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INVENTIONS RESULTED FROM RESEARCH LED TO ENHANCE THE PROFESSIONAL LEVEL OF SPECIALISTS FROM IHP

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Abstract: *The inventions constitute one of the main assessment criteria for the activity of research organizations, both in terms of organization as a whole and for each person involved. Within Hydraulics & Pneumatics Research Institute, inventions overlap with the areas of interest and development: hydraulic / pneumatic drives with high efficiency, use of renewable energy, technological transfer of research results to the economic environment. This article presents some patented devices and installations that can be placed into production to manufacturers interested from SMEs or can be further developed in research projects in partnership.*

Keywords*: research, invention, innovation, progress, competitiveness*

1. Directions and strategies research of IHP

Hydraulics and Pneumatics Institute from Bucharest (INOE 2000-IHP) operates in hydraulics and pneumatics research area over 55 years, but the priority directions of research have adapted to current times, so that the base was expanded into green energy, hydrotronics, mechatronics, tribology area and technological transfer.
IHP's research strategy is based on the following objectives:

- stimulating cooperation with universities and other institutions of higher degree in the field of research on national stage;
- development of international cooperation in bilateral, multilateral and EU-funded projects;
- institutional capacity building by promoting postgraduate education (master and doctoral research teams included);
- efficient transfer of know-how and technology to public institutions and companies using the legal framework;
- increasing the scientific results published and disseminated, thus broadening the visibility through enhancement of research;
- modernization of research infrastructure;
- creating a stimulating research environment friendly and competitive.

2. The role of inventions in innovation

Romanian economy tries to enter in the chains of regional and world added value through its orientation towards innovation by creating a culture of innovation and, ultimately, by the development of a society where innovation is the main factor of increasing competitiveness, turning into a lifestyle. It wants that innovation to be a central factor in the economic and social development in Romania.
Strategy 2014-2020 [1] is to increase the competitiveness of the Romanian economy through innovation, supposing development of the companies to absorb the latest technology, to adapt these technologies to the needs of serviced markets, and to develop, in turn, their technologies and services that enable them to progress.
In a society, the progress is possible if there is a system of research - development that is capable to product inventions when it is necessary to fix a technical problem and to implement in production those solutions that will implicitly lead to an improvement, a change, a perfection of a product / system, so innovation in a particular segment.

In the industrial domain, widespread use of hydraulic drives and automation is explained by productivity growth prospects offered on machinery, equipment and facilities, their static and dynamic performance, reliability and overall efficiency. The preference for such systems is evidenced by increased production of such equipment recorded in developed countries in terms of industry, such as USA, Germany, Japan, Russia, China, etc., where the increases over a decade are between 50 and 480%. It is expected that this rate will continue for the next 10 years.
So if we talk about progress and productivity in the field of hydraulic and beyond, we actually talk about innovation, and thus about inventions.
INOE 2000-IHP has a broad portfolio of patents obtained from numerous research projects over the years, which were made, mostly from the desire to provide SMEs that were partners in projects chance to be competitive on internal market and even foreign.
Among the inventions made in the past two years, some are adapted to new trends priority development: renewable energy, environmental, hydraulic energy recovery; others consists in the modernization of hydraulic elements or mechanical subassemblies.

3. The importance of pump systems and pumps in hydraulic drive installations

In any hydraulic drive installation, pump is an essential component because it is designed to transform mechanical energy (torque, rotational speed) into hydraulic energy (flow, pressure), so as to provide optimum working parameters to consumers that are served. Since the parameters required to the consumer differ greatly from one another, requiring values of flow and pressure are in a wide range, manufacturers respond to market requirements by manufacturing various construction types of pumps or pump systems.
Pump systems offers solutions for high flow rates such as the case of clean water supply, irrigation, wastewater discharge, flood control, etc., but also for areas of industry (ranging from the food industry and ending with the maritime industry).
Latest solutions offered by manufacturers refer to increasing work pressures, increased frequency rotation and displacement speed, increase the energy indicators, increased reliability and durability, etc.
The most popular pumps used in hydraulic drives are [2]: Manual lever pumps, External gear pumps, Gerotor pumps, Internal gear pumps, Lobe pumps, Screw pumps, Fixed displacement vane pumps, Variable displacement vane pumps, Radial piston pumps - Fixed displacement, Radial piston pumps - Variable displacement, Axial piston pumps - Fixed displacement, Axial piston pumps - Variable displacement
Among the most renowned manufacturers mention: Bosch Rexroth, Vickers, Parker, Denisson, Eaton, Hydac, Enerpac, Hawe etc.
In the past two years IHP researchers have obtained four patents regarding to pumps, namely:

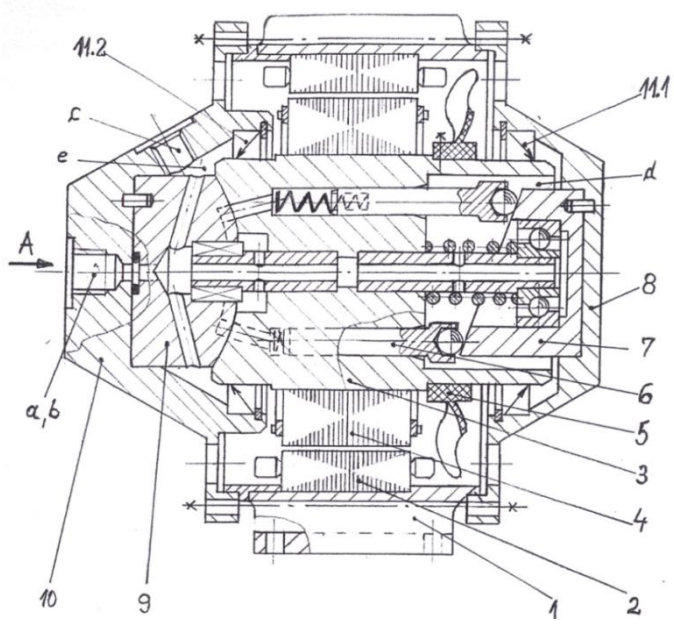
- **Axial piston electro pump**, patent no. **123638/30.06.2015** [3]

This invention relates to a rotary axial piston hydraulic pump that has its own electrical drive, and can be used in hydraulic drive installations with mineral oil.
The axial piston electro pump, according to this invention, consists of a casing (1), inside which there can be found a fixed spooled stator (2), wherein a rotor (3) can rotate electromagnetically on two bearings; this rotor has on the outside a magnetic sub-assembly (4) and an impeller (5), and on the inside axial pistons (6), which resting against a swash plate (7) pressed into a cap (8) sucks and discharges the working fluid, by means of a switch plate (9) pressed into a hydraulic connection cap (10), its inner sealing being provided by means of two seal rings (11.1) and (11.2), which divide the hydraulic chamber from the electrical one; the latter may be cooled by fresh air entering from outside.

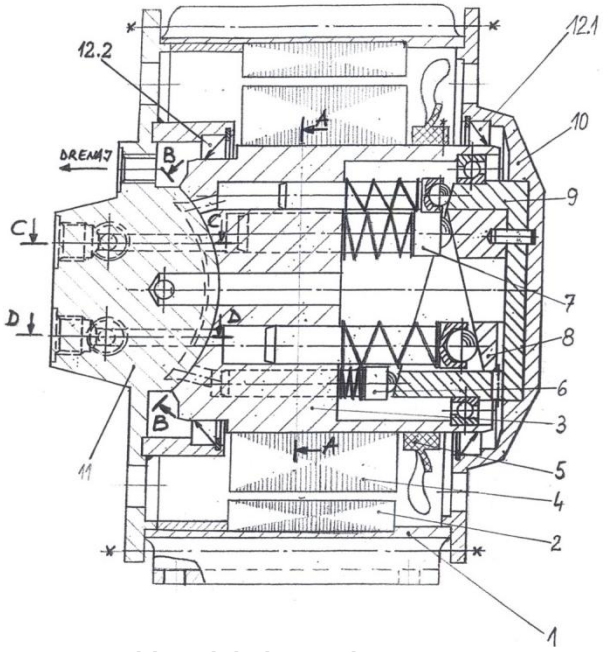
- **Double axial piston electron pump** patent no. **123639/30.06.2015** [4]

This invention relates to a rotary axial piston hydraulic pump that can provide two separate flows or, when needed, one cumulative flow; this pump also has its own electrical drive, which can be used in hydraulic drive installations operating on mineral oil.
The double axial piston electro pump, according to this invention, consists of a casing (1), inside which there can be found a spooled stator (2), wherein a rotor (3) can rotate electromagnetically;

this rotor has on the outside a magnetic sub-assembly (4) and an impeller (5), and on the inside two lines of axial pistons (6) and (7) unpaired and interlaced, resting against two swash plates (8) and (9) concentrically pressed into a closure cap (10).
During rotation each line of axial pistons (6) and (7) can suppress one oil flow, which can be separated inside a hydraulic connection cap (11) or can be merged into a single port by reposition of two screw plugs (13.1) and (13.2), one for the suction ports and one for the discharge ports.



Axial piston electro pump

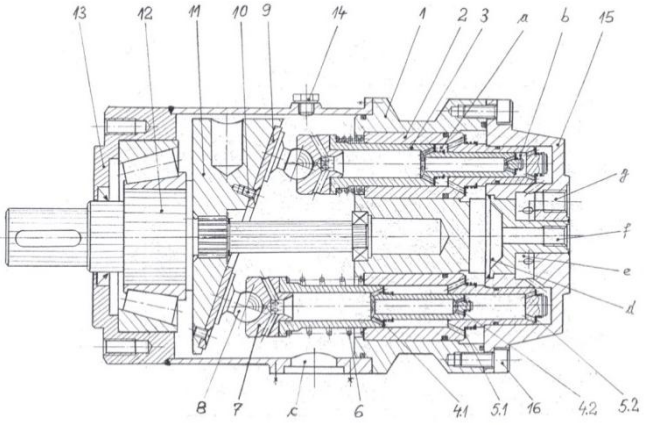


Double axial piston electro pump

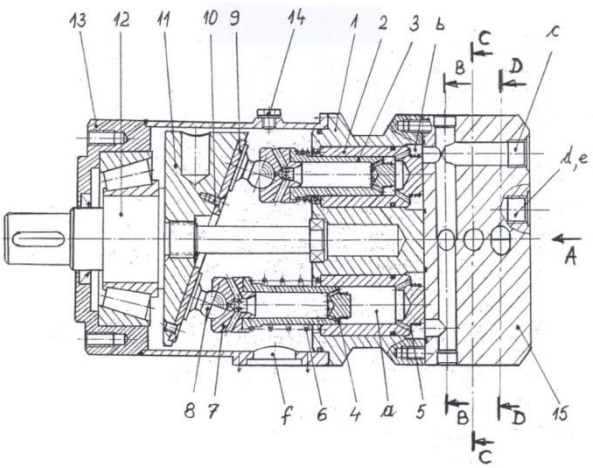
- **Hydraulic pump with two flow rates** patent no. **128856/30.05.2016** [5] relates to a hydraulic axial piston pump that can deliver simultaneously two different flow rates that can be supplied to two separate circuits of a hydraulic drive installation which operates with mineral oil. The pump according to the invention is composed of a central body (1), in which are arranged axially on a diameter of the division, some bushings (2) in odd number, in each there is placed one piston (3) of tubular shape and having two diameters of sliding, which together with some lamellar suction valves (4.1) and (4.2), fixed to the pistons (3) and with some lamellar discharge valves (5.1) and (5.2) secured to the bushing (2) form two compression separate chambers (a) and (b), from which the oil may be discharged through some channels separate inner (d) and (e), to two outlet holes (f) and (g) of a cover (15), during sliding the pistons (3) which are pressed by some springs (6) by means of removable end caps (7) and of some skates ball (8), a friction plate (9), secured through two screws (10) to an inclined plane of the swash plate (11) which can be rotated left or right by a drive shaft (12) rotatably supported in a cover (13), which has at the lower part and the hole of the pump suction.
- **Hydraulic pump with three flow rates** patent no. **128857/30.06.2016** [6] relates to a hydraulic axial piston pump that can deliver in the same time three different flow rates that can provide flow for three separate circuits of a hydraulic drive installation, which operates with mineral oil. The pump according to the invention is composed of a central body (1) in which are arranged on a diameter of the division, nine bushing (2), arranged axially and equally spaced from each other, in which there are a piston (3), of tubular shape which may slide pressed by springs (6) and driven by a swash plate (11) equipped with a friction plate (9) by means of removable end caps (7) and of skates ball (8), driving being made of a drive shaft (12).

The pistons (3) having a suction lamellar valves (4) and the bushing (2) having discharge lamellar valves (5), suction oil in the chambers (a) which it push it then in other chambers (b), grouped three symmetrically arranged in correspondence with three ducts separate (c), (d) and (e), forming three distinct oil flows, at three external orifices practiced in a cap outlet (15), flows which can be equal to each other or not.

The pump has a single suction port (f), cut into the bottom of a cover (13), and a plug for filling and ventilation (14).



Hydraulic pump with two flow rates



Hydraulic pump with three flow rates

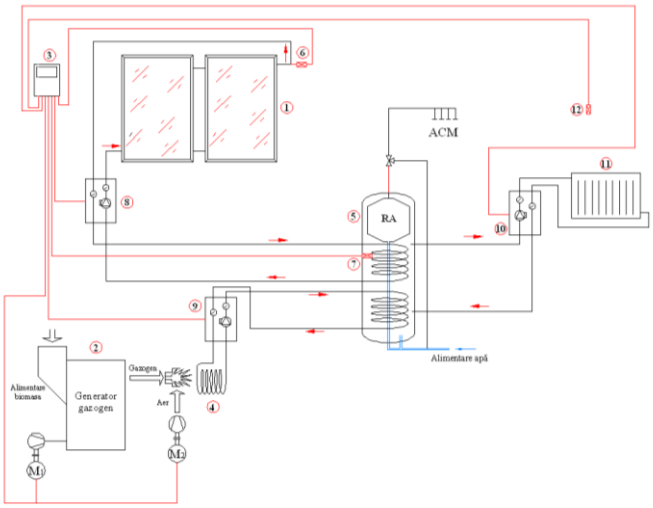
4. Equipments for renewable energy and environmental

- **Installation for thermal energy production using solar energy combined with energy from biomass gasification** patent no. **126699/30.09.2015** [7] relates to an installation for production of thermal energy, used for the preparation of domestic hot water and domestic heating, which combines 2 renewable energy sources: solar energy and energy produced by biomass gasification. The installation, according to this invention, consists mainly of 2 flat solar panels (1) and a gas generator set (2), wherein biomass of agricultural and forestry origin is burned. The number of solar panels and the power of the gas generator set are determined according to the requirements of the housing where they are placed. The energies produced by the 2 sources complement each other, so that the system allows energy independence regardless of time of the day or season of the year. Solar energy is converted into thermal energy by means of solar panels (1) and it is conveyed by means of a pumping group (8), to a bivalent boiler (5), where it is transferred to the fluid inside the boiler, to allow increasing the temperature of the heat-transfer fluid flowing through the radiators (11), and also the temperature of the cold water from the grid, existing in the tank RA and which is converted into domestic hot water (DHW). The gas produced by the gas generator set (2) is combined with air, resulting in a flame that heats the fluid existing in the coiled pipe (4); this coiled pipe is connected to another, existing in the solar boiler (5), heated fluid circulation being carried out by means of the pumping group (9). Through the contribution of the 2 energy sources there are heated the heat-transfer fluid and the water to be consumed existing in the tank RA.

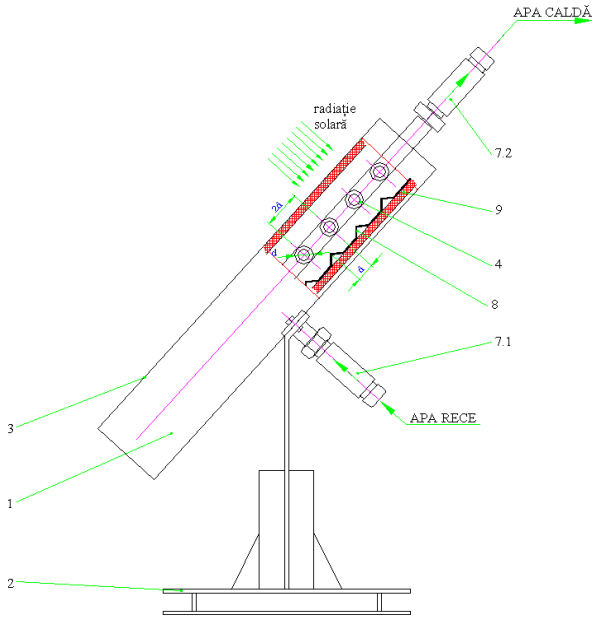
After setting a desired temperature for the fluid in the bivalent boiler (5) in the memory of the controller (3), there are compared the temperature values measured by the sensors (6) and (7); if the difference between the temperature measured in the boiler and the one from the output of the solar panels is higher than a value set in the range 2...16 K, the controller (3) gives a signal for fluid circulation starting the operation of the pumping group (8). If the temperature in the bivalent boiler rises up to the desired value, fluid circulation through the solar circuit stops; if temperature values at the output of the solar panels and in the bivalent boiler become equal and are smaller than the desired value, there starts to operate the gas generator set, by supplying the motors M_1 and M_2, at the same time with starting of the pumping group (9). The pumping group (11) is supplied till reaching in the heated premises a temperature measured by means of the environmental temperature transducer (12) equal to the desired one, stored by the controller (3).

- **Solar thermal panel** patent no. **127041/30.05.2016** [8] refers to a panel for the capture of solar radiation and conversion into heat the water used for domestic purposes.

The solar panel according to the invention comprises a circular frame (1) fixed to a support (2), which contains under a protective glass (3), a circuit of the pipes (4), made from the center to outwards as the spiral Archimedes, with space between coils that is equal to the diameter of the pipe, fixed by means of two clamps (6.1) and (6.2). Circuit by pipes (4) has at the input side a bended connection (5) and a restrictive valve (7.1) and at the exit another restrictive valve (7.2), both oriented in the same direction. Under circuit pipes (4) is a mirror (8) ribbed in plane after the same spiral, but with offset step and a thermal insulation (9).



Installation for thermal energy production using solar energy combined with energy from biomass gasification



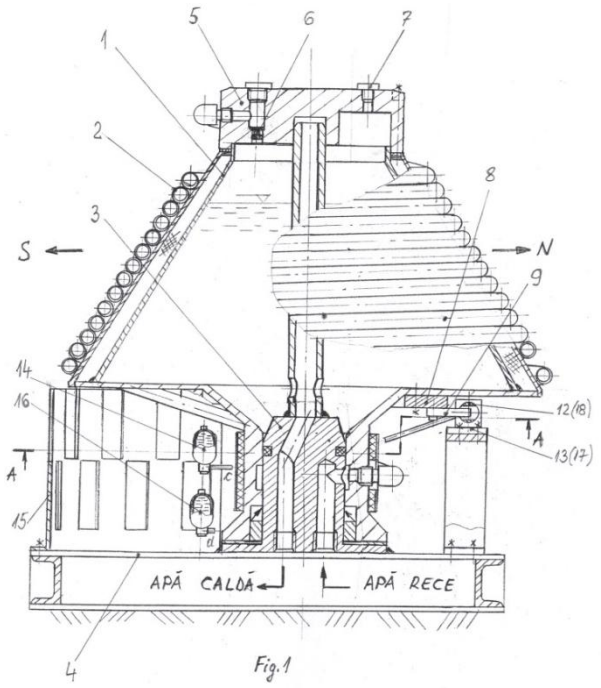
Solar thermal panel

➢ **Solar heater** patent no. **127127/30.06.2016** [9] refers to an aggregate to produce hot water using sunlight for its use in the summer in any individual household, even without another form of energy.

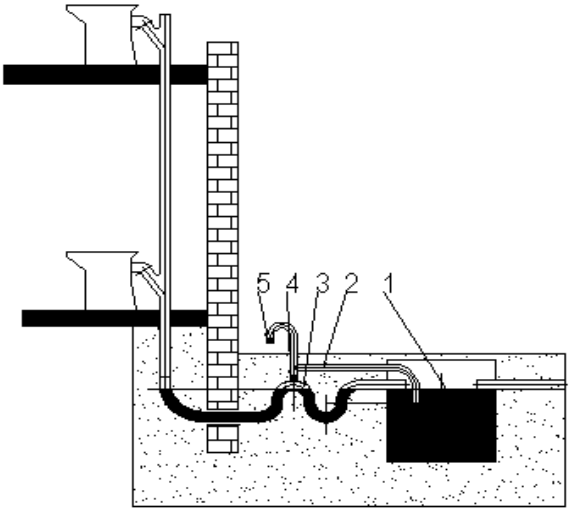
The solar heater according to the invention consists of a conical container (1), on that is wrapped at the outside a heating circuit (2) of pipe which connects a fixed shaft (3) through which cold water can enter, and hot water may be discharged by a cap discharge (5), which has a thermostatic-valve (6) and an air release valve (7), at the lower part being a disc (8), for rotating of the conical container (1) through the drive connecting rods (9) which are supported due to springs (10) on the pins (11) being pushed step by step, by a set of opposing pistons (12) and (18), which slides forward and backward due to the dilatation of the two liquids of the same kind, which there are in two cylinders (14) and (16) which can be radiated in counter to the sun by means of a screen (15) provided with two offset rows of slots between them, the pistons (12) and (18) being able to emerge or withdraw in the bodies (13) and (17) connected by means of pipes with cylinders that contain fluid expansion.

➢ **Installation for bubbling air in septic tanks with biodegradable action** patent no. **126562/30.03.2016** [10] refers to an air pumping installation in a septic tank, where under the action of activated sludge and air take place a bio-degradable action on compost. Technical field is: environmental science, environmental protection, ecological reconstruction, modernization of urban and rural living environment. There are known septic tanks with the biodegradable action of activated sludge under the air action on compost, at that the air is introduced into compost using electrically driven compressors.

The present invention provides an installation for pumping air into the septic tank (1) in which the air is introduced in the bio-degradable mass using the falling energy of a residual water column (a), that compress the air from space (3) of draintrap, evacuating it through the valve (4) and pipe (2) inside the septic tank. After escape, through the valve (5) that allows air in draintrap, the level of the liquid stabilizes to the initial situation.



Solar heater



Installation for bubbling air in septic tanks with biodegradable action

5. Hydraulic drive equipments and energy recovery

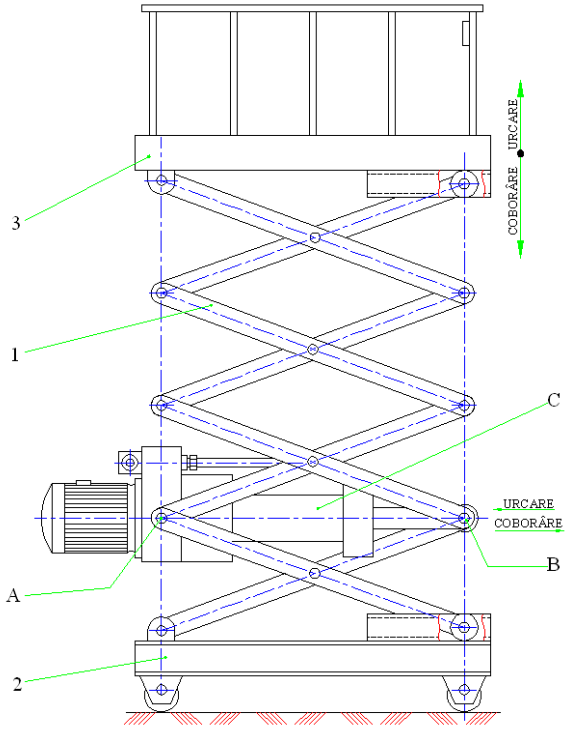
- **Elevating work platform** patent no. **126767/29.01.2016** [11] refers to a foldable elevated work platform for people, electrohydraulic driven with energy recovery, which can be used to renovate facades of buildings, to the maintenance of high technological equipment, aircraft inspection and others.

Elevating work platform of the present invention is composed of a lifting mechanism (1) multiple deformable parallelogram type, that fixed to a chassis (2) can raise up or down a mobile platform (3) by means of a translation horizontal hydraulic unit equipped with a system for recovery of energy from the descent, having a compact construction that consists of an oil tank (4) which contains a gear pump (5), a cap (6) for sealing and communication, an electric motor (7) and an electric distributor (8), attached to a hydraulic cylinder (9), in which is a rod piston (10) and a spring (11), conical in shape, the assembly being closed by a the cover (12) clamped by means of the two outer bolts (13).

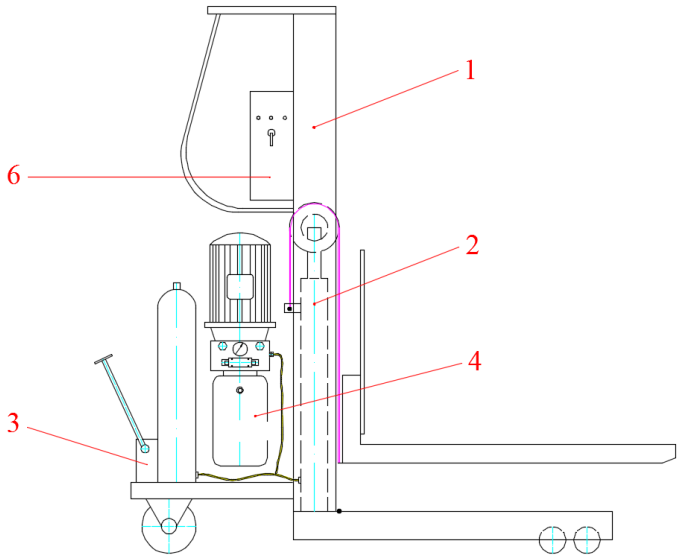
- **Hydraulic elevator for industrial loads,** patent no. **127185/30.06.2016** [12] relates to a hydraulic elevator for lifting industrial loads up to 1000 daN.

The elevator can be operated either via hand pump (3) or electro, using electro pump (9), energized through the electronic power supply and load group (6) from the power supply, when it is possible, or a rechargeable battery (5), which is loaded during the machine is connected to the network.

When using the hand pump, the fluid passes through the check valve (8) to the cylinder and the spool (9) of distributor is on the central position. When supply the electro pump (9) with electric power, either from the electric network or from the battery, simultaneously the spool is moved to the right, allowing the supply of the hydraulic cylinder, and the valve (8) does not allow the passage of fluid by the pump manually. For lowering, the valve with throttle (11) can be actuated manually or through a directional valve the cylinder is connected to the tank.



Elevating work platform



Hydraulic elevator for industrial tasks

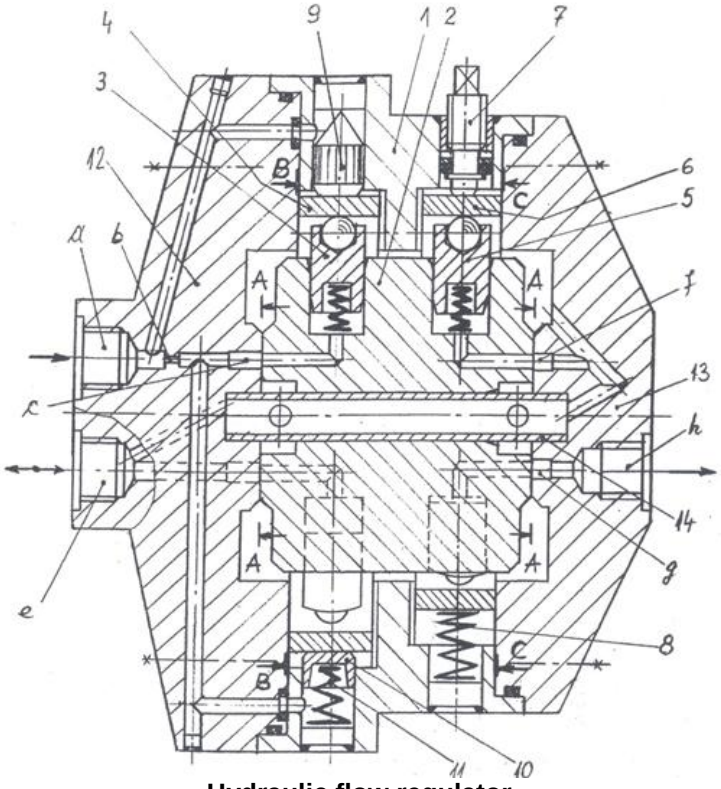
6. Updated hydropneumatic equipment and components

➢ **Hydraulic flow regulator** patent no. **129110/30.03.2015** [13] relates to a hydraulic device by means of which one can adjust an oil flow that must be kept at a constant value regardless of variations in hydraulic parameters of the system; this device is intended for hydraulic equipment actuating compulsory constant speed mechanisms.
The hydraulic flow regulator, according to this invention, consists of a casing (1) in which there is a rotor (2) which includes two rows of pistons, radial pistons (3) resting against a mobile rolling track (4) acting as a motor, and radial pistons (5) resting against an eccentric rolling track (6) whose position is adjusted from a maneuvering screw (7), against a cylindrical spring (8), acting as a pump.
The mobile rolling track (4) is positioned in relation to the oil flow supplying the radial pistons (3), which after passing through a calibrated nozzle in a cap (12), creates a pressure drop, which applied on a control piston (9), against a reduction piston (10) and a conical spring (11) automatically moves it, so that rotor speed (2) stays constant, including the flow discharged by the radial pistons (5) discharged through a cap (13) and absorbed from the outside in case of need by means of a hollow shaft (14).

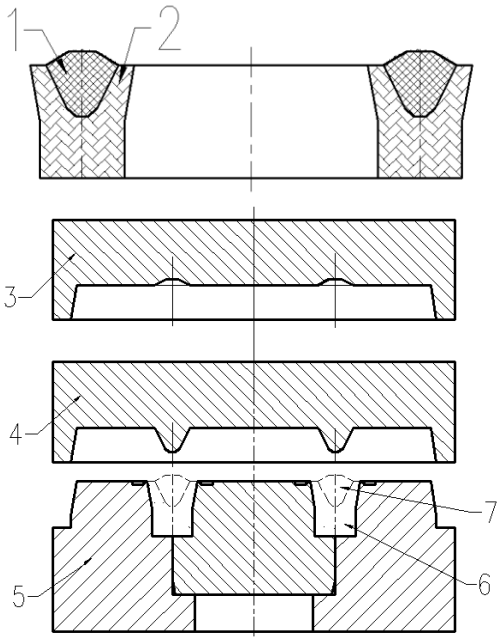
➢ **Technology for obtaining sealing assemblies** patent no. **126389/30.03.2015** [14]
Procedureused in producing hydraulic seals by vulcanizing in presses, according to this invention, consists of using a mold with two caps (3, 4), Fig. 2, to obtain a compound seal assembly, as in figure 1. Profile of the seal assembly (1) is achieved by pre-vulcanizing the rubberized fabric item (6) in the body of the mold (5) with the cap (4), followed in the second stage by vulcanizing the assembly made of the pre-vulcanized fabric item and the elastomer (6, 7) in the body of the mold (5) with the cap (3).

➢ **Elastic pneumatic actuator of force** patent no. **126776/30.09.2015** [15] relates to developing a pneumatic linear actuator type pneumatic muscle, diameter 63 mm and maximum stroke 100 mm, able to function, under the terms of SR ISO 8778, up to 10 bar, withstand a burst pressure of 16 bar, and hysteresis in operation should be not more than 5% when operating under load. Solutions proposed for the realization of the high pressure elastic pneumatic actuator regard the use in its structure of a flexible element composed of three elastic fabric substrates in order to

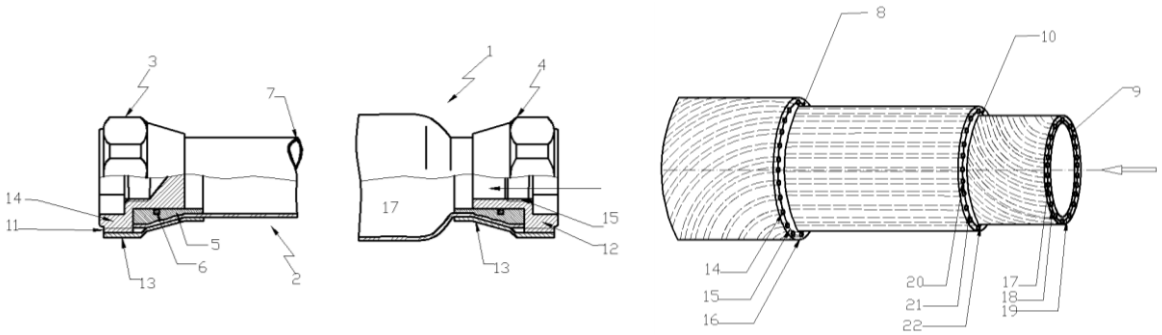
operate under high pressure, whose fabrics are without contact with each other to eliminate friction and minimize hysteresis. The high pressure elastic pneumatic actuator 1, proposed by this invention, includes the following parts: the flexible element 2, comprising the fixed armature 3 and the mobile armature 4, and also the active elastic element 7 with inner diameter 63 mm. Through the fixed armature pressurized air comes in and out; it inflates or deflates the elastic element and causes an alternative linear movement of the mobile armature up to 100 mm, this one being linked to the driven mechanism. The active elastic element 7 in the structure of the actuator is provided with three support and resistance elastic layers, of tubular shape and equal thickness. The elastic medium and nominal size of fibers are the same for each layer.



Hydraulic flow regulator



Technology for obtaining sealing assemblies



Elastic pneumatic force actuator

7. Conclusions

Currently all over in the world there is a very wide range of products / systems for industry, so that a SME can become active or remains on the market if it offers products that have an intake of intelligence, creative, offering the buyer something extra or something very special and useful. Thus it requires innovation, whether it is incremental nature, when it is improve a product or such radical when the product is completely new and provides a qualitative leap that is superior to all available at that time or a new development direction.

Regarding IHP activity, this is mostly based on grants that are based on innovation in the field of hydraulic, environmental, green and renewable energies.
Unfortunately, although we make sustained efforts to achieve a technology transfer of our knowledge to public or private companies, using our very good relations that we have with two technology transfer centers (Cluj and Bucharest), no. of collaboration has been reduced, but we remain optimistic, especially because this year we have an ongoing technological transfer project funded by the European (POC - G axis) and some on PNCDI III -2.1. Competitiveness through research, development and innovation.

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