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(54) **PUMPING APPARATUS**

(57) A pumping apparatus comprising:  
i) a first and a second reversible volumetric gear pump (1, 2); the first volumetric pump (1) drawing in rotation the second volumetric pump (2); the first pump (1) comprising a first housing compartment (12) for housing a first pair (11) of toothed wheels; the second pump (2) comprising a second housing compartment (22) for housing a second pair (21) of toothed wheels;  
ii) a first channel (13) that places in fluid connection a first zone (121) of the first compartment (12) and a first zone (221) of the second compartment (22);  
iii) a second channel (23) that places in fluid connection

a second zone (122) of the first compartment (12) and a second zone (222) of the second compartment (22);  
iv) means (3) for opening/closing the first and the second channel (13, 23);  
v) a first, a second, a third and a fourth openings (14, 15, 24, 25) intended to allow the fluid communication of the pumping apparatus (10) with the outside;

The pumping apparatus (10) can assume a first operating configuration wherein the first and the second pumps (1, 2) have a direction of rotation opposite to that of the second configuration.

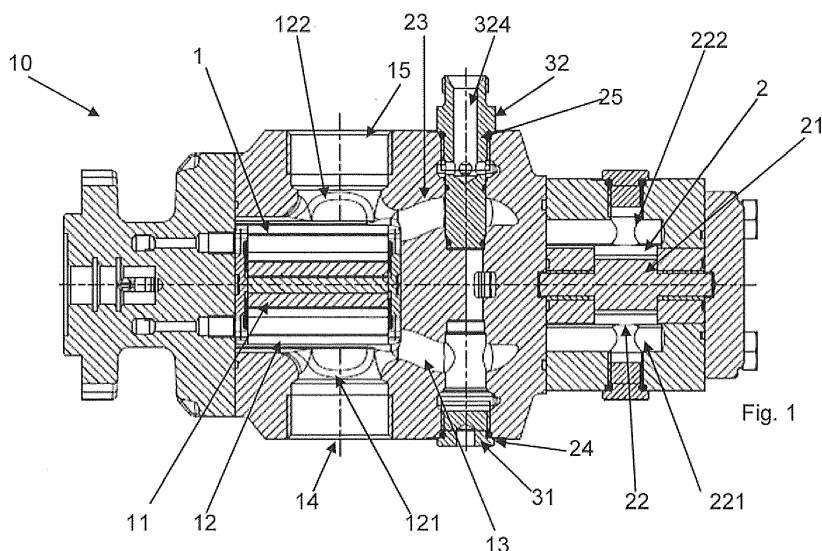


Fig. 1

## Description

**[0001]** The present invention relates to a pumping apparatus. It can be used to drive loads, typically in trucks or tipper trucks.

**[0002]** The use of a plurality of volumetric gear pumps is known, which are used to drive corresponding loads independently of each other.

**[0003]** The object of the present invention is to propose a pumping apparatus equipped with multiple pumping sections which makes it possible to reverse the direction of rotation in a simple way (without opening the pumping apparatus, but simply by modifying the fluid connections from the outside). A further object of the present invention is to implement measures that allow minimising the risk of error during the reversal of the direction of rotation.

**[0004]** The defined technical task and the specified aims are substantially achieved by a pumping apparatus comprising the technical characteristics set forth in one or more of the appended claims.

**[0005]** Further characteristics and advantages of the present invention will become more apparent from the following indicative and therefore nonlimiting description of a pumping apparatus as illustrated in the appended drawings, in which:

- figures 1 and 2 show sectional views of an apparatus according to the present invention in a first operating configuration, these two sections being conducted through parallel sectional planes which are slightly spaced from one another;
- figure 3 shows a functional diagram of the apparatus in the configuration of figures 1 and 2;
- figures 4 and 5 show a sectional view of the apparatus of figures 1 and 2 in a second operating configuration, these two sections being conducted through parallel sectional planes which are slightly spaced from one another;
- figure 6 shows a functional diagram of the apparatus in the configuration of figures 4 and 5;
- figures 7 and 8 show views of the apparatus of figure 1;
- figures 9 and 10 show further details of the apparatus according to the present invention;
- figures 11 and 12 show a further constructive solution of a pumping apparatus according to the present invention, as an alternative to the apparatus in figures 1-8.

**[0006]** In the appended figures of the drawings, reference number 10 denotes a pumping apparatus.

**[0007]** The pumping apparatus 10 comprises a first reversible volumetric gear pump 1. In turn, the first pump 1 comprises:

- a first pair 11 of toothed wheels (meshing with each other);
- a first housing compartment 12 for housing the first

pair 11 of toothed wheels.

**[0008]** The apparatus 10 also comprises a second reversible volumetric gear pump 2. In turn, the second volumetric pump 2 comprises:

- a second pair 21 of toothed wheels (meshing with each other);
- a second housing compartment 22 for housing the second pair 21 of wheels.

**[0009]** The first and second pumps 1, 2 can also be defined as the first and second sections of the same pumping apparatus 10.

**[0010]** The first volumetric pump 1 draws in rotation the second volumetric pump 2, or vice versa.

**[0011]** In this regard, a joint can be present which couples a toothed wheel of the first pair 11 (or an element integral therewith) with a toothed wheel of the second pair 21 (or an element integral therewith). The first and second pumps 1, 2 are advantageously alongside each other. Advantageously, a wheel of the first pair 11 is coaxial with a wheel of the second pair 21. There is therefore a single motor which drives both the first and the second pumps 1, 2. The first pump 1 is operatively interposed between a drive shaft connectable to the motor and the second pump 2. The motor is suitably electrical or thermal.

**[0012]** The apparatus 10 further comprises a first channel 13 that places in fluid connection a first zone 121 of the first compartment 12 and a first zone 221 of the second compartment 22.

**[0013]** The apparatus 10 further comprises a second channel 23 that places in fluid connection a second zone 122 of the first compartment 12 and a second zone 222 of the second compartment 22.

**[0014]** The apparatus 10 further comprises means 3 for opening/closing the first and second channels 13, 23.

**[0015]** The apparatus 10 further comprises a first, a second, a third and a fourth openings 14, 15, 24, 25 intended to allow the fluid communication of the pumping apparatus 10 with the outside.

**[0016]** Appropriately the apparatus 10 comprises an outer casing 4. Preferably such casing 4 is made of metallic material.

**[0017]** The first, second, third and fourth openings 14, 15, 24, 25 are fashioned on the casing 4.

**[0018]** Preferably the first and third openings 14, 24 are fashioned on a first face 41 of the casing 4. The second and fourth opening 15, 25 are instead fashioned on a second face 42 of the casing 4. The second face 42 and the first face 41 are fashioned in separate areas of the casing 4. In particular, the second face 42 is opposite the first face 41 (see for example figures 7 and 8).

**[0019]** The first and second openings 14, 15 allow direct access to the first and second zones 121, 122 of the first compartment 12.

**[0020]** In turn, in the solution of figures 1-10, the third

and fourth openings 24, 25 allow direct access to an intermediate position of the first and second channels 13, 23.

**[0021]** Instead, in the solution of figures 11 and 12, the third and fourth openings 24, 25 respectively allow access to the first and second zones 221, 222 of the second compartment 22.

**[0022]** The apparatus 10 can assume at least a first and a second operating configurations. They correspond to distinct modes of operation associated with the reversibility of the first and second pumps 1, 2. In the second operating configuration the rotation direction of the first and of the second pair 11, 21 of wheels is opposite to that assumed in the first operating configuration.

**[0023]** Figures 1, 2, 3, 7, 8 exemplify the first configuration. In this case, the first zone 121 of the first compartment 12 and the first zone 221 of the second compartment 22 define a suction respectively of the first and second pumps 1, 2, while the second zone 122 of the first compartment 12 and the second zone 222 of the second compartment 22 respectively define a delivery of the first and second pumps 1, 2. Still in the first configuration, the means 3 for opening/closing the first and second channels 13, 23 block the second channel 23. In this way they prevent the fluid communication between the second zone 122 of the first compartment 12 and the second zone 222 of the second compartment 22. The means 3 for opening/closing in the first configuration, however, allow the fluid communication of the first zone 121 of the first compartment 12 and the first zone 221 of the second compartment 22 through the first channel 13.

**[0024]** Still in the first configuration:

- the first opening 14 is crossed by the inflowing operating fluid and directed towards the first zone 121 of the first compartment 11 and the first zone 221 of the second compartment 12;
- the second opening 15 is crossed by the outflowing operating fluid coming from the second zone 122 of the first compartment 11 (and outflowing from the apparatus 1);
- the third opening 24 is blocked;
- the fourth opening 25 is crossed by the outflowing fluid coming from the second zone 222 of the second compartment 12.

**[0025]** Figures 4, 5 and 6 exemplify the second operating configuration. In this configuration, the second zone 122 of the first compartment 12 and the second zone 222 of the second compartment 22 respectively define a suction of the first and second pumps 1, 2, while the first zone 121 of the first compartment 12 and the second zone 221 of the second compartment 22 respectively define a delivery of the first and second pumps 1, 2.

**[0026]** In the second configuration, the means 3 for opening/closing the first and second channels 13, 23 block the first channel 13, thereby preventing communication between the first zone 121 of the first compartment

11 and the first zone 221 of the second compartment 22. Furthermore, in the second configuration they allow the fluid communication between the second zone 122 of the first compartment 12 and the second zone 222 of the second compartment 22 through the second channel 23.

**[0027]** In the second configuration:

- the first opening 14 is crossed by the outflowing operating fluid coming from the first zone 121 of the first compartment 12;
- the second opening 15 is crossed by the inflowing operating fluid directed towards the second zone 122 of the first compartment 12 and the second zone 222 of the second compartment 12;
- the third opening 24 is crossed by the outflowing fluid coming from the first zone 221 of the second compartment 12;
- the fourth opening 25 is blocked.

**[0028]** In the second configuration, the fourth opening 25 is blocked.

**[0029]** In both the first and second configuration there is a single inlet of the operating fluid in the apparatus 10: it is the first opening 14 in the first configuration and the second opening 15 in the second configuration. Having a single suction zone is particularly convenient.

**[0030]** In addition, in both the first and second configuration there are at least two independent outlets of the operating fluid from the apparatus 10: for example, in the first configuration they are the second and the fourth opening 15, 25. They thus make it possible to deliver to two loads which are separate, and in an independent manner.

**[0031]** The apparatus 1 advantageously comprises a first hole 51 which connects the first channel 13 and the outside of the casing 4.

**[0032]** The means 3 for opening and closing the first and second channels 13, 23 comprise a first and a second stoppers 31, 32.

**[0033]** They are applicable to the casing 4 and fittable in the first hole 51. They are applicable to the first hole 51 as an alternative to one another. The first stopper 31, if applied to the first hole 51, allows the passage of fluid between the first and second compartments 12, 22 through the first channel 13. Instead, the second stopper 32, if applied to the first hole 51, prevents the passage of fluid between the first and the second compartments 12, 22 through the first channel 13.

**[0034]** The second stopper 32 can comprise a pair of gaskets. If applied to the first hole 51, the second stopper 32 blocks the first channel 13, preventing the passage of fluid. In this case, the first channel 13 is blocked by a portion of the second stopper 32 interposed between the pair of gaskets (which therefore contribute to a sealing action).

**[0035]** In an alternative solution, this pair of gaskets could be absent. In this case the seal would be defined by the metal walls of the second stopper 32 (and would

therefore be purely mechanical).

**[0036]** The apparatus 1 also comprises a second hole 52 which connects the second channel 23 and the outside of the casing 4.

**[0037]** The first and second stoppers 31, 32 can also be fitted into the second hole 52. In the first configuration, the second stopper 32 is fitted into the second hole 52 and the first stopper 31 is fitted into the first hole 51. In this case, the second stopper 32 can prevent the fluid connection between the first and second compartments 12, 22 through the second channel 23. The first stopper 31 instead allows the connection between the first and second compartments 12, 22 through the first channel 13. In the second configuration, the second stopper 32 is fitted into the first hole 51 and the first stopper 31 is fitted into the second hole 52. In this case, the second stopper 32 prevents the fluid connection between the first and second compartments 12, 22 through the first channel 13 while the first stopper 31 allows the fluid connection between the first and second compartments 12, 22 through the second channel 23.

**[0038]** In the solution exemplified in figures 1-10, the first hole 51 extends between the first channel 13 and the third opening 24 while the second hole 52 extends between the second channel 23 and the fourth opening 25.

**[0039]** The second stopper 32 is suitable for penetrating further into the apparatus 10 (or better inside the casing 4) with respect to the first stopper 31. In this way (unlike the first stopper 31), it can reach and block the first or the second channel 13, 23.

**[0040]** In the solution exemplified in figures 1-10 the second stopper 32 comprises:

- a first and a second longitudinal end 321, 322;
- a lateral wall 323 which connects the first and second ends 321, 322;
- an internal cavity 324 in communication with the outside at the first end 321 and at a zone of the lateral wall 323.

**[0041]** In the first configuration the cavity 324 is crossed by the fluid present along the second channel 23 and coming from the second pump 2 (thus allowing the crossing of the fourth opening 25).

**[0042]** In the second configuration the cavity 324 is crossed by the fluid present along the first channel 13 and coming from the second pump 2 (thus allowing the crossing of the third opening 24).

**[0043]** This arrangement is absent in the solution of figures 11 and 12, wherein the outflow of the fluid processed by the second pump 2 does not cross the second stopper 32, but crosses a different channel. In fact, in this case the first and second holes 51, 52 are separate and independent with respect to the third and fourth openings 24, 25. With reference to the solution of figure 11 (which is in the first operating configuration), the outflow of fluid continues to take place through the fourth opening 25

which, however, does not provide for the transit through the stopper 32. In the case wherein the solution of figure 11 was in the second operating configuration, the fourth opening 25 would be stopped while the third opening 24 would allow the outflow of the fluid processed by the second pump 2.

**[0044]** In the solution of Figure 11, a third stopper 33 different from the first and second stoppers 31, 32 is used to block one among the third and the fourth openings 24, 25 (the other remaining open for the outflow of the fluid coming from the delivery of the second pump 2). In this case, even if the second stopper 32 is not internally crossed by the fluid, the first and second stoppers 31, 32, however, exert the function of allowing or not allowing the passage through the first or the second channel 13, 23. For completeness, it should be noted that advantageously the third stopper 33 is not fittable in the first and second holes 51, 52 intended for the first and second stoppers 31, 32. This is to minimise the risk of accidental errors by users when reversing the motion of the apparatus (which could compromise proper operation). In addition, the operating principle of the schematic solution of figures 3 and 6 is also valid for the solution of figures 11 and 12.

**[0045]** With reference to any of the solutions exemplified in the appended drawings, regardless of the first or second configuration, an inlet of the operating fluid into the apparatus 10 coincides with an inlet of operating fluid into the first pump 1.

**[0046]** In addition, regardless of the first or second configuration, the delivery of the first and second pumps 1, 2 are not mutually communicating. Therefore, an independent delivery of various loads is possible. In addition, regardless of the first or second configuration, the delivery of the first and second pumps 1, 2 are located side by side (or otherwise formed along a same side of the casing 4).

**[0047]** Advantageously, the pumping apparatus 1 comprises a lubrication path 90 of bushings 94 supporting one or more support shafts of the first and/or second pair of toothed wheels 11, 21 (see figures 9 and 10). The lubrication path 90 draws the fluid from the first and/or from the second compartment 12, 22 and conveys it in an environment 93 downstream of the bushings 94 and at least partially delimited by an oil seal. This environment 93 must be at low pressure in order to avoid the breakage of the oil seal separating it from the outside. In fact, the outside will typically have atmospheric pressure. Advantageously, the apparatus 1 comprises a canalisation 91 that connects the first and second holes 51, 52 and which is in communication with such environment (through a section 92). Suitably, such canalisation 91 connects a bottom of the first hole 51 and a bottom of the second hole 52. These measures make it possible to ensure that such an environment has the suction pressure of the operating fluid (and therefore low pressure). In this way, the breakage of the oil seal is avoided.

**[0048]** The present invention achieves important ad-

vantages.

**[0049]** Firstly, it allows reversing the direction of rotation in a simple way, without opening the pump, but acting only on the connections accessible from the outside (the channels that connect to the openings 14, 15, 24, 25). Another important advantage is the minimal risk of error associated with the inversion operations of the direction of rotation.

**[0050]** The invention as it is conceived is susceptible to numerous modifications and variations, all falling within the scope of the inventive concept characterising it. Furthermore, all the details can be replaced with other technically-equivalent elements. In practice, all the materials used, as well as the dimensions, can be any according to requirements.

## Claims

### 1. A pumping apparatus comprising:

i) a first reversible volumetric gear pump (1) comprising:

- a first pair (11) of toothed wheels;
- a first housing compartment (12) for housing the first pair (11) of toothed wheels;

ii) a second reversible volumetric gear pump (2) comprising:

- a second pair (21) of toothed wheels; the first volumetric pump (1) drawing in rotation the second volumetric pump (2);
- a second housing compartment (22) for housing the second pair (21) of wheels;

iii) a first channel (13) that places in fluid connection a first zone (121) of the first compartment (12) and a first zone (221) of the second compartment (22);

iv) a second channel (23) that places in fluid connection a second zone (122) of the first compartment (12) and a second zone (222) of the second compartment (22);

v) a means (3) for opening/closing the first and the second channel (13, 23);

vi) an outer casing (4) comprising a first, a second, a third and a fourth opening (14, 15, 24, 25) intended to allow the fluid communication of the pumping apparatus (10) with the outside;

in a first operating configuration: said first zone (121) of the first compartment (12) and said first zone (221) of the second compartment (22) defining a suction of the first and of the second pump (1, 2), respectively, said second zone (122) of the first compartment (12) and said second zone (222) of the second

compartment (22) defining a delivery of the first and of the second pump (1, 2), respectively, said means (3) for opening/closing the first and the second channel (13, 23) blocking the second channel (23) and allowing the fluid communication of the first zone (121) of the first compartment (12) and of the first zone (221) of the second compartment (22) through the first channel (13); the first opening (14) being crossed by the inflowing operating fluid directed towards the first zone (121) of the first compartment (12) and to the first zone (221) of the second compartment (22); the second opening (15) being crossed by the outflowing operating fluid coming from the second zone (122) of the first compartment (12), the third opening (24) being blocked, the fourth opening (25) being crossed by the outflowing fluid coming from the second zone (222) of the second pump (2);

in a second operating configuration: said second zone (122) of the first compartment (12) and said second zone (222) of the second compartment (22) defining a suction of the first and of the second pump (1, 2), respectively, said first zone (121) of the first compartment (12) and said first zone (221) of the second compartment (22) defining a delivery of the first and of the second pump (1, 2), respectively, said means (3) for opening/closing the first and second channel (13, 23) blocking the first channel (13) and allowing the fluid communication between the second zone (122) of the first compartment (12) and the second zone (222) of the second compartment (22) through the second channel (23); the first opening (14) being crossed by the outflowing operating fluid coming from the first zone (121) of the first compartment (12), the second opening (15) being crossed by the inflowing fluid directed towards the second zone (122) of the first compartment (12) and towards the second zone (222) of the second compartment (22); the third opening (24) being crossed by the outflowing fluid coming from the first zone (221) of the second compartment (2); the fourth opening (25) being blocked;

in the second operating configuration the rotation direction of the first and of the second pair (11, 21) of wheels being opposite to that assumed in the first operating configuration.

**2. The apparatus according to claim 1, characterised in that** it comprises a first hole (51) that connects the first channel (13) and the outside of the casing (4), the means (3) for opening and closing the first and the second channel (13, 23) comprising a first and a second stopper (31, 32) applicable to the casing (4) and fittable in said first hole (51); the first stopper (31), if applied to the first hole (51), allowing the passage of fluid between the first and the second compartment (12, 22) through the first channel (13), the second stopper (32), if applied to the first hole

(51), preventing the passage of fluid through the first channel (13).

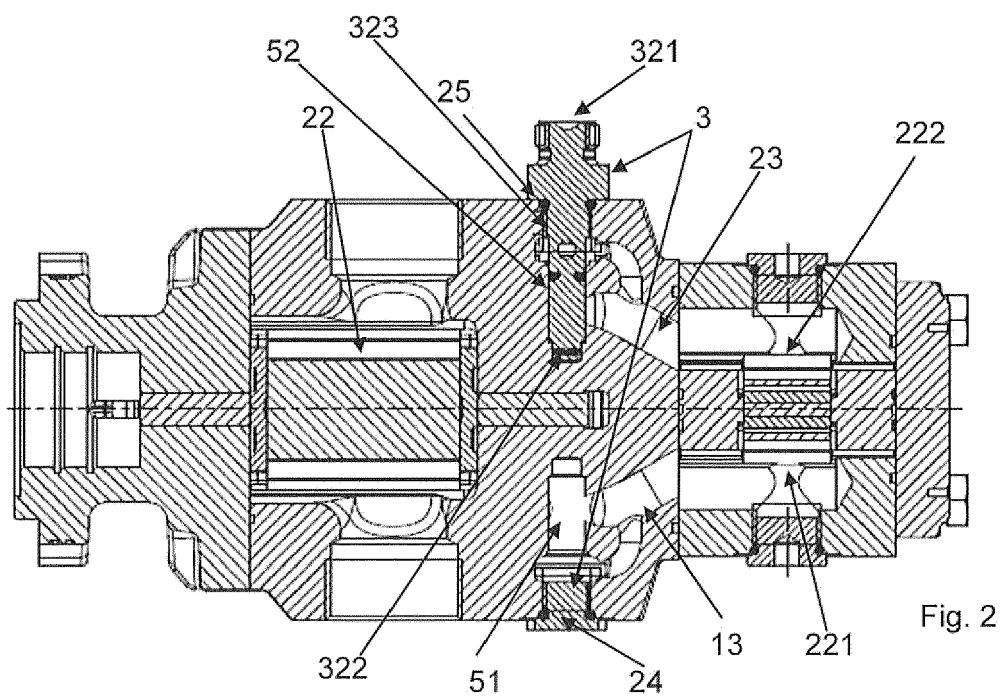
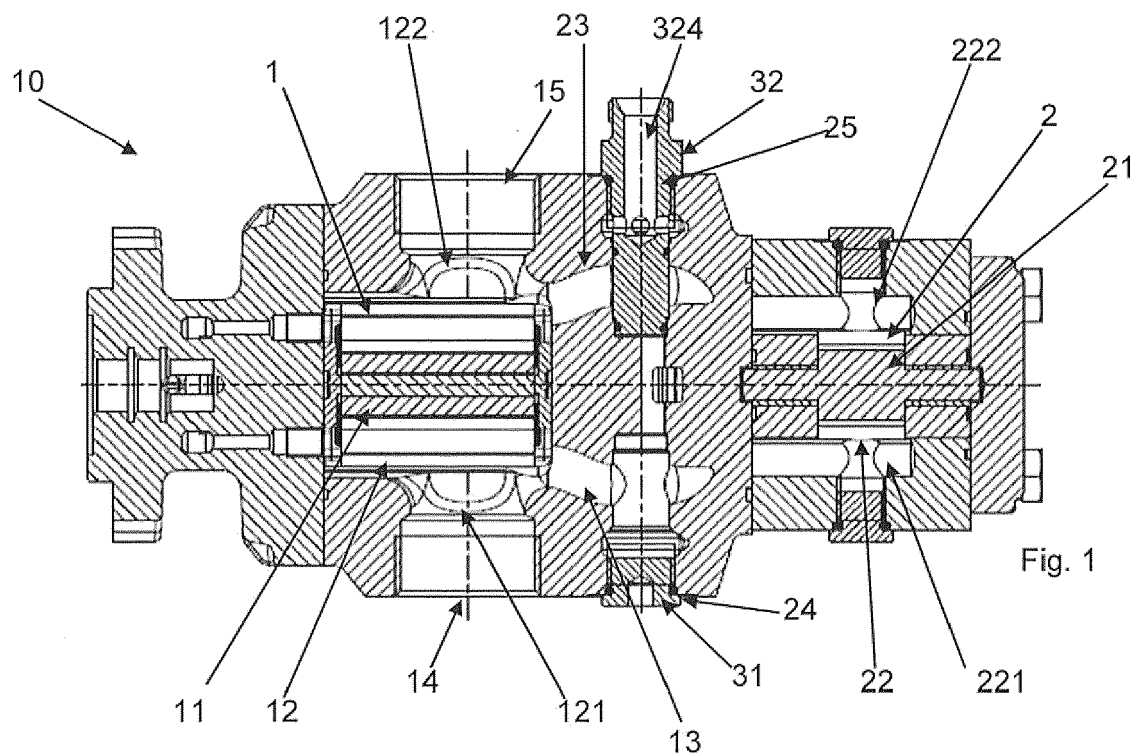
3. The apparatus according to claim 2, **characterised in that** it comprises a second hole (52) that connects the second channel (23) and the outside of the casing (4); the first and the second stopper (31, 32) being fittable also in the second hole (52); in the first configuration the second stopper (32) being fitted in the second hole (52) for stopping the passage of fluid between the first and the second compartment (12, 22) through the second channel (23) and the first stopper (31) being fitted in the first hole (51); in the second configuration the second stopper (32) being fitted in the first hole (51), the first stopper (31) being fitted in the second hole (52) allowing the passage of fluid between the first and the second compartment (12, 22) through the second channel (23). 5
  
4. The apparatus according to claim 3, **characterised in that** the first and the second hole (51, 52) are separate and independent with respect to the third and the fourth opening (24, 25). 10
  
5. The apparatus according to claim 3, **characterised in that** the first hole (51) extends between the first channel (13) and the third opening (24); the second hole (52) extending between the second channel (23) and the fourth opening (25). 15
  
6. The apparatus according to any one of claims 2 to 5, **characterised in that** the second stopper (32) is suitable for penetrating further into the apparatus (10) than the first stopper (31). 20
  
7. The apparatus according to any one of claims 2 to 6, **characterised in that** the second stopper (32) comprises: 25
  - a first and a second longitudinal end (321, 322); 30
  - a lateral wall (323) which connects the first and the second end (321, 322);
  - an internal cavity (324) in communication with the outside at the first end (321) and at a zone of the lateral wall (323); 35

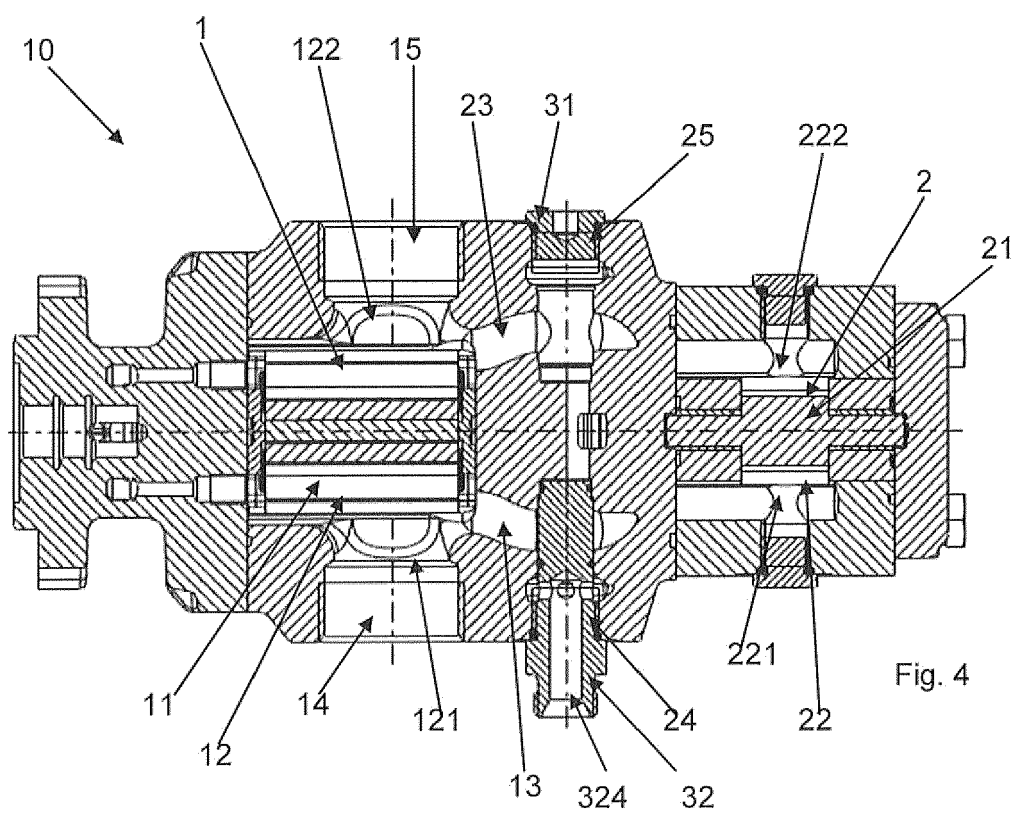
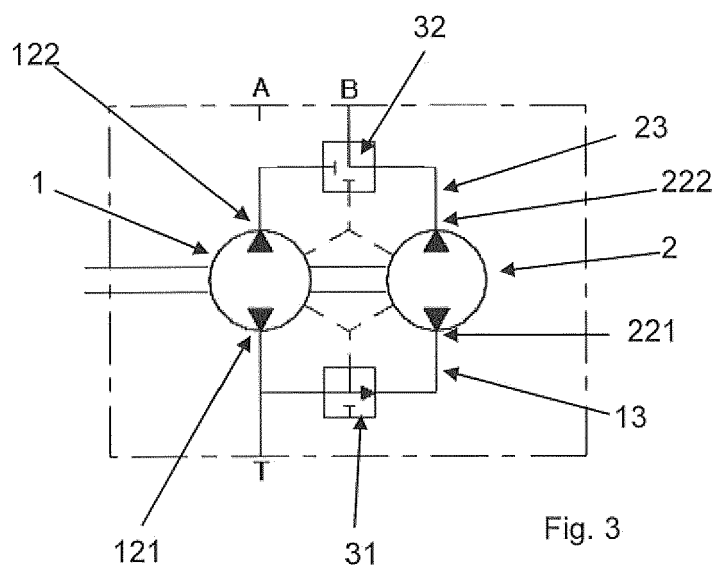
in the first configuration said cavity (324) being crossed by the fluid present along the second channel (23) and coming from the second pump (2) allowing the crossing of the fourth opening (25); 40

in the second configuration said cavity (324) being crossed by the fluid present along the first channel (13) and coming from the second pump (2) allowing the crossing of the third opening (24). 45
  
8. The apparatus according to any one of the preceding claims, **characterised in that** the first and the third opening (14, 24) are fashioned on a first face (41) of 50

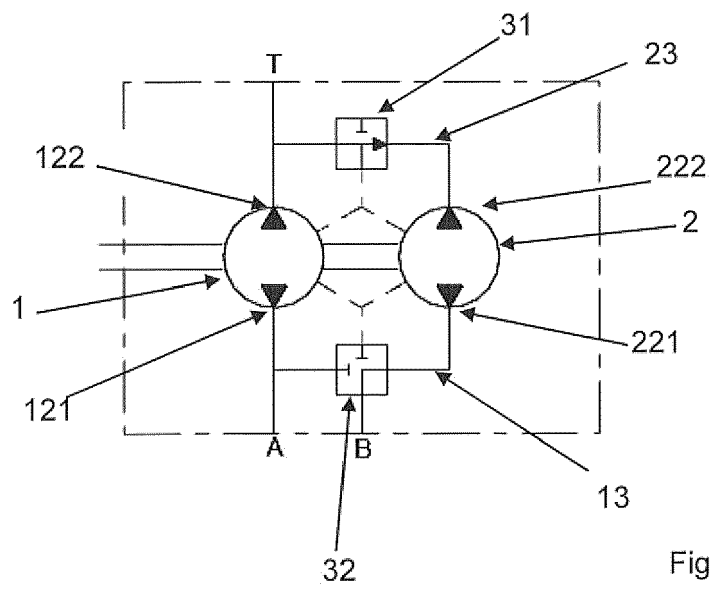
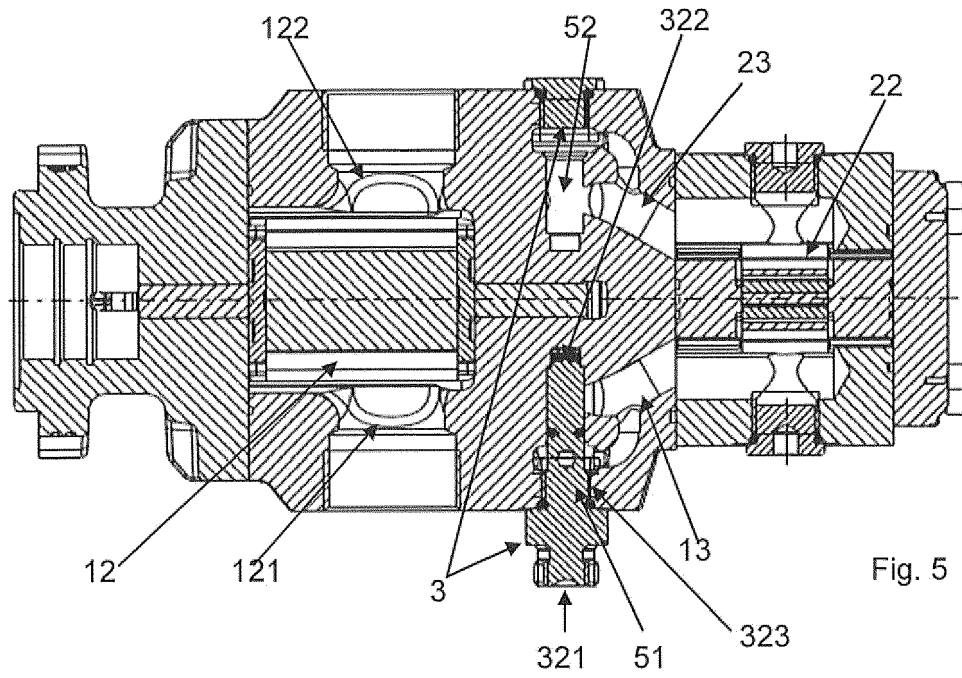
said casing (4); the second and the fourth opening (15, 25) being fashioned on a second face (42) of said casing (4), the second face (42) being opposite the first face (41).

9. The apparatus according to any one of the preceding claims, **characterised in that** both in the first and in the second configuration an inlet of the operating fluid into the apparatus (10) coincides with an inlet of operating fluid into the first pump (1). 55
  
10. The apparatus according to any one of the preceding claims, **characterised in that** both in the first and in the second configuration the delivery of the first and the second pump (1, 2) are not mutually communicating and are located alongside each other.









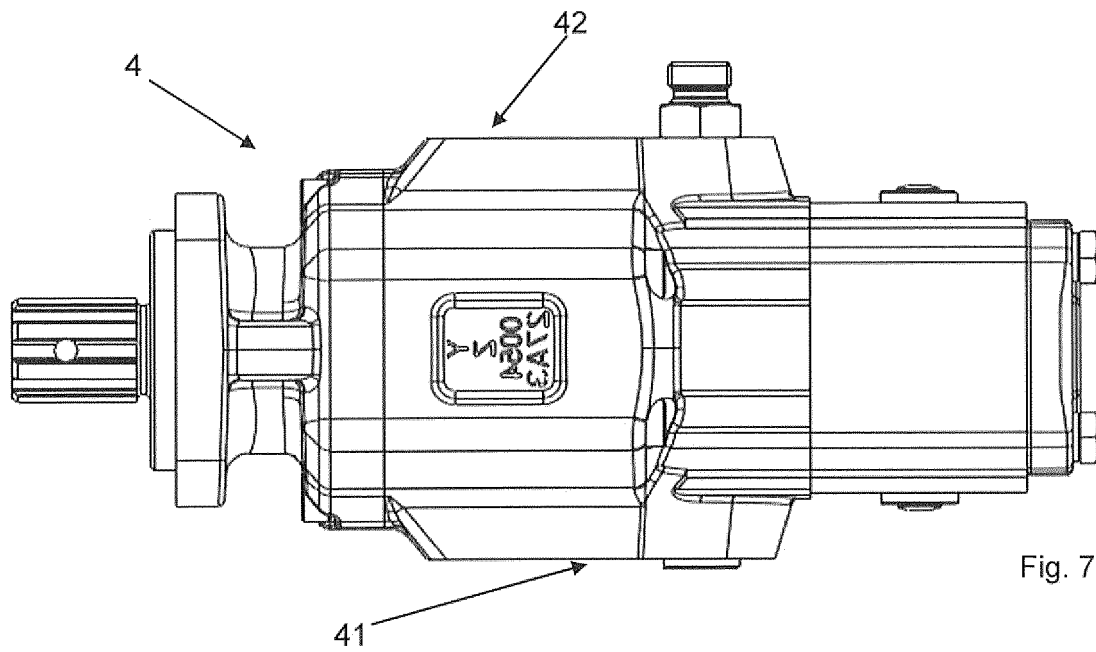


Fig. 7

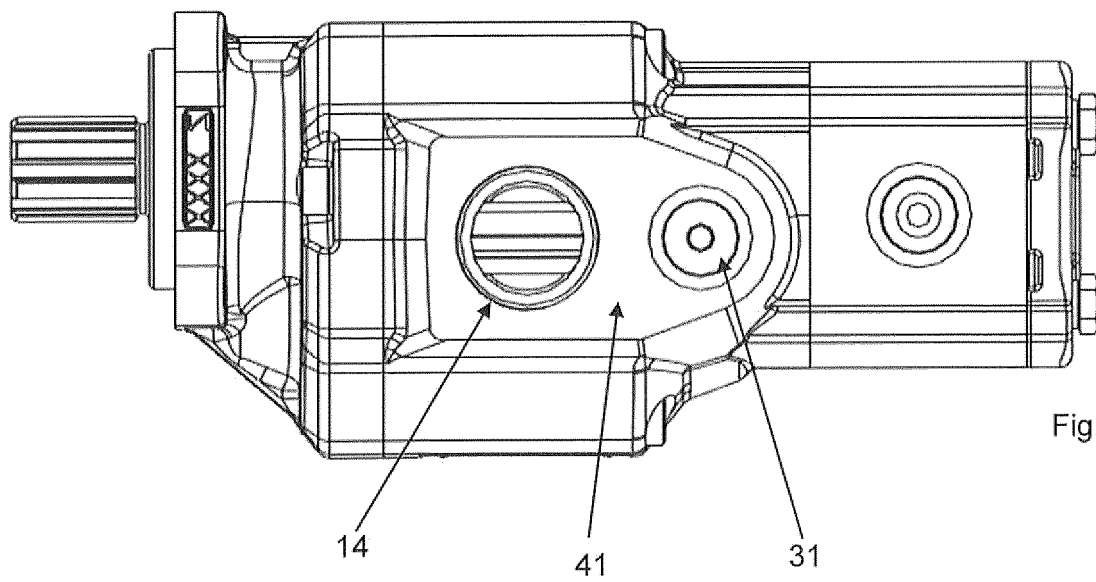


Fig. 8

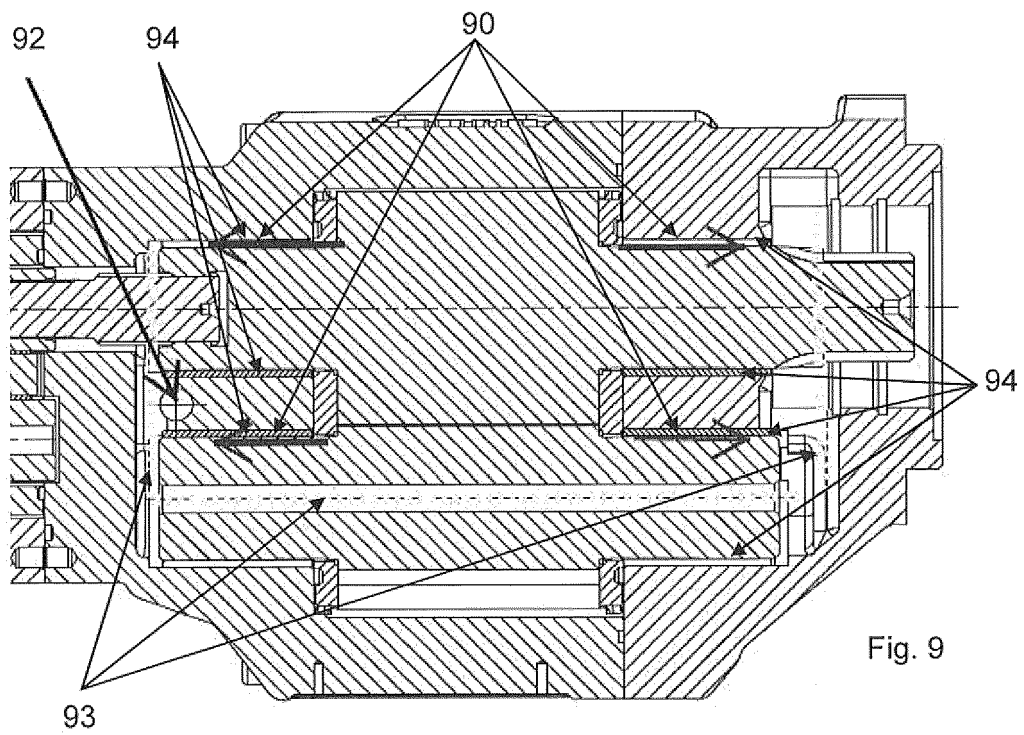


Fig. 9

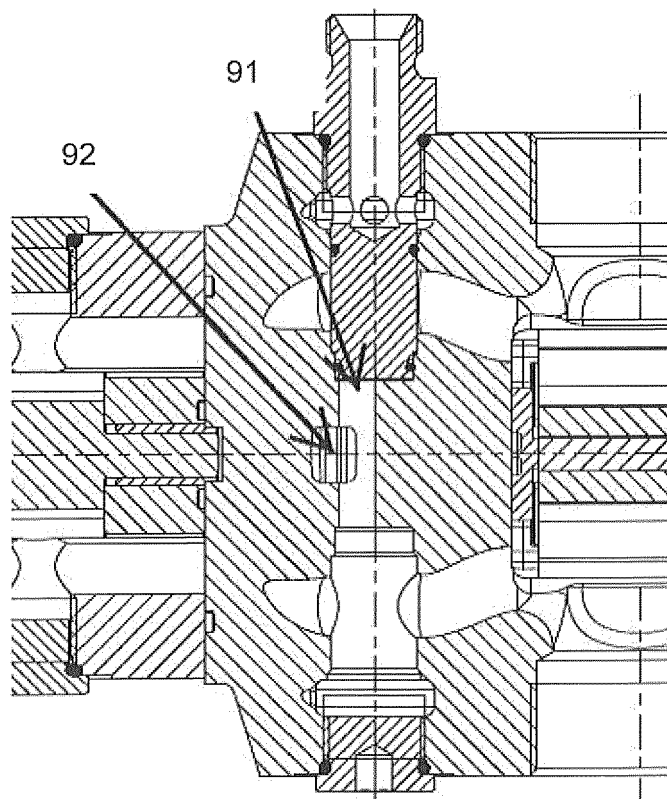
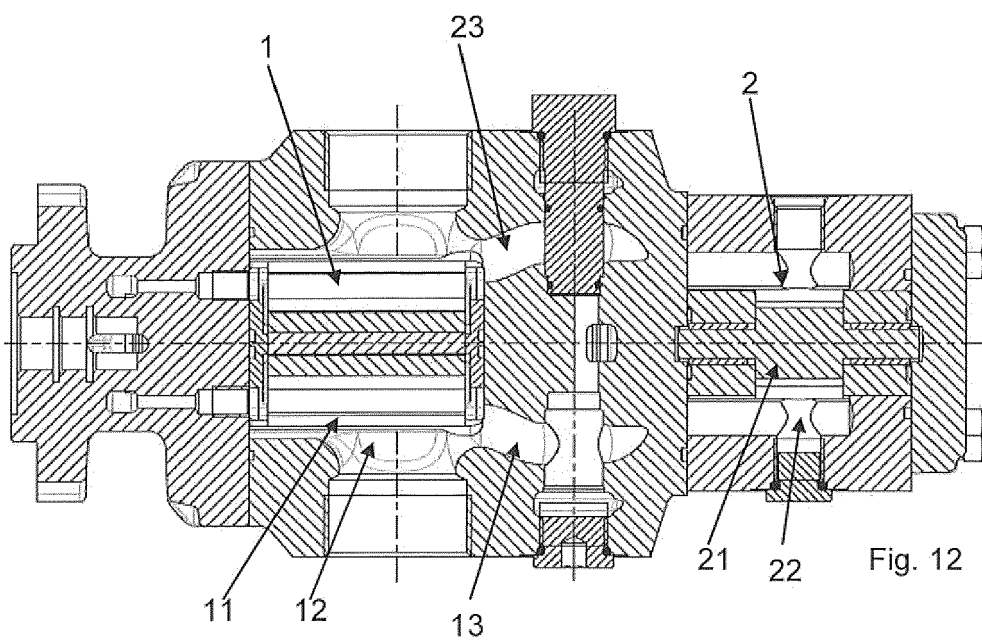
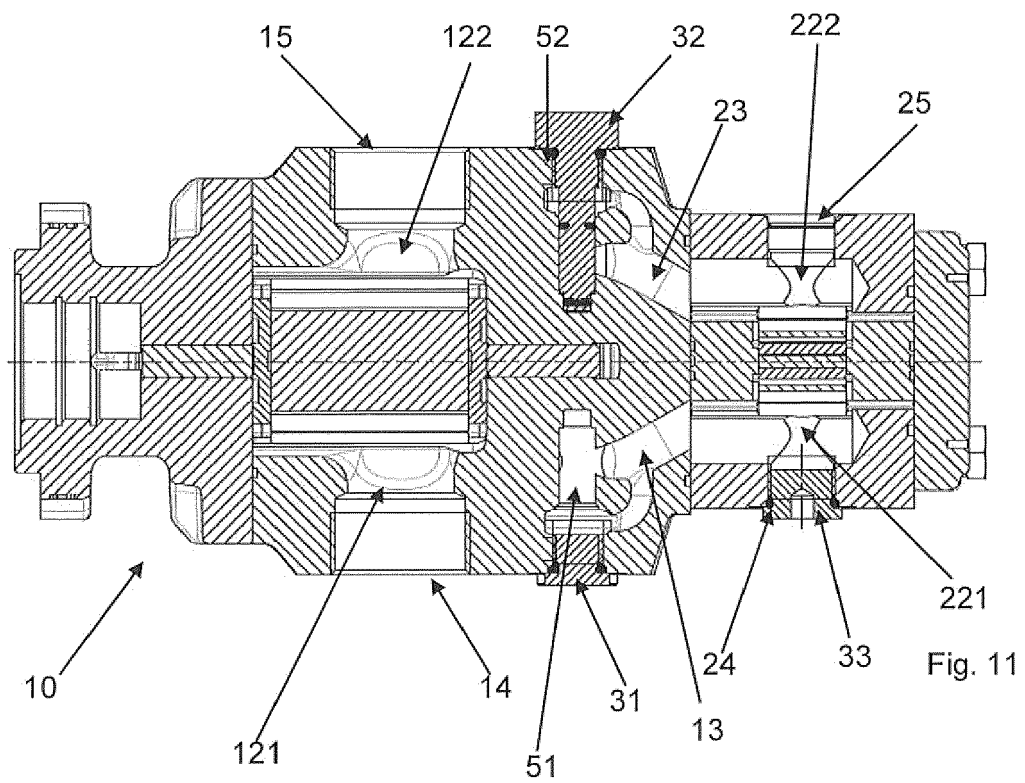


Fig. 10





## EUROPEAN SEARCH REPORT

Application Number  
EP 19 16 3777

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	GB 882 248 A (GEORG WIGGERMANN; REINERS WALTER) 15 November 1961 (1961-11-15) * figures 1-3 * * page 1, line 56 - page 2, line 75 * -----	1-10	INV. F04C2/10 F04C11/00 F04C14/26
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A	EP 0 685 650 A1 (SALAMI SPA [IT]) 6 December 1995 (1995-12-06) * figures 12-16 * * column 8, line 15 - line 48 * -----	1-10	
A	US 2 280 392 A (HERMAN KENNETH R ET AL) 21 April 1942 (1942-04-21) * figure 1 * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F04C
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>22 May 2019</b>	Examiner <b>Durante, Andrea</b>
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			

EPO FORM 1503 03.82 (F04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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