

PATENT SPECIFICATION

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(54) AN OSCILLATING VANE PUMP FOR LIQUIDS

(71) I, WALDEMAR RIEPE of 3 Elsa-Brandstrom-Strasse, 4500 Osnabruck, Federal Republic of Germany; a German national, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to a pump for liquids having an oscillating armature connected to a leaf spring and having a resiliently flexible plate arranged as an extension of the leaf springs:

In known pumps of this type the leaf spring and the flexible plate are integrally formed in one piece so that the plate is the outer end of the leaf spring which serves for mounting of the oscillating armature. In such a pump the front end plate is unable to execute any adequate pumping strokes. The object of the invention is based on improving the above-mentioned pumps to such an extent that a substantial increase in pumping capacity is attained.

According to the present invention there is provided a pump for liquids having an oscillating armature resiliently supported on a leaf spring and operated by alternating current and a resiliently flexible thin-walled plate supported on the armature as an extension of the leaf spring which plate protrudes into a liquid outlet passage of the pump, the leaf spring and the plate being synchronously displaceable in a transverse direction, the plate having a substantially lower bending resistance than the leaf spring.

The ratio of the respective rigidity values is preferably between 1:10 to 1:100, but particularly in the order of substantially 1:60.

Such design of the liquid pump provides on the one hand the desired mounting of the oscillating armature, whilst on the other hand the plate protruding into the liquid-carrying passage on account of its relatively high flexibility is adapted to carry out fin-like movements with correspondingly long strokes

perpendicularly to its own plane. Consequently, the oscillating armature executes rather short strokes in a lateral direction, whilst the relatively soft plate executes strokes which are much longer than those of the oscillating armature connected to the leaf spring. The oscillating armature is retained and guided by the leaf spring and will only reciprocate the flexible plate rhythmically so as to impart thereto a movement in the manner of the tail fin of a fish. With the pumps in question the alternating driving power frequency is generally about 50 Hz.

The required flexibility of the front end plate should be guaranteed by an adequate choice of the plate material. Preferably, the plate is made of rubber or rubber-like plastics of such low hardness as to be deflected for about 1 mm under the influence of a bending power in the order of 0.5 Pond acting on a free length of about 10 mm. In view of such requirements, the plate should have a hardness of between 55-65 Shore hardness A. By this means it is ensured that with small strokes of the oscillating armature the plate will be deflected for substantially larger amounts. The lateral deflection is such that the tip or the free end of the plate moves across the whole or substantially the whole width of the respective liquid carrying passage. Any possible contacts of the plate with the opposite walls of the passage are of no detrimental effect because of the rubber-elastic deformability of the plate.

The liquid carrying passage preferably tapers in the direction of the liquid flow and the plate should protrude into this passage so that the leading edge of the plate be located in the region of the narrowest part of the passage.

The present invention will be described further, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a horizontal medial section through a pump according to the present invention; and

Figure 2 is a longitudinal section through the

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pump of Figure 1.

A base plate 1 serves for mounting and securing the various parts of the pump and may support means for mounting and securing the pump within an aquarium with which it is intended to be used.

The base plate 1 forms the lower wall of the passage 2 of rectangular cross-section through which the liquid to be pumped is conveyed. The passage 2 is further defined by an upper plate 3 and on both sides by shaped members 4. The shaped members 4 enclose a passage 2 decreasing gradually and continually in the direction of liquid flow to a normal cross section maintained for substantially one third of its total length and afterwards being enlarged again to its outlet orifice. Such enlargement of the outlet orifice of passage 2, however, is not essential but it is preferred for optimum discharge flow conditions.

At the rear portion of the base plate 1 a support 6 is provided for a leaf spring 7 which extends towards the passage 2 and at its free end on both sides carries permanent magnets 8. Adjoining the free end of the leaf spring 7 a rubber plate 9 is provided which at its rear end is retained between the two permanent magnets 8.

On opposite edges of the base plate 1 a pair of small electro-magnets 10 are provided such that the two permanent magnets 8 are located substantially centrally between the two electro-magnets 10 having electrical connections 11. By feeding an alternating field (of a frequency of generally 50 Hz) to the electro-magnets 10, the armature 12 comprising the two permanent magnets 8 is caused to oscillate laterally.

The dotted lines 13 in Figure 1 indicate a deflection to the right, whereby the leaf spring 7 accordingly bends to the right, and after swinging to the right armature 12 swings to the opposite side by a similar extent. The armature 12 is thus moved to the right and left in rapid succession perpendicularly to the plane of the leaf spring 7. In practice the leaf spring 7 is made of toughened plastics material which with an effective length of about 10 mm, when subjected to a force of about 30 Pond, is deflected by 1 mm at its free end. The plate 9 on the other hand, which with regard to its wall thickness and its effective length has substantially the same mass as the leaf spring 7, but consists of rubber having a hardness of between 55-65 Shore A and preferably about 60 Shore A and with an effective length of 10 mm and when subjected to a force of 0.5 Pond, will be deflected for 1 mm at its free end. The ratio of the bending resistance of the spring 7 and the plate 9 may be between 1 : 10 and 1 : 100 and is preferably 1 : 60.

The differing bending resistances of spring 7 and plate 9 provide for a particular movement of the plate 9 and thereby cause a substantially high pumping capacity.

If the armature 12 is deflected to the right assuming the position shown by the dotted lines 13, notwithstanding the deflection of the clamped end of the plate 9 together with armature 12 to the right its free end 9' will move in the opposite direction almost to or into abutting contact with the corresponding shaped member 4 and vice versa. Such "bending back" is caused by the inherent dynamic conditions of the system and provides a node or rest point 14 to be produced substantially half way along the length of the plate 9.

Deflection of the armature to the opposite side produces an opposite bending of the plate 9, whereby the free end 9' is displaced towards the right shaped member 4. The plate 9 oscillates in the hatched region shown and hence is effective over substantially the total cross-section of passage 2, since the width of plate 9 is only slightly less than the width of passage 2.

Owing to such deformation of the plate, a relatively powerful pumping action is attained so that liquid entering in the direction of arrows 15 is pumped through the passage 2 and is discharged in the direction of arrows 5.

It should be clear that the moving masses have to be adapted to the electro-magnets 10 to permit the optimum desired deflection of the armature 12.

With an effective length of the leaf spring 7 and the plate 9 of about 10 mm the wall thickness of the plate 9 should be about 1 mm and for mechanical reasons the leaf spring 7 is of the same thickness.

WHAT I CLAIM IS:-

1. A pump for liquids having an oscillating armature resiliently supported by a leaf spring and operated by alternating current and a resiliently flexible thin-walled plate supported on the armature as an extension of the leaf spring which plate protrudes into a liquid outlet passage of the pump, the leaf spring and the plate being synchronously displaceable in a transverse direction, the plate having a substantially lower bending resistance than the leaf spring.

2. A pump as claimed in claim 1, in which the ratio of the bending resistance is between 1 : 10 and 1 : 100.

3. A pump as claimed in claim 1 or 2, in which the ratio of the bending resistance is 1 : 60.

4. A pump as claimed in claims 1 to 3, in which the plate is made of rubber or rubber-like plastics and has a Shore hardness A of between 55-65.

5. A pump as claimed in claim 4, in which the Shore hardness A is 60.

6. A pump as claimed in claims 1 to 5, in which the oscillating armature is located at a distance from the inner end of the liquid outlet passage and the plate protrudes into the passage 7. A pump as claimed in claims 1 to 6, in which the liquid outlet passage gradually narrows



(11) pump of Figure 1.

A base plate 1 serves for mounting and securing the various parts of the pump and may support means for mounting and securing the pump within an aquarium with which it is intended to be used.

The base plate 1 forms the lower wall of the passage 2 of rectangular cross-section through which the liquid to be pumped is conveyed. The passage 2 is further defined by an upper plate 3 and on both sides by shaped members 4. The shaped members 4 enclose a passage 2 decreasing gradually and continually in the direction of liquid flow to a normal cross section maintained for substantially one third of its total length and afterwards being enlarged again to its outlet orifice. Such enlargement of the outlet orifice of passage 2, however, is not essential but it is preferred for optimum discharge flow conditions.

At the rear portion of the base plate 1 a support 6 is provided for a leaf spring 7 which extends towards the passage 2 and at its free end on both sides carries permanent magnets 8. Adjoining the free end of the leaf spring 7 a rubber plate 9 is provided which at its rear end is retained between the two permanent magnets 8.

On opposite edges of the base plate 1 a pair of small electro-magnets 10 are provided such that the two permanent magnets 8 are located substantially centrally between the two electro-magnets 10 having electrical connections 11. By feeding an alternating field (of a frequency of generally 50 Hz) to the electro-magnets 10, the armature 12 comprising the two permanent magnets 8 is caused to oscillate laterally.

The dotted lines 13 in Figure 1 indicate a deflection to the right, whereby the leaf spring 7 accordingly bends to the right, and after swinging to the right armature 12 swings to the opposite side by a similar extent. The armature 12 is thus moved to the right and left in rapid succession perpendicularly to the plane of the leaf spring 7. In practice the leaf spring 7 is made of toughened plastics material which with an effective length of about 10 mm, when subjected to a force of about 30 Pond, is deflected by 1 mm at its free end. The plate 9 on the other hand, which with regard to its wall thickness and its effective length has substantially the same mass as the leaf spring 7, but consists of rubber having a hardness of between 55-65 Shore A and preferably about 60 Shore A and with an effective length of 10 mm and when subjected to a force of 0.5 Pond, will be deflected for 1 mm at its free end. The ratio of the bending resistance of the spring 7 and the plate 9 may be between 1 : 10 and 1 : 100 and is preferably 1 : 60.

The differing bending resistances of spring 7 and plate 9 provide for a particular movement of the plate 9 and thereby cause a substantially high pumping capacity.

If the armature 12 is deflected to the right assuming the position shown by the dotted lines 13, notwithstanding the deflection of the clamped end of the plate 9 together with armature 12 to the right its free end 9' will move in the opposite direction almost to or into abutting contact with the corresponding shaped member 4 and vice versa. Such "bending back" is caused by the inherent dynamic conditions of the system and provides a node or rest point 14 to be produced substantially half way along the length of the plate 9.

Deflection of the armature to the opposite side produces an opposite bending of the plate 9, whereby the free end 9' is displaced towards the right shaped member 4. The plate 9 oscillates in the hatched region shown and hence is effective over substantially the total cross-section of passage 2, since the width of plate 9 is only slightly less than the width of passage 2.

Owing to such deformation of the plate, a relatively powerful pumping action is attained so that liquid entering in the direction of arrows 15 is pumped through the passage 2 and is discharged in the direction of arrows 5.

It should be clear that the moving masses have to be adapted to the electro-magnets 10 to permit the optimum desired deflection of the armature 12.

With an effective length of the leaf spring 7 and the plate 9 of about 10 mm the wall thickness of the plate 9 should be about 1 mm and for mechanical reasons the leaf spring 7 is of the same thickness.

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1. A pump for liquids having an oscillating armature resiliently supported by a leaf spring and operated by alternating current and a resiliently flexible thin-walled plate supported on the armature as an extension of the leaf spring which plate protrudes into a liquid outlet passage of the pump, the leaf spring and the plate being synchronously displaceable in a transverse direction, the plate having a substantially lower bending resistance than the leaf spring.

2. A pump as claimed in claim 1, in which the ratio of the bending resistance is between 1 : 10 and 1 : 100.

3. A pump as claimed in claim 1 or 2, in which the ratio of the bending resistance is 1 : 60.

4. A pump as claimed in claims 1 to 3, in which the plate is made of rubber or rubber-like plastics and has a Shore hardness A of between 55-65.

5. A pump as claimed in claim 4, in which the Shore hardness A is 60.

6. A pump as claimed in claims 1 to 5, in which the oscillating armature is located at a distance from the inner end of the liquid outlet passage and the plate protrudes into the passage. 7. A pump as claimed in claims 1 to 6, in which the liquid outlet passage gradually narrows



from its inner end towards its discharge orifice and the plate protrudes into the constricted part of such passage.

5 8. A pump as claimed in claims 1 to 7, in which the plate is sufficiently resiliently flexible so that during deflection of the armature the free end of the plate moves close to the lateral walls of the passage or makes contact therewith.

10 9. A pump as claimed in claims 1 to 8, in which the plate is sufficiently flexible so that its free end is deflected in an opposite direction to the direction of deflection of the armature.

15 10. A pump as claimed in claims 1 to 9, in which a portion of the plate of the order of between one third and two thirds of its length remains at rest or substantially at rest during the oscillating movement.

20 11. A pump as claimed in claims 1 to 10, in which the plate has a length of about 10 mm and a wall thickness of about 1 mm.

12. A pump as claimed in claim 11, in

which the leaf spring has approximately the same wall thickness as the plate.

13. A pump as claimed in claims 1 to 12, in which the oscillating armature consists of two permanent magnets enclosing the ends of the leaf spring and of the plate.

14. A pump as claimed in claims 1 to 13, in which the height of the plate corresponds substantially to the height of the liquid carrying passage.

15. A pump for liquids substantially as herein described with reference to and as illustrated in the accompanying drawings.

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