A displacement pump with variable volume flow having a casing; a chamber with an inlet opening on a low pressure side and an outlet opening on a high pressure side for a fluid; an internal rotor capable of rotation about a rotational axis (D₀); a ring having a central ring axis (Dₙ) surrounding the internal rotor and forming together with the ring, at least one delivery cell in which fluid is delivered from a low pressure side to a high pressure side of the pump; and an adjusting device which, during an adjusting movement, rolls off on the casing without slipping is provided. The internal rotor is fixed to the adjusting device and rotatable about the rotational axis (D₀), and the position of the rotational axis (Dₙ) relative to the central ring axis (Dₙ) of the ring is adjusted by the adjusting movement of the adjusting device.
DISPLACEMENT PUMP WITH VARIABLE VOLUME FLOW

FIELD OF THE INVENTION

[0001] The invention relates to displacement pumps, in particular internal-axle gear pumps, but also wing cell pumps or for example also pendulum slider pumps, whose volume flow can be varied according to requirement, i.e. can be adjusted. The pumps in accordance with the invention are preferably used as lubricant oil pumps for internal combustion engines, wherein the internal combustion engine itself preferably drives the lubricant oil pump in question. The internal combustion engine can in particular be a drive motor, preferably a piston motor, of a vehicle. The specific volume flow, i.e. the volume flow delivered per revolution of a delivery wheel of the pump, can preferably be adjusted continuously. The displacement pumps can also be advantageously used as supply pumps for automatic transmissions in vehicles and when used in this way are also preferably driven by the drive motor of the vehicle in question. Although the displacement pump of the invention, which can be adjusted according to requirement, is suitable in particular for such applications, in which with increasing drive speed, the fluid requirement increasingly falls short of the delivery volume of pumps whose specific delivery volume is constant, a pump in accordance with the invention can also be advantageously employed in other situations, in which for example the drive speed of the pump is constant and the fluid requirement of the aggregate to be supplied fluctuates for other reasons.

BACKGROUND OF THE INVENTION

[0002] Displacement pumps formed as gear ring pumps, such as the invention also relates to in particular, are known from DE 297 03 369 U1 and EP0 846 861 B1 which is based on it.

[0003] In the known variable pumps, the external rotor of the gear ring running set is rotatably mounted in a variable ring which surrounds the external rotor and rolls off without slipping in the pump casing via an internal-external toothing, such that in accordance with these kinematic ratios, the eccentric axis of the gear ring running set rotates by up to 90° relative to the casing during the varying process. This enables a delivery amount to be varied from a maximum to almost zero, with as small an adjusting path as possible.

[0004] However, it has proven in practice that the design space available in increasingly compact reciprocating piston motors is becoming smaller and smaller. Since these pumps are preferably arranged in the oil sump of the crankcases and since a mass-balance shaft often also has to be additionally accommodated in this region, together with other influencing factors such as conductor frame fortification of the crankcase and a highly pitched oil pan for ground clearance and the arrangement of the vehicle steering parts, the outer diameter of the variable pump is too large. Since, due to the heated idling at low motor speed, the pump has to exhibit a specific minimum delivery amount, the diameter of the gear ring running set cannot be arbitrarily reduced. Limits are also set on enlarging the running set width, for reasons of space and due to the suction limits of the teeth. Wide running sets have the additional disadvantage that during speed regulation, the overthrust losses between the converging and diverging teeth cells caused by differential varying are very high.

SUMMARY OF THE INVENTION

[0005] It is therefore an object of the invention to provide a displacement pump which exhibits smaller dimensions, with respect to both the diameter and width of the running set, for the same specific delivery amount.

[0006] The displacement pump with variable volume flow in accordance with the invention comprises a casing and a chamber which is formed in the casing and comprises an inlet opening on a low pressure side and an outlet opening on a high pressure side for a fluid. The pump can for example be an internal gear pump, a wing cell pump or a pendulum slider pump. The pump further comprises an internal rotor which is accommodated in the chamber and can be rotated about a rotational axis, and a ring which is accommodated in the chamber and has a central ring axis which surrounds the internal rotor. In the case of rotary driving at least one of the internal rotor and the ring, the ring and the internal rotor form at least one delivery cell in which the fluid is delivered from the low pressure side to the high pressure side. An adjusting device is arranged such that during an adjusting movement, it rolls off on the casing without slipping. In accordance with the invention, the internal rotor is fixed to the adjusting device such that it can be rotated about the rotational axis. Furthermore, the position of the rotational axis relative to the ring axis of the ring can be adjusted by the adjusting movement of the adjusting device.

[0007] By adjusting the internal rotor relative to the casing and the surrounding ring in order to adjust the specific volume flow, sealing the delivery space formed between the internal rotor and the outer ring can be simplified.

[0008] If the pump is a gear ring pump, then the outer ring forms an external rotor. In such embodiments, driving the gear ring running set formed by the internal rotor and the external rotor via the external rotor is facilitated. As compared to rotary driving via the internal rotor, the pump speed in the case of rotary driving via the external rotor is advantageously increased in accordance with the ratio of the numbers of teeth of the internal rotor and the external rotor, hence the diameter of the pump can be reduced. The outer ring is also a rotor in a pendulum slider pump, such as is for example described in FR 980766. In a wing cell pump, the outer ring can be fixed relative to the casing, or the casing itself can form the internal cylindrical surface for a wing wheel forming the internal rotor.

[0009] It is advantageous if an adjusting device which adjusts the specific volume flow does not surround the internal rotor and the outer ring but is arranged axially adjacent to them. It is particularly advantageous if arranging the adjusting device adjacent to the internal rotor and/or the outer ring is combined with adjusting the specific volume flow by adjusting the internal rotor. The adjusting device preferably rotationally mounts the internal rotor such that it slaves the internal rotor during its own adjusting movement by being fixedly connected to the internal rotor with respect to the adjusting movement. The adjusting device can for example comprise a toothing which is in toothed engagement with a toothing of the casing during an adjusting movement. The toothing of the adjusting device is preferably a round-flank toothing. A centre point of a flank circle of a tooth of the toothing of the adjusting device can for example approximately describe a hypocycloid when rolling off on the casing.
By omitting the variable ring around the external rotor and by increasing the speed of the internal rotor in proportion to the numbers of teeth from the external rotor to the internal rotor as compared to the drive speed, the design space of the variable pump required is reduced superproportionally, for the same specific delivery amount.

Such a variable pump in accordance with the invention is thus also suitable for small-volume internal combustion engines, in which particular value is placed on reducing the hydrostatic losses and the circulated amount of oil at high speeds.

The compactness of a variable displacement pump in accordance with the invention can hardly be surpassed. Since the shaft bearings are rid of any hydrostatic load, and are only then loaded by the traction rod of a continuously variable transmission such as is preferably used for driving, the diameter of the shaft can be reduced. The smaller effective running set width also improves the suction capacity and reduces the danger of cavitation. The volumetric efficiency is also improved due to the augmented high-speed running. This is also due to the fact that the pinion engagement between the external rotor and the internal rotor then trails at the point of maximum toothed engagement, such that the pressure side of the toothing is sealed better than the suction side.

In accordance with preferred embodiments, the adjusting device adjusts hydraulically by being charged with a fluid pressure which is fed back from the high pressure side of the pump to the adjusting device. The high pressure side of the pump reaches from the high pressure side of the pump chamber to the point or points of the aggregate or number of aggregates to be supplied, from which the fluid, relieved of pressure, is fed back to a fluid reservoir. It can also be advantageous to tap the fluid pressure of the high pressure side of the pump at a location outside the displacement pump and to charge the adjusting device with the pressure in order to vary the volume flow. The pressure can for example be tapped at a crankshaft main gallery of the motor.

In a preferred embodiment, the fluid pressure acting in the pump chamber on the high pressure side, in combination with the fluid pressure fed back to the adjusting device, generates the adjusting force for adjusting. The adjusting force can for example be formed from at least one of the two hydraulic adjusting forces which act on the adjusting device and/or internal rotor. In particular, the adjusting device can be adjusted by an adjusting force against the force of an elastic component. The two adjusting forces are advantageously superimposed positively on each other, preferably by generating adjusting moments in the same direction. In this way, it is possible to achieve a varying which reacts particularly sensitively to changes in pressure. The invention thus also relates to a displacement pump with variable volume flow, comprising the features of the preamble of at least one of the independent claims in combination with feeding the fluid pressure back to the adjusting device and charging the adjusting device with the fluid pressure fed back, in a direction such that the adjusting force thus generated is superimposed positively on an adjusting force generated by the fluid pressure of the high pressure side of the pump chamber acting on one of the internal rotor and the outer ring, the sum of the two forces being greater than each of the two individual forces.

For the adjustability of the variable pump, such an embodiment gives rise to the advantage that the hydraulic adjusting forces of the internal rotor are added, over its bearing journal on the one hand and those between the adjusting device—preferably formed as an adjusting plate—and the casing, and not subtracted as with the known displacement pump. This advantage is very important, particularly for cold starts in which a quick adjustment to a zero delivery amount is necessary in order to prevent damage to the oil filter and oil cooler. Up until now, it has been necessary here to provide an additional pressure control valve due to the inertia of the adjustment to zero.

Although positively superimposing the two hydraulic adjusting forces is particularly advantageous in its own right alone, this embodiment is preferably combined with adjusting the internal rotor or arranging the adjusting device axially adjacent to the internal rotor and/or the outer ring, and particularly preferably combined with both these features.

Due to the machinability of the internal toothing in the casing for the adjusting transmission, the number of teeth here cannot be selected to be arbitrarily large. A round-flank toothing is most suitable on the adjusting plate, such that the internal toothing in the casing—which preferably comprises one tooth more than the external toothing of the adjusting plate—can be machined using a rotating cutting tool (drill rod), as is known from the known variable pump comprising a variable ring in FIG. 10 of EP 0 846 861 B1. The centre point of the flank circle of the tooth on the adjusting plate describes a hypocycloid when rolling off in the casing, although in practice the hypocycloid is not entirely free of overlap. A radial elevation stroke therefore arises during rolling off, such that the eccentricity of the variable plate in the casing therefore fluctuates. The magnitude and/or the rotational angular position of an eccentricity between the rotational axis of the internal rotor and the central ring axis of the ring can for example be adjusted by the adjusting movement. A fluctuation in the eccentricity can, however, be undesirable in the pump running set, since it leads to noise and wear on the pump toothing. Guiding cylinders or cylinder segments which roll off on each other are therefore preferably provided on the adjusting plate and on the casing (in the drawings, on the pump casing in this case), having diameters whose difference is equal to twice the eccentricity of the pump running set. Therefore, the adjusting plate does not roll off in the coarse systematic toothing but on the two exactly machined circular cylinders. The difference in the diameters of these guiding cylinders is equal to 2e with respect to the variable plate and the casing, where e signifies the eccentricity of the pump delivery set, preferably of the pump running set, and of the toothings between the variable plate and the casing. Thus, a radial elevation stroke while rolling the variable plate off in the casing, and thus a fluctuation in the eccentricity of the pump delivery set during the varying process, is avoided. In particular, the magnitude of the eccentricity can be constant.

No eccentric chucks are required for machining the casing parts, since the shaft and external rotor bearings are concentric. The depth of the internal toothing of the casing is minimised and no longer has to be machined over the entire running set width, as with the known design. This toothing can be high-precision manufactured on a CNC machine with a C axis and path-controlled HSC (high speed
cutting) spindle unit in a clamp together with the other machining operations. This results in a considerable reduction in the expenditure of time for machining the toothing of the casing.

[0019] The subject of the invention is shown in the drawings by way of the example of a variable internal gear pump, arranged in the oil sump, for a four-cylinder passenger car engine. This does not, however, mean that the invention is restricted to such an application. It could also, for example, be used in an automatic transmission as an oil pressure pump for switching and for supplying the transmission parts with oil. The variable pump would then be positioned at the end of a continuous transmission input shaft, such that in this case, the chain wheel shown in the drawings is omitted, and instead the pump shaft is coupled, concentrically and rotationally fixed, to the transmission input shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Example embodiments of the invention are explained below on the basis of figures. Features disclosed by the example embodiments, each individually and in any combination of features, advantageously develop the subjects of the claims and also the embodiments described above.

[0021] Specifically, there is shown:

[0022] FIG. 1 an axial section in accordance with the gradient A-A in FIG. 2;

[0023] FIG. 2 a longitudinal section in accordance with the intersection line E-E in FIG. 1;

[0024] FIG. 3 a longitudinal section in accordance with the intersection line B-B in FIG. 1;

[0025] FIG. 4 a view of the variable plate, the variable spring and the pump running set in the pump casing, with the cover (30) removed, in the position in which the pump exhibits its maximum possible delivery amount;

[0026] FIG. 5 the same view as in FIG. 4, but in the position in which the pump exhibits its minimum possible delivery amount;

[0027] FIG. 6 a longitudinal section through the pump along the intersection line D-D in FIG. 5; and

[0028] FIGS. 7 and 8 an illustrative representation of the variable plate 13 together with its rolling off cylinder 25.

DETAILED DESCRIPTION OF THE INVENTION

[0029] For explaining the function in the individual figures, the rotational direction of the running set shall be in the indicated direction of the arrow 32, such that the respective suction and pressure side in accordance with the expanding and compressing delivery cells of the teeth is clearly provided. In the cover 30, the suction support 31 is arranged on the suction side of the running set, on which side the variable spring 28 can also be seen. Thus, the spaces of the variable spring 28 and the rolling cylinders 24 and 25, and the sections of the toothing shown on the right of the image in FIGS. 4, 5, 6 and 7 between the variable plate 13 and the casing 1 are under suction pressure, since the variable plate 13 is fitted in between the cavern base 33 of the casing and the casing-cover partition line, forming an axial seal but able to move. The pressure space 35, which is hydraulically connected to the compressing delivery cells of the gear ring running set with the minimum possible choke (not shown in the drawings), is thus sufficiently sealed against excessively high volumetric losses with respect to the suction side. The delivery cells of the gear ring running set are also sealed against each other by a minimum axial clearance between the variable plate 13 and the slaving disc 26, such that here too, a clear hydraulic partition between the high pressure side and the suction side is provided. FIGS. 1 and 4 show the centre point of the internal rotor in a position in which the pump exhibits its largest possible delivery amount, since the eccentric axis E-E (in FIG. 1) of the running set toothing coincides with the axis of symmetry of the suction and pressure modules in the casing and in the adjusting plate 13. This position is always needed at low pump speeds, if the oil viscosity is relatively low, i.e. when the motor is hot and in particular during heated idling, in order that the oil consumers of the motor are supplied with a sufficient amount of oil at a sufficient oil pressure. The minimum pressure in the pressure chamber 35 should not drop substantially below 1 bar, even when bearing clearances of the motor parts have been enlarged by wear. This maximum position is ensured by an exactly calculated bias on the variable spring which holds the adjusting plate 13 fixed on a stopper 36. The velocity pole for the rotational movement of the variable plate thus lies at M1 in FIG. 4.

[0030] As the viscosity of the oil increases (e.g. during cold starts) or as the speed of the pump increases, the system pressure in the pressure chamber 35 in the compressing delivery cells of the gear ring running set increases. A sum of adjusting moments arises around the velocity pole via the radial acting surfaces on the internal rotor 4 and on the adjusting plate 13, such that the variable spring 28 is no longer capable of holding the adjusting plate 13 on the stopper 36. The variable system thus enters a poise which is determined by the moment equilibrium between the sum of the hydraulic adjusting moments and the moment of the variable spring 28 about the velocity pole M1. As the system pressure in the pressure chamber 35 increases, the adjusting plate 13 rotates clockwise in accordance with the representation in FIG. 4, wherein the velocity pole M1 migrates on the reference circle of the toothing of the casing towards the position M2 in FIG. 5. Simultaneously, the centre point D1 of the internal rotor 4 moves anti-clockwise out of the position P1 on its hollow shaft 16, around the shaft centre point DA on an orbit having the radius e, towards the position P2 in FIG. 5. Given the numbers of teeth of the adjusting plate 13 and of the casing 1 provided (10:11 in the drawings), the angular rotation of the internal rotor centre point and thus of the eccentricity axis of the gear ring running set anti-clockwise is ten times greater than the rotation of the adjusting plate 13 clockwise about its own axis. As can be seen from FIG. 5, a rotation of the adjusting plate 13 clockwise by just 9° generates a rotation of the eccentricity axis e of the gear ring running set anti-clockwise by 90°. In this 90° position in accordance with FIG. 5, the expanding and compressing delivery cells in the gear running set have thus also been rotated by 90° with respect to the casing and thus with respect to the reinfom suction and pressure modules, and even by 99° with respect to the adjusting plate 13. This means that a delivery amount of the pump is no longer possible. Within the suction and pressure
nodules, there then remains only an exchange of liquid between the converging and diverging tooth chambers.

The position P2, i.e. a rotation by 90° of the centre point Dₚ of the internal rotor 4 in accordance with FIG. 5, is of course never assumed during normal motor operation, since as the speed of the system as a whole increases, the motor bearings always have a finite oil requirement which, however, does not remotely increase in proportion to the speed, as opposed to the delivery amount of a non-variable pump. The oil requirement of the motor only increases roughly in proportion to the system pressure in the pressure chamber 35, adapted to the flow resistance of all the oil consumers, the viscosity of the oil and the degree of wear of the shaft bearings of the motor. The pose of the variable system of the adjusting pump in accordance with the invention is thus automatically set, such that the delivery amount of the pump exactly covers the oil requirement for the respective operational state of the system as a whole. The designer then has the option of adapting the adjusting pump to the motor by varying the bias and the slope of the spring characteristic. Thus, a new pump does not necessarily have to be designed for each engine size motor, as long as the range in size varies within certain limits.

As already mentioned in the introductory part of the description, it is expedient for the adjusting plate 13 not to roll off on the reference circles of the toothings between the adjusting plate 13 and the casing 1 but on two cylinder attachments, which roll off on each other, on the adjusting plate and the casing. The embodiment of the cylinder attachment on the adjusting plate is shown somewhat more clearly in FIGS. 7 and 8. The cylinder attachment 24 can also be seen on the left of the image in FIG. 3.

Latterly, attempts have been made to control the delivery amount of the pump in accordance with the oil pressure in front of the crankshaft bearings by providing one or more pressure sensors in the main gallery of the crankshaft which tap the oil pressure there and supply it to the pressure chamber 35 of the adjusting pump. In this case, the pressure chamber 35 would then have to be hydraulically partitioned from the main flow channel of the pressure side of the pump.

What is claimed:

1. A displacement pump with variable volume flow, comprising:
   a.) a casing;
   b.) a chamber defined by the casing and which comprises an inlet opening on a low pressure side and an outlet opening on a high pressure side for a fluid;
   c.) an internal rotor which is accommodated in the chamber and can be rotated about a rotational axis (Dₚ);
   d.) a ring which is accommodated in the chamber, has a central ring axis (Dₚ), surrounds the internal rotor and forms, together with the ring, in the case of rotary driving, at least one delivery cell in which the fluid is delivered from the low pressure side to the high pressure side; and
   e.) an adjusting device which, during an adjusting movement, rolls off on the casing without slipping, wherein

   i.) the internal rotor is fixed to the adjusting device such that it can be rotated about the rotational axis (Dₚ), and wherein
   ii.) the position of the rotational axis (Dₚ) relative to the central ring axis (Dₚ) of the ring is adjusted by the adjusting movement of the adjusting device.

2. The displacement pump as set forth in claim 1, wherein the adjusting device comprises a toothing which is in toothed engagement with a toothing of the casing during the adjusting movement.

3. The displacement pump as set forth in claim 2, wherein the toothing of the adjusting device is a round-flank toothing.

4. The displacement pump as set forth in claim 2, wherein a centre point of a flank circle of a tooth of the adjusting device toothing approximately describes a hypocycloid when rolling off on the casing.

5. The displacement pump as set forth in claim 1, wherein the adjusting device is an adjusting plate.

6. The displacement pump as set forth in claim 1, wherein the adjusting device is arranged axially adjacent to the internal rotor.

7. The displacement pump as set forth in claim 1, wherein the adjusting device forms sealing stays to hydraulically partition the high pressure side from the low pressure side.

8. The displacement pump as set forth in claim 5, wherein during the adjusting movement, cylindrical surfaces which roll off on each other are formed on the adjusting plate and on the casing.

9. The displacement pump as set forth in claim 5, wherein a difference in the diameters of the casing and the adjusting plate, underlying the cylindrical surfaces, is twice an eccentricity (ε) between the rotational axis (Dₚ) of the internal rotor and the ring axis (Dₚ).

10. The displacement pump as set forth in claim 1, wherein at least one of a magnitude and a rotational angular position of an eccentricity (ε) between the rotational axis (Dₚ) of the internal rotor and the central ring axis (Dₚ) of the ring is adjusted by the adjusting movement.

11. The displacement pump as set forth in claim 10, wherein the magnitude of the eccentricity (ε) is constant.

12. The displacement pump as set forth in claim 1, wherein the adjusting device is adjusted by an adjusting force against the force of an elastic component.

13. The displacement pump as set forth in claim 12, wherein the adjusting force is formed from at least one of two hydraulic adjusting forces which act on the adjusting device and the internal rotor.

14. The displacement pump as set forth in claim 1 further comprising an elasticity plane spanned by the rotational axis (Dₚ) and the ring axis (Dₚ), wherein the elasticity plane is rotated about the ring axis (Dₚ) by a rotational angle which is a multiple of the rotational angle of the adjusting device arising as a result of rolling off.

15. The displacement pump as set forth in claim 1 further comprising an amount of fluid delivered by the displacement pump which increases roughly in proportion to a fluid pressure with which the adjusting device is charged.

16. The displacement pump as set forth in claim 1, wherein a pressure of the fluid of the high pressure side of the pump is tapped at a location outside the displacement pump and the adjusting device is charged with the pressure in order to vary the volume flow.
17. The displacement pump as set forth in claim 16, wherein the pressure is tapped at a crankshaft main gallery of a motor.

18. The displacement pump as set forth in claim 1, wherein the displacement pump is at least one of an internal gear pump, a pendulum slider pump, or a wing cell pump.

19. A displacement pump with variable volume flow, comprising:

a.) a pump casing;

b.) a rotary-driven ring which is mounted in the pump casing and comprises an internal toothing;

c.) a rotatably mounted internal rotor which meshes with the ring and comprises an internal toothing;

d.) a gear ring running set comprising the ring and the internal rotor, and having a difference in a number of teeth equal to at least one, wherein the teeth have a tooth shape with which a number of expanding and compressing delivery cells sealed against each other, arise by contact of tips of the teeth;

e.) inlet and outlet openings arranged in the casing adjacent the delivery cells which are partitioned from each other by sealing stays;

f.) wherein an angular position of an elasticity plane of the gear ring running set with respect to the casing is varied; and

g.) an adjusting device including at least one of a pitch circle or pitch circle segment which can be rolled off on at least one of a pitch circle or pitch circle segment of the casing without slipping, wherein

i.) the adjusting device is arranged on one side of the gear ring running set viewed axially, and

ii.) the internal rotor is fixed to the adjusting device such that it can be rotated about a rotational axis (D2).

20. The displacement pump as set forth in claim 19, wherein a difference between the adjusting device pitch circle diameter and the casing pitch circle diameter is equal to twice an eccentricity (e) of the gear ring running set.

21. The displacement pump as set forth in claim 19, wherein the inlet and outlet openings are provided in the adjusting device and are partitioned from each other by sealing stays which substantially overlap with the inlet and outlet openings arranged in the casing.

22. The displacement pump as set forth in claim 19, wherein the at least one pitch circles or pitch circle segments which roll off each other without slipping are formed by pitch circles of an adjusting transmission formed by at least one of a complete or partial internal transmission.

23. The displacement pump as set forth in claim 22, wherein the adjusting transmission has an eccentricity (e) which corresponds to an eccentricity between the ring and the internal rotor.

24. The displacement pump as set forth in claim 22, wherein an inner cylinder guide is provided on the casing and an outer cylinder guide is provided on the adjusting device and the outer cylinder guide rolls off on the inner cylinder guide during the adjusting movement.

25. The displacement pump as set forth in claim 24, wherein each cylinder guides have a constant radius of curvature, and a difference between two radii of the curvature is equal to an eccentricity (e) between the ring and the internal rotor.

26. The displacement pump as set forth in claim 19, further comprising an internal transmission formed by an external toothing of the adjusting device and an internal toothing of the casing, wherein the internal toothing of the casing comprises at least one of a partial toothing or one tooth more than the external toothing of the adjusting device, and wherein a difference in the number of teeth of at least the partial toothing is circumferential.

27. The displacement pump as set forth in claim 19, wherein the internal toothing in the casing is manufactured by a path-controlled HSC (high speed cutting) drill spindle.

28. The displacement pump as set forth in claim 1 further comprising a slaving disc shrunk onto a shaft forming a fixed rotational connection between a drive shaft of the pump and the ring, and wherein the slaving disc comprises an external toothing which is exactly fitted into the internal toothing of the ring, forming an axial and allowing axial movement.

29. The displacement pump as set forth in claim 1 further comprising a bearing journal of the internal rotor formed as a hollow shaft, wherein a size of the inner diameter of the hollow shaft is such that a drive shaft is connected rotationally fixedly to the ring and freely rotates in the hollow shaft despite the eccentric movement.

30. The displacement pump as set forth in claim 1 wherein a magnitude of the adjusting movement of the adjusting device is defined in accordance with the working pressure of the high pressure side of the pump by the characteristic of a variable spring.

31. The displacement pump as set forth in claim 30, wherein the variable spring is formed as a screw pressure spring having a line of application arranged at a distance from the moment pivots (M1, M2) of the adjusting device to generate the moment pivots (M1, M2).

32. The displacement pump as set forth in claim 1, wherein at least one of the internal rotor, the ring, and the adjusting device is manufactured in a powder metallurgical method.

33. The displacement pump as set forth in claim 28, wherein the slave disk is rotationally and axially fixed by a gear shaft spline.

34. The displacement pump as set forth in claim 19, wherein the difference in the number of teeth is exactly equal to one.