

SPECIFICATION

An apparatus for driving an electrical generator

5 This invention relates to apparatus for driving an electrical generator.

According to the present invention, there is provided an apparatus for driving an electrical generator, comprising a closed circuit system to utilise the potential energy of a buoyant component immersed in a fluid, said system including two floats, one in each limb of a U-tube, the floats each being less dense than a liquid to be used to transport the floats in the U-tube, means to cause the liquid to reciprocate in and between each limb, means releasably to hold each float within the liquid as the liquid rises up each limb and power take-off means associated with each float to drive the generator upon movement of the float upwards with the rising liquid level after the float has been released.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 is a diagrammatic side view of one form of apparatus for driving an electrical generator,

Figure 2 is a diagrammatic plan view of part of the apparatus shown in Fig. 1,

Figure 3 is a diagrammatic side view of an air circuit connected to the part of the apparatus shown in Fig. 2,

Figure 4 is a diagrammatic side view of a detail of the apparatus shown in Fig. 1,

Figure 5 is a schematic side view of part of a power take-off means associated with each float to drive an electrical generator upon movement of the floats,

Figure 6 is a view similar to Fig. 1 but showing a modified form of apparatus, and

Figure 7 is a diagrammatic view of a detail of a part of the apparatus shown in Fig. 6.

Referring firstly to Figs. 1 to 4, the apparatus shown is for driving an electrical generator and comprises a closed circuit system to utilise the potential energy of a buoyant component immersed in a fluid.

The system includes two floats 4, one in each limb of a large U-shaped tube or pipe 15 which has an enlarged diameter in the region of the bend of the "U". The pipe 15 is set in a solid foundation 5 and two foundation posts 18 pass through the bottom of the U-bend and reach into the pipe 15. The two foundation posts 18 are securely held by the foundation itself and are shaped to give very little resistance to liquid moving in the pipe 15. Each foundation post 18 carries a float retaining mechanism 6, which can be electromagnetically actuated.

Reference will be made in the specification

to "water" as being the liquid in the pipe 15 but it will be appreciated that any other suitable liquid can be used to achieve the same purpose.

The intention of the float retaining mechanisms 6 is to hold each float 4 under water until the float is completely immersed in the water so that it can then be released to draw itself up through the water as the water level rises.

The upper part of each limb of the pipe 15 carries a head which contains two butterfly or otherwise constructed valves 10. These valves can be electromagnetically operated and are arranged to allow a large throughflow area to be opened or closed quickly. One of the valves gives access to a low-pressure air tank 9, the other to a high pressure air tank 8. It is to be understood that reference to low pressure means pressures below atmospheric pressure and reference to high pressure means pressures above atmospheric pressure.

The upper end of each limb increases in diameter as compared with the main part of the limb so that each upper extremity is dished. A partition wall 10a divides each upper extremity in half; one of these halves carries the horizontal high pressure air valve connected to the high pressure air duct 8 and the other half carries the low pressure valve connected to the low pressure air duct 9. The increase in diameter of each extremity makes it possible, despite the division into the two halves, to accommodate a valve area substantially the same as the cross-sectional area of a respective limb of the pipe 15, thereby ensuring an air flow substantially free of any restrictions.

The right-hand limb carries a small bleeder valve 3 which is required for air to escape while water is filled in through a water inlet valve 16, which is positioned just under the valves 10. The left-hand limb of the pipe 15 has an inlet valve 12 for high pressure air from an air compressor 2 which is bolted to the foundation, a pipe leading from the inlet valve 12 leading into the pipe 15 in the widened section in the left-hand limb.

Each float 4 can be constructed from a high grade marine aluminium in a way similar to aircraft construction to give a light weight but strong body. Three rows of rollers 14 are fitted to the sides of the floats 4, these rollers 14 positioning the floats in the centre of the pipe 15 by running in guide rails 7 fastened to the inside of each limb of the pipe 15. The bottom centre of each float 4 has a clamping device 4a to hold a power take-off steel cable 13 which runs out through the foundation post 18, where they are sealed against water loss, then onto a large drum 30 which is turned by an upwardly moving float and steel cable, while the cable of a descending float is wound up on the drum 30 (see Fig. 5). The bottom centre of each float 4 is also provided

with a member to coact with the float retaining mechanism 6.

To keep friction losses of moving water within the pipe 15 to a minimum, all inside surfaces and the floats can be treated with a friction-reducing coating. The water can be conditioned with an additive to reduce friction even further.

The floats 4 and the cables 13 amount, despite weight saving construction, to a considerable weight which must be lifted at every power creating stroke. This dead weight reduces the efficiency of the apparatus and so to counteract this, both floats 4 can be filled with helium instead of air, thereby contributing to reducing the weight of each float.

Referring more particularly to Fig. 3, the two air tanks 8 and 9 are interconnected by at least one large capacity fan 1 of an axial or radial type, driven by an electric motor. The delivery capacity of the or each fan 1 is calculated to the requirements of air in the apparatus, which depends on the amount of air that is displaced by the moving water in a certain time. As previously mentioned, the air tanks are in communication with the ducts leading to the butterfly valves 10.

The whole construction is a closed circuit system, sealed off from the outside air. The function of the fans 1 is to deliver the required amount of air in a given time and by doing this, create a pressure difference between the "suction" or low-pressure side and the "exhaust" or high pressure side. The most important aspect of the use of air of different pressures in the apparatus is the pressure difference between the two, this pressure difference being arranged to maintain momentum of the water which is moving between the two limbs of the tube 15 and first rises up one limb and then up the other. The air assists in pushing the water level down in one limb whilst simultaneously drawing the water level up in the other limb.

The exact timing of all operations in the apparatus can be executed by an electronic control system, programmed to allow the highest efficiency of the plant. Sensors and other instruments feed information to this control system and actuation of the different devices is simply achieved by electromagnetic operation. To power this electronic control system and all electromagnetic devices, the air compressor and the fans, an outside source of electric power is required. Experiments with the system of communicating pipes have revealed that a high water column in one pipe with air enclosed in the other pipe would, after opening both pipes to air, cause the water-column to drop in the first pipe and to rise in the other pipe to more than three quarters of the height of the pipe and could be held there by closing off the tops of both limbs again. Thus, the air pressure difference discussed above is required to cause the water

column to rise further to the full height of the respective limb. In practice, the descending float will ride down on the falling water column and adds its weight to support the

reciprocating movement of the water in the pipe 15. Timing of the release of the float retaining mechanism 6 is arranged to ensure that the rising float 4 and the rising water act together in a harmonic movement. It is not intended that the float 4 should push its way through the water but rather that it should rise with it once the water level has covered the top of the float.

It will be seen that the high pressure air which is contained in the limb that is empty of water is always absorbed or sucked up by the low pressure air system. There is a temporary increase in the pressure in this system but this has little effect because the volume of the tanks 8,9 are arranged to cope with this. The fans 1 are arranged to shift this air in a few seconds so as to ensure a steady circulation of air at the right pressure within the apparatus.

Operation of the apparatus so far described is initiated as follows.

First of all, all valves in the left-hand limb of the pipe 15 are closed and all valves in the right-hand pipe are closed except for the air bleeder valve 3. The water inlet valve 16 is opened and water flows into the pipe 15. The air compressor 2 is started and, as soon as the water level has risen above the bend in the left-hand limb, the valve 12 is opened and compressed air is pumped in to counteract the weight of the water column in the right-hand limb of the pipe 15. This compressed air is in addition to the air already trapped by the inflow of water into the pipe 15 and prevents the water from rising higher than the level of the float retaining mechanism 6 is that limb. Without this additional high pressure air, there would be an undesirable rise in the water level in the left-hand limb before the apparatus starts working.

After the water level has almost reached the butterfly valves 10 in the right-hand limb of the pipe 15, the valves 3, 16 and 12 are closed. The fans 1 are started and, after the respective high and low pressures have reached operating levels, the apparatus is started by the electronic control system.

All the butterfly valves 10 are opened simultaneously and a gate valve 22 (Fig. 4) opens a release hatch above the low-pressure side of the pipe and closes off the low pressure air duct 9 with the same movement. The high pressure air in the pipe 15 takes only a fraction of a second to escape through the open valves 10 and the hatch opened by the gate valve 22, whereafter the gate valve 22 is closed again and the low-pressure air duct 9 is opened with the same movement. A zone of low pressure is then created above the rising water column to encourage the water level to

reach a level which is just below the butterfly valves 10 in the left-hand limb of the pipe 15.

As previously mentioned, the left-hand float 4 is released once the water level has risen to just above the top of the float 4 so that the float will rise with the water as the water level rises, thus pulling on the cable 13. Meanwhile, the float 4 in the right-hand limb is allowed to ride down on the descending water level in that limb until the float engages and is held with the float-retaining mechanism 6.

The sequence is then reversed so that the water level drops in the left-hand limb with the float 4 on top of it and with high-pressure air assisting this movement. The water rises up the right-hand limb with the associated float 4 drawing the other length of cable 13. It is the rising strokes of the floats 4 which produce the pulls on the cables 13 which in turn drive the electrical generator. The sequence can be repeated continuously so long as the required pressure difference between the high and low pressures is maintained.

It will be appreciated that the apparatus can be adapted to cover the use of any other fluid in the system and any alteration in the application of the required pressure difference above the water column can be accomplished by, for example a chemical action and reaction, heating and cooling, or any other suitable method.

Referring more particularly to Fig. 5, it is intended that the apparatus be used in conjunction with an electrical generator or alternator so constructed as a gyro which is to rotate in a vacuum. This method allows a higher electrical output as compared with conventional units. Such a construction can incorporate a free wheeling drive to counteract any intermittent drive from the floats and special emphasis will be made as regards the construction of bearings and the type of lubrication so as to reduce friction as much as possible. The gyro will be started and accelerated to full operational speed by electric motors with an outside source of electricity and then will be kept in operation by the present apparatus.

Fig. 5 schematically shows suitable components for use in the power chain and the power take-off to ensure that the floats are not slowed down by overload and can rise simultaneously with the rising water column.

The cable take up drum 30 incorporates a rotation-reversing mechanism and planetary gearing 31 adaptable to give any desired range of gear ratio. The drum drive is connected by way of a shaft 32 to a torque converter 33. The torque converter can be placed inside the drum 30. A shaft 34 connects the torque converter to a free-wheeling drive 35 for the gyro fly wheel 36. A geared electric motor 37 is connected by way of a clutch 38 and shafts 39, 40 to the drive 35, the motor 37 being used to accelerate the fly

wheel to full operating speed before start-up of the buoyancy apparatus.

The design of the fly wheel is important to maintain momentum and it is preferable that it is of a type using reinforced carbon fibres in composite with steel and to arrange the fly wheel in an evacuated housing 41 and to suspend it electromagnetically by an electromagnetic suspension ring 42. The fly wheel 36 is connected by a drive 43 to an electrical generator or alternator (not shown). Such a generator or alternator could also be of a similar design so that it acts as a gyro fly wheel which is driven suspended in a vacuum.

Referring now to Figs. 6 and 7, a modified form of apparatus is shown in which the floats are adapted to develop useful power during their downward strokes as well as during their upward strokes. This modification would almost double the power output. As shown, the floats have, in their upper part-spherical regions, openings which can be closed off by hinged, hatch-like flaps 22 which can be electromagnetically opened and closed from inside the floats and in the closed position set on a recessed seat which is fitted with a durable and abrasion resistant seal so as to attain a flush outside surface when closed and to be air and water tight.

In the open position, these flaps 22 allow a substantial through-flow and have two functions, firstly to give air access to the inside of the float and secondly to let air escape from the inside of the float.

Similar openings and flaps 23 are incorporated in the lower parts of the floats 4 but are larger than the flaps 22. The flaps 23 are positioned just above the float retaining mechanism depending from beneath each float 4. The lower end of the float is provided with a conical space 4B, this space allowing water in the float to drain quickly and completely through the flaps 23 when required.

The sequence of operations in this embodiment is as follows. After the float 4 that has been previously exposed to air in the high-pressure side of the pipe 15 and is now filled with this air, all flaps being closed so that the float is air and water tight, arrives at the top of the limb, about 1 metre before the highest point, both sets of flaps 22, 23 are opened simultaneously. The water contained in the enlarged diameter upper portion of that limb of the pipe 15 rushes in through the openings opened by the flaps 23, thereby filling the inside of the float, whilst the air from inside the float rushes out through the openings opened by the flaps 22 and this air fills a space which the water has just left. This action has the effect of gently stopping the upward movement of the rising float. After the float is completely filled with water, all the flaps 22, 23 close and the float is again watertight.

The normal sequence of operation continues, with the high pressure air valves 10 open so that the high water column drops and so the float 4, filled with water, exerts a downward force as it is allowed to drop with the falling water level. Advantage can be taken of the downwards movement of the float by allowing it to exert a force to drive the fly wheel 36.

Shortly before the water-filled float 4 reaches the float retaining mechanism 6, all the flaps 22, 23 are again opened, the water drains quickly over the cone 4B while air of higher pressure fills the float and speeds up this action. After the float 4 is held in the retaining mechanism 6, all the flaps 22, 23 are again closed so that the float contains air and is again air and water tight and ready for a further upward movement.

Since in this case power is developed on both the upward and downward strokes of each float, a different form of power take-off is required. Figs. 6 and 7 show a simple mechanical form of power take-off with an endless chain drive running over sprockets. As shown in more detail in Fig. 7, the chain drive can include a drive chain 26 running over a large sprocket wheel 24 connected with the planetary gearing 31 (no rotation reversing mechanism being needed) and smaller sprocket wheels 25. Chain transport hooks 44 are pivotably mounted on each float 4, these hooks being rotatable intermediate their ends about pins 45. Stops 29 are provided to limit the travel of the hooks 44 once they have engaged with cross-bars 27 of the drive chain 26.

The hooks 44 on one side of each float 4 are arranged to work in unison with one another by means of a push rod 46 operated by an electromagnetic control 47. The whole assembly is mounted on a flange 28 of the float 4. The other side of the float 4 has an independently operable set of hooks 44 facing in the opposite direction.

In operation, taking the left-hand float 4 shown in Fig. 6 as an example, the left-hand set of hooks 44 is swung into engagement with the chain 26 to transmit power developed during the upward movement of the float and the right-hand set of hooks 44 is swung into engagement with the chain 26 to transmit power during the downward movement of the float 4.

It will be appreciated that other forms of power take-off could be used, e.g. hydraulic drive with electromagnetic coupling or linear generators built into the walls of the pipe 15 close to the guide rails 7, also with electromagnetic coupling, and arranged to generate electricity upon movement of the floats.

In both embodiments, the enlargement in diameter of the lower section of the pipe 15 is arranged so that the ring section around a stationary float has the same area as the

cross-section of the float itself, thereby to achieve an unrestricted flow of water around the float.

Instead of providing the axial and radial fans for providing the air pressure difference, it could be possible to incorporate an aircraft-type turbo engine which can be adapted to run on hydrogen. The hydrogen could possibly be produced by using part electrolysis and part heat application. Accordingly, the high exhaust air temperatures at the exhaust of the turbo engine can be used to heat water in hydrogen extractions cells, which act as heat exchangers. There will be a pressure drop by cooling down the hot exhaust air but the remaining pressure would be sufficient to provide the air pressure difference in the apparatus. The fresh water to feed the electrolysis cells will first be used to cool the turbo engine before running into the cells, because the engine would not be cooled by an air stream as in normal operation.

A turbo fan placed behind the jet nozzle and driven by exhaust thrust will supply the combustion chambers with fresh oxygen-rich outside air necessary for complete combustion of the hydrogen gas.

CLAIMS

1. An apparatus for driving an electrical generator, comprising a closed circuit system to utilise the potential energy of a buoyant component immersed in a fluid, said system including two floats, one in each limb of a U-tube, the floats each being less dense than a liquid to be used to transport the floats in the U-tube, means to cause the liquid to reciprocate in and between each limb, means releasably to hold each float within the liquid as the liquid rises up each limb and power take-off means associated with each float to drive the generator upon movement of the float upwards with the rising liquid level after the float has been released.

2. An apparatus as claimed in Claim 1, wherein said U-tube has an enlarged diameter in the region of the bend of the "U".

3. An apparatus as claimed in Claim 1 or 2, wherein said means to hold each float comprises, for each float, a float-retaining mechanism fixably mounted on a supporting member inside and near the foot of a respective limb of the U-tube, this mechanism being able releasably to engage with a part depending from the base of the associated float.

4. An apparatus as claimed in Claim 3, wherein each float retaining mechanism is electromagnetically actuated.

5. An apparatus as claimed in any one of the preceding claims, wherein the upper part of each limb carries a head which contains two valves each arranged to allow a large through-flow area to be opened or closed quickly.

6. An apparatus as claimed in Claim 5,



The normal sequence of operation continues, with the high pressure air valves 10 open so that the high water column drops and so the float 4, filled with water, exerts a downward force as it is allowed to drop with the falling water level. Advantage can be taken of the downwards movement of the float by allowing it to exert a force to drive the fly wheel 36.

Shortly before the water-filled float 4 reaches the float retaining mechanism 6, all the flaps 22, 23 are again opened, the water drains quickly over the cone 4B while air of higher pressure fills the float and speeds up this action. After the float 4 is held in the retaining mechanism 6, all the flaps 22, 23 are again closed so that the float contains air and is again air and water tight and ready for a further upward movement.

Since in this case power is developed on both the upward and downward strokes of each float, a different form of power take-off is required. Figs. 6 and 7 show a simple mechanical form of power take-off with an endless chain drive running over sprockets. As shown in more detail in Fig. 7, the chain drive can include a drive chain 26 running over a large sprocket wheel 24 connected with the planetary gearing 31 (no rotation reversing mechanism being needed) and smaller sprocket wheels 25. Chain transport hooks 44 are pivotably mounted on each float 4, these hooks being rotatable intermediate their ends about pins 45. Stops 29 are provided to limit the travel of the hooks 44 once they have engaged with cross-bars 27 of the drive chain 26.

The hooks 44 on one side of each float 4 are arranged to work in unison with one another by means of a push rod 46 operated by an electromagnetic control 47. The whole assembly is mounted on a flange 28 of the float 4. The other side of the float 4 has an independently operable set of hooks 44 facing in the opposite direction.

In operation, taking the left-hand float 4 shown in Fig. 6 as an example, the left-hand set of hooks 44 is swung into engagement with the chain 26 to transmit power developed during the upward movement of the float and the right-hand set of hooks 44 is swung into engagement with the chain 26 to transmit power during the downward movement of the float 4.

It will be appreciated that other forms of power take-off could be used, e.g. hydraulic drive with electromagnetic coupling or linear generators built into the walls of the pipe 15 close to the guide rails 7, also with electromagnetic coupling, and arranged to generate electricity upon movement of the floats.

In both embodiments, the enlargement in diameter of the lower section of the pipe 15 is arranged so that the ring section around a stationary float has the same area as the

cross-section of the float itself, thereby to achieve an unrestricted flow of water around the float.

Instead of providing the axial and radial fans for providing the air pressure difference, it could be possible to incorporate an aircraft-type turbo engine which can be adapted to run on hydrogen. The hydrogen could possibly be produced by using part electrolysis and part heat application. Accordingly, the high exhaust air temperatures at the exhaust of the turbo engine can be used to heat water in hydrogen extractions cells, which act as heat exchangers. There will be a pressure drop by cooling down the hot exhaust air but the remaining pressure would be sufficient to provide the air pressure difference in the apparatus. The fresh water to feed the electrolysis cells will first be used to cool the turbo engine before running into the cells, because the engine would not be cooled by an air stream as in normal operation.

A turbo fan placed behind the jet nozzle and driven by exhaust thrust will supply the combustion chambers with fresh oxygen-rich outside air necessary for complete combustion of the hydrogen gas.

CLAIMS

1. An apparatus for driving an electrical generator, comprising a closed circuit system to utilise the potential energy of a buoyant component immersed in a fluid, said system including two floats, one in each limb of a U-tube, the floats each being less dense than a liquid to be used to transport the floats in the U-tube, means to cause the liquid to reciprocate in and between each limb, means releasably to hold each float within the liquid as the liquid rises up each limb and power take-off means associated with each float to drive the generator upon movement of the float upwards with the rising liquid level after the float has been released.

2. An apparatus as claimed in Claim 1, wherein said U-tube has an enlarged diameter in the region of the bend of the "U".

3. An apparatus as claimed in Claim 1 or 2, wherein said means to hold each float comprises, for each float, a float-retaining mechanism fixably mounted on a supporting member inside and near the foot of a respective limb of the U-tube, this mechanism being able releasably to engage with a part depending from the base of the associated float.

4. An apparatus as claimed in Claim 3, wherein each float retaining mechanism is electromagnetically actuated.

5. An apparatus as claimed in any one of the preceding claims, wherein the upper part of each limb carries a head which contains two valves each arranged to allow a large through-flow area to be opened or closed quickly.

6. An apparatus as claimed in Claim 5,



wherein each valve is a butterfly valve.

7. An apparatus as claimed in Claim 5 or 6, wherein each valve is electromagnetically operated.

- 5 8. An apparatus as claimed in Claim 5, 6 or 7, wherein one of the valves in each head gives access to an air tank intended to contain air at a pressure below atmospheric pressure and the other valve in that head gives access
10 to an air tank intended to contain air at a pressure above atmospheric pressure.

9. An apparatus as claimed in any one of Claim 5 to 8, wherein the upper end of each limb of said U-tube is of greater diameter than
15 the main part of the limb so as to present a dished shape, there being a partition wall dividing each upper end of each limb in half, each half carrying one of said valves.

10. An apparatus as claimed in any one of the preceding claims, wherein one of the limbs of said U-tube is provided with a bleeder valve to allow air to escape when filling the tube with liquid for start-up of the apparatus.

- 25 11. An apparatus as claimed in Claim 10, wherein a means is provided to supply air under high pressure to the other limb of said tube to prevent liquid from rising up that limb when the liquid is being introduced to the
30 tube upon start-up of the apparatus.

12. An apparatus as claimed in any one of the preceding claims, wherein each float is constructed from a high grade marine aluminium.

- 35 13. An apparatus as claimed in any one of the preceding claims, wherein rollers are fitted to the sides of the floats, these rollers positioning the floats in the centre of the respective limbs of the tube by running in guide rails
40 on the inside of each limb.

14. An apparatus as claimed in any one of the preceding claims, wherein the inside surfaces of the U-tube and the outside surfaces of the floats have a friction-reducing coating.

- 45 15. An apparatus as claimed in Claim 8 or any one of claims 9 to 14 as appendant to Claim 8, wherein the two air tanks are interconnected by at least one large capacity fan to provide said pressure difference.

- 50 16. An apparatus as claimed in any one of the preceding claims, wherein said power take-off means comprises a cable clamped to the bottom of each float and taken out through the base of the U-tube, sealing means
55 being provided to prevent liquid loss from the tube where the cable is run out, the cable being wound onto a rotatable drum so that upward movement of one float simultaneously with downward movement of the other float
60 will cause rotation of said drum in one direction and *vice versa*.

17. An apparatus as claimed in Claim 16, wherein gearing is provided to convert the movement of said drum into constant rotary
65 motion in a single direction to drive the gener-

ator:

18. An apparatus as claimed in Claim 16 or 17, wherein each float is filled with helium to improve its buoyancy.

- 70 19. An apparatus as claimed in any one of Claims 1 to 15, wherein each float is adapted to develop useful power during its downward stroke as well as during its upward stroke.

20. An apparatus as claimed in Claim 19,
75 wherein each float is adapted to develop useful power during its downward stroke by being provided with means to admit liquid to the float and to allow gas to escape from the float as the float approaches its upper limit of
80 travel, this arrangement being such that the weight of the float with the liquid inside it can be utilised as the liquid level falls to drive the power take-off means on the downward stroke, each float being arranged to allow the
85 liquid to drain therefrom to readmit gas as the float reaches its lower limit of travel.

21. An apparatus as claimed in Claim 19 or 20, wherein said power take-off means comprises an endless chain drive associated
90 with each float, each chain having two major runs that are parallel to the limbs of the U-tube, each float having retractable means that can engage one run of the chain during upward movement of the float and the other
95 run of the chain during downward movement of the float so that the chain is driven in a single direction, means being provided to transmit the movement of the chains to drive the generator.

- 100 22. An apparatus as claimed in any one of Claims 1 to 15 or Claim 19 or 20, wherein said power take-off means is a hydraulic drive with electromagnetic coupling.

23. An apparatus as claimed in any one of
105 Claims 1 to 15 or Claim 19 or 20, wherein said power take-off means comprises a linear generator incorporated in the walls of the U-tube and arranged to generate electricity upon movement of the floats.

- 110 24. An apparatus as claimed in Claim 8 or any one of Claims 9 to 23 except Claim 15, wherein a turbo engine is interposed between said tanks to provide the air pressure difference therebetween.

- 115 25. An apparatus as claimed in any one of the preceding claims, wherein said means to cause the liquid to reciprocate in and between each limb includes a gate valve which is intended to be used upon start-up of the
120 apparatus to allow air above atmospheric pressure, which has been built up above a liquid level in one of the limbs, to escape to the atmosphere through a hatch, whereafter the hatch is closed by the gate valve to connect
125 this limb to a source of air below atmospheric pressure.

26. An apparatus as claimed in any one of the preceding claims except Claim 23, wherein said electrical generator is present
130 and is constructed as a gyro which is to rotate



in a vacuum.

27. An apparatus as claimed in Claim 26, wherein said generator is provided with a free wheeling drive to counteract any intermittent drive output from the floats.

28. An apparatus as claimed in any one of the preceding claims, wherein said power take-off means includes components to ensure that the floats are not slowed down by overload and can rise simultaneously with the rising water column.

29. An apparatus as claimed in any one of the preceding claims, and comprising an electronic control system to initiate start-up of the apparatus and to control the sequence of movements of the various parts of the apparatus in use.

30. An apparatus for driving an electrical generator, substantially as hereinbefore described with reference to Figs. 1 to 5, with or without the modification of Figs. 6 and 7 of the accompanying drawings.

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