The present invention concerns a drive mechanism for oscillating positive-displacement machines such as for example diaphragm pumps comprising an eccentric shaft and a plurality of piston rods, wherein the piston rods are connected to the eccentric shaft in such a way that rotation of the eccentric shaft produces an oscillating linear movement of the piston rods. To provide a corresponding drive mechanism which avoids or at least reduces the described disadvantages it is proposed according to the invention that the eccentric shaft and the piston rod are connected together by way of a sliding unit guide.
DRIVE DEVICE FOR OSCILLATING
POSITIVE-DISPLACEMENT MACHINES

[0001] The present invention concerns a drive mechanism for oscillating positive-displacement machines such as for example diaphragm pumps comprising an eccentric shaft and a plurality of piston rods, wherein the piston rods are connected to the eccentric shaft in such a way that rotation of the eccentric shaft produces an oscillating linear movement of the piston rods.

[0002] Oscillatingly operating machines are usually constructed on the basis of the principle of the straight-thrust crank drive. At high levels of power or to keep down the oscillating mass forces acting on the machine foundation, such machines are usually in the form of a multi-crank drive mechanism. In that case the individual eccentrics with connecting and piston rods are arranged in mutually juxtaposed relationship either in an in-line or opposed box of radial star form and are driven by a common crank shaft, the eccentrics of which are respectively displaced relative to each other by the same angle.

[0003] The disadvantage of that structure is essentially that:

- [0004] the crank shaft equipped with a plurality of mutually juxtaposed eccentrics is exposed to high bending moments and has to be of a correspondingly sturdy dimension,
- [0005] particularly in the in-line structure which is the majority of cases high forces occur in the bearings between the crank shaft and the crank casing, which pushes up the costs for the bearing,
- [0006] complete mass balancing is only possible in the case of a six-cylinder machine, and
- [0007] the drive mechanism overall is of a large structural volume, high in weight and involves high manufacturing costs.

[0008] To overcome those disadvantages multi-cylinder machines have already been developed in which the piston rods all lie in one plane and are displaced relative to each other through equal angles. The piston rods are driven by a single eccentric so that the crank shaft can be of correspondingly smaller dimensions. That construction principle is afforded in two different variants:

[0009] a) constructions with a force-locking connection between the eccentric and the piston rods, in respect of which the piston rods are pressed against the slide surfaces of the eccentric by return springs, and
[0010] b) constructions with a positively locking connection between the eccentric and the piston rods, in respect of which the return springs are replaced by a return brace embracing all piston rods.

[0011] Both design configurations suffer from disadvantages. Thus when using a return spring the force thereof is added to the rod force and leads to an additional loading on the components. If the spring is of excessively weak dimensions the connected piston can remain stuck so that the suction stroke is not performed or is not completely performed.

[0012] The return brace which is alternatively used and which embraces all piston rods is an expensive component, in particular in large machines, and also requires a large structural volume for the entire eccentric drive mechanism.

[0013] DE 85 21 520 describes a multi-cylinder diaphragm pump having a plurality of diaphragm pump heads which each have a diaphragm actuable by a hydraulic piston. Here the pump drive is effected by way of a connecting rod-eccentric arrangement. The connecting rod is rotatably coupled both to the piston or the piston rod and also to the eccentric shaft whereby the drive mechanism is expensive to manufacture.

[0014] U.S. Pat. No. 5,268,451 describes a corresponding arrangement with three hydraulic cylinders, in which the piston rod is urged against the eccentric surface by means of a return spring.

[0015] DE 196 26 938 A1 also describes a star-shaped piston-cylinder arrangement in which the shaft is surrounded by radially oriented cylinders in which are arranged displaceable pistons connected to the shaft by connecting rods by way of an eccentric.

[0016] Taking the described state of the art as the basic starting point the object of the present invention is to provide a corresponding drive mechanism which avoids or at least reduces the described disadvantages.

[0017] According to the invention that object is attained in that the eccentric shaft and the piston rod are connected together by way of a sliding unit guide. A sliding unit guide comprises a sliding unit having a slot, a land or a groove, and a sliding block of corresponding configuration which is positively guided by the sliding unit.

[0018] The use of a sliding unit guide makes it possible to dispense with connecting rods, which reduces the costs of the drive mechanism and also makes it possible for example for a diaphragm pump equipped with such a drive mechanism to be made smaller as now the pistons guided in the metering cylinders can be coupled directly to the eccentric shaft without a connecting rod being required.

[0019] In a preferred embodiment all piston rods lie in one plane, wherein particularly preferably the piston rods are arranged in a star configuration. The term star configuration in accordance with the present application is used to mean that the piston rods are equally spaced from each other in the peripheral direction of the eccentric shaft. In other words, adjacent piston rods respectively include the same angle in a projection on a plane perpendicularly to the eccentric shaft.

[0020] In a further preferred embodiment it is provided that the sliding unit guide is of such a configuration that the eccentric shaft and the piston rods are connected together in positively locking relationship in a first direction in space, preferably also in a second direction in space perpendicularly thereto, while a relative movement in a third direction in space which is arranged perpendicularly to the first and second directions in space is possible.

[0021] For example the sliding unit can be in the form of a T-groove and the sliding block can be in the form of a suitably matched sliding block. It has been found in that respect that the sliding unit is preferably arranged on the piston rod and the sliding blocks are preferably fixed to the eccentric shaft.

[0022] By way of example the eccentric shaft can be connected to a sliding element (for example rotationally) which has the sliding units or the sliding blocks, wherein the sliding units or the sliding blocks lie on the boundary surfaces of a regular polygon with a constant.

[0023] In that respect preferably n is an integral multiple of m. It is best for n=m.

[0024] It has further been found that the sliding unit is preferably made from hardened steel. The sliding block is best made from a copper alloy, preferably bronze to permit movement of the sliding block in the sliding unit, with as low friction as possible.
[0025] The multi-piston drive mechanism according to the invention eliminates the disadvantages set forth in the opening part of this specification in that the piston forces both for the pressure stroke and also for the suction stroke are transmitted to the individual piston rods directly by the eccentric sliding unit which is rotatably connected to the eccentric shaft, wherein additional components such as for example an expensive return rod or connecting rods are eliminated and thus the structural size of the overall drive mechanism can be markedly reduced.

[0026] Further advantages, features and possible uses will be clearly apparent from the description hereinafter of preferred embodiments and the associated Figures in which:

[0027] FIG. 1 shows a sectional view of a first embodiment of an eccentric sliding unit drive mechanism according to the invention.

[0028] FIG. 2 shows a further sectional view perpendicularly to the view in FIG. 1.

[0029] FIGS. 3a-c show three variants of the drive mechanism according to the invention, and

[0030] FIGS. 4a+b and 5a+b show various embodiments of the connection between the piston rod and the sliding element.

[0031] In the embodiment shown in FIGS. 1 and 2 the drive mechanism serves to drive a three-cylinder machine. The drive mechanism thus has three piston rods 1 which lie in one plane and which are arranged displaced relative to each other through 120°. The eccentric shaft 2 is rotatably movably connected to an eccentric sliding unit. When the eccentric shaft is rotated about the axis 12 the center point 11 of the eccentric sliding unit will move on the circle denoted by reference 13. In other words the eccentric sliding unit performs a translatory circular movement. The sliding element 6 is preferably triangular, wherein the sliding or groove blocks are arranged on the three sides of the triangle, which have slide surfaces 8. The piston rods 1 have corresponding slide shoes 5 which serve as a sliding unit. As can be seen in particular from FIG. 1 the slide shoe 5 embraces the sliding blocks of the sliding element 6 so that the slide surfaces 8 of the sliding blocks bear against the slide surfaces 7 of the sliding unit. The sliding blocks of the sliding element 6 are thus embraced by the slide shoe 5 in positively locking relationship. Upon rotation of the shaft 2 the slide shoes 5 will slide along the slide surfaces 8 of the sliding blocks. That structure provides that almost no transverse forces are applied to the piston rods 1 by the eccentric shaft.

[0032] The extremely compact structure of the drive mechanism can be clearly seen.

[0033] FIGS. 3a through 3e show three different embodiments of the invention. FIG. 3a shows a two-cylinder drive. The drive mechanism therefore has only two piston rods 1. The sliding element 6 is here of a rectangular shape, wherein it is only at two opposite sides of the rectangle that there are arranged corresponding sliding blocks which are provided with slide surfaces and which are embraced by the slide shoes 5 of the piston rods 1. Upon rotation of the shaft the center point 11 of the sliding element 6 will move along the circle 13.

[0034] FIG. 3b shows the embodiment already known from FIGS. 1 and 2, with three cylinders.

[0035] FIG. 3c shows a four-cylinder drive. The sliding element 6 is similar to the sliding element 6 of the embodiment of FIG. 3a, but in this case arranged at all four sides of the square sliding element 6 are corresponding slide blocks carrying slide surfaces 11, which are respectively embraced by a slide shoe 5 of one of the four piston rods 1.

[0036] FIGS. 4 and 5 show special embodiments of the slide shoes 5.

[0037] FIGS. 4a and 4b show a view on an enlarged scale of the sliding unit guide. The piston rods 1 at their end have a pressure plate 5 which together with the restraint claws 14 form the slide shoe. The restraint claws 14 are fixed to the pressure plate 5 by means of a screw. In the embodiment shown in FIG. 4a the restraint claw 14 is screwed at the end face onto the pressure plate 5.

[0038] In the embodiment shown in FIG. 4b the restraint claw 14 is of a U-shaped configuration so that it embraces both the sliding block and also the pressure plate 5. For fixing purposes the claw 14 is then screwed to the pressure plate 5 from behind, that is to say from the side thereof, that is remote from the sliding block.

[0039] FIGS. 5a and 5b show embodiments in which the restraint claws 14 are screwed to the peripherally extending edge of the pressure plate 5. In the embodiment in FIG. 5b both restraint claws 5 are connected together by means of a bolt and suitable fitting screws 15.

LIST OF REFERENCES

[0040] 1 piston rods
[0041] 2 eccentric shaft
[0042] 5 slide shoe
[0043] 5' slide shoe pressure plate
[0044] 6, 6' 6" sliding element
[0045] 7 slide surfaces of the sliding unit
[0046] 8 slide surfaces of the sliding blocks
[0047] 10 circle
[0048] 11 center point of the sliding element
[0049] 12 axis of the eccentric shaft
[0050] 13 circle
[0051] 14 restraint claw
[0052] 15 bolt/fitting screw

1. A drive mechanism for oscillating positive-displacement machines, comprising: an eccentric shaft and a plurality m of piston rods, wherein the piston rods are connected to the eccentric shaft in such a way that rotation of the eccentric shaft produces an oscillating linear movement of the piston rods, wherein the eccentric shaft and the piston rod are connected together by way of a sliding unit guide.

2. A drive mechanism as set forth in claim 1, wherein all piston rods are disposed in one plane.

3. A drive mechanism as set forth in claim 1, wherein the piston rods are arranged in a star configuration.

4. A drive mechanism as set forth in claim 1, wherein the eccentric shaft and the piston rods are connected together in positively locking relationship in a first direction in space, and also in a second direction in space arranged perpendicularly thereto, while a relative movement in a third direction in space which is arranged perpendicularly to the first and second directions in space is possible.

5. A drive mechanism as set forth in claim 1, wherein the sliding unit guide is in the form of a T-groove/groove block connection, wherein the piston rods have the T-groove and the groove blocks are fixed to the eccentric shaft.

6. A drive mechanism as set forth in claim 5 wherein the eccentric shaft has a sliding element which has the T-grooves.
or the groove blocks, wherein T-grooves or groove blocks lie on the edges of a regular polygon with n corners.

7. A drive mechanism as set forth in claim 6 wherein n is an integral multiple of m, wherein preferably n is equal to m.

8. A drive mechanism as set forth in claim 5, wherein the T-groove is made from hardened steel.

9. A drive mechanism as set forth in claim 5, wherein the groove block is made from a copper alloy, preferably from bronze.

10. A drive mechanism as set forth in claim 5, wherein the T-groove is formed by a pressure plate and a restraint claw fixed to the pressure plate.

11. A drive mechanism as set forth in claim 10, wherein the restraint claws are connected to the pressure plate of the piston rod by means of a bolt or a fitting screw, wherein the restraint claw is preferably rotatably movably connected to the pressure plate.

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