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

(11) EP 1 006 281 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.06.2000 Bulletin 2000/23

(51) Int. Cl.[7]: **F04C 18/12**, F04C 23/00

(21) Application number: **99123818.9**

(22) Date of filing: **01.12.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **04.12.1998 JP 34501198**

(71) Applicant:
Kabushiki Kaisha Toyoda Jidoshokki Seisakusho
Aichi-ken 448-8671 (JP)

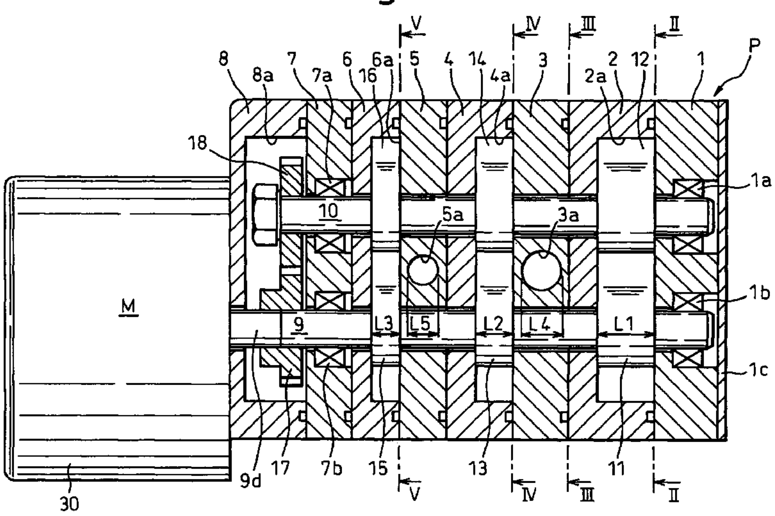
(72) Inventors:
- **Goto, Kunifumi**
  K.K. Toyoda Jidoshokki Seisakusho
  Kariya-shi, Aichi-ken 448-8671 (JP)
- **Hoshino, Nobuaki**
  K.K. Toyoda Jidoshokki Seisakusho
  Kariya-shi, Aichi-ken 448-8671 (JP)
- **Uchiyama, Osamu**
  K.K. Toyoda Jidoshokki Seisakusho
  Kariya-shi, Aichi-ken 448-8671 (JP)

(74) Representative:
Hoeger, Stellrecht & Partner
Uhlandstrasse 14 c
70182 Stuttgart (DE)

(54) Multi-stage roots pump

(57) A multi-stage Roots pump has a plurality of parallel pump chambers formed in the casing thereof. Each pump chamber has a pair of rotors arranged therein for rotation to effect a pumping action, an intake port and an exhaust port. Exhaust ports of pump chambers of the preceding stages are connected to intake ports of pump chambers of the succeeding stages through communication holes, one after another, in series. The communication hole extends across an imaginary plane that include the axes of shafts and is perforated in the casing between the shafts so that the communication hole does not contact the shafts.

Fig.1



EP 1 006 281 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a multi-stage Roots pump driven by a rotary drive unit such as a motor or the like to effect pumping actions in pump chambers of respective stages one after another, and to a multi-stage pump device comprising a multi-stage Roots pump and a rotary drive unit constructed in a unitary structure.

2. Description of the Related Art

[0002] In a multi-stage Roots pump disclosed in Japanese Unexamined Patent Publication (Kokai) No. 8-14172, a plurality of pump chambers each having an intake port and an exhaust port are constituted in parallel in a casing. A set of two rotors are arranged in each pump chamber, the rotors being mounted to two parallel shafts, respectively, so as to rotate with a small gap relative to each other. In the casing, the intake port of the pump chamber of the frontmost stage is opened. A partitioning wall having relatively greater axial length is formed between the pump chamber of a preceding stage and the pump chamber of a succeeding stage, and the discharge port of the pump chambers of the preceding stage is connected to the intake port of the pump chamber of the succeeding stages through a communication chamber formed in the partitioning wall, and the pump chambers are connected in series in this way. Here, the communication chambers extend across an imaginary plane including axes of the two shafts, and the shafts are exposed to the communication chambers. The exhaust port of the pump chamber of the last stage is opened.

[0003] In addition, the end of a shaft of the multi-stage Roots pump is coupled to a drive shaft protruding from a drive body of a rotary drive unit such as a motor for rotation. A drive gear is secured to the other end of the shaft of the multi-stage Roots pump and rotates in mesh with a driven gear secured to an end of the other shaft of the multi-stage Roots pump. Thus, the multi-stage Roots pump together with the rotary drive unit such as a motor constitutes a multi-stage pump device.

[0004] When it is desired to evacuate the interior of a certain chamber to establish a reduced-pressure chamber by using the above-mentioned multi-stage pump device, the intake port of the pump chamber of the frontmost stage in the multi-stage Roots pump is opened in that chamber, and the exhaust port of the pump chamber of the last stage is opened to the atmosphere or the like. The multi-stage Roots pump is then driven by the motor. Then, the rotors rotate in the respective pump chambers of the multi-stage Roots pump with a small gap relative to each other. Therefore, the pumping action is successively effected in the pump chambers, whereby the air in the chamber is released into the atmosphere and the pressure in the chamber is reduced.

[0005] According to the above-mentioned conventional multi-stage Roots pump and multi-stage pump device, however, the communication chamber is formed in the partitioning wall between the stages as a means for connecting the exhaust port of the pump chamber of the preceding stage to the intake port of the pump chamber of the succeeding stage, and the shafts for mounting the rotors are exposed to the communication chamber. In the multi-stage Roots pump or the multi-stage pump device, therefore, the fluid in the high-pressure pump chamber of the succeeding stage leaks into the low pressure communication chamber through the shaft holes, and the fluid in the communication chamber further leaks into the low pressure pump chamber of the preceding stage, resulting in a decrease in the evacuating performance. In order to suppress the above-mentioned defect, a shaft-sealing device must be provided between the shaft holes and the shafts among the stages, causing an increase in the number of parts and, hence, an increase in the cost of production.

SUMMARY OF THE INVENTION

[0006] The present invention is accomplished in view of the above-mentioned circumstances, and an object of the present invention is to provide a multi-stage Roots pump and a multi-stage pump device which can accomplish an increase in the pressure-reducing performance and a decrease in the cost of production.

[0007] A multi-stage Roots pump of the present invention comprises: a casing constituting having a plurality of parallel pump chambers formed therein, each pump chamber having an intake port and an exhaust port; a plurality of parallel shafts extending through pump chambers; rotors arranged in said pump chambers and mounted to the shafts so that a set of rotors are arranged in each of the pump chambers in mesh with each other to rotate with a small gap relative to each other; and said casing being formed such that said intake port of one pump chamber positioned at one of the casing is opened, said exhaust ports of said pump chambers are connected to said intake ports of the succeeding pump chambers one after another through communication holes extending across an imaginary plane that includes axes of said shafts, and said exhaust port of the pump chamber positioned at the other end in the casing is opened, said communication holes being perforated in said casing between said shafts so that said communication hole does not contact said shafts.

[0008] In this multi-stage Roots pump, the exhaust ports of the pump chambers of the preceding stages are connected to the intake ports of the pump chambers of the succeeding stages through communication holes that do not contact the shafts. Therefore, the fluid in the high-pressure pump chamber of the succeeding stage does not leak into the pump chamber of the preceding stage through the shaft hole or the communication hole, and the pressure-reducing performance is hardly affected. In addition, this is accomplished without providing a shaft-sealing device between the shaft holes and the shafts among the stages; i.e., it is made possible to decrease the cost of production without increasing the number of parts.

[0009] In the multi-stage Roots pump of the present invention, where the individual pump chambers are referred to as a first pump chamber, a second pump chamber, an (n-1)-th chamber and an n-th chamber from the frontmost stage, it is preferable that an communication area of the communication hole connecting the exhaust port of said (n-1)-th pump chamber to the intake port of said n-th pump is not smaller than a value obtained by multiplying an area of the intake port of said (n-1)-th pump chamber by a ratio of the length of the shaft of said n-th pump chamber to an axial length of said (n-1)-th pump chamber. Then, the fluid in the high-pressure pump chambers of the succeeding stages does not expand while it is being conveyed, and the pressure-reducing performance is not impaired.

[0010] Preferably, adjacent to the multi-stage Roots pump of the present invention, there is provided a rotary drive unit having a drive body and a drive shaft extending from said drive body, and a timing gear train comprising a drive gear secured to said drive shaft of said rotary drive unit and a driven gear secured to one of the shafts of said multi-stage Roots pump and is driven by said drive gear.

[0011] Thus, the multi-stage pump device of the present invention is realized, comprising the multi-stage Roots pump of the present invention and the rotary drive unit such as a motor, constructed in a unitary structure. In the multi-stage pump device, the drive force transmitted from the drive shaft of the rotary drive unit is converted into the rotation of the rotors through the timing gear train comprising the drive gear and the driven gear, and the shafts. Therefore, no slipping occurs unlike that of the belt drive. Further, the multi-stage Roots pump is not affected by twisting in the shafts. Therefore, the drive force of the rotary drive unit is entirely converted into the rotation of the rotors in the pump chambers, enabling the pumping action to be smoothly effected.

[0012] In the multi-stage pump device of the present invention, preferably, the intake port of the pump chamber of the frontmost stage is opened at a position remote from the timing gear train, and the exhaust port of the pump chamber of the last stage is opened at a position close to the timing gear train. Therefore, the lubricating oil of the timing gear train does not flow into the chamber in which the intake port of the pump chamber of the most front stage is opened, and the pressure is reduced while maintaining a favorable environment in the chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will become more apparent from the following description of the preferred embodiments, with reference to the accompanying drawings, in which:

Fig. 1 is a vertical cross-sectional view of a multi-stage pump device according to the embodiment of the present invention;
Fig. 2 is a cross-sectional view of the multi-stage pump device, taken along the line II-II of Fig. 1;
Fig. 3 is a cross-sectional view of the multi-stage pump device, taken along the line III-III of Fig. 1;
Fig. 4 is a cross-sectional view along the line IV-IV of Fig. 1, and illustrates the multi-stage pump device according to the embodiment;
Fig. 5 is a cross-sectional view of the multi-stage pump device, taken along the line V-V of Fig. 1;
Fig. 6 is a plan view of the multi-stage pump device according to the embodiment; and
Fig. 7 is a cross-sectional view illustrating a clearance in the pump device according to the embodiment and the pump device of a comparative example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The preferred embodiment of the present invention will now be described with reference to the drawings.

[0015] In the multi-stage pump device, the multi-stage Roots pump P is integral with a motor M which is a rotary drive unit, as shown in Fig. 1. The multi-stage Roots pump P includes first to eighth cylinder blocks 1 to 8 arranged in this order in close contact to each other with O-rings interposed among them, and are fastened together with a front plate 1c on the side of the first cylinder block 1 by through-bolts (not shown). The first to eighth cylinder blocks 1 to 8 and the front plate 1c constitute a portion of the casing.

[0016] Two horizontal shaft holes are formed through the first to seventh cylinder blocks 1 to 7 in parallel and one above another, and a first shaft 9 and a second shaft 10 are accommodated in the shaft holes. Bearing means 1a and 1b are provided in the shaft holes of the first cylinder block 1 to support the first and second shafts 9 and 10, which are covered by the front plate 1c.

[0017] As also shown in Fig. 2, a pump chamber 2a is formed as a recess in the second cylinder block 2 from the front side thereof. A first rotor 11 mounted to the first shaft 9 on the lower side and a second rotor 12 mounted to the second shaft 10 on the upper side are arranged in the pump chamber 2a. The first and second rotors 11 and 12 rotate in mesh with each other with a small gap relative to each other. An intake port 2b and an exhaust port 2c communicated with the pump chamber 2a are horizontally formed in the second cylinder block 2 to suck and exhaust the air accompanying the rotation of the first and second rotors 11 and 12.

[0018] Also, in the fourth and sixth cylinder blocks 4 and 6 shown in Fig. 1, similar pump chambers 4a and 6a are formed as a recess from the front side, as shown in Figs. 4 and 5. First and second similar rotors 13 to 16 are arranged in the pump chambers 4a and 6a. Similar intake ports 4b and 6b and exhaust ports 4c and 6c are horizontally formed in the fourth and sixth cylinder blocks 4 and 6. Here, as shown in Fig. 1, the pump chamber 2a of the frontmost stage formed in the second cylinder block 2 has the greatest axial length L_1, the pump chamber 4a formed in the fourth cylinder block 4 has the second greatest axial length L_2, and the pump chamber 6a of the last stage formed in the sixth cylinder block 6 has the smallest axial length L_3. The axial lengths of the first and second rotors 11 to 16 are different in conformity with the axial lengths of the pump chambers 2a, 4a and 6a.

[0019] The third cylinder block 3 has a horizontal communication hole 3a, as shown in Figs. 1 and 3, extending across an imaginary plane 100 that includes the axes of the two shafts 9 and 10. The communication hole 3a is perforated or drilled in and through the third cylinder block 3 between the shafts 9 and 10 so that the communication hole 3a does not contact the shafts 9 and 10. Where the communication hole 3a has a diameter L_4, the communication area S_1 of the communication hole 3a is expressed as,

$$S_1 = \pi(L_4/2)^2$$

[0020] When the communication area of the intake port 2b of the pump chamber 2a is denoted by S, the communication area S_1 of the communication hole 3a is given by,

$$S_1 \geqq S \times L_2/L_1$$

[0021] A similar horizontal communication hole 5a is horizontally formed in the fifth cylinder block 5, and is perforated in and through the fifth cylinder block between the shafts 9 and 10 so that the communication hole 5a does not contact the shafts 9 and 10. Where the diameter of the communication hole 5a is denoted by L_5, the communication area S_2 of the communication hole 5a is given as,

$$S_2 = \pi(L_5/2)^2$$

[0022] When the communication area S of the intake port 4b of the pump chamber 4a is the same as the communication area S of the intake port 2b of the pump chamber 2a, the communication area S_2 of the communication hole 5a is given as,

$$S_2 \geqq S \times L_3/L_2$$

[0023] Bearing means 7a and 7b are provided in the shaft holes of the seventh cylinder block 7 shown in Fig. 1 to support the first and second shafts 9 and 10. A gear chamber 8a is formed in the eighth cylinder block 8 as a recess from the rear side, as shown in Fig. 1, and a drive gear 17 is secured to the first shaft 9 in the gear chamber 8a. A driven gear 18 is secured to the second shaft 10. The driven gear 18 is in mesh with the drive gear 17 and constitutes a timing gear train together with the driven gear 17. A drive body (drive unit body) 30 of the motor M is secured to the eighth cylinder block 8 by bolts (not shown), a drive shaft 9d extends from the drive body 30. The drive shaft 9d is coupled to the first shaft 9 by a joint (not shown). The drive gear 17 can be mounted to one or both of the drive shaft 9d and the first shaft 9.

[0024] First and second side plates 19 and 20 are coupled to the side surfaces of the second to sixth cylinder blocks 2 to 6 via gaskets 21 and 22 by bolts (not shown), as shown in Figs. 2 to 6. The first and second side plates 19 and 20 constitute the remaining portion of the casing.

[0025] Referring to Figs. 2 to 6, the second plate 20 has an intake port 20a that horizontally penetrates therethrough and communicates with the intake port 2b of the second cylinder block 2, the intake port 20a having the same communication area as that of the intake port 2b. The second plate 20 also has a communication groove 20b formed as a recess for communicating the communication hole 3a of the third cylinder block 3 with the intake port 4b of the fourth cylinder block 4 with a constant communication area, and a communication groove 20c formed as a recess for communicating the communication hole 5a of the fifth cylinder block 5 with the intake port 6b of the sixth cylinder block 6 with a constant communication area. The first plate 19 has a communication groove 19a formed as a recess for communicating the exhaust port 2c of the second cylinder block 2 with the communication hole 3a of the third cylinder block 3 with a constant communication area, and a communication groove 19b formed as a recess for communicating the exhaust port 4c of the fourth cylinder block 4 with the communication hole 5a of the fifth cylinder block 5 with a constant communication area. The first plate 19 also has an exhaust port 19c that horizontally penetrates therethrough and communicates with the exhaust port 6c of the sixth cylinder block 6 with a constant communication area.

[0026] When it is desired to evacuate the interior of a certain chamber to establish a reduced-pressure chamber by using the thus constituted multi-stage pump device, the intake port 20a to that the second plate 20 of the multi-stage Roots pump P is opened in a chamber through a hose or the like, as shown in Fig. 6, and the exhaust port 19c of the first plate 19 is opened to the atmosphere through a hose or the like. The multi-stage Roots pump P is then driven by the motor M. The first and second rotors 11 to 16 thus rotate with a small gap between each pair of rotors in the pump chambers 2a, 4a and 6a of the multi-stage Roots pump P, whereby the pumping action is successively executed in the pump chambers 2a, 4a and 6a, and the air in the chamber is evacuated to the atmosphere to reduce the pressure in the chamber.

[0027] In the multi-stage pump device in this case, the high-pressure air in the pump chamber 4a is less likely to leak into the pump chamber 2a through the shaft holes and the communication hole 3a since the exhaust port 2c of the pump chamber 2a and the intake port 4b of the pump chamber 4a are connected together through the communication hole 3a that does not contact the shafts 9 and 10. Besides, the high-pressure air in the pump chamber 6a is less likely to leak into the pump chamber 4a through the shaft hole and the communication hole 5a since the exhaust port 4c of the pump chamber 4a and the intake port 6b of the pump chamber 6a are connected together through the communication hole 5a that does not contact the shafts 9 and 10. Therefore, the pump device does not almost lose the pressure-reducing performance. Besides, no shaft-sealing device is provided between the shaft holes and the shafts 9 and 10 among the stages. Accordingly, the number of the parts does not increase and the cost of production can be decreased

[0028] In the multi-stage pump device, further, the communication areas S_1 and S_2 of the communication holes 3a and 5a are determined as described above. Therefore, the high-pressure air in the pump chambers 4a and 6a does not expand when it is being transported, and the pressure-reducing performance is not deteriorated.

[0029] In the multi-stage pump device, further, the drive force transmitted from the drive shaft 9d of the motor M is converted into the rotation of the rotors 11 to 16 through the timing gear train comprising the drive gear 17 and the driven gear 18, and through the first and second shafts 9 and 10. Therefore, the multi-stage Roots pump P is not affected by the twist of the first and second shafts 9 and 10, and the driving force of the motor M is all converted into the rotation of the rotors 11 to 16 in the pump chambers 2a, 4a and 6a, so that smooth pumping action is realized.

[0030] In the multi-stage pump device of the present invention, the intake port 2b of the pump chamber 2a of the frontmost stage is opened at a position remote from the timing gear train, and the exhaust port 6c of the pump chamber 6a of the last stage is opened at a position close to the timing gear train. Therefore, the lubricating oil of the timing gear train does not flow into the chamber in which the intake port 2b of the pump chamber 2a of the most front stage is opened, and the pressure is reduced while maintaining a favorable environment in the chamber.

[Evaluation]

[0031] Regarding the multi-stage pump device of the embodiment of the present invention and the pump device of a comparative example, the amounts of air leakage from the exhaust port up to the intake port were calculated, and compared and evaluated.

[0032] The pump device of the embodiment has the same structure as the pump device of the above-mentioned embodiment except that it has six pump chambers. On the other hand, the pump device of comparative example has the structure same as that of the pump device disclosed in the above-mentioned Japanese Unexamined Patent Publication (Kokai) No. 8-14172. In the pump device of the embodiment and the pump device of the comparative example shown in Fig. 7, a clearance between the inner peripheral surface of the pump chamber 40a and the outer peripheral surfaces of the rotors 41 and 42 is denoted by CLra, a clearance between the rear end surface of the pump chamber 40a and the rear end surfaces of the rotors 41 and 42 is denoted by CLre, a clearance between the front end surface of the pump chamber 40a and the front end surfaces of the rotors 41 and 42 is denoted by CLf, a clearance between the rotors 41 and 42 is denoted by CLro, and a clearance between the cylinder block 45 and the first and second shafts 43 and 44 is denoted by CLs. The same also holds for other cylinder blocks constituting the pump chambers.

[0033] In both the pump device of the embodiment and the pump device of the comparative example, CLra = 0.15 mm, CLf = 0.15 mm, CLre = 0.20 mm, CLro = 0.15 mm, and CLs = 0.10 mm. The displacement of the pump chamber 40a of the frontmost stage per a turn of the rotor was 0.3 cc/rev, the ratio of volumes of the pump chambers of the preceding stage to the succeeding stage was 0.8, and the rotational speed of the rotors 41 and 42 was 5000 rpm.

[0034] In the pump device of the embodiment, the amount of leakage of the air was 0.229 Torr • L/sec whereas in the pump device of comparative example, the amount of leakage of the air was 0.593 Torr • L/sec. It is thus obvious that in the pump device of the embodiment, the amount of leakage of the air was decreased down to about 1/2.5 compared to that of the pump device of comparative example, offering an improved pressure-reducing function.

[0035] It will thus be understood that the multi-stage Roots pump and the multi-stage pump device of the present invention make it possible to accomplish both an improved pressure-reducing performance and a decreased cost of production.

Claims

1. A multi-stage Roots pump comprising:

a casing having a plurality of parallel pump chambers formed therein, each said pump chamber having an intake port and an exhaust port;

a plurality of parallel shafts extending through the pump chambers;

rotors arranged in said pump chambers and mounted to said shafts so that a set of rotors are arranged in each of said pump chambers in mesh with each other; and

said casing being formed such that said intake port of one pump chamber positioned at one end in the casing is opened, said exhaust ports of said pump chambers are connected to said intake ports of the succeeding pump chambers one after another, through communication holes extending across an imaginary plane that includes axes of said shafts, and said exhaust port of the pump chamber positioned at the other end in the casing is opened, said communication holes being perforated in said casing between said shafts so that said communication hole does not contact said shafts.

2. A multi-stage Roots pump according to claim 1, wherein where the pump chambers are referred to as a first pump chamber, a second pump chamber, ..., an (n-1)-th chamber and an n-th chamber, from the frontmost stage, an area of the communication hole connecting the exhaust port of said (n-1)-th pump chamber to the intake port of said n-th pump chamber, is not smaller than a value obtained by multiplying an area of the intake port of said (n-1)-th pump chamber by a ratio of an axial length of said n-th pump chamber to an axial length of said (n-1)-th pump chamber.

3. A multi-stage pump comprising a multi-stage Roots pump according to claim 1, a rotary drive unit having a drive body and a drive shaft extending from said drive body, and a timing gear train comprising a drive gear secured to said drive shaft of said rotary drive unit and a driven gear secured to one of the shafts of said multi-stage Roots pump and driven by said drive gear.

4. A multi-stage pump device according to claim 3, wherein said intake port of said pump chamber of said frontmost stage is opened at a position remote from said timing gear train, and said exhaust port of said pump chamber of said last stage is opened at a position close to said timing gear train.

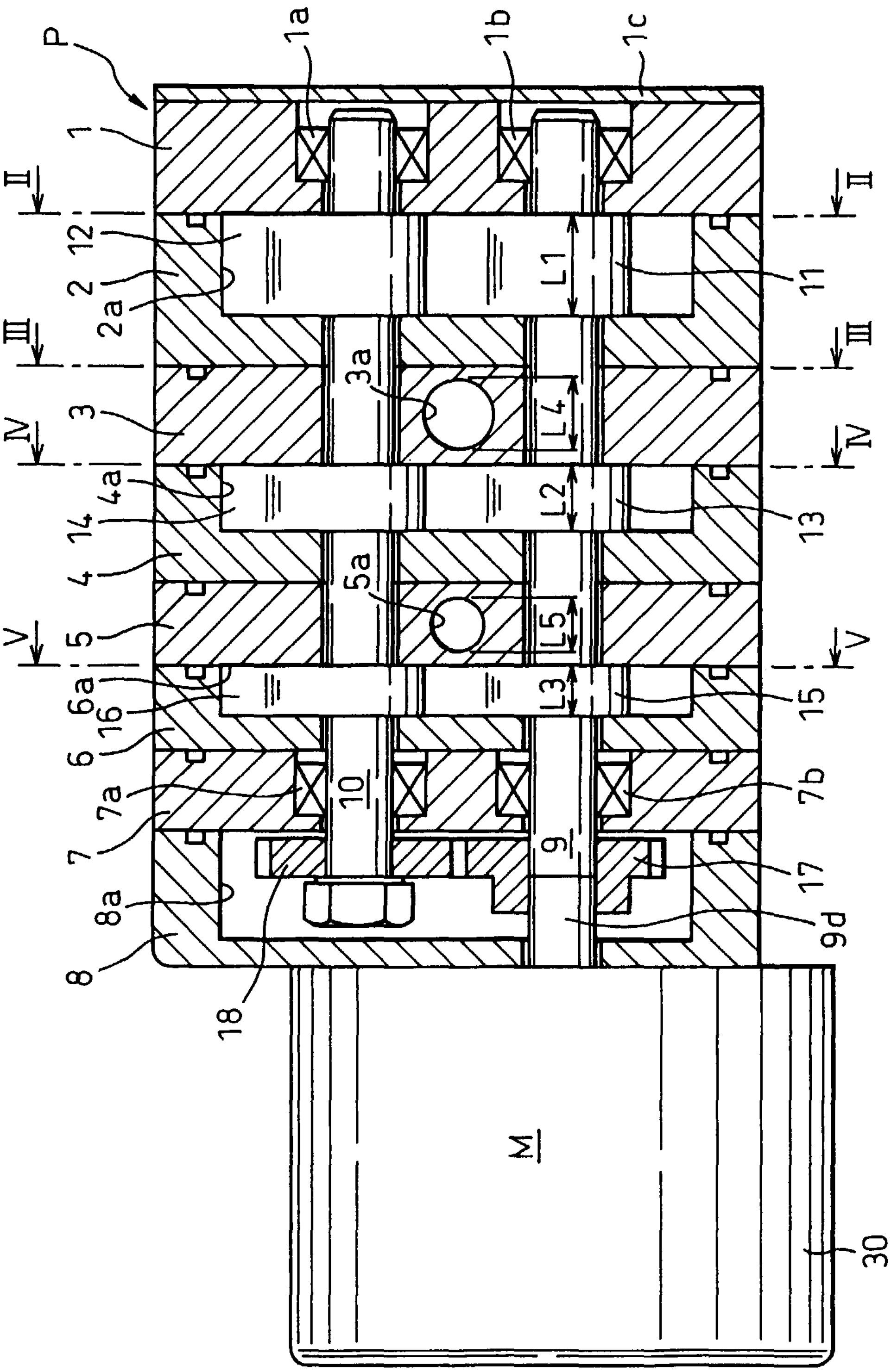

P
1a
1b
1c
1
II
III
IV
V
12
2
2a
11
L1
3a
3
L4
4a
14
4
L2
13
5a
5
L5
6a
16
6
L3
15
7a
7
10
7b
9
17
8a
8
9d
18
M
30

Fig. 1

Fig. 2

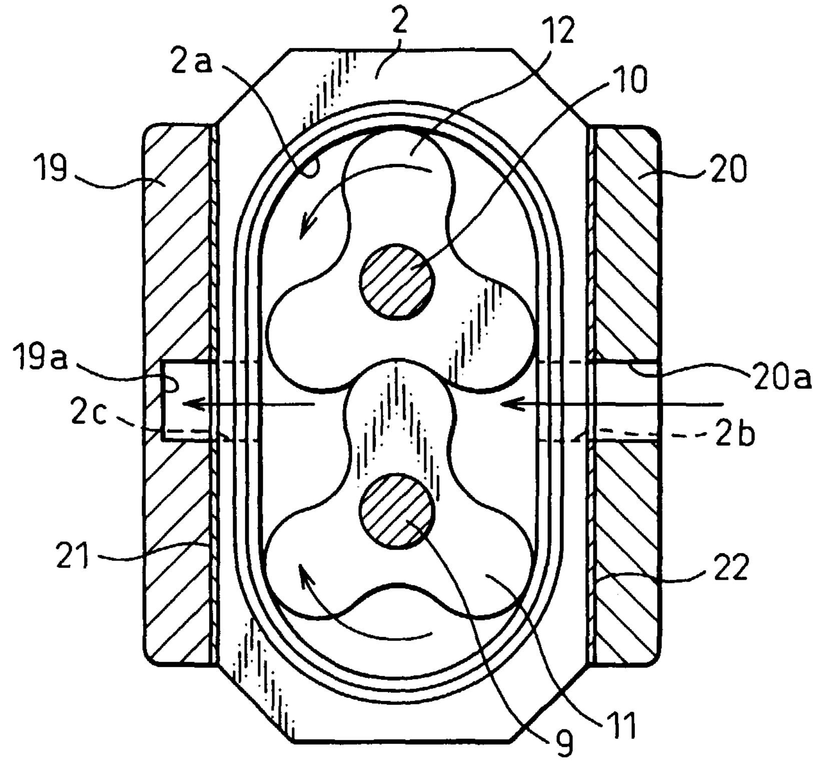

2
2a
12
10
19
20
19a
20a
2c
2b
21
22
9
11

Fig. 3

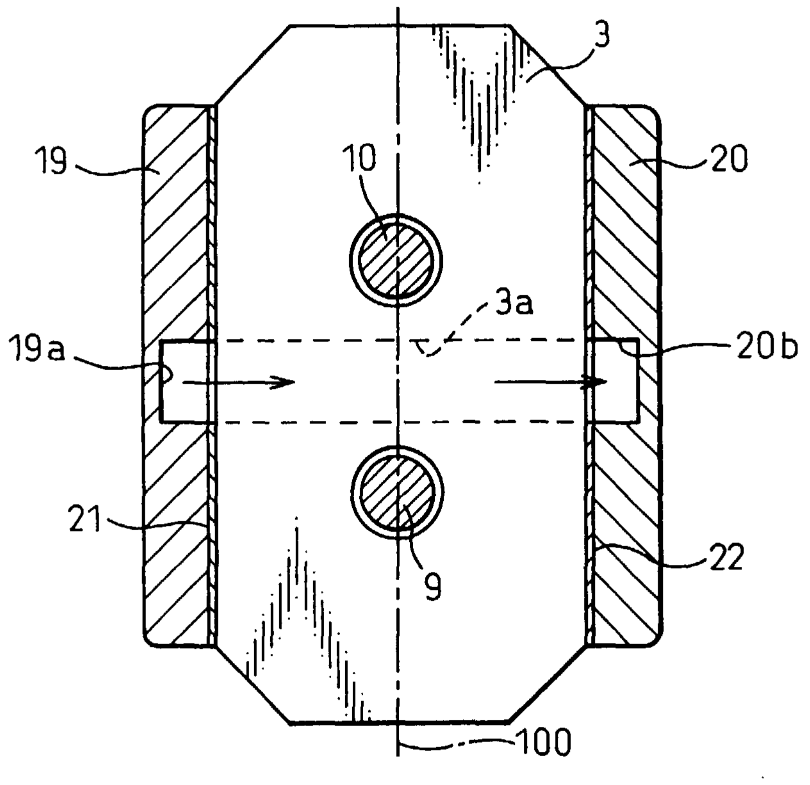

3
19
20
10
3a
19a
20b
21
22
9
100

Fig. 4

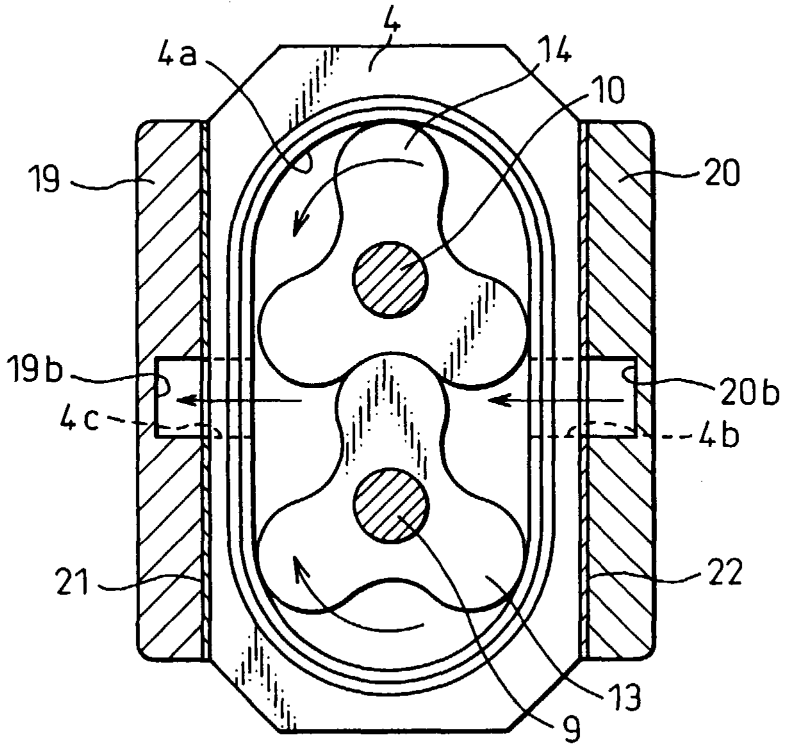
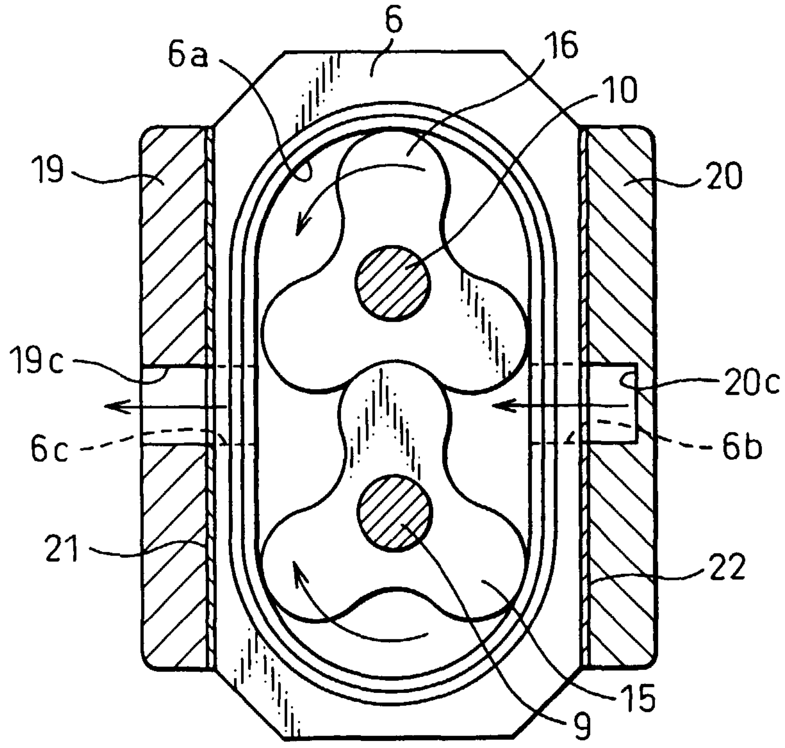

4
4a
14
10
19
20
19b
20b
4c
4b
21
22
13
9

Fig. 5


6
6a
16
10
19
20
19c
20c
6c
6b
21
22
15
9

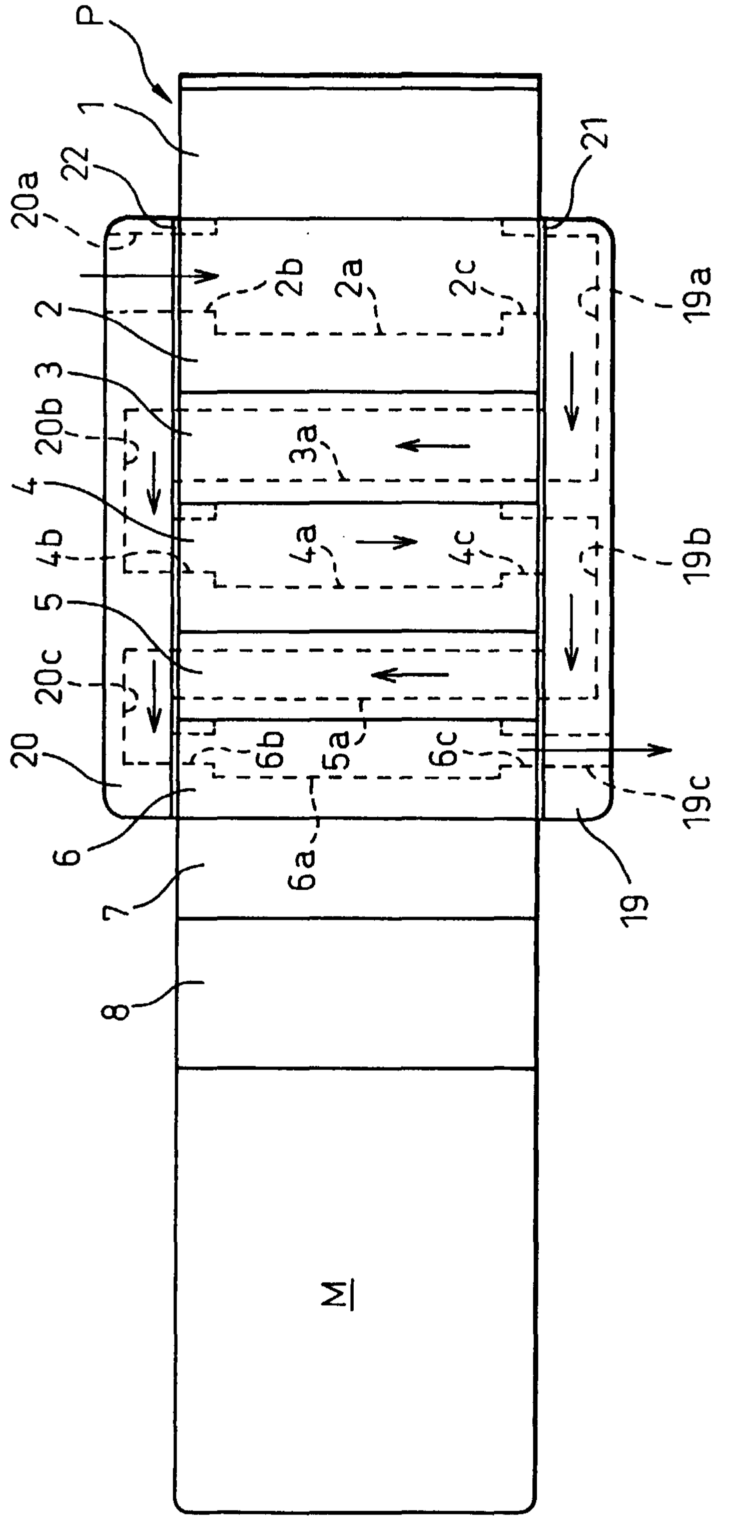
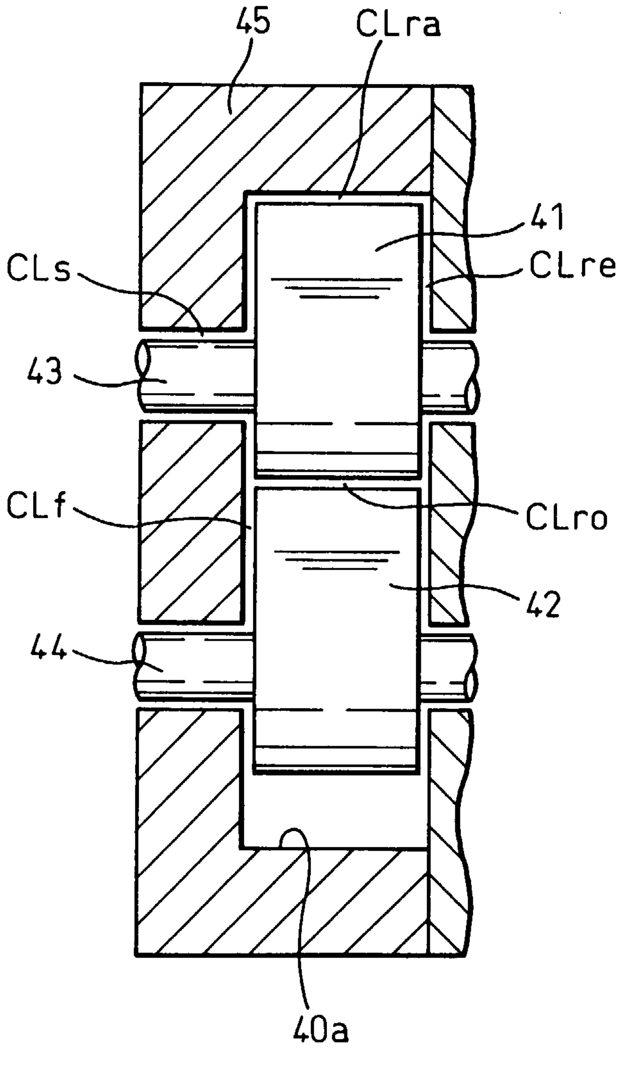

P
1
21
22
20a
2b
2a
2c
19a
2
3
3a
20b
4
4a
4c
4b
19b
5
20c
20
6b
5a
6c
19c
6
6a
7
19
8
M

Fig.6

Fig.7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 12 3818

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	GB 2 088 957 A (BOC LTD) 16 June 1982 (1982-06-16) * page 1, line 52 - page 2, line 1; figure 2 *	1	F04C18/12 F04C23/00
A	EP 0 476 631 A (EBARA CORP) 25 March 1992 (1992-03-25) * column 2, line 46 - column 3, line 27; figure 1 *	1	
A	DE 195 03 716 C (K BUSCH GMBH DRUCK & VAKUUM DR) 28 March 1996 (1996-03-28) * claim 1; figure 7 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 183 (M-598), 12 June 1987 (1987-06-12) & JP 62 010491 A (SHUICHI KITAMURA), 19 January 1987 (1987-01-19) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 February 2000	Dimitroulas, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 12 3818

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-02-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2088957 A	16-06-1982	DE 3147824 A	24-06-1982
		FR 2495701 A	11-06-1982
		JP 1759806 C	20-05-1993
		JP 4033997 B	04-06-1992
		JP 57146093 A	09-09-1982
EP 0476631 A	25-03-1992	JP 2537696 B	25-09-1996
		JP 4132895 A	07-05-1992
		DE 69112160 D	21-09-1995
		DE 69112160 T	21-03-1996
		US 5173041 A	22-12-1992
DE 19503716 C	28-03-1996	NONE	
JP 62010491 A	19-01-1987	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82