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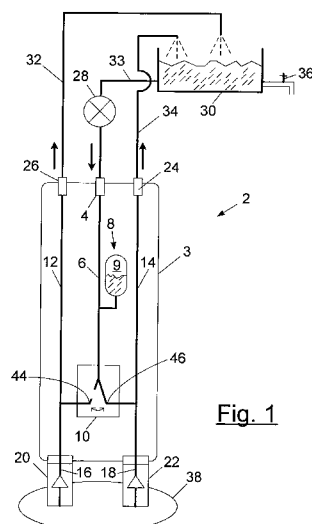


Fig. 1

(57) Abstract: A pump (2) for raising a fluid (38), such as bore water, includes: a fluid inlet (4) for a supply fluid source (30), e.g. pumped water. A first riser pipe (12) and a second riser pipe (14) having respective inlets (44, 46) for the supply fluid source; a diverter valve (10) to place the supply fluid source (30) in communication with either the first riser pipe (12) or the second riser pipe (14); and respective unidirectional inlets (20, 22) in communication with the first riser pipe and the second riser pipe for ingress of the fluid to be raised, wherein the diverter valve (10) operates in response to flow rate through at least one of the first riser pipe (12) and the second riser pipe (14).

A FLUID DRIVEN PUMP

TECHNICAL FIELD

The invention relates to fluid pumping and to a pump that is suitable for raising fluids,
5 such as water from bores or the like.

BACKGROUND

Windmills have been used throughout rural areas of Australia for over seventy years to
drive pumps for raising water from deep bores or wells. However, it is now becoming
10 impossible to maintain these windmill driven pumps due to a lack of spare parts and
the man power required to carry out repairs.

As an alternative to windmill powered pumping stations, solar pumps have been
sometimes used. However, the photovoltaic solar panels that are required are very
15 expensive because their fabrication requires the use of very high grade silicon and they
are in great demand globally.

Submersible electric motor drive pumps have also been used. However, such pumps
are very expensive, being many times the cost of a surface pump of similar size. Cost
20 is also incurred in installing submersible electric pumps into deep bores as down hole
cabling and submersible cable splices are required. Furthermore, in remote locations
where no mains power is available, an engine powered generator must be provided
which is wasteful since it entails firstly converting mechanical energy to electrical
energy, by means of the generator, and then back to mechanical energy, by means of
25 the pump.

Shaft drive pumps are more efficient but again expensive, only suitable for well cased
straight bore holes and have lots of moving parts so that they cannot be moved from
bore to bore.

30 Air pumps are very simple and inexpensive but are extremely inefficient at depth and
the expense of the system is greatly increased when the cost of the air compressor is
considered. It may be possible to reduce these costs by using multiple pumps on a
single compressor and running poly air lines between bores.

- A venturi jet pump presents itself as a more suitable alternative to those pumps discussed above. However, the venturis system cannot be readily adapted for powering from a windmill and is limited to an operational depth of 50 meters.
- 5 Furthermore, the venturi is intolerant to sand or grit and requires a specially adapted supply water pump which adds to its cost and reduces flexibility. Moreover, venturi pumps are inefficient since they use up to five times the energy to run them as a comparable capacity submersible pump.
- 10 It would be desirable if an alternative pump for raising water from bores was provided that overcomes the problems discussed above.

SUMMARY OF THE INVENTION

- According to a first aspect of the present invention there is provided a pump for raising
- 15 a fluid including:
- a fluid inlet for a supply fluid source;
 - a first riser pipe and a second riser pipe having respective inlets for the supply fluid source;
 - a diverter valve to place the supply fluid source in communication with either the
 - 20 first riser pipe or the second riser pipe; and
 - respective unidirectional inlets in communication with the first riser pipe and the second riser pipe for ingress of the fluid to be raised.
 - wherein the diverter valve operates in response to flow rate through at least one of the first riser pipe and the second riser pipe.

- 25 Preferably the pump includes an accumulator for reducing a fluid hammer during operation of the pump.

- In a preferred embodiment the pump includes a housing and the accumulator
- 30 comprises a gas space at the top of the housing.

Preferably the diverter valve includes a paddle that is arranged to alternately seal opposing orifices in communication with the first riser pipe and the second riser pipe respectively.

In the preferred embodiment, the paddle slides on at least one runner between the opposing orifices.

- 5 A drainage valve or plug may be fitted to the housing and arranged for remote operation prior to uninstalling the pump.

In some embodiment the pump may include a diaphragm to prevent the gas space being dissolved.

10

Preferably the drainage valve or plug is arranged to operate in response to a high diversion pressure spike to thereby release pressure in the pump.

The may include a gas inlet for replenishing the accumulator.

15

In one embodiment of the invention the paddle is elongated and seals multiple opposing orifices in communication with the first and second riser pipes.

20 The orifices may be formed through flanges fast with said first and second riser pipes wherein the paddle slides on runners located about fasteners, such as bolts, between the flanges.

In the preferred embodiment the respective unidirectional inlets comprise check valves.

25

Strainers may be included to prevent debris and the like entering the unidirectional inlets.

Preferably the orifices are surrounded by sealing rings to seal with the paddle.

30

Further embodiments, preferred features and variations will be apparent from the following Detailed Description which will make reference to a number of drawings as follows. Throughout the drawings common item numbers are used to refer to like components.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of a pump according to an embodiment of the present invention shown installed.

5 Figure 2 is a perspective view of the exterior of a preferred embodiment of a pump according to the present invention.

Figure 3 is a partial view of the pump of Figure 2 showing internal piping.

Figure 4 is an exploded view of a portion of the pump of Figure 2.

Figure 5 is an assembly view of the portion of the pump of Figure 4.

10 Figure 6 is a somewhat schematic view of the internal layout of the pump of Figure 2 during a first state of operation.

Figure 7 is similar to Figure 6 but in a second state of operation of the pump.

Figure 8 depicts a cross section through the pump.

Figure 9 is a diagram depicting the pump of Figure 2 in use.

15 Figure 10 is a diagram similar to Figure 8 of a further embodiment of a pump according to the present invention.

DETAILED DESCRIPTION

Referring now to Figure 1, there is depicted a schematic diagram of a pump 2 according to a preferred embodiment of the present invention in use. The invention will be explained in the context of pumping water (wherein embodiments of it are often referred to herein as a "hydro pump"), however it may be applied to pumping other fluids as well. In one application, the pump may also be used for pumping water from coal seams to retrieve coal gas (Methane) liquefied natural gas.

25

The pump 2 includes a housing 3 having a fluid inlet port 4 that is connected to a water inlet pipe 6. The fluid inlet port 4 is for conveying fluid from a supply source such as reservoir 30. The supply source water is pumped by supply pump 28 which may be an electric pump for example. An accumulator 8, is provided in communication with the water inlet pipe. The accumulator contains air 9, or other compressible fluid, to smooth out water shocks that are generated during operation of the pump 2 as will be explained. A diverter valve 10 splits the flow of water from the inlet pipe 6 so that it is connected to either supply fluid inlet 44 of first riser pipe 12 or supply fluid inlet 46 of second riser pipe 14. Each riser pipe is in fluid communication with a respective first

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harvester pipe 16 and a second harvester pipe 18. The riser pipes terminate at their upper ends on respective outlet ports 24 and 26. Each harvester pipe terminates at its lower end in a unidirectional inlet in the form of respective one way check valves 20, 22. The lower end of each harvester pipe is submerged in bore water 38. The inlet
5 ports 24 and outlet ports 24, 26 are typically simply portions of pipes 12, 6 and 14.

External to the pump 2, and preferably located at the surface adjacent the top of the bore, is a supply pump 28 that is arranged to pump water from a reservoir 30 into inlet port 4 and so into inlet pipe 6. Outlet ports 26 and 24 are connected to respective
10 reservoir riser pipes 32 and 34 which empty into reservoir 30. A spigot 36 on the side of reservoir 30 is provided to conveniently draw off the raised bore water.

Initially, the diverter valve 10 assumes a first configuration so that riser pipe 12 and inlet pipe 6 are in fluid communication. Supply pump 28 forces water through the
15 inlet pipe 6 and up riser pipe 12, through riser reservoir pipe 32 and into reservoir 30. Upon the flow of water having been accelerated sufficiently, the diverter valve 10 switches riser 12 out of communication with inlet pipe 6 and instead into communication with riser pipe 14. As this occurs, the moving water in first riser pipe 12, which has an inertia, continues upward thereby drawing bore water 38 through
20 check valve 20 so that the bore water is moved up riser reservoir pipe 32 and into reservoir 30.

Meanwhile, the water in the second riser pipe 14 is accelerated by virtue of its connection, via diverter valve 10 to supply pump 28. Once sufficient acceleration of
25 the water is achieved the diverter valve 10 switches back to its previous position. Consequently, the upwardly moving water in the second riser 14, and the second riser reservoir pipe 34, draws bore water 38 up through check valve 22 and ultimately out into the reservoir 30.

30 The accumulator 8 serves to smooth water hammers generated by the sudden switching of diverter valve 10. While the accumulator 8 is not necessarily essential to the operation of pump 2, it increases its efficiency and reduces wear of the pump 2.

Figures 2 to 5 are views of a physical implementation of the preferred embodiment of the pump.

Figure 1 are indicated with like reference numerals, there It will be noted that the housing 3 constitutes a cylinder that terminates at its lower end in a socket 60. The socket 60 receives a sealing plate 56 that is held in place by sealing ring 54 which is threaded to engage with the socket. First and second harvester pipes 16, 18 are fitted through the sealing plate 56. Located within housing 3 are first and second tubular T-pieces 58, 59. Cross tubes 62, 64 of each T-piece 58, 59 are connected between a top end of respective first and second riser pipes 12, 14 and a lower end of first and second riser pipes 12 and 14. Extending at right angles from each cross tube 62, 64 are stem tubes (not clearly visible) in fluid communication with the cross tubes 62 and 64. The stem tubes terminate outwardly in orifices 44 and 46 which are surrounded by respective flanges 40, 42.

15

A narrow, slightly raised sealing ring 41 is located around each orifice

A diverter paddle 50 is arranged to slide between T-pieces 58 and 59 thereby alternatively sealing orifices 44 and 46 as will be described in more detail shortly.

20

Further explanation of the operation of the pump 2, will now be described with reference to Figures 6 to 9

With reference to Figure 6, the paddle 50 which in the presently described embodiment comprises the diverter valve of Figure 1, is located between the flanges 42, 40 and runs on slide tubes 53 that are located about flange bolts that pass through the bolt holes 48. The slide tubes 53 have a wider diameter than the flange bolt holes 48 so that as the flange bolts are tightened, the slide tubes 53 hold the opposing flanges 40 and 42 a set distance apart that is somewhat wider than the width of the paddle 50. Accordingly, the paddle 50 can be slid on the slide tubes from a first position, (visible in Figure 3), wherein paddle 50 abuts flange 40 and seals with sealing ring to a second position (visible in Figure 4), wherein it abuts flange 42 and seals with respective sealing ring 41.

It is important that as much of the paddle's area as possible, on both sides, is exposed to the pressure inside the pump. A circular raised section on either side of the paddle, slightly larger than the flange orifice, may be used to assist in achieving this objective.

5

The operation of the pump will now be explained with reference to Figures 6, 7 and 9 and assuming that initially the paddle 50 is resting against flange 40 as shown in Figure 6. Upon starting pump 28, water begins to flow down inlet pipe 6 into housing 3, through orifice 46 and up riser pipe 14, since it cannot escape through one way valve 22. The narrow gap between paddle 50 and flange 42 causes the water to increase its velocity. The increased velocity creates a low pressure area between paddle 50 and flange 42. Furthermore, a large part of the area of the paddle on the flange 40 side, outside of the raised sealing ring on flange 40, is exposed to the pump's internal ambient pressure so that only the relatively small area of the orifice 44 of Flange 40 acts to maintain the paddle 50 against flange 40.

When the water is travelling sufficiently fast the lower pressure area between paddle 50 and flange 42 causes the paddle 50 to slide across so that it seals orifice 46 of flange 42 thereby blocking the flow of water from inlet 6 up riser pipe 15 as shown in Figure 7. The water rising in riser pipe 14 has by now developed considerable inertia so that it continues to rise thereby causing the non return check valve 22 to open and draw up bore water until the inertia in the rising water is overcome.

Meanwhile, upon the paddle 50 sealing orifice 46 of flange 42, the water from the inlet pipe 6 begins to enter orifice 44 of flange 40 and pass up through riser 12. The sudden diversion of water from one riser to the other would cause a large hammer effect were it not for the air trapped in the top of housing 3 above waterline 66, which acts as an accumulator 8 that absorbs the shock associated with the diversion until the water in riser 12 starts to move. Once the water in riser 12 is moving sufficiently quickly, and the water in riser 14 sufficiently slowly, the low pressure area in between flange 40 and the paddle 50 increases to the point where the paddle 50 is drawn back to seal with flange 40 thereby blocking the flow to riser 12, as shown in Figure 6, from which point the cycle repeats.

The more powerful the supply water pump, the quicker it will be able to accelerate the flow, and consequently the stored inertia, up to the point where the harvest occurs. The air pressure accumulator in the top of the hydro pump has an important role to play here, storing the inertia energy of the water coming down the supply water line gently raising the pressure in the pump and applying it to the riser pipe flow. Delivering this power, that is rapidly raising the flow rate, will be a function of pressure. The supply pump will have to deliver high pressure for fast acceleration of flow. But a very weak low pressure pump will still be able to pump water from great depths as long as its maximum flow against the friction loss of the loop is greater than the diversion flow rate.

Since 2000 the inventor has observed the decommissioning of many windmills in rural Australia. Usually the windmill tower and often the head of the mill are in good condition. For every mill being replaced with solar, there are two or more being replaced with fossil fuelled engines or electricity. These are often big systems and the capital cost of replacing them with solar is beyond the means of the property owner.

The reason they are being replaced is usually because of failures in the column, rods and pumps down the bore hole. It is no longer possible to purchase windmill column and we have been told repeatedly the galvanised piping used on the smaller mills, when replaced, fails in a fraction of the time of the old piping. Apparently the quality needed to withstand the rigors of pumping artesian water is no longer there.

Pulling the pump up, particularly on a deep mill, is a time consuming, heavy, difficult, and dangerous exercise requiring many hands. Now days these large cattle properties only have one or two people running them and they hire in people for musters etc.

When the wind is insufficient to pump the required volumes of water a Pump Jack is often used. This means disconnecting the mill rod from the pump, at ground level, and dragging in an engine powered contraption to drive the pump rod up and down. These machines are also difficult and dangerous. The pump jack is universally hated by the people working these properties and is a major contributor to the demise of the windmill.

On the other side of the equation the windmill has the ability to pump 24hours a day, are enormously powerful and they are there. These machines have a lot of embodied energy and to simply destroy them is a huge waste. To replace them with anything no matter how green, is going to have a carbon impact.

5

In a lot of areas around Australia the wind mills do a great job. It is not uncommon for these large properties to have 50 mills. The amount of greenhouse emissions these machines have saved over the past 70 years is incomprehensible.

- 10 The fluid (or as it is sometimes called in the context of pumping water “hydro”) pump described herein not only has the potential to save a lot of these old towers, it could revive the use of wind power to pump water. Using the windmill to drive a surface pump as the supply water pump, means no column and rod down the hole. An ordinary fire fighter pump could be used as backup. Pump Jacks would no longer be needed.

15

Efficiencies are less an issue, as with solar, because of the power available and the fact the pumps that they were originally designed to run, only pumped for less than half of each rotation of the drive.

- 20 One major engineering difficulty with windmills is because of the low and varying revs per minute they have to use positive displacement pumps. This means that after coming to a standstill they must pump against the total head of the system in order to get started. A significant gust of wind is therefore needed to get them moving.

- 25 With the use of a hydro pumping system, the supply water pump will have no head on start, only the weight of water in the loop. The constant pressure of a light breeze will eventually set the water loop in motion. A double action siphon pump normally used on windmills to pump from dams would be ideal. They are an old simple reliable proven technology that most property owners have dealt with and understand. These
30 pumps would need to be fitted with a pressure relief valve on the supply water line back to the suction line or tank, so the windmill can not over pressure the system in high wind.

Using a vertical axis wind turbines has been tried in the past without much success because they still required long lengths of column and rod. They used helical rotor positive displacement pumps down the hole so also had starting problems. The restrictive confines of the bore meant the pumps were not really big enough for most applications.

A Vertical axis wind turbine coupled to a hydro pumping system would have none of these problems. Using a centrifugal above ground means the diameter can be as wide as it needs to be to get high peripheral speed on the impeller illuminating gear boxes. A pressure relief would not be required because of the centrifugals ability to bypass internally.

It is important to remember here the hydro pump does not need high pressure all the supply water pump has to do is cause water to flow in a loop.

That would mean no crank shafts, fans, turning assemblies, tails, column, rod, or draw plunger. Vertical axis turbines also have the ability to work well in blustery conditions where the wind continually changes direction.

A windmill powered hydro pumping system combination would be a great innovation not least because of the way they work compliments one another.

Pumping from deep bores with solar is usually done with a positive displacement submersible pump helical rotor (progressive cavity pumps). This can present major problems on some sites as the water is often hot, corrosive or saline. Also there are problems with chemical action causing pump rotors to stick or become tight and electrolysis attacking the metals used.

Often the bore casings are old and rusty and a large part of the owner's investment is many meters down these old casings. For the same reason it is not possible or at least not advisable to use these pumps in creeks or rivers because of the possibility of loss in the next flood.

Due to the excessive cost of solar panels the efficiency of the pumping system is paramount.

So:

- Venturi (jet pumps about 15% efficient max head 50mtr)
- 5 ➤ Conventional 240volt centrifugal pumps 30% electrical to water
- Air pumps (compressed air powered air/water displacement pumps are even less efficient and get worse as they go deeper)
- Column and rod pumps (traditional windmill type pumps spend a large proportion of there rotation pumping very little water so some form of energy
- 10 storage has to be used to get gains in efficiency)

None of these are financially viable in deep well applications because of the cost of the solar panels to run them.

15 An efficient DC foot mount motor driven pump directly connected to a solar array via a maximum power point tracker would be significantly less expensive than a solar submersible.

Also down the hole cabling and submersible splicing kits would not be required. These savings could purchase additional solar power to cover for the losses in efficiency

20 using a hydro pump.

A pump like this on the surface driving a hydro pump could be a viable option particularly on difficult sites as described above.

25 In a typical domestic water supply situation where the ground water is over 7 meters deep venturi pumps are often used with a pressure tank and switch to provide water for the home without the need of a storage tank or a second pump. These systems sense pressure and turn on when pressure is low and off when high causing pressure and flow to continually surge this is particularly noticeable and annoying when showering.

30

All home pressure systems used to operate in this way the only alternative was a header tank on a high stand to provide constant pressure. They are expensive and ugly.

However now there are constant flow pressure pumps available that provide high flow and a constant pressure. These are in fact old style large bodied centrifugal pumps. They could not be used on pressure systems in the past as there pressure varied very little from low to high flow, making it impossible to control them using a pressure switch.

The new innovation is an electronic device that enables them to be controlled. So now if you have a small tank on the ground you can have continuous constant water flow.

For those with water below 7 meters deep they also need a pump, venturi or submersible, to lift the water to the tank.

By coupling a hydro pump to a continuous flow pump the same goal can be achieved with the purchase of only one pump. A hand valve could be used to divert the water to the hydro pump when the tank needed filling or a float switch and solenoid could be used for automatic operation.

A balance valve in circuit would insure there was always enough water for the home if a tap was turned on when the tank was filling.

If the application was just water for the garden, a small vessel could be plumbed to the hydro pumping system, similar to the old pressure tanks in size but not needing to be a pressure vessel. A valve could be set to ensure harvest water was sufficient to keep the tank full. Any overflow could be returned to the bore.

The hydro pump would represent a considerable saving for the home owner in either of these situations.

A pump according to the present invention could be made of numerous different materials. Stainless steel and brass or plastic could be used particularly on corrosive water sites to ensure as long a service life as possible.

The air accumulator plays a very important role in harnessing the considerable energy of the downward flowing water immediately the diversion occurs. The pressure rise

in a water hammer situation i.e. no accumulator, could spike to a pressure equal to the pressure in the pump squared. Engineering for this type of impact, while possible, will incur considerable expense. So the accumulator should be considered a safety device against the destructive force of the hammer effect as well as a means to improve efficiency. For this reason the pump design proposed has the three pipes penetrating the top of the housing welded together as one piece eliminating the possibility of leaks. All access to the inner workings of the pump is through the bottom. The air trap in the top of the pump will probably be self replenishing as small amounts of air that are dissolved in the water often bubble out when the water is pumped. Once the area above the end of the supply water inlet pipe is full any extra air will find its way up the supply water pipe when the pump is turned off. An air bleed valve at the top of the pipe would discharge it to atmosphere the next time the pump is started.

It will be only through trialling the pump in different situations over time that it will be known if this air is likely to be depleted in some way, perhaps by being dissolved in the water or pumped out due to turbulence within the pump. Measures like sponges or diaphragms may need to be adopted on some sites.

Figure 10, which is similar to the view of Figure 8 illustrates a further variation of the pump including a diaphragm 68 to protect the gas space above it.

In any event, simplicity is of the utmost importance particularly when dealing with a device tens of meters down a bore hole in a remote location. If it proves to be a possibility over time that the air will be depleted, a maintenance regime may need to be put in place, where say once a year the pump drain valve (shown as item 70 in Figure 10) be opened by pulling line 74, the pump may then be lifted clear of the bore water so it is emptied then the system refilled. This will trap a fresh volume of air.

If this is the case, it may be advisable to incorporate a weakness into the pump or drain valve 20, so that in the event the air got too low and the diversion pressure spikes too high, an easily replaceable or reset able form of drain valve 20 would open thereby preventing major damage to the system.

Deeper and faster flowing systems will require larger accumulators. It may be that very deep systems have accumulators two or three meters long. As stated earlier a 40mtr system could weigh 300 kilograms so buoyancy will not be a problem.

- 5 It may be advantageous to have a small air line from the top down to the hydraulic pump on deep systems so extra air can be pumped in through a gas inlet 72 (Figure 10). When the pump on a deep system is filled, the pressure of the head of water above the pump will cause the air to be squeezed up in to the very top of the pump. This would leave room for more pressurised air to be forced in to fill the whole section
10 above the end of the supply water inlet. This larger air capacity will improve the anti hammer characteristics of an accumulator of a given size.

- A pressure gauge on this air line would also enable monitoring of the pressure rises and falls in the pump when pumping. This air inlet 72 would need to be welded into
15 the top of the pump with a tube 76 (Figure 10) down inside similar to the supply water inlet so in the event of a leak no air escapes from the pump.

- Also slotting or using multiple flange orifices with an elongated paddle could provide a means of increasing flow rates within the confines of a bore hole. In the embodiment
20 of Figure 10, an elongated flange 44 and paddle 53 is used, with three orifices 41 formed through the flange 40 and in communication with riser 12. Opposing orifices are similarly formed through flange 42 (not shown in Figure 10) in communication with the second riser pipe 14.

- 25 It may be advantageous to manufacture the diverter assemblies out of cast and or machined and drilled blocks of material rather than the flange and tee piece arrangement proposed here.

- In some pump applications having the two riser pipe check valves incorporated in this
30 assembly rather than screwed on externally might be more cost effective.

In well or river applications the pump can be made as big as it needs to be to minimise friction loss and attain the desired flow rates.

In river situations making the pump L or C shaped could have advantages. The pump could then be laid on the river bed parallel to the river's flow. These shapes would present a much smaller profile to the current in times of flood reducing the possibility of being swept away by the water or a snag.

5

Often for prolonged periods of the year, Australian rivers continue to run or have vast amounts of water contained within them below a dry sandy riverbed. These sites are a pump installer's worst nightmare. There are many rivers throughout Australia at places like this where water is needed but they remain unequipped or the resource only partially exploited because of the inherent difficulties with these sites. Venturi pumps are sometimes used but there intolerance of sand and the often long piping distances required make them unsuitable for most applications.

A pump according to the present invention could be placed near the bank perhaps in a location on the inside of a river bend, where the possibility of getting hooked and dragged away by a fast moving snag is least. The pump could be made as strong as it needs to be in order to survive a flood or cattle traipsing all over it. If it was felt that the walls needed to be ten millimetres thick to achieve this, there is no reason why it could not be. This pump could be saddled to rock or to a large block of concrete. Two check valves and sand spears could then be buried in the sand below the minimum water level and plumbed to the pump via poly lines. Three poly lines could then be run to the supply water pump which if necessary could be several hundred meters away. Depending on flows and distances required this may mean the lines need to be very large 63 or even 75mm.

25

A system like this would provide a more reliable water supply than any other system on the market today. Often when these rivers are in flood, water is still required from them. A system like this would offer the best chance of a year round supply, whether the pump was under a raging torrent in a puddle or laying out in the blistering heat of a dry sandy creek bed.

30

If some poly or even the pump was to be swept away the cost of replacement would be minimal as compared to submersibles, floaters or transportable pumping systems.

- In situations where the bore has rusted and partially collapsed around ground water level as is usually the case. Smaller poly lines could be fitted to the bottom of the hydro pump extending down a few meters. This would enable the installer to lower the hydro pump to a safe point above the damaged casing and allow the smaller diameter poly lines to pass through into the water below. A heavy retrieval line would ensure that if the bore case did eventually collapse sufficiently to crush the poly lines and block flow, the pump could be retrieved by the use of brut force breaking the poly lines or fittings at the base of the pump.
- 10 While there are high pressures and stresses, wearing parts in a pump according to the present invention are minimal. Any difficulties likely to be encountered have been addressed in other devices. Since it is not a high tech device, parts replacement will not be difficult or expensive. A spare hydro pump would be a good idea on difficult and critical sites. Preferably, in use a strainer will be used in the suction line of the supply pump to prevent solids entering it or the hydro pump.

It is important to note the harvest water does not enter the hydro pump. Solids getting caught between the paddle and flange would reduce or stop any yield on that particular divert. The paddle and the flanges should be self cleaning to a certain degree but material getting caught under the sealing surfaces could damage the seal.

Since the system will require the check valves to operate at high frequency possibly greater than once a second they will need to be of a type that is designed for many millions of operations before replacement. The riser pipe intakes may be fitted with a strainer (e.g. item 78 in Figure 10) as recommended by the non return valve manufacturer to ensure maximum life of there seals. On the plus side the pulsing nature of the pumps harvest flows will help prevent these strainers becoming blocked.

The Hydro pump can be run dry with no ill effect. The supply pump will need some protection to stop this occurring though. Failure of one of the non return valves could result in loss of supply water back down the hole so on sites where this can not be allowed to happen the pump will need to have a separate vessel for the circulation of water that overflows into the main storage or a loss of prime switch on the riser pipes outlet.

The paddle may need to be replaced over time. Obviously the paddle and seal arrangement will need to be made of materials and designed so that many years of service can be expected.

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A wind powered system incorporating a pump according to the present invention will not require highly technical expertise or specialist plant infrastructure. They could be manufactured in the towns close to where they are being utilised. A lot of the materials could be recycled or better still re used. Since the logistics of say transporting a large vertical axis wind turbine will be expensive the construction of these devices in the region they are used will provide useful employment and a renewable energy industry in Australia that does not rely on imports.

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These systems could provide a reliable easy to maintain renewable water supply with arguably less environmental impact than a photo voltaic solar pumping system.

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In the present specification and claims, the word "comprising" and its related and derivative terms, including "comprises" and "comprise", are to be interpreted in an inclusive sense as including each of the stated integers but without excluding the inclusion of one or more further integers.

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In compliance with the statute, the invention has been described in language more or less specific to structural or methodical features. It is to be understood that the invention is not limited to specific features shown or described since the means herein described comprises preferred forms of putting the invention into effect.

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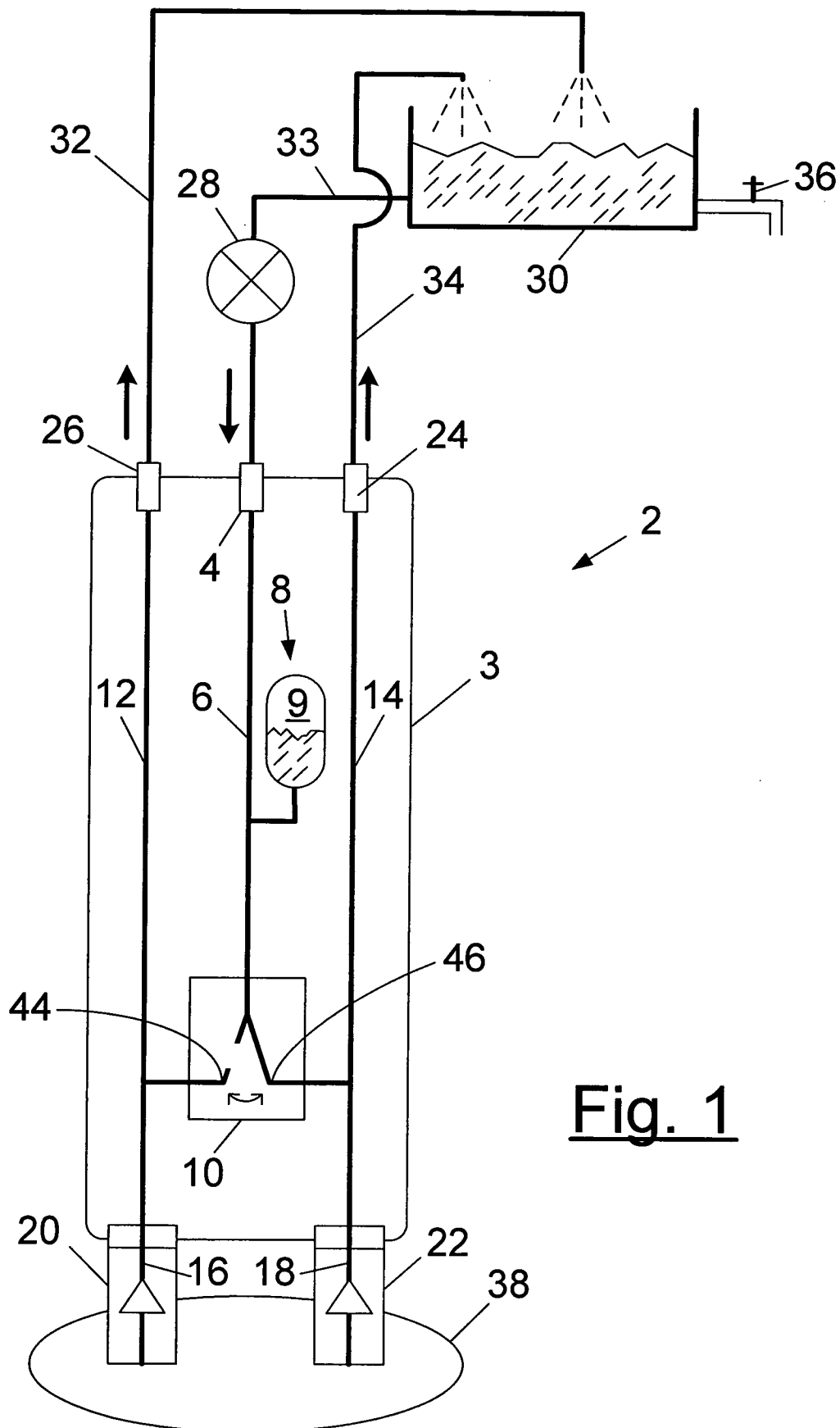
The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted by those skilled in the art.

Claims:

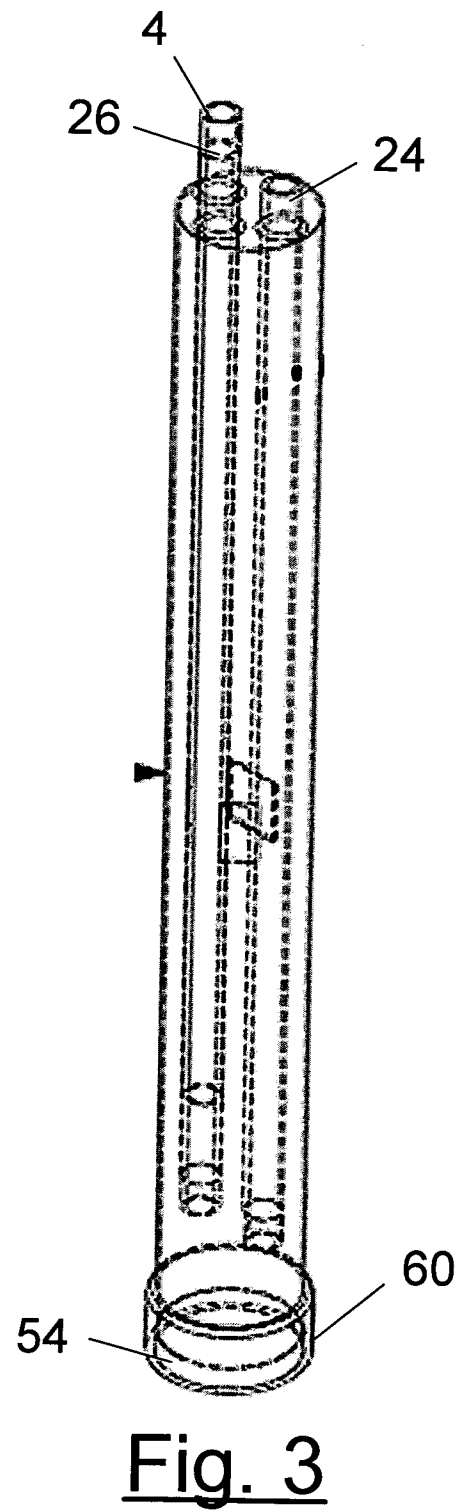
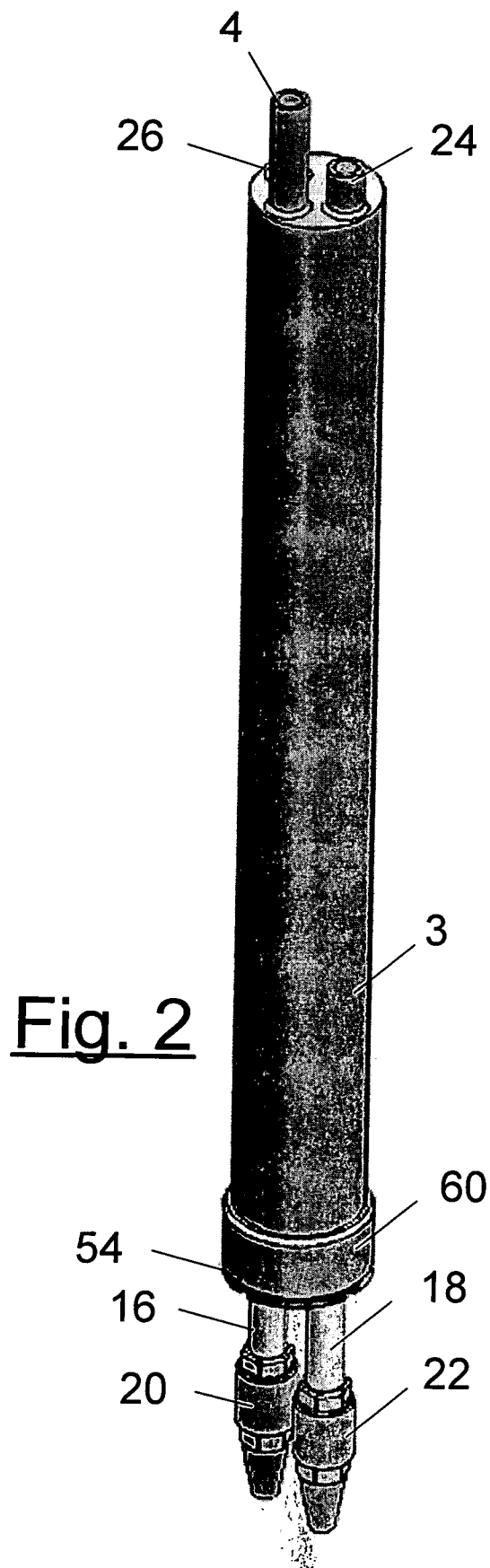
1. A pump for raising a fluid including:
 - a fluid inlet for a supply fluid source;
 - a first riser pipe and a second riser pipe having respective inlets for the supply fluid source;
 - a diverter valve to place the supply fluid source in communication with either the first riser pipe or the second riser pipe; and
 - respective unidirectional inlets in communication with the first riser pipe and the second riser pipe for ingress of the fluid to be raised.wherein the diverter valve operates in response to flow rate through at least one of the first riser pipe and the second riser pipe.
2. A pump according to claim 1, including:
 - an accumulator for reducing a fluid hammer during operation of the pump.
3. A pump according to claim 2, wherein the pump includes a housing and wherein the accumulator comprises a gas space at the top of the housing.
4. A pump according to any one of the previous claims wherein the diverter valve includes a paddle that is arranged to alternately seal opposing orifices in communication with the first riser pipe and the second riser pipe respectively.
5. A pump according to claim 5, wherein the paddle slides on at least one runner between the opposing orifices.
6. A pump according to claim 3, wherein a drainage valve or plug is fitted to the housing arranged for remote operation prior to uninstalling the pump.
7. A pump according to claim 3, including a diaphragm to prevent the gas space being dissolved.

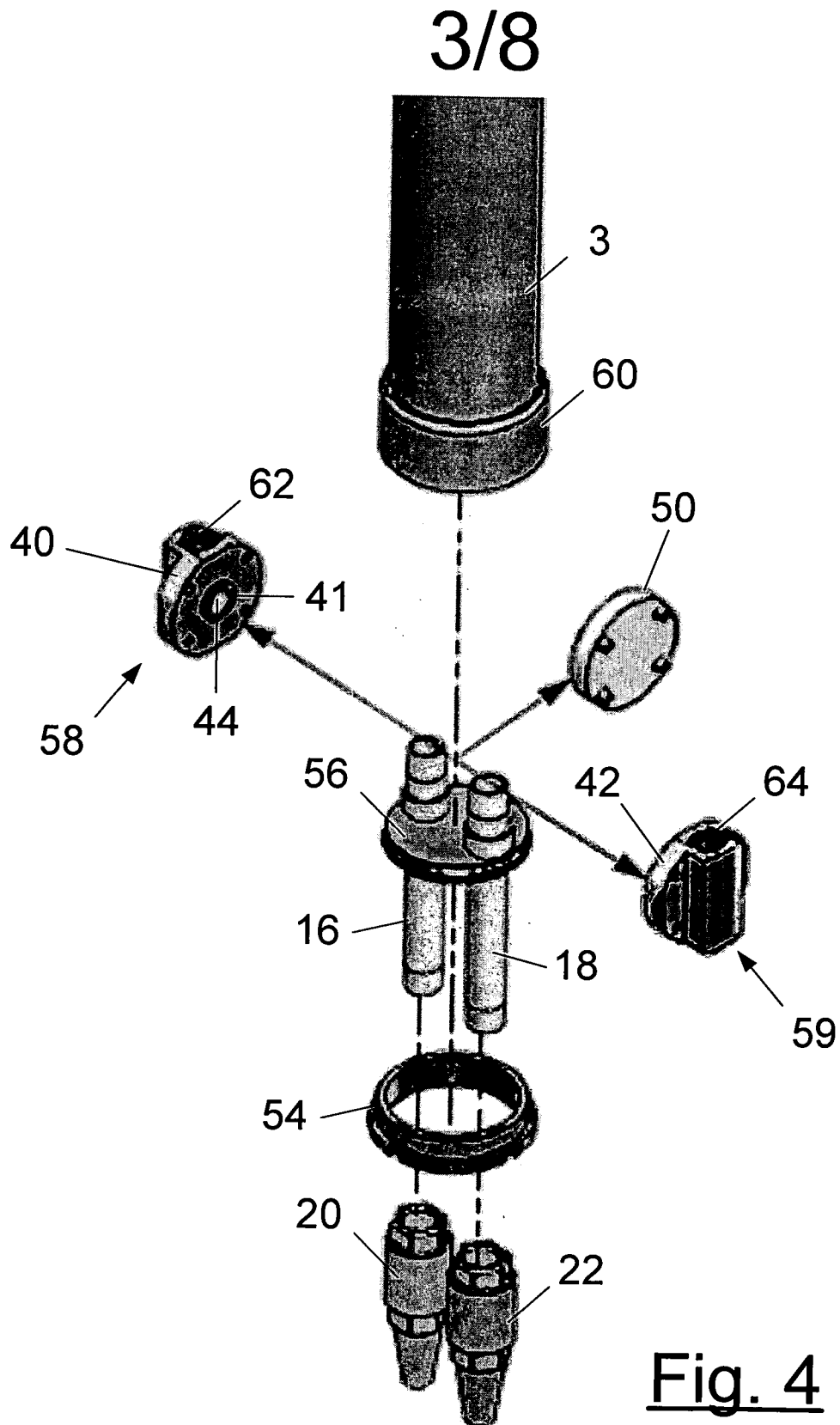
8. A pump according to claim 6, wherein the drainage valve or plug is arranged to operate in response to a high diversion pressure spike to thereby release pressure in the pump.
9. A pump according to anyone of claims 3, 6, 7, 8 including a gas inlet for replenishing the accumulator.
10. A pump according to claim 4, wherein the paddle is elongated and seals multiple opposing orifices in communication with the first and second riser pipes.
11. A pump according to claim 4, or claim 10, wherein said orifices are formed through flanges fast with said first and second riser pipes and wherein the paddle slides on runners located about fasteners, such as bolts, between the flanges.
12. A pump according to any one of claims 3, and 6 to 11, wherein the respective unidirectional inlets comprise check valves.
13. A pump according to any one of the preceding claims including strainers to prevent debris and the like entering the unidirectional inlets.
14. A pump according to any one of claims 4, 10, 11 wherein the orifices are surrounded by sealing rings to seal with the paddle.

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Fig. 1

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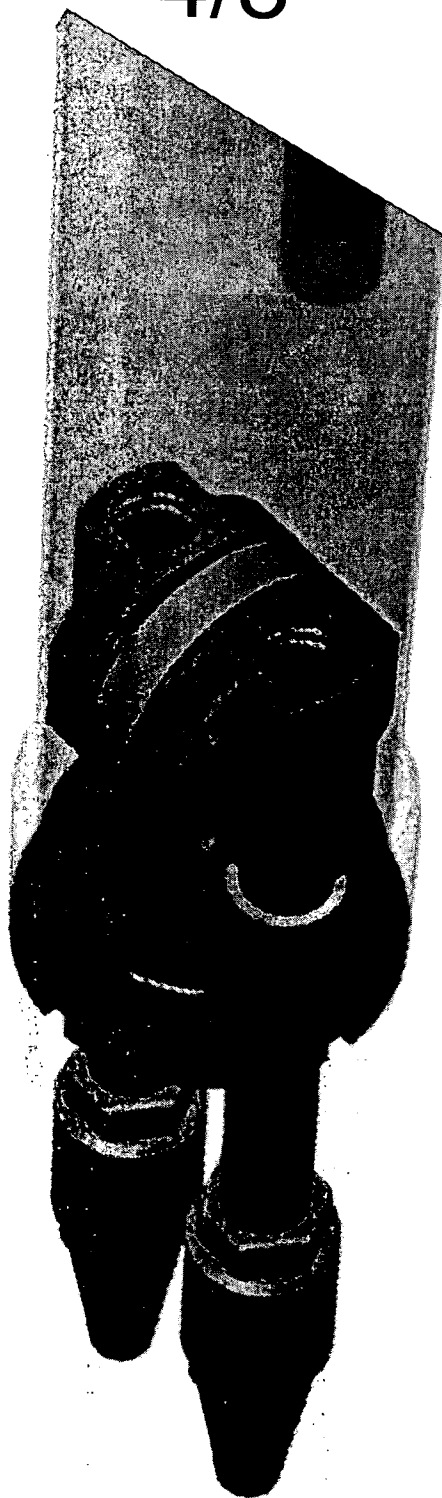


Fig. 5

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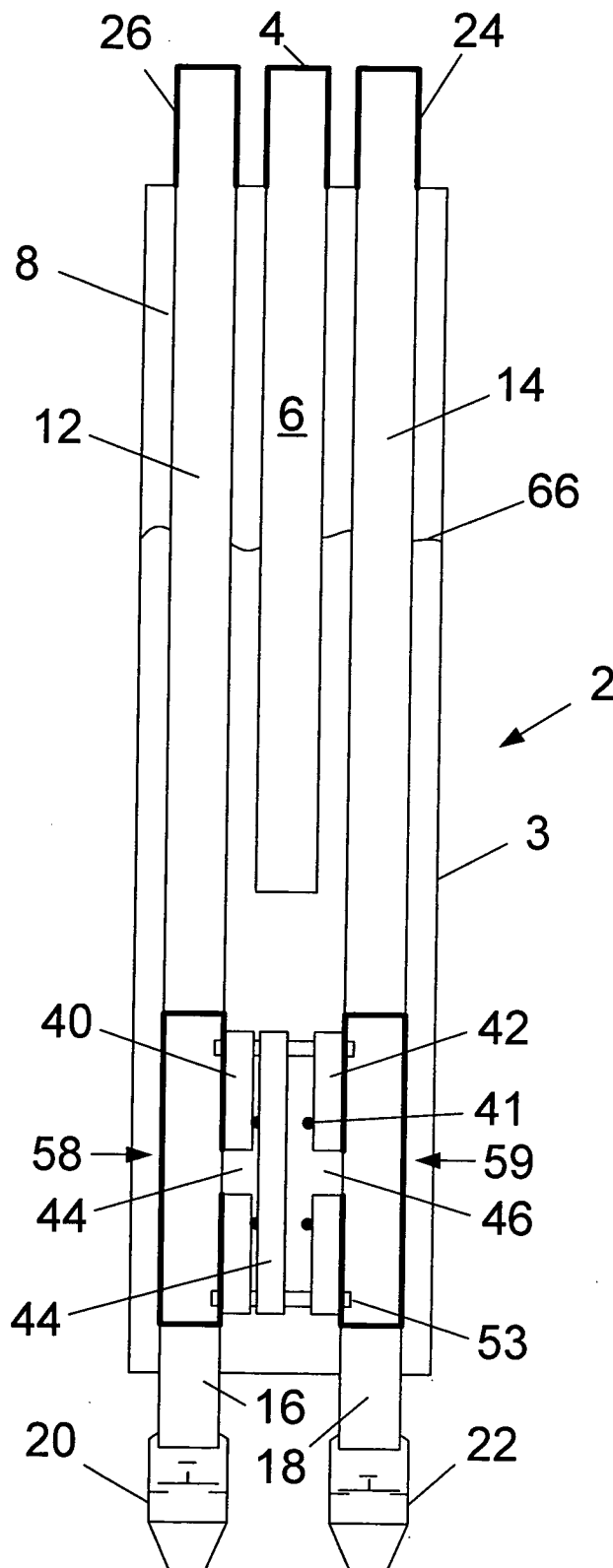


Fig. 6

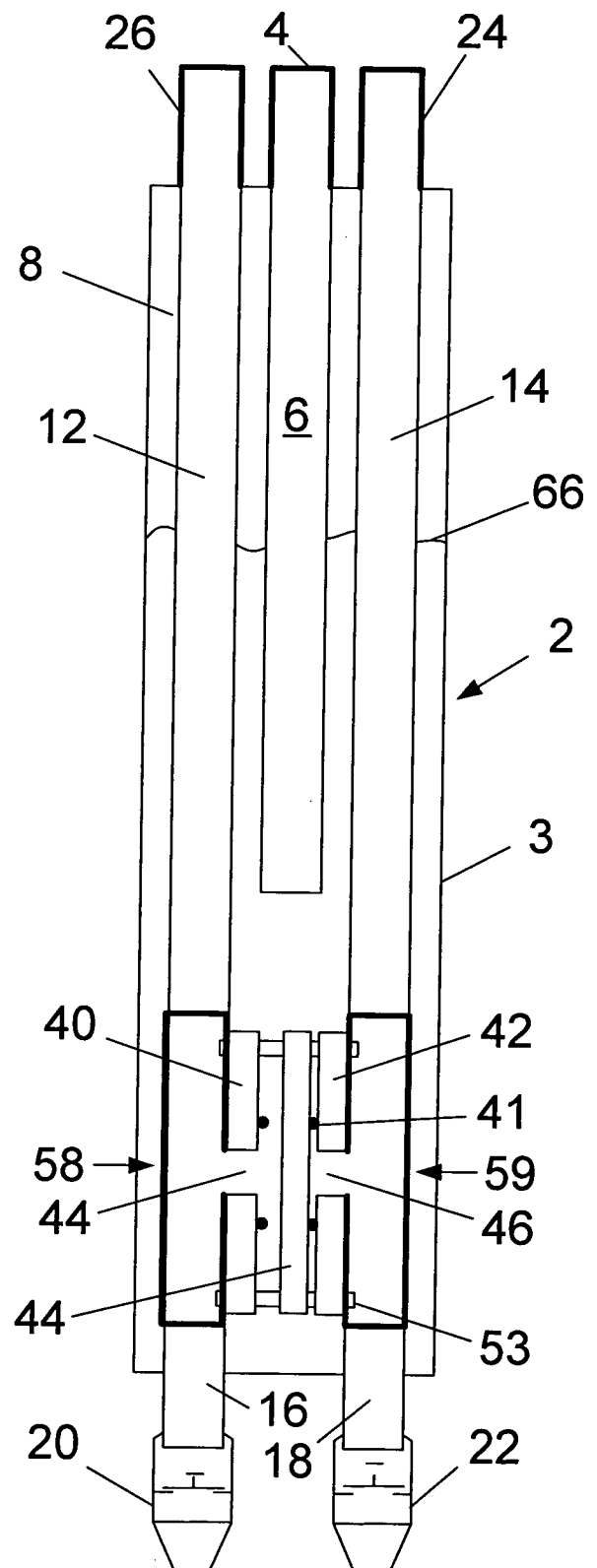


Fig. 7

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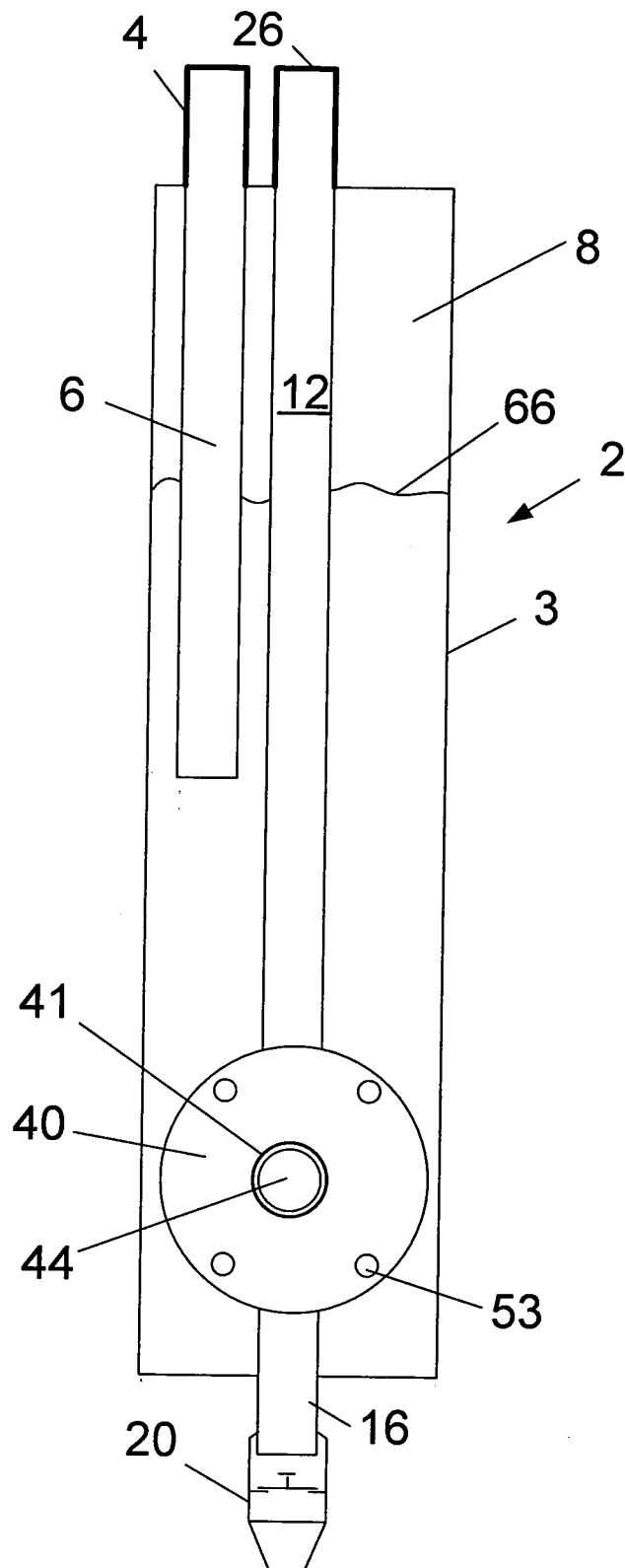
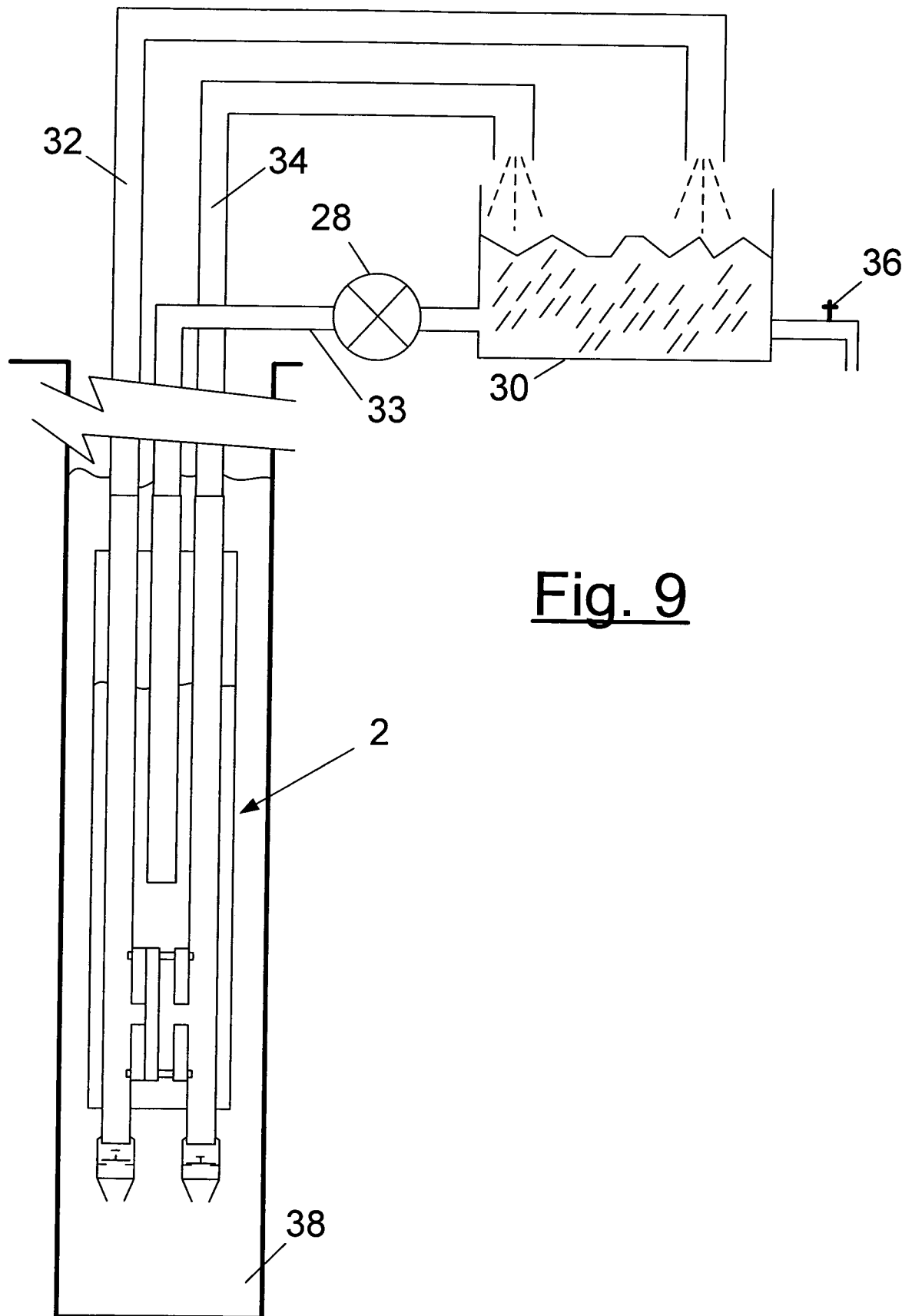
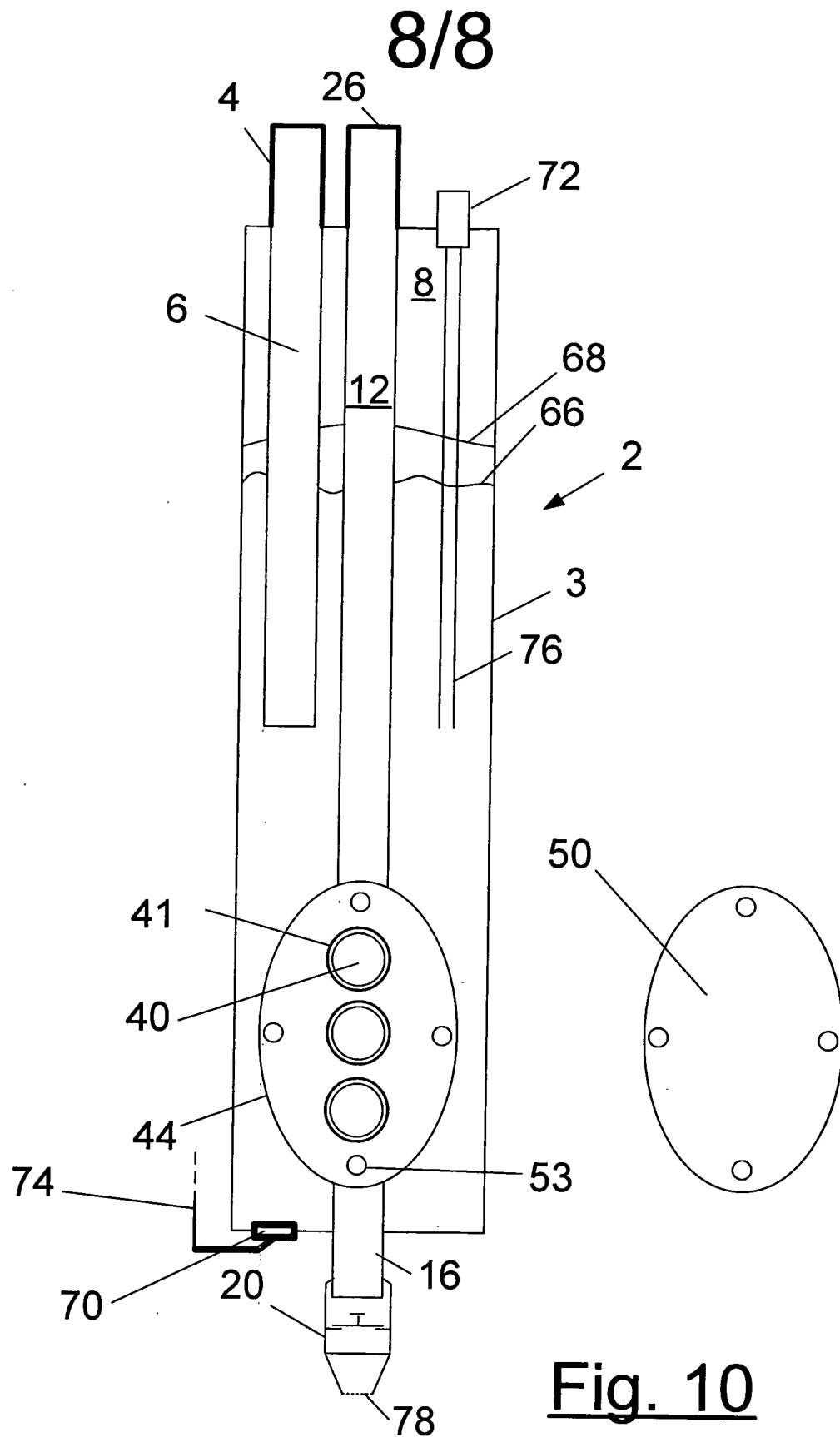


Fig. 8

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Fig. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2010/000558

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F04F 7/00 (2006.01)

F04F 1/18 (2006.01)

F04F 1/20 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI & EPODOC: IPC and ECLA F04F 7/00, 1/18, 1/18. US classification 417/104 and keywords distribute, shuttle, toggle, bi-stable, change-over, two-position, cyclic, reciprocate, valve, inertia and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4121895 A (WATSON) 24 October 1978 Abstract, column 4 lines 33 to 57, column 5 line 41 to column 6 line 33, column 7 line 38 to column 8 line 25, figure 1.	1 - 2, 13
Y	Column 7 line 38 to column 8 line 25, figure 1.	5 - 8
X	GB 25143 A (DUQUENNE) 12 December 1912 Page 1 line 27 to page 2 line 5, figures 1 and 2.	1 - 4, 9, 12, 13
Y	Page 1 line 27 to line 33, figures 1 and 2.	5 - 8
X	US 3123009 A (WATSON) 3 March 1964 Abstract, column 3 line 18 to column 4 line 31, figure 1	1
Y	US4413652 A (ALLEWITZ) 8 November 1983 Abstract, figure 1	6, 7, 8

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2010/000558

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3460565 A (SANDERSON) 12 August 1969 Column 4 line 14 to 28, figure 3.	10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2010/000558

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member
US	4121895	NONE
GB	25143	NONE
US	3123009	NONE
US	4413652	NONE
US	3460565	NONE
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.		
END OF ANNEX		