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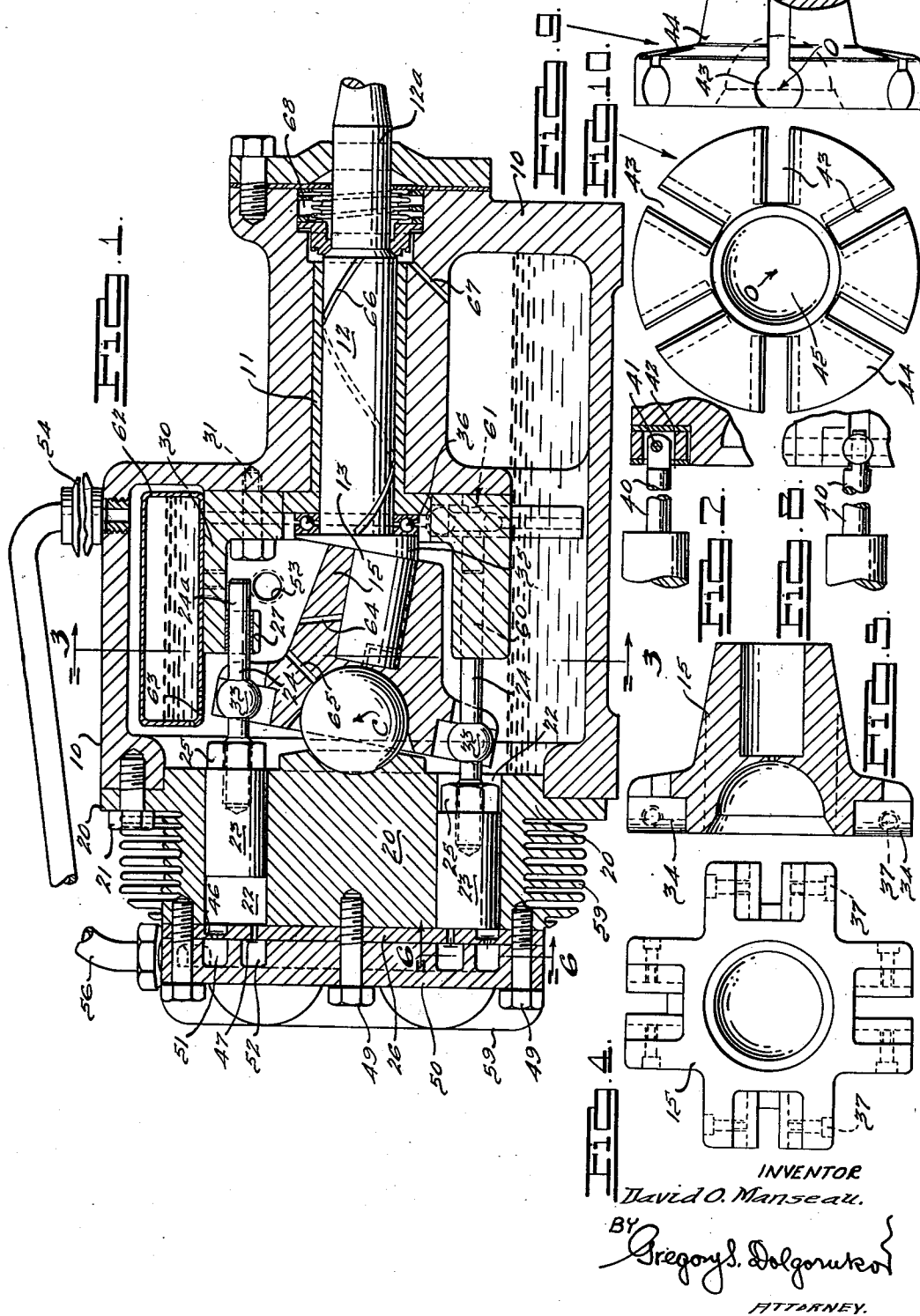
D. O. MANSEAU

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PUMP

Filed Aug. 12, 1946

2 Sheets-Sheet 1



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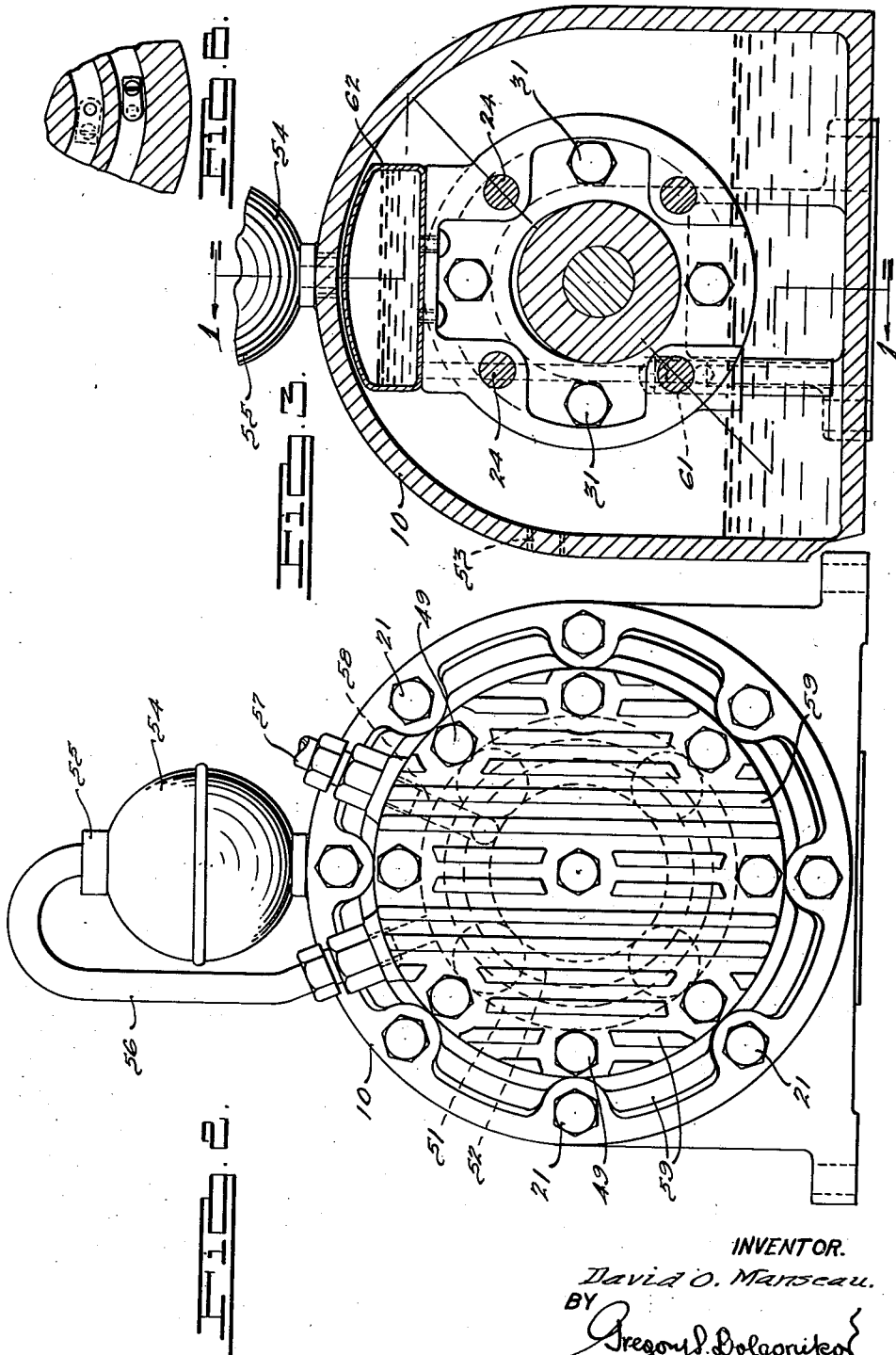
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## UNITED STATES PATENT OFFICE

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6 Claims. (Cl. 103-173)

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This invention relates to pumps and more particularly to an improved positive displacement pump.

One of the objects of the present invention is to provide an improved lightweight positive displacement pump adapted for a large number of pumping applications both for liquids and gases, such, for instance, as for compressing gaseous refrigerant in refrigerators of domestic, commercial or industrial types; for circulating cutting fluid in various machine tools; for functioning as an oil pump in such machines as, for instance, internal combustion engines both for lubricating purposes as well as for forcing the fuel oil into the engine cylinders; for creating hydraulic pressure and actuating various devices, such as motor vehicle brakes; for lifting liquids; creating vacuums for various purposes; and for other like applications.

One of the objects of the present invention is to provide an improved positive displacement pump which combines in itself the well appreciated advantages of reciprocating piston pumps with the numerous advantages of positive displacement rotary pumps, such as absence of connecting rod with its disadvantages, substantially uniform discharge and suction characteristics, and many other important advantages.

Another object of the invention is to provide an improved pump of the reciprocating piston type in which a large number of cylinders may be arranged in a very small space and actuated from a single rotating shaft without the necessity of providing the train of mechanisms of the conventional type.

A further object of the invention is to provide an improved pump of the character specified in the preceding paragraph, in which pump means are provided whereby the transmission of driving force from the shaft to the pistons and conversion of rotary motion into reciprocating motion is effected in an improved manner.

A still further object of the invention is to provide an improved pump of the reciprocating piston type in which pump means are provided whereby the piston actuating forces are applied substantially along the axis of the pistons and the pistons are guided in their reciprocating movements in such a manner that the objectionable side thrust on the pistons is greatly reduced. It is well appreciated in the art that such side thrust produces very high local pressures between the piston and the cylinder walls, requiring careful lubrication and yet producing excessive friction, heating, and uneven wear of the cylinder and the piston.

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A further object of the invention is to provide an improved pump which combines in a single self-sustained unit the advantages of a reciprocating pump without the disadvantage of producing an objectionably intermittent or pulsating discharge and suction. It is well appreciated in the art that pulsating discharge may not be objectionable in pumping gases particularly where relatively large volume of gas in discharge conduits or tanks is capable of absorbing the pulsating surges due to compressibility of the gas. However, in cases of liquids, due to their substantial incompressibility, pulsations of liquid columns produce such impact loads on the pump itself as well as on the actuated devices as to cause very often their breakage or premature wearing out due to the repeated "water hammer" effect.

A still further object of the present invention is to provide an improved pump of the foregoing character, which pump is flexible in its capacity, i. e. the output of which can be varied within wide limits and particularly by varying the speed of the pump.

A still further object of the invention is to provide an improved pump of the foregoing character the capacity of which for a given speed may be changed by changing only a few relatively inexpensive parts of the pump.

A still further object of the invention is to provide an improved rotary positive displacement pump in which the ratio of the moment of inertia of the unbalanced mass to the capacity of the pump is greatly reduced.

A still further object of the invention is to provide an improved positive displacement pump which is simple, rugged and compact in construction, has less moving parts, which is better balanced in operation and operates more smoothly with less friction, heat and wear, requires less lubrication, and produces less noise.

A still further object of the invention is to provide an improved pump which is dependable in operation and after being once properly installed can operate for a number of years without requiring special attention, adjustments and manual lubrication. In many devices, such for instance as refrigerators, this is a feature of critical importance.

It is an added object of the present invention to provide an improved pump of the foregoing character which is relatively inexpensive to make, and is easy to service and repair.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specifica-

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tion, wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a longitudinal sectional view taken in the direction of the arrows on the sectional planes passing through the broken line 1—1 of Fig. 3 and showing my improved pump embodying the present invention;

Fig. 2 is an end view looking from left to right and illustrating the pump of Fig. 1;

Fig. 3 is a transverse sectional view taken in the direction of the arrows on the section line 3—3 of Fig. 1;

Fig. 4 is an end view of the wobbling member taken on the larger end and along the axis thereof;

Fig. 5 is a longitudinal sectional view of the wobbling member of Fig. 4;

Fig. 6 is a fragmentary sectional view illustrating the valve arrangement for one cylinder, the section being taken in the direction of the arrows on the sectional plane passing through the line 6—6 of Fig. 1;

Figs. 7 and 8 illustrate a modified universal connection between the piston rod and the wobbling member;

Figs. 9 and 10 show in a side and bottom view, respectively, the wobbling member adapted to receive the universal connection of Figs. 7 and 8.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In the drawings there is shown by way of example a pump embodying the present invention. Referring to the drawings and particularly to Fig. 1 thereof, the pump illustrated therein comprises a housing 10 in which there is mounted in a long bearing 11 a shaft 12 having an end 12a adapted to be connected in any suitable manner to a driving motor (not shown). The opposite end of the shaft 12 is provided with a crank pin 13, preferably formed integrally with the shaft 12. The crank pin 13 is arranged in such a manner that its axis is disposed in the plane of the axis of the shaft but at a predetermined angle thereto with both of said axes intersecting, if continued, at a point C. The crank pin 13 engages for driving a wobbling member 15, said member being supported at its opposite end with a ball 16 received in the sockets provided in the member 15 and in the center of the cylinder block 20.

With the construction so far described it will now be seen that as the shaft 12 rotates, the crank pin 13 causes the member 15 to move in such a manner that its axis will generate a cone having its vertex at the point C, and included angle equal twice the angle which its axis makes with the axis of the shaft 12. The member 15 being restrained from rotation around its own axis by the piston rods, the construction of which is described in detail later, its movement may therefore be termed wobbling movement.

The cylinder block 20 is detachably secured to the housing 10 in any suitable manner such as with the aid of screws 21 equidistantly arranged around its periphery. In the cylinder block 20 there is provided a plurality, in the present instance four, of cylinders 22, each of

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said cylinders having a piston or plunger 23 slidably fitted therein. The cylinders 22 are arranged preferably equidistantly around the continuation of the axis of the shaft 12, and parallel thereto.

Each of the pistons 23 is provided with a central internally threaded hole receiving the externally threaded end of a piston rod 24. A nut 25 is provided to tighten the piston on the rod in a predetermined and adjustable location to ensure that the piston 23 fully discharges the cylinder and yet does not strike a valve plate 26. The opposite ends 24a of the three of the piston rods 24 are sliding such as 27 in guide holes provided in a bracket 30 secured to the housing 10 in any suitable manner, such as with the aid of the screws 31. It is an important advantage that the guiding means thus provided are co-axial with the pistons.

Means are provided to connect the wobbling member 15 to the piston rods 24 in a manner to cause said piston rods 24, and consequently the pistons 23, to reciprocate in response to the wobbling movements of said member 15. In the present embodiment of the invention said means are exemplified by the universal connections received in the nests provided in the wobbling member 15. From a consideration of the nature of movement of the wobbling member 15 it will be understood that points on said wobbling member viewed in Fig. 1 will move on arcs having radii equal to their respective distances from the point C. Since, in the same view the points on piston rods move along straight lines parallel to the axis of the shaft 12 and since the member 15 also oscillates sidewise on piston rods, the connecting means are of such a character as to provide for reciprocating movements of the piston rods under such condition without binding.

Figs. 1, 4 and 5 illustrate one type of universal connection ensuring such reciprocating movements of the piston rods. With this type of connection, which may be termed a "ball and cylindrical socket connection," a ball 33 is formed on the piston rod, which ball is received in a cylindrical recess 34 in the member 15, and is slidable for a certain distance therein. The recesses may be provided in special inserts made of any suitable metal, which inserts may be received in the member 15 and adjustably held therein with the aid of screws 37.

Figs. 7 and 10 illustrate a modified universal connection in which the end of each of the piston rods 40 is hinged as at 41 in a piston-like head 42 slidably fitted in a cylinder-like recess 43, a plurality of which is provided in a wobbling member 44, said recesses being radially arranged with their axes disposed in the plane perpendicular to the axis of the member and passing through the geometric center of the socket 45 provided in said member.

It will now be seen from an examination of the above described universal connections that each of them provides for three types of movements of the wobbling member 15, namely its independent rocking around two mutually perpendicular axes and sliding with respect to the center of the connection. Therefore, any suitable universal connection which satisfies the above requirements is applicable in my improved pump.

Intake and the discharge valves 46 and 47, respectively, are provided for each of the cylinders 22. The valves 46 and 47 are operatively mounted in a valve plate 48 detachably connected to

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the cylinder block 20 with the aid of screws 49 which hold to the cylinder block 20 also a cylinder head 50. The head 50 is provided with a circular intake recess registering with ports of the intake valves 46 of all cylinders, and a circular recess 52, preferably concentric with the recess 51, and registering with the ports of the discharge valves 47.

In operation, the fluid in the present embodiment of invention a gaseous refrigerant, enters through the intake opening 53 provided in the housing 10 and passes through the dampening chamber 54, filter 55, pipe 56 into the circular intake recess 51. From the recess 51 the gas is drawn into the cylinder 22 through the intake valves 46 during the suction stroke of each of the pistons 23. On the discharge stroke of the respective piston, the intake valve of its cylinder closes and the discharge valve opens allowing the gas to pass into the discharge recess 52, the discharge pipe 57 connected to the cylinder head 50 and communicating with the discharge recess 52 through a conduit 58, and from the discharge pipe 57 toward its destination or application. The suction and discharge strokes of the cylinders 22 occur successively and the intake and the discharge characteristics of the pump illustrated in the drawing are substantially as in a four cylinder pump with intakes and discharges being 90° apart. The heat generated by the compressed gas is dissipated through the cooling ribs 59 provided on the cylinder block 20. It will be understood, that in cases of liquid pumps, ribs such as 59 may be omitted.

It can be appreciated that in operation, particularly where high pressures are involved, strong end thrust is exerted on the member 15 and is transmitted therefrom to the shaft 12. In accordance with the invention, means are provided to receive and resist such thrust forces. In the present embodiment of the invention, said means are in the form of a shoulder 35 provided on the shaft 12, and a thrust bearing 36. The thrust forces exerted on said shoulder 35 are transmitted through said bearing 36 to the bracket 30 and to the housing 10, as can be clearly seen from an examination of Fig. 1.

Means are provided to ensure automatic lubrication of the pump in operation. In the present embodiment said means are exemplified by the extension 60 of one of the piston rods 24, which extension is actuated by the wobbling member 15 in a manner described above and which operates as a plunger of an oil pump, generally indicated by the numeral 61, and pumping oil into the tank 62. From the tank 62 the oil is sprayed through a number of holes such as 63 on the operating parts of the pump and particularly on the universal connections, piston rods, into the cylinders, and through the holes 64 and 65 to the ball 16 and the crank pin 13, respectively. A groove 66 carries the oil through the bearing 11 toward the end of the shaft 12, from where it is returned through the hole 67 into the lower portion of the housing 10, wherein the oil level is maintained approximately at the height of the lowest cylinder. At the end of the shaft 12 there is provided a suitable seal, such as indicated by the numeral 68, to prevent leakage of the pumped fluid or of oil out of the housing.

It should be particularly appreciated that in my improved pump both the amount of unbalanced mass and location of its center of gravity from its axis of gyration are greatly reduced thus improving the static and the dynamic balance of

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the pump. Expressed in the form of a ratio of the moment of inertia of the mass to the capacity of the pump at a given speed, such ratio for my improved pump is exceptionally low. It should be appreciated in this connection, that since moment of inertia of a revolving or an oscillating mass is determined not only by the magnitude of such mass but also by the square of the radius of its gyration, merely decreasing the unbalanced mass may not be appreciably beneficial and, in fact, may be detrimental to the balance of the pump if it must be achieved by moving such mass further away from the axis of its movement.

It can also be appreciated that since because of its improved dynamic balance, my improved pump may be operated at a relatively high speed, such as 5,000 R. P. M., and its speed may be varied selectively through a wide range, the capacity of my pump is extremely flexible and may be widely varied. This feature is extremely important, since in many installations the most advantageous capacity can be selected by an actual trial after the pump has been installed, and effected merely by changing the gearing or pulleys.

Moreover, should an installation be limited to some particular speed or a relatively narrow range of operation speeds or should varying the capacity of the pump in still wider limits be desired, such results can be effected merely by using a cylinder block 20 having cylinders of different bore with corresponding pistons. No other changes may be necessary, since the same valve plate, piston rods 24 and nuts 25 may be used.

It will now be understood in view of the foregoing that various modifications may be made in my improved pump to adapt it for particular types of fluids, applications or conditions. For instance, the number of cylinders may be increased or decreased; double acting pistons with cylinders closed at both ends may be used instead of the single-acting pistons or plungers. Bores and stroke of the pistons may be changed as desired. Single or double acting pistons and cylinders may also be provided at the ends 24a of the piston rods 24. Also another complete pump unit may be provided on the opposite end of the shaft 12, and such pump may be used as a second stage pump, if desired.

It should also be understood that if fluid under pressure is forced into the intake conduit of my pump, the same may be made to operate as a fluid motor. By using various types of fluids, liquids such as water, air, or steam my improved pump may be made to operate as a hydraulic motor, a pneumatic motor, or a steam engine, respectively. It may also be utilized as a hydraulic transmission for varying the torque or speed or both of a rotative movement. Moreover, by generating gaseous pressure within the cylinders themselves, such as by burning fuel therein in a manner well known in the art, my improved pump may be made into an internal combustion engine.

There is thus provided an improved pump whereby objects of the present invention listed above and numerous additional advantages are attained.

I claim:

1. A pump having an inlet port and an outlet port, said pump comprising a rotatably mounted shaft; an integral crank pin on said shaft, said pin being arranged to have its geometric axis disposed in the plane of said shaft but at a predetermined angle to the axis thereof to intersect the continuation of said axis of the shaft at a predetermined point; a member having one end

engaged by said pin, the opposite end thereof being supported at said point of intersection of the axes of the crank and the shaft; a cylinder block having a plurality of cylinders provided therein and arranged around the axis of said shaft on one side of said member, each of said cylinders having inlet and discharge ports communicating with the inlet and discharge ports of the pump, valves controlling said cylinder ports, a piston for each of said cylinders slidably fitted therein, a piston rod for each of said pistons, said rod having one end connected to the respective piston and its opposite end constrained on the opposite side of said member to move along the center line of the piston, the intermediate portion of said rod carrying the male portion of a universal connection engaging said wobbling member to be reciprocally actuated thereby along the center line of the cylinder.

2. A construction as defined by the preceding claim 1, the engagement of the wobbling member by the piston rod being effected by a universal connection therebetween providing for limited relative rotation of the wobbling member on the rod and its sliding on the rod in the plane perpendicular to said crank.

3. A construction as defined by claim 1, the connection between the piston rod and the piston including means for adjustment along the center line of the piston.

4. A pump having an inlet port and a discharge port, said pump comprising a housing, a rotatable shaft mounted in said housing, an integral pin on said shaft, said pin being arranged to have its geometric axis disposed at a predetermined angle to the axis of said shaft to intersect the continuation of the axis of said shaft at a predetermined point; an integral cylinder block connected directly to said housing and having a center line coinciding with the axis of the shaft with a plurality of cylinders formed in said block equidistantly around the center line thereof with each cylinder having inlet and discharge ports communicating with the inlet and discharge ports of the pump, valves controlling said cylinder ports, said block having a socket in the shape of a portion of a sphere having its center at the point of intersection of the axes of said shaft and said pin; a ball arranged in said socket; a wobbling member having one end engaged by said pin with its other end having a

socket adapted to engage said ball for support; a plurality of pistons slidably fitted in said cylinders, each of said pistons having a piston rod engaged by said wobbling member for reciprocating said pistons; and universal connections between each of said rods and said wobbling member, each of said connections including cylindrical recess in said member with partially opened walls for the passage of said rods.

5. A pump as defined by the preceding claim 4 and having a valve plate connected to said cylinder block.

6. A pump as defined by the preceding claim 4 and having means including an oil pump arranged within the housing and actuated by at least one of said piston rods to cause in operation of the pump constant oil spray within said housing.

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