

FLUID PUMP WITH A FLEXIBLE TOOTHED BELT

This invention relates to a fluid pump, and is particularly, although not exclusively, useful for the self-priming pumping of liquids.

Gear pumps are known which entrain fluid into the mesh of two counter-
5 rotating cogs and expel the fluid under pressure, but such gear pumps need fast rotation of the gears and require to be manufactured with close tolerances.

The present invention overcomes or mitigates these drawbacks of the gear pump. The present invention provides a fluid pump comprising an internally-toothed drive belt drivingly coupled to a correspondingly externally-toothed first
10 pulley wheel and arranged over a belt guide, which preferably takes the form of a second pulley wheel, spaced from the perimeter of the first pulley wheel, a fluid-tight housing containing the drive belt and pulley wheel, and means for coupling the motion of the first pulley wheel and the drive belt to that of an external drive; the housing having a fluid inlet port communicating with a space between the pulley
15 wheels and the belt guide, and a fluid outlet port closely adjacent the region at which the drive belt engages tangentially with the first pulley wheel with their respective teeth in partial engagement; whereby motion of the first pulley wheel causes fluid from the space between the pulley wheel and the belt guide to be drawn into the nip of the first pulley wheel and the drive belt and then to be expelled
20 under pressure to the fluid outlet port.

The invention also provides a pumping system comprising a main fluid pump and a pump according to the invention used as a primer for the main fluid pump.

The fluid pump of the invention has been found surprisingly to pump with great efficiency even at low rotational speeds; whilst the gap between the drive belt
25 and the housing is important, there is still a reasonable degree of manufacturing

tolerance allowed, and the fluid pump can be mass produced from plastic materials with great economy.

In order that the invention may be better understood, preferred embodiments thereof will now be described, by way of example only, with reference to the
5 accompanying drawings, in which:

Figure 1 is a front elevation of a first embodiment of the invention, but with a front closure plate removed for greater clarity;

Figure 2 is a top plan of the fluid pump of Figure 1, including the front closure plate;

10 Figure 3 and Figure 4 are respectively left-hand and right-hand elevations of the fluid pump of Figures 1 and 2;

Figure 5 is a rear elevation of the fluid pump of Figures 1-4;
and

Figure 6 is a front elevation of a modification, as a second embodiment of
15 the invention.

With reference to Figures 1 to 5 of the accompanying drawings, a first embodiment of the invention consists of a fluid pump 10 for pumping either air or another gas, or else a liquid such as a hydrocarbon or an aqueous liquid. The fluid pump may be used in an extremely wide range of applications, including for
20 example as a fuel injection pump and as a primer for a larger pump. It is self-priming.

In this example, the fluid pump 10 has a box-shaped housing 20 with a front plate 23 removably secured thereto by screws (not shown). The space within the housing 20 is sealed from the exterior throughout by double track seals, and one

example of this is shown between the housing 20 and the front plate 23, in the form of an O-ring 19.

The housing contains two identical spaced toothed pulley wheels 11, 12 mounted for rotation in a common plane on pins 13, 14 respectively. The pulley wheels mesh with an internally-toothed flexible drive belt 16, and rotate in the same direction 17. At least half of the space between the pulley wheels 11, 12 is taken up by a fluid guide block 15 which is as wide as the drive belt 16. As shown in Figure 1, the guide block 15 has side edges which define the lengthways path of the drive belt 16 between the pulley wheels. Arcuate surfaces 21, 22 of the guide block 15 follow closely the path of the teeth of the respective pulley wheels 11, 12 and assist in entraining fluid from the space between the pulley wheels into the nip between the drive belt 16 and each respective pulley wheel 11, 12.

The space between the pulley wheels 11, 12 communicates with a fluid source (not shown), i.e. with the pump inlet, by symmetrically-arranged fluid inlet ports 31, 32 and inlet pipes 31a, 32a connected respectively thereto. In this example, the inlet ports 31, 32 are on the rear of the fluid pump only, but another pair of fluid inlet ports could of course be arranged opposite those fluid ports, at the front side of the fluid pump.

As indicated above, fluid in the space between the pulley wheels 11, 12 is entrained by the teeth of the pulley wheels, and guided by the guide block 15, to enter the region at which the pulley wheel teeth mesh with the drive belt 16. The fluid is compressed by the meshing action of the teeth, as the internal teeth of the drive belt enter into the correspondingly-recessed portions between teeth of the pulley wheels 11, 12. In this example, the teeth are of a constant cross section across the width of the belt. In this particular example, in fact, the drive belt has an

HTD profile, and has an 8 mm pitch with a 30 mm width: the pulleys are also of the HTD standard. However, any configuration of belt and pulley wheel which allows intermeshing with an associated fluid expulsion would suffice and could be substituted as appropriate to different engineering requirements.

- 5 One of the toothed pulley wheels could be replaced by a non-toothed one, or even simply by a stationary belt guide sufficient to keep the belt on its path around the first pulley wheel within the sealed housing.

I have discovered that the fluid is pumped by the intermeshing teeth, and that the gap between the housing and the belt and pulley, at least in the
10 intermeshing region, is such as to cause the fluid to be expelled transversely, i.e. normal to the plane of the pulley wheels and drive belt. For this reason, outlet ports are disposed in two pairs, over the respective regions at which the drive belt engages tangentially with the first and second pulley wheels with their respective teeth in partial engagement. In this example, the two pairs of outlet ports are all
15 cylindrical. A first pair 35, 37 is arranged adjacent the upper pulley wheel 11, with one outlet port 35 at the rear and the other outlet port 37 at the front, facing in mutually opposite directions. At the corresponding position over the second pulley wheel 12, outlet ports 34 and 36 are also disposed on opposite sides of the pulley wheel. In each case, the diameter of the outlet port is approximately 1.5 times the
20 spacing between adjacent teeth of the pulley wheel 11. However, the outlet ports do not have to be cylindrical, and they could for example be slot-shaped or arcuate. Their overall length, following the path of the pulley wheel teeth, is preferably in the range of 1 to 4 times the spacing of the teeth, and advantageously even between 2 and 4 times the spacing, the greater length tending to reduce the back pressure and
25 hence the unwanted hydraulic braking.

In this example, the outlet ports at the rear communicate with bores in the housing 20 which exit the housing on its left and right-hand sides, as shown most clearly in Figure 2. The outlet ports 34-37 communicate respectively with outlet pipes 34a-37a.

- 5 The pulley wheels, 11, 12 are driven by an external prime mover (not shown) such as an electric motor through appropriate gearing. In this example, the prime mover is drivingly coupled to the lower pulley 12 through a spindle 24 on the axis of the pulley.

 The gap between the outer smooth surface 18 of the drive belt 16 and the
10 inner surface of the housing is fairly constant and is sufficiently narrow to restrict fluid flow, yet sufficiently wide to allow relative movement. Preferably the gap is in the range of 0.1-2 mm. The gap is particularly important in the region of the outlet ports.

 In the alternative examples where there is only one toothed pulley wheel,
15 clearly there would only be one nip region to use as the pump fluid outlet.

 Clearly the efficiency of the pump, the velocity ratios and mechanical advantages and other relevant parameters will be selected by appropriate design, to suit the pumping requirement. For the pumping of fluids, I have found that it is advantageous to set the width of the drive belt in the range of 0.1-0.5 times the
20 radius of the pulley wheel. For greatest efficiency, I have found it ideal to have the two pulley wheels equal in size, but this is not essential, and neither is it essential for the second pulley wheel to be toothed, if the second pair of outlets is not required. Further, while two pulleys are provided in this example, a different number could function satisfactorily.

In the preferred example, the belt is of polyurethane, although other plastics materials are envisaged. It is of course important that the drive belt should be of an impervious material, when liquids are to be pumped. Again, in this example, the pulley wheels are of nylon (registered trade mark) or other thermoplastics compounds, and the pins 13, 14 are of stainless steel, the housing 20 being of aluminium and the front plate 23 of perspex, but for mass production it is envisaged that an all-plastics assembly would be appropriate and would offer greatest economy. Different plastics materials may be used for different components.

The pump illustrated in Figures 1 to 5 has been driven at 150 rpm, and at this speed it developed a pressure differential of 0.8 bar, pumping water at 7.5 litres per minute, with an internal pressure of greater than about 20 bar (300 psi). To achieve this pumping action, the pump was driven by a 380 watt electric motor.

A second embodiment of the invention will now be described with reference to Figure 6, which shows a variant of the first embodiment in a view corresponding to Figure 1.

Instead of the guide block 15, there are two guide blocks 1,3 following part of the periphery respectively of pulley wheels 11 and 12 which are driven in the directions 4 and 2. This leaves more open space in the region between the pulley wheels.

**CLAIMS**

1. A fluid pump comprising an internally-toothed drive belt drivingly coupled to a correspondingly externally-toothed first pulley wheel and arranged over a belt guide, which preferably takes the form of a second pulley wheel, spaced from the
5 perimeter of the first pulley wheel, a fluid-tight housing containing the drive belt and pulley wheel, and means for coupling the motion of the first pulley wheel and the drive belt to that of an external drive; the housing having a fluid inlet port communicating with a space between the pulley wheels and the belt guide, and a fluid outlet port closely adjacent the region at which the drive belt engages
10 tangentially with the first pulley wheel with their respective teeth in partial engagement; whereby motion of the first pulley wheel causes fluid from the space between the pulley wheel and the belt guide to be drawn into the nip of the first pulley wheel and the drive belt and then to be expelled under pressure to the fluid outlet port.
- 15 2. A fluid pump according to Claim 1, in which the belt guide is a second pulley wheel.
3. A fluid pump according to Claim 1 or 2, in which the fluid outlet port faces one side of the first pulley wheel so that it receives fluid expelled transversely thereof, generally normal to the plane of rotation of the drive belt and pulley wheels.
- 20 4. A fluid pump according to Claim 3, comprising a further fluid outlet port transversely opposite the said fluid outlet port, so that it receives fluid expelled transversely in the opposite direction to the fluid expelled through the said fluid outlet port.
5. A fluid pump according to Claim 2, in which the second pulley wheel is
25 correspondingly externally toothed, and the housing has an additional fluid outlet





port closely adjacent the region at which the drive belt engages tangentially with the second pulley wheel with their respective teeth in partial engagement.

6. A fluid pump according to Claim 5, in which the housing has a still further fluid outlet port transversely opposite the said additional fluid outlet port, so that it receives fluid expelled transversely in the opposite direction.
7. A fluid pump according to any preceding claim, in which the housing and drive belt have therebetween, for at least a portion of the belt path around the said nip of the first pulley wheel and the drive belt, a narrow gap sufficiently wide to allow relative movement but sufficiently narrow to restrict fluid flow.
8. A fluid pump according to Claim 7, in which the housing encloses the drive belt with a narrow gap everywhere except for the said space between the pulley wheels, and the said fluid outlet ports are closely adjacent the surface of the corresponding pulley wheel or wheels.
9. A fluid pump according to any preceding claim, in which the fluid outlet port or ports are as wide as between 1 and 4 teeth of the first pulley wheel.
10. A fluid pump according to Claim 9, in which the said width of the outlet port or ports corresponds to the width of between 2 and 4 teeth of the first pulley wheel.
11. A fluid pump according to Claim 7 or 8, in which the said gap is in the range 0.1 - 2.0 mm.
12. A fluid pump according to any preceding claim, in which the drive belt has a width in the range of 0.1-0.5 times the radius of the first pulley wheel.
13. A fluid pump according to any preceding claim, in which the drive belt is of a plastics material.
14. A fluid pump according to any preceding claim, in which the housing and pulley wheels are of a plastics material or of different plastics materials.





15. A fluid pump according to any preceding claim, further comprising a prime mover drivingly coupled to the said coupling means.
16. A fluid pump according to any preceding claim, comprising a fluid reservoir and means for entraining fluid from the reservoir into the gap between the drive belt
5 and the housing.
17. A fluid pump according to Claim 16, in which the entraining means comprises a third pulley wheel drivingly coupled to the first and second pulley wheels by means of external teeth which mesh with external teeth on the drive belt, the arrangement being such that fluid from the fluid reservoir is collected by the
10 external teeth of the third pulley wheel, and the fluid is transferred to the gap by means of the intermeshing of the teeth of the pulley wheels.
18. A fluid pump according to any preceding claim, in which the said fluid which is arranged to enter the space between the pulley wheel and the belt guide and which is expelled from the housing is air or a different gas.
- 15 19. A fluid pump according to any preceding claim, in which the said fluid which is arranged to enter the space between the pulley wheel and the belt guide and which is expelled from the housing is a liquid.
20. A pumping system comprising a main fluid pump and a fluid pump according to any of the preceding claims connected to the main fluid pump as a primer
20 therefor.
21. A fluid pump substantially as described herein with reference to the accompanying drawings.

THIS SHEET HAS BEEN REPLACED

