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(54) Pump particularly for hydraulic rudder control systems

(57) A pump for hydraulic rudder control systems of the volumetric type with a stator and a rotor; its particularity consists of the fact that the rotor is made of plastics, ensuring very low weight and low cost of the machine.

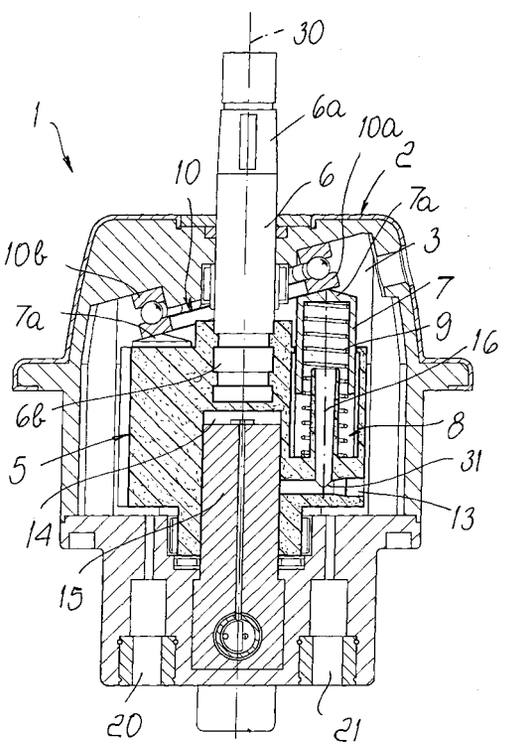

Fig. 1

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Description

[0001] The present invention relates to a pump particularly for hydraulic rudder control systems.

[0002] The rudder of a watercraft is normally connected to the steering wheel of the rudder by means of a hydraulic control system that includes a pump.

[0003] Generally, the rudder of the watercraft is connected to a hydraulic actuator, usually a hydraulic cylinder and piston system, which is connected to a reversible hydraulic pump, manually actuated by means of the steering wheel, to the pump and to the actuator, thus forming a closed hydraulic circuit.

[0004] A conventional type of hydraulic pump for rudder control systems includes a stator, which also acts as a reservoir for the hydraulic fluid, on which there are discharge and intake ducts for the passage of the fluid, and that are connected to the corresponding discharge and intake ducts of the hydraulic actuator connected to the rudder.

[0005] A rotor is accommodated inside the stator and a shaft is fixed axially thereto. The shaft protrudes from the frame of the stator with one of its ends. The control wheel is keyed onto this end of the shaft.

[0006] The rotation of the wheel in one direction by the user causes a corresponding rotation of the rotor which, by means of a system of small pistons, induces a circulation of the working fluid, which exits from one duct and enters the other, causing the movement of the piston of the actuator, and therefore of the rudder, in a given direction.

[0007] The operation of the pump is perfectly reversible, and therefore the rotation of the wheel in the opposite direction causes a circulation of the fluid in the opposite direction, producing the movement of the piston connected to the rudder in the other direction.

[0008] In such conventional pumps for rudder control systems, the frame, and especially the rotor with the small pistons, are made of metal, entailing a considerable weight and a high production cost.

[0009] The rotor made of metal is particularly sensitive to attack on the part of salt deposits, which entails a considerable shortening of the useful life of the pump, facilitating corrosion.

[0010] The aim of the present invention is to provide a pump, particularly for hydraulic rudder control systems, that overcomes the drawbacks of the cited prior art.

[0011] An object of the invention is to provide a pump that is very light.

[0012] Another object is to provide a pump that is less expensive than conventional pumps.

[0013] Another object of the invention is to provide a pump that is durable and is characterized by high resistance to salt deposits and therefore to the consequent corrosion.

[0014] This aim and these and other objects that will become better apparent hereinafter are achieved by a pump, as claimed in the appended claims.

[0015] Further characteristics and advantages will become better apparent from the description of a preferred but not exclusive embodiment of the invention, illustrated by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a sectional side view of a hydraulic pump for a rudder control system, according to the invention;
Figure 2 is a sectional view of the pump, taken along a plane that is perpendicular to the sectional plane of Figure 1;
Figure 3 is a perspective view of the rotor-shaft assembly of the pump;
Figure 4 is a side view of the rotor-shaft assembly of Figure 3;
Figure 5 is a sectional side view of the rotor-shaft assembly of Figure 4;
Figure 6 is a sectional view taken at right angles to the longitudinal axis of the rotor, along the line A-A;
Figure 7 is a sectional view taken at right angles to the longitudinal axis of the rotor, along the line B-B.

[0016] With reference to the cited figures, a hydraulic pump for rudder control system, generally designated by the reference numeral 1, comprises a frame that acts as a stator 2 of the pump 1, which is substantially cylindrical and inside which there is a compartment 3 that is also substantially cylindrical.

[0017] A rotor 5 of the pump 1 is accommodated in the compartment 3.

[0018] The compartment 3 is filled with a hydraulic fluid, preferably oil, so that the compartment 3 also constitutes a reservoir for the fluid.

[0019] The compartment 3 is connected to the outside of the pump by means of at least two ducts 20 and 21, for the intake and discharge of the fluid, that act as intake and delivery ducts of the pump.

[0020] Each of the two ducts can perform these two functions reversibly, depending on the actuation direction imparted to the wheel by the helmsman.

[0021] The rotor 5 is mounted axially with respect to the stator 1, and is provided with an axial hole 14 that rotatably engages on a pivot 15 that protrudes inside the compartment 3, in axial alignment with the hole 14.

[0022] A shaft 6 is monolithically coupled to the rotor 1 and has an axis that coincides with the axis of the rotor 1.

[0023] The axes of the stator 2, of the rotor 5, of the shaft 6, of the hole 14 and of the pivot 15 therefore coincide with a single axis, which is referenced hereafter simply as machine axis 30.

[0024] The shaft 6 is, as mentioned, monolithically coupled to the rotor 1 and is fixed axially in the rotor 5 by means of an interference coupling. The coupling is rendered even more solid by the presence of circumferential slots on the end 6b of the shaft 6 and of corre-

sponding complementarily shaped slots formed in the hole of the rotor 5, in which the shaft 6 is accommodated with interference.

[0025] The other end of the shaft 6, the end 6a, protrudes from the stator 2 and has a slightly conical portion in which a control wheel is keyed, the wheel being gripped by the helmsman in order to steer the boat.

[0026] The shaft 6 and the hub of the control wheel are mutually torsionally coupled by means of a semicircular lug.

[0027] The rotor 5 includes a means which, by cooperating with the stator, allows to provide the intake and delivery of the fluid through the intake/discharge ducts 20 and 21.

[0028] A particularity of the pump 1, according to the invention, is that the rotor 5 is made entirely or completely of plastics, differently from conventional similar pumps, in which the rotor is made of metal.

[0029] In the described preferred embodiment, the rotor 5 is in fact made substantially of plastics and has inserts made of metallic material, which are embedded in the body made of resin, in order to provide greater mechanical strength to the regions of the rotor that are stressed most intensely, as will become better apparent hereinafter.

[0030] The main body of the rotor 5 is substantially cylindrical, and its outer lateral surface has a lobate profile.

[0031] The intake and delivery means mentioned above includes a system of small pistons 7, which are accommodated in corresponding cylinders 8 formed in the body of the rotor 5 and arranged in a ring all around the axis of the rotor 5. The axes 31 of the cylinders 8 are parallel to the axis 30 and mutually equidistant in an angular direction.

[0032] The head 7a of each piston 7 is engaged with the ring 10a of an axial ball bearing 10, and the other ring 10b is firmly anchored to the stator 2, resting and being fixed thereto against an internal wall of the compartment 3, which forms a plane whose orthogonal axis is inclined at a certain angle with respect to the axis 30.

[0033] The axis of the ball bearing 10 is therefore inclined by the same angle with respect to the axis 30.

[0034] A rotation of the rotor 5 therefore entails a movement, with a reciprocating rectilinear motion, of the pistons 7 along their axis 31, by contrast with an elastic means constituted by helical springs 9 which are interposed between the pistons 7 and the rotor 5.

[0035] The pistons 7 are in fact internally hollow, and each piston accommodates internally a spring 9 that acts by compression and one end of which abuts against the base of the cylinder 8, the other end resting on the internal surface of the cavity of the piston at the head 7a.

[0036] A jacket made of metallic material, perfectly integrated as an insert on the plastic material of the rotor 5, is interposed between the side wall of each one of the pistons 7, which are also made of plastics, and the side wall of the corresponding cylinder 8.

[0037] As mentioned above, the metallic inserts are inserted in the points of highest stress in order to ensure greater strength and therefore longer life. The surfaces for contact between the pistons 7 and the corresponding cylinders 8 are in fact particularly subject to wear.

[0038] Finally, each cylinder 8 is connected to the compartment 3, in order to allow the fluid propelled or aspirated by the corresponding piston 7 to flow from the cylinder 8 into the compartment 3 or vice versa, and be conveyed from there through the intake and delivery ducts 20 and 21.

[0039] Each cylinder 8 in fact has a sleeve 16, which protrudes inside the cylinder 8 and whose axis coincides with the axis 31 of the cylinder 8. The helical spring 9 is wound around the sleeve 16.

[0040] Each sleeve 16 of each one of the cylinders 8 leads into the central portion of a corresponding channel 13, one end of which leads into the compartment 3. The channels 13 are formed inside the plastic body of the rotor 5, and branch radially inside it, as clearly shown by Figure 7.

[0041] Each sleeve 16 and each corresponding channel 13 form a sort of T-shaped duct. The number of sleeves 16 and channels 13 is equal to the number of cylinders 8, and in this case is seven.

[0042] The other end of the channels 13 is connected to a secondary hydraulic circuit, which by preadjusted ball valves, is connected to, and is part of, an automatic piloting device that is not described here.

[0043] Briefly, the operation of the pump is as follows: when the helmsman operates the wheel of the rudder in one direction, the rotary motion imparted manually to the wheel is transmitted through the shaft 6 to the rotor 5.

[0044] As can be seen in Figure 1, the rotation of the rotor 5 causes a reciprocating motion of the pistons 7.

[0045] At each instant, by engaging with the inclined bearing 10, half the pistons 7 act so as to propel and the other half acts so as to produce suction; therefore the former half propels the hydraulic fluid through one of the ducts 20 or 21, for example the duct 20, which acts as a delivery duct of the pump, and the latter half draws fluid through the other duct, in this case the duct 21, which acts as a pump intake duct.

[0046] Since the pump is reversible, by turning the control wheel in the opposite direction, the exact opposite occurs, and therefore by inverting the reciprocating motion of the pistons 7 the duct 20 acts as a pump intake duct, while the duct 21 acts as a delivery duct.

[0047] The rotor 5 and the pistons 7 made of plastics ensure very low weight and low costs of the pump.

[0048] The metal inserts 11 inserted in the critical points of the plastic material of the rotor 5 ensure that the pump is tough, reliable and durable.

[0049] In practice it has been found that the invention achieves the intended aim and objects, providing a hydraulic pump for rudder control systems.

[0050] The pump according to the invention is susceptible of numerous modifications and variations, with-

in the scope of the appended claims. All the details may be replaced with technically equivalent elements.

[0051] The materials used, as well as the dimensions, may of course be any according to requirements and to the state of the art.

Claims

1. A pump, particularly for hydraulic rudder control systems, comprising a stator in which there is a compartment filled with a hydraulic fluid, said compartment being connected to the outside by means of at least two intake and discharge ducts for the hydraulic fluid, said compartment accommodating a rotor which is mounted in axial alignment with said stator, said pump further comprising a shaft that is fixed axially to said rotor, said shaft protruding from said stator with one end on which a control wheel is keyed, said pump being **characterized in that** said rotor is entirely or partially made of plastics.

2. The pump according to claim 1, **characterized in that** said rotor comprises a means for the delivery and intake of the fluid through the discharge/intake ducts.

3. The pump according to claim 2, **characterized in that** said delivery and intake means comprises a system of pistons accommodated in corresponding cylinders formed in the body of said rotor and arranged in a ring around the axis of said rotor, the head of said pistons cooperating with said stator in order to provide a reciprocating rectilinear motion of the pistons along their axis, said motion being promoted by a rotation of the rotor and by virtue of the contrast of an elastic means interposed between each one of said pistons and said rotor.

4. The pump according to claim 3, **characterized in that** said pistons are made of plastics.

5. The pump according to claim 3, **characterized in that** the head of said pistons is engaged with the ring of an axial ball bearing, the other ring being rigidly anchored to said stator, the axis of said ball bearing being inclined with respect to the axis of said rotor.

6. The pump according to claim 3, **characterized in that** a metallic jacket, integrated in the material of said rotor, is interposed between the side wall of each one of said pistons and the side wall of each one of the corresponding cylinders.

7. The pump according to claim 3, **characterized in that** said cylinders have an axis that is parallel to the axis of said rotor and are mutually equidistant in an angular direction.

8. The pump according to one or more of the preceding claims, **characterized in that** it comprises a secondary hydraulic circuit connected to an automatic piloting device.

9. The pump according to claims 3 and 8, **characterized in that** said cylinders are connected to said compartment and to said secondary hydraulic circuit by virtue of channels that branch out radially in the body of said rotor and are connected to said compartment by virtue of one of their ends, to said secondary hydraulic circuit by virtue of their other end, and to said cylinders at their central portion.

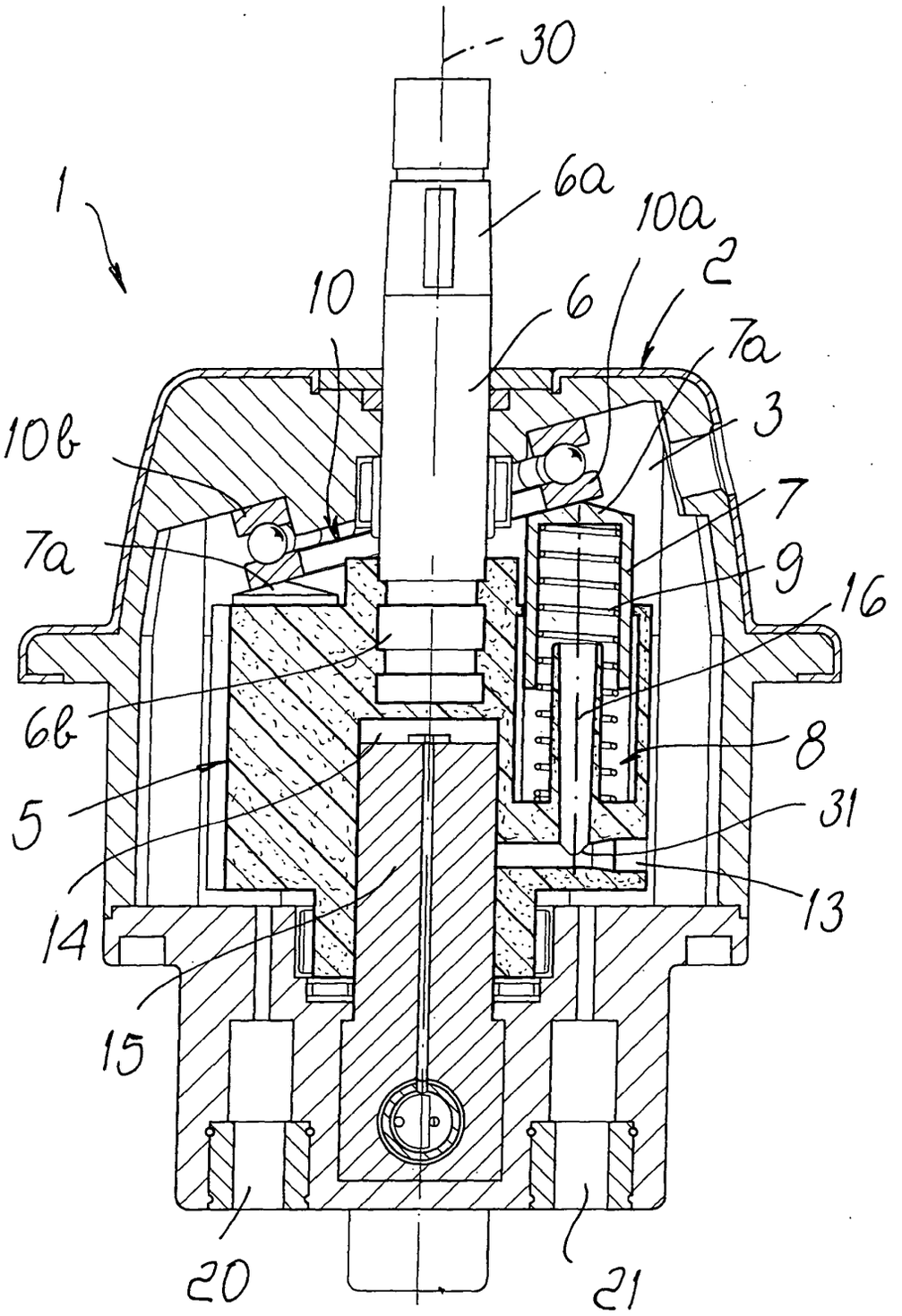

Fig. 1

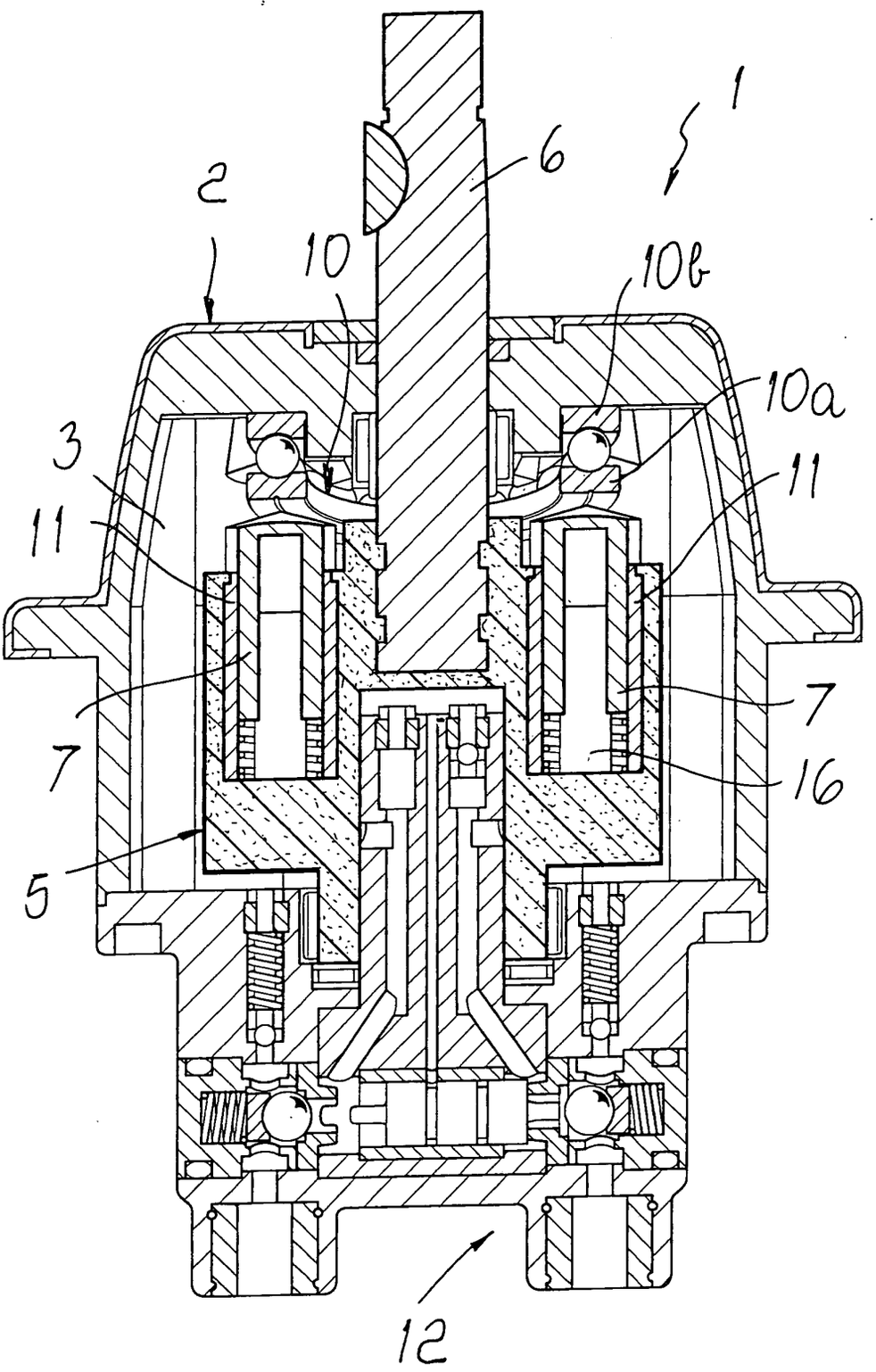

Fig. 2

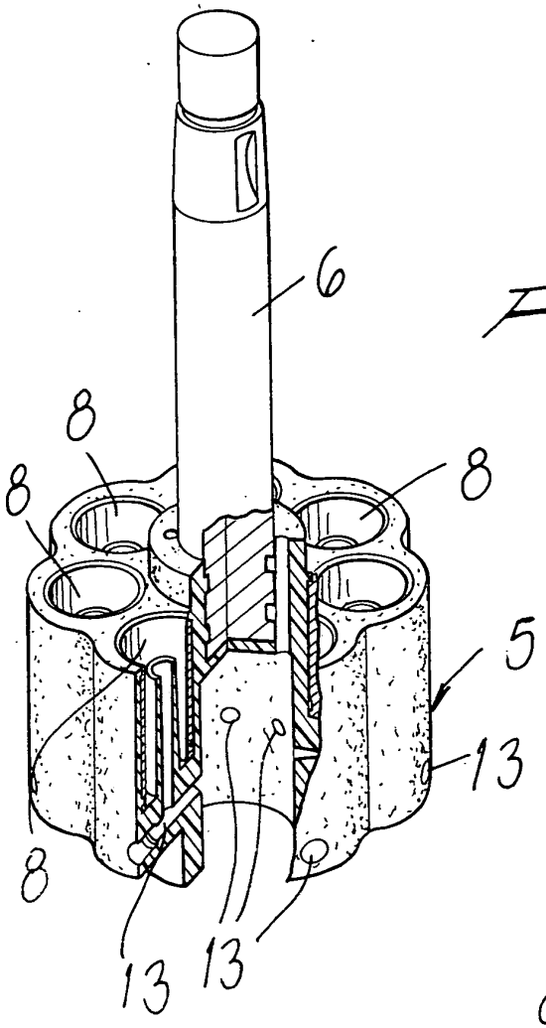

Fig. 3

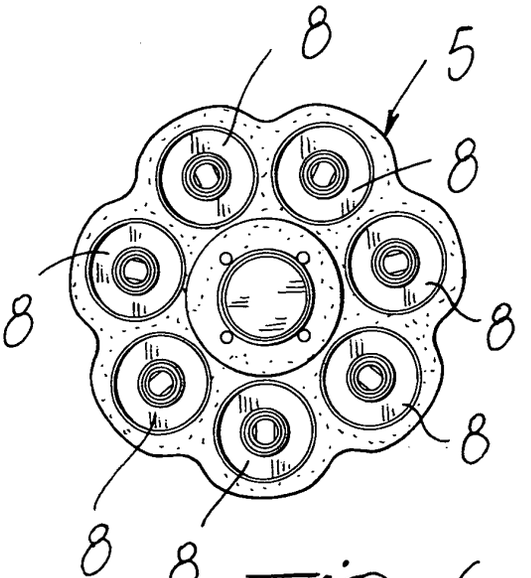

Fig. 6

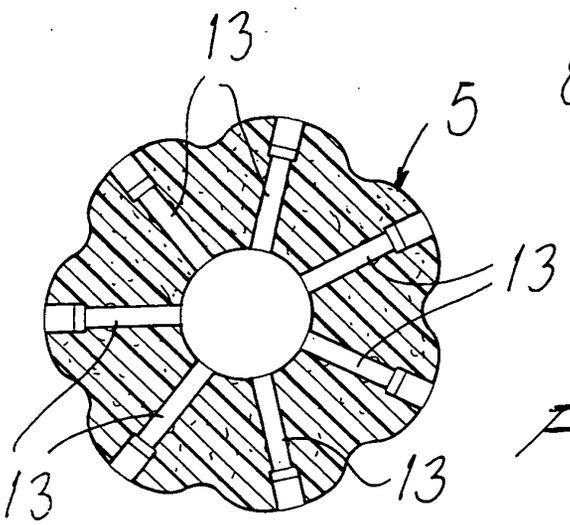

Fig. 7

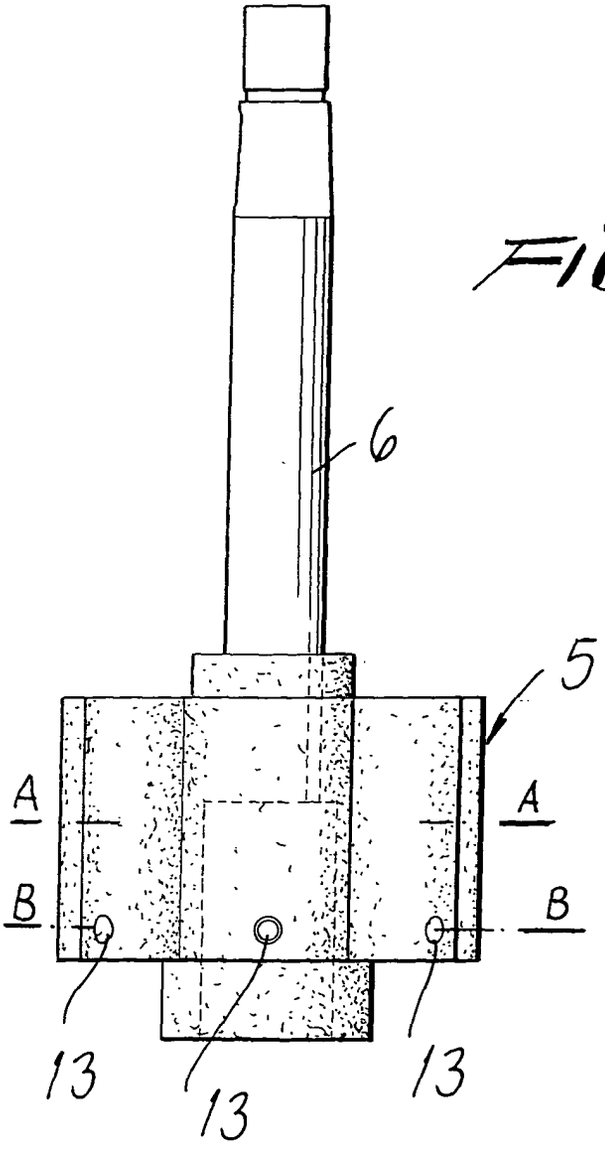

FIG. 4

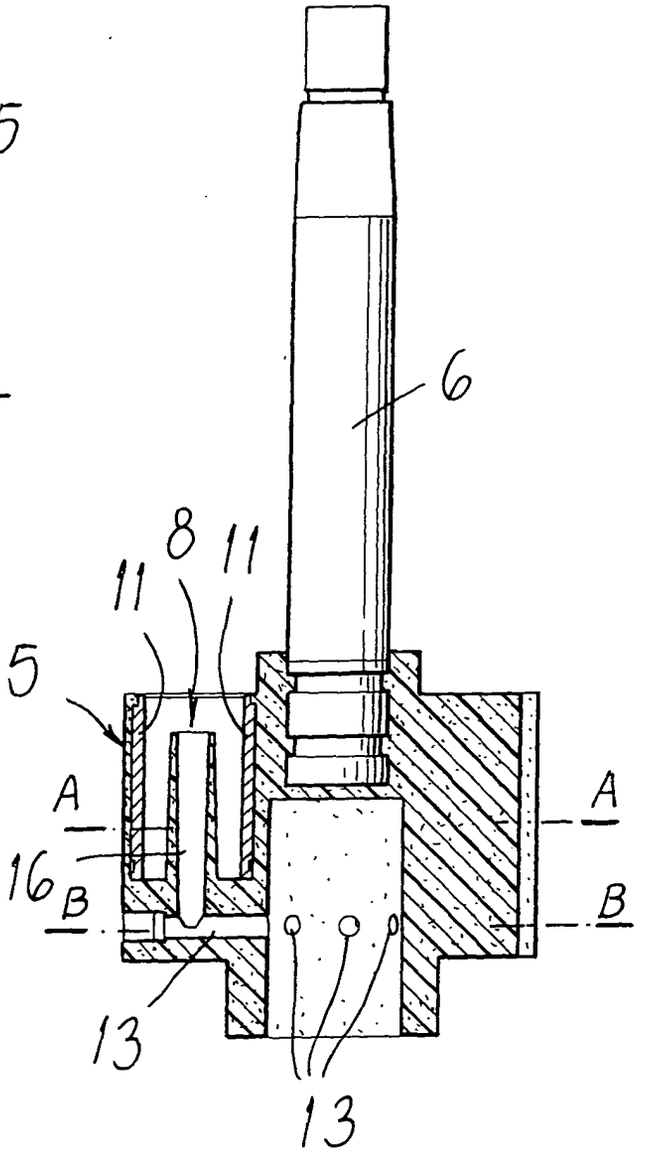

FIG. 5