Prototype of Rexroth hybrid power transmission system

Zbigniew Pawelski*

* Vehicle Research Institute Technical University of Łódź, Poland
pawelski@p.lodz.pl

Abstract **– The prototype of hybrid power transmission system is mounted in city bus IKARUS 266, where following components of Rexroth products. Results, obtained during these tests concerned with control and action of energy accumulators, and observed effects can be fundamentals for further experiments of new solutions of hybrid power transmission system of microprocessor control.**

In introduced solution hydrostatic transmission was used as a power transmission system.

Combustion engine and connected with it variable delivery pump, are a part of a power transmission with an intensitycoupling. This pump and high-pressure accumulators hold working pressure in range 20-33 [MPa] and create system with a active pressure. A governor, that is responsible for this part of the system, realizes steering: with a pump elementary volume and with a angular velocity of the combustion engine.

To making up leakages serves feed pump. This pump, together with low-pressure accumulators, has to hold in a suction line of the pump the pressure, that prevents the cavitation despite of variable oil demand.

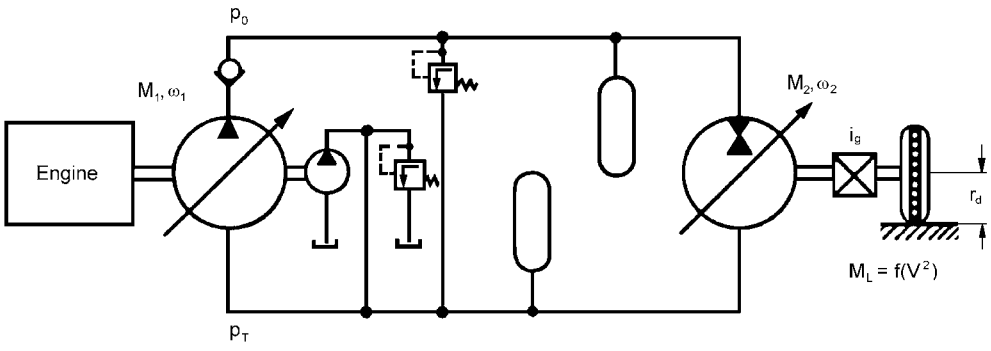

Fig.1. Power transmission system of the hydrobus

The two main tasks hydrostatic unit, installed on the live axle of the bus, is responsible for are: realization of movement of the vehicle and recovery of the energy from the braking process. When the elementary absorptivity of the pump is changed, the output moment is

adapted to the load conditions. But working as an engine a stream of oil is taken from the system, and working as a pump, during the braking process, such a stream is formed.

Entire dividing angular velocities: ω_1 - of the pump and ω_2 -of the engine, permits on separate optimization of work both: internal-combustion engine and hydrostatic machines, and by the way higher efficiency is provided.

The task of the control system of the power transmission is providing set values for closed subordinated systems i.e.:

- combustion engine - angular velocity ω_1,Fig.2,
- pump - deflection angle of the disk, Fig.2,
- secondary unit - angular velocity ω_2, Fig.4.

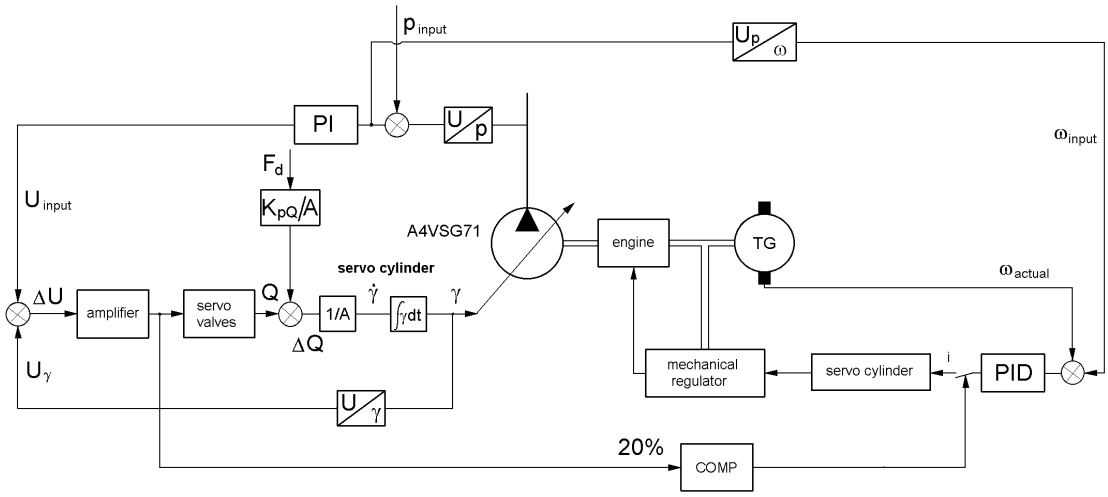

Fig.2. The schematic diagram of the control system of the capacity of the hydrostatic pump

In this solution, changing of efficiency of the pump can be done by: changing its elementary volume and changing angular velocity. The microprocessor regulator, Fig.2, realizes following tasks:

- control of the elementary volume of the pump,
- control of the angular velocity of the combustion engine (speed governor),

After turning on the “accumulator charging” switch, the hydraulic servo-motor moves the slat of the injection pump and the servomechanism of the pump moves the keep plate in maximum position. After the given value of the pressure is reached, servos in injection and hydraulic pump are withdrawn.

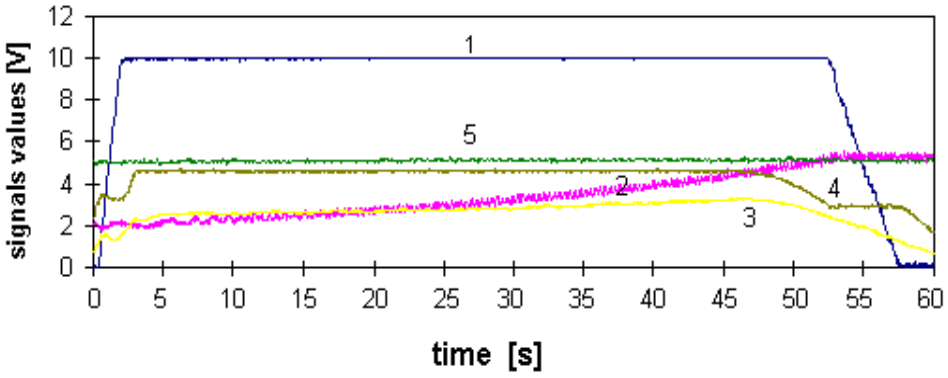

Fig.3. Accumulators charging process course in the hydrobus while standing

1 – servo-cylinder position in hydrostatic pomp, 2 – real pressure, 3 – fuel pomp signal, 4 – servovalve signal, 5 – angular velocity of the engine

The main essence of the power transmission with regulation of the elementary volume of the engine, is running in the closed system, where the real value of the angular velocity, measured with a rate generator, is compared with its set value. The set value is provided by a driver. Control error, converted by the governor, is an input signal for the main automatic control system of the deflection angle. There is a logic circuit in this governor, with what we can have the set signal for a main automatic control system elaborated, according to signals from acceleration and break pedal. The logic circuit follows the hierarchy importance, and does not permit on simultaneous application of signals from the brake and the accelerator. The superior calculations of the process should show the proper settings of hydraulic subassemblies and combustion engine, in relation to efficiencies of all components, but the total efficiency is optimized as well. The very special meaning in calculations of the process has controlling the power balance, because in every working point, the power required of the secondary unit, should not be greater than the one delivered from the engine and accumulator, taking into consideration losses in the hydrostatic transmission.

Vehicles, in which hydrostatic transmissions with the energy accumulation are used, are characterized by comfort of traveling, servicing and low fuel consumption. This kind of the transmission its recommended for vehicles moving mostly with not stationary speeds, because the advantages of this system can be observed mostly during the breaking process and the weight of a vehicle with an hydrostatic transmission can be slight.

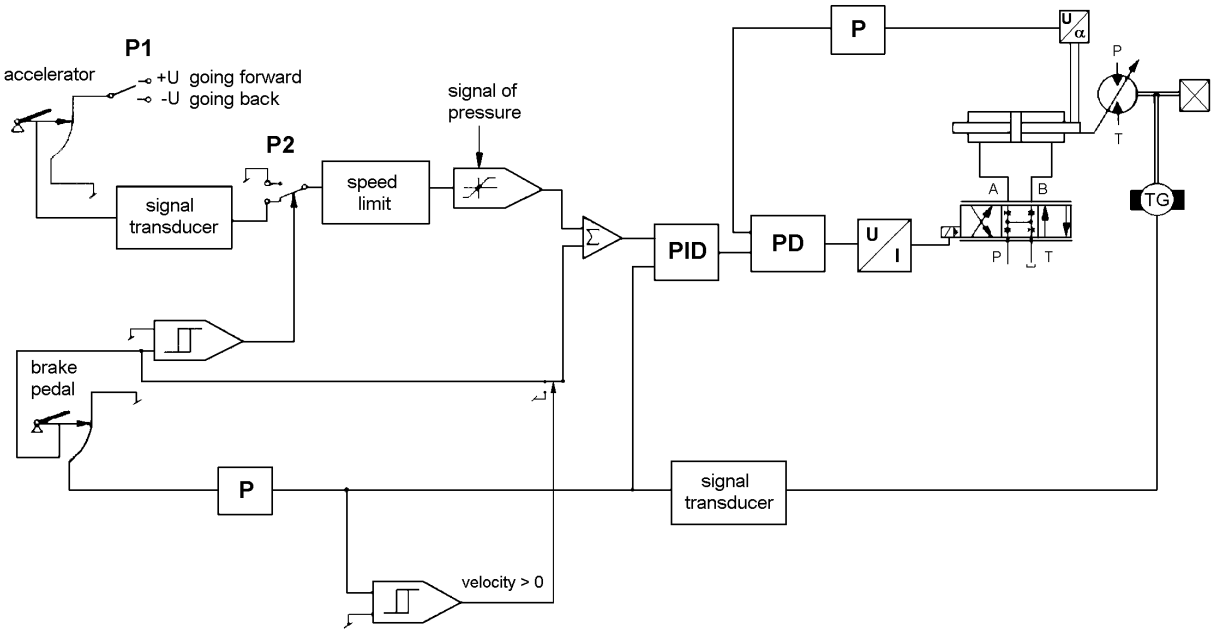

Fig.5. The schematic diagram of the speed governor of the vehicle

After road tests of the power transmission with the microprocessor control system, full verification of the system could be made. The results showed, that for the average traffic in Łódź, there is a possibility of saving 10-12% of the fuel and the toxicity of the exhaust gas can be twice lowered. Further savings in this system are not possible due to the selection of the hydrostatic machine, regard to the peak power and maximum speed of the vehicle. Savings in the fuel consumption are connected mostly with regeneration of the energy from the braking process.

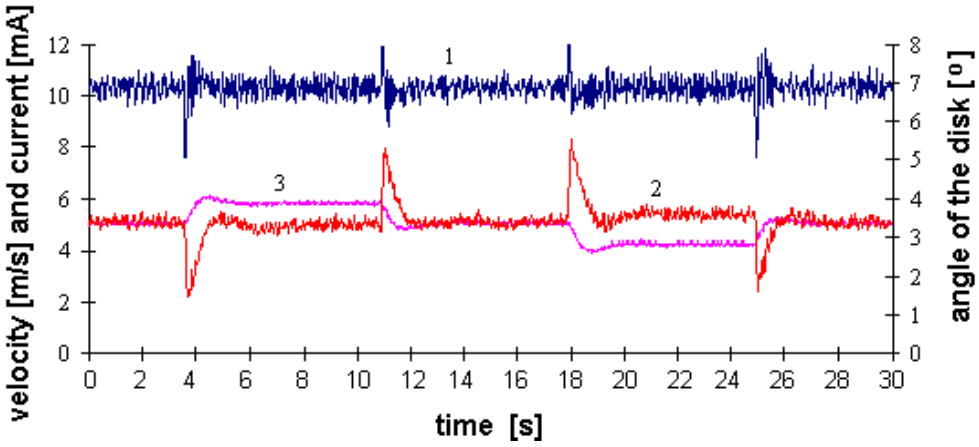

Fig.6. Example course of the basic parameters in the vehicle velocity control system with 50% forced accelerator pedal position while driving forward and backward

1 – servovalve controlling current, 2 – angle of the hydrostatic motor disk position, 3 – vehicle velocity

Pic.1. Hydrobus with prototype, hybrid power transmission system

References

[1] Der Hydraulik Trainer. Band 1-6. Mannesmann Rexroth Gmbh, Lohr am Main.
[3] Pawelski Z.: Modelowanie i obliczanie napędu hydrobusu. Wydawnictwo Politechniki Łódzkiej, Monografia nr 979, 2000.