



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

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                                                                                                                               |
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| <b>(51) International Patent Classification<sup>3</sup> :</b><br><br><b>F04B 47/04</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 84/ 01002</b><br><br><b>(43) International Publication Date:</b> 15 March 1984 (15.03.84) |
| <p><b>(21) International Application Number:</b>      PCT/AU83/00124</p> <p><b>(22) International Filing Date:</b>      7 September 1983 (07.09.83)</p> <p><b>(31) Priority Application Number:</b>      PF 5822</p> <p><b>(32) Priority Date:</b>      9 September 1982 (09.09.82)</p> <p><b>(33) Priority Country:</b>      AU</p> <p><b>(71)(72) Applicant and Inventor:</b> MacLEOD, Donald, Ian, Guy [AU/AU]; 41 Phelps Street, Geraldton, W.A. 6530 (AU).</p> <p><b>(74) Agent:</b> COLLISON &amp; CO.; Savings Bank Building, 97 King William Street, Adelaide, S.A. 5000 (AU).</p> <p><b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU, US.</p>                                                                                                                                                        |           | <p><b>Published</b><br/><i>With international search report.</i></p>                                                                          |
| <p><b>(54) Title:</b> HYDRAULICALLY ACTUATED BORE AND WELL PUMP</p> <p><b>(57) Abstract</b></p> <p>A hydraulically actuated bore or well pump in which a driving unit (1) at the bore or well surface comprises interconnected pistons (6 and 7) arranged to hydraulically actuate a slave piston (27) in a submerged well or bore unit (2) through a hydraulic pressure line (40) and a pump delivery line (42). The driving unit (1), being double-acting, imparts both pumping and return movement to the slave piston (27) and a coupled pumping piston (28) as the driving unit (1) is reciprocated. A valve (50) in the pump delivery line (42) allows outflow from the pump during the pumping stroke and also allows the pump delivery line (42) to be pressurised by the driving unit (1) for the return stroke of the coupled slave and pump pistons (27, 28). A controlled hydraulic drive motor (13) is preferred for actuating the driving unit (1).</p> <div> </div> |           |                                                                                                                                               |

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1.

"HYDRAULICALLY ACTUATED BORE AND WELL PUMP"

This invention relates to improvements in and relating to a hydraulically actuated bore and well pump, and in particular it relates to pumps of the type in which an actuating mechanism for a pump  
5 which is situated beneath the liquid level in a bore or well and is adapted to reciprocate a piston within the submerged pump to raise liquid to the surface. According to the older types of pump it was customary to use a windmill or pump jack at  
10 the surface of the bore or well and to have a mechanical connecting rod between the operating mechanism and the piston of the submerged pump to actuate the piston during its pumping action.

In an earlier system I used a submerged pump  
15 which, instead of being connected by mechanical coupling means to the actuating mechanism at the surface of the bore or well, I used a hydraulic connection so that pressure in an actuating hose moves the piston in one direction to initiate a pumping  
20 action and return was by the weight of water in the system, the balance being such that the pumping action was under control of pressure in a hose which was intermittently applied on one stroke of the pump and on the other stroke of the pump the piston  
25 was returned by water pressure for the next stroke.

I also experimented with a system in which two coupled pistons were used, one of which was a larger piston adapted to draw water on one stroke into the barrel of the pump and to deliver the water on the next  
30 stroke of the piston through a discharge pipe, the weight of fluid in the delivery line forcing the smaller piston downwardly carrying the larger piston



## 2.

with it to draw liquid into the space above the larger piston in readiness for the next lifting action. For this device to operate it was necessary to raise the discharge pipe above the level of the piston mechanism at the surface which actuated the submerged pump to obtain the necessary pressure to return the pistons.

The present invention related generally to these systems but combines the advantages of the foregoing specifications with a double-acting driving system at the bore or well head, and with a double-acting slave system in the submerged pump the object being to provide a simpler and more effective system.

The invention utilises two driving pistons in barrels at the head of the bore or well which are connected to the submerged pump in the bore or well, the arrangement resulting in a balanced system of high efficiency.

The present invention comprises a hydraulically actuated bore or well pump in which a submerged pump unit comprises a pumping piston in a barrel having a foot valve to admit liquid to the barrel and a non-return valve at the piston, and in which the piston is connected to a slave unit, comprising a slave piston in a barrel coaxial with the first barrel, by a hollow connecting rod opening through the pumping and slave piston and communicating with a delivery line adapted to discharge liquid to the surface of the bore or well, and in which a driving unit at the bore or well surface comprises piston and barrel means adapted to actuate the slave piston through a pressure line between the



3.

driving unit and the slave piston, characterised in that the said driving unit is double-acting to impart both up and down movement to the pumping and slave pistons as the driving unit piston means  
5 are reciprocated, further characterised by valve means in the delivery line to control outflow from the delivery line to make possible drive in both directions using only at least a pressure line and a delivery line.

According to a preferred construction the  
10 invention comprises a hydraulically actuated bore or well pump in which a submerged pump comprises a first upper barrel and a second lower barrel with the space of one barrel isolated from the other by a dividing wall, an apertured piston being positioned in each  
15 barrel interconnected by a hollow connecting rod so that the space within the upper barrel above the piston therein which forms a slave piston is in communication with the space in the lower barrel on both sides of the piston therein which forms a pumping piston, the  
20 hollow connecting rod passing sealingly through the dividing wall, the lower end of the hollow connecting rod being apertured into the space in the lower barrel above the pumping piston therein, characterised in that the aperture through the pumping piston  
25 in the lower barrel has a non-return valve to admit fluid from below the pumping piston into the space above the piston and into the hollow connecting rod, a non-return valve being provided in the lower end of the lower barrel, further characterised by a pair of remote  
30 barrels at the surface having oppositely acting interconnected driving pistons therein whereby to reciprocate the pistons of the submerged pump, a delivery line connecting the top of the upper barrel with a surface delivery point, a pressure line connect-



4.

ing the lower end of the upper barrel with one of the remote barrels, an auxiliary pressure line connecting the delivery line with the other surface barrel, a valve located in the delivery line between the auxiliary pressure line and the delivery point in communication with the first pressure line whereby the valve opens the delivery line when liquid flows upwardly in the delivery line but pressurises the delivery line on the return stroke, and means to actuate the remote surface pistons.

In order that the invention will be fully understood, embodiments thereof will now be described with reference to the accompanying drawings in which:

FIG. 1 shows somewhat schematically a transverse section of the system of this invention showing the pistons of the surface driving unit actuated by hydraulic motor means and showing in principle a submerged pump and its actuation, the interconnecting lines being shown as passing down the bore or well independently but the pressure line can be positioned within the delivery line.

FIG. 2 is a fragmented longitudinal section showing a mechanical drive in place of the hydraulic motor means.

Referring first to the driving unit 1 at the surface of the bore or well for actuating the pump unit 2, a pair of barrels 3-4 are supported in a trough 5, which barrels 3-4 have within them pistons 6-7 interconnected by a rod 8 so arranged that when the rod 8 moves the pistons 6-7 in one direction liquid is displaced from the barrel 3 at one end but when the rod



5.

8 is moved in the opposite direction, liquid is displaced from the barrel 4 at its other end. This unit thus forms a double-acting surface driving unit.

5 In the form illustrated in FIG. 1 a hydraulic motor is used to provide the reciprocation, but a crank or other drive means can be used as illustrated in FIG. 2, or the hydraulic motor may be replaced by pneumatic motor means or by electrical actuating means such as a linear motor.

10 As shown in FIG. 1 the rod 8 between the pistons is coupled by a mechanical link 9 to a second rod 10 parallel to the first rod 8 and this rod 10 connects a pair of pistons 11-12 of hydraulic motor means 13 in  
15 barrels 14-15 arranged parallel to the first pair of barrels 3-4 so that when the second rod 10, which is the driver rod, is actuated, it moves the rod 8 which interconnects the pistons 6-7 which displace the fluid for the driving action.

20 The hydraulic motor means 13 have their pistons 11-12 operated by hydraulic fluid from a suitable supply tank 18 by a hydraulic pump 19 of any usual or approved type, acting through a solenoid controlled valve 20 which is regulated in its position by a pair of micro-switches 21-22 positioned so that, as the  
25 mechanical link 9 between the two rods 8-10 reaches the one micro-switch, the direction of movement is reversed, and when it reaches the other micro-switch the direction is again reversed and so on, this then ensuring that the driver pistons 11-12 which have their  
30 rod 10 coupled to the rod 8 of the surface driving unit, causes the pistons 6-7 to displace the liquid to cause reciprocation of the driving pistons 6-7.



6.

The control of the motor means 13, whether they are hydraulic, pneumatic, or electrical can be controlled to vary the speed of the driving means such as by having a speed variation at the end of one or each stroke to avoid water hammer, and for this purpose a microprocessor 23 can be coupled to the control means.

The submerged pump unit has an upper barrel 25 and a lower barrel 26, these barrels 25 and 26 having the same volume displacement as the barrels 3 and 4.

The barrel 25 has in it a slave piston 27, the lower barrel 26 having in it a pumping piston 28, the pistons 27 and 28 being interconnected by a hollow connecting rod 30 which passes through a central dividing wall 31 and having a seal 32, and both the upper slave piston 27 and the lower pumping piston 28 have openings therethrough but the lower pumping piston 28 has a check valve 33 to allow only upward flow therethrough.

A foot valve 34 allows liquid flow through an opening 35 into the lower part of the chamber 36 formed by the barrel 26 while ports 37 in the hollow connecting rod 30 allows liquid from the hollow connecting rod to flow into the space 38 above the pumping piston 28 in the barrel 26.

The pressure line is designated 40 and the delivery line 42.

The barrel 3 of the surface driving unit 1 is in communication with the space 44 in the cylinder 25 below the slave piston 27 through an annular space 45 between the sleeve 46 and the barrel 25, while the



7.

delivery line 42 connects to the chamber 48 in the barrel 25 above the slave piston 27.

5       The delivery line 42 has in it a valve 50 which is loaded to a closed position by a spring 51 but is urged from the seat 52 in the chamber 53 by pressure on a piston 54 from the pressure line 40 acting through a branch line 55.

10       The purpose of the valve 50 in the chamber 53 in the delivery line 42 is to close off outflow from the delivery line 42 during the time that liquid in the pressure line 40 is lifting the pistons 27 and 28 to allow outflow of the liquid being pumped from the discharge point but closes off the flow when the pistons 27 and 28 return after a lifting stroke.

15       Return of the pistons 27 and 28 is by pressure in the delivery line 42 obtained from outward movement of the piston 7 in the barrel 4 through the auxiliary pressure line 57 which is connected to place the barrel 4 into communication with the chamber 53 on the submerged pump unit 2 side of the valve 50.

20

25       In the drawings the solid line arrows show flow and movement direction during the lifting stroke in which case the valves 50 and 34 are open and the valve 33 is closed. The dotted line arrows show the flow and movement direction on the return stroke when the valves 50 and 34 are closed and the valve 33 is open.

It should be noted also that the piston 27 could have a valve, not shown, to close when return pressure is applied to the slave unit.



## 8.

The drive shown in FIG. 2 can replace the hydraulic motor means 13 and comprises a crank 60 connected by a rod 61 to a cross-head 62 slidable on a guide rod 63 secured to the barrels 3a and 4a, the cross-head 62 being fixed to the rod 8a interconnecting the pistons in the barrels 3a and 4a.

In this case the pumping speed of the driving unit is controlled by the crank 60, but as stated earlier, in the form shown in FIG. 1, or in the case of replacement of the hydraulic motor unit by a pneumatic unit or for instance a linear electric motor unit, the pumping speed can be controlled incrementally by use of for instance the microprocessor 23, so that the best pumping rate can be achieved to avoid water hammer or similar problems.

From the foregoing it will be realised that a simple and effective liquid pump results which has an improved double-acting mechanism for actuating the submerged pump which, because it is also double-action results in a balanced system having a high pumping efficiency with high control of the actual pumping and return strokes if this is required.

9.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A hydraulically actuated bore or well pump in which a submerged pump unit comprises a pumping piston in a barrel having a foot valve to admit liquid to the barrel and a non-return valve at the piston, and in  
5 which the said piston is connected to the piston of a slave unit having a barrel coaxial with the first said barrel, said connection being by a hollow connecting rod opening through the said pumping piston and the said slave piston and communicating through the second  
10 said barrel with a delivery line adapted to discharge liquid to the surface of the bore or well, and in which a driving unit at the bore or well surface comprises piston and barrel means adapted to actuate the said  
15 slave piston through a pressure line between the said driving unit and the said slave piston, characterised in that the said driving unit is double-acting to impart both up and down movement to the said pumping and slave pistons as the said driving unit piston means are reciprocated, further characterised by valve means  
20 in the said delivery line to control outflow from the said delivery line to allow the said delivery line to be pressurised for a return stroke.

2. A hydraulically actuated bore or well pump according to claim 1 characterised in that the said driving unit comprises a pair of cylinders having  
5 pistons therein connected to act oppositely, one said barrel being connected by the said pressure line to one side of the barrel of the said slave unit to return the said slave piston, the other said barrel being connected to the said delivery line by an auxiliary pressure line, further characterised in that the said



10.

10 valve means are arranged to close the said delivery line on the return stroke of the said slave piston.

3. A hydraulically actuated bore or well pump according to claim 1 or 2 characterised in that the said valve means in the said delivery line comprise a valve in a chamber and means to urge the said valve to a closed position, and a piston connected to the said valve arranged to open the said valve when pressure from the said pressure line is applied to the said piston.

4. A hydraulically actuated bore or well pump according to any preceding claim wherein the said driving unit is actuated by fluid motor means arranged to reciprocate the said pistons in the said driving unit and optionally has control means to vary the rate of movement of the said pistons of the driving unit during a stroke.

5. A hydraulically actuated bore or well pump in which a submerged pump comprises a first upper barrel and a second lower barrel with the space of one barrel isolated from the other by a dividing wall, an apertured piston positioned in each barrel interconnected by a hollow connecting rod so that the space within the upper barrel above the piston therein which forms a slave piston is in communication with the space in the lower barrel on both sides of the piston therein which forms a pumping piston, the hollow connecting rod passing sealingly through the dividing wall, the lower end of the hollow connecting rod being apertured into the space in the lower barrel above the pumping piston



11.

15 therein, characterised in that the aperture through the  
pumping piston in the lower barrel has a non-return  
valve to admit fluid from below the pumping piston into  
the space above the pumping piston and into the hollow  
connecting rod, a non-return valve in the lower end of  
the lower barrel, further characterised by a pair of  
10 remote barrels at the surface forming a driving unit  
having oppositely acting interconnected driving pistons  
therein whereby to reciprocate the pistons of the  
submerged pump, a delivery line connecting the top of  
the said upper barrel with a surface delivery point, a  
25 pressure line connecting the lower end of the upper  
barrel with one of the said driving unit barrels, an  
auxiliary pressure line connecting the delivery line  
with the other driving unit barrel, a valve located in  
the delivery line between the auxiliary pressure line  
30 and the delivery point in communication with the first  
said pressure line arranged so that the valve opens the  
delivery line when liquid flows upwardly in the  
delivery line but pressurises the delivery line on the  
return stroke, and motor means to actuate the said  
35 driving pistons.

6. A hydraulically actuated bore or well pump  
according to claim 5 characterised by means to control  
the rate of movement of the said motor means during  
each stroke, and optionally microprocessor means to  
5 control the said rate of movement.

7. A hydraulically actuated bore or well pump  
according to claim 5 characterised in that the motor  
means to actuate the said driving pistons comprise  
barrels with pistons therein, means interconnect-  
5 ing the said pistons and connected to reciprocate the



12.

said driving pistons, and fluid supply means to alternately pressurise the said barrels of the said motor means.

8. A hydraulically actuated bore or well pump according to claim 6 characterised in that the said fluid supply means are hydraulic means.

9. A hydraulically actuated bore or well pump according to claim 6 characterised in that the said fluid supply means are pneumatic means.

10. A hydraulically actuated bore or well pump according to claim 5 wherein the means to actuate the said driving pistons comprise a crank adapted to be driven by motor means and a rod connecting the said crank to a rod interconnecting the said driving pistons.

11. A hydraulically operated bore or well pump comprising a double-acting driving unit at a bore or well head and a pump adapted to be submerged in the liquid in the said bore or well having a double-acting slave unit, a line interconnecting one side of the said driving unit with one side of the said slave unit, a second line connecting the other side of the said driving unit with the other side of the said slave unit whereby reciprocation of the said driving unit causes reciprocation of the said slave unit to have a pumping stroke and a return stroke, one of said lines being a delivery line, a pumping piston in a barrel coupled to reciprocate with the said slave unit and communicating also with the said delivery line, and valve means in the said delivery line to open the said delivery line to an outlet on a pumping stroke but close the said outlet of the said delivery line on the return stroke.



13.

12. A hydraulically operated bore or well pump according to claim 8 characterised in that the said driving unit comprises a pair of barrels coaxially arranged, a pair of pistons in the said barrels to move similarly, the said lines being connected to the said barrels, further characterised in that the said slave unit comprises a barrel with a piston therein, the said lines being connected one to one side of the said barrel and the other to the other side of the said barrel further characterised in that the said pump comprises a barrel coaxial with the said barrel of the slave unit, a piston in the said coaxial barrel connected by a hollow rod opening through each piston and having port means therethrough at the said pump piston, and a non-return valve in the said pump piston.

13. A hydraulically operating bore or well pump according to claim 12 characterised by means to generate fluid pressure, connecting means to connect the said fluid pressure means to supply fluid pressure to said driving unit, solenoid control means in said connecting means, and means to actuate the said solenoid control means to reciprocate the said pistons of the said driving unit.

14. A hydraulically operated bore or well pump constructed and operating substantially as described and illustrated.



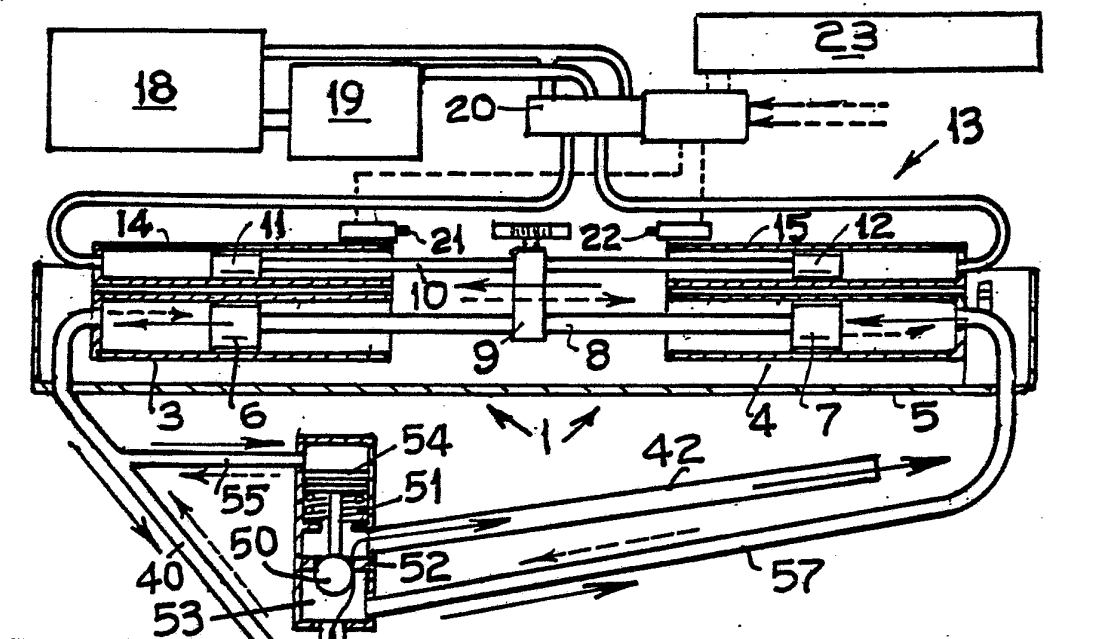


**FIG. 1**

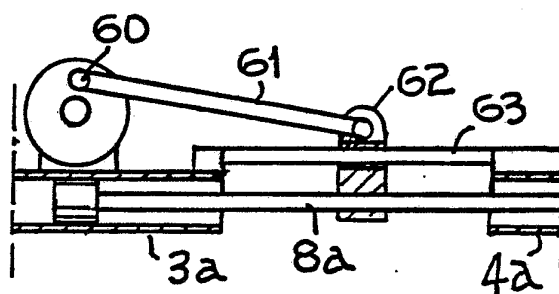
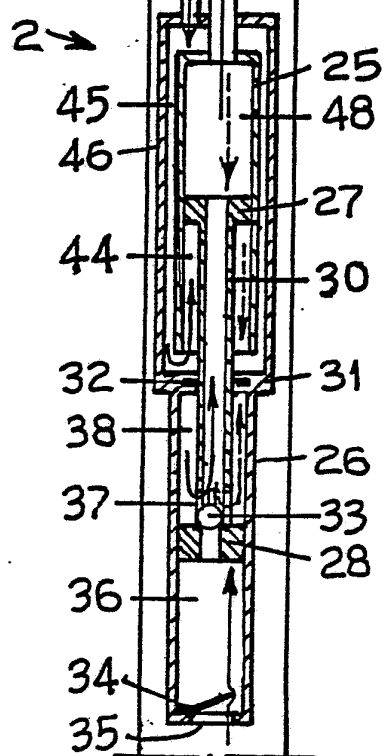


**FIG. 2**

# INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 83/00124

| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup><br>According to International Patent Classification (IPC) or to both National Classification and IPC<br>Int. Cl. <sup>3</sup> F04B 47/04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------|--|---|-----------------------------------------------------------------------------------------|--|---|------------------------------------------------------------|--|
| <b>II. FIELDS SEARCHED</b><br><div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched <sup>4</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">IPC<br/>US Cl.</td> <td style="padding: 5px;">F04B 47/04<br/>417/56, 166/68.5</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>5</sup></div> <p style="padding: 5px;">AU: IPC as above; Australian Classification 68.5</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                |                                     | Classification System                                                                                 | Classification Symbols                                                                                         | IPC<br>US Cl.                                                              | F04B 47/04<br>417/56, 166/68.5                                                |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| Classification System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Classification Symbols                                                                                         |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| IPC<br>US Cl.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | F04B 47/04<br>417/56, 166/68.5                                                                                 |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category <sup>*</sup></th> <th style="width: 70%; border-bottom: 1px solid black;">Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup></th> <th style="width: 20%; border-bottom: 1px solid black;">Relevant to Claim No. <sup>18</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A,P</td> <td style="padding: 5px;">WO, A, 83/02805 (NAESS) 18 August 1983 (18.08.83)</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">AU, B, 23857/77 (508931) (JBFN DEVELOPMENT (PROPRIETARY) LTD) 5 October 1978 (05.10.78)</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">AU, B, 50557/59 (239991) (STAER) 2 January 1961 (02.01.61)</td> <td></td> </tr> </tbody> </table>                                                                                                                                                                                                                                                                                                                         |                                                                                                                |                                     | Category <sup>*</sup>                                                                                 | Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup> | Relevant to Claim No. <sup>18</sup>                                        | A,P                                                                           | WO, A, 83/02805 (NAESS) 18 August 1983 (18.08.83) |  | A | AU, B, 23857/77 (508931) (JBFN DEVELOPMENT (PROPRIETARY) LTD) 5 October 1978 (05.10.78) |  | A | AU, B, 50557/59 (239991) (STAER) 2 January 1961 (02.01.61) |  |
| Category <sup>*</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup> | Relevant to Claim No. <sup>18</sup> |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| A,P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | WO, A, 83/02805 (NAESS) 18 August 1983 (18.08.83)                                                              |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | AU, B, 23857/77 (508931) (JBFN DEVELOPMENT (PROPRIETARY) LTD) 5 October 1978 (05.10.78)                        |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | AU, B, 50557/59 (239991) (STAER) 2 January 1961 (02.01.61)                                                     |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents: <sup>16</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> </div> <div style="width: 45%;"> <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>"G" document member of the same patent family</p> </div> </div> |                                                                                                                |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| <b>IV. CERTIFICATION</b> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">           Date of the Actual Completion of the International Search <sup>1</sup><br/>           15 November 1983 (15.11.83)         </td> <td style="width: 50%; padding: 5px;">           Date of Mailing of this International Search Report <sup>2</sup><br/>           16 November 1983 (16-11-83)         </td> </tr> <tr> <td style="padding: 5px;">           International Searching Authority <sup>1</sup><br/>           Australian Patent Office         </td> <td style="padding: 5px;">           Signature of Authorized Officer <sup>19</sup><br/>           A.S. Moore <i>A.A. Moore</i> </td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                |                                     | Date of the Actual Completion of the International Search <sup>1</sup><br>15 November 1983 (15.11.83) | Date of Mailing of this International Search Report <sup>2</sup><br>16 November 1983 (16-11-83)                | International Searching Authority <sup>1</sup><br>Australian Patent Office | Signature of Authorized Officer <sup>19</sup><br>A.S. Moore <i>A.A. Moore</i> |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| Date of the Actual Completion of the International Search <sup>1</sup><br>15 November 1983 (15.11.83)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Date of Mailing of this International Search Report <sup>2</sup><br>16 November 1983 (16-11-83)                |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |
| International Searching Authority <sup>1</sup><br>Australian Patent Office                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Signature of Authorized Officer <sup>19</sup><br>A.S. Moore <i>A.A. Moore</i>                                  |                                     |                                                                                                       |                                                                                                                |                                                                            |                                                                               |                                                   |  |   |                                                                                         |  |   |                                                            |  |