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**DE-A- 3 109 090            DE-B- 2 252 304**  
**FR-A- 2 233 877            US-A- 3 348 489**

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## Description

This invention relates to an electrical pump for fluids, eg hot water or for coffee machines, with economical outlay and power consumption.

According to a known pump, a generally cylindrical armature/piston combination which slides axially and has a generally axial internal bore to pass fluid from an inlet to an outlet, also has one or more radial bores between the axial bore and its exterior inside a sliding guide for the combination. In the state of the art represented by US-A-3348 489 or FR-A-2 233 877, the combination has axial external grooves for the same purpose.

The general purpose is to prevent fluid build-up between the combination and its guide. Such a build-up has a braking effect on the armature/piston combination due to pressure and viscosity, but is relieved by these prior art artifices. Unfortunately the bore is expensive to machine and the machining can form a burr (a jagged irregularity projecting from the hole) which tends to scrape and wear out at least the assembly and its guide. In spite of consequent expense, burrs or wear, the loss of force and power due to peripheral fluid build-up can amount to 50%, and so has typically been dealt with in this way. Also external grooves of the state of the art can be expensive and time consuming to produce by machining etc.

The invention aims also to minimize the peripheral fluid presence and consequent braking effect, but without causing a burr and/or incurring the expense of shaping the armature/piston combination. The reduction in braking effect can lead to greater noise and shocks being generated.

Accordingly the invention is set out in Claim 1. The armature/piston assembly guide is shaped according to one feature of the invention to facilitate peripheral fluid mobility. Also the piston face is equipped to counter the noise and shock generation. According to a preference of the invention, production of the downstream part or end of the combination is simplified. In the past it has been externally tapered or reduced in diameter by machining; which is quite expensive in time and loss of magnetic material. The machining of the guide, or other shaping is advantageous, then, even though the guide has to be radially thicker, with some loss of magnetic coupling to the armature. A preferred embodiment provides an armature assembly formed by a reduced diameter body which may be of a different, non-magnetic material or metal, crimped to the main body of the assembly. The axial bore must be continuous but the reduced diameter body can be machined or moulded, cast etc separately before the two pieces are crimped together. The preferred embodiments are now detailed with reference to the drawings, in which:

Figure 1 shows in diametrical section a pump embodying the invention;

Figures 2 and 3 show likewise an armature/piston piece, and its crimped together combination with a narrower downstream piece; and

Figure 4 shows a guide cross section.

Referring to Figure 1, a pump has an inlet port 1 from which fluid is pumped by an axially vibrating armature/piston combination 2 to an outlet port 3, through an axial bore 4 in the entire length of combination 2, an inlet valve 5 and an outlet valve 6 in an axial passage in the housing 7 leading to the outlet port 3.

The outlet valve 6 is merely a one-way passive or flow-responsive valve, but the inlet valve 5 is opened by separation of the piston part, ie by the leftward movements of armature/piston 2 in its vibrations. The leftward movements cause fluid to be transferred from inlet port 1 past the inlet valve 5 and thence to the outlet 3. The leftward armature movements are caused by repeated energizations of a solenoid coil 8 via a terminal T and act against a return spring 9. The repeated energizations can result conveniently from half-wave rectified ac, eg at 50 Hz, between the half-waves of which the spring returns the combination rightward to close inlet valve 5.

Both valves 5 and 6 are spring closed by return springs 10 and 11, spring 10 being weaker than spring 9.

Unfortunately fluid unavoidably flows between the outside of the armature/piston and its guide 13, which can impede the armature vibrations. This tendency can be relieved, by measures described below.

As will also be appreciated, the wider part of the armature 2 comes to rest each return stroke against a shock absorber ring 15. By the above very desirable avoidance of the impeding of the vibrations, there is an unfortunate tendency to cause greater shocks which the invention aims to counter. Through ring 15 an elongated narrow part 16 of the armature extends, preferably via sealing O-rings 17 and 18, to abut and seat inlet valve 5. The state of the art is to machine the mild steel down from the wider to this narrower diameter which takes time, wastes material and may cause burrs or leave particles which can separate later and block flow-ways. Moreover mild steel is heavy, causing greater shocks. More machining away is involved to provide annular volume 12. Although a relatively long axial bore has to be provided, the narrow end according to this embodiment need not be magnetic or so heavy, especially if the aforesaid shocks are to be minimized. The magnetic circuit may comprise outside the coil outer encapsulation 19, a rectangular yoke (not shown) of two L-sec-

tioned pieces crimped together along their corners, a first cylindrical internal part 20 outside the thin armature guide 13, a ring 21 magnetically connecting the yoke and cylinder 20, a second cylindrical internal part 22, and a ring 23 communicating cylinder 22 to the yoke.

The L-pieces have respective holes closely surrounding rings 21, 23.

Many alternative magnetic circuits are possible. The cylindrical magnetic gap 24 between the two cylindrical parts as well known attracts the armature adjacent to it, ie. leftward in Fig.1 against spring 9, whenever coil 8 is energized. The material used for the narrow part 16 of the armature therefore need not be magnetic since it cannot appreciably interact with gap 24 or other magnetic circuitry.

Referring to the desirable reduction of flows external to the combination piston, the guide 13 has eg. five internal longitudinal ribs 25 (see also Fig.4) on which the sliding armature bears and between which any trapped fluid can readily return (as shown by the flow line arrows 25') to the pumped stream travelling rightwards through the bore. The ribs can be provided without machining and at low cost in the mould of plastic guide 13, and free particles are unlikely and not metallic. There should be longitudinal ribs or grooves or non-circular irregularities in the guide providing bearing surfaces, and no trapped space, but instead, a continuous communication between all peripheral points and the main axial pumped stream. The longitudinal irregularities in the guide either can be strictly parallel to the axis, or can be oblique or helical or otherwise to provide this longitudinal communication, and hence lack of pressure build-up and viscosity drag, while enabling efficient piston effect and hence pumping action. The armature/piston can be preferably in two parts as shown in Figs. 2 and 3, while having the inventive elongated irregularities of Fig 4 or variations thereof. The pressure reducing irregularities in the guide are best seen in the transverse cross-sectional view of Fig 4, but they are longitudinal in nature, being grooves or ribs or corners either parallel to the axis on having an axially directed component (eg. helical irregularities in the guide).

Referring to Fig. 2 a wide part 26 of the armature/piston has a central bore 27 and a holding portion 28, the top of which has an annular groove 29 to surround a lip 30 which can be crimped inwards by a suitable tool (not shown). The section of bore 31 of holding part 28 serves to accommodate a non-magnetic part 32 (eg. of brass or lighter plastics as suitable) shown in Figs 1 and 3. Part 32 has a waist 33 to accommodate in fluid-tight manner an annulus of crimped-in material from lip 30 as can be seen in Fig. 3.

The end 34 of part 32 is shaped to serve as a valve seat for inlet valve 5, Fig. 1. The inlet end 35 of wide part 26 may be flared to promote flow and have a circular projection to seat and hold the return spring 9. No ribs or grooves in the wide part of the armature need be present, such flow-conductive shapings applied to the guide only are adequate. Not only is the narrow part provided without necessity to machine down the wide part, but boring only of shorter axial lengths is needed.

## Claims

1. A fluid pump comprising a reciprocating armature/piston combination, through a bore in which the pumped fluid passes, wherein fluid tending to become trapped between the internal walls of the guide (13) and the external wall of the wide part (26) of the armature/piston combination (2) is instead returned to the pumped stream, by means of a shaping composing cross-sectional differential or relative irregularities between said internal and external walls, providing continuous longitudinal fluid communication between each end of the armature/piston; characterised in that said irregularities are non-circular irregularities (25) in the guide (13), which nevertheless provides a bearing surface for the reciprocation of the armature/piston (2); and in that shock or noise caused by reduction of braking by the resulting reduction of trapped fluid, is countered by a shock-absorber ring (15) and any necessary sealing rings (17,18) acting on a transverse face (29,30) of the wide part (26) of the piston.
2. A fluid pump according to Claim 1 wherein the reciprocating armature/piston combination has a relatively narrow extension (32) not abutted by said rings but passing therethrough, which seats and unseats a valve (5), wherein the extension projects axially from said transverse face (29,30) of the armature, and is a separate bored non-magnetic piece crimped (30, 33) or otherwise attached to a wide part (26) which is magnetic.
3. A fluid pump according to Claim 2 comprising a waist (33) in the axial extension (32) receiving a crimped in portion (30) of said transverse face of the wide part (26) of the combination.
4. A fluid pump according to any of Claims 1-3, wherein the non-circular irregularities are longitudinal guide ribs (25) extending along the inside wall of the armature guide.
5. A fluid pump according to any of Claims 1-4

having series inlet and outlet valves on the downstream side of the combination, which are passive but biased towards closure positions.

## Revendications

1. Une pompe à liquide comprenant un ensemble oscillant combiné noyau magnétique piston, avec un forage à travers passe le liquide pompé, dans laquelle le liquide infiltré tendant à se trouver emprisonné entre les parois intérieures du manchon de guidage (13) et la surface extérieure de la partie de grand diamètre (26) de l'ensemble noyau piston (2) se trouve renvoyé au lieu de cela dans le courant de liquide pompé, au moyen d'une structuration avec des irrégularités différentielles ou relatives entre lesdites surfaces de parois internes et externes caractérisée par le fait que lesdites irrégularités sont des irrégularités non circulaires (25) prévues à l'intérieur du manchon de guidage (13) qui comporte néanmoins une surface de portée pour le mouvement alternatif de l'ensemble noyau piston (2), que lesdites irrégularités assurent une communication longitudinale continue pour le liquide entre les deux extrémités du noyau piston et par le fait que les chocs et les bruits résultant de l'atténuation de l'effet de freinage obtenue avec la réduction des quantités de liquide emprisonnées sont contre-carrés par un anneau amortisseur (15) et par des bagues d'étanchéité (17,18) pouvant être nécessaires et agissant la surface frontale (29,30) de la partie de grand diamètre (26) du noyau.
2. Une pompe à liquide selon la revendication 1 caractérisée par le fait que l'ensemble noyau-piston comporte un prolongement (32) de diamètre relativement faible, ne bute pas contre ledit anneau et lesdites bagues d'étanchéité mais passe à travers, qui provoque l'ouverture et la fermeture d'une soupape (5), ladite extension étant en saillie sur ladite face transversale (29,30) du noyau, et qui est constitué par une pièce forée non magnétique séparée assemblée par sertissage (30,33) ou de quelque autre manière avec une partie de grand diamètre (26) qui est magnétique.
3. Une pompe à liquide selon la revendication 2 comprenant un gorge (33) pratiquée dans le prolongement axial (32) dans laquelle est rabattue la partie (30) de ladite face transversale de la partie de grand diamètre (26) de l'ensemble.
4. Une pompe à liquide selon l'une quelconque

des revendications de 1 à 3 caractérisé par le fait que les irrégularités non circulaires sont des nervures de guidage longitudinales (25) qui s'étendent le long de la paroi intérieure du manchon de guidage du noyau.

5. Une pompe à liquide selon l'une quelconque des revendications de 1 à 4 caractérisé par le fait qu'elle comporte des soupapes d'entrée et de sortie disposées en série du côté aval de la pompe, qui sont des soupapes passives mais comportant des ressorts de rappel en position fermée.

## Patentansprüche

1. Flüssigkeitspumpe mit einem in einer Bohrung, durch die die gepumpte Flüssigkeit durchfließt, hin- und hergehenden Anker/Kolben-Einheit, wobei die Flüssigkeit, die dazu neigt, zwischen der inneren Wand der Führung (13) und der äußeren Wand des großen Abschnittes (26) der Anker/Kolben-Einheit festgehalten zu werden, statt dessen in den gepumpten Strom infolge einer Formgebung zurückgeführt wird, die eine Querschnittsveränderung oder bezogen aufeinander Unregelmäßigkeiten zwischen der inneren und der äußeren Wand umfaßt, die ununterbrochene längsverlaufende Strömungsverbindungen zwischen beiden Enden der Anker/Kolben-Einheit bilden, dadurch gekennzeichnet, daß die Unregelmäßigkeiten nicht-ringförmig umlaufende Unebenheiten (25) in der Führung (13) sind, die dennoch eine Führungsfläche für die Schwingbewegung des Ankers/Kolbens bilden, und daß Schläge oder Geräusche, die durch die Verringerung der Bremsung infolge der resultierenden Verringerung von festgehaltener Flüssigkeit verursacht werden, mittels eines Stoßdämpferinges (15) und den erforderlichen Dichtringen (17, 18) entgegen gewirkt wird, die auf eine Querfläche (29, 30) an dem großen Abschnitt des Kolbens wirken.
2. Flüssigkeitspumpe nach Anspruch 1, bei der die hin- und hergehende Anker/Kolben-Einheit eine relativ dünne Verlängerung (32) aufweist, die nicht gegen die Ringe anstoßt, sondern durch diese hindurchgeht und die ein Ventilverschlußglied (5) abhebt und sich aufsetzen läßt, wobei sich die Verlängerung axial von der Querfläche (29, 30) des Ankers weg erstreckt und ein separat gebohrtes unmagnetisches Teil ist, das an dem größeren und magnetischen Teil (26) durch Bördeln (30, 33) oder anderweitig befestigt ist.

3. Flüssigkeitspumpe nach Anspruch 2, bei der die axiale Verlängerung (32) eine Einschnürung (33) aufweist, die einen hineingebördelten Bereich (30) der Quersfläche des großen Abschnittes (26) der Einheit aufnimmt. 5
4. Flüssigkeitspumpe nach einem der Ansprüche 1 bis 3, bei der die nichtkreisförmigen Unebenheiten längsverlaufende Führungsrippen (25) sind, die sich entlang der inneren Wand der Ankerführung erstrecken. 10
5. Flüssigkeitspumpe nach einem der Ansprüche 1 bis 4, die hintereinanderliegende Einlaß- und Auslaßventile an der Abströmseite der Einheit aufweist, die passiv, jedoch auf die geschlossene Stellung zu vorgespannt sind. 15

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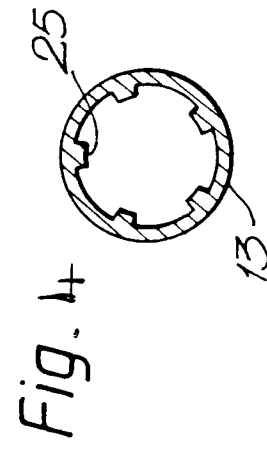
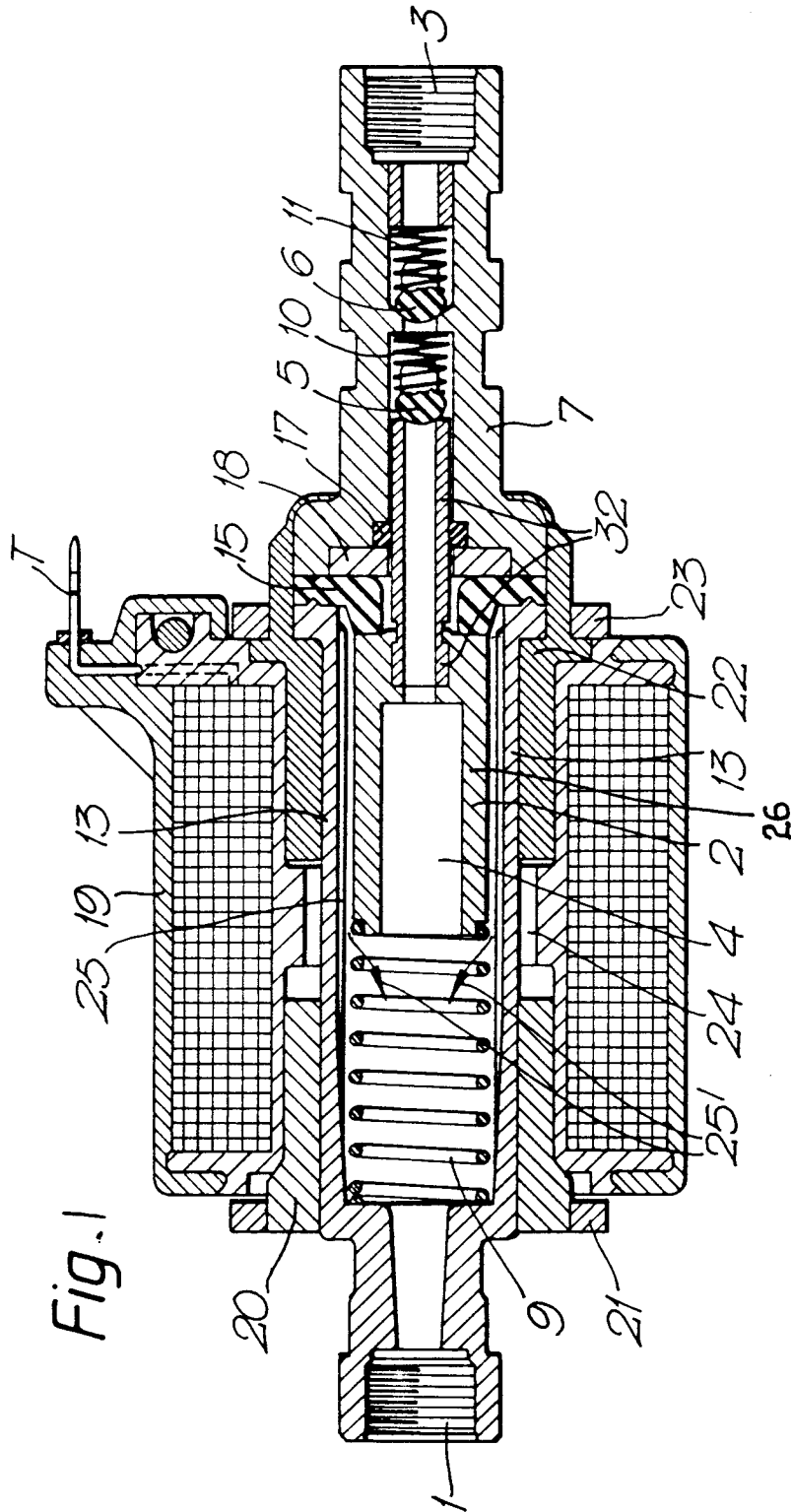


Fig. 2

