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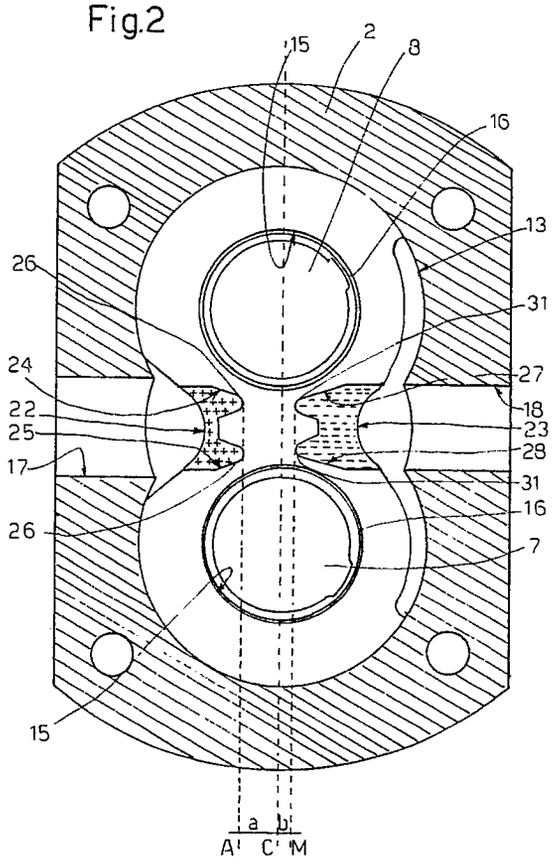
(54) Gear pump.

(57) The pump (1) comprises a pump body (2), two meshing gears (5) and (6), two ports, an intake port and a delivery port (17) and (18), formed on opposite sides of the meshing zone of the gears (5 and 6), and two bushes (13) installed at the sides of the gears (5 and 6) and defining faces (14) in grazing relationship therewith. The face (14) of each bush (13) is formed with a first recess (22) of predetermined depth relative to a central axis (C) defined by joining the axes of the gears (5 and 6) and communicating with the induction port (17), and a second recess (23) communicating with the delivery port (18) and having a depth extending towards the axis (C) such as to communicate with an area (33) defined between the teeth (21) of the gears (5 and 6) in the meshing zone up to the point at which the area (33) has its minimum size, thus avoiding compression of the liquid housed therein.

Fig.2



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The present invention relates to a gear pump of an improved type with reduced noise.

It is known that gear pumps have two gears, one driven and the other a drive gear, which intermesh and have respective hubs supported by two figure-of-eight-shaped bushes. An induction port and a delivery port are defined on opposite sides of the meshing zone.

The main problem with these pumps, if they have more than one tooth in mesh, is that they are excessively noisy, so much so that, if they are installed in vehicles, their noise may even exceed the noise of the vehicle engine. This noise is due above all to the compressive force exerted on the liquid trapped between the teeth of the gears in their meshing zone. In fact, a closed area is created in this zone which is sealed by the contact between the flanks of the teeth and which tends first to diminish and then to increase in size. When this area is decreasing, the trapped liquid is compressed whereby a pressure peak occurs which causes a hammering or mechanical drumming on the pump body and on some components such as the linings of the figure-of-eight-shaped bushes of the pump. Some companies have formed notches in the grazing faces, that is, in the surfaces of the figure-of-eight-shaped bushes facing the lateral faces of the gears, in correspondence with the meshing zone, both on the induction side and on the delivery side. The sole purpose of these notches, however, is to allow the liquid which is present on the grazing faces to escape and hence does not solve the noise problem. Other companies have formed a duct between the notches in order to solve this problem but this puts the induction port in communication with the delivery port. This solves the noise problem but, as will be clear, causes a corresponding reduction in the performance of the pump.

The object of the present invention is to provide a gear pump which does not have the disadvantage mentioned above, that is, which is less noisy without thereby impairing the performance of the pump itself.

On this basis, the present invention provides a gear pump of the type comprising:

a pump body ;

two meshing gears housed in the pump body, of which one is driven and the other is a drive gear;

two ports formed in the pump body on opposite sides of the gear meshing zone and of which one is a liquid intake port and the other is a delivery port;

two bushes fitted at the sides of the gears, each supporting hub portions of the latter and defining respective faces in grazing relationship with the gears;

characterised in that the grazing face of each of the bushes is formed with a first recess of predetermined depth relative to a central axis defined by the line joining the axes of the gears, formed on the intake side and in hydraulic communication with the intake port, and a second recess formed on the delivery side in hydraulic communication with the delivery port and having a depth towards the central axis such as to maintain hydraulic communication with an area which is defined between the teeth of the gears in the said meshing zone and in which a quantity of liquid remains enclosed until the point at which the said area has substantially its minimum size, thus avoiding compression of the liquid enclosed therein.

To provide a better understanding of the present invention, a preferred embodiment will now be described, purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a section through a gear pump according to the present invention;

Figure 2 is a section, on an enlarged scale, taken on the line II - II of Figure 1; and

Figures 3, 4, and 5 are schematic views illustrating the operation of the pump of Figure 1.

As illustrated in Figure 1, a gear pump generally indicated 1 comprises a pump body 2, the two sides of which are closed by respective cover plates 3 and 4 and in which two meshing gears 5 and 6 are installed. The gear 5 is a driven gear and has a hub 7 whose length is substantially equal to that of the pump body 2. The gear 6 is a drive gear and has a hub 8 which at one end extends beyond the plate 3 where it is connected mechanically to an output shaft of an engine, not illustrated. For this purpose, the plate 3 has a through-hole 11 traversed by the hub 8. The hubs 7 and 8 are supported by two support bushes 13 located on opposite sides of the gears 5 and 6 and having respective faces 14 in grazing relationship with the tips of the teeth of these latter. The pump 1 also has two hydraulic seal assemblies 19 between the plates 3 and 4 and the pump body 2 and the outer faces of the bushes 13 respectively.

With reference to Figure 2, the pump body 2 has an internal shape which reproduces the peripheral shape of the pair of gears 5 and 6, that is a figure-of-eight shape. Similarly, the bushes 13 have a peripheral figure-of-eight shape and, naturally, each bush 13 has two parallel through-holes 15 for housing portions of the hubs 7 and 8 with the interposition of respective bushes 16. The pump body 2 is formed with an intake port 17 on one side of the meshing zone of the gears 5 and 6 and with a delivery port 18 on the opposite side. The gears 5 and 6 have a predetermined number of teeth 21 such as to cause more than one tooth 21 of each gear 5 and 6 to be in mesh at any one

time. The shape of the teeth 21 is known and is such as to cause hydraulic sealing between the surfaces in contact during meshing. Due to the shape of the teeth 21 and the number of these which are in mesh, there is no direct hydraulic communication between the ports 17 and 18 in the meshing zone. With reference to Figures 1 and 2, the grazing faces of both of the bushes 13 are formed with recesses 22 and 23 in correspondence with the meshing zone. The recess 22 is on the induction side and is thus in hydraulic communication with the induction port 17. This recess 22 is defined by two notches 24 and 25 which intercommunicate at their bases and which extend in parallel towards a (central) axis "C" defined by the line joining the axes of the holes 15. The notches 24 and 25 are essentially of triangular-wedge shape with respective ends 26 rounded and lying on a straight line "A" (intake side) parallel to the axis "C" and spaced therefrom by a distance "a". The recess 23 is on the delivery side and is thus in hydraulic communication with the delivery port 18. The recess 23 is also constituted by two notches 27 and 28 which intercommunicate at their bases and which extend in parallel towards the axis "C". The notches 27 and 28 are also of essentially triangular-wedge shape with respective ends 31 which are rounded and lie on a straight line "M" (delivery side) parallel to the axis "C" and spaced therefrom by a distance "b".

With reference to Figure 2, it should be noted that the recesses 22 and 23, while having a similar shape, are not symmetrical about the axis C but, on the contrary, the distance "a" is greater than the distance "b". More particularly, the common base of the notches 27 and 28 is deeper in the direction of the axis "C" than that defined by the notches 24 and 25, while the depths of the various notches 24 and 25, and 27 and 28, starting from their common bases, are substantially equal.

The formation of the recesses 22 and 23 serves two purposes the first of which is to allow the escape of liquid present on the grazing faces 14 as occurs in other, known pumps. The second purpose, which is determined by the novel conformation of the recesses 22 and 23, is to avoid a phase in which the liquid is compressed in the meshing zone which, it will be remembered, causes noise and wear on the various components of the pump.

Figures 3, 4 and 5 schematically illustrate the situations which are created successively in the meshing zone. More particularly, three areas 32, 33 and 34 can be distinguished in Figure 3, of which the area 32 is defined by the recess 22 and is represented by a plurality of "+" signs. The area 33 is defined between two contiguous teeth 21a and 21b of the gear 5 (the tooth 21b of which is immediately in front of the other with reference to the sense of rotation of the gear 5) and two contiguous teeth 21c and 21d of the gear 6 (the tooth 21d of which is immediately in front of the other with reference to the sense of rotation of the gear 6). The area 33 is represented by a plurality of "." signs and "-" signs. The area 34 is defined by the recess 23 and is represented by a plurality of "-" signs. The area 33 is hydraulically sealed from the area 32 due to the contact between the teeth 21b and 21d while it communicates with the area 34 through the notch 27, the end portion of which underlies a part of the area 33. Naturally the areas 32 and 34 are not in hydraulic communication with each other.

The illustration of the area 33 in Figure 3 relates to the instant at which the teeth 21a and 21c come into contact. At this instant, the area 33 has a specific size which, in subsequent moments, tends to diminish until it reaches a minimum size which occurs when the tooth 21a almost fully occupies the space between the teeth 21c and 21d. The depth of the recess 23 and, in particular, of the notch 27 is such that, when the area 33 has its minimum size, there is no hydraulic communication between the area 34 and the area 33, which is completely sealed. Figure 4 illustrates this final situation and, for this reason, the area 33 is shown only by a plurality of "." signs. In passage from the situation illustrated in Figure 3 to that illustrated in Figure 4, there is thus a reduction in the size of the area 33 which does not, however, result in any compression of the liquid since the area 33 is still in communication with the area 34.

From the situation illustrated in Figure 4, the size of the area 33 increases progressively until the situation illustrated in Figure 5 is reached in which this area 33 has its maximum size. The situation illustrated in Figure 5 relates to the first instant of hydraulic communication between the area 32 and the area 33 which is still sealed from the area 34.

The advantages achieved by the present invention will be clear from what has been described above.

In particular, the phase in which the liquid is compressed during the reduction in the size of the area enclosed between the teeth of the gears in the meshing zone thereof is avoided. This is achieved by putting this area into hydraulic communication with the delivery port up to the instant at which the minimum size is reached. The hydraulic communication just described is achieved by the appropriate shaping of the recesses 22 and 23 and, in particular, by the formation of the recess 23 with a predetermined depth extending towards the central axis "C" which is different from, and more specifically greater than, that of the recess 22. It will be clear that, having avoided the phase of compres-

sion of the liquid the pressure peak which causes noise and wear, by drumming, on the machine body 2 and the components of the pump 1 does not occur. It should be stressed, moreover, that any communication between the induction and delivery sides in the meshing zone is avoided whereby the performance of the pump 1 is not harmed in any way. Finally, it is clear that the noise problem is solved in a simple manner which thus has little effect on the costs of production of the pump 1.

Finally, it is clear that the pump 1 described and illustrated may be modified and varied without thereby departing from the scope of protection of the present invention.

In particular, the principle being retained that the area 33 should be sealed from the area 34 at the moment of minimum size, the conformation of the recesses 22 and 23 and, in particular, that of the recess 23, may differ from that described depending on the number of teeth in mesh and their conformation. Moreover, each bush 13 may be formed in one piece or in two pieces which are fitted together in the zone in which the recesses 22 and 23 are formed; for each of these latter, a first notch 24 and 27 is formed in a first piece and the other notch 25 and 28 is formed in the second piece.

Claims

1. A gear pump of the type comprising:
   a pump body (2);
   two meshing gears (5 and 6) housed in the pump body (2) and of which one (5) is a driven and the other (6) is a drive gear;
   two ports (17 and 18) formed in the pump body (2) on opposite sides of the meshing zone of the gears (5 and 6) and of which one (17) is a liquid intake port and the other (18) is a delivery port;
   two bushes (13) fitted at the sides of the gears (5 and 6), each supporting hub portions (7 and 8) of the latter and defining respective faces (14) in grazing relationship with the gears (5 and 6);
   characterised in that the grazing face (14) of each of the bushes (13) is formed with a first recess (22), of predetermined depth relative to a central axis (C) defined by the line joining the axes of the gears (5 and 6), formed on the intake side and in hydraulic communication with the intake port (17), and a second recess (23) formed on the delivery side in hydraulic communication with the delivery port (18) and having a depth towards the central axis (C) such as to maintain hydraulic communication with an area (33) which is defined between the teeth (21) of the gears (5 and 6) in the said meshing zone and in which a quantity of liquid remains enclosed until the moment at which the said area (33) has substantially its minimum size, thus avoiding compression of the liquid enclosed therein.

2. A pump according to Claim 1, characterised in that the second recess (23) extends towards the central axis (C) such that one end (31) thereof is spaced from the latter by a distance (b) less than a second distance (a) defined between the axis (C) and a corresponding end (26) of the first recess (22).

3. A pump according to Claim 2, characterised in that the first recess (22) is defined by two notches (24 and 25) which intercommunicate at their bases,which extend in parallel towards the said axis (C) and which have essentially triangular-wedge shapes with their ends (26) rounded and lying on a straight line (A) parallel to the axis (C) and spaced therefrom by the said second distance (a).

4. A pump according to Claim 2 and/or 3, characterised in that the second recess (23) is defined by two notches (27 and 28) which intercommunicate at their bases, which extend in parallel towards the said axis (C) and which have substantially triangular wedge-shapes with their said ends (31) rounded and lying on a second straight line (M) parallel to the said axis (C) and spaced therefrom by the said first distance (b).

5. A pump according to Claims 3 and 4, characterised in that the common base of the notches (27 and 28) of the second recess 23 is deeper in a direction towards the axis (C) than that defined between the notches (24) and (25) of the first recess (22).

6. A pump according to Claim 5, characterised in that the depth of the notches (27 and 28) of the second recess (23), starting from their common base, is substantially equal to that of the notches (24 and 25) of the first recess (22) starting from the common base of these latter.

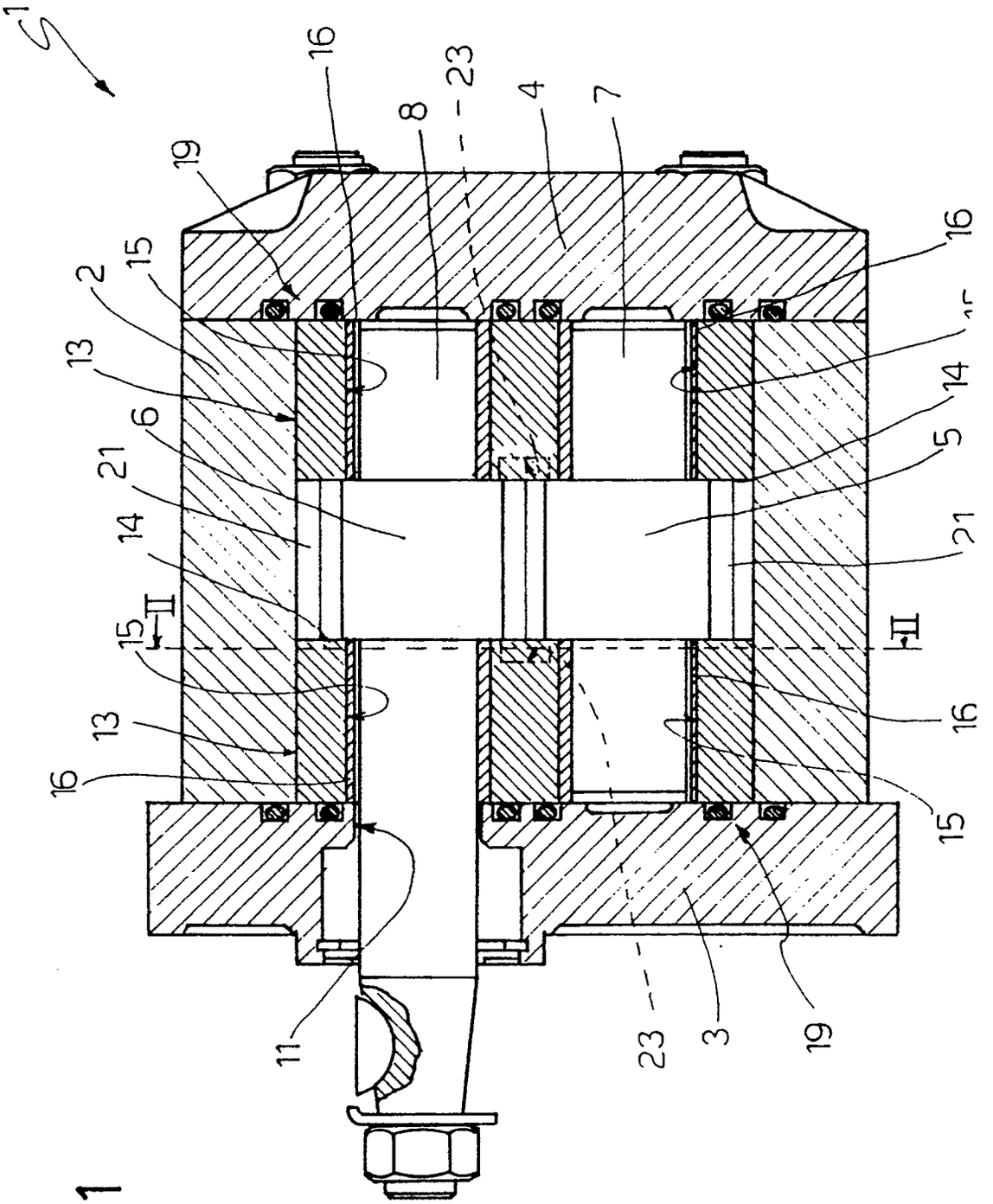


Fig. 1

Fig.2

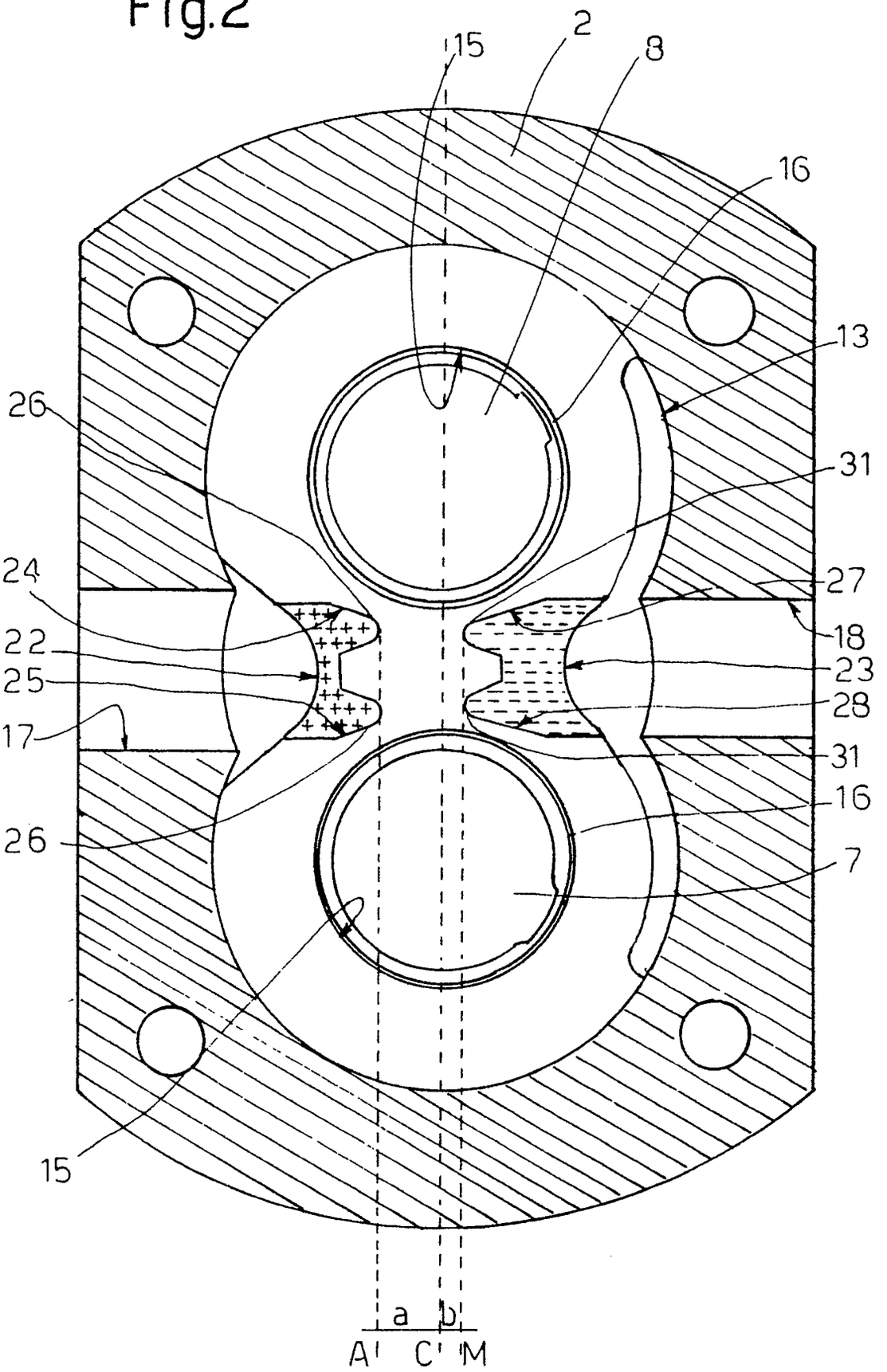


Fig.3

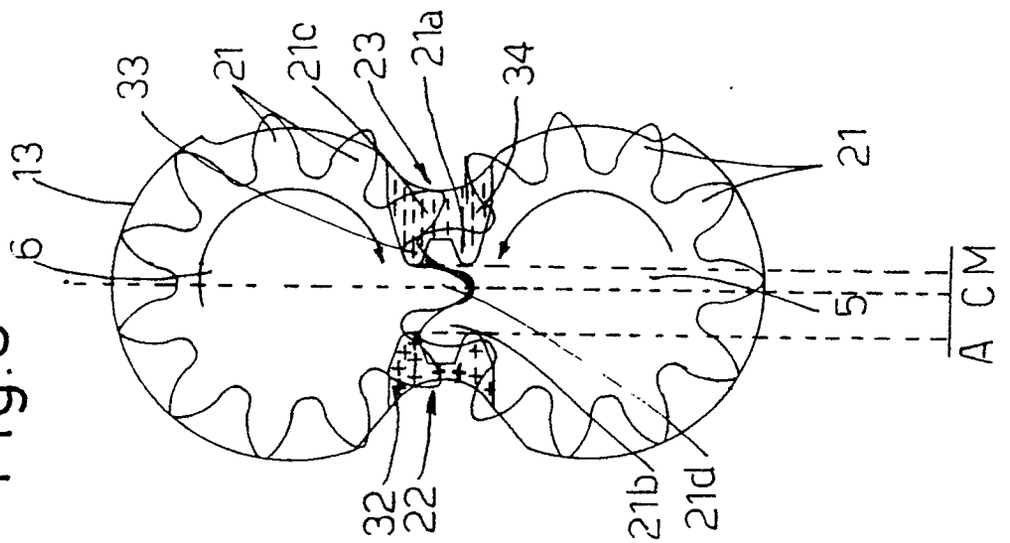


Fig.4

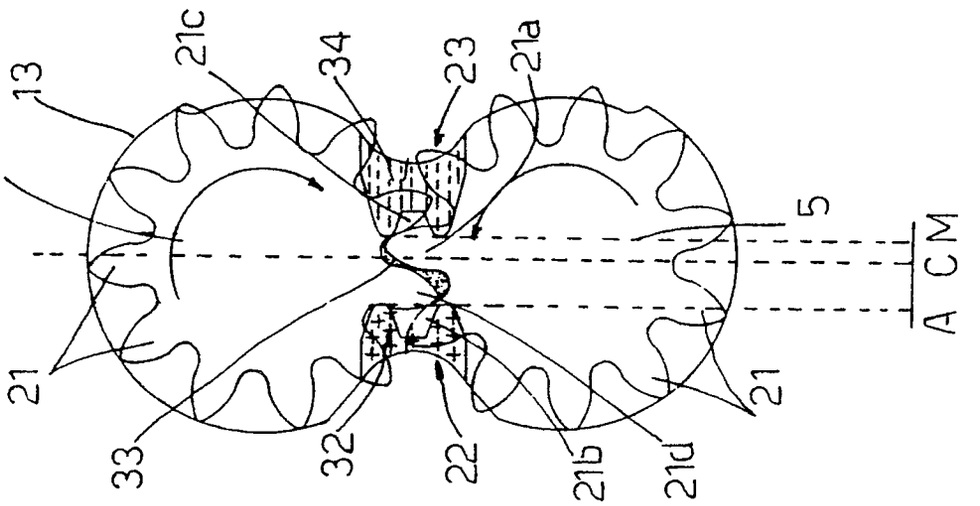
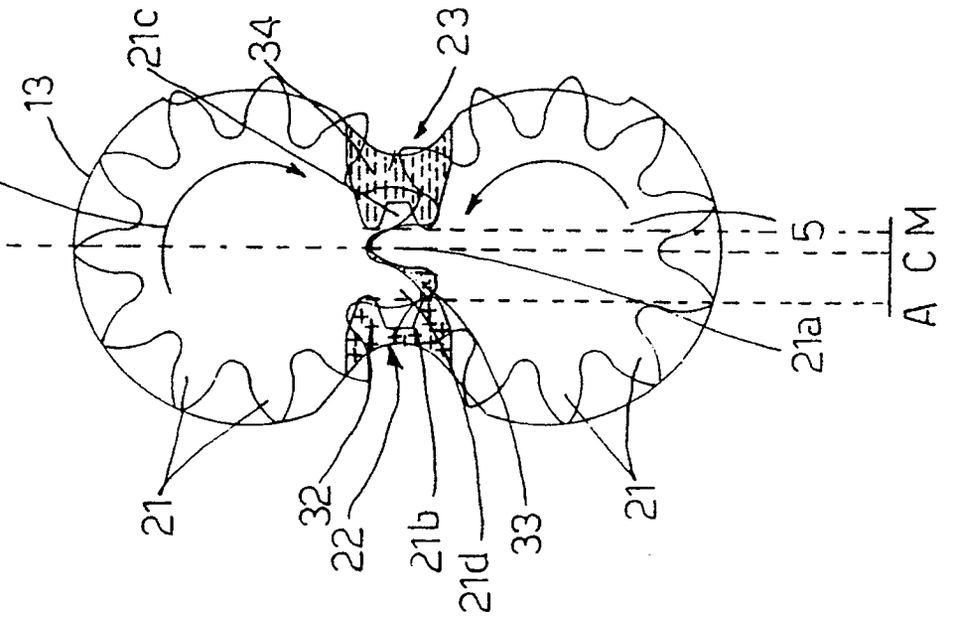


Fig.5



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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 6237

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	FR-A-2 352 947 (ROBERT BOSCH G.M.B.H.) * the whole document *	1-6	F 04 C 2/08
X	US-A-3 690 793 (POLLMAN) * the whole document *	1	
X	GB-A-7 816 97 (BORG-WARNER CO.) * the whole document *	1	
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A	GB-A-8 570 46 (PARKER-HANNIFIN CO.)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
F 04 C

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	05 August 91	DIMITROULAS P.

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