This invention relates in general to pump construction, and in particular to a new and useful high speed, high pressure axial piston pump in which the delivery fluid is separated from the lubricating fluid of the drive and including a control piston for simultaneously shifting a wobble plate for varying the stroke of the pistons of the pump and for shifting an inertial mass for maintaining the balance of the pump parts.

The present invention is particularly applicable for a pump in which the delivered fluid is separated from the operating fluid of the pump drive. Such a system is used, for example, when emulsified water is to be delivered as a medium for the operation of a hydraulic machine, press, and the like, which machine operates at high pressures and where the medium is not suitable as the operating fluid for the drive mechanism of the pump.

In such a construction, the operating fluids and the delivered fluids must be separated from each other and there should be no leakage so that the one fluid would come into contact with the other fluid.

For high pressure axial piston pumps with a direct drive of a hydraulic press it is necessary that the delivery be variable rapidly and infinitely between 0 and a maximum. This can be done by displacement of a swash plate mounted on a cradle by means of a servo drive unit which varies the position of the swash plate and thus the stroke of the pistons. Such a pump, due to its high speed, also requires as complete as possible a compensation of the inertial forces of the revolving parts in every rotative position. Prior to the present invention, inertial compensation of such pumps was done by means of counterweights provided on the side of the swash plate facing the cylinder block which were shifted separately by a complicated mechanism in order to maintain the center of gravity of the pump along the pump axis to as great an extent as possible. Such constructions, however, were possible only with small pumps or engines. Larger pumps require, due to their power and due to the larger forces which act, a better inertial compensation in every cradle position. In addition, the axial piston pump construction cannot be employed where the operating fluid is separated from the lubricating fluid.

At the present time, there are axial piston pumps or machines having separate operating fluid and lubricating fluid systems where longitudinally extending bores of the working pistons are closed on the side of the displacement zone by longitudinally displaceable differential pistons. The large working surface of the pistons is loaded by the flow medium, for example an oil emulsion, while the small working surfaces can push lubricating oil from the closed off bore portion of the longitudinal bore to the points of lubrication and to the relief zones of the working pistons. Structural apparatus necessary for such a construction is extremely expensive. While it largely prevents the passage of flow medium into the zone of the lubrication points, it does not necessarily prevent the passage of lubricating oil into the flow liquid. An adjustable inertial compensation of the revolving machine parts is not provided in such a pump construction.

In accordance with the invention there is provided a high speed, infinitely variable high pressure axial piston pump having ideal inertial compensation and a practically complete separation of the working or operating fluids and the delivered fluids. In accordance with the invention, the pump includes a partition tightly sealing the flow medium or delivered fluid from the interior of the pump with which the working pistons are guided. The construction includes a servo piston or control piston which is guided centrally in the partition and may be moved to adjust the counterweight and the swash plate for piston displacement simultaneously so that inertial compensation is automatically made. The principal advantage of the pump construction is that despite a relatively small structural size of pump the inertial compensation in every cradle position is improved as compared with the known pump constructions, and, in addition, the separation of the liquids within the pump is accomplished by means of the partition flange. A feature of the construction is that the same partition wall which is provided for the separation of the liquids is used as a supporting wall and guide member for the working pistons and for the control piston. The wall divides the pump interiorly into two closely closed compartments, one for the drive mechanism and the transmission oil and one for the cylinder block and the flow medium and any leakage liquid of the flow medium which can flow off unhindered. The central guidance of the control piston permits a construction to provide for a movement of the swash plate for varying piston displacement as well as for simultaneously adjusting the counterweight in a simple and easy manner.

Accordingly, it is an object of this invention to provide a high speed, infinitely variable high pressure axial piston pump having means for separating the pump operating and delivery fluids and for providing for inertial compensation during a change in the output of the pump.

A further object of the invention is to provide a high speed axial piston pump having a partition wall dividing the pump so that the pump operating fluid and the delivery fluid are maintained separate and with a control piston slidable in the partition wall for simultaneously adjusting the stroke of the piston and the location of balancing weights for insuring that the pump is inertially balanced at all speeds and outputs.

A further object of the invention is to provide a pump which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the above claims and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention. In the drawings:

FIG. 1 is a longitudinal section through a pump constructed in accordance with the invention; and

FIG. 2 is a section taken along the line 2—2 of FIG. 1. Referring to the drawings in particular, the invention embodied therein comprises a pump with a valve block or cylinder head 1 which is firmly connected to a spacer ring 2 which, in turn, is connected at its opposite end with a flange plate or disk member 3. The drive mechanism for the pump comprises a shaft journal 4 having a shaft head 5 rotatable within the interior of the spacer ring 2. The inner end of the shaft head 5 is provided with a semicircular recess 6 in which is pivotal a cradle 7 which carries a swash plate 8 mounted axially and radially on rolls or roller bearings for rotation about its axis within the cradle. The swash plate 8 carries piston shoes 9 which slide in an elliptical path according to the pivotal position of the cradle 7.

A pull-back disk 10 is rotatably mounted on rollers.
and absorbs the pull-back forces of the pistons 11. The pistons 11 are pivotally connected by spherical end portions 10 of a spherical sleeve and are guided at the bushings 13 of partition wall 15. The bushings 13 are provided with low pressure packings 14 which seal the space 16 formed by the partition 15 in accordance with the invention.

The partition 15 also functions as a guiding plate or flange of the drive mechanism. The space 15 serves as a collecting chamber for any leakage fluid of the flow delivering medium and communicates with a drain bore 41 defined in the cylinder block 1.

In accordance with a further feature of the invention, the partition wall 15 is provided with a central guiding bushing 17 which is also held in the cylinder block 1. The partition wall 15 insures that the drive mechanism containing the transmission oil or operating fluid is tightly separated from the cylinder block 1 containing the emulsified fluid medium or delivery fluid so that in practice there are two compartments formed within the interior of the pump.

The pistons 11 move in bushings 18 provided with high pressure packings 19. The bushings 18 define valve cages 20 and a valve seat for an inlet valve 21 which is disposed for axial movement parallel to the axis of the pump. The valves 21 can be easily replaced by releasing a threaded closure 22 without dismantling the pump. All the inlet valves (only one being indicated) are connected by a ring channel or annular passage way 23 with a suction passage 24 which is connected to a suction line (not shown). A pressure line (not shown) is connected to a discharge passage 25 which, in turn, connects through an annular channel or ring channel 26 to discharge valve cages 27 which are defined in radially extending passages of the cylinder block 1. A discharge valve 28 may be removed in the manner similar to the inlet valve by removing a threaded closure 29. This closure may also be removed for the replacement of packings without disassembly of the pump.

In accordance with a further feature of the invention, in the center of the cylinder block 1 there is arranged a guide bushing 17 in which is axially displaceable a servo piston or control piston 30. The control piston 30 is displaced by fluid pressure in accordance with the positioning of a control piston element or rod member 31 having control portions 31a and 31b of relatively large diameter separated by a flat or small diameter portion 31c.

The ring surface or annular surface 33 of the servo piston 30 is continuously loaded with a constant oil pressure through a connection 32 defined in the cylinder block 1. If the control piston element 31 is displaced in the direction of the arrow, the control channels 34 and 35 are connected together and the control oil flows into the pressure zone behind the servo piston 30 to displace the piston in the direction of the arrest until the control edges of the piston 31a and 31b interrupt the connection of the control channels 34 and 35. When displacement of the control piston is opposite to the direction of the arrest, the control channel 34 is closed by the control surface 31a and the control pressure loads only the annular surface 33 of the piston 30. The fluid from the pressure zone 34 then flows off through the control channel 35 and the central bore 36 of the piston 30 until the piston is displaced counter to the direction of the arrest to move the control surfaces 31a and 31b back to the position indicated in FIG. 1.

In accordance with a further feature of the invention, a rack 37 is rotatably connected with the servo piston 30 by radial and axial bearings 45 and 46. The rack 37 is engaged with a toothed segment 38 which is rigidly connected with a pinion 39. The pinion 39 meshes with serrations 43 formed on the surface of a counterweight 40 so that each is displaced correspondingly by adjustment of the rack 37. If the servo piston 30 is moved in the direction of the arrow, the rack 37 is displaced axially in the same direction and thus rotates the toothed segment 38 and the pinion 39 clockwise. Thus, at the same time the cradle 7 is pivoted and the counterweights 40 are shifted to a corresponding degree. The weights are guided in grooves 44 and are displaced toward or away from the center or axis of the pump. The shifting is such that in every position of the cradle 7 the weights 40 are moved by an amount to compensate as perfectly as possible for the shifting of the inertial mass in the pump structure.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A high pressure axial piston pump comprising a pump housing including a cylinder block having a plurality of concentrically arranged axially extending pump cylinders therein, a piston axially slideable in each of said pump cylinders, a swash plate pivotally mounted within said pump housing for tilting away from a plane normal to the axis of the pump, a swash plate including a rotatable member articulated to said pistons for displacing said pistons during rotation thereof in accordance with the amount of tilt of said swash plate, inlets and discharge valve means connected to said piston cylinders in said cylinder block for the drawing in and discharging of a delivery fluid, a partition dividing said pump housing and separating the operating fluid for said swash plate from the delivery fluid in said cylinder block, said partition having a central guide bushing with a bore therein for said piston control means, counterweight means within said housing mounted for displacement, and control piston means slideable in said housing and connected to said counterweight means and said swash plate for shifting said counterweight and said swash plate.

2. A high pressure axial piston pump comprising a cylinder block having a plurality of concentrically arranged pump cylinders therein, a piston axially slideable in each of said pump cylinders, a swash plate pivotally mounted within said pump, a pump housing, said swash plate including a rotatable member articulated to said pistons for displacing said pistons during rotation thereof in accordance with the amount of tilt of said swash plate, inlets and discharge valve means connected to said piston cylinders in said cylinder block for the drawing in and discharging of a delivery fluid, a partition dividing said pump housing and separating the operating fluid for said swash plate from the delivery fluid in said cylinder block, said partition having a central guide bushing with a bore therein for said piston control means, counterweight means within said housing mounted for displacement, and control piston means slideable in said housing and connected to said counterweight means and said swash plate for shifting said counterweight and said swash plate simultaneously.

3. A high pressure axial piston pump comprising a cylinder block having a plurality of concentrically arranged pump cylinders therein, a piston axially slideable in each of said pump cylinders, a swash plate pivotally mounted within said pump, a pump housing, said swash plate including a rotatable member articulated to said pistons for displacing said pistons during rotation thereof in accordance with the amount of tilt of said swash plate, inlets and discharge valve means connected to said piston cylinders in said cylinder block for the drawing in and discharging of a delivery fluid, a partition dividing said pump housing and separating the operating fluid for said swash plate from the delivery fluid in said cylinder block, counterweight means within said housing mounted for displacement, and control piston means slideable in said housing and connected to said counterweight means and said swash plate for shifting said counterweight and said swash plate simultaneously.
A pump comprising a cylinder block having a central axially extending bore for a control piston defined therein, said cylinder block having a plurality of angularly spaced axially extending pump cylinders defined around the central bore, a pump piston slidable in each of said pump cylinders, inlet and outlet valve and passage means defined in said cylinder block for the suction of a circulating fluid into each of said pump cylinders and for the discharge of said circulating fluid during operation of said pump pistons, wall means defining with said cylinder block a housing, a shaft rotatably mounted in said housing, and means movable by said control piston to pivot said housing and to shift said balancing mass.

7. A pump comprising a cylinder block having a central axially extending bore for a control piston defined therein, said cylinder block having a plurality of angularly spaced axially extending pump cylinders defined around the central bore, a pump piston slidable in each of said pump cylinders, inlet and outlet valve and passage means defined in said cylinder block for the suction of a circulating fluid into each of said pump cylinders and for the discharge of said circulating fluid during operation of said pump pistons, wall means defining with said cylinder block a housing, a shaft rotatably mounted in said housing, and means movable by said control piston to pivot said housing and to shift said balancing mass.

8. A pump comprising a cylinder block having a central axially extending bore for a control piston defined therein, said cylinder block having a plurality of angularly spaced axially extending pump cylinders defined around the central bore, a pump piston slidable in each of said pump cylinders, inlet and outlet valve and passage means defined in said cylinder block for the suction of a circulating fluid into each of said pump cylinders and for the discharge of said circulating fluid during operation of said pump pistons, wall means defining with said cylinder block a housing, a shaft rotatably mounted in said housing, a swash plate, a partition wall located between said swash plate and said pump cylinders and dividing the interior of said housing into an operating fluid chamber and a delivery fluid chamber, a swash plate cradle being mounted on said shaft for pivotal movement for shifting said swash plate.
out of a plane normal to the axes of said pump cylinders for varying the strokes of said pistons, a control piston slidably mounted in said housing, and means movable by said control piston to pivot said cradle and to shift said balancing mass, a spacer ring connected to said cylinder block at one end, a flanged disk closing the opposite end of said spacer ring, the interior of said spacer ring with said flanged disk on one side and said block on the other defining a housing, and a partition wall on the interior of said housing spaced from said block and separating the interior of said spacer ring into a compartment for operating fluid and a compartment for delivery fluid and having a bushing for each piston, and a piston rod connected to each piston and to said swash plate and passing through a respective bushing in sealing engagement therewith.