(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 627 555 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.08.1997 Bulletin 1997/33

(51) Int Cl.[6]: **F04B 43/06**

(21) Application number: **94830178.3**

(22) Date of filing: **15.04.1994**

(54) **Device for pumping by a diaphragm pump operated by a hydraulic circuit**

Vorrichtung zur Förderung von Flüssigkeiten mittels einer durch einen hydraulischen Kreislauf betätigte Membranpumpe

Dispositif de pompage de liquides à l'aide d'une pompe à membrane actionnée par un circuit hydraulique

(84) Designated Contracting States:
DE ES FR GB NL

(30) Priority: **16.04.1993 IT RM930239**

(43) Date of publication of application:
07.12.1994 Bulletin 1994/49

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EP 0 627 555 B1

Printed by Jouve, 75001 PARIS (FR)

Description

The present invention relates to devices for the displacement of liquids and particularly a device for pumping liquids provided with a diaphragm pump which is reciprocated by a hydraulic circuit operatively connected to a rotary positive-displacement pump.

In some thermodynamic apparatus such as, for example, absorption heat pump, in particular water-ammonia heat pump, the most critical component is the pump of the near-saturated solution which must have requirements of reliability, high head, capability of operating with a near-saturated liquid, and capability of operating under "dry" conditions, i.e. without liquid to be pumped.

At the present state of art several pumping devices for satisfying the requirements listed above are known; in any case, however, there are a lot of drawbacks due to several problems such as the extreme mechanical complexity with the result of high cost, the insufficient reliability, the poor capacity to the "dry" operation, and the high overall dimensions.

The invention seeks to provide a device of the type mentioned above having all of above requirements and being of reliable operation ad easy construction.

In the USA patent No. 3,357,203 (Briggs) there is disclosed a pump operating under water-ammonia cooling cycles and generally comprising a diaphragm hydraulically operated with pressurized oil, two check valves for suction and delivery, respectively, and a cylindrical tank for stocking cooling liquid for starting.

A very similar pump has been used by ARKLA Company producing refrigerating absorption machines. In such case, a hydraulically operated diaphragm pump is connected to a hydraulic circuit operated by a rotary pump in order to take advantage in the same machine of the operation of a diaphragm pump and a rotary pump which are, as known, cheaper, strong and reliable in the operation of a piston-connecting-rod-crank system used in the conventional diaphragm pumps.

In a diaphragm pump the pumping operation is executed by a strong diaphragm which divides the head of the pump in two sections, the chamber for the liquid with its suction and delivery valves and the chamber for the oil, so that the outer motor does not pump directly the liquid but an intermediate hydraulic fluid with the advantage of a sealed circuit for the liquid. In the pump employed by ARKLA the device coupling the rotating system having unidirectional flow with the diaphragm pump having reciprocating flow is formed of a rotary distributor operating only in order to expose to the atmosphere the pipe in which the oil is flowing in the suction stroke of the diaphragm pump.

Such solution, however, has the serious problem that the diaphragm of the pump can be lowered for the suction of the liquid to be pumped only if the suction pressure is higher than the atmospheric pressure (passive suction).

US-A-2 843500 (Harper) discloses a pumping device comprising a reciprocating diaphragm pump and a rotary pump connected to said diaphragm pump through a distributor cyclically inverting the suction and delivery strokes so as to transmit said reciprocating motion to the diaphragm. However the rotary distributor does not exibit any high performance and does not reach high operating pressures. This is due to the lack of suitable sealing devices and an automatic slack taking up device installed between the moving components of the distributor.

To overcome these inconveniences, according to the present invention there is provided a pumping device, in particular for absorption heat pumps, comprising in combination a diaphragm pump, an oil stock tank, and a rotary pump coupled to a rotary distributor, wherein said rotary distributor consists of two metal disks for the automatic shim adjustment of the wear clearance hydraulically provided by the delivery pressure of the rotary pump.

Said rotary distributor connected to the rotary pump takes out oil from the tank and delivers it under pressure below the diaphragm, thus causing the liquid above the diaphragm to be pumped, and then sucks it back to the tank with the resulting suction stroke of the liquid above the diaphragm.

The connection between oil tank and the suction valve of the rotary pump allows a vacuum suction stroke to be provided so that the diaphragm pump may operate even if the liquid to be sucked is at a lower pressure than the atmospheric pressure, as may be the case with a liquid having a low boiling point.

Thanks to the automatic shim adjustment of the wear clearance, this pumping device is able to operate at high pressure without sealing problems.

This invention will now be described with reference to the accompanying drawings which show by way of an illustrative, non-limitative example a preferred embodiment of the invention.

In the drawings:

Figs. 1 and la show schematically the operation of the device during the delivery and suction strokes of the liquid to be pumped, respectively.

Figs. 2 and 2a show the whole assembly during the strokes mentioned above.

Fig. 3 shows a detail of the reducer-distributor assembly in partial section along an axial plane.

Fig. 4 is a graphic comparing the absorbed power and the instant flow rate of a conventional alternative connecting-rod-crank pump with those of a reciprocated diaphragm pump according to the present invention.

With reference to Figs. 1 and 1a the device includes a diaphragm pump 10 located in the pipes of delivery 11 and suction 12 of the liquid to be pumped which are connected to the upper room 13 of said pump above the elastic diaphragm 14.

A pipe 16 is connected on one end to the oil-containing tank 17 and on the other end to the lower room 15 of

pump 10.

Rotary pump 18 is inserted in pipe 16 and connected to a rotary distributor 19 which is provided with two curved, slantwise disposed rooms 20 and 21 defining two different flow passageways A,B and C,D.

When the system is under the conditions of Fig. 1 the oil taken out from tank 17 flows through pipe 16 and the passageways in the directions A-B and C-D and is fed to lower room 15 of pump 10. Diaphragm 14 is pushed upwards so as to cause the liquid to be pumped to pipe 11.

When the rotary distributor 19 is in the position of Fig. 1a the oil flows in the directions C-D and A-B to tank 17, the diaphragm 14 is lowered, and the liquid to be pumped is sucked to pipe 12.

In Figs. 2 and 2a, in which already described parts are designated by the same numerals, tank 17 is sealed and provided with dip stick 34, and includes rotary pump 18 whose output shaft drives distributor 19. The operation is similar to that described above; in Fig. 2 there is shown the delivery stroke with the diaphragm 14 of pump 10 pushed downwards. A safety valve 23 is provided on the delivery side of rotary pump 18.

Preferably, the reducer-distributor assembly may be formed by one compact piece shown in detail in Fig. 3. Rotary distributor 19 provided with the passageways for the flow and the downflow of the oil is rotated through gear reduction unit 22 comprising gear wheel 24 and worm screw 25. Such gear reduction unit 22 is secured directly to valve casing 26 and is connected to disk 19 through stem 27 which is in turn supported to distribution flange 28 by ball bearing 29. Two sealing 0-rings indicated at 30 are placed between stem 27 and valve casing 26.

Four pipe fittings of the oil pipes connected to the four already described passageways A-B-C-D are secured to distribution flange 28.

An 0-ring indicated at 31 seals the distribution flange 28 to valve casing 26, while the oil pressure onto the disk seals the plane of rotary disk 19 to the plane of distribution flange 28; the initial position of disk 19 contacting flange 28 is determined by rubber seal 32 having a suitable length so as to provide a preloading on the disk during the assembling. A shim adjustment washer 33 has the function of avoiding that seal 32 is subjected to a torque moment during the operation of the valve.

The above-described device, as already mentioned at the beginning, can be used in all such cases where a positive-displacement high-head pump is used with the following advantages of the coupling of a diaphragm pump with a rotary pump: feasibility of easy inspection without influencing the process; greater economy; high reliability; small overall dimensions, especially in the vertical direction; lower vibrations transmitted to the pipes and the down-stream equipment; use of lower-power motors under the same efficiency.

As shown in Fig. 4, the plots of the instant flow rate and the absorbed power has the form of a square wave in contrast with the plots of a conventional alternative connecting-rod-crank pump. Therefore, both the absorbed power and the consumed power are constant and equal to the mean value of the corresponding sinusoid. As can be seen, the mean value is equal to 64% of the maximum peak.

The present invention has been illustrated and described according to a preferred embodiment thereof, however construction modifications can be made by one skilled in the art without departing from the scope of the present invention.

Claims

1. A pumping device, of the type comprising a reciprocating diaphragm pump casing (10) and a rotary pump (18) connected to said diaphragm pump casing trough a distributor (19) cyclically inverting the suction and delivery strokes so as to transmit said reciprocating motion to the diaphragm (14), characterized in that said rotary distributor (19) consists of two metal disks (19,28) for the automatic shim adjustment of the wear clearance hydraulically provided by the delivery pressure of the rotary pump.

2. Pumping device, of the type comprising a reciprocating diaphragm pump casing (10), a rotary pump (18) and a rotary distributor (19) that transmits said reciprocating motion, said diaphragm pump (10) being operated by a hydraulic circuit formed of an oil stock tank (17), said rotary pump (18) being located between the tank (17) and the lower room (15) of the diaphragm pump casing (10), and said rotary distributor having the function of delivering and sucking said oil in reciprocating motion to said diaphragm pump casing (10) so as to cause a pulsing delivery and suction motion of the liquid to be pumped flowing to the upper room (13) of said diaphragm pump casing, said rotary distributor (19) consisting of two metal disks (19,28) for the automatic shim adjustment of the wear clearance hydraulically provided by the delivery pressure of the rotary pump.

3. Pumping device according to claim 1 or 2, characterized in that the suction stroke of the liquid to be pumped is assisted by the rotary pump (18), thus allowing liquids having a lower suction pressure than the atmospheric pressure to be pumped.

4. Pumping device according to the preceding claims, characterized in that said rotary distributor (19) is operated through a gear reduction unit (22) by the same drive stem (27) of the rotary positive-displacement pump (18).

5. Pumping device according to the preceding claims,

characterized in that the mechanical assembly comprising the positive-displacement pump (18), the gear reduction unit (22) and the rotary distributor (19) is located in a sealed tank (17) contained the oil of the hydraulic circuit operating the diaphragm pump casing.

6. Pumping device according to the preceding claims, characterized in that said rotary distributor (19) comprises a pair of symmetrical rooms (20,21) located along opposite circle sectors which alternatively cause the delivery of the oil to the diaphragm pump casing and the flow of the oil from the pump back to the tank.

7. Pumping device according to the preceding claims, characterized in that all of the rotary components are driven by only one motor (M) located outside said tank (17).

Patentansprüche

1. Fördervorrichtung eines Typs, der ein Gehäuse mit einer hin- und hergehenden Membranpumpe (10) und eine Rotationspumpe (10) besitzt, die mit dem Gehäuse der Membranpumpe über einen Verteiler (19) verbunden ist, der zyklisch die Saug- und Förderhübe zur Übertragung der hin- und hergehenden Bewegung auf die Membran (14) invertiert, dadurch gekennzeichnet, daß der Drehverteiler (19) aus zwei Metallscheiben (19, 28) für die automatische Abstandseinstellung des hydraulisch durch den Förderdruck der Rotationspumpe gelieferten Gebrauchspiels besteht.

2. Fördervorrichtung eines Typs, der ein Gehäuse mit einer hin- und hergehenden Membranpumpe (10) eine Rotationspumpe (18) und einen Drehverteiler (19) besitzt, der die hin- und hergehende Bewegung überträgt, wobei für die Membranpumpe (10) eine Betätigung mittels eines hydraulischen Schaltkreises vorgesehen ist, der aus einem Ölvorratstank (17) gebildet ist, wobei die Rotationspumpe (18) zwischen dem Tank (17) und dem unteren Raum (15) des Gehauses der Membranpumpe (10) angeordnet ist, und wobei der Drehverteiler die Aufgabe hat, das Öl in hin- und hergehender Bewegung derart an das Gehäuse der Membranpumpe (10) zu liefern und wegzusaugen, daß eine pulsierende Förder- und Saugbewegung der zu pumpenden Flüssigkeit, die zu dem oberen Raum (13) des Gehäuses der Membranpumpe (10) strömt, veranlaßbar ist, wobei der Drehverteiler (19) aus zwei Metallscheiben (19, 28) für die automatische Abstandseinstellung des hydraulisch durch den Förderdruck der Rotationspumpe gelieferten Gebrauchspiels besteht.

3. Fördervorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß für den Saugdruck der zu pumpenden Flüssigkeit eine Unterstützung durch die Rotationspumpe (18) vorgesehen ist, damit Flüssigkeiten mit einem niedrigeren Saugdruck als der atmosphärische Druck pumpbar sind.

4. Fördervorrichtung nach den vorangehenden Ansprüchen, dadurch gekennzeichnet, daß der Drehverteiler (19) durch denselben Antriebsstutzen (27) der Rotationsverteilungspumpe (18) über eine Untersetzungsgetriebeeinheit (22) betrieben ist.

5. Fördervorrichtung nach den vorangehenden Ansprüchen, dadurch gekennzeichnet, daß die mechanische Anordnung, die die Rotationspumpe (18), die Untersetzungsgetriebeeinheit (22) und den Drehverteiler (19) umfaßt, in einem abgedichteten Tank (17) angeordnet ist, der das Öl des hydraulischen Schaltkreises enthält, der die Membranpumpe betreibt.

6. Fördervorrichtung nach den vorangehenden Ansprüchen, dadurch gekennzeichnet, daß der Drehverteiler (19) ein Paar symmetrischer Räume (20, 21) aufweist, die längs gegenüberliegender Kreisabschnitte angeordnet sind, welche alternierend die Förderung von Öl zu dem Gehäuse der Membranpumpe und die Strömung des Öls von der Pumpe zurück zu dem Tank veranlassen.

7. Fördervorrichtung nach den vorangehenden Ansprüchen, dadurch gekennzeichnet, daß alle Drehbestandteile von nur einem Motor (M) angetrieben sind, der außerhalb des Tanks (17) angeordnet ist.

Revendications

1. Un dispositif de pompage du type comprenant un boîtier de pompe à diaphragme en va-et-vient (10) et une pompe rotative (18) reliée audit boîtier de pompe à diaphragme par l'intermédiaire d'un distributeur (19) inversant de manière cyclique les courses d'aspiration et de décharge de manière à transmettre ledit mouvement de va-et-vient au diaphragme (14), caractérisé en ce que ledit distributeur rotatif (19) se compose de deux disques métalliques (19, 28) pour le réglage automatique du calage du jeu d'usure fourni de manière hydraulique par la pression de décharge de la pompe rotative.

2. Dispositif de pompage du type comprenant un boîtier de pompe à diaphragme en va-et-vient (10), une pompe rotative (18) et un distributeur rotatif (19) qui transmet ledit mouvement de va-et-vient, ladite pompe à diaphragme (10) étant actionnée par un circuit hydraulique formé d'un réservoir de stockage

d'huile (17), ladite pompe rotative (18) étant placée entre le réservoir (17) et la chambre inférieure (15) du boîtier de pompe à diaphragme (10), et ledit distributeur rotatif présentant la fonction de décharger et d'aspirer ladite huile dans un mouvement de va-et-vient audit boîtier de pompe à diaphragme (10) de manière à assurer un mouvement de décharge et d'aspiration pulsé du liquide à pomper qui passe vers la chambre supérieure (13) dudit boîtier de pompe à diaphragme, ledit distributeur rotatif (19) se composant de deux disques métalliques (19, 28) pour le réglage automatique du calage du jeu d'usure fourni de manière hydraulique par la pression de décharge de la pompe rotative.

3. Dispositif de pompage selon la revendication 1 ou 2, caractérisé en ce que la course d'aspiration du liquide à pomper est assistée par la pompe rotative (18), en permettant ainsi que soient pompés des liquides présentant une pression d'aspiration inférieure à la pression atmosphérique.

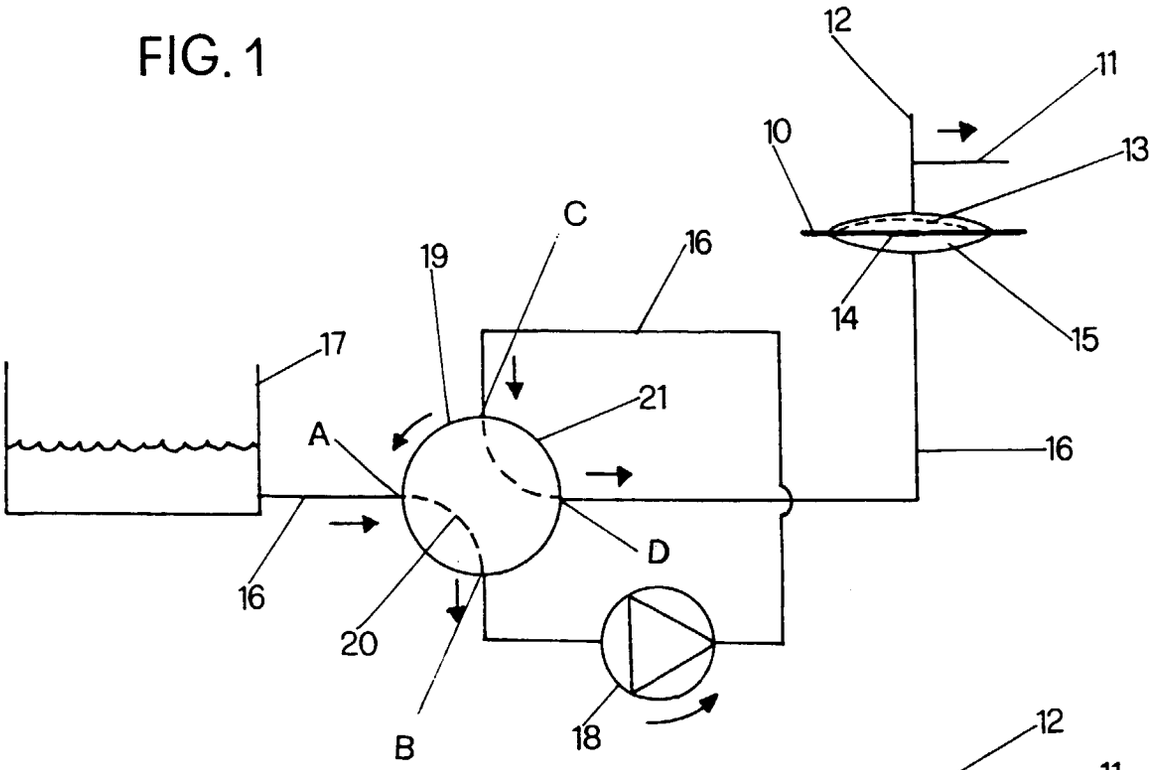
4. Dispositif de pompage selon les revendications précédentes, caractérisé en ce que ledit distributeur rotatif (19) est actionné par l'intermédiaire d'un réducteur de vitesse (22) par la même tige d'entraînement (27) de la pompe rotative à déplacement positif (18).

5. Dispositif de pompage selon les revendications précédentes, caractérisé en ce que l'ensemble mécanique comprenant la pompe à déplacement positif (18), le réducteur de vitesse (22) et le distributeur rotatif (19) est placé dans un réservoir étanche (17) contenant l'huile du circuit hydraulique actionnant le boîtier de pompe à diaphragme.

6. Dispositif de pompage selon les revendications précédentes, caractérisé en ce que ledit distributeur rotatif (19) comprend une paire de chambres symétriques (20, 21) placées le long de secteurs circulaires opposés qui provoquent alternativement la décharge de l'huile vers le boîtier de pompe à diaphragme et le passage de l'huile depuis la pompe en retour vers le réservoir.

7. Dispositif de pompage selon les revendications précédentes, caractérisé en ce que l'ensemble des éléments rotatifs est entraîné par un seul moteur (M) placé à l'extérieur dudit réservoir (17).

FIG. 1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11
10
13
C
19
16
14
15
17
21
A
16
D
16
20
B
18

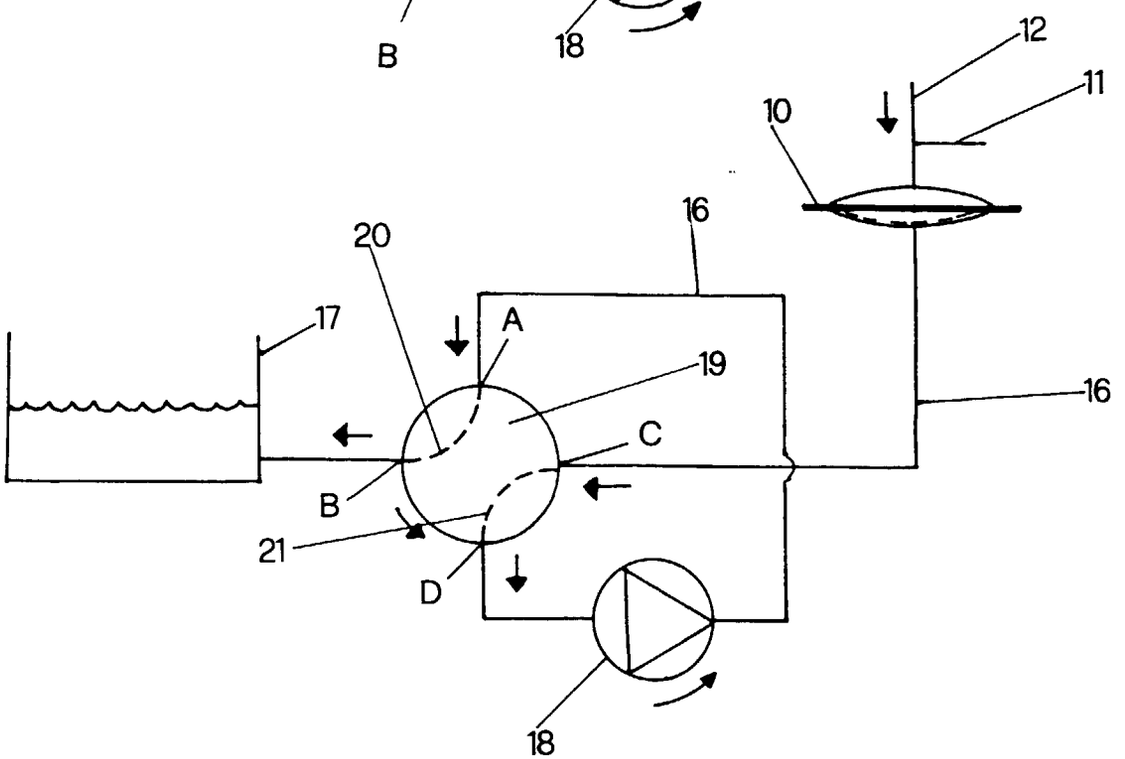
12
11
10
16
20
17
A
19
16
C
B
21
D
18

FIG. 1a

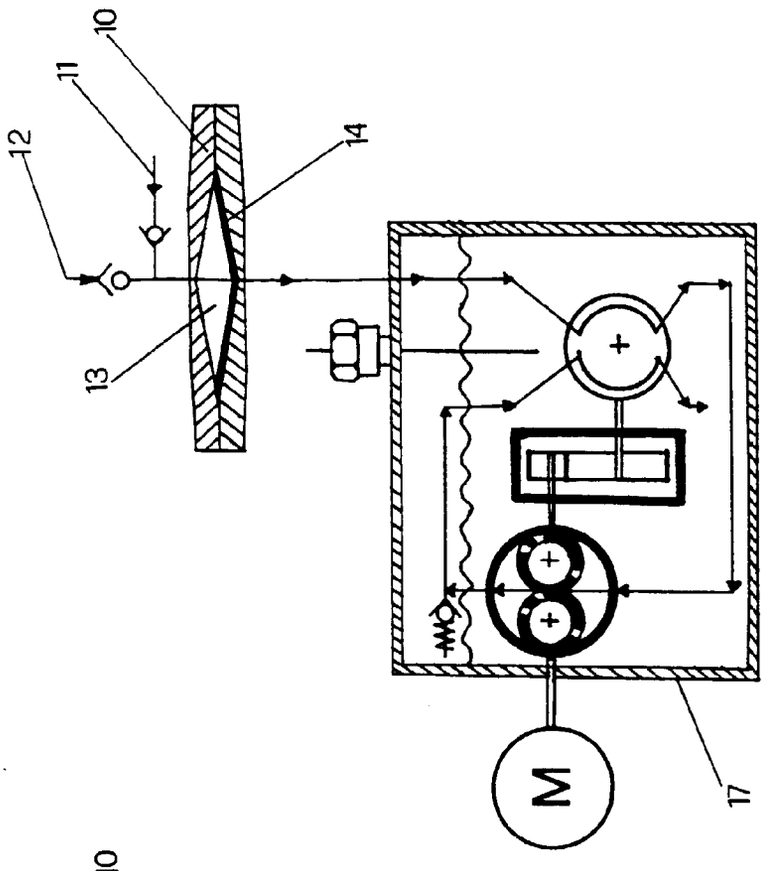

FIG. 2a

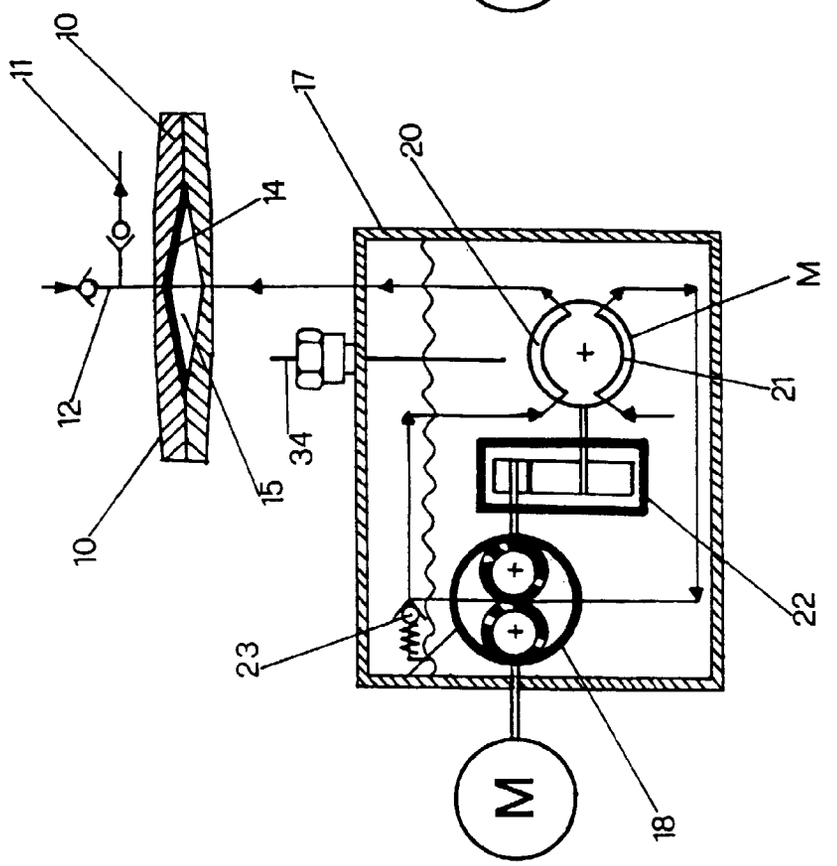

FIG. 2

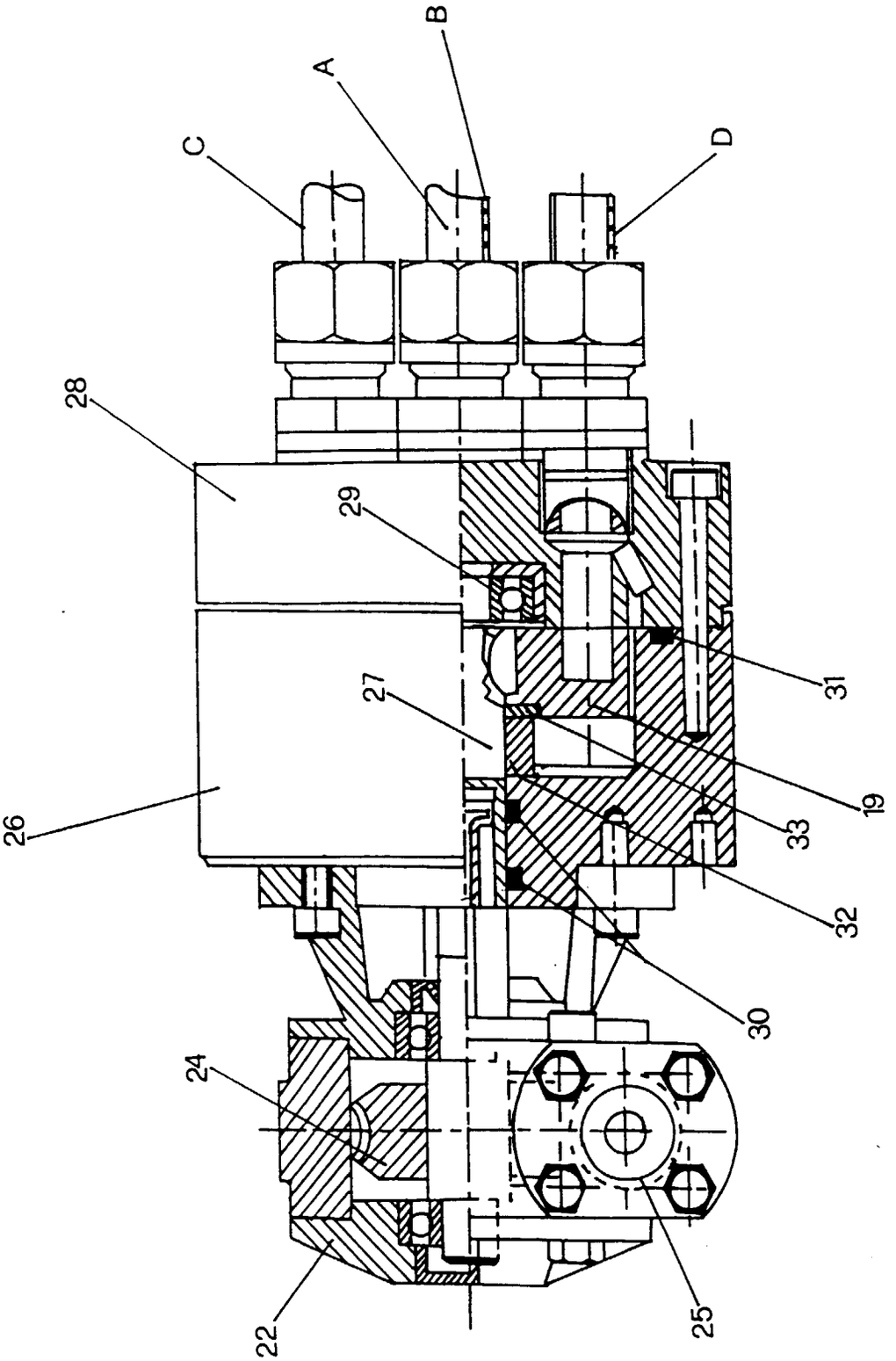

FIG. 3

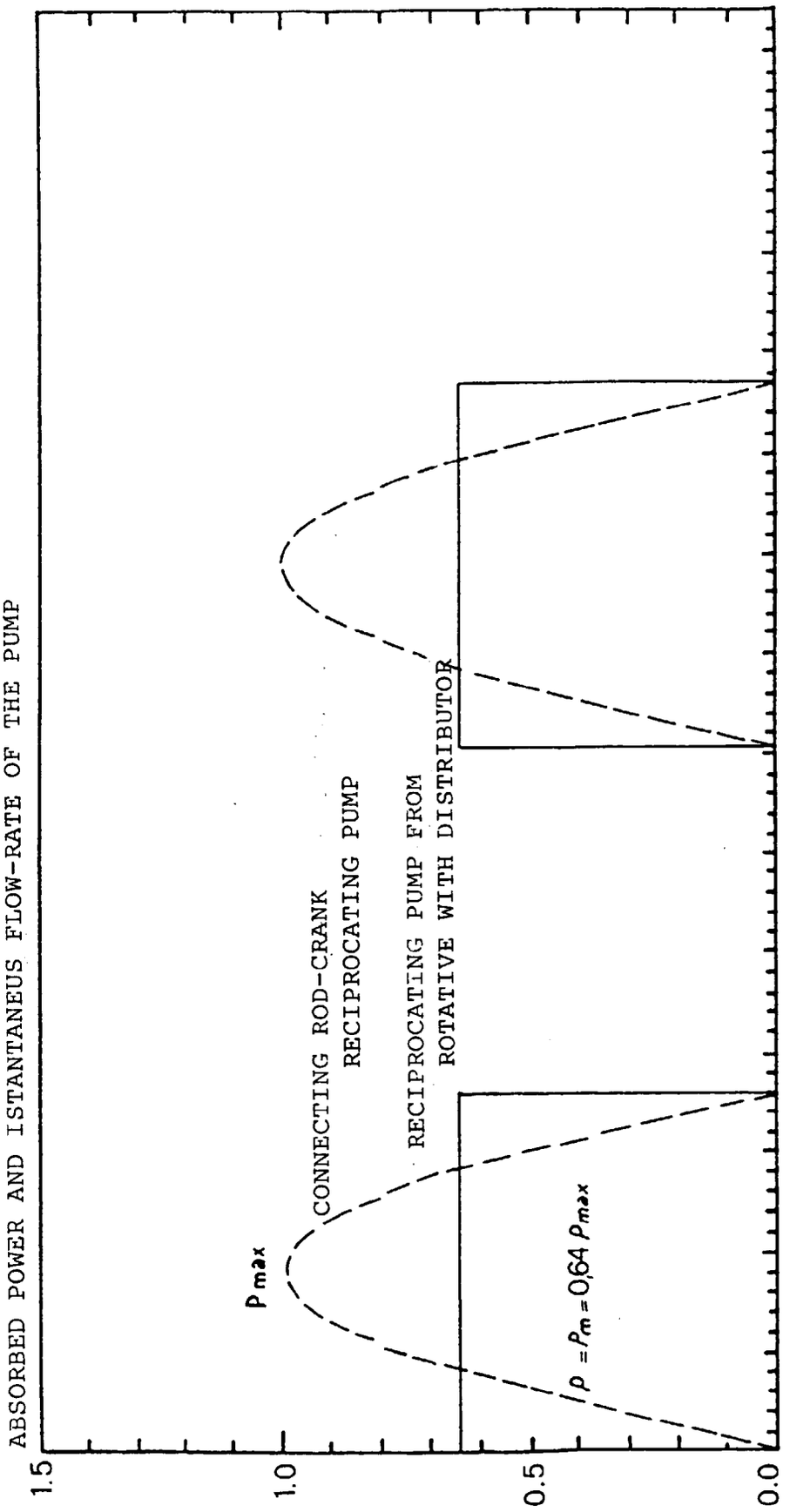
ABSORBED POWER AND ISTANTANEUS FLOW-RATE OF THE PUMP
1.5
1.0
0.5
0.0
P max
CONNECTING ROD-CRANK RECIPROCATING PUMP
RECIPROCATING PUMP FROM ROTATIVE WITH DISTRIBUTOR
p = Pm = 0,64 Pmax
TIME AXIS

FIG. 4