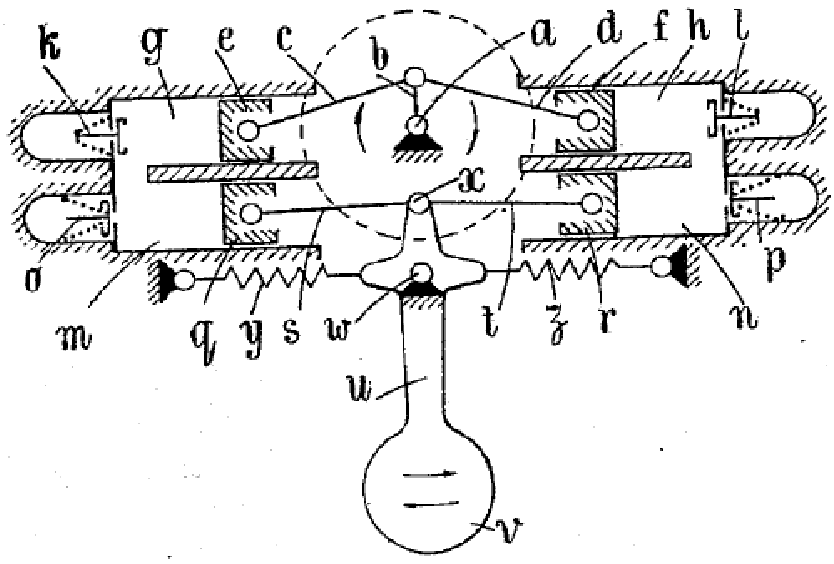


Fig.2

Fig.2: Schematic diagram of the hydraulic pump double acting piston connected in parallel with the oscillating mass (hydraulic converter), after

Figure 2 shows one form of pump constructed according to the invention. The driving shaft *a* carries a crank *b* connected by the connecting rods *c, d* to opposed pistons *e, f* working in co-axial cylinders *g, h*, suction valves *k, l* being provided in the ends of the cylinders. The ends of the cylinders are in communication with parallel cylinders *n, m* having 28 delivery valves *o, p* at their ends. Opposed pistons *q, r* are provided in these cylinders connected by rods *s, t* with lever *u* carrying a mass *v* and pivoted at a fixed pivot *w*. Springs *y,z* are provided tending to keep the swinging mass in its mean position.

Supposing that the suction valves *k, l* are in permanent communication with a liquid tank under given constant pressure, the pump cylinders *g, h, m, n* being filled with liquid together with the other pipes in the system. Then for any given oscillation of the pump pistons *e, f* the liquid will transmit movement to the lever *u* and mass *v*. Since the liquid columns are relatively short, the liquid will practically operate as a flexible connecting rod. If the frequency of the pump piston increases the inertia of the mass *v* will oppose considerable reactance to the motion and considerable pressures will be generated in the pump cylinders.

When there is no delivery from the pump, these pressures will be greater or less according to the speed of the pump pistons *e, f*, but the displacements of the points of connection *x* to the inertia device will always be the same as the displacement of the pump pistons *e, f*. When the pump is delivering liquid the pressures diminish and the displacement of the inertia will be less than that of the pump pistons *e, f*. At each suction stroke of the pump piston a fall of pressure will take place on the corresponding side of the piston. The inertia device, however, will not be able to follow the liquid column immediately and thus the suction valve on that side will open and the liquid will enter the cylinder. On the pressure stroke of the pump piston, the pressures generated will not be able to move the inertia device immediately and some liquid will, therefore, be discharged through the delivery valve, if the backpressure is not higher than the pump pressure.

If the backpressure rises to a certain limit, the delivery valve will not open and the inertia device will then be simply kept swinging back and forth, with its maximum stroke, the motion going on without any absorption of power by the prime mover driving the pump except to overcome friction. When, however, the backpressure diminishes, for example, by utilizing the liquid the delivery valve will again open and work will be done by the prime mover depending on the amount of flow.

It will be readily seen that the maximum pressure obtained at the delivery valves for constant flow is a function of the frequency of the pump and therefore by speeding up or slowing down the prime mover, different maximum pressures may be obtained for the same flow.

It is obvious that this pump produces pressures even when there is no flow and this property enables it to be used as a governor by allowing such pressure to act on a suitable servo-motor; the pressure rising as the square if the speed.

THE WORKING PRINCIPLE OF THE STUDIED SYSTEMS

In the following, the studied hydraulic converters will be presented. Three versions were considered. In the construction in figure 3 the sine signal sources 1, 2 give the driving frequency of the pistons. Conversion of signal into a linear displacement and velocity using first order lag is made by the elements 3 and 4 , parameters which define the behavior of the actuators 5 and 6 , a single hydraulic chamber single rod jack with spring assistance. A double hydraulic chamber double rod jack with no orifices at flow ports 7 to which an external mass 8 is attached represents the inertia mass. As a driving motor for the vehicle's wheels, an ideal fixed displacement hydraulic motor 9 is used.

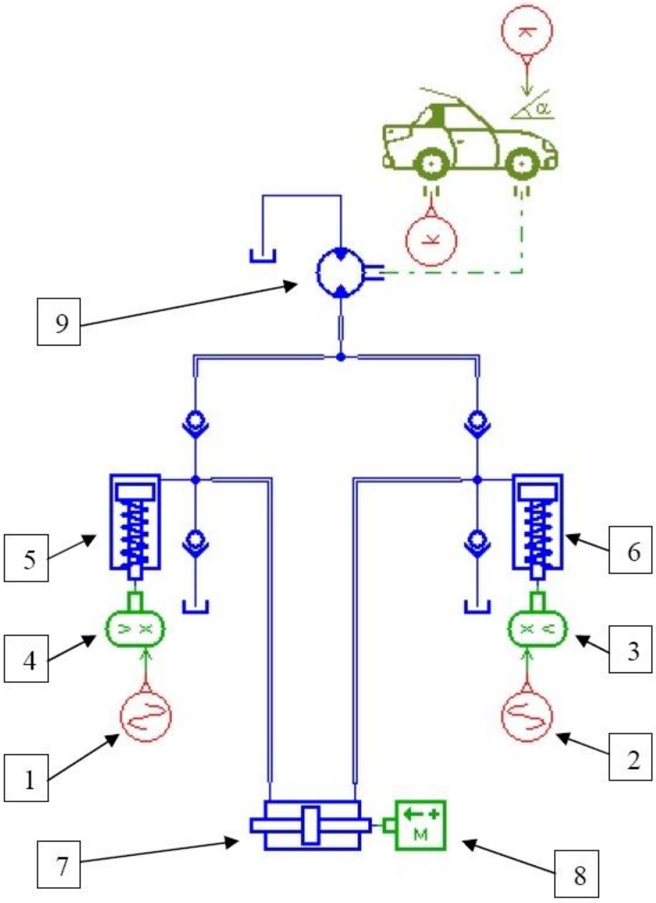


Figure 3. The converter using an external mass attached to a double hydraulic chamber double rod jack

CALCULUS RESULTS OF THE CONVERTER

Further, the functional details of each construction will be presented and also the influence of each parameter. In figure 1 the system contains 2 single hydraulic chamber single rod jacks and a double hydraulic chamber double rod jack. For simplicity diameters have been chosen to be equal (50mm). The pipes leading form the main actuators to the hydraulic motor and the ones leading from the nodes xx and xx to the double chamber jack will also have equal diameters of 30mm.

The influence of the inertia mass attached to the double jack is presented in figures3.1, 3.2, 3.3, 3.4. It can be observed that until reaching the value of 10m/s the masses of 1kg,2kg, 5kg, and 10kg have a similar influence, only masses over the value of 10kg having a greater impact on velocity. Overall velocity in turn increases proportionally with the increase of mass in all cases.

In the case of acceleration, the proportionality is not obvious, dependencies that are more complex appear in this case. As in the case of velocity, only masses over 10kg start having a greater impact on acceleration.

Torque and pump pressure will have a similar behaviour. Masses over 10kg are the only ones having a more notable impact on the discussed parameters but in figure 8 it can be observed that these masses generate much higher pressures. These values of pressure emphasize the fact that using masses over 10kg is not convenient considering existing material limitations and costs.

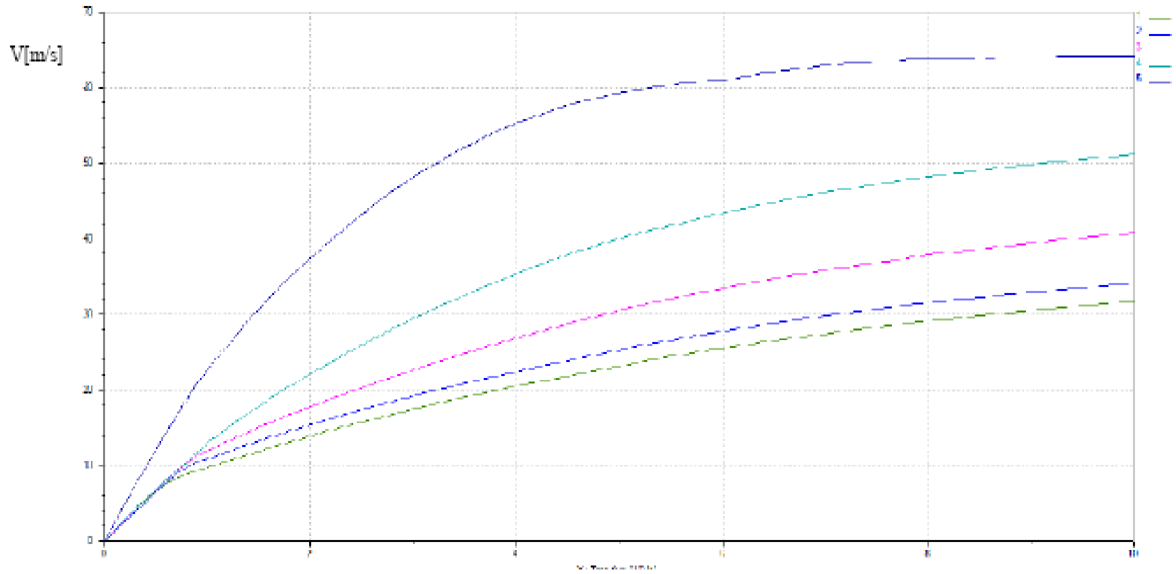


Figure 3.1. Influence of the magnitude of mass on velocity (1-1kg, 2-2kg, 3-5kg, 4-10kg, 5-20kg)

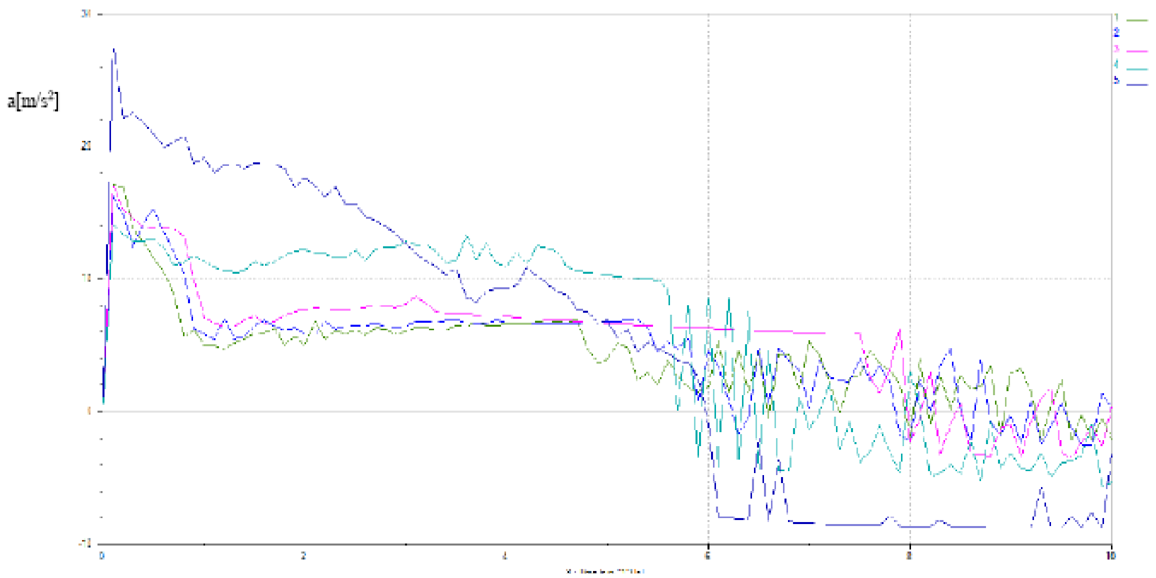


Figure 3.2. Influence of the magnitude of mass on acceleration (1-1kg, 2-2kg, 3-5kg, 4-10kg, 5-20kg)

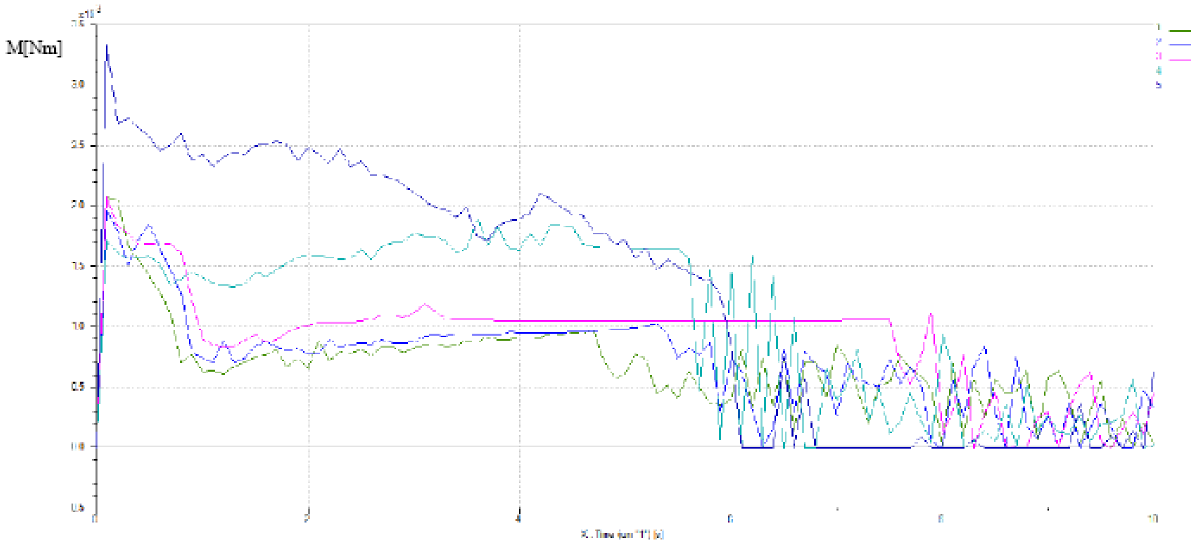


Figure 3.3. Influence of the magnitude of mass on torque (1-1kg, 2-2kg, 3-5kg, 4-10kg, 5-20kg)

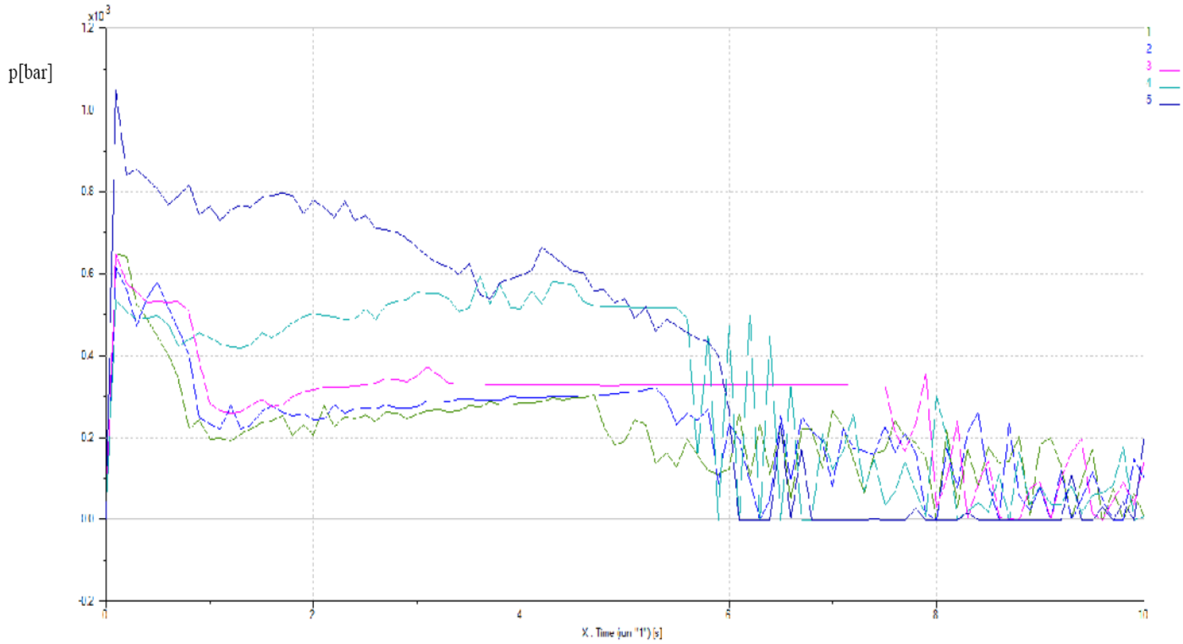


Figure 3.4. Influence of the magnitude of mass on pump pressure (1-1kg, 2-2kg, 3-5kg, 4-10kg, 5-20kg)

CONCLUSIONS

The analysis made on this new type of converter transmitting power from the engine to the wheels has shown the fact that it can be a good candidate to replace existing vehicle transmissions. Reduced friction and high efficiency enable this system to be superior in performances, losses of power being reduced to minimum.

Although different results have been obtained with the different versions of the converter, similar performances can be achieved if they are adapted to the system is use. The multitude of variables in the functioning of these systems require further studies and analyses in order to make these transmissions as efficient as possible but, as the author of this invention has proven, the principle on which they rely assures the best achievable results for transmitting power.

Another innovation introduced with this transmission is the use of sonic motors. Despite de fact that the achieved results are inferior to existing solutions, as the hydrostatic motor, further improvements can be made. As any other new and untested technology, this motor needs a thorough analysis and further research must be made in order to get the most of this invention.

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REFERENCES

(1) Pop, I. Ioan, Tratat de TeoriaSonicitatii, Ed. Performantica, 2006

(2) Pop, I, Selecție de brevete, Ed. Performantica, 2007

(3) www.sae.org

(4) www.wikipedia.com

(5) www.jackssmallengines.com

(6) *** LMS AMESIM AME help