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(54) **A rotary distributor for pressure multiplier**

(57) The invention provides a system for multiplying pressure comprising: at least two hydraulic cylinders communicating with an exit supplying pressure (4), wherein each cylinder has a piston (1A;2A) within a chamber; said pistons cooperating respectively with an

associated piston (1B;2B) to supply pressure at the exit (4); and a rotary distributor (5) communicating with said both hydraulic cylinders, able to supply alternatively a fluid to each chamber for motion of the respected pistons and to ensure alternatively return of the pistons.

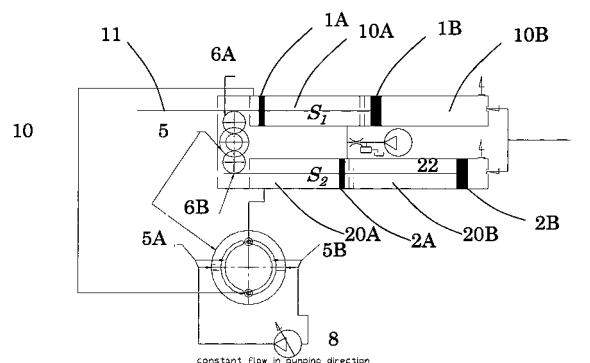


Figure 2

Description

Field of the invention

[0001] The present invention broadly relates to well injection for example cementing. More particularly the invention relates to servicing apparatus for pumping fluids in downhole wells into a subterranean reservoir, such as for instance an oil and/or gas reservoir or a water reservoir.

Description of the Prior Art

[0002] When a cementing job is performed, pumping units are used to pump a fluid downhole in the well. Usually high pressure pumps are needed to ensure efficient pumping. To allow amplification of pressure, for example pressure multiplier can be used. Pressure multipliers are well known in prior art. Figure 1 shows a schematic representation of a pressure multiplier. When piston 1A extends to the right at a constant speed, piston 1B delivers a constant downstream flow of oil. At the same time piston 1B is moving to the right, piston 2A retracts to the left in conjunction with piston 2B. When piston 1A reaches the right end of the cylinder, piston 2A reaches the left end of its cylinder. Piston 2A then extends while piston 1A retracts. Pistons 1A and 2A have a surface larger than pistons 1B and 2B, in such a way that high pressure comes out of exit 4 when a relatively low pressure (compared to exit 4) comes in via the input 3. However such a pressure multiplier from prior art has some drawback. The motion of the two pistons should produce a constant and uniform flow output, but due to the change of directions of piston 1A and 2A, a dip is generated in the output flow at the downstream of pistons 1B and 2B. Therefore, there is a need to improve the pressure multiplier from prior art.

Summary of the invention

[0003] The invention discloses a system for multiplying pressure comprising: at least two hydraulic cylinders communicating with an exit supplying pressure, wherein each cylinder has a piston within a chamber; said pistons cooperating respectively with an associated piston to supply pressure at the exit; and a rotary distributor communicating with said both hydraulic cylinders, able to supply alternatively a fluid to each chamber for motion of the respected pistons and to ensure alternatively return of the pistons. In this way, the rotary distributor ensures an alternative supply of the fluid into the chambers and also an exit of the fluid from the chambers.

[0004] Preferably, the rotary distributor is made of a mirror distributor plate able to rotate within a holder, wherein the position of the plate versus the holder determines the supply of the fluid to one chamber and/or to another. The mirror distributor plate rotates clockwise or inverted clockwise and each cycle of the system is de-

termined by sequences in position of the plate versus the holder. In a preferred embodiment, the mirror distributor plate is made of, but not limited to, at least two slots, the first slot ensuring supply of the fluid to each chamber and second slot ensuring return of the fluid from each chamber. By rotation of the plate, each cylinder is alternatively supplied by the fluid and emptied from the fluid, depending if the sequence is respectively a compression or a depression.

[0005] Preferably, the system is made of a first rod coupling first piston with third associated piston; a second rod coupling second piston with fourth associated piston; and a first free wheel connected to the first rod and a second free wheel connected to the second rod, said both free wheels coupled with the rotary distributor such that motion of each piston ensures self rotation of the rotary distributor in one direction ensuring alternative supply of each chamber with the fluid. This configuration allows a self driving of the rotary distributor.

[0006] In another embodiment, the rotary distributor is rotate by a step motor. In this way, the rotation is independent and controlled preferably with a micro-controller.

[0007] Preferably, a first sensor determining position of first or second piston in associated chamber is added. Advantageously, the system comprises two sensors; the first sensor determines position of first piston in first chamber and further comprising a second sensor determining position of second piston in second chamber.

[0008] In another aspect of the invention a method for pumping an injection fluid in a well using an apparatus above is disclosed. Preferably, the injection fluid is but not limited to a cement slurry and the system is used in a cementing job. Other fluids can also be pumped, for various applications for example fracturing, stimulation or various well treatments.

[0009] The system thanks to its little size can be used in environment where place is limited, for example offshore or on trucks.

[0010] Preferably, the system is used for multiplying pressure with a step of pre-compression within each chamber of the cylinder.

Brief description of the drawings

[0011] Further embodiments of the present invention can be understood with the appended drawings:

- Figure 1 shows a schematic diagram of a pressure multiplier from prior art.
- Figure 2 shows the apparatus according to the invention comprising a rotary distributor valve.
- Figure 3A shows the rotary distributor in a first position.
- Figure 3B shows the rotary distributor in a second position, respectively turned from an angle of 180°

compared to first position.

- Figure 4 shows the sequences of the apparatus according to the invention during function.

Detailed description

[0012] The present invention involves the use of a rotary distributor in the pistons assembly of prior art. Figure 2 shows a schematic representation of the apparatus 10 according to the invention. A first piston 1A is connected to a third piston 1B through a first rod 11. The first piston 1A moves within a first chamber 10A and the third piston 1B moves within a third chamber 10B. The first piston 1A moves with a speed S1. This system defines the first hydraulic cylinder. In the same way, a second piston 2A is connected to a fourth piston 2B through a second rod 22. The second piston 2A moves within a second chamber 20A and the fourth piston 2B moves within a fourth chamber 20B. The second piston 2A moves with a speed S2. This system defines the second hydraulic cylinder. The position of each piston can be known by using positioning sensors. Preferably, two position sensors are used for both first 1A and second 2A piston; advantageously the sensors are magneto restrictive positioning sensors which avoid contact. An exit 4 is located at the end of both cylinders and communicates with the third chamber 10B and the fourth chamber 20B. A rotary distributor 5 is coupled between the two cylinders. In this way, the hydraulic sequential valves are replaced by this rotary distributor. Accordingly, the rotary distributor of the invention is preferably a mirror distribution plate 5 within a holder 7.

[0013] The linear motion of each hydraulic rod (11, 22) is transformed to a rotation motion that drives the rotary distributor 5 via a dual free wheel device (one for each cylinder). In this way, a first free wheel 6A is connected to the first rod 11 and a second free wheel 6B is connected to the second rod 22. The rotary distributor is placed between those two free wheels (6A, 6B) and so always turns in the same rotation direction. Preferably, the rotary distributor is a rotary distributor built of mirror distribution plate 5 containing two slots, first one to supply the oil to the hydraulic cylinder chambers 5A and second one to ensure return of the cylinder to its initial position 5B. Figures 3A and 3B show the rotary distributor 5 in more details and in function.

[0014] Alternatively, the rotary distributor can be rotated using a step motor (not shown on Figure). There are no free wheels and the rotary distributor drives independently to ensure supply and return of oil into and from the cylinders. Advantageously, the rotary distributor is coupled with a micro-controller and displacement sensors to ensure a regular cycle of the apparatus 10. For example, two potentiometers one in each hydraulic cylinder will slave the step motor position.

[0015] Figure 3A is a double view of the rotary distributor 5, at the right in a longitudinal view, at the left, in a

transverse view according to the plan A-A. In following figures, the rotary distributor is described with two slots; however several slots can be used, especially if the pressure of the mirror distributor plate wants to be balanced. Advantageously, the slippers on each slot/orifice shall be equipped with de-pressurizing grooves. The rotary distributor may also be built with multi stages because of high flowrate.

[0016] The first slot 5A supplies the oil to the hydraulic cylinder chambers to allow the motion in the pumping direction. A variable displacement pump 8 (Figure 2) only supplies the oil to the pumping direction chambers. At each end of the slot a progressive groove allows for a short period to supply oil to both cylinder chambers. Due to constant oil flow in the system the sum of the linear speed of the rods is constant in this way reducing the pulsation of the system to a minimum. The second slot 5B ensures the return of the cylinder to its initial position (suction direction). The return is ensured by a pressure/flow controlled hydraulic spring (not shown) allowing a good volumetric efficiency of the pumping system. For a short period of time (Short angle of the rotary distributor) the pressure discharge is connected to both hydraulic cylinders. This feature allows the process pumping system to work without spikes.

[0017] Figure 3B is a double view of the rotary distributor 5, at the right in a longitudinal view, at the left, in a transverse view according to the plan A-A. Compared to Figure 3A, Figure 3B represents the mirror distributor plate turned from an angle of 180°. In this configuration supply of the second cylinder is ensured and return of the first one is allowed.

[0018] Figure 4 is a diagram showing sequences of the function cycle of the apparatus 10 of the invention. Step A shows the first cylinder in pumping mode and the second cylinder in return mode, the first slot 5A ensures supply to extension of the first piston 1A in first cylinder and second slot 5B return of the second piston 2A in second cylinder. Step B shows the first cylinder in pumping mode and the second cylinder in pre-compression mode, the first slot 5A ensures supply to extension of the first piston 1A in first cylinder and also to pre-compress the second piston 2A in second cylinder. Pre-compression ensures a better efficiency of the apparatus 10. Step C shows the first cylinder in pumping mode and the second cylinder also in pumping mode, the first slot 5A ensures both supply to extension of the first piston 1A in first cylinder and the second piston 2A in second cylinder. Step D shows the first cylinder in return mode and the second cylinder in pumping mode, the first slot 5A ensures supply to extension of the second piston 2A in second cylinder and second slot 5B return of the first piston 1A in first cylinder. Step E shows the second cylinder in pumping mode and the first cylinder in pre-compression mode, the first slot 5A ensures supply to extension of the second piston 2A in second cylinder and also to pre-compress the first piston 1A in first cylinder. Step F shows the first cylinder in pumping mode and the second cylinder

der also in pumping mode, the first slot 5A ensures both supply to extension of the first piston 1A in first cylinder and the second piston 2A in second cylinder. Step G shows the apparatus at the same stage as defined in step A, and cycle can continue.

Claims

1. A system (10) for multiplying pressure comprising:

- at least two hydraulic cylinders communicating with an exit (4) supplying pressure, wherein each cylinder has a piston (1A, 2A) within a chamber (10A, 20A); said pistons (1A, 2A) co-
- operating respectively with an associated piston (1B, 2B) to supply pressure at the exit (4); and
- a rotary distributor (5) communicating with said both hydraulic cylinders, able to supply alternatively a fluid to each chamber (10A, 20B) for motion of the respected pistons (1A, 2A) and to ensure alternatively return of the pistons (1A, 2A).

2. The system of claim 1, wherein the rotary distributor is made of a mirror distributor plate (5) able to rotate within a holder (7), wherein the position of the plate (5) versus the holder (7) determines the supply of the fluid to one chamber and/or to another.

3. The system of claim 2, wherein the mirror distributor plate (5) is made of at least two slots (5A, 5B), the first slot (5A) ensuring supply of the fluid to each chamber (10A, 20B) and second slot (5B) ensuring return of the fluid from each chamber (10A, 20B).

4. The system according to anyone of claim 1 to 3, further comprising:

- a first rod (10A) coupling first piston (1A) with third associated piston (1B);
- a second rod (10A) coupling second piston (2A) with fourth associated piston (2B); and
- a first free wheel (6A) connected to the first rod and a second free wheel (6B) connected to the second rod, said both free wheels (6A, 6B) coupled with the rotary distributor (5) such that motion of each piston (1A, 2A) ensures self rotation of the rotary distributor in one direction ensuring alternative supply of each chamber (10A, 10B) with the fluid.

5. The system according to anyone of claim 1 to 3, wherein the rotary distributor is rotate by a step motor.

6. The system according to anyone of claim 1 to 5, further comprising at least a first sensor determining position of first or second piston in associated cham-

ber.

7. The system of claim 6, wherein the first sensor determines position of first piston (1A) in first chamber (10A) and further comprising a second sensor determining position of second piston (2A) in second chamber (20A).

8. A method for pumping an injection fluid in a well using an apparatus according to any one of claim 1 to 7.

9. The method of claim 8, wherein the injection fluid is cement slurry.

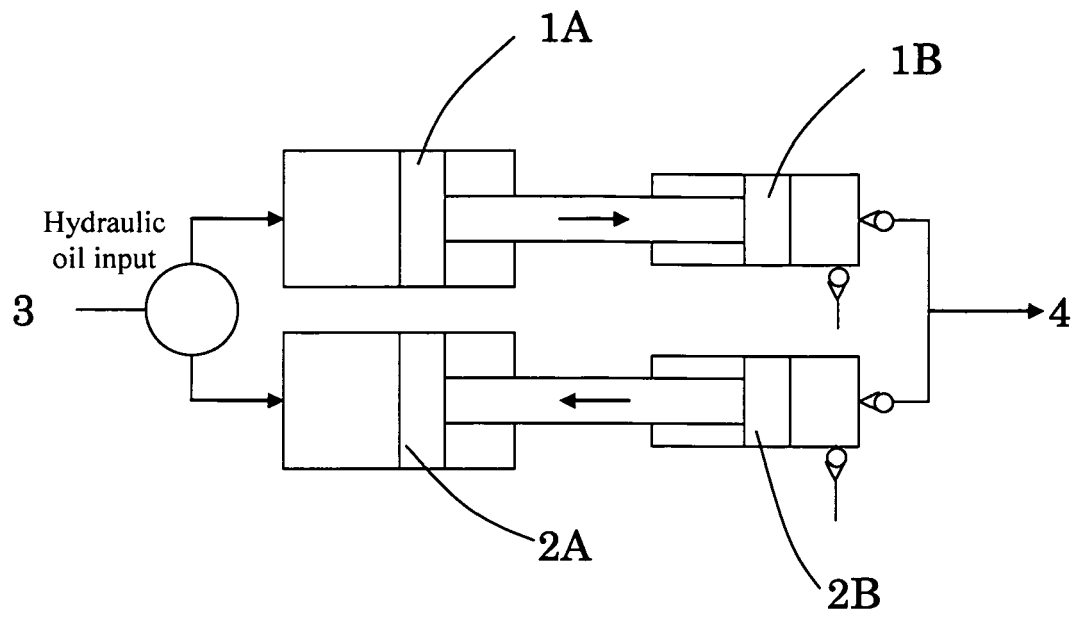


Figure 1
PRIOR ART

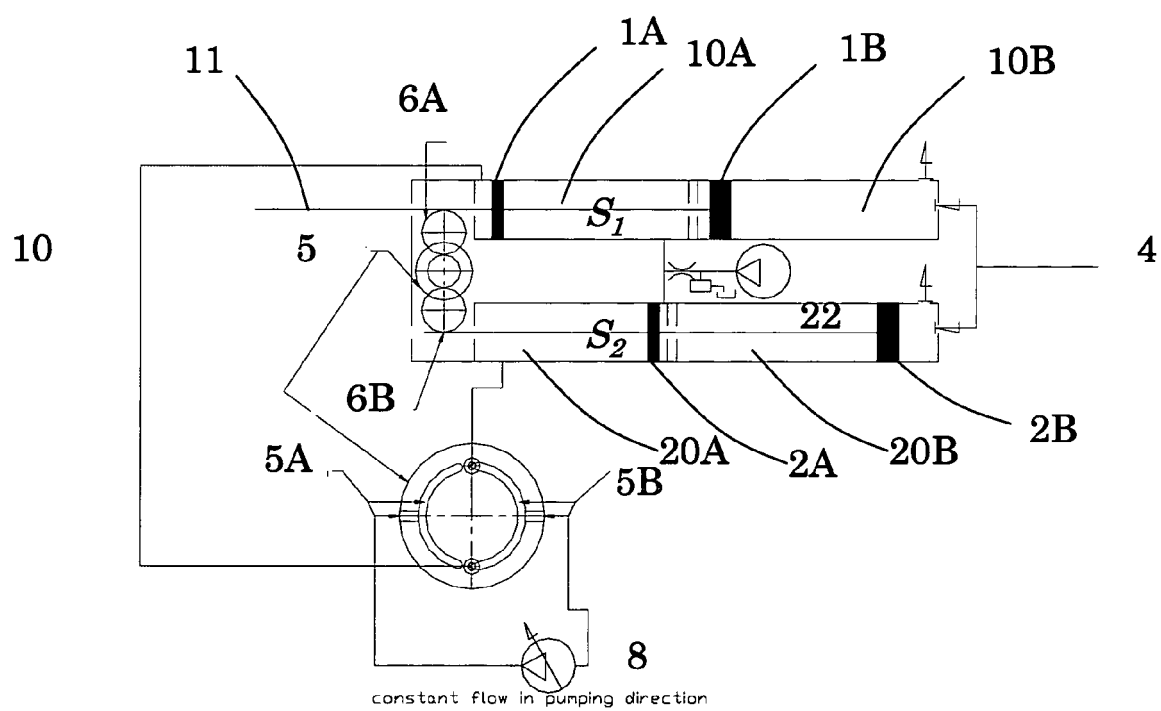


Figure 2

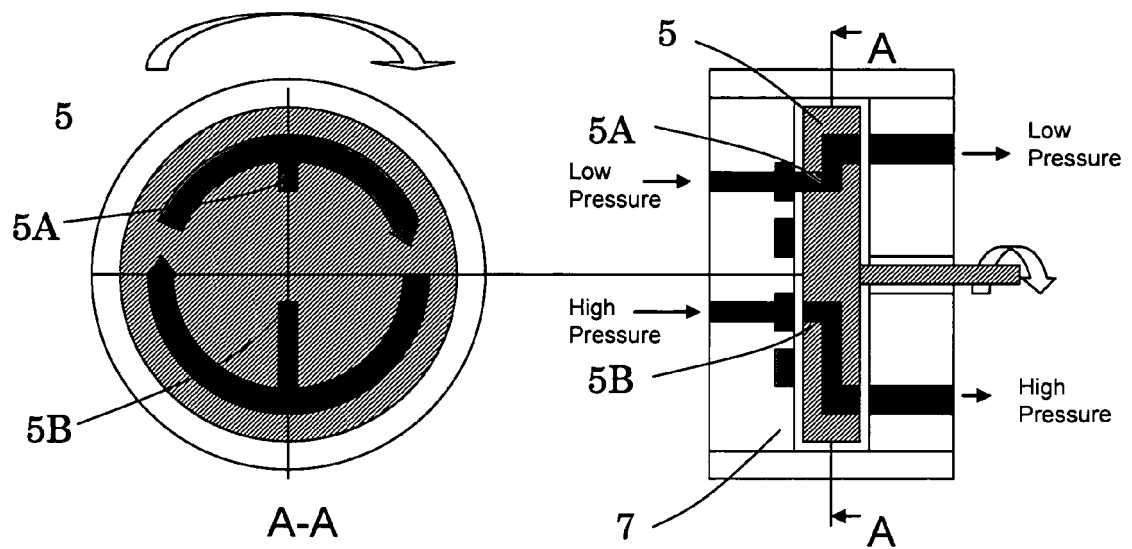


Figure 3A

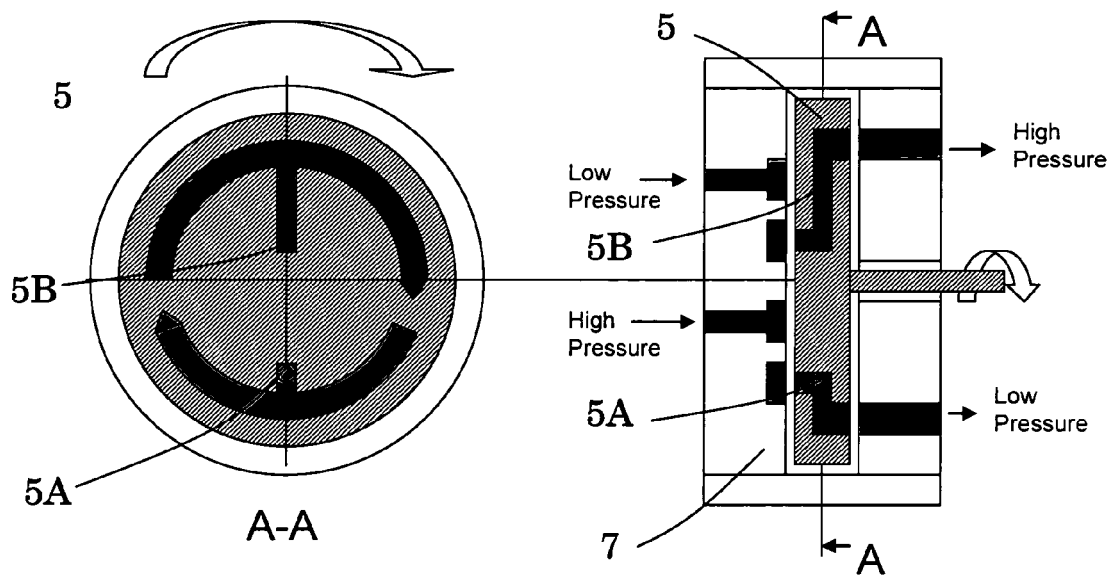


Figure 3B

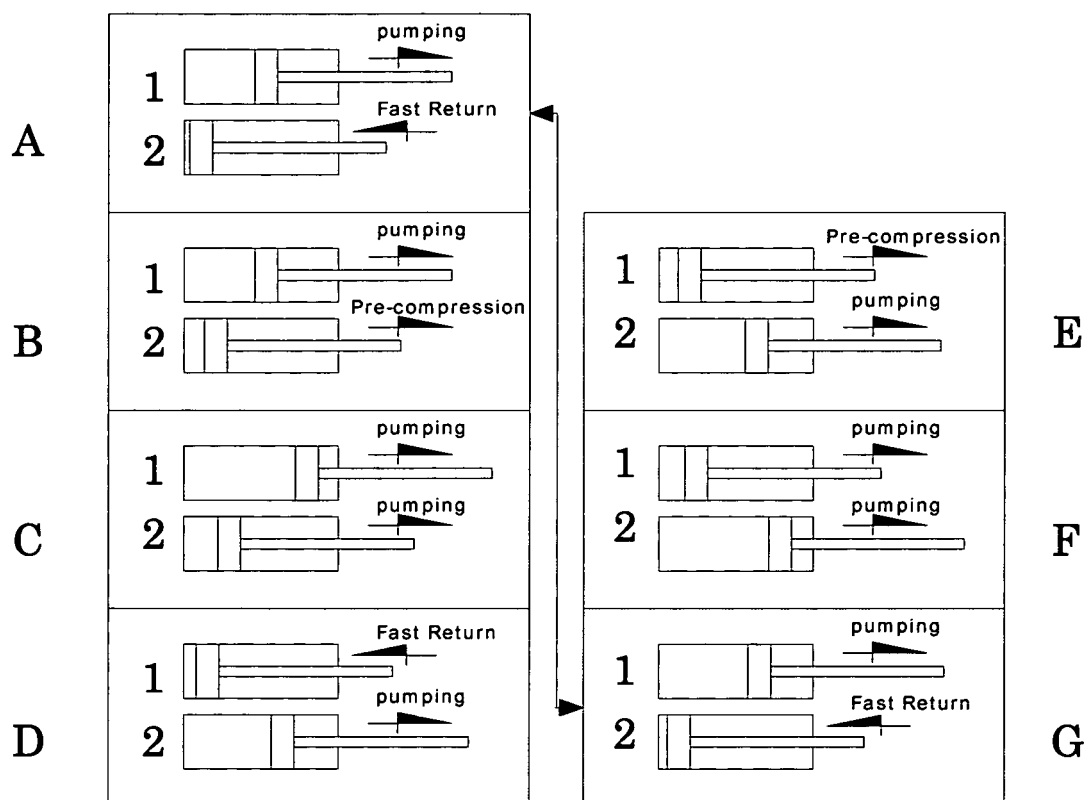


Figure 4



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Application Number
EP 07 29 0551

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EPO FORM 1503 03/02 (P04C01)



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EUROPEAN SEARCH REPORT

Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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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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