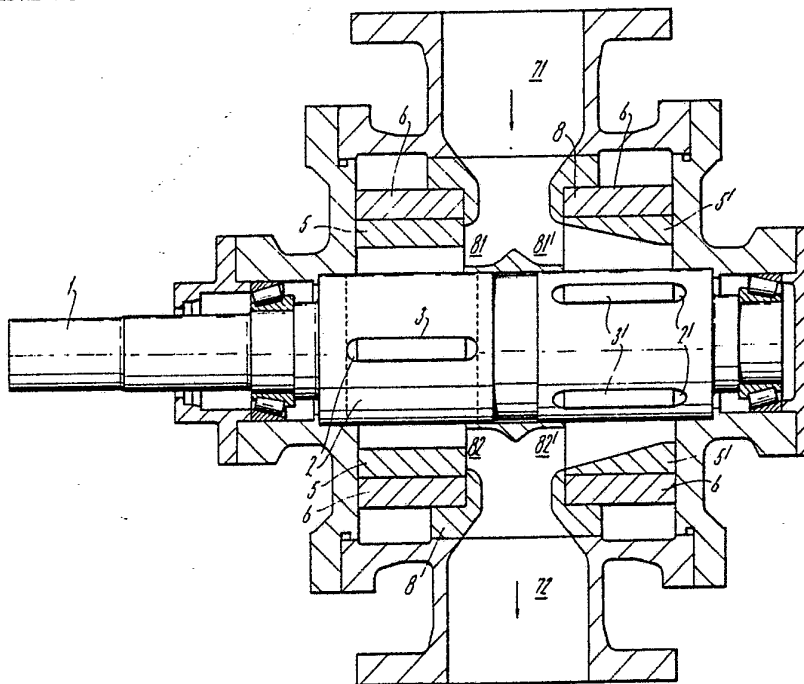




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>3</sup> : F04C 11/00, 2/348, 15/04</p>	A1	<p>(11) International Publication Number: WO 84/ 01408 (43) International Publication Date: 12 April 1984 (12.04.84)</p>
<p>(21) International Application Number: PCT/GB83/00243 (22) International Filing Date: 28 September 1983 (28.09.83) (31) Priority Application Number: 8227630 (32) Priority Date: 28 September 1982 (28.09.82) (33) Priority Country: GB  (71) Applicant (for all designated States except US): PLENTY LIMITED [GB/GB]; Hambridge Road, Newbury, Berkshire RG14 5TR (GB). (72) Inventor; and (75) Inventor/Applicant (for US only) : KAIN, Alexander, Stanley [GB/GB]; Bourne Valley Farm, Minety, Wiltshire (GB). (74) Agent: ALLEN, Oliver, John, Richard; Lloyd Wise, Tregear &amp; Co., Norman House, 105-109 Strand, London WC2R OAE (GB).</p>		<p>(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i></p>

(54) Title: DOUBLE VANE PUMP



## (57) Abstract

A rotary vane pump in which two sets of vanes (3, 3') are each slidably mounted on a rotor shaft (1), each set of vanes being axially spaced, the vanes of the first set being preferably set at 45° to those of the second set, each set of vanes forming a pumping section which feeds into a common pump outlet (72), preferably the inlet (71) is between the sets of vanes and feeds axially into pump chambers (54a-d) formed between the vanes and the rotor.

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TITLE: DOUBLE VANE PUMP

The present invention relates to rotary pumps of the sliding vane type.

Rotary pumps of the sliding vane type are well known and for example are shown in British Patent No. 834,925.

5 These pumps comprise a rotor driven by a rotor shaft, the rotor shaft having four vanes slidingly mounted in slots in the shaft, the ends of the vanes being in bearing engagement with inwardly facing bearing surfaces provided on the rotor to form four pump chambers  
10 between the vanes and rotor. Rotation of the rotor shaft causes rotation of the rotor and fluid is conveyed by the rotating pump chambers from an inlet in the pump casing or stator to an outlet in the casing or stator. Such pumps may be variable in capacity by  
15 moving the axis of the rotor surrounded by a sliding cage relative the shaft and stator. The ends of the vanes where they bear on the rotor are often angled or chamfered relative to the tangent of the radial centre line of the vanes at an angle of about  $15^{\circ}$ . The  
20 rotor of the known pumps are radially ported so that as the rotor revolves in the stator a portion of the stator which can be on the sliding cage interacts with the ports to open or close the chambers.

Such pumps produce a pulsating output, each pulse  
25 corresponding in frequency to the rate of travel of each vane and subsequent vane past the outlet. In order to reduce the pulse frequency it is possible to increase



the number of vanes. Unfortunately this results in a large rotor diameter since the rotor must have provision for each blade to slide in it.

A rotary vane pump according to the present invention  
5 comprises a rotor shaft, a rotor, a set of vanes slidably mounted to the rotor shaft at one axially longitudinal position on the rotor shaft, and a second set of vanes slidably mounted to the rotor shaft at a second axially longitudinal position on the rotor shaft, a stator surrounding the rotor,  
10 the first set of vanes and rotor forming a first pumping section and the second set of vanes forming a second pumping section where each pumping section feeds into a common pump outlet.

Preferably there are four vanes in each set, those of  
15 the first set being set at  $45^{\circ}$  to those of the second set. Preferably each set has its own rotor.

Advantages of the pump of the invention are that the outlet flow is smoother and therefore faster, the rotor can be also made smaller and thus a smaller pump may be provided  
20 for a given duty.

According to another aspect of the invention a rotary vane pump according to the present invention comprises a rotor and rotor shaft, at least one set of vanes slidably mounted to the shaft and a stator having a pump inlet with an axial  
25 feed from the inlet to rotary pump chambers formed between the vanes and the rotor.



Preferably a second set of vanes slidably mounted on the rotor shaft is provided, the second set being axially longitudinally spaced from the first set and wherein the feed from the inlet to the rotary pump chambers formed by each set of vanes is axial. The axial feed may be from the centre of the stator axially outwards.

Feeding the pump chambers axially eliminates the need for ports in the side of the rotor which in turn eliminates the acceleration and deceleration of fluid in the inlet and outlet lines caused by the rotor ports. Thus removal of the need for ports combined with splitting the flow enables the pump to run faster and more quietly. Furthermore eliminating the rotor ports has the effect of increasing the area supporting the rotor which enables the pump to operate at higher discharge pressures.

Combining the increased output with an increased running speed enables the smaller pump to be offered for a given duty.

Preferably the vane ends terminate in a flat surface angled at about  $80^{\circ}$  to the vane sides. Hitherto this angle has been about  $75^{\circ}$ . The increase in angle that is the decrease in terminal slope enables the rotor bore to be increased and in turn the eccentricity between stator block or cage and rotor axes can be increased so as to further increase the pump output.



\*4\*

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a transverse vertical cross-section of a first embodiment of the invention being a universal rotary vane pump,

Figure 2 is an axial horizontal cross section of the first embodiment taken along line A-A of Fig. 1,

Figure 3 is an axial vertical cross section of a second embodiment of the invention being an inboard fixed flow pump section being taken along line A-A of Figure 4,

Figure 4 is a transverse vertical cross section of the second embodiment being on the left a section along line B-B and on the right a section along line C-C of Fig 3,

Figure 5 is an axial vertical cross section of a third embodiment of the invention being an outboard fixed flow pump the section being similar to that of Fig. 3,

Figure 6 is a vertical cross section of a hand control valve for varying the output of the pumps shown in Figs. 3 to 5,

Figure 7 is a vertical cross section of a hydraulic control arrangement replacing the hand control valve of Fig. 6.



In Figures 1 and 2 may be seen a rotary shaft 1 provided with two transverse slots 2 at right angles to each other and forming a first set of slots, and two transverse slots 2' at right angles to each other forming a second set of slots. The second set of slots is axially aligned at  $45^{\circ}$  to the first set.

Each slot 2, 2' has a pair of vanes 3, 3' mounted therein. Each vane has parallel sides 33, a perpendicular inner end face 34 and an angled or chamfered outer end face 35 which is angled at  $80^{\circ}$  to the vane sides at  $\theta$ . That is to say is angled at  $10^{\circ}$  to the inner end face. The vanes freely slide in slots 2, 2'. The vanes may be both coupled in similar way to those shown in British Patent No. 1,013,801 or else one diametral pair may be coupled as shown at 3a in Fig. 1 and the other diametral pair may be uncoupled but in abutting relationship as shown at 3b in Fig. 1.

The outer end faces 35 abut on inner planer surfaces 4 of a rotor 5 the outer cylindrical surface 51 of which is carried rotatably by an inner corresponding surface 61 of a cage 6 which is either fixed in a stator 7 as shown in Figs. 3 and 5 or else can be adjustable to vary the distance and thus the eccentricity between the rotor axis 52 and shaft axis 12. This adjusting may be either by a manual

arrangement as shown in Fig. 6 or by a hydraulic arrangement as shown in Fig. 7. A similar axially spaced rotor 5' to rotor 5 is provided in stator 7 for the second set of vanes 3'.

5        Between each inner planar surface 4 of each rotor 5, 5' is curved surface 53. Chambers 54a, b, c are formed between the vanes and rotor 1 and a fourth chamber 54d is scarcely formed.

10        An inlet 71 and outlet 72 in stator 7 are provided which connect with the pump chambers 54a - d. The inlet and outlet diverge in a centre member 8 to provide two inlet ducts 81 and 81' and two outlet duct 82 and 82' which stream the inlet and outlet liquids axially into and out of the pump chambers. This eliminates the  
15        need for ports in the outer periphery of the rotors which reduces or eliminates the acceleration and deacceleration of the fluid in the suction and delivery lines caused by the rotor ports, thereby together with  
20        the split flow the pump may run faster and more quietly than known pumps. Also by eliminating the rotor ports this has the effect of increasing the area of the cage 6 supporting the rotors which enables the pump to operate at higher discharge pressures.

25        Figures 3 to 5 show in more detail two embodiments of the pump of the invention. The indexing of parts similar to those of Figures 1 and 2 is the same



as in those figures. The inboard pump shown in Figure 3 has roller bearings 90 which are lubricated by the medium being pumped. A seal 91 either mechanical or soft packing seals between the shaft 1 and stator 7. The outboard  
5 pump shown in Figure 5 is designed to handle low lubricity liquids or liquids not compatible with roller bearings; in this pump shaft 1 is supported in roller bearings 93 which are external of the liquid being pumped and are grease lubricated. The bearings 93 are in turn supported in  
10 brackets 94. The stator 7 is sealed to shaft 1 by means of mechanical or soft packing seals 95. Brackets 94 also form heating or cooling chambers 96.

In Figures 3 to 5 a cover plate 100 is provided on the stator 7 when the pumps are used as fixed flow  
15 pumps. The cover plate has a centre stud 101 which locks the cage 6 to the stator. When it is desired to convert the pumps to variable flow pumps, cover plate 100 and stud 101 are removed and either the hand control generally shown at 103 in Figure 6 or the hydraulic  
20 actuator generally shown at 105 in Figure 7 are bolted to the stator.

In the hand control 103 a handwheel 107 has a threaded portion 109 which cooperates with a threaded sleeve 110 to move a pin 112 up or down. Pin 112  
25 is connected to cage 6 so that the cage eccentricity can be varied.



In the hydraulic actuator 105 a piston 116 is secured to a pin 118 which is connected to cage 6 so that piston movement causes the cage eccentricity to be varied. Piston 116 works in cylinder 118 the upper part of which above the piston 116 is connected via line 120 to accumulator chamber 124 in accumulator 122. The space 126 above piston 116, line 12 and chamber 124 are filled with hydraulic oil. Weight is applied to weight container 128 in the form of steel pellets 130. The weight of the container 128 and pellets 130 pressurises the oil in line 120, the container 128 sliding up and down ram 129. Pump pressure is fed to space 132 under the piston. A slight change in pump discharge pressure causes piston 116 to move which in turn moves cage 6 thus adjusting the pump output until the system balances again.



## WHAT WE CLAIM IS:-

1. A rotary vane pump comprising a rotor shaft, a rotor, a first set of vanes slidably mounted to the rotor shaft at one axially longitudinal position on the rotor shaft, and a second set of vanes slidably mounted to the rotor shaft at a second axially longitudinal position on the rotor shaft, a stator surrounding the rotor, the first set of vanes and rotor forming a first pumping section and the second set of vanes forming a second pumping section wherein each pumping section feeds into a common pump outlet.
- 10 2. A rotary vane pump comprising a rotor and rotor shaft, at least one set of vanes slidably mounted to the shaft and a stator having a pump inlet, with an axial feed from the inlet to rotary pump chambers formed between the vanes and the rotor.
- 15 3. A pump as claimed in Claim 2 wherein a second set of vanes slidably mounted on the rotor is provided, the second set being axially longitudinally spaced from the first set and wherein the feed from the inlet to the rotary pump chambers formed by each set of vanes is axial.
- 20 4. A pump as claimed in any one of Claims 1 to 3 wherein there are two sets of vanes only and there is a common pump outlet between each set of vanes.
5. A pump as claimed in any one of Claims 1 to 4 wherein there are two sets of vanes only and there is a common pump inlet in the centre of the stator between each set of vanes communicating axially outwards with the pump chambers.
- 25



6. A pump as claimed in any one of Claims 1 to 5 wherein there are two sets of vanes, the vanes of the first set being set at  $45^{\circ}$  to those of the second set.
7. A pump as claimed in any one of Claims 1 to 6 wherein the outer ends of the vanes terminate in a flat surface angled at about  $80^{\circ}$  to the vane sides.
8. A pump as claimed in any one of Claims 1 to 7 wherein each set of vanes has its separate rotor.
9. A pump as claimed in any one of Claims 1 to 8 wherein the or each rotor is mounted in a cage which is adjustable radially from the pump axis so as to vary the distance between the or each rotor axis and the rotor shaft axis.
10. A pump as claimed in Claim 9 wherein the radial adjustment is by means of a piston or the like.
11. A pump as claimed in Claim 9 wherein the radial adjustment is by means of a hand-operable control cooperating with a threaded member to move the cage so that the cage eccentricity may be varied.
12. A pump as claimed in Claim 10 wherein the piston or the like is mounted in a cylinder connected to an accumulator chamber in an accumulator by a conduit filled with a liquid.
13. A pump as claimed in Claim 12 wherein the liquid acts on one side of the piston or the like whilst the pump discharge is connected to the other side of the piston or the like, and wherein the accumulator pressure is adjustable to vary the pressure acting on said one side of the piston or the like.



14. A pump as claimed in Claim 13 wherein the accumulator comprises a hollow fixed shaft or ram the interior of which is connected to the cylinder, and wherein the accumulator chamber surrounds a part of the shaft or ram, the chamber  
5 being formed in a part of a container the container containing weighting means, preferably a number of weights, the weight of which can be adjusted to bias the pressure acting on said one side of the piston or like.

15. A rotary vane pump substantially as described with  
10 reference to Figures 1 and 2 of the accompanying drawings.

16. A rotary vane pump substantially as described with reference to Figures 3 and 4 of the accompanying drawings.

17. A rotary vane pump substantially as described with reference to Figure 5 of the accompanying drawings.

15 18. A rotary vane pump substantially as described controlled by the control of Figure 6 of the accompanying drawings.

19. A rotary vane pump substantially as described controlled by the control of Figure 7 of the accompanying  
20 drawings.



## AMENDED CLAIMS

[received by the International Bureau on 19 March 1984 (19.03.84);  
original claims 1 to 19 replaced by amended claims 1 to 11]

1. A rotary van pump comprising a pair of rotors and a rotor shaft, two sets of vanes only, slidably mounted to the shaft at separate longitudinal positions on the shaft, the rotors and stator surrounding each vane set, the rotors  
5 having flats on their inner surfaces on which the outer ends of the vanes engage, a common pump inlet and a common pump outlet between the vane sets, with axial feeds from the inlet to rotary pump chambers formed either side of the inlet between the vanes, rotor, rotor shaft and stator.
- 10 2. A pump as claimed in claim 1 wherein the inlet and outlet diverge in a centre member to provide two inlet ducts and two outlet ducts to stream the inlet and outlet fluids axially into and out of the pump chambers.
3. A pump as claimed in claim 1 wherein the vanes of the  
15 first set of vanes are set at  $45^{\circ}$  to those of the second set.
4. A pump as claimed in any one of claims 1 to 3 wherein the outer ends of the vanes terminate in a flat surface angled at about  $80^{\circ}$  to the vane sides.
- 20 5. A pump as claimed in any one of claims 1 to 4 wherein each set of vanes has its separate rotor.
6. A pump as claimed in any one of claims 1 to 5 wherein the rotors are mounted in cages which are adjustable radially from the pump axis so as to vary the distance



between the or each rotor axis and the shaft axis.

7. A pump as claimed in claim 6 wherein the radial adjustment is by means of a piston or the like.

8. A pump as claimed in claim 6 wherein the radial  
5 adjustment is by means of a hand-operable control cooperating with a threaded member to move the cage so that the cage eccentricity may be varied.

9. A pump as claimed in claim 7 wherein the piston or the like is mounted in a cylinder connected to an accumulator  
10 chamber in an accumulator by a conduit filled with a liquid.

10. A pump as claimed in claim 9 wherein the liquid acts on one side of the piston or the like whilst the pump discharge is connected to the other side of the piston or the like, and wherein the accumulator pressure is adjustable to vary the  
15 pressure acting on said one side of the piston or the like.

11. A pump as claimed in claim 10 wherein the accumulator comprises a hollow fixed shaft or ram the interior of which is connected to the cylinder, and wherein the accumulator chamber surrounds a part of the shaft or ram, the chamber  
20 being formed in a part of a container the container containing weighting means, preferably a number of weights, the weight of which can be adjusted to bias the pressure acting on said one side of the piston or like.

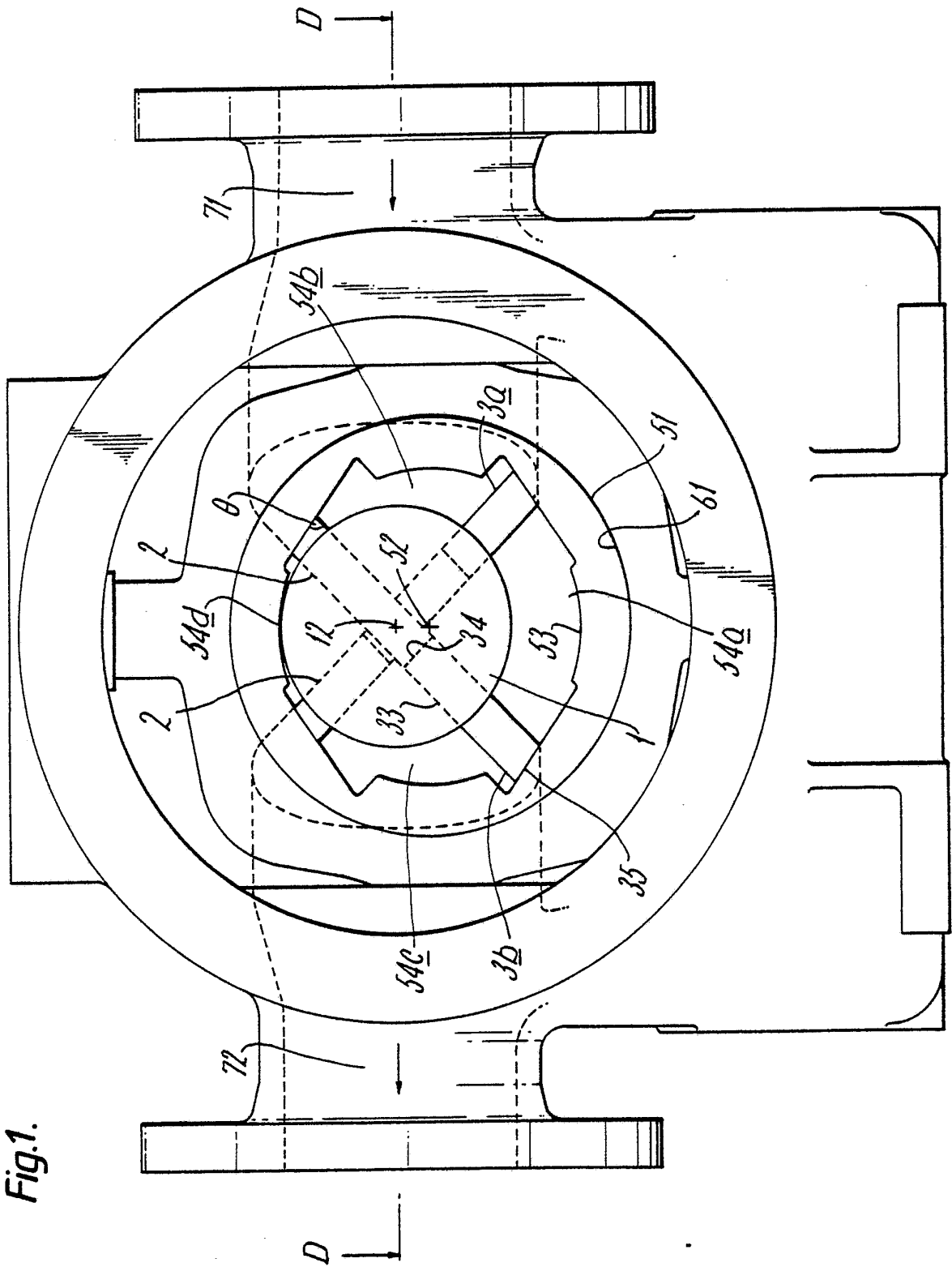


Fig. 1.



2/6

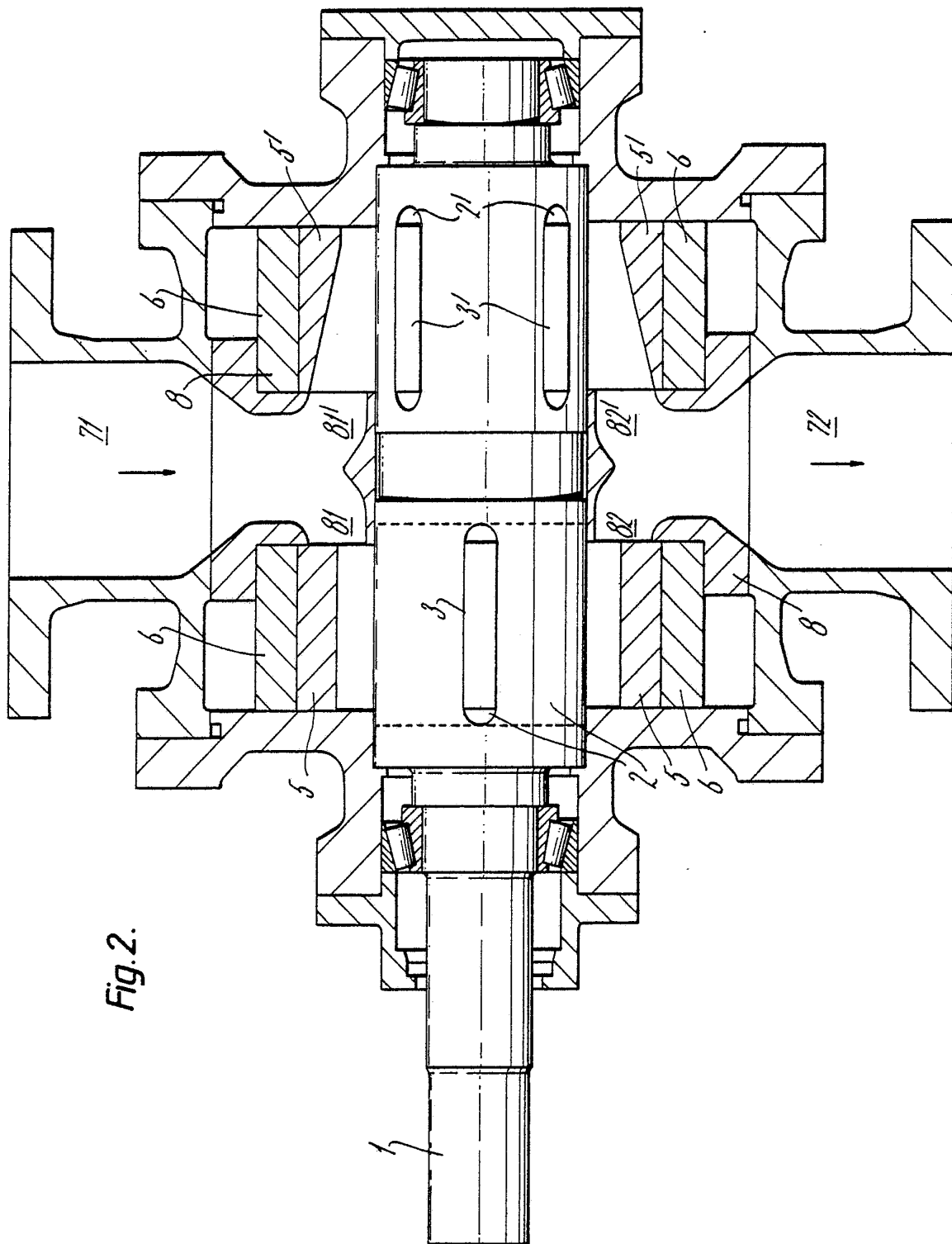
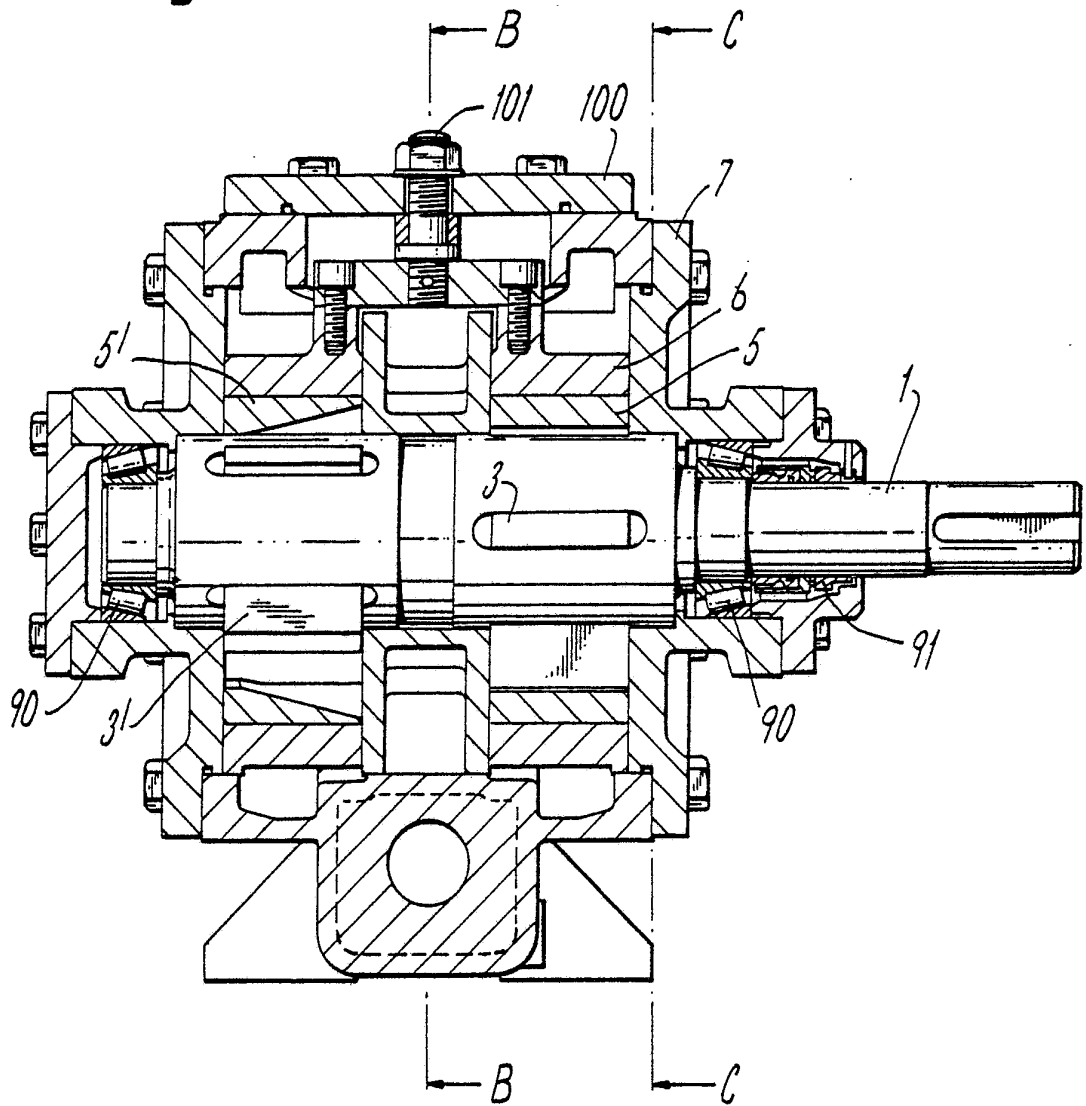
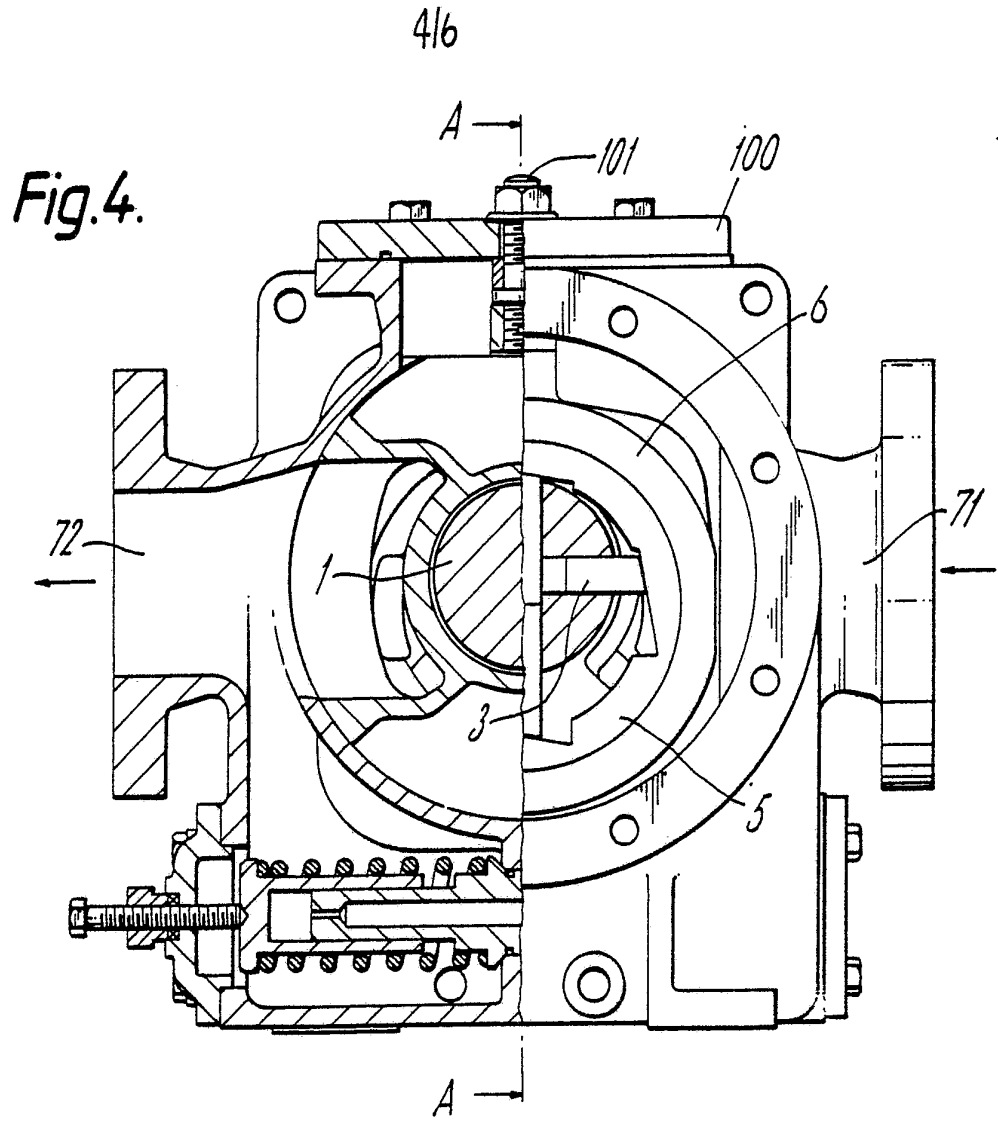


Fig. 2.

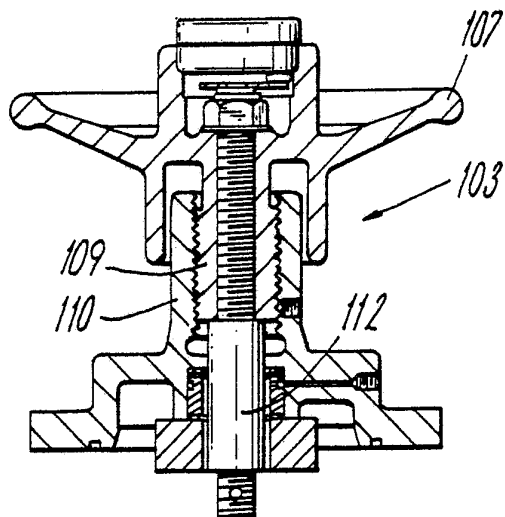
3/6

Fig. 3.





*Fig. 6.*



5/6

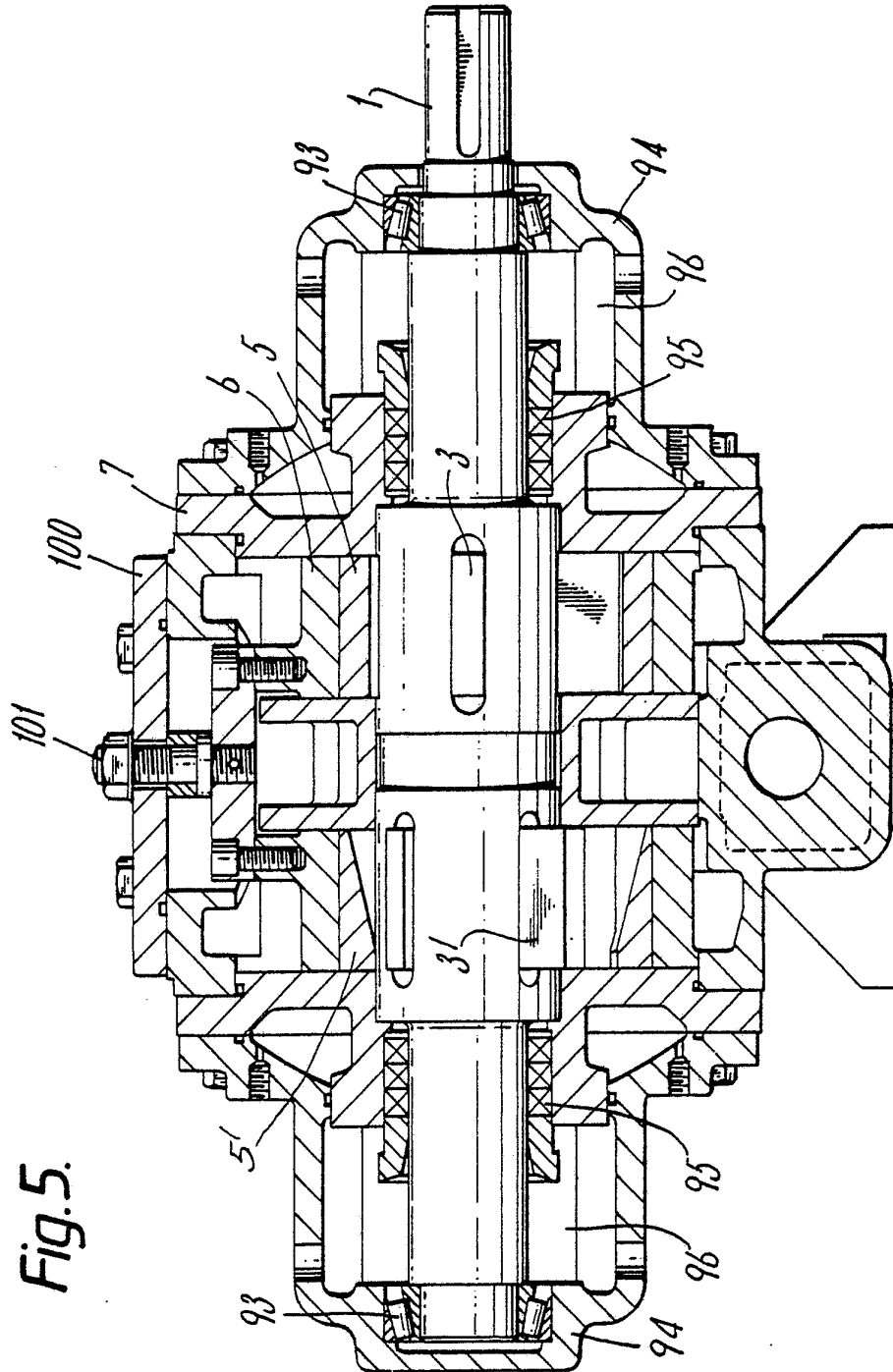
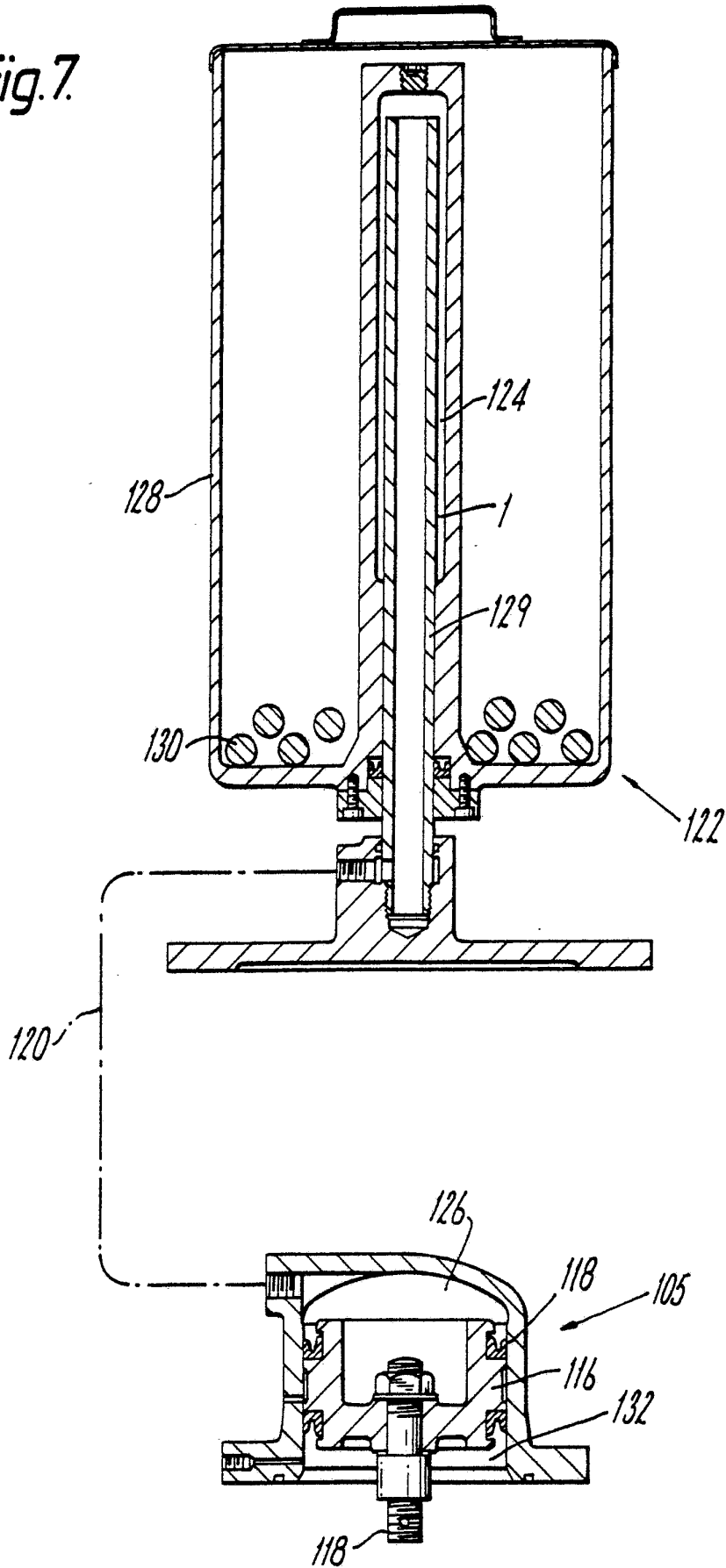


Fig. 5.

6/6

Fig. 7.



# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 83/00243

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>3</sup> : F 04 C 11/00; F 04 C 2/348; F 04 C 15/04		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
IPC <sup>3</sup>	F 04 C 11/00; 2/34; 15/04; F 01 C 11/00; 1/34	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category *	Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
Y	DE, B, 1203611 (BRAKESHOE INTERNATIONAL) 21 October 1965 see column 3, line 65 - column 5, line 45; figures	1-5,8,9,11
Y	US, A, 2720171 (HARRINGTON) 11 October 1955 see column 2, lines 9-44; figures 1,4,6	1,2,3,5
Y	EP, A1, 0007535 (RMC) 6 February 1980 see page 3, line 27 - page 4, line 10; figures; page 5, last paragraph	1,2,3,5
Y	US, A, 1692473 (SMITH) 20 November 1928 see page 1, lines 81 to the end; page 2, lines 7-39 and 91-101; figures 1-4	1-5
Y	DE, C, 1199618 (EICKMANN) 26 August 1965 see column 4, line 32 to the end; figures 1,2; column 6, lines 5-27; figure 3	1,8,9,11,18
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<p>* Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>1</sup>	Date of Mailing of this International Search Report <sup>2</sup>	
5th January 1984	24 JAN 1984	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>10</sup>	
EUROPEAN PATENT OFFICE	G. L. M. Krügerberg	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category*	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
A	FR, A, 2353729 (BEPEX CORP.) 30 December 1977 see page 3, line 9 - page 4, line 23; figures; page 5, first paragraph	6
Y	GB, A, 414752 (COX) 6 September 1934 see page 4, line 89 - page 5, line 47; figures 1-3	7,9,11,18
Y	GB, A, 2047807 (PLENTY GROUP LTD.) 3 December 1980 see page 1, lines 79-105; figure 2	7
Y	GB, A, 810099 (PLENTY & SON LTD.) 11 March 1959 see page 2, lines 45-97; figures 1,2	7,9,10-14, 19
Y	GB, A, 689313 (PLENTY & SON LTD.) 25 March 1953 see page 2, lines 53-108; figures	7,9,10-14, 19
A	GB, A, 562441 (BATH) 15 February 1946 see figure 2	17

## ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

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 INTERNATIONAL APPLICATION NO.      PCT/GB 83/00243 (SA      5865)  
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This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/01/84

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-B- 1203611		None	
US-A- 2720171		None	
EP-A- 0007535	06/02/80	JP-A- 55019986	13/02/80
US-A- 1692473		None	
DE-C- 1199618		None	
FR-A- 2353729	30/12/77	AU-A- 2008876 JP-A- 52076709	16/02/78 28/06/77
GB-A- 414752		None	
GB-A- 2047807	03/12/80	None	
GB-A- 810099		None	
GB-A- 689313		None	
GB-A- 562441		None	

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