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(54) Electrical fluid pump.

(57) The pump operates using an electromagnetically vibrated armature (26) with a central through-conduit (4) and passive valves (5,6,). The armature has a narrower extension (32) to operate the valves, through which the conduit also passes.

In order to avoid fluid building up between the armature and its guide (13), and impeding the movements of the armature, at least one of these is irregularly shaped, to provide firstly longitudinal through paths for such fluid to be quickly scavenged and removed, and secondly, cooperating guiding surfaces which are bypassed by the fluid, and not subject to fluid build-up between them.

Therefore, power losses through fluid build ups is avoided, without necessity for state of the art radial drilling of the armature (13).

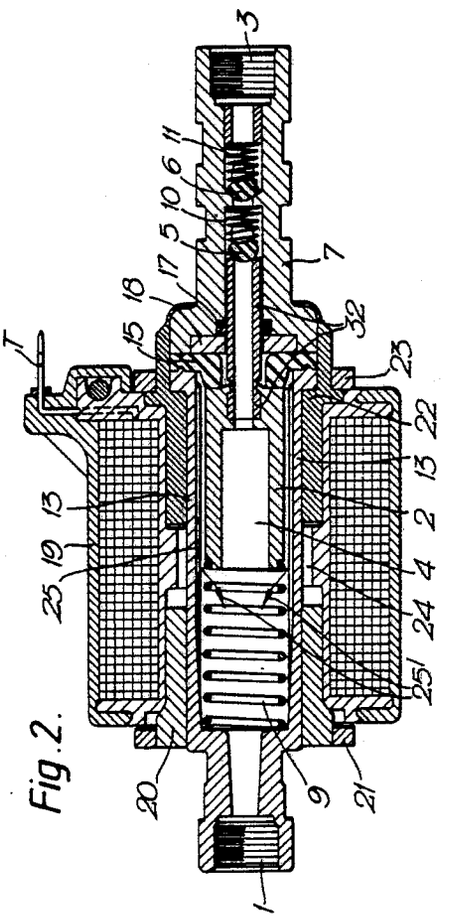

Fig.2.

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ELECTRICAL FLUID PUMP

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.

The radial bore serves 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 the prior art radial bore. 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 of 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.

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 radially machining into the axial bore.

According to the invention set out in Claim 1 the armature/piston assembly and/or its guide is shaped to facilitate peripheral fluid mobility. A second aim according to a preference of the invention is to simplify production of the downstream part or end of the combination which has in the past been externally tapered or reduced in diameter by machining, which is quite expensive in time and loss of magnetic material. The invention preferably 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 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:

Figures 1 and 2 show in diametrical section a known pump and an inventive pump;

Figures 3 and 4 show likewise an armature/piston piece, and its crimped together combination with a narrower downstream piece; and

Figures 5, 6 and 7 show guide and armature cross sections.

Referring to Figure 1, the known 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.

An annular volume 12 is arranged to collect fluid which unavoidably flows between the outside of the armature/piston and its guide 13, but tends to get full enough of fluid to impede the amature vibrations. This tendency can be relieved, as known, by one or more radial bores 14, which provide relief conduits, from volume 12 when undesirably full of collected fluid, to the central bore 4. Such machining as aforesaid is costly and can leave burrs or loose metal particles prejudicial to the action or life of the pump. Another drawback, trapped fluid suffers a time delay before it can even reach volume 12, so it is impeding the vibrations during this time delay, even if fluid does not accumulate unduly in volume 12. The invention seeks to avoid all these possible drawbacks.

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 impending of the vibrations, there is an unfortunate tendency to cause greater shocks. 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. The invention appreciates that, although a relatively long axial bore has to be provided, the narrow end need not be magnetic or so heavy. The magnetic circuit may comprise outside the coil outer encapsulation 19, a rectangular yoke (not

shown) of two L-sectioned 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 does not interact with gap 24 or other magnetic circuitry.

Referring to the inventive pump of Fig.2 wherein like numerals reference like components, there is no external annular volume 12 but the guide 13 has eg. five internal longitudinal ribs 25 (see also Fig.5) 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 as before. 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. Alternatively, the wide part of the armature/piston can have a non-circular cross-section as shown by the four longitudinal flutes of Fig.6 or the extended polygon of Fig.7. There should be longitudinal ribs or grooves or non-circular irregularities 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 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 in two parts as shown in Figs. 3 and 4, while having the inventive elongated irregularities of Figs.5-7, although the two-part arrangement could be adopted alone. The pressure reducing irregularities are best seen in the transverse cross-sectional views of Figs 5-7, 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).

Referring to Fig. 3 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 2 and 4. 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. 4. The end 34 of part 32 is shaped to serve as a valve seat for inlet valve 5, Fig. 2. 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. Any ribs or grooves in the wide part of the armature cannot be seen in Fig.4, and indeed may not be present whenever such flow-conducive shapings are applied to the guide only (as presently preferred, eg see Fig 5) and not to the armature (embodied as by Fig 6 or Fig 7).). 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, characterised by (Fig 6 or 7) a shaping of, either the exterior of the combination or the interior of a guide for its reciprocation (Fig 5) , whereby 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, said shaping composing cross-sectional differential or relative irregularities between said internal and external walls.

2. A fluid pump according to Claim 1 characterised in that shock or noise caused by lack of braking by 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.

3. A fluid pump according to Claim 2 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.

4. A fluid pump according to Claim 3 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.

5. A fluid pump according to any of Claims 1-4, wherein the longitudinal irregularities are guide ribs (25) extending along the inside wall of the armature guide.

6. A fluid pump according to any of Claims 1-4 wherein the longitudinal irregularities are provided by channelling, or by a hexagonal (Fig 6) or grooved (Fig 5) cross-section of the wide part (26) of the combination.

7. A fluid pump according to any of Claims 1-6 having series inlet and outlet valves on the downstream side of the combination, which are passive but biased towards closure positions.

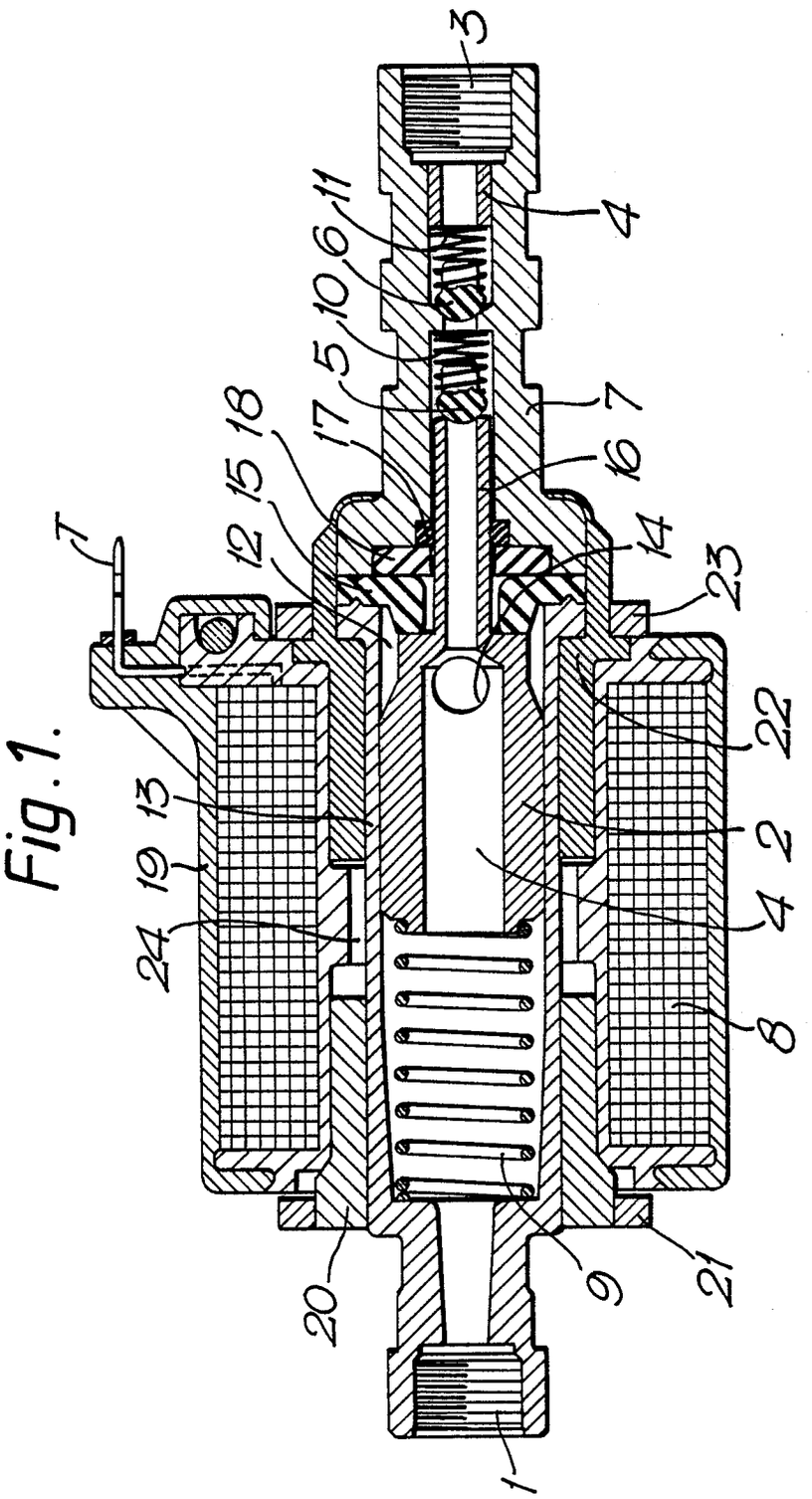


Fig. 1.

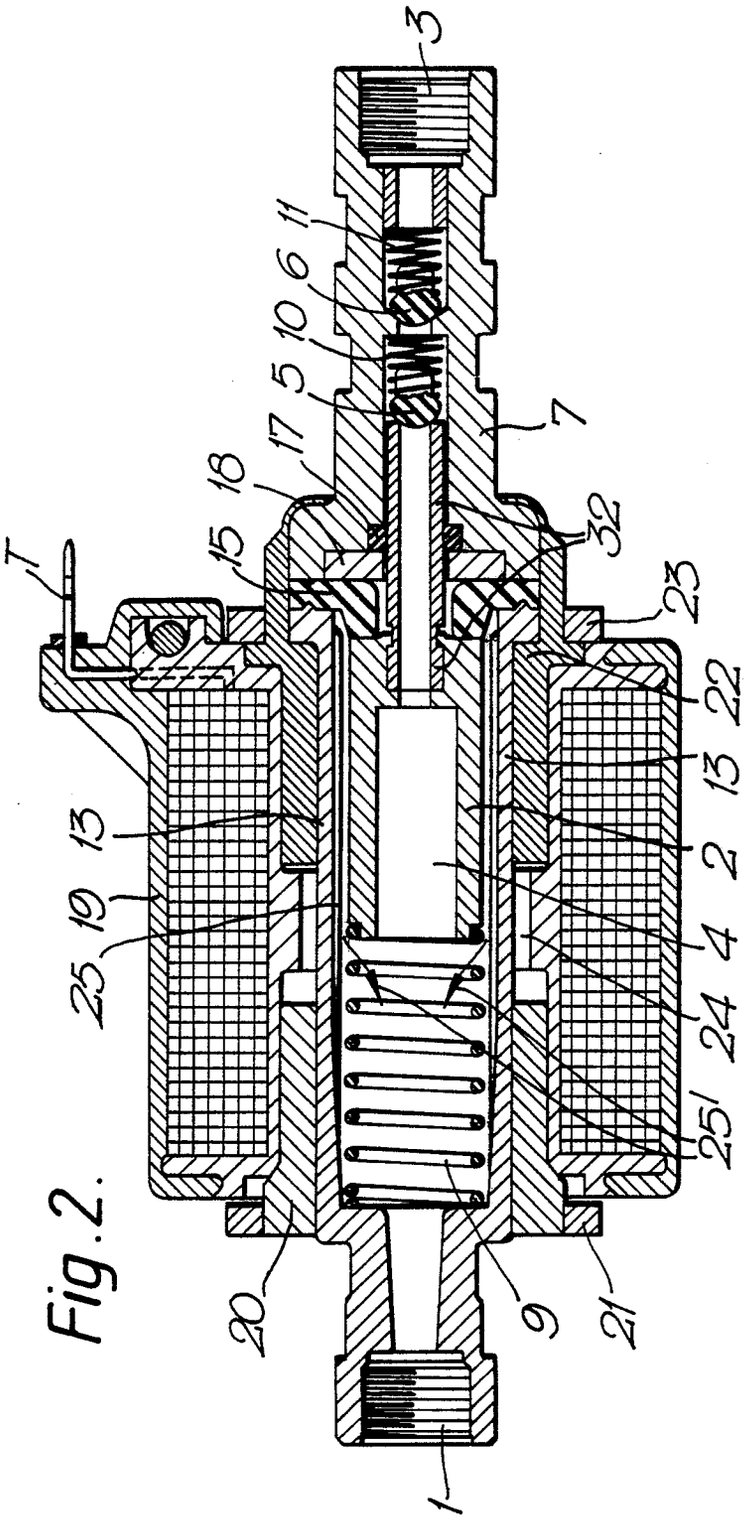


Fig.2.

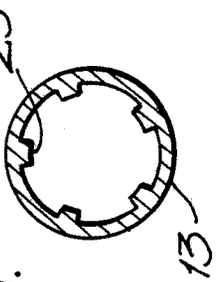


Fig.5.

Fig.3.

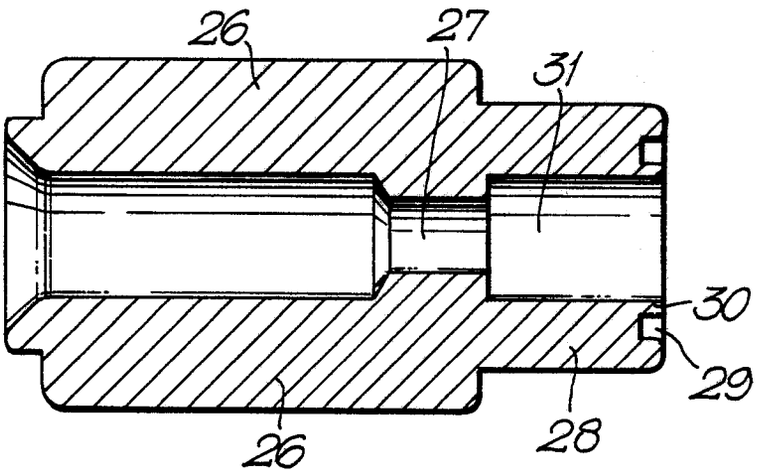


Fig.4.

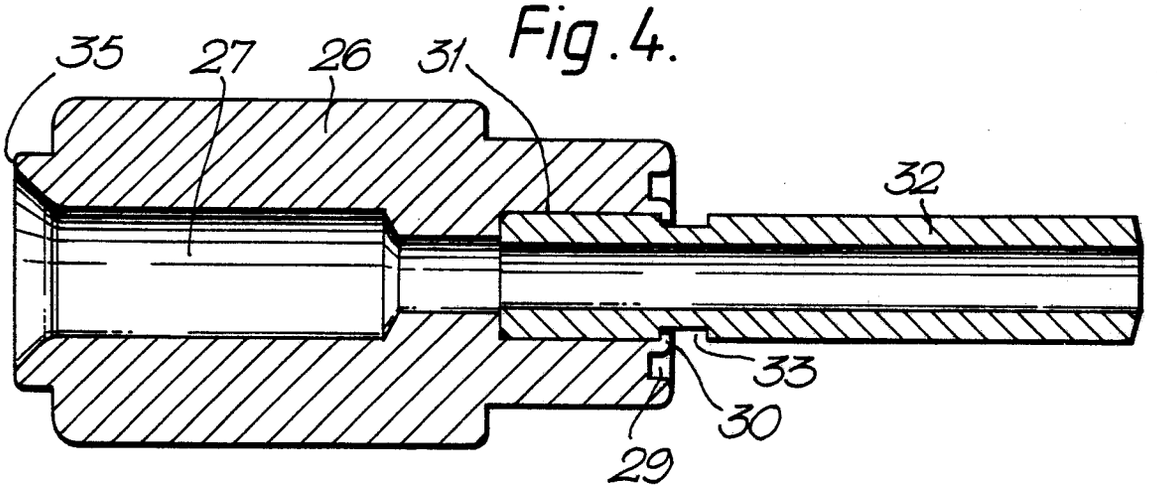


Fig.6.

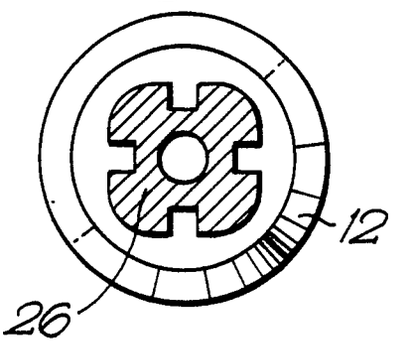
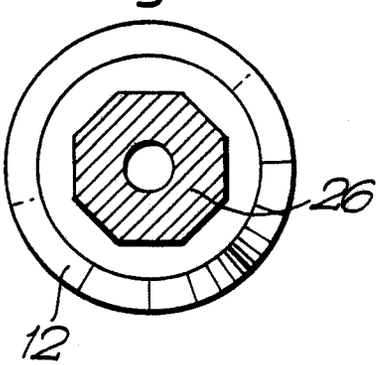


Fig.7.



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EUROPEAN SEARCH REPORT

Application number

EP 88303388.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
X	US - A - 3 348 489 (MEYER) * Totality; especially fig. 2,8; column 3, lines 48-54; claims 3,4 *	1,6	F 04 B 17/04
A		3,4	
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X	DE - B2 - 2 252 304 (LANDIS & GYR) * Totality; especially fig. 4 *	1,6	
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A	FR - A5 - 2 233 877 (STASSE) * Totality; especially fig. 1,4,5 *	1,6	
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A	DE - A1 - 3 109 090 (DE DIONIGI) * Totality *	2,3,7	
	--		TECHNICAL FIELDS SEARCHED (Int. Cl 4)
A	DE - A1 - 2 908 190 (NIPPON) * Totality; especially fig. 2; page 8, last paragraph *	3,4	A 47 J 31/00 F 04 B 13/00 F 04 B 17/00 F 04 B 21/00
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A	DE - A1 - 2 653 025 (PEREZ-PORTA-BELLA) * Totality; especially fig. 1, pos.no. 14,16 *	3,4	F 04 B 35/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	22-07-1988	WERDECKER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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