Stand for Experimental Verification of Components in the Structure of Hydraulic Drive Systems

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Abstract: *For the experimental verification of the components in the structure of hydraulic drive systems, stands dedicated to a single category of components are used: stands for pumps, stands for hydraulic cylinders, stands for hydraulic devices (directional control valves, other valves, etc.). The article presents a stand on which one can be perform the experimental verification of almost all the components of a hydraulic drive system: pumps, rotary motors, hydraulic cylinders, devices (directional control valves, other valves, etc.).*

Keywords: *Experimental verification, stand, hydraulic drive systems*

1. Introduction

In the structure of a hydraulic drive system, there are three large groups of components: *hydraulic pumps* that convert the energy received at the shaft into hydraulic energy, *hydraulic motors* that convert the hydraulic energy received into mechanical work, which is further supplied to the driven mechanisms, *devices* that regulate and control working fluid parameters (pressure, flow, temperature, etc.). For the experimental verification of the components in the structure of the hydraulic drive systems stands dedicated to a single category of components are used: for pumps, motors, or hydraulic devices. With the stand presented in this article, one can check almost all the components of a hydraulic drive system: pumps, rotary hydraulic motors, linear hydraulic motors and various devices (directional control valves, other valves, etc.). The equipment of the stand allows the following tests and verifications: functional static tests with didactic character within the teaching line "Hydraulic drives" in the curriculum of technical universities, dynamic tests for investigating the components in the structure of hydraulic drive systems, functional verifications (type or batch tests) of hydraulic devices and components at the request of economic operators. The stand can also be used for practical training at any level (workers, technicians, engineers) of persons who specialize and / or improve in the field of hydraulic drives.

2. Technical characteristics

2.1. Technical parameters

• Main electric pump:
- electric motor: 45 kW; 1450 rpm;
- pump capacity, v_g: 70 cm^3 / rev;
- maximum pressure: 320 bar;
- maximum flow: 100 l / min at 225 bar;
- maximum flow: 75 l / min at 320 bar.

• Electric pump controls:
- electric motor: 4 kW; 1460 rpm;
- pump capacity, v_g: 6 cm^3 / rev;
- maximum pressure: 250 bar.

2.2. Measuring devices for:
- pressure: pressure gauges and pressure transducers;
- flow: turbine flow transducers;
- torque and speed: torque and speed transducer;

- oil temperature: temperature transducer;
- force: force transducer.

3. Structure and operation of the test stand [1, 2, 3, 4]

Fig. 1 shows the hydraulic diagram and the structure of the test stand, SAH - 0.

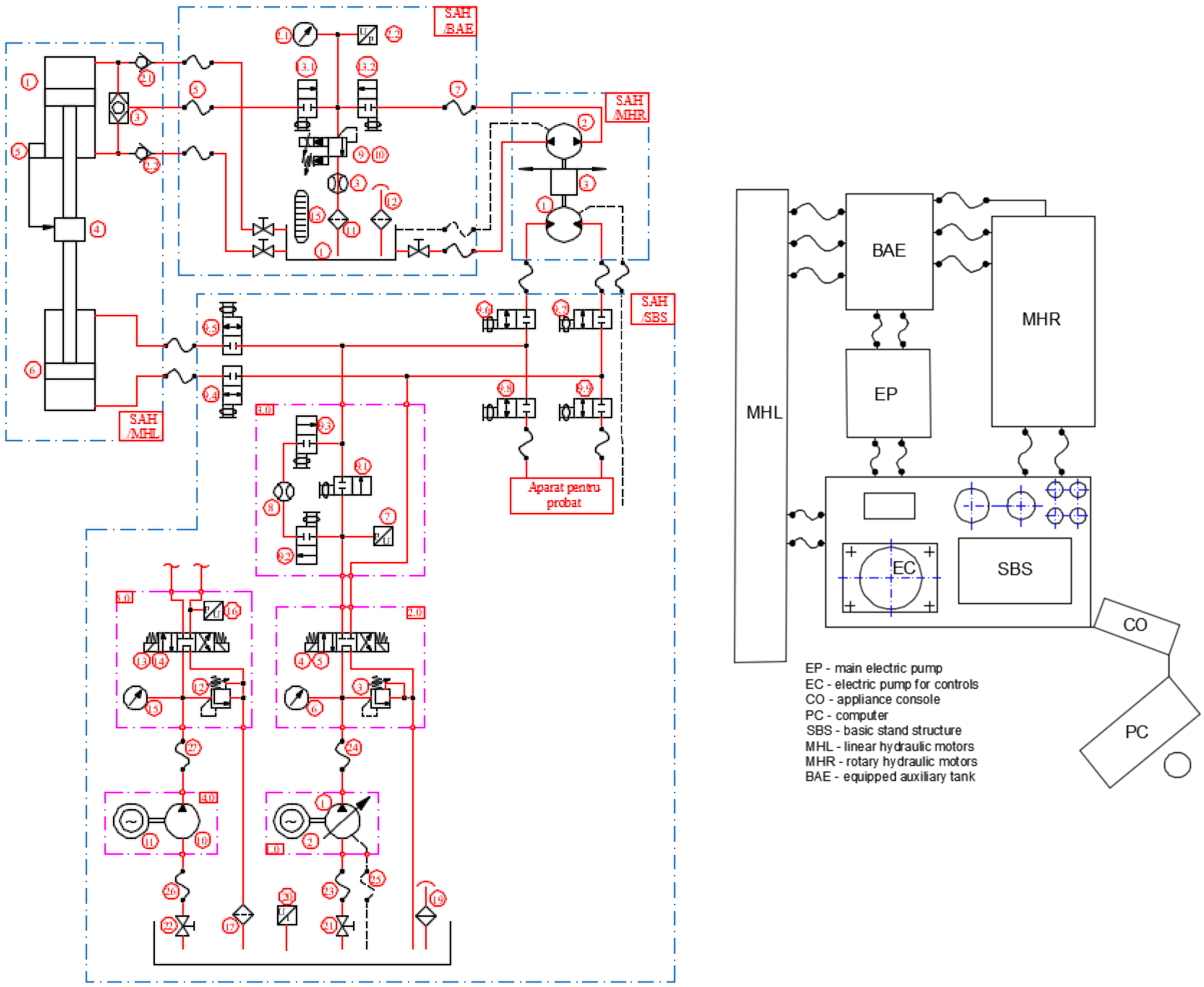

Fig. 1. The hydraulic diagram and the structure of the test stand

The SAH hydraulic drive test stand consists of four subassemblies:
• SBS - the basic structure of the stand;
• MHL - subassembly for linear hydraulic motors;
• MHR - subassembly for rotary hydraulic motors;
• BAE - equipped auxiliary tank.

3.1. The basic structure of the stand - SAH / SBS

It is the subassembly that generates the hydraulic energy necessary for the operation of the stand. Its hydraulic diagram is shown in fig. 2.
The basic structure of the stand consists of six subassemblies:
• *Main electric pump: SAH / SBS - 1.0.*
It consists of variable flow pump *1* and electric motor *2*. Axial piston pump *2* is equipped with a flow and pressure regulator. Both the flow and the pressure are remotely adjusted electrically proportionally.

• *Block with devices A: SAH / SBS - 2.0.*
It is associated with the main electric pump and consists of safety valve *3*, which limits the pressure in the discharge circuit of main pump *1*, directional control valve *4*, which directs the flow of main pump *1* to the consumers, and pressure gauge *6*.

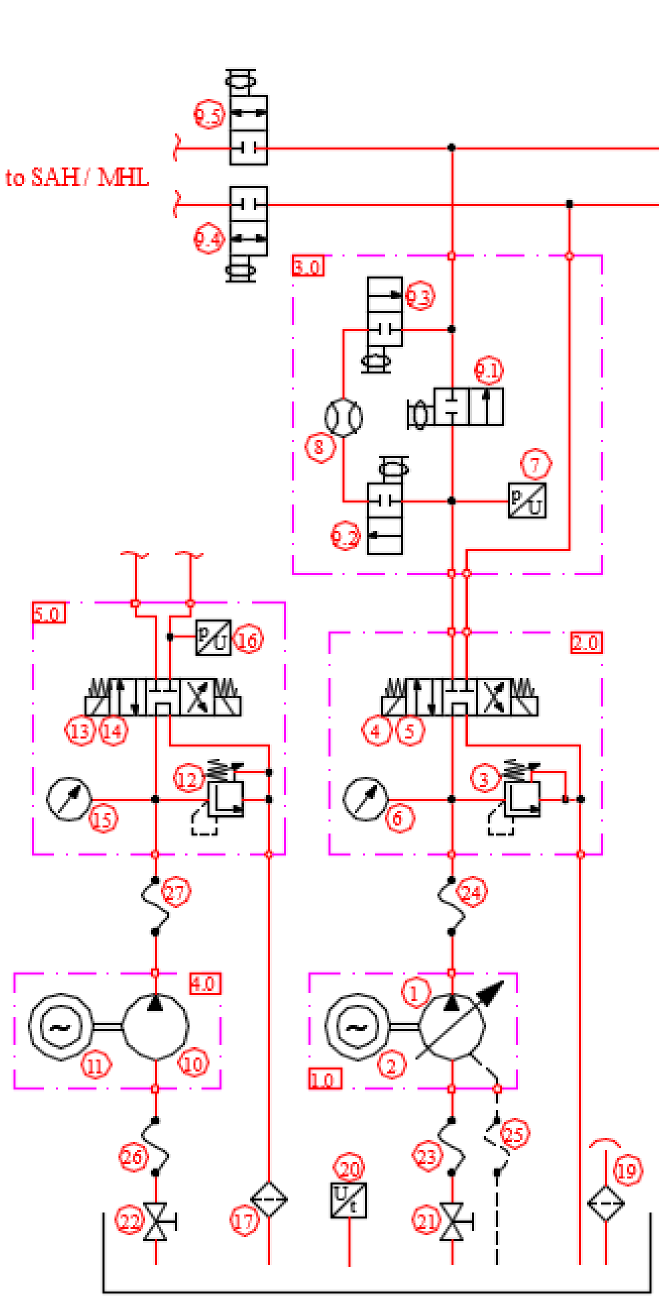

Fig. 2. The hydraulic diagram of the test stand

• *Measuring subassembly p - Q: SAH / SBS - 3.0.*
It consists of turbine flow transducer *8* and pressure transducer *7*. Valves *9.2* and *9.3* isolate flow transducer *8* when no flow measurement is required.
• *Filter and control electric pump: SAH / SBS - 4.0.*
It consists of gear pump *10* and electric motor *11*, and alternately performs two functions: oil filtration and, where appropriate, ensures the pressure required for the operation of the hydraulic devices that are being tested.

• *Block with devices B: SAH / SBS - 5.0.*
This hydraulic block with devices is associated with the filter and control electric pump and consists of safety valve *12*, directional control valve *13*, pressure gauge *15*, and pressure transducer *16*. Pressure valve *12* regulates / limits the pressure on the discharge circuit of pump *10*. Directional control valve 13 directs the flow of pump *10* to return filter *17* when not electrically controlled or to the testing apparatus which needs hydraulic control pressure when supplied with electricity.

• *Oil basin: SAH / SBS - 6.0.*
The working fluid required for the operation of the stand is in oil tank *18*. Pump *1* and pump *10* suck oil from tank *18* through valves *21* and *22* and flexible connections *23* and *26*. On tank *18* cover there are located: return filter *17*, filling and ventilation filter *19*; oil temperature indicator *20*, and T-channel bench to which the device (directional control valve, other valve, etc.) to be tested is fixed. Valves *9.4* ... *9.9* close / open depending on the equipment under tests: hydraulic cylinders, rotary hydraulic motors or hydraulic devices.

3.2. The subassembly of rotary hydraulic motors SAH / MHR

This assembly is intended for testing rotary hydraulic pumps and motors. The constructive solution for its physical development is presented in fig. 3. Supports *2* are fixed to the ends of U-profiles of frame *1* with screws *5*. On one of the supports the pump is fixed, and on the other - the hydraulic motor. Between them, there is subassembly *4* at the ends of which there are the bearings of the torque and speed transducer. The rotational motion is transmitted from the motor to the pump by means of couplings *3*. The hydraulic motor *MH* receives hydraulic energy (flow x pressure) from the basic structure of the stand *SBS* and transforms it into mechanical energy (torque x speed), which it transmits through the flow and speed transducer *TDT* to the pump *PH* shaft. The pump *PH* suctions oil from the auxiliary tank *BAE* and discharges it into the *BAE* as well. The pressure on the discharge circuit of the pump *PH* is regulated by means of a piloted proportional valve. This is how the "load" is achieved on the motor *MH* shaft with the help of the pump *PH*.

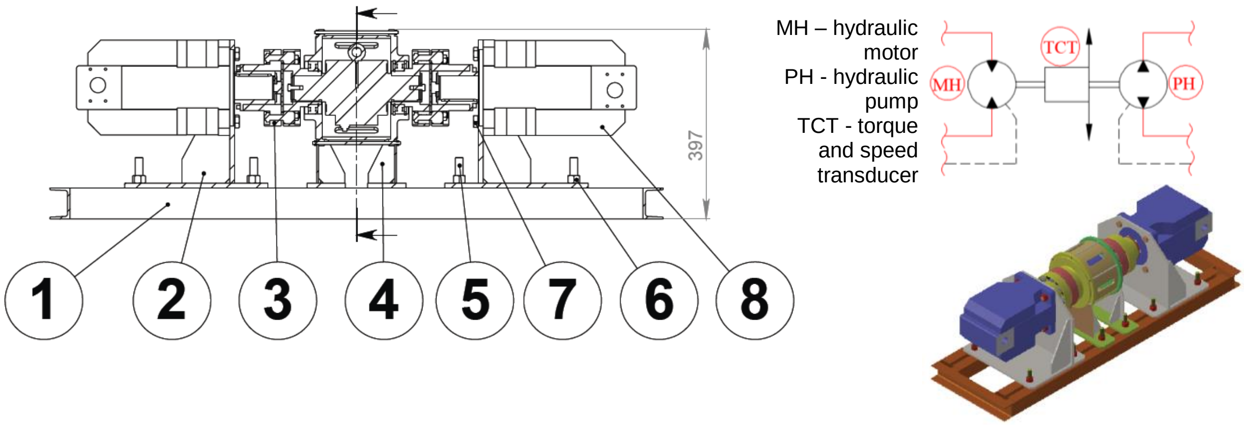

Fig. 3. Subassembly of rotary hydraulic motors

3.3. The assembly for testing linear hydraulic motors: SAH / MHL

This assembly is intended for testing hydraulic cylinders. The constructive solution for its physical development is presented in fig. 4.
On to the ends of frame *1*, hydraulic cylinder to be tested *20* and load cylinder *19* are fixed by means of supports *2* and *3*. Force transducer *13* is placed between the rods of the two cylinders. On support *2* of load cylinder, wire stroke transducers *21* are fastened with the help of screws *16*. The movable element of stroke transducer *21* is attached to plug *5* of load piston rod *19*. The hydraulic cylinder to be tested *CHP* is supplied with hydraulic energy (flow x pressure) from the basic structure of the stand *SBS*, and converts it into mechanical energy (force x displacement) which it transmits through the force transducer *TF* to the rod of the load cylinder *CHS*. The load

cylinder sucks oil from the auxiliary tank *BAE* through the one-way valves *SU*, and discharges it into the tank *BAE* as well through the selection valve *SS*. Pressure on the discharge circuit of the load cylinder *CHS* is achieved by means of a piloted proportional pressure valve. From a functional point of view, the load cylinder *CHS* is a pumping element that sucks and discharges oil from the basin *BAE*.

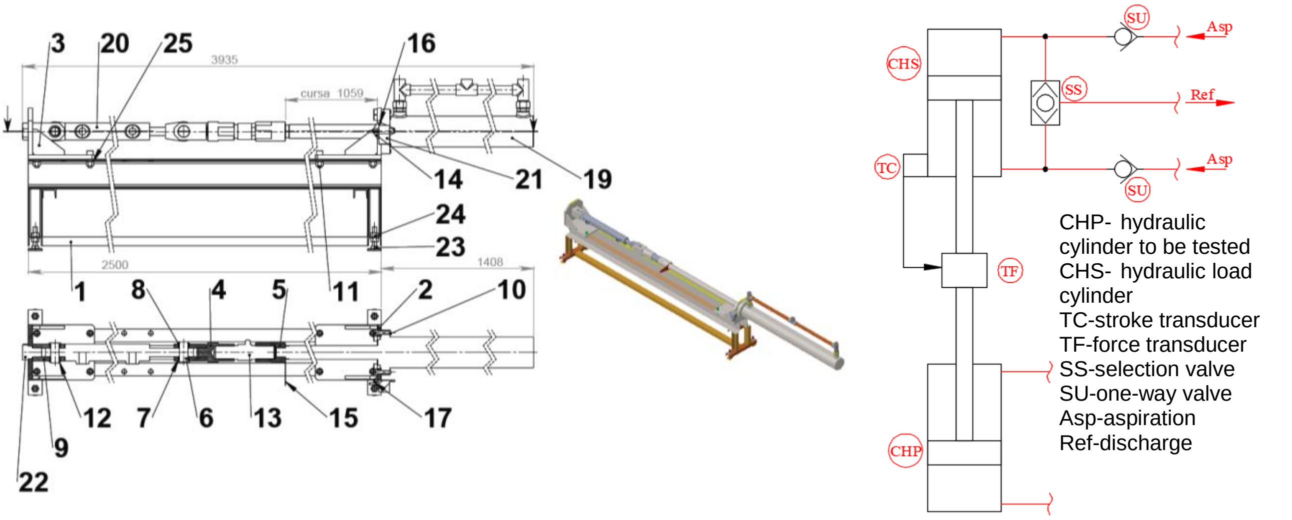

Fig. 4. Assembly for testing linear hydraulic motors

3.4. The equipped auxiliary tank: SAH / BAE

The equipped auxiliary tank *BAE* (fig. 5) is associated with the assembly for testing rotary hydraulic motors *MHR* and the assembly for testing linear hydraulic motors *MHL*.

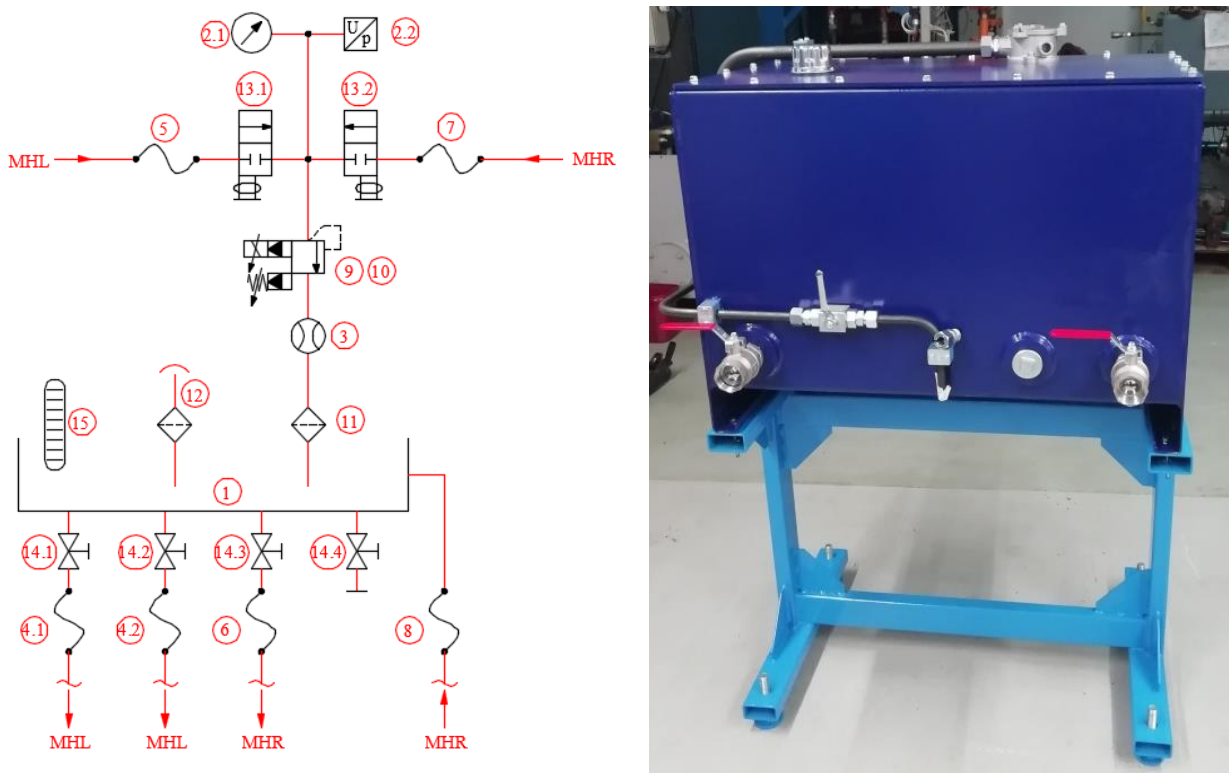

Fig. 5. Equipped auxiliary tank of the stand

The load cylinder sucks oil from the tank through valves *14.1* and *14.2* and flexible connections *4.1* and *4.2*, and discharges it through flexible connection *5*, valve *13.1*, proportional pressure valve *9*, flow transducer *3*, and return filter *11*. The pump in the subassembly for tests on rotary hydraulic machines *MHR* sucks oil from the tank through valve *14.3* and flexible connection *6*, and discharges it through flexible connection *7*, valve *13.2*, proportional valve *9*, turbine flow meter *3*, and filter *11*. The two discharge circuits operate alternately by closing / opening valves *13.1* and *13.2*. Pressure gauge *2.1* and pressure transducer *2.2* both serve discharge circuits.

4. Control, monitoring and data acquisition [3, 5, 6, 7]

The control, monitoring and data acquisition system of the multifunctional stand for testing hydraulic equipment, hereinafter referred to as SCADA (Supervisory Control and Data Acquisition), implements the electrical control of the stand equipment such as the asynchronous electric motor which operates the hydraulic pump, the hydraulic pump with variable flow valve electrically controlled, proportional pressure valve that controls the value of the testing pressure, electrohydraulic directional control valves that determine the configuration of hydraulic circuits, etc. Another function of SCADA is the acquisition of data from the transducers on the stand: pressure, flow, torque / speed, temperature transducers. The values of the process parameters are displayed locally on the operating panel of the stand and they are transmitted, via the beneficiary's computer network, to the PC by which the stand is operated. In addition, the acquired process values are stored in a database that can run on the operating PC of the stand or on the beneficiary's server. The required software components, namely the PC stand console and the process data database management programs, can be ordered by the beneficiary to run under Windows or Linux.

5. Conclusions

The test stand shown in the above allows the experimental verification of all the components of a hydraulic drive system: pumps, rotary hydraulic motors, linear hydraulic motors, hydraulic devices such as check valves, directional control valves, throttles, flow / pressure regulators, etc.
The stand presented can be used for:
- functional static tests with didactic character within the teaching line "Hydraulic drives" in the curriculum of technical universities;
- dynamic tests for the investigation of the components in the structure of hydraulic drive systems;
- functional tests (type or batch tests) of hydraulic devices and components at the request of economic operators;
- practical training at any level (workers, technicians, engineers) of persons who specialize and / or improve in the field of hydraulic drives.

Acknowledgments

This work was carried out under the project ASHEUP - *Hydro powered motor chassis for high energy efficiency operation of interchangeable equipment intended for performing public works / Autoșasiu hidroficat pentru acționarea cu eficiență energetică ridicată a echipamentelor interschimbabile destinate realizării unor lucrări de utilitate publică*, Grant no 53PTE ⁄ 2020, PN III: Programe 2 - Increasing the competitiveness of the Romanian economy through research, development and innovation, Subprogramme: Subprogramme 2.1 - Competitiveness through research, development and innovation, Project type - Transfer project to the economic operator.

References

[1] Dumitrescu, Liliana, Alexandru-Polifron Chiriță, Ștefan Șefu, and Remus Marius Oprescu, "Innovative stand for testing of hydraulic pumps and motors." Paper presented at the 24th International Conference on Hydraulics and Pneumatics Hervex 2018, Băile Govora, Romania, November 7-9, 32-37.
[2] Dumitrescu, Liliana, Alexandru-Polifron Chiriță, and Corneliu Cristescu. "Working bench for reconditioning hydraulic cylinders." Paper presented at the 23rd International Conference on Hydraulics and Pneumatics Hervex 2017, Băile Govora, Romania, November 8-10, 287-291.

[3] Lepădatu, Ioan, Isaiea Zaharia, Cătălin Dumitrescu, Petrică Krevey, Iulian Duţu, and Liliana Dumitrescu. "Computerized stand for testing hydraulic equipment at very high pressures / Stand informatizat pentru încercarea aparaturii hidraulice la presiuni foarte înalte." Paper presented at the 14th International Conference on Hydraulics and Pneumatics Hervex 2006, Călimănești-Căciulata, Romania, November 15-17, 300-306.
[4] Pavel, Ioan, Radu Iulian Rădoi, and Alina Iolanda Popescu. "Test stand with specific sensors for digital hydraulic cylinders." Paper presented at the 24th International Conference on Hydraulics and Pneumatics Hervex 2018, Băile Govora, Romania, November 7-9, 86-95.
[5] Călinoiu, Constantin. *Sensors and transducers / Senzori si traductoare*. Vol. I. Bucharest, Technical Publishing House, 2009.
[6] Lepădatu, Ioan, Constantin Chiriță, Marian Blejan, Liliana Dumitrescu, and Alexandru-Polifron Chiriță. "Technology and computerized stand for proofing reversible hydrostatic pumps." Paper presented at the 22nd International Conference on Hydraulics and Pneumatics Hervex 2016, Baile Govora, Romania, November 9-11, 248-255.
[7] Duțu, Iulian, and Gabriela Matache. "Computer assisted electro-hydraulic stand for testing servovalves." *Hidraulica Magazine*, no. 3-4 (December 2012): 73-77.