Feb. 25, 1941. J. M. SCHMIED 2,232,976

VARIABLE DISPLACEMENT PUMP

Filed April 6, 1938 2 Sheets-Sheet 1

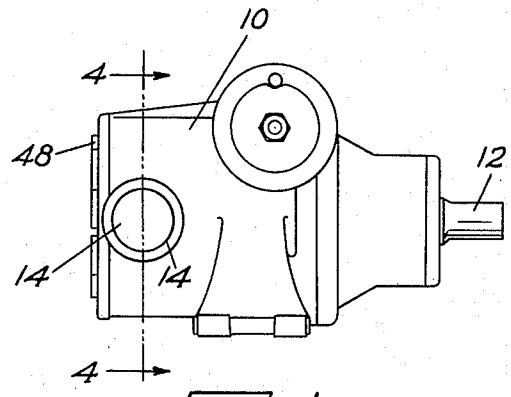


FIG. 1

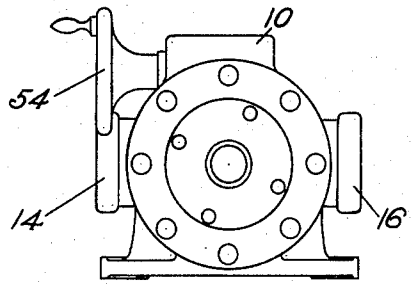


FIG. 2

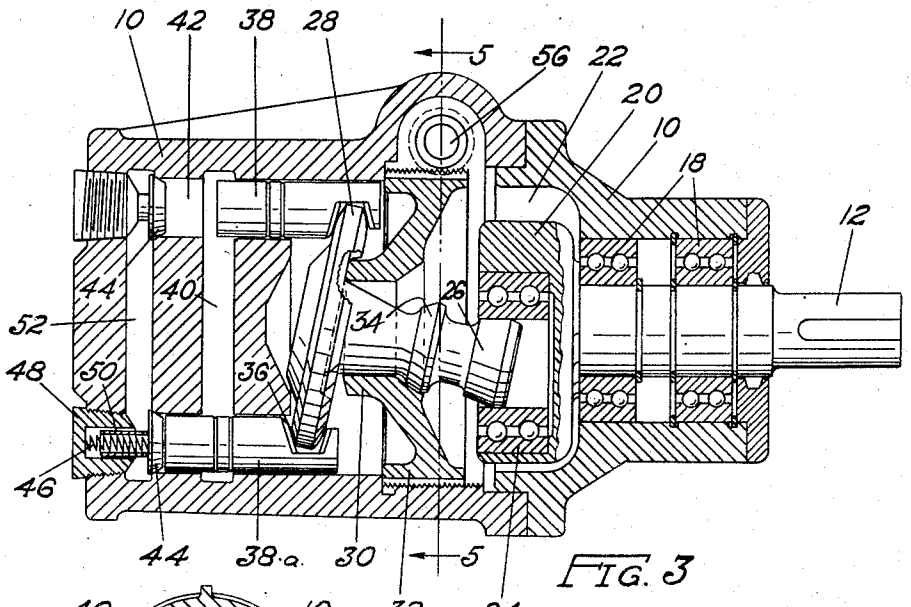


FIG. 3

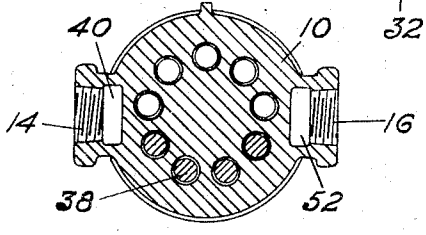


FIG. 4

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VARIABLE DISPLACEMENT PUMP

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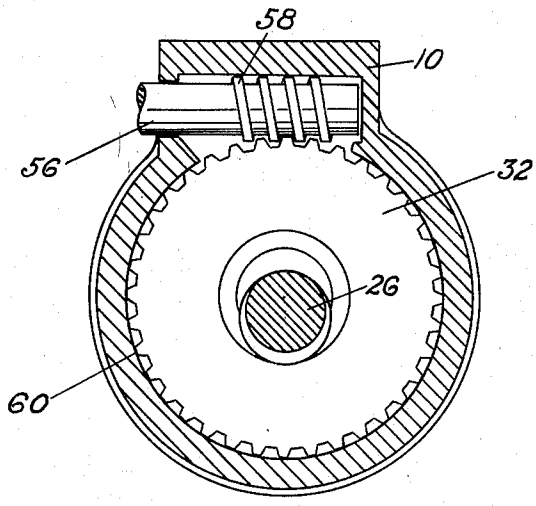


FIG. 5

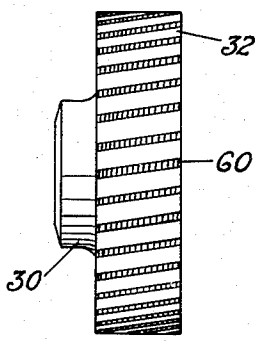


FIG. 6

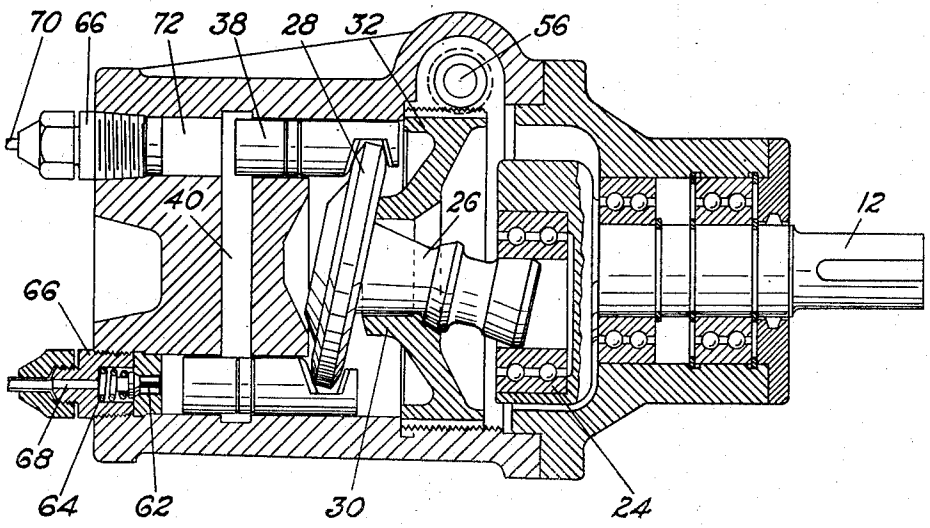


FIG. 7

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VARIABLE DISPLACEMENT PUMP

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Application April 6, 1938, Serial No. 200,454

6 Claims. (Cl. 103—173)

This invention relates to an improved variable displacement pump and has, for one of its principal objects, the provision of a comparatively simple yet highly efficient pump of the displacement type which is especially adapted for use with hydraulic systems.

Another object of the invention is to provide a variable displacement pump which can be used for pumping fuel; for example, a fuel pump for Diesel engines driven directly by means of gears from the engine crankshaft, wherein high pressures can be quickly and economically developed and wherein the amount of fuel passing through the pump can be very accurately controlled whereby the speed of the Diesel engine can be accordingly varied.

Another important object of the invention is to provide a powerful yet relatively simple fuel pump or hydraulic pump of the class described which is composed of a minimum of parts and which is so designed that there will be no necessity for any gasketing on the high pressure side of the pump.

Another and still further important object resides in the provision of a variable displacement pump of the hydraulic type wherein the bearing surfaces and those which actually enter into the most strenuous performance are so constructed that sliding rotary friction is not present while at the same time a maximum power development results.

Other and further important objects of the invention will be apparent from the disclosures in the accompanying drawings and following specification.

The invention, in a preferred form, is shown in the drawings and hereinafter more fully described.

In the drawings:

Figure 1 is a side elevation of the improved variable displacement hydraulic pump of this invention.

Figure 2 is an end view of the pump of Figure 1.

Figure 3 is a somewhat enlarged sectional view of the pump of Figures 1 and 2, showing the interior construction.

Figure 4 is a section taken on the line 4—4 of Figure 1, looking in the direction indicated by the arrows.

Figure 5 is a section on the line 5—5 of Figure 3, showing the means for adjusting the amount of material delivered through the pump.

Figure 6 is a side elevation of the gear of Figure 5, showing particularly the screw-threaded surfaces of the teeth.

Figure 7 is a sectional view somewhat similar to Figure 3, showing a modified form of the invention wherein the same is adapted particularly as a fuel pump for Diesel engines.

As shown in the drawings:

Reference numeral 10 indicates generally the casing or body of the improved pump of this invention, the same having a driving shaft 12 fitted thereinto for operation and also having inlet and outlet ports 14 and 16 respectively.

Referring now to Figure 3, the driving shaft 12 is mounted in suitable ball bearings 18 in the casing 10 and terminates in a cup-shaped head 20 eccentrically positioned with respect to the shaft and adapted to rotate in a space 22 in the casing 10. A ball race 24 is positioned in the cup-shaped head 20, this being adapted for the driving reception of the lower end of a stem 26 which has a wobble plate 28 around its outer end and preferably integral therewith.

The wobble plate 28 operates on a track 30 which is part of a circular gear structure 32 (Figures 5 and 6), and it will be noted that the wobble plate is recessed on its under face to provide a rolling contact with the upper face of the track 30. At the same time, the stem 26 of the wobble plate has an offset annular portion 34 which also has a rolling or sliding contact with a correspondingly shaped inner face of the track and gear combination 30—32, and the lower end of the stem 26 is shaped as best shown in Figure 3, to provide a two-line contact, one on each face, with the inner portion of the ball race 24.

Additionally, the outer edge of the wobble plate 28 has the same profile as a standard stub tooth, and said profile fits into the corresponding tooth rack groove 36 cut into the lower end of each of a number of piston elements 38 which are practically solid metal cylinders adapted to slidingly fit into correspondingly bored and honed barrels in the casing 10.

A suction chamber 40 is formed in the outer end of the casing 10, this being transverse of the casing and communicating with the inlet opening 14, and from an inspection of Figure 3, it will be noted that when certain of the pistons 38 are in retracted position, owing to the action of the wobble plate 28, the outer ends of such piston will terminate within the confines of the chamber 40.

There is an extension of each cylinder opening beyond the chamber 40, as illustrated at 42

in Figure 3, into which the ends of the pistons are adapted to move on their forward stroke, as shown by the piston 38a in Figure 3. This action of the piston forces any liquid which has entered the chamber 40 and the extension 42, past a corresponding valve 44. These valves are equal in number to the pistons, and each valve is held in place by a comparatively light helical spring 46, mounted in a threaded plug 48, the valve stem 50 being loosely slidable in the plug 48, so as to eliminate any possibility of undesirable compression inside the plug 48.

A chamber 52, similar to chambers 40, is formed in the casing head 10, beyond the ends of the piston cylinders, and the valves 44, and the liquid forced past the valves 44 enters this opening or pressure chamber 52, which communicates with the outlet 16, all as best shown in Figure 4.

In the embodiment of the invention illustrated, the cylinders are nine in number, but this arrangement can obviously be changed to meet desired requirements or any particular number of cylinders or conditions.

Adjustment of the amount of liquid forced through the pump can be readily and accurately made by means of a hand wheel 54, which is mounted on the outer end of a shaft 56 (Figure 5), the shaft entering into the casing 10 and terminating in a worm 58, which is in mesh with the helical geared outer face 60 of the wobble plate track 30—32.

As best illustrated in Figure 6, the helical gear teeth 60 of the element 32 are exteriorly screw-threaded and correspondingly fitted into an interiorly screw-threaded recess in the casing 10. Obviously, a rotation of the hand wheel 54 and the shaft 56 with its worm 58 will cause a corresponding rotation of the track and helical gear element 30—32 in the casing, and a consequent forward or rearward movement of the same in the casing, on account of the screw-threaded mounting 60. In this way, the amount of liquid taken into the chamber 40 and later delivered by the pump can be very accurately adjusted from a minimum to maximum, and this is especially important in some operations, as, for example, in the control of speeds and feeds of lathes, milling machines and in fact, in any other position where a hydraulic pump is employed, wherein an accurately measured amount of delivered liquid is necessary.

In Figure 7, substantially the same device is employed, including the driving shaft 12, the stem 26, the track and gear combination 30—32, the wobble plate 28 and the pistons 38. However, this device being designed especially for delivering fuel under high pressure to a Diesel engine or the like, has an inlet 40, from which the liquid is delivered by the pistons past valves 62, held in position by springs 64 in plugs 66, which plugs are apertured as at 68 for the passage of the liquid fuel therethrough, and thence lead to delivery tubes 70, whereby the fuel under pressure is injected through spray valves directly into the cylinders of the internal combustion engine.

Obviously, the number of pistons 38 in the injection pump must correspond to the number of cylinders in the Diesel engine, whereby injection for each cylinder is rendered possible.

Suction is created when the pistons 38 move to the right (Figure 7) and as soon as the ports 72 in the intake chamber 40 are freed, fuel rushes into the ports. On the return stroke, the fuel is forced past the valve 62 and to the connections 66 and 68 to the spray valves or fuel injectors of the Diesel engine cylinders.

The amount of fuel forced through the valves depends upon the effective volume of the chamber 40, which is controlled by the position of the wobble plate, and this, in turn, is, of course, adjusted by means of the shaft 56 and its worm, in conjunction with the externally threaded helical gear 60 of the wobble plate track element 30—32. The worm may be rotated either manually or by means of a governor, thereby accurately controlling the amount of fuel reaching each cylinder, and accordingly varying the speed of the engine.

The cylinder block 10 is made of cast steel and all the pistons or plungers are lapped into the barrels or otherwise the barrels are honed to provide a very accurate non-leakable fit.

The practically line contact existing between the various moving elements such as the end of the stem 26 and the inner element of the ball race 24, and also the line contact between the inner face of the wobble plate 28 and the upper surface of the track 30, and the further line contact between the upper end of the stem 26 and the inner portion of the track 30, provides a device which is free from any sliding friction, and which, furthermore, on account of the number of cylinders, the relatively short and powerful stroke of each, and the rapidity with which the strokes are repeated, will build up enormous pressures, which, however, can be very accurately controlled, particularly so far as delivery is concerned.

I am aware that many changes may be made and numerous details of construction varied throughout a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than as necessitated by the prior art.

I claim as my invention:

1. A pump comprising a casing, a plurality of pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and a tapered notch in each piston for the reception of the plate edge

2. A pump comprising a casing, a plurality of solid pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and fitting into a corresponding tooth rack groove cut into each piston.

3. A pump comprising a casing, a drive shaft having one end fitted into the casing, a cup on said end, a plurality of pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons a stem integral with the plate, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and fitting into corresponding tooth rack grooves cut into the pistons, and a head on the wobble plate stem adapted for a double line sliding contact with the interior face of the cup on the drive shaft.

4. A pump comprising a casing, a drive shaft having one end fitted into the casing, a cup on said end, a plurality of pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons, a stem integral with the plate, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and fitting into corresponding tooth rack grooves

cut into the pistons, a head on the wobble plate stem adapted for a double line sliding contact with the interior face of the cup on the drive shaft and a supporting track for the plate, the inner face of the wobble plate adjacent its juncture with the stem being shaped so as to conform to the upper edge of the supporting track by rolling line contact.

5. A pump comprising a casing, a drive shaft having one end fitted into the casing, a cup on said end, a plurality of pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons, a stem integral with the plate, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and fitting into corresponding tooth rack grooves cut into the pistons, a head on the wobble plate stem adapted for a double line sliding contact with the interior face of the cup on the drive shaft and a supporting track for the plate, the inner face of the wobble plate adjacent its juncture with the stem being shaped so as to conform to the upper edge of the supporting track by rolling line contact, and the inner surface of said track being also formed to conform with the sliding line contact with the corresponding portion of the wobble plate stem.

6. A pump comprising a casing, a drive shaft having one end fitted into the casing, a cup on said end, a plurality of pistons slidably mounted in cylinders in the casing, a wobble plate engaging each of the pistons a stem integral with the plate, the periphery of the wobble plate having a profile corresponding to a standard stub tooth and fitting into corresponding tooth rack grooves cut into the pistons, a head on the wobble plate stem adapted for a double line sliding contact with the interior face of the cup on the drive shaft and a supporting track for the plate, the inner face of the wobble plate adjacent its juncture with the stem being shaped so as to conform to the upper edge of the supporting track by rolling line contact, the inner surface of said track being also formed to conform with the sliding line contact with the corresponding portion of the wobble plate stem, and an annular guide formed integral with the medial portion of the wobble plate stem for a sliding line contact with the lowermost portion of the said track.

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