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(54) **Pendulum pump, in particular to feed oil under pressure to a final device**

(57) A pendulum pump to feed oil under pressure to a final device has an outer rotor (11) and an inner rotor (8) which are mounted to rotate around respective rotation axes (10, 12), and a plurality of dragging pendulums (13), which are interposed between the two rotors (8, 11), are rotationally coupled to one of the rotors (8, 11), and

are slidably coupled to respective guide recesses (15) obtained on the other rotor (8, 11); each guide recess (15) having a symmetry plane (P) which is tangent to a circumference (C) which is concentric with respect to the rotation axis (10, 12) of one of the rotors (8, 11).

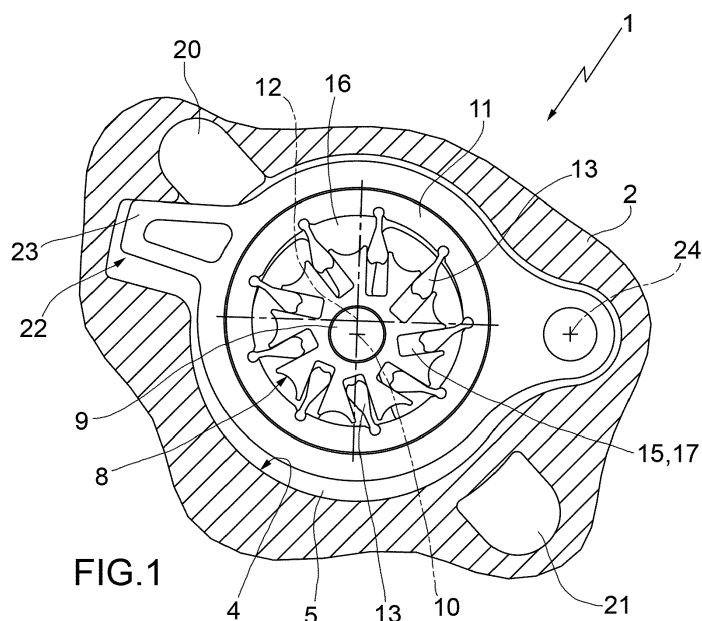


FIG.1

Description

[0001] The present invention relates to a pendulum pump, in particular to feed oil under pressure to a final device.

[0002] In order to feed oil under pressure to a final device, for example to an internal combustion engine, it is known to provide a pendulum pump of the type comprising an outer rotor mounted to rotate around a first rotation axis; an inner rotor mounted inside the outer rotor to rotate around a second rotation axis which is parallel to the first rotation axis; and a plurality of dragging pendulums interposed between the outer rotor and the inner rotor.

[0003] The dragging pendulums are generally rotationally coupled to the outer rotor and slidingly engage respective guide recesses obtained on the inner rotor.

[0004] Each guide recess is separated from each adjacent guide recess by means of a respective partition wall radially extending outward with respect to the rotation axis of the inner rotor.

[0005] The inner rotor is keyed onto a motorized drive shaft, which sets the inner rotor in rotation to allow the dragging pendulums to rotate the outer rotor.

[0006] Each dragging pendulum defines a first variable-volume chamber together with the inner rotor, the outer rotor, and each adjacent dragging pendulum, and further defines a second variable-volume chamber together with the corresponding guide recess.

[0007] The chambers are axially limited by two lateral sides which are parallel to each other, each of which extends perpendicular to the rotation axes of the two rotors, and has two cavities, which extend around the second rotation axis according to respective angles smaller than 180°, face towards the chambers, and are hydraulically separated from each other in a fluid-tight manner.

[0008] A first cavity of each lateral side is hydraulically connected to a corresponding first cavity of the other lateral side and to an oil intake in the pendulum pump, while the second cavity of each lateral side is hydraulically connected to a corresponding second cavity of the other lateral side and to an oil delivery for the mentioned final device.

[0009] The two first cavities are configured so as to hydraulically connect a part of the mentioned first and second chambers together and to the intake, during the rotation of the rotors around the respective rotation axes, while the two second cavities are configured so as to hydraulically connect the remaining first and second chambers together and to the delivery, during the rotation of the rotors around the respective rotation axes.

[0010] Since the two rotors are mounted so as to be eccentric, each chamber has a volume varying between a maximum volume at the first cavities and thus at the intake, and a minimum volume at the second cavities and thus at the delivery.

[0011] Known pendulum pumps of the above-described type have certain drawbacks mainly originating from the guide recesses having respective radial sym-

metry planes which contain the rotation axis of the inner rotor. Accordingly, the minimum tangential thickness of each partition wall and the structural strength of the inner rotor are relatively small.

[0012] It is the object of the present invention to provide a pendulum pump, in particular to feed oil under pressure to a final device, which is free from the above-described drawbacks and is simple and cost-effective to be implemented.

[0013] According to the present invention, a pendulum pump, in particular to feed oil under pressure to a final device, is provided as claimed in the appended claims.

[0014] The present invention will now be described with reference to the accompanying drawings, which show a nonlimiting embodiment thereof, in which:

figure 1 is a diagrammatic front view, with parts in section and parts removed for clarity, of a preferred embodiment of the pendulum pump of the present invention;

figure 2 is a diagrammatic front view of a first detail of the pendulum pump in figure 1;

figure 3 is a diagrammatic front view of a second detail of the pendulum pump in figure 1; and

figure 4 is a diagrammatic front view of a third detail of the pendulum pump in figure 1.

[0015] With reference to the accompanying drawings, numeral 1 indicates, as a whole, a pendulum pump adapted to take oil from a storage tank (not shown) and to feed oil under pressure to a final device (not shown), for example an internal combustion engine.

[0016] The pendulum pump 1 comprises a pump body 2, which is cup-shaped, is limited by a substantially flat end face 3, and defines a cavity 4, which opens outward at face 3, and is limited by a bottom wall 5 which is substantially parallel to the face 3 itself.

[0017] Cavity 4 is closed by a plate 6 which is limited by a substantially flat face 7 arranged in contact with face 3.

[0018] The pendulum pump 1 further comprises an inner rotor 8, which is accommodated inside cavity 4, and is keyed onto a drive shaft 9 rotationally engaged through the pump body 2 and plate 6 to rotate around its own longitudinal axis 10 which is substantially perpendicular to the faces 3 and 7.

[0019] The pendulum pump 1 further has an outer rotor 11 mounted so as to be eccentric with respect to the inner rotor 8 so as to rotate around its own longitudinal axis 12 which is parallel to, and separate from, the mentioned axis 10.

[0020] The rotation motion of shaft 9 and, therefore, of the inner rotor 8 around axis 10 is transmitted to the outer rotor 11 by means of a plurality of dragging pendulums 13, which are distributed around axis 12, are interposed between the inner rotor 8 and the outer rotor 11, and have a dimension, measured parallel to the axes 10 and 12, which is substantially equal to a dimension of the

inner rotor 8 and of the outer rotor 11, which is also measured parallel to the axes 10 and 12.

[0021] Each pendulum 13 has a first free end rotationally fitted to the outer rotor 11 to oscillate around a fulcrum axis 14 parallel to axis 12, and also has a second free end rotationally coupled in an axially sliding manner to a guide recess 15 obtained in the inner rotor 8.

[0022] Each recess 15 is laterally limited by two flat sides 15a which are parallel to each other, and is separated from each adjacent recess 15 by means of an intermediate wall 15b.

[0023] The two sides 15a are parallel to the axes 10, 12 and are connected to each other by a bottom wall 15c of recess 15. In this case, wall 15c is flat and perpendicular to the sides 15a themselves.

[0024] The recesses 15 are distributed around axis 10 and have respective symmetry planes P, which extend parallel to axis 10, and are tangent to a circumference C which is concentric with respect to axis 10 and common to all the planes P.

[0025] Each plane P is parallel to the sides 15a and perpendicular to the wall 15c of the corresponding recess 15.

[0026] The distance between the sides 15a of each recess 15 and the dimensions of the corresponding pendulum 13 are such that pendulum 13 is always in contact with both the sides 15a and therefore is coupled to the recess 15 itself in a substantially fluid-tight manner.

[0027] Each pendulum 13 thus defines a first variable-volume chamber 16 together with the inner rotor 8, the outer rotor 11, and each adjacent pendulum 13, and defines a second variable-volume chamber 17 together with the corresponding recess 15.

[0028] The coupling between each pendulum 13 and the corresponding recess 15 allows the pumping effect of the corresponding chamber 17 to be utilized, ensures a uniform dragging of the outer rotor 11, and allows noises, vibrations and impacts to be avoided.

[0029] The chambers 16, 17 are axially limited by the bottom wall 5 of the pump body 2 and by the face 7 of plate 6.

[0030] Wall 5 and face 7 each have two respective cavities 18, 19, which extend around axis 10 according to respective angles smaller than 180°, face towards the chambers 16, 17, and are hydraulically separated from each other in a fluid-tight manner.

[0031] The two cavities 18 of wall 5 and of face 7, respectively, are hydraulically connected to each other by means of the chambers 16, 17, and are also hydraulically connected to a duct 20 for taking the oil in the pendulum pump 1.

[0032] The two cavities 19 of wall 5 and of face 7, respectively, are hydraulically connected to each other by means of the chambers 16, 17, and are also hydraulically connected to a duct 21 for delivering the oil to the mentioned final device.

[0033] The two cavities 18 are configured so as to hydraulically connect a part of the chambers 16, 17 together

and to duct 20, when the inner rotor 8 and the outer rotor 11 rotate around the respective axes 10, 12, while the two cavities 19 are configured so as to hydraulically connect the remaining chambers 16, 17 together and to duct 21, when the inner rotor 8 and the outer rotor 11 rotate around the respective axes 10, 12.

[0034] Since the inner rotor 8 and the outer rotor 10 are mounted so as to be eccentric, each chamber 16, 17 has a volume varying between a maximum volume at the first cavities 18 and thus at duct 20, and a minimum volume at the cavities 19 and thus at duct 21.

[0035] As shown above, it is worth noting that the maximum volume of the chambers 16, 17 and thus the displacement of the pendulum pump 1 depend on the eccentricity between the axes 10, 12, and that the eccentricity between the axes 10, 12 is selectively controlled by means of an adjusting device 22.

[0036] Device 22 comprises a crank 23, which is substantially cylindrical in shape, is mounted inside cavity 4 and is rotationally engaged by the outer rotor 11.

[0037] Crank 23 is hinged to the pump body 2 to oscillate, with respect to the pump body 2 and under the thrust of a known actuating device (not shown), around a fulcrum axis 24 which is parallel to the axes 10 and 12.

[0038] According to a variant (not shown), the pendulums 13 are rotationally fitted to the inner rotor 8, the recesses 15 are obtained in the outer rotor 11, and the planes P are tangent to a circumference C which is concentric with respect to axis 12.

[0039] Since the planes P are not radial and are tangent to circumference C, the dimensions of the inner rotor 8 being equal, the pendulum pump 1 allows:

an increased number of recesses 15 and thus of pendulums 13 to be used, with a subsequent reduction of the pressure pulsation; or
the number of recesses 15 and thus of pendulums 13 to be kept constant, with a subsequent increase of the thickness of walls 15b and thus of the structural strength of the inner rotor 8.

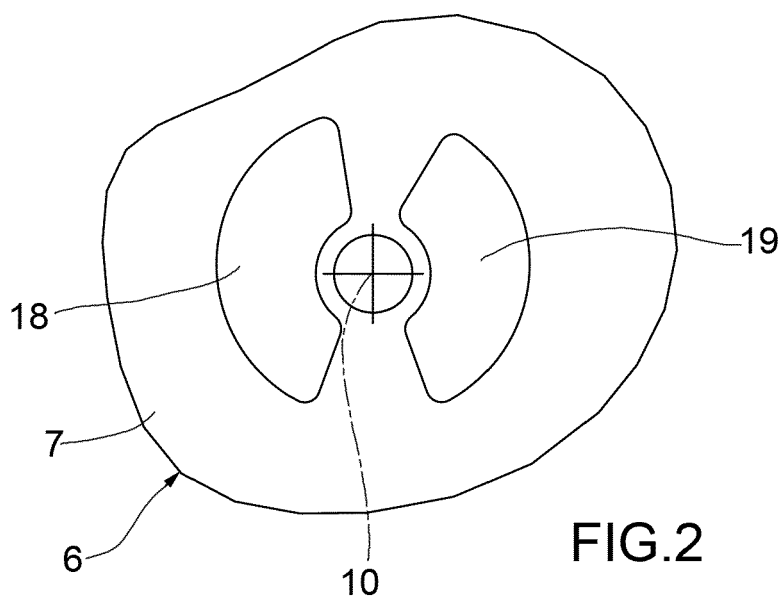
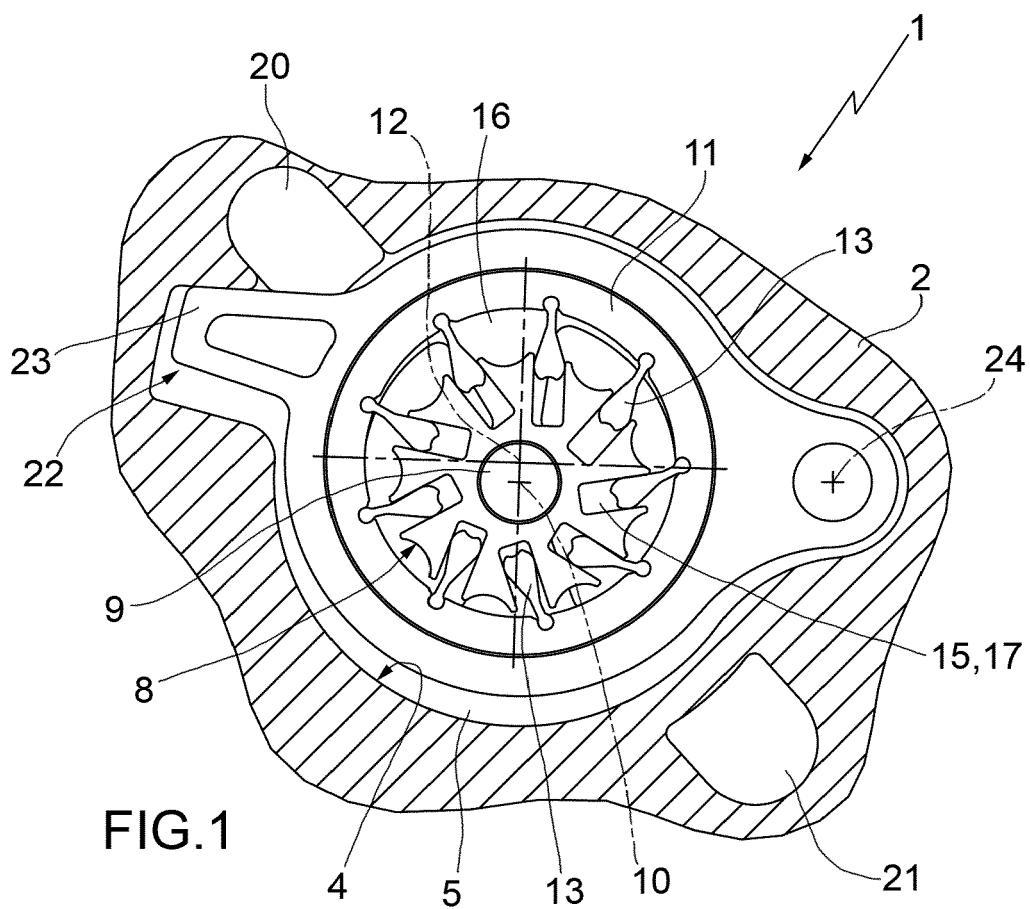
Claims

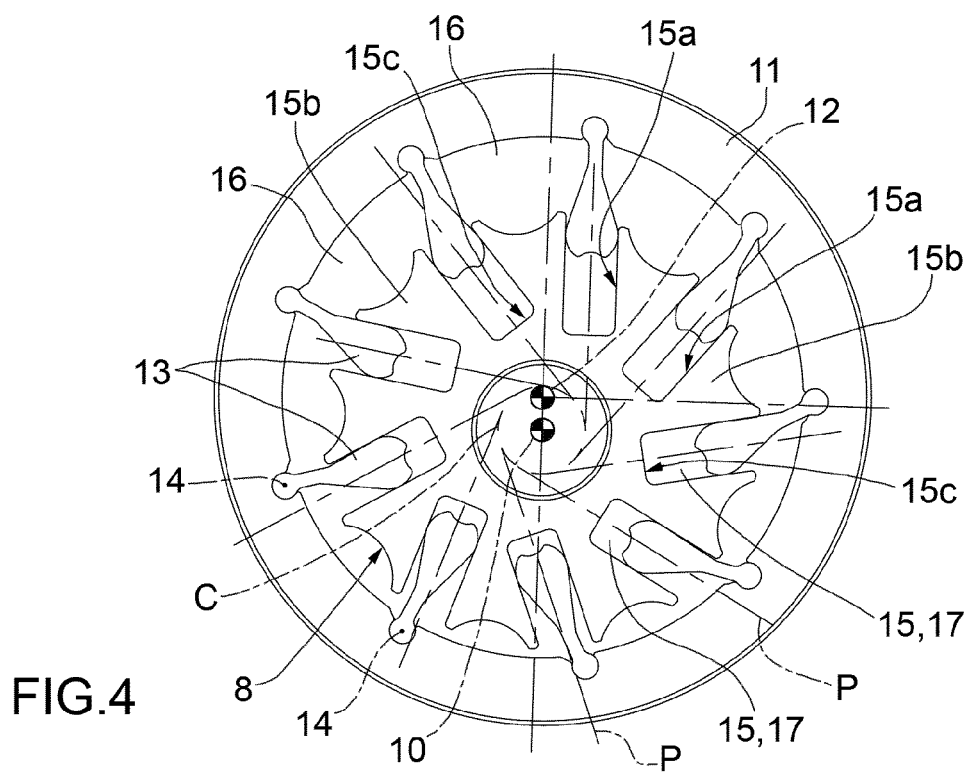
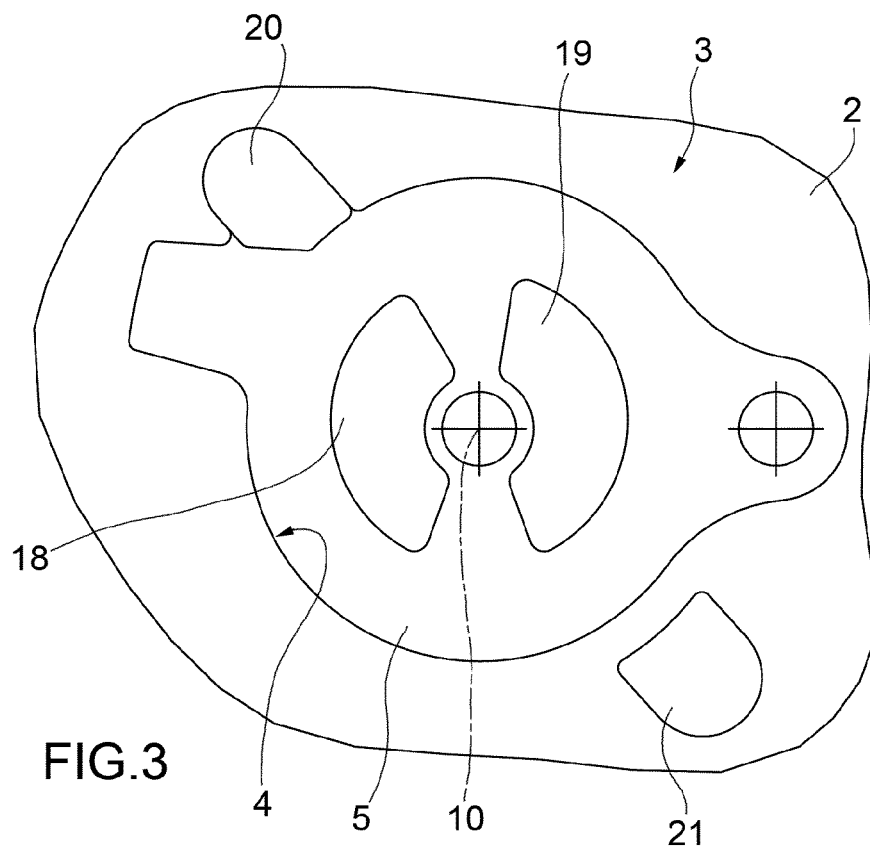
1. A pendulum pump, in particular to feed oil under pressure to a final device, comprising an outer rotor (11) mounted to rotate around a first rotation axis (12); an inner rotor (8) mounted inside the outer rotor (11) to rotate around a second rotation axis (10) which is parallel to the first rotation axis (12); and a plurality of dragging pendulums (13), which are interposed between the two rotors (8, 11), are rotationally coupled to one of the rotors (8, 11), and are slidingly coupled to respective guide recesses (15) obtained on the other rotor (8, 11); each guide recess (15) being limited by two lateral sides (15a), which are parallel to each other and to the rotation axes (12, 10), and are connected together by a bottom

wall (15c) of the guide recess (15) itself; and **characterized in that** each guide recess (15) has a symmetry plane (P) which is parallel to the corresponding lateral sides (15a), and is tangent to a circumference (C) which is concentric with respect to the rotation axis (10, 12) of the rotor (8, 11) having the guide recesses (15). 5

2. A pendulum pump according to claim 1, wherein the symmetry planes (P) of all the guide recesses (15) are tangent to the same circumference (C). 10
3. A pendulum pump according to claim 1 or 2, wherein each symmetry plane (P) is perpendicular to the bottom wall (15c) of the corresponding recess (15). 15
4. A pendulum pump according to any one of the preceding claims, wherein the lateral sides (15a) and the bottom wall (15c) of each recess (15) are flat. 20
5. A pendulum pump according to any one of the preceding claims, wherein the dragging pendulums (13) are rotationally fitted to the outer rotor (11) and the guide recesses (15) are obtained on the inner rotor (8). 25
6. A pendulum pump according to claim 5, wherein the circumference (C) is concentric with respect to the second rotation axis (10). 30
7. A pendulum pump according to any one of the preceding claims and further comprising a drive shaft (9), which is engaged through the inner rotor (8) in an angularly fixed manner, in order to move the inner rotor (8) around the second rotation axis (10). 35
8. A pendulum pump according to any one of the preceding claims, wherein said first and second rotation axes (10, 12) are parallel and eccentric to each other. 40
9. A pendulum pump according to any one of the preceding claims, wherein each dragging pendulum (13) and the corresponding recess (15) are sized so that the dragging pendulum (13) is always in contact with the lateral sides (15a) of the recess (15) itself. 45
10. A pendulum pump according to any one of the preceding claims, wherein each dragging pendulum (13) is coupled to the corresponding recess (15) in a substantially fluid-tight manner, and thus defines a first variable-volume chamber (16) together with the two rotors (8, 11) and with each adjacent dragging pendulum (13), and defines a second variable-volume chamber (17) together with the corresponding guide recess (15); said first and second variable-volume chambers (16, 17) connecting, during the rotation of the two rotors (8, 11) around the rotation axes (10, 12) thereof, to at least one intake (20) and 50

to at least one delivery (21) of the pendulum pump.







EUROPEAN SEARCH REPORT

Application Number
EP 14 19 1963

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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	WO 2009/014661 A1 (BORGWARNER INC [US]; FELDT KEITH V [US]; KOPEC MARK [US]) 29 January 2009 (2009-01-29) * page 3, line 8 - line 26; figure 1 * -----	1-10	INV. F04C2/332 F04C2/348
A	DE 195 32 703 C1 (BEEZ GUENTHER [DE]; BAUER HANS GUENTER [DE]; LADEMANN SVEN [DE]) 21 November 1996 (1996-11-21) * column 5, line 6 - line 36; figure 1 * -----	1-10	
A	DE 10 2006 058979 A1 (HELLA KGAA HUECK & CO [DE]) 19 June 2008 (2008-06-19) * abstract; figures 5,6 * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F04C F01C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 March 2015	Examiner Descoubes, Pierre
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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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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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WO 2009014661	A1	29-01-2009	NONE	

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