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HYDRAULIC CYLINDER WITH EMBEDDED DISTRIBUTION USED IN FERTILIZER INJECTORS

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Abstract: *This paper refers to the concerns of our institute related to the hydraulics of systems which dose fertilizers in irrigation systems. The paper describes the problems encountered in developing a fertigation dosing device and solutions to solve them, materialized in a patent application, namely "Hydraulic cylinder with embedded distribution". It is characterized by the fact that it has a single inlet port and a discharge port through which the working fluid is circulated in one direction. Through a system of valves, there is allowed the access of the working fluid on the two surfaces of the piston, causing rod movement in one direction or another. This type of linear hydraulic motor can actuate a pump which injects fertilizers into the irrigation water, but it has also multiple other uses in the economy.*

Keywords*: Fertigation, hydraulic cylinder, injector, dosing device*

1. Introduction

Introducing of fertilizers into the irrigation water concerns the researchers worldwide.
The current technical level is in accordance with the products sold by famous companies, such as DOSATRON INTERNATIONAL-France, NETAFIM, AMIAD, PLASTRO GVAT, NAANDAN, DOROT, TAVLI-Israel, TMB-USA, that produce a wide range of devices and equipment for administration of liquid chemical fertilizers.
An example of a dosing device is shown in the images below, where one can see the drive mechanism of the dosing device, manufactured under the name of DOZATRON.

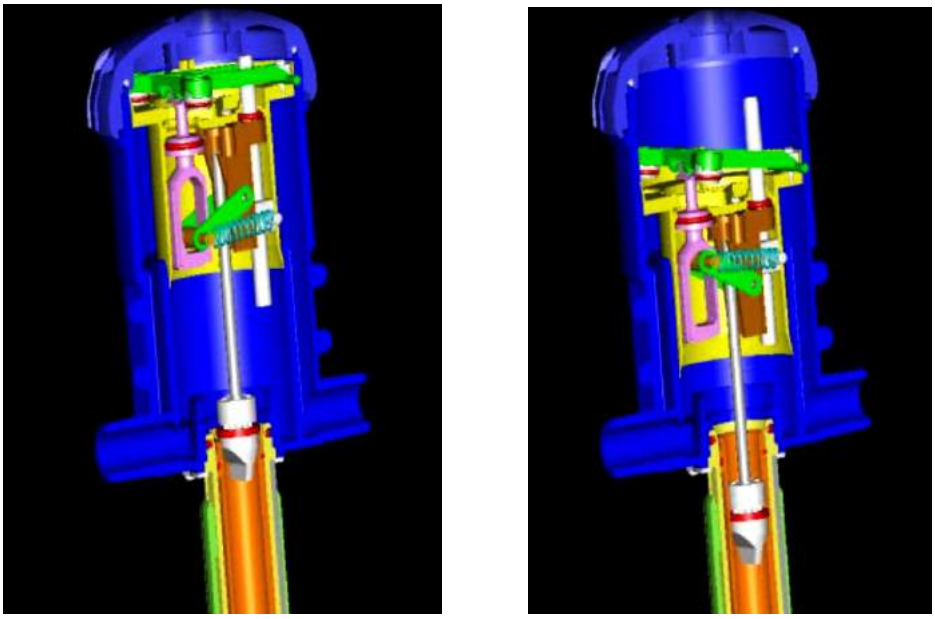

Fig. 1. Engine of the dosing device where one can see the two positions of the distribution mechanism maintained in tilting motion positions by the coil traction spring

2. Methodology

It can be noted that the dosing device consists of a linear drive motor and fertilizer pump. The Dozatron is connected to the irrigation water by connection on the left side of the housing (see picture); it has a drive mechanism under the action of water, a fertilizer pump in the bottom side and an outlet port for the fertilizer mixed with water, right side of picture.
The drive mechanism is in fact a linear hydraulic motor with embedded distribution. It consists of a piston provided with ports that can clog or open under the influence of some drive elements. Depending on the surface of the piston which water pressure is applied on the piston moves up or down, actuating the fertilizer pump. To do this the valves are mounted in a mechanism that can be switched by a control rod when they reach the end positions of the stroke. The mechanism is maintained by a spring that can be tilted on two positions corresponding to the two directions of movement.
The problems that arise are related to the compatibility between the material the spring is made of and the working environment, which is water with fertilizer. Our institute has interests in this field through several research projects in progress and it has submitted a patent application for such an engine in which the tension spring is replaced with an elastic diaphragm which can be made of materials resistant to water and corrosive substances in the fertilizers. The invention relates to a hydraulic cylinder with embedded distribution that, by operating some valves embedded in the piston, performs distribution of the working fluid enabling alternative linear movement between two adjustable limiters.
Figures 2 and 3 show schematically the drive mode of a cylinder the invention is applied to. Figure 4 shows a version of the annular spring <3>. The cylinder consists of housing <1>, fitted with limiters <u1> and <u2> coming into contact with the piece <5> at the stroke ends. The piece <2> is a part of the piston and it can occupy two positions depending on the forces acting on it. In the two positions the ports <a> or <b> are closed or opened, allowing penetration of working agent, on the active sides of the piston, which leads to movement of rod <6> in one direction or another. The rod <6> is moving in the piston guide <9> provided with the sealing system <10>. The disc spring <3>, see Figure 4, can take two mounting positions depending on how stressed the blades on the inner circle are. In one of the positions the piece <2> is kept pressed against the rod body <6> by the disc spring <3>, closing the port <a> and opening the port <b>, in the other position of the spring the port <a> opens and the port < b> closes. The piece <5> is made up of rods that are attached to an annular disc. The annular disc makes contact with the limiters <u2> at the end of stroke, and the rods are supported at the other end of the stroke by the housing <1> that is the limiter <u1>. The rods are guided and sealed with the O rings <4> at crossing through the rod body <6>. The rods have a notch which they enter and can drive the annular spring <3>.
In the phase shown in Figure 2 (top of the diagram) the driving agent penetrating through the <supply> port and finding the port <a> closed pushes the assembly rod-piston to the left, the working agent in front of the piston is expelled through the port <b> and then through <discharge >, until the rod in the assembly <5> makes contact with the limiter <u1>, moment at which due to pressure further acting on the surface it pushes the assembly <6.2> a few millimeters until the annular spring <3> is tilted and the sealing piece <2> flips in the second position, see bottom side of Figure 2, where the valve <a> opens and the valve <b> closes. In this position the working agent freely penetrates through the valve <a> and acting due to pressure difference on the section formed by the cylindrical surface <d> moves the piston to the right until the piece <5> gets in contact with the limiter <u2>, see Figure 3, the bottom side. In this position due to the pressure of the working agent, the assembly <2.6> moves forward until the annular spring <3> that supports on <5> flips, opens the valve <b> and closes the valve <a>. The direction of the rod movement changes and the cycle repeats.

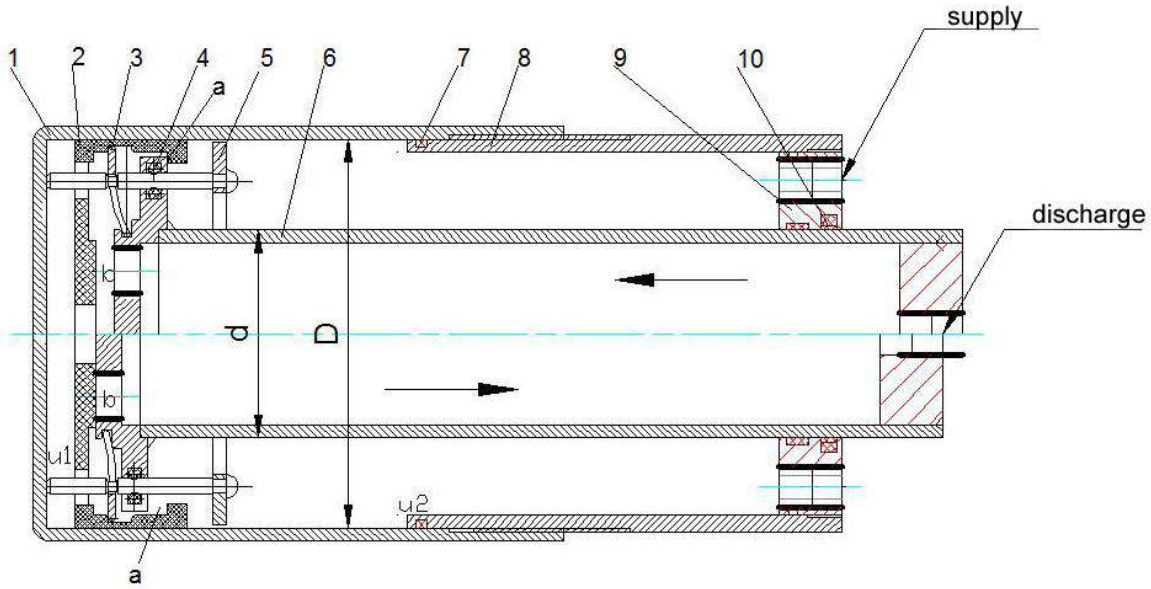

Fig. 2. Left position of the piston before and after switching

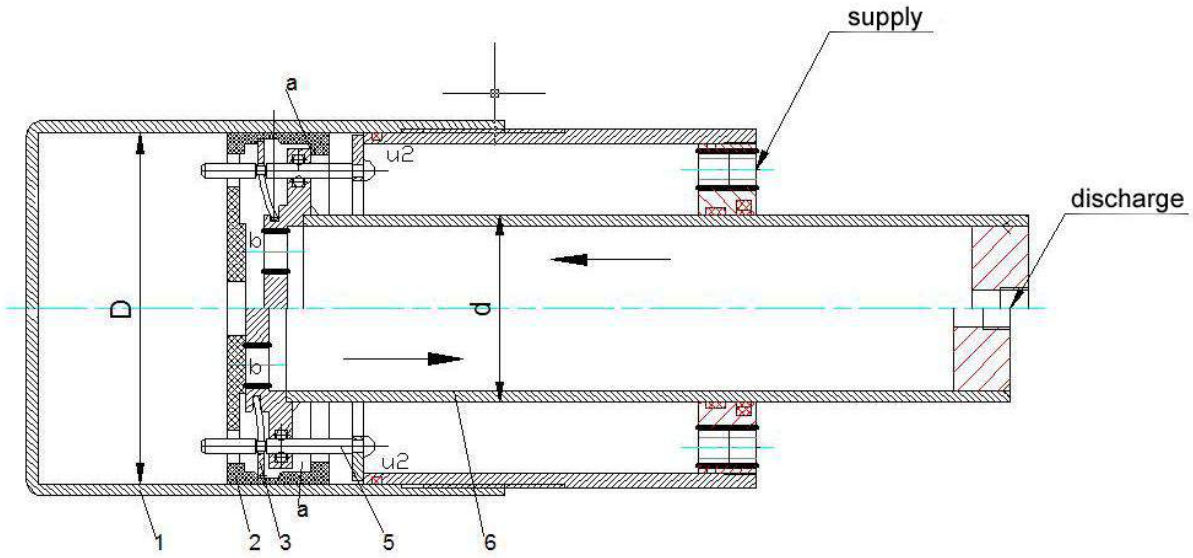

Fig. 3. Right position of the piston where, under the action of the adjustable limiter <u2>, there is ordered closing of port <b> and cycle repetition

Figure 4 shows the annular spring <3>, where due to pressure exerted by the mounting dimensions it is forced to occupy two positions of tilting motion. Tilting motion occurs suddenly when there is forced the crossing over the unstable middle position.

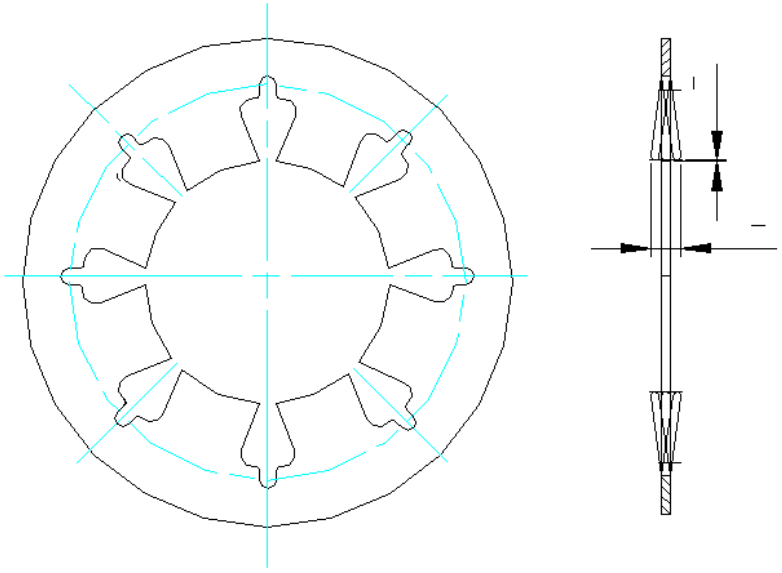

Fig. 4. Lamellar spring made of corrosion resistant materials

3. Conclusions

By developing the hereinbefore mentioned invention we are trying to solve some technical problems occurring when using fertigation pumps. At the same time we intend to establish collaboration between the Hydraulics and Pneumatics Institute and researchers in agriculture sector by developing models of devices whose performances can be proven in operation. In this case we propose a model of linear hydraulic motor that can be applied to various devices, including fertilizer dosing devices.

Acknowledgement

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