A water moving device comprises a diaphragm pump with a receiving chamber 30, an inlet 60 with a one-way inlet valve 80, and an outlet 70 with a one-way outlet valve 80. The diaphragm 50 forms at least part of an external wall 54 of the chamber 30 which is adapted to receive water through the inlet 60 and expel water through the outlet 70 in response to movement of the diaphragm 50 while remaining substantially filled with air. The pump is driven by a wind turbine 110 via shaft 100 and an eccentric cam, and may be used for irrigation purposes.
WATER MOVING DEVICE

FIELD OF THE INVENTION
This invention relates to devices for transferring water from one location to another for irrigation and other purposes.

BACKGROUND OF THE INVENTION
It is useful to transfer water from locations in which it may be available, possibly abundantly available, to other locations where it is needed and not available at all. It is particularly useful to have this facility for irrigation purposes, for example for farming where it is essential to irrigate crops and water may not be easily accessible at critical times, or at all.

Many devices have been developed over centuries of civilization to transfer water and thereby support for example farming, but many require constant attendance and effort from farmers and other workers to maintain supplies, and others require machinery, involving maintenance and expense.

What is needed is a simple mechanism to transfer water without excessive reliance on maintenance and a farmers time.

The present invention seeks to provide such a mechanism.

The present invention, in accordance with a first aspect, discloses a water moving device comprising a diaphragm compressor with a receiving chamber, an inlet with a one-way inlet valve, and an outlet with a one-way outlet valve, wherein the diaphragm forms at least part of an external wall of the chamber. The receiving chamber is adapted to receive water through the inlet and discharge water through the outlet, responsive to movement of the diaphragm, while remaining substantially filled with air.

Preferably the diaphragm forms an entire wall of said chamber.
Preferably the inlet is adapted to be in fluid communication with a water source.

Preferably the inlet is connected to a first end of a pipe, the second end of which is submerge-able in water.

Preferably movement of the diaphragm is actuated by wind power.

Preferably the diaphragm is attached to a wind powered rotor via an eccentric bearing.

Preferably the wind powered rotor is attached to the diaphragm by means of a rotatable shaft.

Preferably rotation of the shaft is dependent on wind via the wind powered rotor.

Preferably movement of the diaphragm is actioned manually.

Preferably the diaphragm is attached to the manual actuation means via an eccentric bearing.

Preferably the inlet and outlet are at a first end of the chamber.

Preferably the diaphragm is at a second end of said chamber.

Preferably the second end is distal said first end.

In a further embodiment the receiving chamber comprises two parts, the diaphragm forming at least part of an external wall of the first part, the inlet and outlet positioned in the second part, wherein the two parts are in fluid communication via a pipe. Preferably the volume of the receiving chamber, with the diaphragm in a non-flexed, rest orientation, is greater than or equal to the volume of air displaced in a diaphragm compression-expansion cycle.
If greater, the chamber volume may be between 30% and 80% greater, for example at least 50% greater, or may be more than 100% greater.

Preferably the pipe is flexible.

Preferably at least the first part and the pipe are adapted to remain filled with air.

Preferably the device is portable.

The present invention, in accordance with a second aspect discloses a method of moving water including the steps of, with a diaphragm compressor including a receiving chamber, an inlet with a one way inlet valve and an outlet with a one way outlet valve, wherein the diaphragm forms at least part of an external wall of said chamber, alternately: increasing the volume in the chamber to close the outlet valve, open the inlet valve, and create suction at the inlet; then compressing the air in the chamber to close the inlet valve, open the outlet valve, and create an expelling force at the outlet, such that water is respectively sucked into the chamber via the inlet and discharged from the chamber via the outlet, responsive to movement of the diaphragm, while the chamber remains substantially filled with air.

A preferred arrangement of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 shows a first embodiment of a water mover in accordance with the present invention,

Figure 2 shows a second embodiment of a water mover in accordance with the present invention, and

Figure 3 shows movement of the flexible sheet changing the size of the chamber, and showing the volume of air displaced in a cycle.
The first embodiment of the present invention will now be described with reference to Figure 1.

Figure 1 shows an apparatus in accordance with a first embodiment of the present invention in which water can be moved from one location, for example a lake or river 10 to another location 20, for example a field for irrigation.

The apparatus includes a chamber 30 with surrounding, external walls, in which at least part of one external wall 40 includes or comprises a flexible sheet 50. The flexible sheet 50 is sandwiched between, and held firmly by, two rigid plates 52, 54. The rigid plates 52, 54 are engaged with the flexible sheet 50 by conventional means, for example screws or bolts 56. A first one 54 of the two rigid plates forms an outwardly facing portion of the external wall with the second one 52 of the two rigid plates forming an inwardly facing portion of the internal wall, facing into the internal volume of the chamber.

Plates 52, 54 are attached to a pole 90 which is connected to a shaft 100 via an eccentric bearing or cam (not shown), such that rotation of the shaft provides for movement of the pole relative to the chamber. Such pole movement causes the flexible sheet 50 to flex, urging the rigid plates 52, 54 first towards the chamber to reduce the interior volume of the chamber, and second away from the chamber to increase the interior volume of the chamber, in a cycle which continues for as long as the shaft rotates. During the course of one cycle a volume of air 1040 (as shown in Figures 3 (a) to (d)) is displaced by movement of the diaphragm. The shaft is rotated by a wind powered rotor 110, although it is contemplated that the shaft may alternatively be rotated by other conventional means, for example by hand.

Figure 1 further shows an inlet passage 60 and outlet passage 70, positioned adjacent an external chamber wall distal the flexible sheet 50 and wall 40. Inlet 60 and outlet 70 passages are provided with respective one-way valves 80 controlling fluid communication between the interior volume of the chamber and the outside of the chamber.
Figure 1 further shows a first pipe or hose 120 fixed at a first end 121 to the inlet 60, with a second end 122 adapted for submersion in a volume of water 10; and a second pipe or hose 130 fixed at a first end 131 to the outlet 70 and with a second end 132 open. The first pipe 120 may be sufficiently long that the first end 122 is some significant distance from the inlet 60 on chamber 30.

Figure 1 further shows housing 140 in which chamber 30 may be positioned, the housing designed to provide further bracing support for the apparatus, the shaft 100 and in particular for example for rotor arrangement 110.

The particular arrangement in accordance with the invention has the advantage that rotation of the rotor 110 responsive to for example wind, or other force, causes shaft 100 to rotate. Rotation of shaft 100 urges pole 90 to move relative to chamber 30 by action of the eccentric bearing or cam (not shown) to cause movement of the rigid plates 52, 54 to alternately reduce and increase the volume of chamber 30 due to flexing of the flexible sheet 50.

Figures 3 (a) to (d) show this process. In particular, Figure 3 (a) shows a chamber 30 with diaphragm 50 in a rest position, the chamber having an interior volume 1000. Figure 3 (b) shows the flexible sheet flexed towards the internal volume of the chamber, so that the internal volume of the chamber is reduced 1010. Figure 3 (c) shows the flexible sheet flexed away from the internal volume of the chamber so that the internal volume of the chamber is increased 1020. Figure 3 (d) provides a representation of the volume of air 1040 displaced by movement of the flexible sheet through one complete cycle, from a position where the chamber volume has a minimum value to a position where the chamber volume has a maximum value.

With the flexible sheet moving to a position in which the volume of the chamber 30 is minimised, air in the chamber is subject to a compressive force, which results in exertion of an outward force on the remaining walls of the chamber. With the flexible sheet moving to a position in which the volume of the chamber is maximised, air in the chamber is subject to an expanding force, which results in exertion of an inward
force on the remaining walls of the chamber, pulling the remaining walls into the interior volume of the chamber.

As part of this process, as the volume of chamber 30 increases, one way valve 80 on the outlet 70 closes and one way valve 80 on the inlet 60 opens providing for water from water source 10 at end 122 of pipe 120 to be sucked into the interior volume of the chamber 30. As the volume of chamber 30 decreases, one way valve 80 on the inlet 60 closes and one way valve 80 on the outlet opens and water which has entered into the chamber is urged out of the outlet and into the outlet pipe 130.

This process continues for as long as the shaft 100 rotates to move the pole and therefore the flexible sheet. The vacuum caused by movement of the diaphragm away from the internal volume of the chamber to increase the volume of the chamber acts first on air in the inlet pipe 120, then, with the second end 122 submerged in water, on water at that second end 122. Water is thereby sucked into the inlet pipe 120 and ultimately into chamber 30. As is well known, movement of liquid through a pipe is subject to a resistance that is dependent on the pipe length, cross sectional area, and the liquid itself among other things, and this resistance is greater than the resistance to movement of air through a similar pipe. For the present apparatus this has the consequence that the outlet pipe is contemplated to be short, and in any event shorter than the inlet pipe. A short outlet pipe has the advantage that less water will need to be moved through the outlet pipe before it is discharged, than would be the case for a longer outlet pipe. The length of the inlet pipe is less of an issue. In particular as the length of the inlet pipe increases, the amount of water moved and entering into the chamber is likely to be impacted by the resistance to such water movement, however provided the outlet pipe has less resistance (for example is shorter) all or substantially all the water in the chamber may be discharged during one cycle. If the outlet pipe has greater resistance to movement of water than the inlet pipe, for example if it is longer, then water may not be discharged sufficiently quickly, and water may build up in the chamber. If the chamber fills with water the action of the diaphragm becomes less effective as the diaphragm is acting on water rather than air. Eventually it is contemplated that the apparatus would cease to work.
Water which enters the outlet pipe or hose 130 may then pass through the exit of the outlet pipe 132 and may be used at will, for example to fill a tank, irrigate fields 20, or for other purposes.

The size or shape of chamber 30 is not material to the functionality of the apparatus. However the relative size of the volume of the chamber with the diaphragm in a rest position 1000, and the volume through which the diaphragm moves from a minimum chamber volume to a maximum chamber volume, to displace a volume of air 1040, as shown in Figures 3 (a) to (d), will impact on the strength of the pumping action of the apparatus, and the amount of water moved.

For example, if $X$ is the volume of the chamber with the flexible sheet in a rest position, and $Y$ is the volume through which the diaphragm moves from a minimum chamber volume to a maximum chamber volume, i.e. the volume of air displaced 1040, then there are a variety of relationships that may link the two volumes, for example:

$$X = Y \quad \quad (1)$$

$$X > Y \quad \quad (2)$$

$$X \gg Y \quad \quad (3)$$

$$X = 1.5Y \quad \quad (4)$$

It is contemplated that for the present apparatus chamber 30 remains substantially full of air while the diaphragm moves to change the volume of air in chamber 30 and consequently urge water from inlet 60 to outlet 70. This has the advantage that movement of the diaphragm influences air, and the movement of air. As a consequence no consideration need be given to the properties of any fluid such as water to be moved. Compression and expansion of air is relied upon to suck water in
through the inlet 60 and discharge water through the outlet 70, resulting in a device which is very simple and straightforward.

However, any one of the arrangements set out in equations (1) to (4) will provide for an apparatus that will move water. In respect of the arrangement disclosed in equation (1), with the chamber volume the same as the volume of air displaced by movement of the diaphragm, an optimum action is likely to be achieved.

In the arrangement disclosed in equation (2) or (3), in which the volume of the chamber in each case is larger, or much larger, than the volume displaced by movement of the diaphragm, the vacuum or suction force on the water is comparatively less, meaning that the apparatus is less optimised in respect of sucking water into the chamber.

Equation (4) provides one example of comparative volumes which would be suitable as it provides for sufficient suction to move water while retaining the advantage of having a chamber that is substantially full of air while the water is being moved.

If the volume of the chamber is less than the volume of air displaced by the diaphragm, then the chamber would quickly fill with water. In such a case the diaphragm would be acting against water rather than air, in particular compressing and expanding water rather than air, with the result that it would unlikely to be effective for moving water, or would not be effective for very long.

As discussed, Figure 1 shows an apparatus in accordance with a first embodiment of the present invention, showing a chamber 30, having a first, rectangular volume 150, with flexible sheet 50 forming an external wall 40, opposite which there is a channel 151 leading to, and positioned in the middle of, a passage 152 with inlet 60 at one end and outlet 70 at an opposite end.

Figure 2 shows a second embodiment of the invention. The difference between the first embodiment and the second embodiment is that the flexible sheet 50 is attached
to a single externally facing rigid plate 54, and the channel 151 is replaced by a tube 551, which may be rigid or flexible. The apparatus in accordance with the second embodiment works in the same way as that of the first embodiment. The second embodiment may be easier to transport and store as the component parts, if dismantled, would take up less space.

In use, the apparatus may be taken to a desired location, for example a location where water is needed perhaps to irrigate fields, or where tanks are stored to be transported elsewhere, and put together, if needed. Second end 132 of outlet pipe 130 will be suitably placed to discharge water to a field or into a tank, local to the apparatus. Inlet pipe 120 may be extended until second end 122 may be submerged in the selected water source 10, which may be a significant distance from the apparatus. As the shaft 100 is rotated by action of the wind, or by other means, its connection to pole 90 by eccentric bearing or cam causes pole 90 to move so that the flexible sheet 50 is flexed by action of the pole 90 on rigid plates 52, 54 to alternately reduce and increase the volume of the chamber 30. As the volume of the chamber varies water is sucked into the chamber and discharged from the chamber in a cycle dependent upon rotation of the shaft 100, the flexing of the sheet, and expansion and compression of air in the chamber 30. In particular as the volume of the chamber increases to its maximum the outlet one way valve closes and the inlet one way valve opens and water from the source 10 is sucked into the chamber 30 through pipe or tube 120 and inlet 60. As the volume of the chamber decreases to its minimum the inlet one way valve closes and the outlet one way valve opens, and water held in the chamber passes through the one way valve, the outlet 70, and enters into the pipe or tube 130. Water in pipe 130 passes through end 132 and is discharged to for example irrigate fields or for other purposes. The water source may be a considerable distance from the apparatus, and the apparatus is capable of moving quantities of water from such a source for long periods of time. Any resistance experienced by water passing through the inlet pipe may slow the rate at which water enters the chamber, however the outlet pipe is short, and any resistance to flow of water through the outlet pipe will be less than that for the inlet pipe, so the chamber should discharge all or substantially all of the water in the chamber during each cycle.
An additional advantage of the present invention is that the apparatus is self-priming. For example, as an initial step, the air held in the chamber is discharged through the outlet 70 and pipe or tube 130, until eventually water sucked into the chamber is discharged instead.

A further advantage of the present invention is that the apparatus is portable, in either embodiment.

A still further advantage is that the apparatus may move water long distances in a horizontal direction, and is adapted to move significant quantities of water in this way. While the apparatus may also move water vertically, it is contemplated that the apparatus would generally be suitable to move water a few feet vertically, only.

Clearly, the larger the apparatus used, the more water may be transferred from a first location to a second location.

The invention is not restricted to the details of the foregoing embodiment. For example while it is contemplated that the subject apparatus be used to transport water, any fluid may be transported. In addition, in the second embodiment, two plates may sandwich the flexible sheet, or in the first embodiment only one plate may be relied upon to engage with flexible sheet 50.
CLAIMS

1. A water moving device comprising:
a diaphragm pump with a receiving chamber, an inlet with a one-way inlet valve, and an outlet with a one-way outlet valve, wherein the diaphragm forms at least part of an external wall of said chamber,
said receiving chamber adapted to receive water through the inlet and expel water through the outlet, responsive to movement of the diaphragm, while remaining substantially filled with air.

2. The water moving device of claim 1, wherein said diaphragm forms an entire wall of said chamber.

3. The water moving device of claim 1, wherein the inlet is adapted to be in fluid communication with a water source.

4. The water moving device of claim 1, wherein the inlet is connected to a first end of a pipe, the second end of which is submerge-able in water.

5. The water moving device of claim 1, wherein movement of the diaphragm is actuated by wind power.

6. The water moving device of claim 4, wherein the diaphragm is attached to a wind powered rotor via an eccentric bearing or cam.

7. The water moving device of claim 6, wherein the wind powered rotor is attached to the diaphragm by means of a rotatable shaft.

8. The water moving device of claim 7, wherein rotation of the shaft is dependent on wind via the wind powered rotor.

9. The water moving device of claim 1, wherein movement of the diaphragm is actioned manually.
10. The water moving device of claim 9, wherein the diaphragm is attached to the manual means via an eccentric bearing.

11. The water moving device of any one of the preceding claims wherein said inlet and outlet are at a first end of said chamber.

12. The water moving device of claim 11, wherein said diaphragm is at a second end of said chamber.

13. The water moving device of claim 12, wherein said second end is distal said first end.

14. The water moving device of claim 1, wherein said receiving chamber comprises two parts, said diaphragm forming at least part of an external wall of the first part, said inlet and outlet positioned in the second part, wherein the two parts are in fluid communication via a pipe.

15. The water moving device of any one of the preceding claims wherein the volume of said chamber, with the diaphragm in a non-flexed, rest orientation, is greater than the volume of air displaced in a diaphragm compression-expansion cycle.

16. The water moving device of claim 15, wherein the chamber volume is between 30 to 80 % greater.

17. The water moving device of claim 15, wherein the chamber volume is at least 50% greater.

18. The water moving device of claim 15, wherein the chamber volume is at least twice as great.

19. The water moving device of claim 14, wherein the pipe is flexible.
20. The water moving device of claim 14 or claim 15, wherein at least the first part and the pipe remain filled with air.

21. The water moving device of any of the preceding claims wherein the device is portable.

22. A method of moving water including the steps of, with a diaphragm compressor including a receiving chamber, an inlet with a one way inlet valve and an outlet with a one way outlet valve, wherein the diaphragm forms at least part of an external wall of said chamber, alternately:

   increasing the volume in said chamber to close the outlet valve, open the inlet valve, and create suction at the inlet,

   compressing the air therein to close the inlet valve, open the outlet valve, and create an expelling force at the outlet,

   such that water is respectively sucked into the chamber via the inlet and expelled from the chamber via the outlet, responsive to movement of the diaphragm, while the chamber remains substantially filled with air.

23. The water moving device substantially as described in the accompanying drawings.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

Worldwide search of patent documents classified in the following areas of the IPC

F04B

The following online and other databases have been used in the preparation of this search report

Online: WPI, EPODOC

International Classification:

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