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MODERNIZED DISCHARGE VALVE FOR FUEL SUPPLY SYSTEM WITH ELECTRONIC CONTROL

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Keywords: annular type valve, electronic control, fuel delivery system, current.

Abstract. The article discusses the possibility of using a discharge valve of the annular type for fuel-supply systems with electronic control.

МОДЕРНИЗИРОВАННЫЙ НАГНЕТАТЕЛЬНЫЙ КЛАПАН ДЛЯ ТОПЛИВОПОДАЮЩЕЙ СИСТЕМЫ С ЭЛЕКТРОННЫМ УПРАВЛЕНИЕМ

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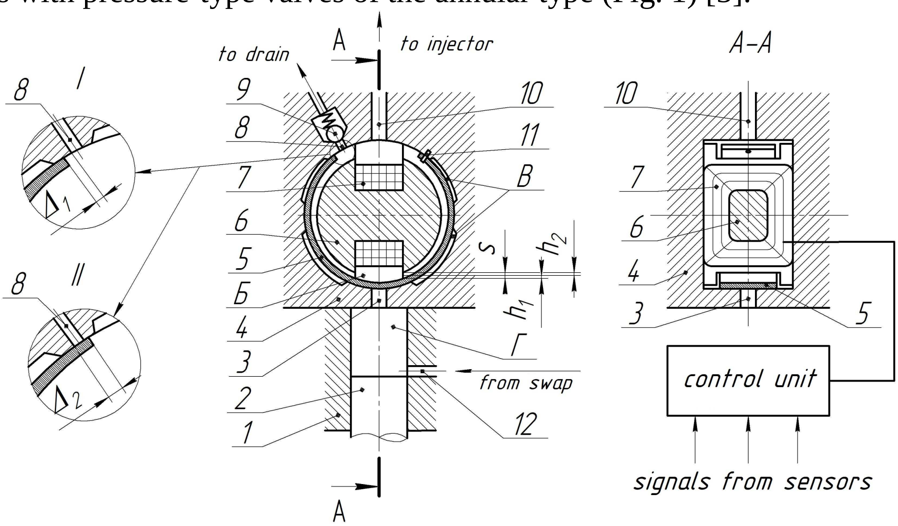
Ключевые слова: кольцевой клапан, электронное управление, топливоподающая система, сила тока.

Аннотация. В статье рассматривается возможность использования нагнетательного клапана кольцевого типа для топливоподающих систем с электронным управлением.

The centrifugal type mechanical regulators used in modern diesel engines are characterized by a high inertness of action and do not allow achieving the required high economic and environmental indicators.

These requirements can be relatively easily met by switching to electronic controllers.

The Bashkir SAU has developed an original electronic regulator for fuel systems with pressure-type valves of the annular type (Fig. 1) [3].



1 and 2 - sleeve and plunger; 3, 8, 10 and 12 - channels; 4 - valve body (socket); 5 - ring; 6 and 7 - core and winding of an electromagnet; 9 - check ball valve; 11 - pin; B - intraclavicular cavity; B - recesses in the valve seat; G - supraplunger space; s is the gap between the ring and the core; I and II - the position of the edge of the ring at the section with the open and closed positions of the channel 8

Fig. 1. Diagram of a fuel supply system with an electronic regulator

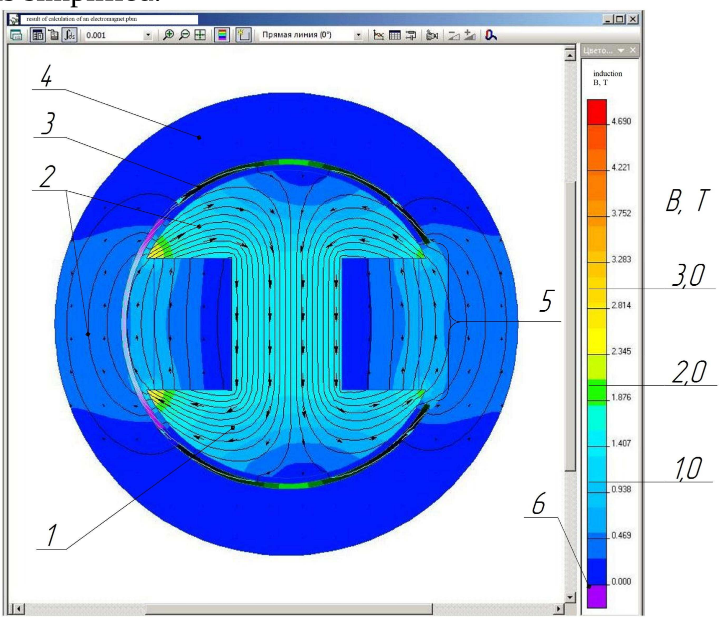
A system with such a regulator operates as follows.

During the discharge stroke of the plunger 2, performed under the action of the cam of the pump shaft, the inlet channel 12 of the sleeve 1 is closed and the fuel from the supraplunger cavity, stepping through the channel 3, lifts the ring 5 by the value of h1 and passes into the intra-valve cavity 5.

Since one end of the ring is rigidly fixed with a pin 11, when the fuel is supplied, its free end moves by $\Delta 1 = \pi \cdot h1$ [4]. The ring was originally set so that this movement is not enough to close the opening of the drain channel 8. In this regard, the fuel entering the cavity B is drained through the non-return valve 9 into the low pressure cavity.

To supply fuel to the nozzle, the control unit supplies voltage to the electromagnet winding 7. In this case, the ring 5 is additionally raised by the value of h2, and its free end, moving by the value of $\Delta 2 = \pi \cdot h2$, closes the hole of the drain channel 8. To attract the ring, a small force of the electromagnet is required, since by the moment of attraction it is already torn off from the socket by pressure fuel.

When the electromagnet winding is de-energized, the ring returns (due to elastic forces) to its original position and thereby opens the drain channel opening and stops fuel injection and unloads the HPD. To control the progress of the ring, a neutral DC electromagnet with an external location of the armature was used (Figure 1). The lines of force of the electromagnet are directed along the circumference of the ring around the circumference (Fig. 2). Due to this, the dimensions of the electromagnet turn out to be small, and its alignment with respect to the socket is simplified.



1 - core; 2 - directions of lines of force; 3 and 5 - a ring and a zone of its section; 4 - valve seat; 6 - valve induction saturation scale

Fig. 2. Design diagram of a ring valve with an electromagnet

The core of the electromagnet should be made of electrical steel E12 (carbon content 0.025%) with a low coercive force of 95 A / m with high magnetic permeability of 3.8 MG / m and saturation induction up to 2.5 T.

To reduce magnetic losses, the valve seat is advisable to be made of non-magnetic stainless steel grade 12X18H10T. The valve seat can be equipped with special recesses 13, which reduce the hydraulic sticking of the ring to the socket.

Valve rings should be made of spring-spring steel (for example, 65G) [2,4], but since this steel has low magnetic permeability, we chose 35KhGSA alloy structural steel. It will interact better with magnetic flux.

To calculate the electromagnet, the Elcut version 5.0 simulation program for electromagnetic tasks was used.

No magnetic saturation of the valve elements was observed (Fig. 2).

The speed of the regulator is determined by the speed of the electromagnet and the controllability of the ring.

The speed of the electromagnet can be determined by the dependence of the force developed by it on the time of supplying the voltage Fe = f (τ) to its winding (Fig. 2 b).

When a control voltage of 12 V is applied for 1 ms (Fig. 2 a) to the winding of an electromagnet consisting of 84 turns of copper wire with a cross section of 0.71 mm, the current in the winding of the electromagnet increases to 80 A. At the same time, the attractive force Fe of the electromagnet reaches 30.8 N / mm (Fig. 2 b).

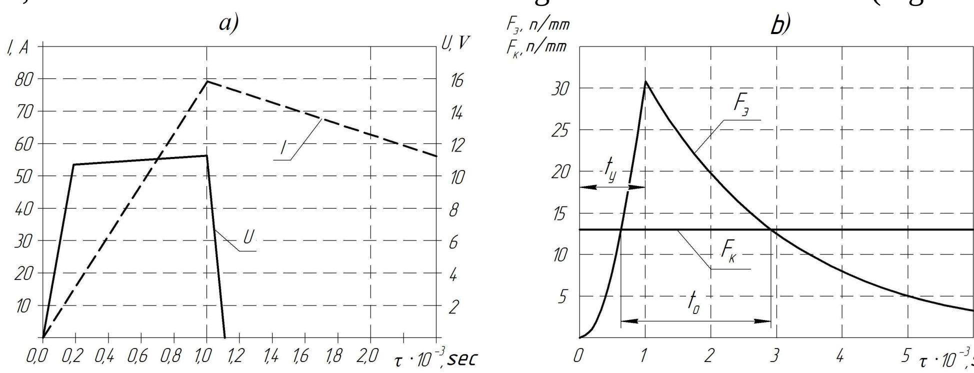


Fig. 3. Dependences of the current and voltage (a) and the force developed by the electro-magnet Fe (b) on the time τ of applying voltage to its winding (for comparison, the graph shows the stiffness Fc of the ring with dimensions D = 30 mm, b = 11 mm and t = 0.5 mm)

As can be seen from the graph, the force of the electromagnet is sufficient to attract the ring with the same dimensions D = 30 mm, b = 11 mm and t = 0.5 mm and rigidity 13 N / mm (Figure 2 b). In this case, the ring will be in the attracted position 2.2 ms.

The controllability of the annular valve is estimated by the ratio of the duration ty of the control pulse to the duration of the separation of the ring from the socket to. For this case, the controllability coefficient is: k = ty / to = 1 / 2.2 = 0.46.

The duration of the separation of the ring from the socket t_0 consists of:

$$t_o = t_{pod} + t_{pr} + t_v,$$

where t_{pod}, t_{pr}, t_v - time, respectively, of the lifting of the ring, the attracted state and return to the starting position.

The rise time can be reduced by increasing the attractive force of the electromagnet, and the time of the attracted state by the duration of the control pulse.

The return time t_v of the return ring to its initial position is determined by the elastic force of the ring.

For a ring with dimensions D = 30 mm, b = 11 mm and t = 0.5 mm, manufactured by thermal method [1,4], with dry friction against the socket, the return time was 1.51 ms, with liquid friction (wetted with diesel fuel) it decreases to tv = 1.18 ms.

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