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(54) **HYDRAULIC PUMP**

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ABSTRACT

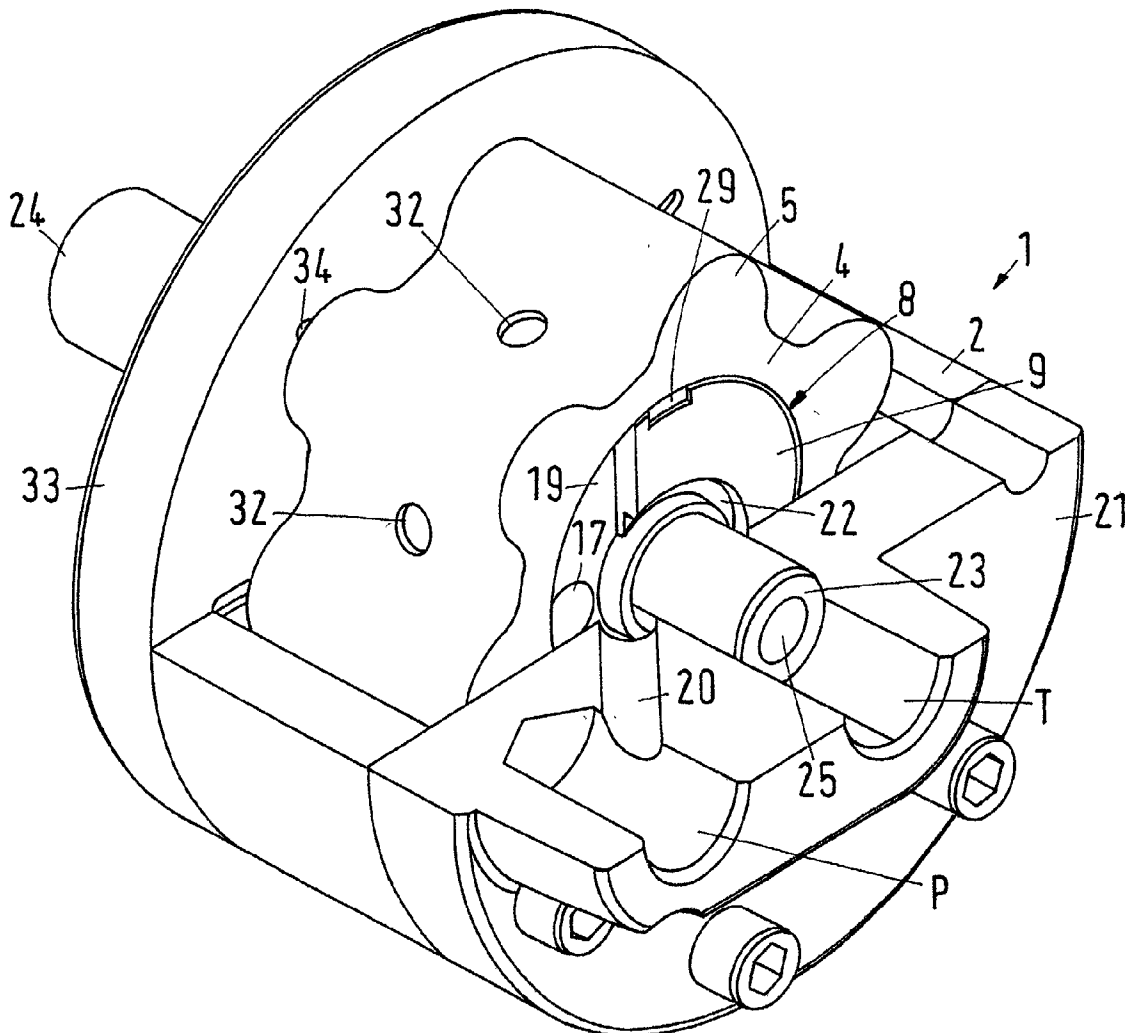
A hydraulic pump has a housing with an inner toothed ring, and an outer toothed wheel eccentrically mounted within the ring, with pressure pocket space between the teeth of the ring and the wheel. The wheel is eccentrically rotatably and orbitally mounted within the ring. A rotary slide valve is mounted within the wheel. A valve plate with an open center is adjacent the wheel. A rotary slide valve is positioned within the open center of the valve plate. Fluid under pressure in passageways is provided to a front group of pressure pocket spaces to cause the wheel to rotate. A shaft is operatively connected to the wheel.

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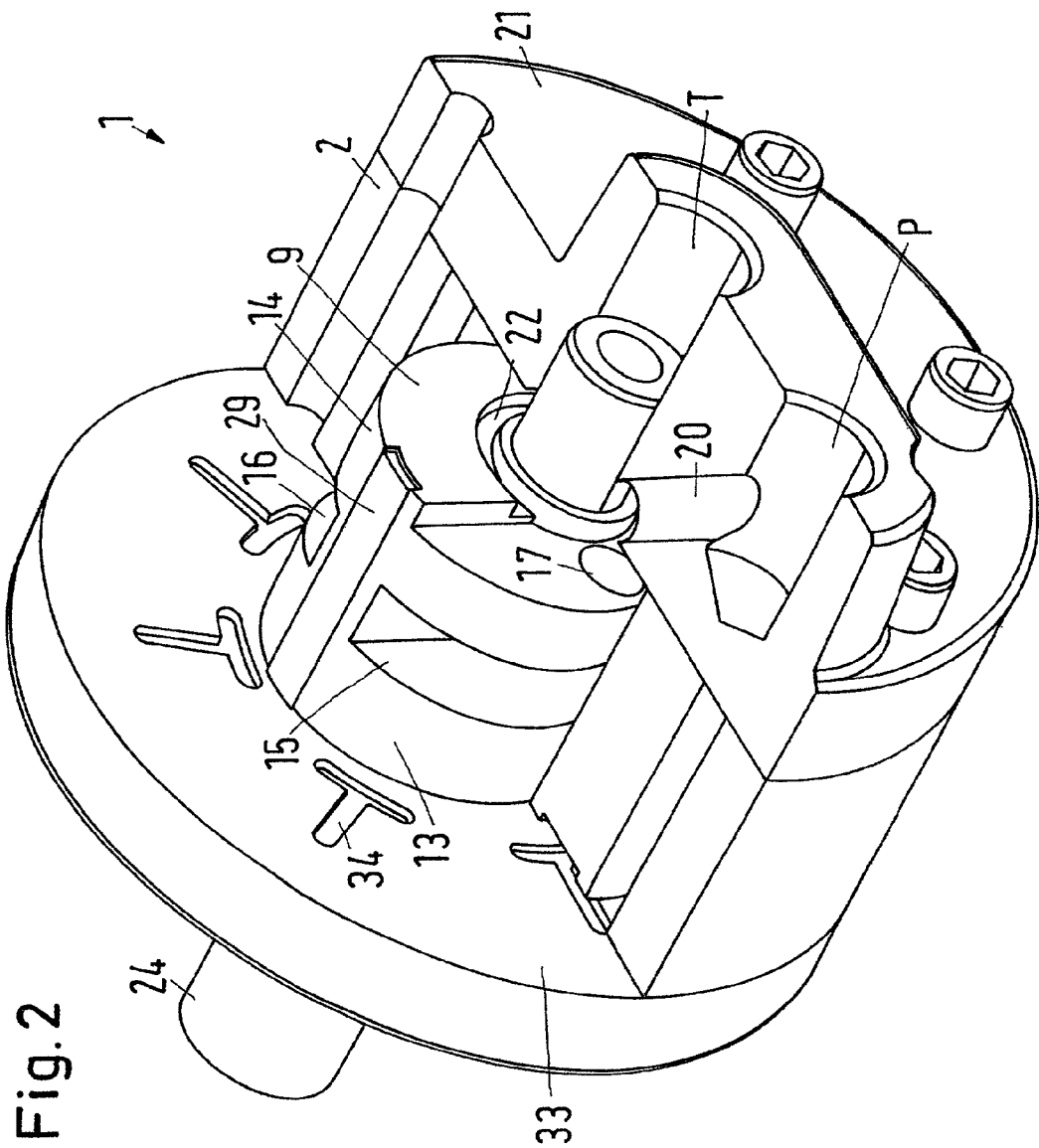
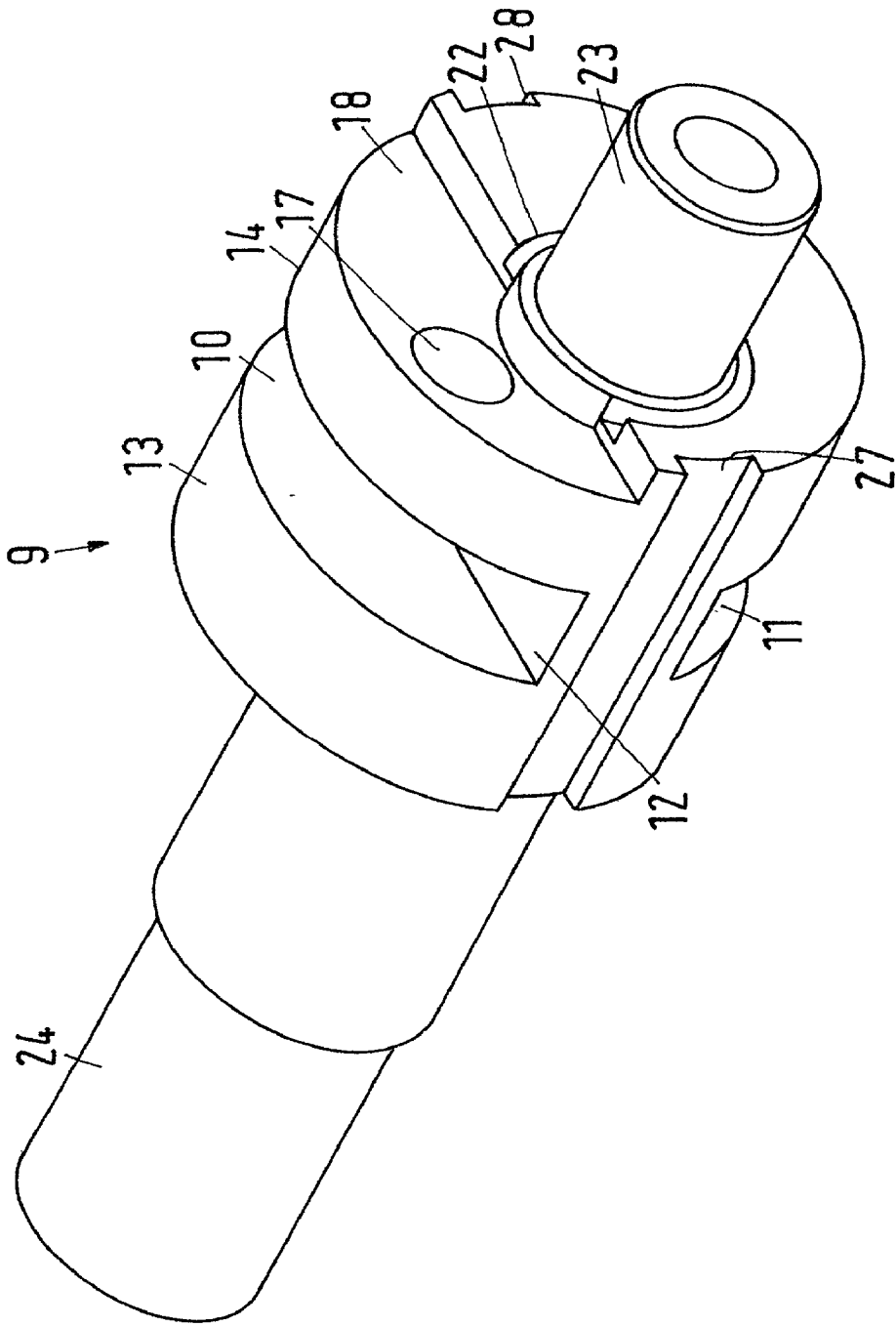


Fig.3



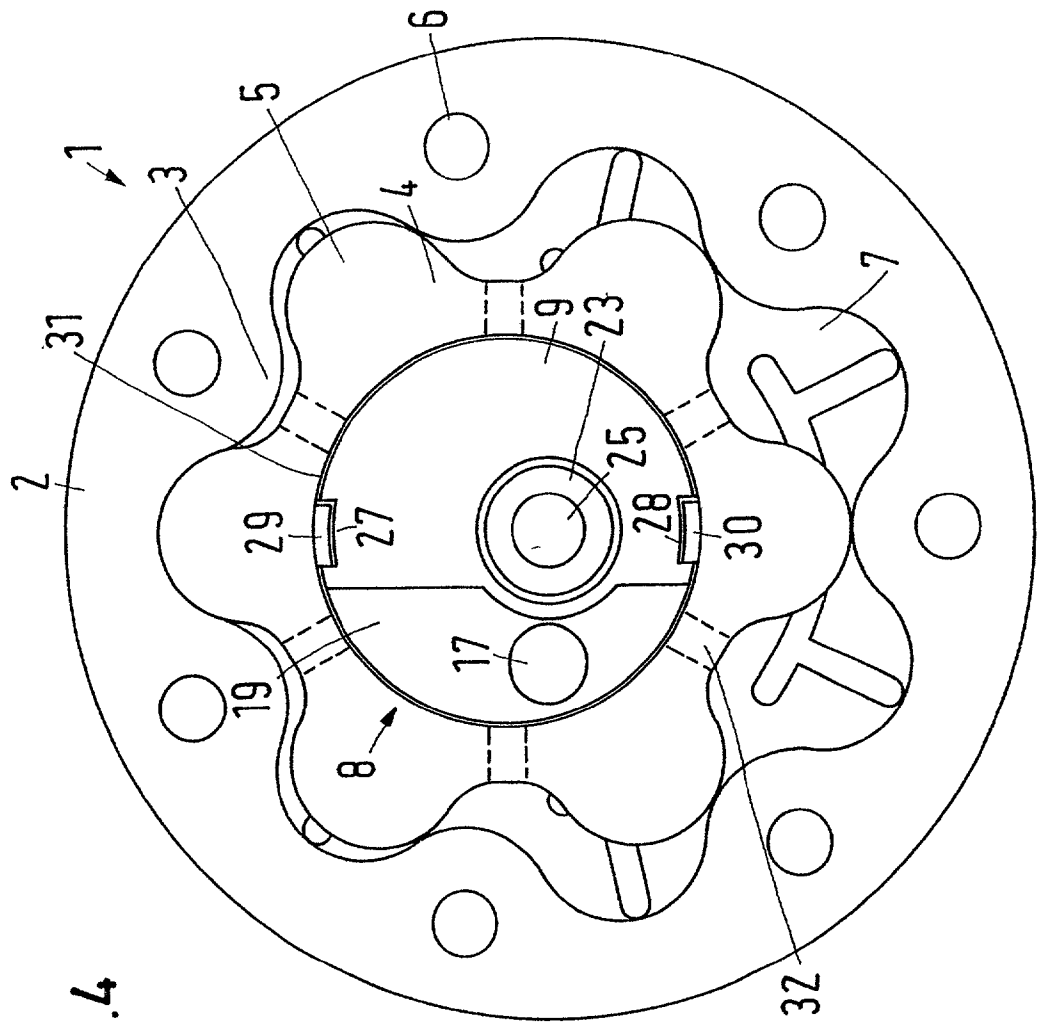


Fig.4

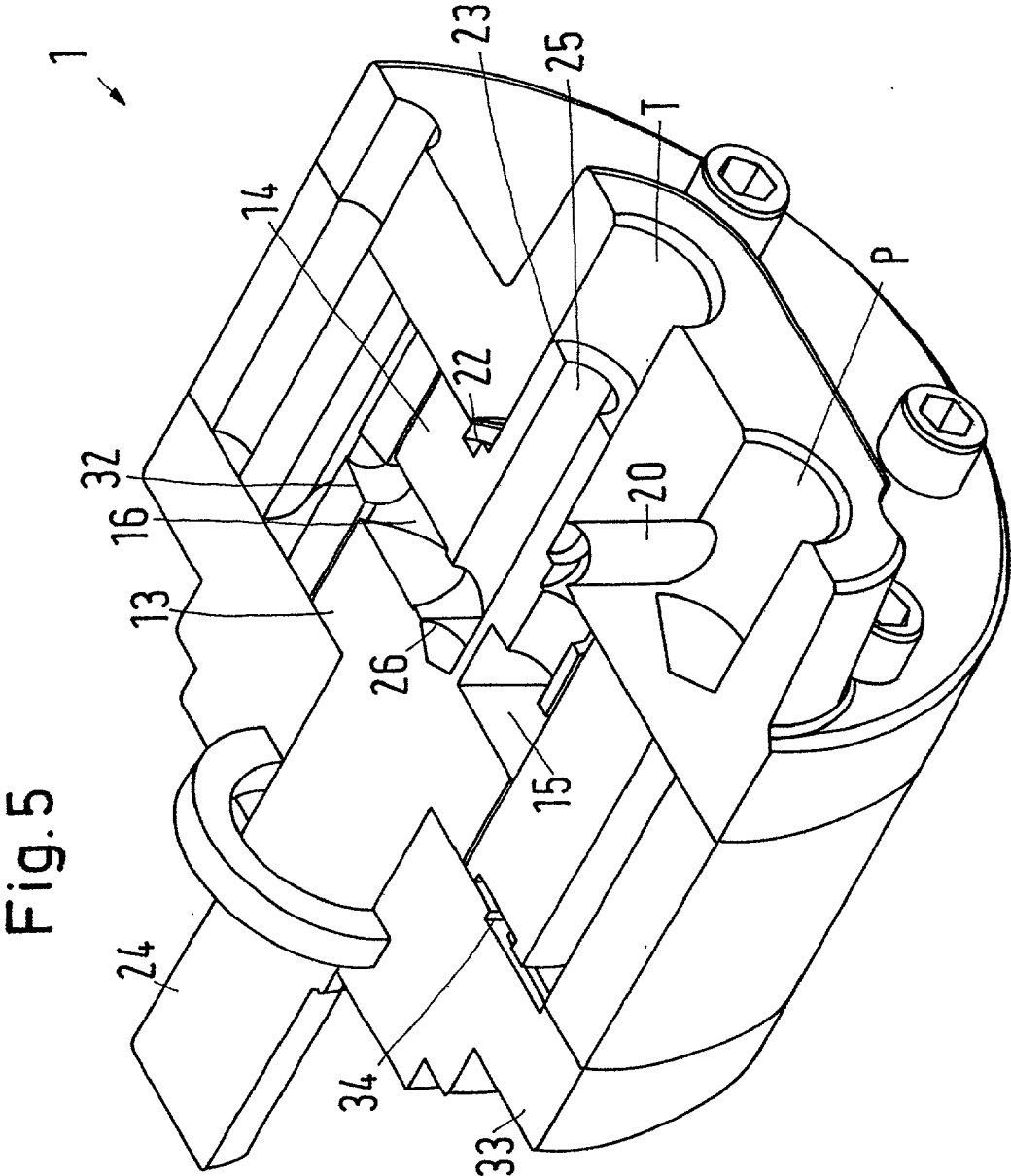


Fig. 6

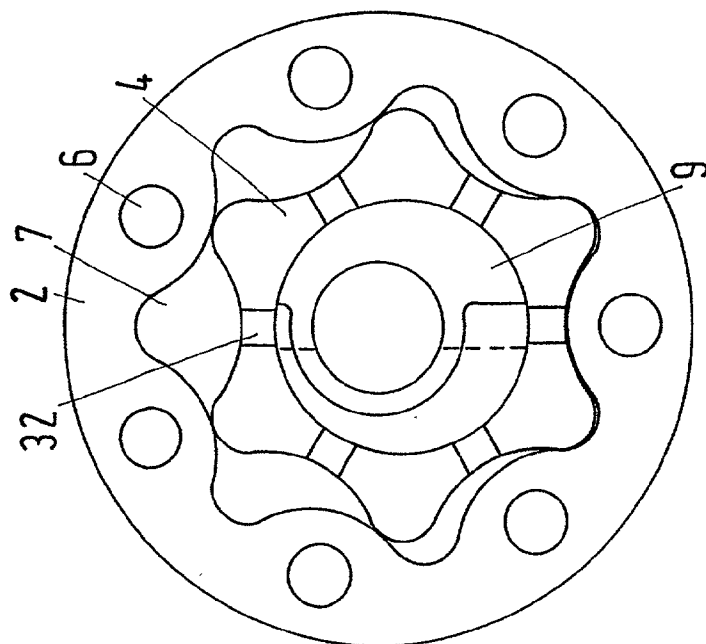
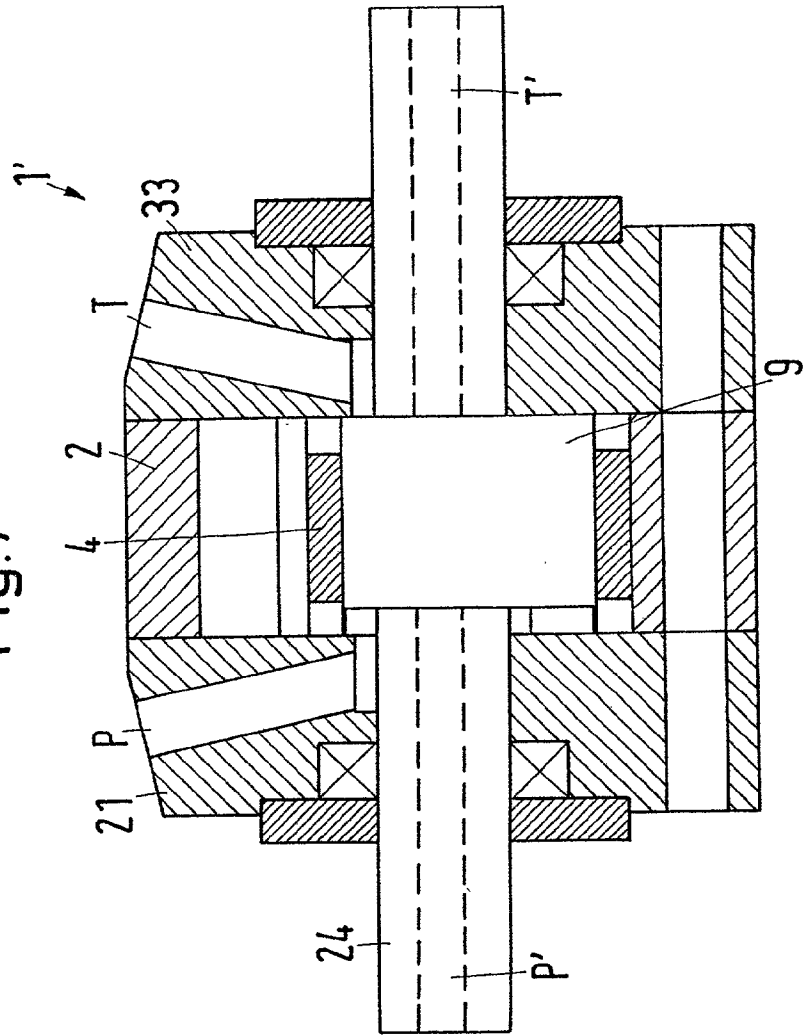


Fig. 7



HYDRAULIC PUMP

BACKGROUND OF THE INVENTION

[0001] The invention relates to an improvement in a hydraulic pump, comprising an internally toothed ring and an externally toothed gear wheel that rotates and orbits in the toothed ring, with a valve suitable hydraulic fluid valve.

[0002] A hydraulic pump of this kind is known from U.S. Pat. No. 3,288,034.

[0003] The principle, according to which such machines work, is also called "gerotor" principle. Usually, the gear wheel has one tooth less than the toothed ring and is supported eccentrically in the toothed ring. The gear wheel orbits and rotates relative to the toothed ring. During one rotation of the gear wheel, the gear wheel orbits in relation to the toothed ring by a number of rotations, which corresponds to the number of teeth on the gear wheel. During the movement in relation to the toothed ring, the teeth of the gear wheel are continuously supported on the inner contour of the toothed ring. Thus, the gear wheel, together with the toothed ring, forms a number of pressure pockets, which corresponds to the number of teeth on the gear wheel. In the course of the movement of the gear wheel in relation to the toothed ring, the pressure pockets expand and decrease. Hydraulic fluid must be supplied into the expanding pressure pockets. In the decreasing pressure pockets, it must be ensured that the displaced fluid can escape. This is the task of the valve arrangement. In a pump, the valve arrangement thus connects the decreasing pressure pockets with the pressure outlet, whereas the expanding pressure pockets must be connected with the suction side. In a motor, it is vice versa. Here, the valve arrangement connects the expanding pressure pockets with a pressure connection, whereas the decreasing pressure pockets are connected with the tank connection. In this connection it must be ensured that the connection always occurs at the right moment. For this reason, the embodiment of the valve arrangement is usually relatively extensive, which causes an increased volume of the machine and particularly an increase in the weight.

[0004] Therefore, a principal object of this invention is to build a hydraulic pump of less weight.

[0005] This and other objects will be apparent to those skilled in the art.

SUMMARY OF THE INVENTION

[0006] With a hydraulic pump as mentioned in the introduction, the weight decrease is solved in that the valve arrangement is arranged inside the gear wheel. Further, this invention offers several advantages at a time. The fact that the valve arrangement is arranged inside the gear wheel means that no additional space is required. Thus, on a whole, the machine can be built shorter. Further, weight is saved. The weight of the valve arrangement remains. However, the volume required by the valve arrangement has to be removed from the gear wheel, so that the weight of this material is saved. Further, the distances, which the hydraulic medium had to travel from the valve arrangement to the pressure pockets, are kept short. Thus, pressure losses are reduced. The pump can work with a higher efficiency. Also the commutation, that is the correct positioning of the connection of the individual pressure pockets with the high-pressure side and the low-pressure side, is simplified.

[0007] Preferably, the tooth spaces of the gear wheel have channels, which are connected with the valve arrangement. The tooth spaces, or more precisely, the deepest spots of the tooth spaces, are the areas, which are practically always open in the pressure pockets, that is, which are not, or only very briefly, closed by the toothed ring. The teeth of the toothed ring only cover them, when the volume of the corresponding pressure pocket has been reduced to zero. Thus, this embodiment facilitates the fluid control.

[0008] Preferably, the valve arrangement divides an inner chamber of the gear wheel into two pressure chambers, namely a high-pressure chamber and a low-pressure chamber. In a manner of speaking, the cooperation of gear wheel and tooth ring divides the machine into two halves, namely a high-pressure side and a low-pressure side. When, by means of the valve arrangement, it is ensured that inside the gear wheel a corresponding division of the fluid is already made, the correct positioning of the connection of the individual pressure pocket with the high pressure connection or the low pressure connection is particularly easily realised.

[0009] It is particularly preferred that the valve arrangement has a rotary slide, which rotates with the orbit speed of the gear wheel. This means that the rotary slide rotates with a higher speed than the gear wheel in relation to the toothed ring. The orbit speed of the rotary slide is several times higher than the speed, at which the gear wheel orbits around the centre of the toothed ring. This facilitates the commutation substantially, as a direct allocation of the pressure pockets to the high-pressure connection or the low-pressure connection, respectively, is possible right away, without requiring a complicated valve design. Thus, the commutation can be performed more accurately. The embodiment of the machine is simplified. The efficiency is increased, as the pressure losses are reduced.

[0010] Preferably, the rotary slide is driven directly by the gear wheel. Thus, shafts are not required, which would imply the disadvantage that each connection is subject to a play, which reduces the steering accuracy. With the direct driving, frictional losses are also avoided, which could result from a transmission by means of shafts or other transmission members. All in all, the efficiency of the machine is improved. The machine can be made smaller and with a lower weight, without reducing the output.

[0011] Preferably, the rotary slide is arranged centrally in the gear wheel and has an eccentric spigot joint with the toothed ring, said joint being arranged centrally in relation to the toothed ring. When the gear wheel orbits in the toothed ring, this orbit movement is transmitted immediately and directly to the rotary slide, meaning that a very accurate coordination between the gear wheel movement and the rotary slide movement can be realised.

[0012] Preferably, sealing faces are arranged on the rotary slide between the high-pressure chamber and the low-pressure chamber, the sealing faces bearing on the inside of the gear wheel. These sealing faces ensure that otherwise the rotary slide and the gear wheel can be made with a small play in relation to each other, that is, the frictional losses between gear wheel and rotary slide are reduced, as a contact is limited to the relatively small area of the sealing face in the circumferential direction. The sealing faces provide a sufficient division between the high-pressure chamber and the low-pressure chamber, this sealing zone rotating together with the rotary slide in relation to the gear wheel.

[0013] It is particularly preferred that the sealing face is supported in the circumferential direction with a significant play in relation to the rotary slide. Thus, it is possible for hydraulic fluid from the high-pressure side to penetrate under the sealing face to ensure a contact pressure for the sealing face on the inner circumference of the gear wheel.

[0014] Preferably, the high-pressure chamber and the low-pressure chamber are in the shape of grooves, the bottom of these grooves extending in parallel to a tangent on the rotary slide. This facilitates the manufacturing of the rotary slide. In principle, the rotary slide can be made as a cylinder part. Then, the high pressure chamber and the low pressure chamber can be made by face milling, the front side limiting walls of the two pressure chambers being maintained.

[0015] Preferably, one of the two pressure chambers is connected with a recess on one front side of the rotary slide, said recess being connected with a fluid connection via an annular channel. This facilitates the fluid inlet or outlet, respectively.

[0016] Preferably, the other pressure chamber is connected with another fluid connection through the spigot joint. This permits a close decoupling of both fluid flows.

[0017] Preferably, the rotary slide is connected with a shaft extending to the outside. The shaft is arranged eccentrically to the rotary slide. Thus, it is coaxial to the axis of the toothed ring. This saves an additional hinged joint between a cardan shaft and the gear wheel. At the same time, the shaft has the speed of the rotary slide, that is, the orbit speed of the gear wheel. This means that the shaft in question is running relatively fast. Particularly in connection with pumps, this has the advantage that an equally fast drive member can be used, which is particularly advantageous, when such a pump is used in a motor vehicle.

[0018] Preferably, the toothed ring is unrotatably supported in the housing. Thus, in a manner of speaking, the toothed ring can be made as a housing, which saves additional steps in the assembly.

[0019] Preferably, a rear wall facing a supply wall is provided with pressure pockets, which cooperate with a front face of the gear wheel. This ensures a pressure relief in the axial direction and prevents the gear wheel from rubbing on the rear wall with a too high pressure.

[0020] Preferably, the two fluid connections are arranged on different axial sides of the gear wheel. This is an additional opportunity of decoupling the fluid supply to the high-pressure side and the low-pressure side.

[0021] Preferably, the shaft extends to both axial sides of the gear wheel and the two fluid connections are led through the shaft. This embodiment is always recommended, when the machine is operated with stationary shaft.

[0022] In the following, the invention is explained in detail on the basis of a preferred embodiment in connection with the drawings, showing:

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a perspective view of a hydraulic pump of this invention with a section through the toothed ring;

[0024] FIG. 2 is the pump of FIG. 1 with a section through the gear wheel;

[0025] FIG. 3 is a perspective view of a rotary slide;

[0026] FIG. 4 is a front side view of the pump in FIG. 1

[0027] FIG. 5 is a perspective view of a half pump;

[0028] FIG. 6 is a front side view of a second embodiment of the invention; and

[0029] FIG. 7 is a longitudinal section through the hydraulic pump of FIG. 6.

[0030] The FIGS. 1 to 5 show a first embodiment of a hydraulic machine 1 with a toothed ring 2, having seven inner teeth 3, and being in the present case in the shape of a housing, and with a gear wheel 4, having six outer teeth and being eccentrically supported in relation to the gear ring. Openings 6 are provided in the toothed ring, through which openings bolts, which are not shown in detail, can be led to keep the toothed ring 2, a cover 21 and a rear wall 33 together in the axial direction.

[0031] The gear wheel 4 has an outer diameter, which has exactly the size of the distance between the peak of an inner tooth 3 of the gear ring 2 and the facing bottom of a tooth clearance. Otherwise, the outer teeth 5 of the gear wheel 4 and the inner teeth 3 of the toothed ring 2 are synchronised with each other in such a way that a movement of the gear wheel 4 in relation to the toothed ring 2, which is stationary, will provide a number of pressure pockets, which are closed in relation to each other by way of the contact areas between the toothed ring 2 and the gear wheel 4. These pressure pockets 7 expand on one "half" of the gear wheel 4 and reduce on the other half, while the gear wheel 4 rotates and orbits in the toothed ring. During one rotation of the gear wheel 4, the gear wheel 4 orbits six times (=the number of teeth on the gear wheel 4) in relation to the toothed ring.

[0032] In order to ensure the correct position of the connection of the pressure pockets 7 with a high-pressure connection P and a low-pressure connection T, a valve arrangement 8 is provided inside the gear wheel 4. The valve arrangement 8 has a rotary slide 9, shown in FIG. 3. As can be seen from FIG. 4, the rotary slide 9 is eccentrically supported in relation to the gear wheel 4. In fact, the rotary slide 9 is made as a cylinder, in which two grooves 10, 11 have been cut in such a way that their basal surface 12 is parallel to a tangent on the cylinder. Front walls 13, 14 remain on the cylinder, which, as can be seen from FIGS. 2 and 5, surround two pressure chambers, namely a high-pressure chamber 15 and a low-pressure chamber 16. Via a bore 17 in the first front wall 14, the high-pressure chamber 15 is connected with a recess 18 on the rotary slide 9, the recess forming, as shown in FIG. 1, a chamber 19 that is connected with the high-pressure connection P via a channel 20. The channel 20 and the high-pressure connection P as well as a low-pressure connection T are provided in the cover 21, which is unrotatably connected with the toothed ring 2. The supply to the chamber 19 occurs independently from the rotary position of the rotary slide 9 in relation to the cover 21, while on the front side of the rotary slide 9 an annular channel 22 is provided, which connects the channel 20 with the chamber 19 in any rotary position.

[0033] The rotary slide 9 has a front side finger 23, which is, as can be seen from FIG. 4, arranged eccentrically to the rotary slide 9 but centrically to the toothed ring 2. Of course, it is also possible to provide a finger on the cover 21 and a

corresponding bore in the rotary slide 9. Further, the rotary slide 9 is unrotatably connected, or preferably made in one piece with, an outward extending shaft 24, whose axis corresponds to the axis of the finger 23.

[0034] The low-pressure chamber 16 is connected with the low-pressure connection T through the finger 23. As can be seen from particularly FIG. 5, a radial bore 26 is provided between the low-pressure chamber 16 and a bore 25 penetrating the finger 23.

[0035] On the rotary slide two axially extending grooves 27, 28, facing each other, are provided between the high pressure chamber 15 and the low pressure chamber 16, in which grooves sealing faces 29, 30 are arranged, as can be seen from FIGS. 2 and 4, which bear on the inside of the wall of a cylinder bore 31, which is made in the gear wheel 4 and in which the rotary slide 9 is arranged. The sealing faces 29, 30 extend over the whole axial length of the rotary slide 9.

[0036] As can be seen from FIG. 4, the sealing faces 29, 30 are arranged in the grooves 27, 28 with a substantial play, so that they are pressed from the high pressure side (in FIG. 4 to the right) to the low pressure side (in FIG. 4 to the left). Hydraulic fluid can then also get under the sealing faces 29, 30 and press them radially outwards against the wall of the cylinder bore 31. Thus, the inner chamber of the gear wheel 4, that is the cylinder bore 31, is divided into two halves, namely a high-pressure side and a low-pressure side.

[0037] As can be seen from FIGS. 1, 4 and 5, the gear wheel 4 has in its tooth clearances, or more precisely in its deepest spots, radial bores 32, which penetrate the gear wheel 4 completely in the radial direction, that is, create a connection between the pressure pockets 7 and the cylinder bore 31. On the side of the toothed ring 2 facing the cover 21, the housing has a rear wall 33, in which pressure pockets 34 are provided, which cooperate with the gear wheel 4 to cause an axial pressure release between the rear wall 33 and the gear wheel 4.

[0038] The pump 1 works as follows: The shaft 24 is rotated by a drive, not shown in detail, and thus causes the rotary slide 9 to perform a corresponding rotation. The rotary slide 9 rotates in the gear wheel 4. As, in this connection the rotary slide 9 moves eccentrically around the axis of the finger 23, the gear wheel 4 with its outer teeth 5 is pressed into the tooth clearances between the inner teeth 3 of the toothed ring. The gear wheel 4 orbits in relation to the toothed ring 2 with the rotary speed of the rotary slide 9, and rotates with a speed in relation to the toothed ring 2, which corresponds to the orbit speed divided by n, n being the number of outer teeth 5 of the gear wheel. During the movement of the gear wheel 4 in relation to the toothed ring, the pressure pockets 7 on one half of the gear wheel 4 are reduced. Through the channels 32, these pressure pockets supply their fluid into the cylinder bore 31, exactly on the half, on which the high pressure chamber 15 is arranged in the rotary slide 9. This allocation is maintained, as the rotary slide 9 moves with the orbit speed of the gear wheel 4 in relation to the toothed ring 2. In relation to the rotary speed of the gear wheel 4, the rotary speed of the rotary slide 9 is thus geared up by the factor n mentioned above. This permits an accurate commutation, as the opening and closing of the individual channels 32 into the pressure chambers occur faster. Further, with less effort, an improved allocation is maintained.

[0039] Vice versa, the channels 31 at the pressure pockets 7, which are expanding, are connected with the low-pressure chamber 16. As, actually, the channels 32 form the only connection, through which the fluid must travel between the high pressure chamber or the low pressure chamber and the pressure pockets 7, flow losses in this area are kept small and the efficiency of the machine 1 increases additionally.

[0040] The FIGS. 6 and 7 show a modified embodiment, in which the same parts have the same reference numbers. The difference is mainly obvious from FIG. 7. Here, it can be seen that the two supply connections are no longer arranged on the same axial side of the gear wheel 4, but on axially opposite sides. Also the shaft 24 is led out to two sides in relation to the gear wheel 4. When, as shown by dotted lines, the supply connections P', T' are moved to the shaft 24, the machine 1' can preferably be used with stationary shaft 24.

I claim:

1. A hydraulic pump, comprising,

a housing means,

an inner toothed ring within the housing,

an outer toothed wheel eccentrically rotatably and orbitally mounted within the inner toothed ring and having upon being energized a rotational speed and an orbital speed within the inner toothed ring, with pressure pocket spaces appearing between the teeth of the ring and wheel,

a hydraulic valve plate having an open center adjacent the means for providing fluid under pressure into a first group of pressure pocket spaces for flow outwardly of the housing through a second group of pressure pocket spaces to cause the wheel to rotate in a first direction, and

a shaft operatively connected to the wheel.

2. A pump according to claim 1, wherein the spaces of the gear wheel have channels, which are connected with the valve.

3. A pump according to claim 2, wherein the valve divides an inner chamber of the gear wheel into two pressure chambers, namely, a high pressure chamber and a low pressure chamber.

4. A pump according to claim 1, wherein the valve has a rotary slide, which rotates with the orbit speed of the gear wheel.

5. A pump according to claim 4, wherein the rotary slide valve is driven directly by the gear wheel.

6. A pump according to claim, wherein the rotary slide valve is arranged centrally in the gear wheel and has an eccentric spigot joint with the toothed ring, said joint being arranged centrally in relation to the toothed ring.

7. A pump according to claim 4, characterised in that sealing faces are arranged on the rotary slide between the high pressure chamber and the low pressure chamber, the sealing faces bearing on the inside of the gear wheel.

8. The pump according to claim 7, wherein the sealing faces are supported in the circumferential direction with a significant play in relation to the rotary slide valve.

9. The pump according to claim 4, characterised in that the high pressure chamber and the low pressure chamber are in the shape of grooves, with the bottom of these grooves extending in parallel to a tangent on the rotary slide.

10. The pump according to claim 4, wherein one of the two pressure chambers is connected with a recess on one front side of the rotary slide, said recess being connected with a fluid connection via an annular channel.

11. The pump according to claim 10, wherein the other pressure chamber is connected with another fluid connection through the spigot joint.

12. The pump according to claim 4, characterised in that the rotary slide valve is connected to a shaft extending to the outside of the housing.

13. The pump according to claim 1, wherein the toothed ring is not rotatably supported in the housing.

14. The pump according to claim 1, wherein a rear wall is provided with pressure pockets, which cooperate with a front face of the gear wheel.

15. The pump according to claim 1, wherein the two fluid connections are arranged on different axial sides of the gear wheel.

16. The pump according to claim 15, wherein the shaft extends to axial sides of the gear wheel and the two fluid connections extend through the shaft.

17. The pump according to claim 1 wherein the means for providing fluid under pressure causes the rotary slide valve to rotate in a direction opposite to the direction of rotation of the wheel.

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