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Steiger

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[54] **HYDRAULIC PISTON MACHINE HAVING RADIALLY DISPOSED PISTONS**

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[30] **Foreign Application Priority Data**

June 21, 1971 Switzerland 9007/71

[52] **U.S. Cl.** **74/49**, 91/476

[51] **Int. Cl.** **F16h 21/18**

[58] **Field of Search** 91/476, 481; 417/500; 74/49, 55

[56] **References Cited**

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Assistant Examiner—Wesley S. Ratliff, Jr.
Attorney—Hugh A. Chapin et al.

[57] **ABSTRACT**

The block on which the radially disposed pistons bear is guided to rotate about the axis of the cam without rotating about its own axis in order to allow the hydrostatic pockets in the bottom of the pistons to be centrally located relative to the pistons. This avoids tilting of the pistons in their respective cylinders during a stroke.

6 Claims, 5 Drawing Figures

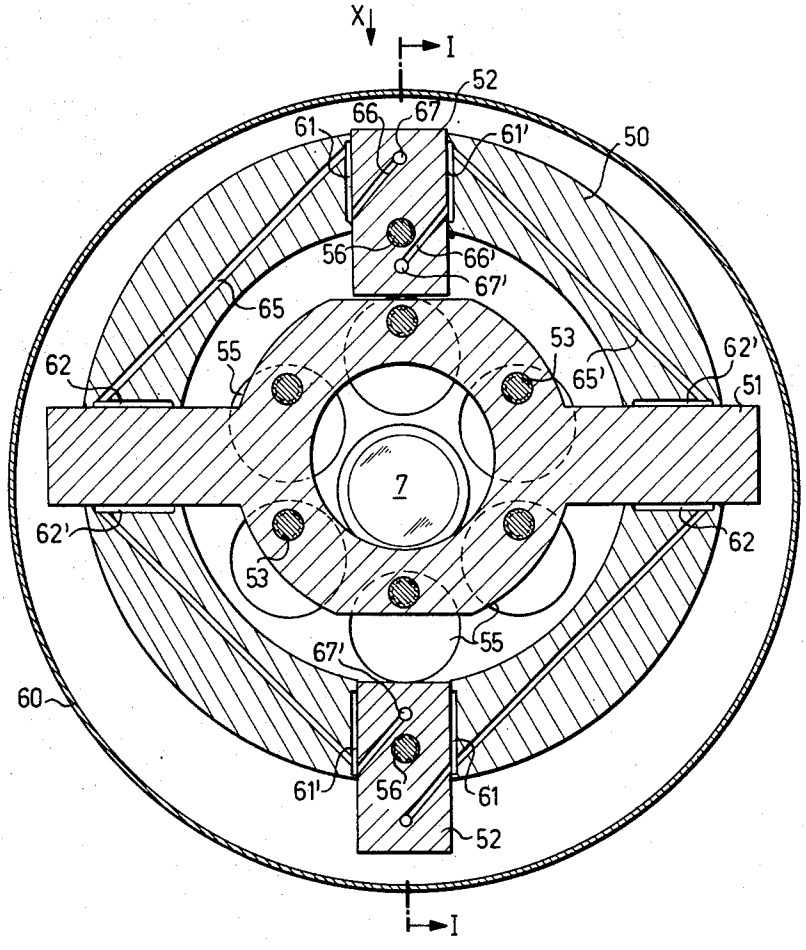

Fig.1

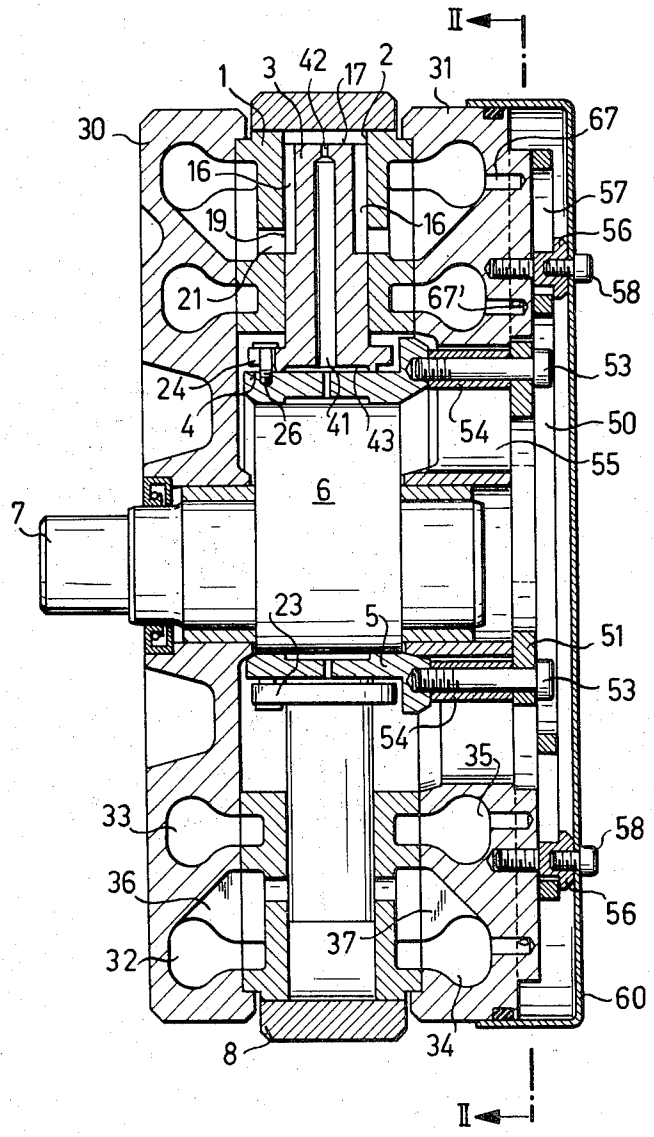
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Fig.2

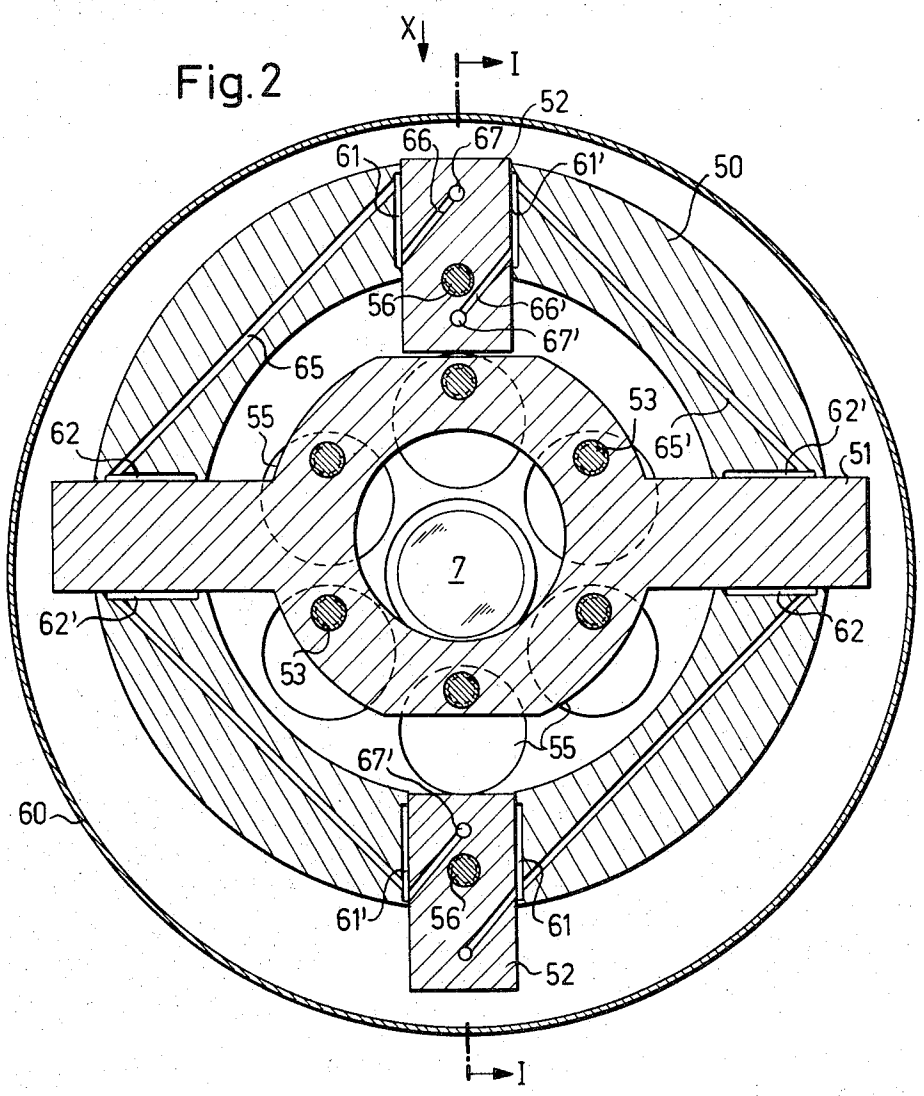
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Fig.3

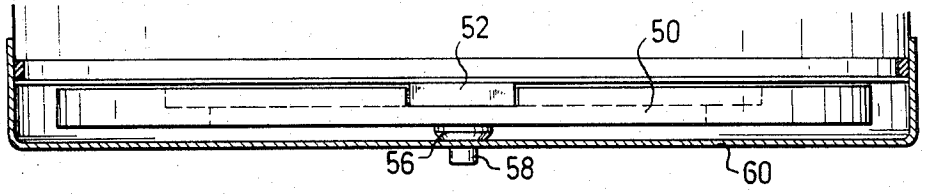
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Fig. 4

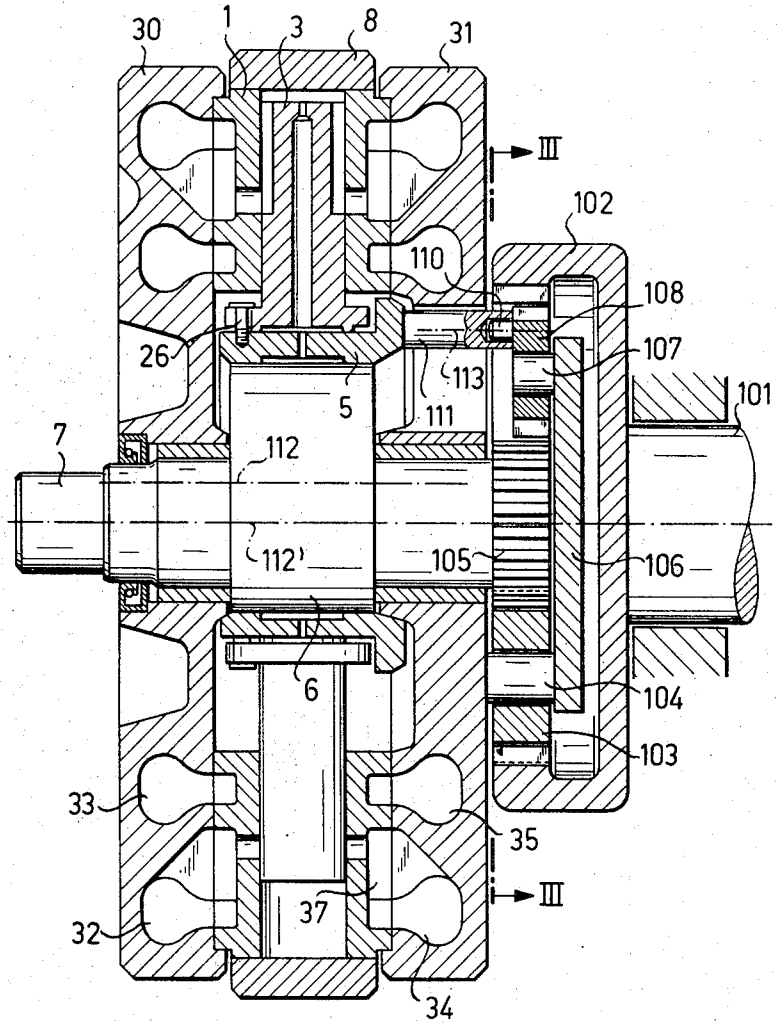
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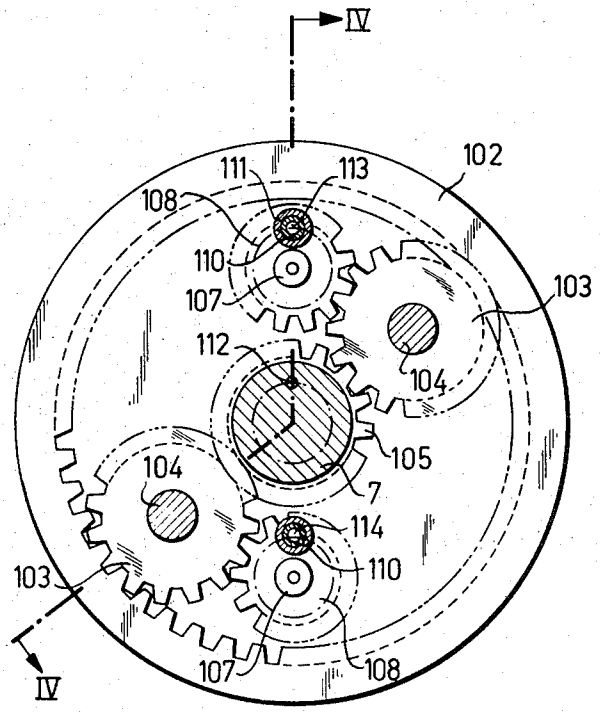
Fig.5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HYDRAULIC PISTON MACHINE HAVING RADIALLY DISPOSED PISTONS

This invention relates to a hydraulic piston machine having radially disposed pistons.

Hydraulic piston machines have been known in which pistons are arranged radially and are provided with flat bearing surfaces transverse to their axes. Generally, the pistons have been reciprocated by means of an eccentric via a central block which has flat supporting surfaces cooperating with the bearing surfaces of the pistons. In addition, the bearing surfaces have been provided with pockets for a hydrostatic bearing arrangement. For example, a piston machine of this type has been described in copending U.S. patent applications Ser. No. 172,091 filed Aug. 16, 1971, now abandoned and Ser. No. 184,159 filed Sept. 27, 1971. This machine affords a compact construction which is robust and simple while at the same time providing for hydrostatic lubrication of the various machine parts in order to minimize friction and wear.

The present invention is a further development of the piston machine according to the above two patent applications and is directed to an improvement in the hydrostatic lubrication of a piston machine of this kind. In accordance with this invention, a construction is obtained in which metal-to-metal contact of the parts and unsymmetric piston load of the machine outside its axis are avoided.

According to this invention, the piston machine is characterized by the fact that the central block is connected with a guide means which allows the block to move around the axis of the eccentric but prevents the block from revolving around its own axis.

As the guide means prevents a rotary motion of the block, the pockets for the hydrostatic bearings can be arranged centrally in each piston. Each piston is consequently loaded by a force which passes through its axis without producing any tilting or bending movements, so that, practically, only insignificant guide forces result between the piston and the wall of the associated cylinder.

The guide means formed of two moving parts which are mounted in perpendicular relation to the eccentric axis. One part is movably mounted on a casing of the machine so as to be guided in a plane, such as a vertical plane, perpendicular to the eccentric axis while the second part is guided in the first part at a right angle to this plane, i.e., in a horizontal plane, and is fixedly secured to the block. Thus, as the eccentric is rotated, the central block is disposed relative to the axis of the eccentric shaft to cause reciprocation of the pistons while at the same time being restrained from revolving about its own axis.

The guide means can be preferably located on an end face of the piston machine and dimensioned so that the external dimensions are essentially the same as those of the machine. A construction will consequently result which is supported on a large diameter on the periphery of the machine with corresponding small forces being produced as a result.

Preferably, it is further possible to provide the mutually supporting areas of the parts of the guide means with pockets for a hydrostatic bearing. These pockets are connected via connection bores with a duct of the machine for the pressure medium, the duct being under pressure at a corresponding direction of rotation. In this way, the guide means can also be lubricated hydrostatically so that friction and wear therein are minimized.

In another embodiment, the guide means is formed with at least one crank located outside the eccentric axis and frictionally connected with the eccentric shaft. The crank, which is connected with the block, carries out a rotary motion of the same phase and same eccentricity as the eccentric. A construction of this kind is especially advantageous is cases where the piston machine must be provided with an output gearing.

This guide means preferably contains two gear wheels connected with the eccentric shaft and diametrically disposed to its axis. Each of these gear wheels has a crank with the arms of both cranks pointing in the same direction. The cranks are also connected pivotally with the block. With a construction of this kind, optimum guidance of the block with minimum play is obtained.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a view taken on line I—I of FIG. 2 of a piston machine utilizing a guide means according to the invention;

FIG. 2 illustrates a view taken on line II—II of FIG. 1;

FIG. 3 illustrates a part section with a partial view of the machine shown in FIGS. 1 and 2 as viewed in the direction of the arrow X in FIG. 2;

FIG. 4 illustrates a view taken on line IV—IV of FIG. 5 of a modified guide means according to the invention; and

FIG. 5 illustrates a view taken on line V—V of FIG. 4.

Referring to FIG. 1, the piston machine comprises a ring-shaped cylinder block 1 containing cylinder bores 2 arranged radially of the axis of the block 1. The cylinder bores 2 serve to guide pistons 3 therein which are each supported on flat surfaces 4 of a block 5. The block 5 is mounted on an eccentric 6 of an eccentric shaft 7, or may be supported on a crankpin formed on a crankshaft (not shown). In addition, the cylinder bores 2 are closed by cylinder covers 8.

Each piston 3 is provided with grooves 16 running in an axial direction of the piston 3. These grooves 16 lead from the front surface of each piston 3 to communicate with the cylinder chamber of the cylinder bore 2 and end in an intermediate area of the piston length. The grooves 16 are positioned for cooperation with control ports 19 situated in the periphery of each cylinder bore 2 on either side of each groove 16. The ports 19 are formed by the mouth of ducts 21 serving to supply and discharge pressure medium, respectively. A hydrostatic lubrication pocket 43, communicating via bores 41, 42 with the cylinder chamber above the piston 3, is formed at the bottom end of the piston 3.

The bottom ends of the pistons 3 are also provided with flange-like projections 23 on one side to form a lever arm 24 which contains a guide slot. This slot guides a stud 26 which is fixed to the block 5. A guide shoe (not shown) may also be arranged between the stud 26 and the guide slot. Thus, as the block 5 is caused to move via the cam 6, the block 5 causes the pistons 3 to oscillate via the studs 26 and lever arms 24.

Lateral covers 30, 31 containing annular ducts 32, 33, 34 and 35 are fixed on either side of the cylinder block 1. One pair of ducts on each side of the cylinder block 1, e.g., ducts 32 and 34, is always connected with the control ports 19. These ducts 32, 34 serve to discharge the pressure medium, while the other pair, i.e., ducts 33 and 35 serves to supply the pressure medium through the control ports (not shown) situated close to the control ports 19. The annular ducts are connected with the associated control ports by means of pockets 36, 37.

Since the construction of this part of the piston machine does not constitute the subject matter of the present invention, a further description thereof can be omitted. In this connection, however, reference is made to the above-mentioned two patent applications in which the structure and function of this part of the piston machine is fully described and the disclosures of such applications are hereby incorporated herein.

According to the present invention, the piston machine illustrated in FIGS. 1 to 3, is provided with a guide means containing two parts 50 and 51 which are movable perpendicularly to each other within a plane transverse to the axis of the eccentric 6. As shown in FIG. 2, part 50 is guided in a vertical direction on two projections 52 which are formed on cover 31. For this purpose, part 50 is provided with corresponding gooves and as shown in FIG. 3, encloses the projections 52 so as to slide thereon.

Part 50 is also provided laterally with grooves in which arms of part 51 are movable horizontally. Part 51 contains a ring-shaped area in the middle which is connected with the block 5 by means of bolts 53. As can be seen in FIG. 1, bushings 54 are located between part 51 and block 5 to enclose the bolts 53. This results in a rigid connection of part 51 with block 5. The bushings 54, which carry out a rotary motion together with the block 5, are located in recesses 55 of the lateral cover 31 which allow this motion.

Part 50 is held in an axial direction by means of threaded bolts 56 with flat heads screwed into the projections 52. The threaded bolts 56 pass through slots 57 in part 50, so that the heads of the threaded bolts 56 prevent the part 50 from being separated from cover 31. In addition, bolts 58 are screwed into the threaded bolts 56 to secure an end cap 60 over the guide parts 50, 51.

As can be seen in FIG. 2, part 50 can move along the projections 52 in a vertical direction. On the other hand, part 51 moves in part 50 in a horizontal direction. Both movements combined allow a rotary motion of part 51 and consequently also a rotary motion of the block 5 which encloses the eccentric 6 of the eccentric shaft 7. The rotary motion of the block 5, i.e., the rotation of the axis of the block 5 about the axis of the eccentric shaft 7, guided by the guide means, allows each hydrostatic pocket 43 to be located centrally, i.e., axially, on a piston 3. As a result, tilting moments on the piston 3 due to hydrostatic pressure are avoided. At the same time, the block 5 is prevented from revolving around its axis, which would otherwise occur except for the guide means with parts 50 and 51.

Referring to FIG. 2, part 50 is provided with hydrostatic lubrication pockets 61, 62 in the sliding surfaces as well as with symmetrically formed lubrication pockets 61' and 62'. The lubrication pockets 61 and 62 are connected by means of bores 65 and 66 in the part 50 and projections 52 with a connection bore 67 in the projections 52 which lead into the duct 34 of the cover 31. Lubrication pockets 61' and 62' communicate via bores 65' 66' with connection bores 67' which lead into the duct 35 of the cover 31. Depending on the direction of rotation of the piston machine, the respective loaded lubrication pockets are connected in this manner with the duct of the cover 31 which is under pressure. Hydrostatic lubrication of the guide means is consequently obtained, and friction and wear are thus reduced to a minimum.

Referring to FIG. 1, the guide means with parts 50 and 51 is located on the end face of the piston machine. On account of this, the guide means can be dimensioned so that the external dimensions are essentially the same as those of the machine. As a result of this, the bearing surfaces cooperating with the pockets 61 and 62 lie radially on a great radius. This results in a corresponding reduction of the bearing forces and consequently allows the block 5 to be guided accurately.

Referring to FIGS. 4 and 5, wherein like reference characters as above indicate like parts, the hydraulic piston machine can alternatively be provided with a guide means which uses a reduction gearing having a gear wheel 102 with internal teeth mounted on a shaft 101. In this case, the gear wheel 102 meshes with two gear wheels 103 which are pivoted on pins 104 fixed in the lateral cover 31. The gear wheels 103 also mesh with toothing 105 of the eccentric shaft 7. In addition, a mounting plate 106 with pivots 107 is fixed on pins 104 while gear wheels 108 meshing with the gear wheels 103 and having pins 110 are supported on pivots 107. The pins 110 are pivoted in parts 111 which are firmly connected with the block 5.

As can be seen in FIG. 5, both gear wheels 108 are arranged diametrically to the axis of the eccentric shaft 7. Also, the crank arms of the cranks formed by the two pins 110 point in the same direction as the eccentric of the eccentric shaft 7. The crank arm of pins 110 is as large as the eccentricity of the eccentric 6, which is determined in FIG. 4, by the distance of the eccentric axis 112 from the axis 112' of the eccentric shaft 7. These relations can be seen in FIG. 5 in which the axis of the top pin 110 is designated as 113, while the axis of the bottom pin 110 is designated 114.

Because of the parallel motion of the three axes 112, 113 and 114 with the same phase, the same effect is obtained as with the machine described above. The construction of the piston machine according to FIGS. 4 and 5 is especially suitable in cases where the hydraulic piston machine must be provided with a reduction gearing.

In principle, only one of the cranks formed by the pins 110 would be sufficient to prevent the block from turning and to guide the block parallelly during the rotary motion, provided that the axis of this crank, as illustrated, lies outside the axis of the eccentric 112. However, becuase two pins 110 are provided, the block 5 can be guided more accurately.

What is claimed is:

1. A hydraulic piston machine comprising

a plurality of radially disposed pistons, each piston having a flat bearing surface at one end perpendicular to the longitudinal axis thereof and a pocket in said end within said bearing surface for a hydrostatic bearing;

a central block having flat supporting surfaces thereon, each supporting surface being disposed in opposition to a respective bearing surface of a respective one of said pistons;

an eccentric rotatably disposed within said block for rotating said block about the axis of said eccentric; and

guide means connected to said block to prevent rotation of said block about the axis of said block during rotation about the axis of said eccentric.

2. A hydraulic piston machine as set forth in claim **1** wherein said guide means includes two parts, said parts being disposed in perpendicular relation to the axis of said eccentric, one of said parts being movably mounted in a first plane perpendicular to said axis of said eccentric and the second of said parts being guidably mounted in said one part for movement in a plane disposed at a right angle to said first plane, said second part being fixedly secured to said block to move therewith.

3. A hydraulic piston machine as set forth in claim **2** wherein said guide means is located on one end face of said machine with the same external dimensions as said machine.

4. A hydraulic piston machine as set forth in claim **2** wherein said guide means further includes hydrostatic bearing pockets between said parts and connection bores connecting said pockets with a pressure medium duct in said machine for circulating a pressure medium through said pockets.

5. A hydraulic piston machine as set forth in claim **1** which further includes a shaft connected to said eccentric for rotating said eccentric and wherein said guide means includes at least one crank located outside the axis of said eccentric and frictionally connected to said shaft, said crank being connected with said block for carrying out a rotary motion of the same phase and said eccentricity as said eccentric.

6. A hydraulic piston machine as set forth in claim **5** wherein said guide means further includes two gear wheels connected to said shaft in diametrically disposed relation to the axis of said shaft, and a crank mounted on each gear wheel and pivotally connected to said block, each crank having a crank arm disposed in the same direction as the other crank arm.

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