Abstract: An apparatus for pumping or compressing a fluid, the apparatus comprising a housing having a bore, at least one inlet and at least one outlet in communication with the bore, one or more pistons adapted for movement relative to the bore and one or more electromagnetic devices, wherein activation of the one or more electromagnetic devices results in movement of the one or more pistons relative to the bore.
A Magnetic Drive Fluid Pump

Field of the Invention.
The present invention relates to a pump. In particular, the present invention relates to a magnetic drive fluid pump.

Background Art.
Pumps are commonly used for a wide variety of different applications. Common conventional varieties of pump include positive displacement pumps (such as those comprising a reciprocating piston in a cylinder) and non-positive displacement pumps (such as those comprising centrifugal impellers which fling fluid into a diffusing passageway).

Pumps and compressors which use moving pistons are extremely well known in the art. Typically, the piston is connected to a crank. The piston reciprocates in a cylinder and the reciprocating action results in pumping fluid which passes into the cylinder. The pump is typically electrically powered, powered by an internal combustion motor and the like. One disadvantage with this type of pump is that pumping occurs only when piston is in the compressive stroke. When the piston is in the drawdown stroke, no pumping occurs as the drawdown stroke is required to suck additional fluid into the cylinder or housing. Therefore, half the action of the piston does not contribute to the pumping action. Another disadvantage with existing piston pumps is that the piston has a short stroke and this results in increased wear and tear of the pump. Moreover, these types of pumps generally suffer from excessive noise levels making them unsuitable in many applications.

In addition to the drawbacks mentioned above, both of the conventional varieties of pump suffer from the further disadvantages that they are heavy, complicated (in terms of both using and maintaining the pump) and expensive.

Thus, there would be an advantage if it were possible to provide a pump which reduces or eliminates the inefficiencies of existing pumps, while at the same time being easy to use, simple to construct and relatively inexpensive.
It will be clearly understood that, if a prior art publication is referred to herein, this reference does not constitute an admission that the publication forms part of the common general knowledge in the art in Australia or in any other country.

Throughout this specification, the term "comprising" and its grammatical equivalents shall be taken to have an inclusive meaning unless the context of use indicates otherwise.

**Object of the Invention.**

It is an object of the present invention to provide a pump which may overcome at least some of the abovementioned disadvantages, or provide a useful or commercial choice.

In one aspect, the invention resides broadly in an apparatus for pumping or compressing a fluid, the apparatus comprising a housing having a bore, at least one inlet and at least one outlet in communication with the bore, one or more pistons adapted for movement relative to the bore and one or more electromagnetic devices, wherein activation of the one or more electromagnetic devices results in movement of the one or more pistons relative to the bore.

The apparatus includes a housing. The housing may comprise a unitary housing, a two-part housing or a multiple part housing in which the parts are attached together. Typically, the housing comprises a two-part housing consisting of an upper and a lower part which are fastened together typically via separate fasteners such as screws, bolts and the like. Each housing part may be of any suitable size, shape or configuration. Hi some embodiments of the invention, a first housing part may contain the at least one outlet while a second housing part may contain the at least one inlet. Alternatively, each housing part may contain both the at least one inlet and the at least one outlet. Hi a preferred embodiment of the invention, each housing part may have an at least partially curved outer surface.

The housing contains a bore. Suitably, the bore is defined at least partially by the inner wall of the housing. Preferably, the one or more pistons travel through the bore.
The bore may be of any suitable shape or configuration. In some embodiments of the invention, the bore may be circular, oval, elliptical, or any other suitable shape when viewed in plan view.

In some embodiments of the invention, the housing may include at least one passageway extending axially therethrough. Preferably, the at least one passageway extends axially through the housing at substantially the centre of the housing. In this embodiment of the invention, the at least one passageway may be disposed at an angle substantially perpendicular to the bore. Preferably, the at least one passageway and the bore are not in fluid communication with one another. Thus, one portion of the bore may be defined by an inner wall of the housing and another portion of the bore may be defined by the wall of the at least one passageway extending axially through the housing.

In a preferred embodiment of the invention, the bore may be substantially circular when viewed in plan and may also be circular in cross-section. Therefore, in one form the bore may be in the form of a toroid. The length of the bore can vary to suit but it is envisaged that a length of between 20-200cm will be suitable in respect of most applications. It should be appreciated that these values are not limiting and could, for certain applications, be exceeded, for instance in the hub of a wind turbine. The cross-section length or diameter of the bore may vary to suit but it is envisaged that a cross-section length or a diameter of between 1-20cm will be suitable in respect of most applications. Again, no limitation is meant by this range, and the bore may have a diameter of 1 meter or more. A skilled addressee will understand, however, that the size of the bore may be limited by the amount of power required by the one or more electromagnetic devices, and/or the efficiency with which the power supplied to the one or more electromagnetic devices is used by the one or more electromagnetic devices.

The housing is provided with at least one inlet and at least one outlet which communicate with the bore. It is envisaged that more than one inlet may be provided and that more than one outlet may be provided. The size and shape of the or each inlet and the or each outlet may vary and the shape may be circular, oval, rectangular,
polygonal, or have an irregular shape. The size of the or each inlet and the or each outlet can vary, although smaller nozzle sizes may be preferred if a nozzle effect is desired. It is envisaged that the inlet and the outlet may be provided with a valve arrangement to regulate fluid passing into and from the bore. It is also envisaged that some form of manifold may be provided with the inlet and the outlet and a manifold may find particular suitability if multiple inlet and outlets form part of the apparatus which may be the case if the bore contains multiple pistons. A skilled addressee will understand that geometry of the housing adjacent the inlet and/or the outlet may be adjusted to optimize the fluid flow in and out of the apparatus.

Preferably, the at least one outlet is positioned so as to be at an angle substantially tangential to the bore. The apparatus may be provided with a flowpath, (such as a conduit, pipe, channel or the like) extending between the at least one outlet of the bore and the at least one outlet of the apparatus, such that any fluid exiting the bore will flow along the flowpath to the outlet of the apparatus. Although the flowpath may be of any suitable configuration, it is preferred that the flowpath is substantially straight. In addition, it is preferred that the flowpath extends substantially tangentially to the bore. In this way, fluid that exits the bore will flow between the bore and the outlet of the apparatus in a substantially straight line so as to reduce frictional losses.

In some embodiments of the invention, the flowpath may be formed integrally with the housing, while in other embodiments of the invention, the flowpath may be formed separately to the housing and may be adapted for permanent or temporary connection thereto.

The inlet and the outlet may be located adjacent one another (e.g. the inlet may be spaced closely above the outlet). The inlet and the outlet may be located adjacent one another as fluid exiting the apparatus through the bore outlet will generally travel in a straight line along the pathway towards the apparatus outlet, rather than continuing around the curve of the bore towards the inlet. In addition, it is unlikely that fluid can short circuit the apparatus from the inlet to the bore outlet without first traveling around the bore as the positioning of the pistons will generally ensure that fluid entering the bore will travel around the bore in the direction of the movement of the
pistons.

In addition, the faster the movement of the pistons around the bore, the less likely it is that fluid would recirculate around the bore rather than exit the bore through the bore outlet. It is only when a substantial resistance is applied downstream that some recirculation of fluid is likely to occur.

The apparatus may contain a plurality of pistons. Each piston is suitably shaped such that, as it passes along the bore, the piston seals, or at least partially seals against the bore wall. Typically, sealing means are provided to create a seal or a partial seal. Preferably, the pistons are shaped to correspond to the shape of the bore. Thus, in a preferred embodiment of the invention, the bore may be circular in cross-section and therefore the piston will also be circular in cross-section. If the bore has a different cross-section configuration, such as oval, it is envisaged that the piston will also have an oval cross-section configuration. Essentially, the pistons will generally conform to the shape of the bore regardless of the shape of the bore, the presence of corners or the like.

The piston will typically have a body provided with a front face, a rear face, and an outer wall which is located adjacent the internal wall of the bore. The outer wall typically seals or is closely spaced from the wall of the bore, or piston rings or the like may be provided to assist in obtaining a close seal between the piston and the wall of the bore. Preferably, each piston is substantially disc-shaped.

The length and/or the thickness of the body of the piston may vary to suit. For instance the piston may be substantially disk shaped which means the thickness of the body is quite small. The side wall or edge of the disk shaped piston is typically rounded. Alternatively, the piston may have a body thickness which is quite large which means that the piston will have a relatively elongate shape. It is envisaged that the outer wall of the piston will be curved in two directions to enable the piston to travel along the bore while still maintaining a reasonably good seal between the outer wall of the piston body and the wall of the bore.
The pistons, however, need not be disk shaped and may have quite irregular shapes. In one embodiment of the invention, each piston has a front wall and a rear wall. The front wall has a concave portion and the rear wall has a convex portion.

In a preferred embodiment of the invention, the one or more pistons are at least partially constructed from a ferrous material, such as, but not limited to, iron having magnetic properties. Alternatively, at least one magnet may be embedded in, or attached to each of the one or more pistons using any suitable technique, in some embodiments of the invention, the one or more magnets may be located vertically against the front wall and/or the rear wall of the one or more pistons. Not only does this arrangement simplify construction of the apparatus, but it also ensures that the one or more magnets may be correctly aligned as the pistons travel around the bore past the one or more electromagnetic devices.

Constructing the pistons from a magnetic material, or attaching magnets to the pistons, ensures that, when the one or more electromagnetic devices are activated, movement of the pistons relative to the bore is achieved due to the magnetic interaction between the pistons and the electromagnetic devices. The interaction between the pistons and the electromagnetic devices may be of any form, such as a magnetic attraction or magnetic repulsion. Thus, the alignment of the one or more magnets on the pistons may assist in generating the magnetic attraction or repulsion between the pistons and the electromagnetic devices.

In the embodiments of the invention in which a plurality of pistons are present, two or more of the pistons may be connected to one another via connection means. For instance, the pistons may be connected to one another by connection means (for instance, a bridge) located within the bore.

In some embodiments of the invention, the apparatus may be provided with mounting means adapted for mounting the one or more pistons thereto. The mounting means may be of any suitable form, although it is preferred that the mounting means is adapted for movement relative to the bore. In a preferred embodiment of the invention, the mounting means is located at least partially within the bore.
As previously mentioned, the mounting means may be adapted for mounting the one or more pistons thereto. Any suitable technique may be used for mounting the pistons to the mounting means. For instance, the pistons may be formed integrally with the mounting means, or may be formed separately and either permanently or temporarily mounted to the mounting means. The pistons may be mounted so that they move relative to the bore in the same direction and/or at the same speed as the mounting means, or the pistons may be mounted so as to move relative to the bore in a different direction and/or at a different speed as the mounting means. Preferably, however, the pistons are mounted so that they move relative to the bore at the same speed and in the same direction as the mounting means.

In some embodiments of the invention, all of the pistons may be mounted to a single mounting means. However, it will be understood that the present invention could include a situation in which a plurality of mounting means are provided wherein one or more pistons are mounted to each of said plurality of mounting means.

Although the skilled addressee will understand that the mounting means may be of any suitable shape, size or configuration, in some embodiments of the invention, the mounting means may be in the form of a ring, disc, rotor, impeller or the like. Preferably, the ring, disc, rotor or impeller rotates about its rotational axis such that the one or more of the pistons mounted to the mounting means move along the bore.

Preferably, the movement of the pistons relative to the bore alone results in the movement of the mounting means relative to the bore. However, in some embodiments of the invention, the movement of the mounting means relative to the bore may be enhanced by the use of a drive means to drive the movement of the mounting means relative to the bore. The drive means may be of any suitable form, such as, but not limited to, a motor. In some embodiments of the invention, the drive means may transfer a driving force (for instance, a rotational force) to the mounting means. The drive means may transfer the driving means directly to the mounting means, or via one or more intermediate means. The intermediate means may be of any suitable form, although in some embodiments of the invention, the one or more
intermediate means comprise wheels (e.g. gear wheels) adapted to transfer the driving force from the drive means to the mounting means. In some embodiments of the invention, the mounting means may be provided with engagement means adapted to allow an engagement between the mounting means and the drive means and/or the intermediate means. The engagement means may be of any suitable form, such as, but not limited to, one or more projections (such as teeth) adapted to engage with corresponding projections on the intermediate means and/or the drive means. In some embodiments of the invention, the one or more projections are located on an inner edge of the mounting means. In a preferred embodiment of the invention, the intermediate means is provided with a plurality of projections.

The intermediate means may be provided at any suitable location within the apparatus. However, in a preferred embodiment of the invention, the intermediate means extend at least partially into the bore. Preferably, the intermediate means extend at least partially into the bore through one or more apertures in a wall of the housing. The one or more apertures may further be provided with any suitable sealing means to prevent leakage of fluid from the bore and/or to prevent a loss of pressure from the bore.

In some embodiments of the invention, the apparatus may comprise one or more magnetic pistons and one or more non-magnetic pistons. The non-magnetic pistons may be used to reduce the possibility of recirculation of fluid within the bore. In embodiments of the invention in which a plurality of magnetic pistons and a plurality of non-magnetic pistons are present, it is preferred that a non-magnetic piston is mounted on the mounting means between two adjacent magnetic pistons.

The one or more electromagnetic devices may be located at any suitable point of the apparatus. For instance, the one or more electromagnetic devices may at least partially surround at least a portion of the outer surface of the housing. Preferably, the one or more electromagnetic devices entirely surround at least a portion of the outer surface of the housing. Alternatively, one or more electromagnetic devices may be located on one or both of the upper and/or lower surfaces of the housing, or one or more electromagnetic devices may be located on one or both sides of the outer surface of the housing. A skilled addressee will understand that any suitable electromagnetic
device may be used for the present invention. In a preferred embodiment of the invention, the electromagnetic devices comprise an electromagnetic coil.

The one or more electromagnetic devices may run continuously, or may be switched on and off as required. Energy to operate the one or more electromagnetic devices may be provided using any suitable energy source, such as, but not limited to, batteries, solar cells, mains power, commutation, solid-state electronic means or the like, or any combination thereof. In addition, the delivery of energy to the electromagnetic devices may be controlled either manually or automatically, such as by making use of a computer to control the activation of the electromagnetic devices.

Preferably, when the apparatus of the present invention is in use, at least one of the electromagnetic devices is activated by an electrical current of any suitable voltage which produces an electromagnetic field in the bore in the vicinity of the electromagnetic device. Preferably, the strength of the electromagnetic field is such that any piston the vicinity of the electromagnetic field will interact with the affected region of the bore, thereby causing the one or more pistons to travel around the bore. The interaction between the electromagnetic field and the piston may be of any type, such as a magnetic attraction or a magnetic repulsion. Preferably, the movement of the piston relative to the bore results in fluid to be moved relative to the bore in the direction of movement of the piston.

In a preferred embodiment of the invention, the apparatus is provided with a plurality of electromagnetic devices spaced around the length of the bore. In this embodiment of the invention, each of the plurality of electromagnetic devices may be continuously activated so as to constantly produce an electromagnetic field, or individual electromagnetic devices may be switched on and off as required. In some embodiments of the invention, each of the plurality of electromagnetic devices is activated sequentially, typically so that adjacent electromagnetic devices are activated one after another. In this way, a piston will move relative to the bore as a result of the sequential activation of adjacent electromagnetic devices.

Preferably, as a piston passes a first electromagnetic device, the electrical current to
the first electromagnetic device is altered (for instance, by removing the current to the electromagnetic device or by reversing the polarity of the electromagnetic device), thereby altering the electromagnetic field associated with the first electromagnetic device. Simultaneously, a second electromagnetic device located further along the bore may be activated, creating an electromagnetic field in the vicinity of the second electromagnetic device. The electromagnetic field created by the second electromagnetic device (in conjunction with, in the relevant embodiments, the electromagnetic field created by reversing the polarity of the first electromagnetic device) will cause the piston to move along the bore towards the second electromagnetic device. As the piston passes the second electromagnetic coil, the electrical current to the second electromagnetic coil is altered and a third electromagnetic device located further along the bore may be activated. By sequentially activating electromagnetic devices in this manner, the piston can be made to travel continuously around the bore.

Another embodiment of the invention the pistons may be formed of a material, and especially a ferrous material, that is not a permanent magnet. In this embodiment each piston becomes a temporarily magnetised. The piston may then behave in a similar manner to a poled conventional electric motor wherein the electromagnetic devices magnetise the iron pole shoes but switch the current direction at a certain frequency, such as, but not limited to, 50 to 60 cycles per second. This switching may be effected by, for instance, alternating mains current or may be delivered from any source at any frequency.

The rotor of the conventional motor is at first attracted to the pole shoe and as it passes the pole shoe the current flow direction is reversed thereby reversing the polarity of the electromagnetic device. However this current flow reversal happens faster than the magnetic polarity of the piston can reverse and so by timing, the piston is then repelled on as it is passing the pole shoe.

Thus, in one embodiment of the invention, the apparatus may be made to operate in a similar manner. In this embodiment, a piston is attracted to an electromagnetic device and as the piston passes that device, the polarity of the device is reversed due to the
continuous reversing of the alternating current. Thus, the piston is then repelled by the same electromagnetic device and it continues to travel in the same direction around the bore. As a result, mains electricity supply may be utilized so no other electronics are required resulting in a version which may be simpler and of lower cost to manufacture.

Hi embodiments of the invention in which multiple pistons are present, the pistons and electromagnetic devices are preferably arranged such that two or more pistons are drawn towards an electromagnetic device at all times when the apparatus is in operation. Thus, in this embodiment of the invention, multiple electromagnetic devices may be activated simultaneously in order to increase the rotational velocity of the pistons. In some situations, such as when the apparatus is operating at high RPM, one or more of the electromagnetic devices may be deactivated entirely. In embodiments of the invention in which mains power is utilized, the maximum RPM of the apparatus may be limited by the frequency of the alternating current electricity.

The electromagnetic devices may be formed from any suitable material. However, in a preferred embodiment of the invention, the electromagnetic devices are constructed from wire, and preferably metal wire.

Embodiments of the invention, one or more spacing means may be provided between at least a pair of adjacent electromagnetic devices. The spacing means may be of any suitable form, provided that they serve to maintain a predetermined distance between adjacent electromagnetic devices. In a preferred embodiment of the invention, the spacing means may also have magnetic insulating properties. In this embodiment of the invention the insulating properties of the spacing means ensure that the electromagnetic fields create by each of the electromagnetic devices do not overlap or interfere with one another. The spacing means may be formed from any suitable material, and a skilled addressee will understand which materials may be suitably used to provide the spacing means with suitable magnetic insulating properties.

In a most preferred embodiment of the invention, a plurality of spacing means are provided. In this embodiment, spacing means are provided between all adjacent
electromagnetic devices.

The one or more spacing means may be connected to the apparatus using any suitable technique. For instance, the one or more spacing means may be formed as a single unit that partially or entirely surrounds a portion of the outer surface of the housing. Alternatively, the spacing means may be constructed from two or more pieces which are joined together to at least partially surround the housing.

It is envisaged that any suitable fluid, either gaseous or liquid, may be pumped by the apparatus.

No limitation is meant to be construed on the invention by the description of the invention as a compressor or a pump. For instance, it is envisaged that the invention may be utilised as an engine or electric motor.

Alternatively, the apparatus may be used as a generator to generate electrical current. In this embodiment of the invention, fluid entering the apparatus through the inlet port may force the one or more pistons to move relative to the bore. As the one or more pistons pass an electromagnetic device, the magnetic nature of the pistons causes an electrical current to be generated in the wire of the electromagnetic device. This generated electrical current may be used for any suitable electrical application. Any suitable fluid may be used to drive the movement of the pistons relative to the bore, such as, but not limited to, water, oil, gases (including combustion gases), steam or the like.

Hi another embodiment of the invention the magnetic attraction or repulsion of the pistons may be accomplished by one or more permanent magnets that are mounted on a member that is caused to rotate around the outside of the bore. The member may be located substantially parallel to the outside of the housing of the apparatus. The one or more permanent magnets may be oriented in any way around the outside of the bore and may be moved relative to the bore when viewed in plan, such as by rotation. The movement around the bore may be effected by any suitable means.
In another embodiment of the invention the one or more permanent magnets may be replaced by one or more electromagnetic devices, such as, but not limited to wire coils, in this case the electromagnetic devices would move around the outside of the toroidal housing and would remain activated at least semi-permanently. The electromagnetic devices may at least partially encircle the bore (although preferably the electromagnetic device do not come into contact with the housing of the apparatus) such that the pistons may be placed in an upper part or a lower part of the bore or peripherally and medially within the bore.

**Brief Description of the Drawings.**

An embodiment of the invention will be described with reference to the following drawings in which:

- **Figure 1** illustrates a plan view of a mounting means according to an embodiment of the present invention;
- **Figure 2** illustrates a side view of a mounting means according to an embodiment of the present invention;
- **Figure 3** illustrates a cross-sectional view of an apparatus according to an embodiment of the present invention;
- **Figure 4** illustrates a plan view of an apparatus according to an embodiment of the present invention;
- **Figure 5** illustrates a plan view of an apparatus according to an embodiment of the present invention;
- **Figure 6** illustrates a plan view of an apparatus according to an embodiment of the present invention;
- **Figure 7** illustrates a plan view of an apparatus according to an embodiment of the present invention;
- **Figure 8** illustrates a plan view of an apparatus according to an embodiment of the present invention;
- **Figure 9** illustrates a perspective view of a mounting means according to an embodiment of the present invention;
- **Figure 10** illustrates a portion of an apparatus according to an embodiment of the present invention;
- **Figure 11** illustrates a portion of an apparatus according to an embodiment of the
present invention; and
Figure 12 illustrates a portion of an apparatus according to an embodiment of the present invention.

**Detailed Description of the Drawings.**

It will be appreciated that the drawings have been provided for the purposes of illustrating preferred embodiments of the present invention and that the invention should not be considered to be limited solely to the features as shown in the drawings.

hi Figure 1 there is illustrated a mounting means in the form of a ring 10 for an apparatus (not shown) according to an embodiment of the present invention. The ring 10 is provided with four pistons 11 spaced around the ring 10. Each of the pistons 11 is either formed from a magnetic material, or has magnets (not shown) embedded therein or attached thereto. In the embodiment of the invention illustrated in Figure 1, the ring 10 is adapted for rotation in the direction indicated by arrow 12.

hi Figure 2, the ring 10 is shown in a side elevation. It may be seen in this figure that the pistons 11 of the present embodiment are substantially circular in cross-section. The front surface 13 in the back surface 14 of each of the pistons 11 are provided with a plurality of magnets 15, while the side wall 16 of each of the pistons 11 is rounded so as to ensure that the pistons 11 move smoothly along the bore (not shown).

In Figure 3, the ring 10 is shown when housed within the apparatus 17 according to an embodiment of the present invention. The apparatus 17 has a toroidal housing 19 with an annular bore 18 along which the pistons 11 travel when the apparatus 17 is in use.

Turning now to Figure 4, the apparatus 17 according to an embodiment of the present invention is shown. The toroidal housing 19 of the apparatus 17 comprises an inlet 20 into which fluid flows into and then around the apparatus 17 through the bore 18 in the direction indicated by arrow 21. The flow of fluid around the bore 18 is enhanced by the rotation of the ring 10 in the action of the pistons 11 which serve to move fluid around the bore 18. The apparatus 17 has a bore outlet 28 through which fluid flows
in the direction indicated by arrow 23. Fluid exiting the bore 18 through the bore outlet 28 passes along a flowpath 29 to the apparatus outlet 22.

In Figure 5, the apparatus 17 according to an embodiment of the present invention is shown in a plurality of electromagnetic devices in the form of electromagnetic coils 24 connected to the outer surface of the toroidal housing 19. The electromagnetic coils 24 may be supplied with an electrical current continuously, or they may be switched on and off as required. If the coils are switched on and off, it is preferred that they switched on and off sequentially in order to enhance the movement of the pistons (not shown) around the bore 18.

Figure 6 illustrates the apparatus 17 according to an embodiment of the present invention in which spacing means 25 have been connected to the outer surface of the toroidal housing 19. The spacing means 25 are located between adjacent electromagnetic coils (not shown) so as to maintain a predetermined distance between each electromagnetic coil. In this way, the electromagnetic field produced by adjacent electromagnetic coils (not shown) will not overlap or interfere with one another. The spacing means 25 illustrated in Figure 6 also have magnetic insulating properties.

The spacing means 25 illustrated in Figure 6 comprise two portions, the first portion adapted to abut an upper surface of the toroidal housing 19 and a second portion adapted to abut a lower surface of the toroidal housing 19. The first and second portions may be connected together using fasteners 26, such as screws, bolts, nails or the like.

In Figure 7, the apparatus 17 is shown with both electromagnetic coils 24 and spacing means 25 connected to the outer surface of the toroidal housing 19.

In Figure 8, an apparatus 17 according to an embodiment of the present invention is illustrated. In this embodiment of the invention the ring 10 may be provided with the usual magnetic pistons 11 as well as additional pistons 27. The additional pistons 27 are typically non-magnetic and are provided to assist in reducing the possibility of the recirculation of fluid within the bore 18, as well as enhancing the movement of fluid
around the bore 18.

In Figure 9 there is shown a mounting means 10 according to an embodiment of the present invention. The mounting means 10 is in the form of a ring or disc to which a plurality of pistons 11 have been mounted. The pistons 11 are spaced apart from one another around the mounting means 10. The pistons 11 are substantially oval shaped when viewed from the front or rear so as to be adapted for use within a substantially oval bore (not shown).

Turning now to Figure 10 there is shown a portion of a bore 18 according to an embodiment of the invention. The bore 18 is provided with an inlet 20, a bore outlet 28 and an apparatus outlet 22, the bore outlet 28 and the apparatus outlet 22 being in fluid communication with one another via a flowpath 29 in the form of a pipe or conduit.

The inner wall 30 of the bore 18 is provided with a pair of apertures 31 adapted to provide an access point for connection of drive means (not shown) to the mounting means (not shown).

In Figure 11, drive means 32 in the form of a motor is shown located centrally to the toroidal housing 19 of the apparatus. Each of the apertures 31 in the inner wall 30 of the bore 18 is provided with a toothed wheel 33 adapted for engagement with both a wheel (not shown) attached to the motor spindle 34 and the mounting means (not shown) within the bore 18.

In Figure 12 there is shown a mounting means 10 located within the bore (obscured) of the toroidal housing 19. The inner edge 35 of the mounting means 10 is provided with a plurality of teeth 36 adapted to engage with the toothed wheels 31 located in the apertures (obscured) in the inner wall 30 of the housing 19. In this way, the rotation of the wheel (not shown) connected to the drive means (not shown) transfer a driving force to the toothed wheels 31 which in turn transfer a driving force to the mounting means 10, thereby causing the mounting means 10 to rotate around the bore (obscured).
Those skilled in the art will appreciate that the present invention may be susceptible to variations and modifications other than those specifically described. It will be understood that the present invention encompasses all such variations and modifications that fall within its spirit and scope.
Claims.

1. An apparatus for pumping or compressing a fluid, the apparatus comprising a housing having a bore, at least one inlet and at least one outlet in communication with the bore, one or more pistons adapted for movement relative to the bore and one or more electromagnetic devices, wherein activation of the one or more electromagnetic devices results in movement of the one or more pistons relative to the bore.

2. An apparatus according to claim 1 wherein the one or more pistons are at least partially constructed from a magnetic material.

3. An apparatus according to claim 1 wherein the one or more pistons include one or more magnets embedded therein or attached thereto.

4. An apparatus according to any one of the preceding claims wherein the one or more electromagnetic devices are activated by supplying an electrical current thereto.

5. An apparatus according to any one of the preceding claims wherein the activation of an electromagnetic device generates an electromagnetic field at least partially inside the bore.

6. An apparatus according to any one of the preceding claims wherein an electromagnetic device is activated as a piston approaches the electromagnetic device along the bore.

7. An apparatus according to any one of the preceding claims wherein an electromagnetic device is deactivated or has its polarity reversed after a piston passes the electromagnetic device along the bore.

8. An apparatus according to any one of the preceding claims wherein the apparatus comprises a plurality of electromagnetic devices spaced apart from one another around the housing.

9. An apparatus according to claim 8 wherein each of said plurality of electromagnetic devices are maintained at a predetermined distance from one another by spacing means located between adjacent electromagnetic devices.

10. An apparatus according to claim 9 wherein the spacing means comprise
a magnetic insulating material.

11. An apparatus according to any one of the preceding claims wherein the one or more electromagnetic devices comprise electromagnetic coils.

12. An apparatus according to any one of the preceding claims wherein the one or more pistons are adapted to be mounted to a mounting means located at least partially within the bore and movable relative to the bore.

13. An apparatus according to any one of the preceding claims wherein the mounting means comprises a disc, ring, rotor or impeller.

14. An apparatus according to any one of the preceding claims wherein the apparatus comprises one or more magnetic pistons and one or more non-magnetic pistons.

15. An apparatus according to any one of the preceding claims wherein the bore is substantially toroidal in shape.

16. An apparatus for generating an electrical current, the apparatus comprising a housing having a bore, at least one inlet and at least one outlet in communication with the bore, one or more pistons adapted for movement relative to the bore and one or more electromagnetic devices spaced around the bore, wherein movement of the one or more pistons around the bore generates an electrical current in the one or more electromagnetic devices.

17. An apparatus according to claim 16 wherein the one or more pistons are at least partially constructed from a magnetic material.

18. An apparatus according to claim 15 wherein the one or more pistons include one or more magnets embedded therein or attached thereto.
**INTERNATIONAL SEARCH REPORT**

**International application No.**
PCT/AU2008/000518

### A. CLASSIFICATION OF SUBJECT MATTER

<table>
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<tr>
<th>Int. Cl.</th>
<th>Field of Search</th>
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According to International Patent Classification (IPC) or to both national classification and IPC.

### 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)

- DWPI F04B 31/00, F04B 3/00, F04B 17/00, F04B 35/04, F04B 9/00, FOIB 7/00, FOIB 11/00 with keywords: pump, piston, bore and similar terms.

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US 4381181 A (CLEGG) 26 April 1983 Whole document</td>
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<td>23 December 1986 Abstract</td>
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* Further documents are listed in the continuation of Box C

- **x** Special categories of cited documents
  - 'A' document defining the general state of the art which is not considered to be of particular relevance
  - 'E' earlier application or patent but published on or after the international filing date
  - '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)
  - '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

- **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

- **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

- **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 documents, such combination being obvious to a person skilled in the art

- **&** document member of the same patent family

Date of the actual completion of the international search:
18 June 2008

Date of mailing of the international search report:
26 JUN 2003

Name and mailing address of the ISA/AU:
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Telephone No: (02) 6283 2638

Form PCT/ISA/210 (second sheet) (April 2007)
INTERNATIONAL SEARCH REPORT

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

This International Searching Authority found multiple inventions in this international application, as follows:

See supplemental box.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-15, 18

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
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<td>A</td>
<td>US 5564908 A (PHILLIPS ET AL) 15 October 1996 Abstract</td>
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Supplemental Box
(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

- Claims 1-15 and 18 are directed to an apparatus for pumping or compressing a fluid. It is considered that the activation of one or more electromagnetic devices to move one or more pistons relative to the bore comprises a first distinguishing feature.

- Claims 16 and 17 are directed to an apparatus for generating an electrical current. It is considered that the generation of electrical current in one or more electromagnetic devices comprises a second distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

The only feature common to all of the claims is an apparatus having a bore, at least one inlet and at least one outlet in communication with the bore, one or more pistons adapted for movement relative to the bore. However this concept is not novel in the light of:

D1-US 2006/0226728
D2-US 4381 181

D1 discloses a bore having an inlet I, an outlet E, and one or more pistons A, B and C adapted for movement within the bore (see page 5, part [0068]; figures 1A-1F).

D2 discloses a bore having an inlet 11, an outlet 12, and one or more pistons C1, C2 and C3 adapted for movement within the bore (see abstract; figures 1-10)

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention aposteriori.
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.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX