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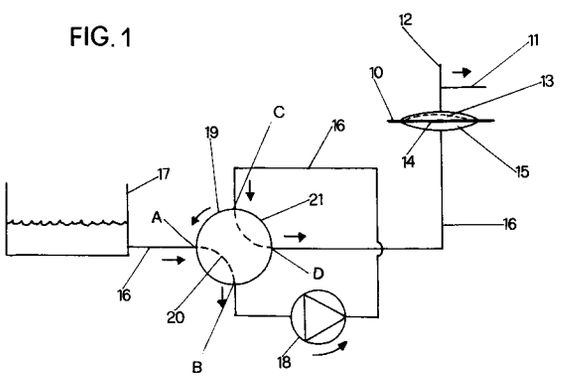
(54) Device for pumping by a diaphragm pump operated by a hydraulic circuit.

(57) A device for pumping liquids, particularly in heat pumps, comprising a diaphragm pump (10) operated by a hydraulic circuit formed of a oil tank (17), a rotary pump (18) located between the tank (17) and the lower room (15) of the diaphragm pump (10), and a rotary distributor (19) having the function of delivering and sucking said oil in reciprocating motion to said diaphragm pump (10) so as to cause a reciprocating suction and delivery of the liquid to be pumped flowing to the upper room (13) of the diaphragm pump (10).

FIG. 1



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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).

The inventive step of this invention is of establishing during the suction stroke conditions of maximum suction pressure, which cause the diaphragm pump to operate even in case the solution to be pumped is at a negative pressure with respect to the atmosphere.

To this purpose 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, a rotary pump coupled to a rotary distributor, which takes out oil from said stock tank and delivers it to the same again according to a succession of steps causing the reciprocation of the diaphragm and the following pumping of the liquid.

In other words 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.

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 1a 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 con-

nected 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, wherein it comprises in combination a reciprocating diaphragm pump casing and a rotary positive-displacement pump connected to said diaphragm pump casing trough a distributor cyclically inverting the suction and delivery strokes so as to transmit said reciprocating motion to the diaphragm.

2. Pumping device, wherein it comprises in combination a diaphragm pump casing operated by a hydraulic circuit formed of an oil stock tank, a rotary pump located between the tank and the lower room of the diaphragm pump casing, and a rotary distributor having the function of delivering and sucking said oil in reciprocating motion to said diaphragm pump casing so as to cause a pulsing delivery and suction motion of the liquid to be pumped flowing to the upper room of said diaphragm pump casing.

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, 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 consists of two metal disks for the automatic shim adjustment of the wear clearance hydraulically provided by the delivery pressure of the rotary pump.

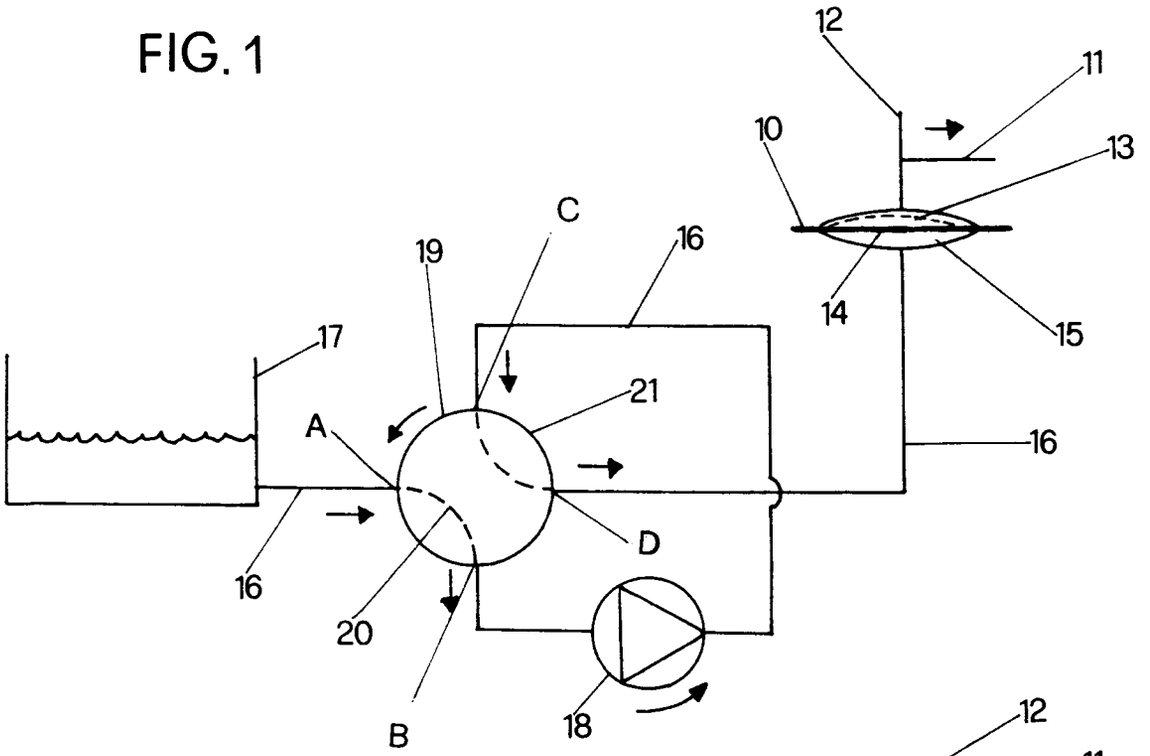
5. Pumping device according to the preceding claims, characterized in that said rotary distributor is operated through a gear reduction unit by the same drive stem of the rotary positive-displacement pump.

6. Pumping device according to the preceding claims, characterized in that the mechanical assembly comprising the positive-displacement pump, the gear reduction unit and the rotary distributor is located in a sealed tank contained the oil of the hydraulic circuit operating the diaphragm pump casing.

7. Pumping device according to the preceding claims, characterized in that said rotary distributor comprises a pair of symmetrical rooms 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.

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

FIG. 1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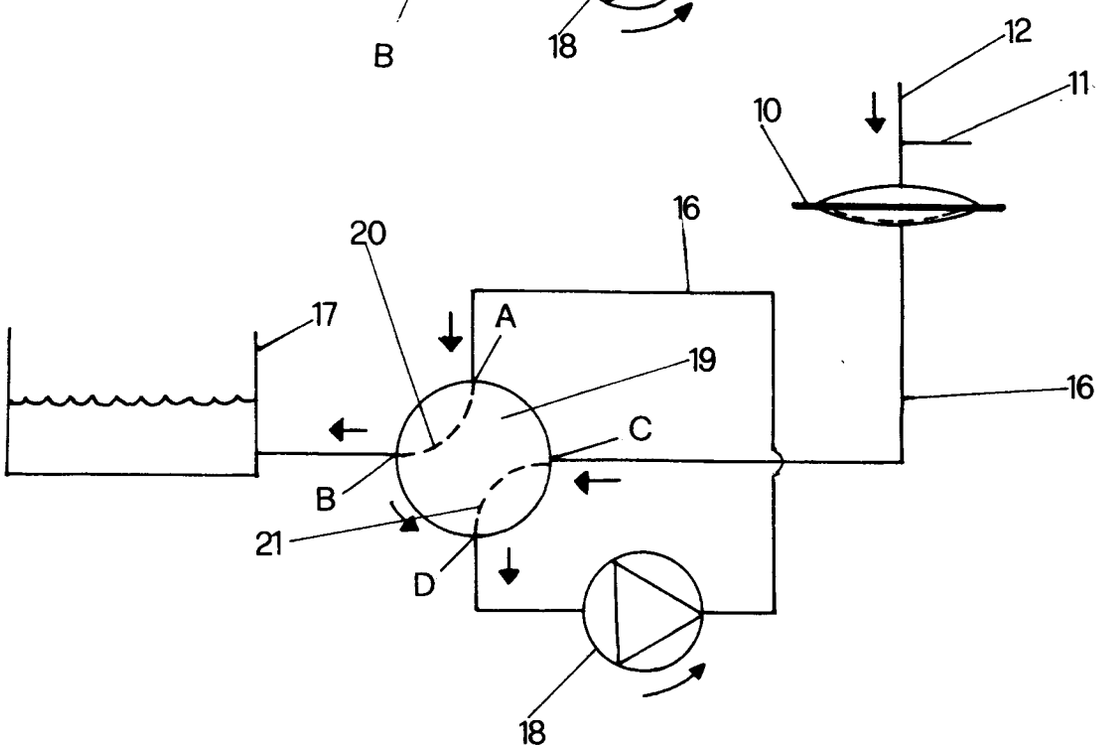
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FIG. 1a

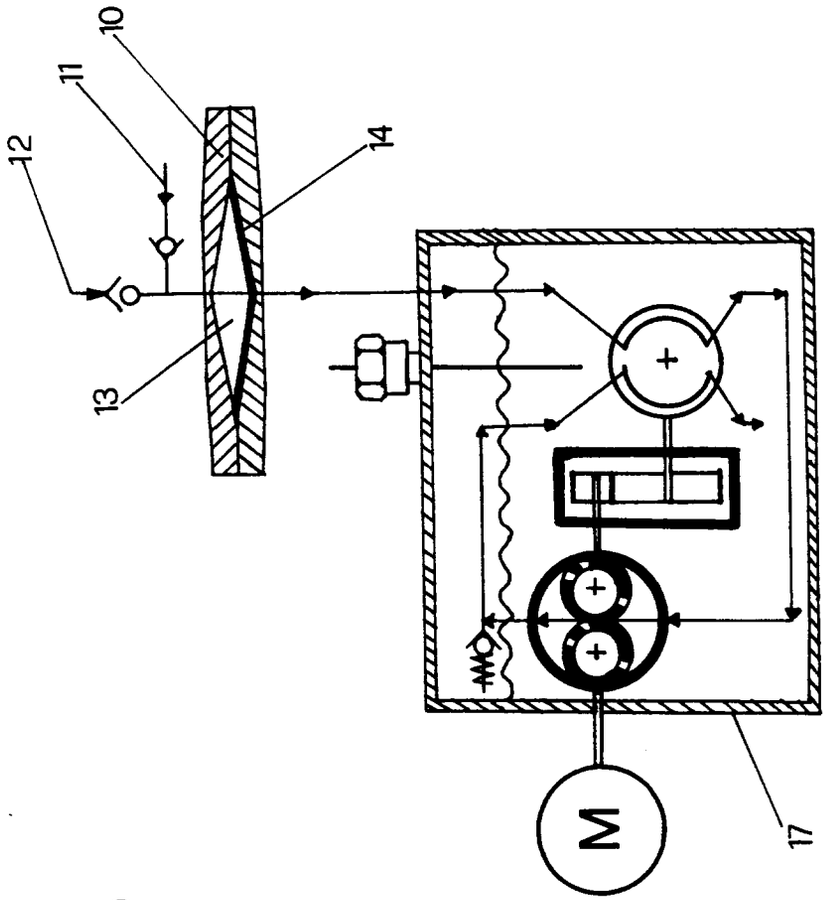

FIG. 2a

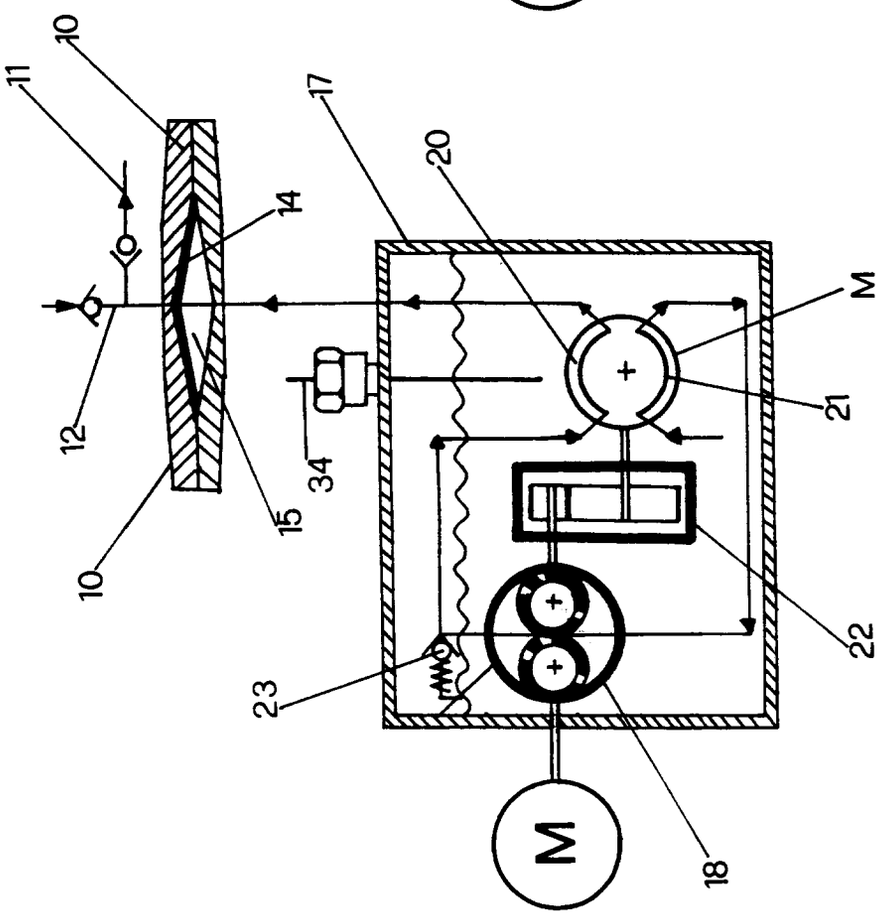

FIG. 2

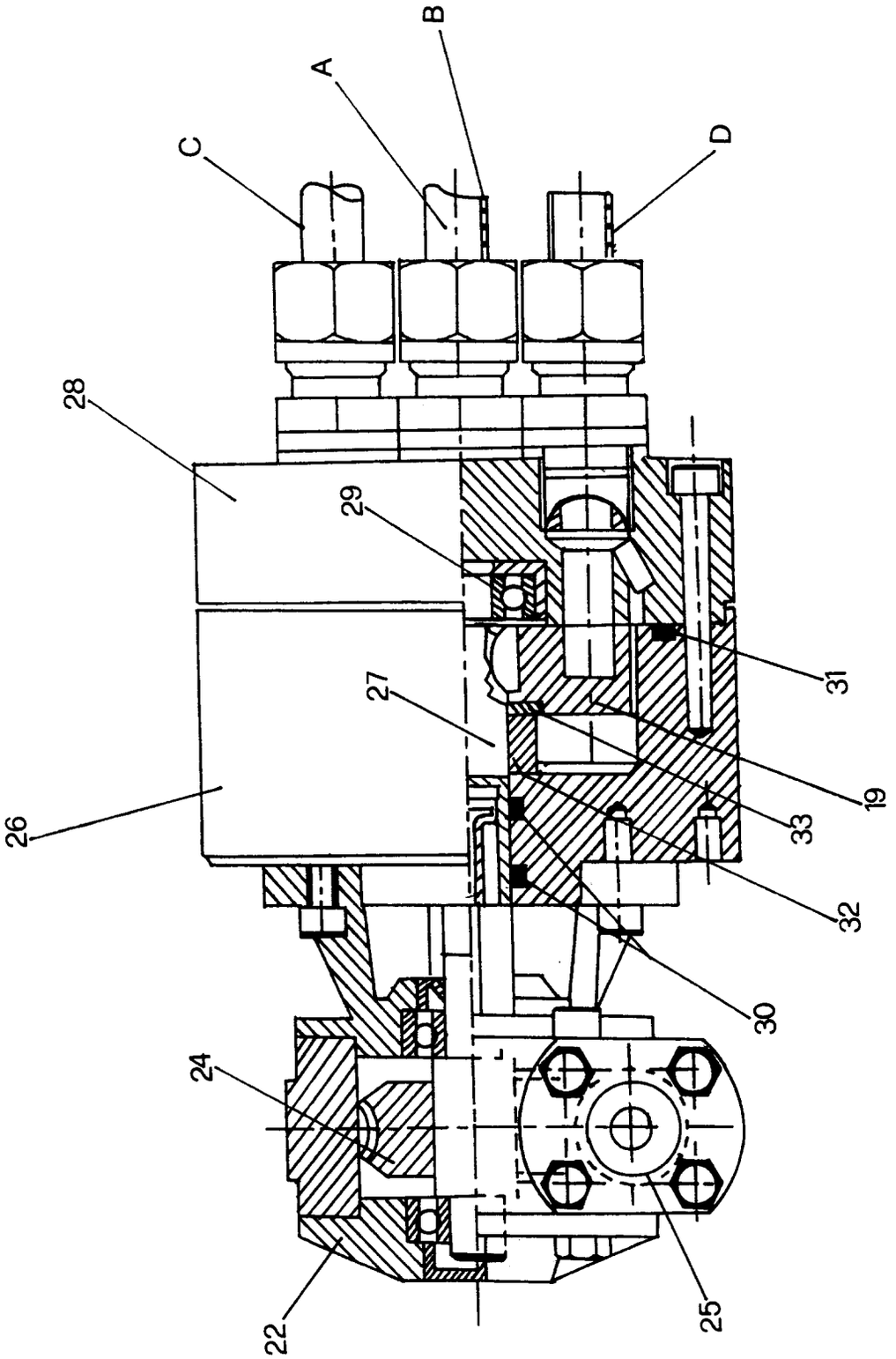

FIG. 3

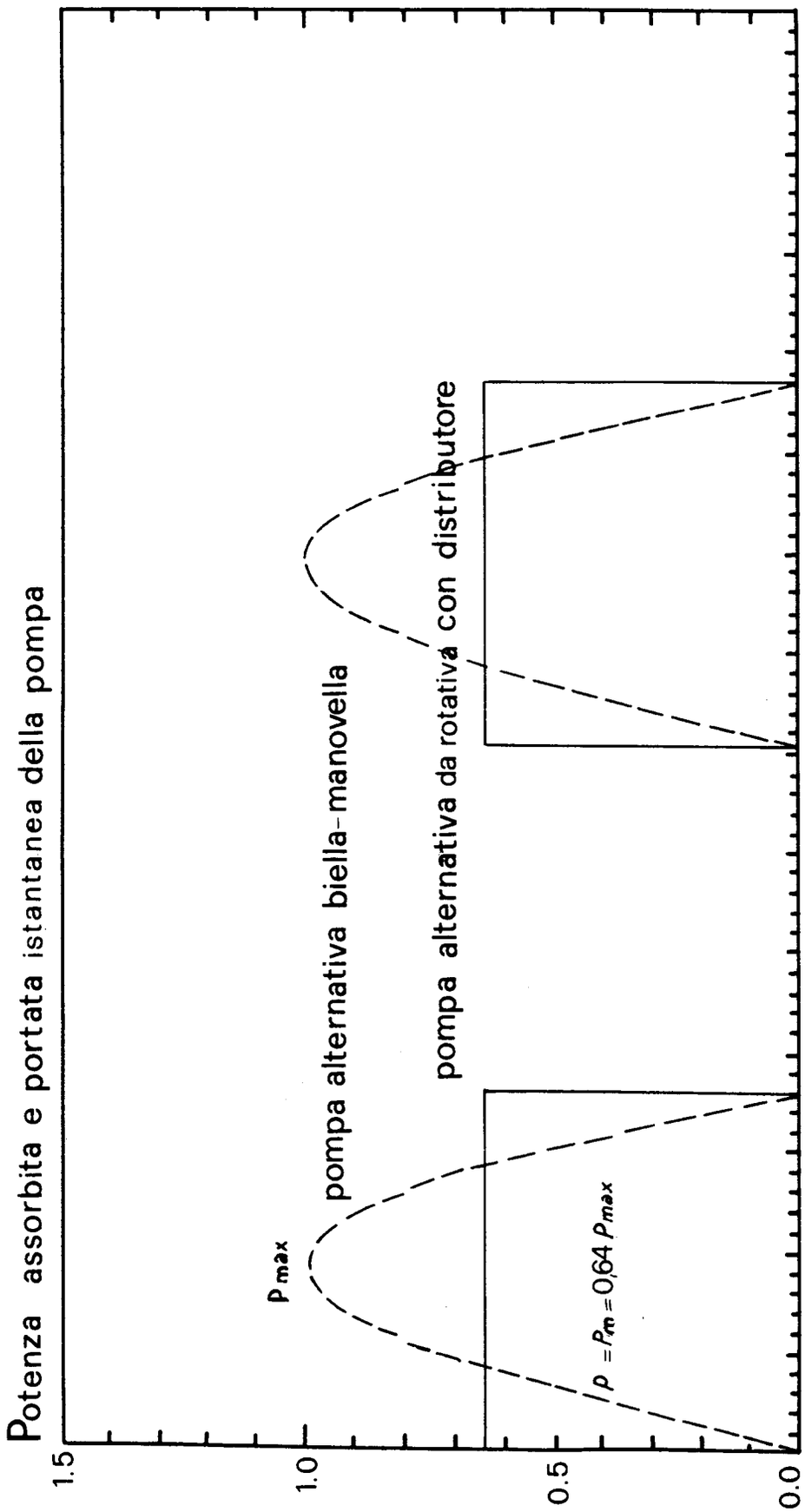
Potenza assorbita e portata istantanea della pompa
1.5
1.0
0.5
0.0
P_{max}
pompa alternativa biella-manovella
pompa alternativa da rotativa con distributore
$P = P_m = 0{,}64\ P_{max}$
Asse dei tempi

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 83 0178

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.5)
X Y	US-A-2 843 050 (HARPER) * the whole document * ---	1-3,5,7,8 6	F04B1/00 F04B43/06
Y A	US-A-4 523 901 (SCHIPPERS ET AL.) * column 4, line 66 - column 5, line 46; figure 1 * ---	6 1	
A	GB-A-681 139 (MONOYER) * the whole document * ---	1-8	
A	GB-A-1 323 006 (THE BRITISH GAS CORP.) * page 2, line 51 - page 3, line 23; figure * -----	1,2	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 September 1994	Von Arx, H

CATEGORY OF CITED DOCUMENTS

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