

SYSTEM AND METHOD FOR THE AUTONOMOUS PRODUCTION OF FLUID AND ELECTRICITY

"THE PRINCIPLES OF AUTONOMOUS SERIAL DEPRESSION AND COMPRESSION"

Prior art

The various artificial methods of pumping that exist today all have one factor in common in that they require a source of energy mechanical, electrical, solar, wind or hydrodynamic in order to be able to produce hydraulic or hydrodynamic energy needed for transferring liquid or from one point to another. There are electrical pumps (submersible or axial ones with the electric motor at the surface) which, as the name implies, require electrical energy in order to be able to pump a liquid from one point to another. There are also man-powered piston pumps which are used for pumping water from bore-holes. These pumps require a constant input of manpower in order to operate. There are also pumps of the Glockeman type which also operate continuously but requires a drop or natural source in order to be capable of operating autonomously.

All these various pumping systems require external energy; they need mechanical movement in order to supply the hydraulic energy necessary for displacing liquids. Therefore, they are subject to mechanical component wear which means that the more they are used, the more their life becomes shortened. The hand pumps fitted to almost all village bore-holes in the third world do not last very long because they wear out quite quickly. The best of these pumps has difficulty in reaching a depth of 100 m, and this makes this type of pump impractical in certain basement regions where the water table lies at a depth beyond 100 m. Recourse is then had to a system of submerged pumps using solar panels or even electric generator sets. The maximum delivery that these hand pumps can pump decreases greatly with depth. Most of these pumps have a mean hourly flow rate of 750 litres making access to drinking water in the villages difficult. That leads to long queues. Therefore, these pumping systems cannot readily be applied to most developing countries, particularly when the issue is one of irrigation or of effective distribution of drinking water.

One of the crucial problems of today's era is the production of "green" energy. Nowadays, all the most widely used energy production systems are based on fossil fuels. There are power stations which require fossil fuel in order to produce electricity. The burning of these fuels produces carbon dioxide gas and other greenhouse gases

responsible for global warming. These power stations use so-called combustion engines which, on start-up, turn a shaft which drives the alternator which in turn generates electricity.

Nuclear power stations use fissile fuel to heat up water the steam from which is directed at high pressure to turbines and turns these. The spinning of these turbines then drives an alternator which produces electrical energy as it rotates. Nuclear power stations do not produce greenhouse gases but do, however, emit a great deal of radioactive waste which is very difficult to control. Nuclear power stations, irrespective of where they are situated, present global dangers in the event of an accident like the one that befell the nuclear power station at Chernobyl. Their cost of investment and the skills required to control these nuclear power stations are enormous and for this reason a great many countries throughout the world cannot even dream of using such technology.

Nowadays, a great deal of effort has been turned towards renewable energy such as solar energy, wind energy, geothermal energy, etc.

Solar energy uses the rays of the sun to energize photovoltaic panels which at output supply electrical energy. This is a non-polluting and cost-free energy although the cost of the solar equipment is still exorbitant and, furthermore, seasonal or climatic changes affect the performance of the photovoltaic systems. That makes them somewhat unattractive and inapplicable for power consumption on a scale experienced in built-up areas. Wind energy is widely used in many developed countries but then again, wind is required in order to create this energy. Wind systems are not under human control. They are dependent on wind cycles. They can be used only as a top-up in support of other energy production systems.

In the case of wind energy, it is the wind that drives a turbine which in turn turns the alternator which produces electricity.

All of the abovementioned systems convert energy received into a rotational movement which drives an alternator, thus producing electricity. The ideal case is that of hydroelectric power stations which use a continual drop of water to produce a fairly substantial amount of energy. Hydroelectric dams are the best systems because they do not pollute, they do not require the addition of fuel and do not produce greenhouse gases. However, these hydroelectric dams can be built only where there is a natural drop with the height of the drop being fairly great in order to allow operation. That limits their use geographically; hydroelectric power stations cannot be created. Hydroelectric power stations can be built on sites where technical studies show that there is potential

for them. Many have conceived of the idea of building a closed-loop hydroelectric power station, that is to say a power station consisting of a reservoir at a height and another reservoir down below. The idea was to cause the water to fall or drop from the reservoir at a height, this drop driving a turbine to produce electricity. A pump would be installed in the collecting reservoir at the bottom so that the water could be pumped backed up to the reservoir built at the top. However, such a system is impossible to realize because the turbine will already dissipate some of the potential energy of the falling water because of friction and, secondly, the total energy absorbed by the pump is not 100% converted into hydraulic energy for returning water to the initial reservoir. A closed hydroelectric system is impossible. Hence the need to find a natural drop for the flow.

Description of the invention

The present invention will therefore solve the problem of the supply of external energy for conversion into hydraulic energy required for pumping or transporting a fluid from one point to another. The invention consists in a method based on the principles of autonomous serial depression or expansion and compression and a system allowing any liquid in contact with the system to be pumped autonomously and continuously. The system does not have any immersed pump or a mechanical piston nor does it require an external energy supply in order to be able to operate continuously. With these aforementioned features, the system has solved one of the greatest problems: the need to use external energy.

Autonomous serial depression

The principle of serial depression is based on the fact that a gas contained in a non-isolated closed system can receive work from the external surroundings or supply work to the external surroundings. A non-isolated closed thermodynamic system is a system which does not exchange material with the external surroundings but may exchange all kinds of energy with the external surroundings (for example heat, mechanical force, displacement, etc.).

The present invention therefore exploits the situation whereby it is the closed system which supplies work to the external surroundings. Here we are dealing mainly with compressible fluids.

Let us consider the case of a compressible fluid, for example air, contained in a tube that is isolated from the external surroundings by a plug of negligible weight which is

able to slide without any friction along the wall of the tube. If the pressure in the external surroundings is reduced to below the pressure obtaining inside the system, the plug will move under the effect of the expanding of the compressible fluid located inside the system. The system is then said to be supplying work.

Figure 1 depicts two chambers separated by an impervious plug of negligible weight. The plug is secured by two pins [100] in order to hold the plug in position against differential pressures. Let V_1 and P_1 respectively be the volume and the pressure in compartment B and let P_{ex} be the pressure in compartment A such that $P_{ex} \ll P_1$. When the two pins [100] are removed, the plug [101] is pushed upwards because of the expanding of the gas as shown by Figure 2. This is the result of the work of the gas contained in chamber [B].

The work performed by the system results in an increase in volume [103] which corresponds to the equation:

$$w = -P_{ex} dV \quad (\text{Equation 1})$$

Where P_{ex} is the pressure obtaining in the external surroundings and dV is the variation in volume [103].

Let us reconsider the same experiment but instead of having a plug able to slide without friction under the effect of the expanding or expansion of the gas, we replace this with a plug [104] which is completely fixed to the wall of the tube by welding or bonding. This plug cannot therefore move as the gas expands. Let us now fill compartment B with an incompressible liquid [107]. Let us have a tube [106] pass through the plug [104] between compartments A and B. This tube [106] penetrates by a certain depth so as to avoid any exchange of gas between compartment B and compartment A. This system is therefore a closed non-isolated thermodynamic system in which the floating plug is replaced by an incompressible liquid. The tube [106] which passes through the two compartments is isolated by a valve [105]. When the valve [105] is closed as shown in Figure 3, the two compartments A and B are thermodynamically closed and isolated. Let us keep the pressure P_{ex} of the gas in compartment A lower than the pressure P_1 of the gas [110] obtaining above the liquid in compartment B. If the valve [105] is kept closed, the two compartments are therefore isolated from one another as shown by Figure 3. Under such conditions, nothing happens in compartment B. If the valve [105] is opened [slowly], because the

pressure P_{ex} in compartment A is lower than the pressure of the gas [110] in compartment B, this gas will begin an isothermal expansion which will therefore cause the liquid [107] in compartment B to rise up along the tube [106] as shown in Figure 4. This rising of liquid is accompanied by an increase in the volume of gas [110] in the compartment. This increase in volume [108] is the result of the work performed by the gas [110] of compartment B. The increase in volume with no exchange of material in compartment B is therefore accompanied by a drop in the pressure P_1 of the gas [110].

The total work performed by the gas [110] in its expansion is therefore expressed by the following relationship:

$$w = -Pdv - mgh = -P_{ex}dV \quad (\text{Equation 2})$$

Where P is the pressure of the gas in compartment B, dv is the variation in the volume [108] of the gas [110] in Figure 4, m is the mass of the liquid, g is the acceleration due to gravity and h is the height or head [111] of the incompressible liquid [107] in the tube [106]. P_{ex} is the pressure outside the compartment B obtaining in compartment A, dV is the variation in volume [103] in Figure 2.

The condition for the liquid [107] to completely fill the tube [106] is that the work supplied by the expanding or expansion of the gas [110] be sufficient to provide the required work. And that is connected directly to the magnitude of the pressure P_{ex} in compartment A. In the experimental device of Figure 3 and Figure 4 the work that has to be supplied for the liquid [107] to completely fill the length of the tube [106] is described by the formula below which has been devised taking experimental factors into consideration:

$$W = -\frac{P_1V_1}{(V_1 + V_t)} \lambda^{-\frac{\rho g V_t^2 \sin \alpha}{RTV_{isp}}} \iiint dv - \frac{\rho g dv^2}{V_{isp}} \sin \alpha \quad / \quad (\text{Equation 3})$$

P_1 and V_1 respectively are the pressure and the volume of the gas [110] in the initial state, that is to say prior to the opening of the valve [105]; ρ is the density of the liquid [107]; g is the acceleration due to gravity, R is the universal gas constant; T is the

temperature of the gas; V_t is the total volume of the tube [106]; V_{tsp} is the specific volume of the tube [106]; α is the angle between the system and the horizontal plane. The pressure of the gas [110] in compartment B when the work performed is great enough for the liquid [107] to rise the full height of the tube [106] is expressed by the equation described by Equation 4. This pressure is known as the *critical pressure*, P_c , above which the liquid [107] will overspill from the tube into compartment A. It is expressed by the following expression:

$$P_c = \frac{P_1 V_1}{V_1 + V_t} \lambda^{-\frac{\rho g V_t^2 \sin \alpha}{RT V_{tsp}}} \quad (\text{Equation 4})$$

The total work supplied by the isothermal expansion of the gas [110] is therefore expressed by the relationship below, which is the solution of Equation 3:

$$W = -\frac{P_1 V_1}{(V_1 + V_t)} \lambda^{\left(-\frac{\rho g V_t^2 \sin \alpha}{RT V_{tsp}} + \ln V_t\right)} - \frac{\rho g V_t^2}{V_{tsp}} \sin \alpha \quad (\text{Equation 5})$$

The reduction of the pressure of the gas [110] in compartment B as a result of the expanding thereof can be exploited by way of external pressure by another non-isolated closed system similar to the system of Figures 3 and 4. That amounts to arranging these simple devices of the model studied in Figures 3 and 4 in series by stacking them one on top of the other as shown by Figure 5. This device is made up therefore of a series of thermodynamic systems that are closed and isolated in terms of the gas stored above the liquid of each system. The number of moles of these gases remains constant because there is no exchange of material with the other systems. However, from the thermodynamic standpoint, the incompressible liquid behaves as in an open system because there is the possibility of liquid being transferred from one system to another. It is therefore this combination of systems between the liquid and the gas which will therefore be crucial to the operating of the entire system as set out in Figure 5. The expanding of the gas contained in a closed and isolated system will supply the work needed for transporting the liquid contained in an open system from one system to another.

In the device of Figure 5, if a lower pressure is applied to the gas in the first system [112] this (that?) will cause the expanding of the system [114] located below it and this "series or serial expansion or depression" will spread to the last system [115] dependent on the pressure created at the first system [112]. The last system [115] is connected directly by a tube [117] to the external surroundings (external system [116] containing liquid above which there is a pressure P which may in most cases be atmospheric pressure or a different pressure if this external system is likewise closed to the atmosphere. This pressure P is more or less equal to the initial pressures of the gases of each system of the device of Figure 5. If the pressure applied to the first system [112] is sufficient to cause the gas contained in the last system [115] to expand. This expanding will in turn cause a reduction in pressure in the system [115]. That will create a pressure differential between the ambient pressure of the external system [115] the consequence of which will be that the liquid contained in the system [115] will rise up inside the tube [117]. The arrival of liquid in the system [112] will increase the pressure of the gas in this system and this will cause a further rising of the liquid in system [112] towards the system situated above. This rise will continue sequentially – the term employed is "serial flow" until the liquid reaches the first system and becomes deposited [113] there. If the pressure in the first system is kept constant, this serial depression followed by the serial flow will never end.

When the depression created in the first system [112] is great enough that the pressure in the last system [115] is equal to the critical pressure, the pressure P_i of the gas contained in each system i can be described or evaluated using the following equation:

$$P_i = P_{i-1} \lambda^{\left(\frac{\rho g d v_i^2 \sin \alpha}{RTV_{tsp}}\right)} + \frac{\rho g d v_i}{V_{tsp}} \quad (\text{Equation 6})$$

Where i is the rank of the system, downwards, and P_{ex} is the absolute pressure applied to the first system.

For a depression P_{ex} created at the first system [112] the maximum number n of thermodynamic systems to be arranged in series so that the pressure of the gas in the

last system is equal to the critical pressure P_c is calculated using the following equation:

$$n = -\frac{RTV_{tsp}}{(\rho g V_t^2 \sin \alpha)} \ln\left(\frac{P_{ex}(V_1 + V_t)}{P_1 V_1}\right) - 1 \quad (\text{Equation 7})$$

According to Equation 7, the number of systems to be placed in series tends towards a constant when the angle α tends towards 90 degrees, that is to say a vertical position. The magnitude of n is limited by the square of the volume of the tube, or, put differently, the mass m of the liquid because of the work ($-mgh$) that has to be supplied in order to cause the water in the tube to rise.

However, if the angle α tends towards zero, the total number of systems n tends towards plus infinity, which means to say that if this system is installed in a horizontal plane, that is to say is laid out along the surface of the ground, the length of the system tends towards plus infinity. This means that this system is the ideal pipeline for transporting liquid from one point to another. Hence, pressure losses due to friction are negligible and can be considered to be zero especially since these losses are confined only to the losses all along the tube [106] of each system only, these pressure drops do not add up. That means that the device can be of enormous length as shown in Figure 5. The layout of the tubes has no influence on the system. The tubes may come in various forms as for example in Figure 6.

Hence, knowing the total number of systems mounted in series, it is possible to calculate the depression P_{exR} that has to be created at the first system [112] in order to be able to achieve the critical pressure P_c in the last system, by applying the following equation:

$$P_{exR} = \frac{P_1 V_1}{V_1 + V_t} \lambda^{-\frac{\rho g V_t^2 (n+1) \sin \alpha}{RTV_{tsp}}} \quad (\text{Equation 8})$$

The condition for serial flow to continue as far as the reservoir is dependent on the differential pressure between the pressure above the liquid [116] and the pressure of the gas inside the last system [115]. This differential has to be great enough to cause the liquid [125] to rise the full height of the tube [117] and overspill into the last system [115].

Hence, in order for this system to operate continuously, it is important to note that the pressure of the gas [110] has to be above the boiling pressure. Below this pressure,

the dissolved gases will gasify and will make up the pressure difference in the system adjacent to the first system. Gases coming out of the liquid phase will therefore increase the pressure of the gas above the liquid, and this will not allow autonomous serial depression to be activated. The critical pressure P_c and the pressure of the first system P_{ex} absolutely must be above the boiling pressure. In the case of water, the boiling pressure even at 50 degrees Celsius is sufficiently low (0.123 bar) and can be estimated for all temperatures ranging between 5 and 140 degrees Celsius using the following equation:

$$\ln p_{sat} = 13.7 - \frac{5120}{T} \quad (\text{Equation 9})$$

Where T is the temperature on the Rankine scale and P_{sat} is the saturation pressure in atmospheres.

The device of Figure 5 is therefore capable of an autonomous serial depression followed by an autonomous serial flow. This operation will be perpetual provided that the external system does not run out of liquid and provided that the depression created in the first system [112] is kept constant. In practical terms, that can be achieved by using a vacuum pump connected to the system [112]; flow will be continuous. Using a vacuum pump means using energy from an external (electrical or mechanical) source. It is therefore one of the well known properties of fluid mechanics which will be used to create the depression needed in the system [112] in order to ensure continuous operation of the system or perpetual operation of the system. Let us consider a device like the one described in Figure 7. It is made up of a pipe filled with liquid up to a height [119]. Above the free surface of the liquid there obtains a normal pressure which may be equal to the ambient pressure of the gas of the external surroundings. The pipe has a drain orifice [122] closed by a valve [121]. When the valve [121] is open, water flows from the orifice under its self weight. This flow causes an increase in the volume of the gas [123], similar to expanding but expanding forced by the flow of the water. The consequence of that is that it reduces the pressure of the gas [123]. If the extension [124] of Figure 7 is connected to the first system [112] of Figure 5 as shown by Figure 8, the depression of the gas [123] will create a reduction in pressure required at the first system [112] to activate the autonomous serial depression. Further, if this pressure P_{ex} at the system [112] is equal to the pressure described by

Equation 8, the autonomous serial depression will be followed by autonomous serial flow.

Flow through the opening [122] will cease at a minimal head or height described by the following equation:

$$H_{\min} = \frac{P_{\text{atm}} - P_{\text{ex}}}{\rho g} \quad (\text{Equation 10})$$

Where P_{atm} is the external pressure corresponding to atmospheric pressure in a system open to the atmosphere. If the connecting of the extension [124] is performed at the base [125] of the system [112], the serial flow will increase the level of the liquid which will therefore flow through the extension [124] of the motive column of Figure 7. The height of this motive column needs to be fairly tall so that when the level of the liquid reaches the minimum height or head $H_{\min}$ at which flow at the tap [122] ceases, the gas pressure P_{ex} is equal to the pressure P_{exR} needed to activate autonomous serial depression and autonomous serial flow.

Autonomous serial compression

Also, the same system as described above using the principle of autonomous serial depression can be used by creating an autonomous serial compression. In order to achieve this (that), all that is required is for the pump to be immersed by a sufficient depth to cause compression of the gas contained above the liquid. The key objective is to create a compression so that there is a differential with respect to the external or ambient pressure. At the same time as compression is taking place and because the liquid is open to the system located above it at a lower pressure, the gas being compressed will supply work which will cause the liquid in the system to rise into the compartment above. The gas is compressed by the ingress of liquid via its submerged part. The ingress of liquid into the system therefore reduces the volume of the air hence increasing its pressure. The compression pressure is equal to the hydrostatic pressure or head of liquid in which the pump is immersed. Figure 13 shows the pump operating in autonomous serial compression mode. The total work received and produced by the gas is described by the following relationship.

$$w = P_h dv_h - \sum_{i=1}^{n-1} p_i dv + \sum_{i=1}^{n-1} p_i dv - \sum_{i=1}^n mgh_i - p_n dv = 0 \quad (\text{Equation 11})$$

Where P_h is the hydrostatic pressure on immersion in the liquid, dv_h is the volume of compressed gas, P is the pressure of the gas after it has been extended, dv is the volume gained by the gas as it expands, and dV is the total variation in the volume of the gas when contained in an isolated system to which P_h is applied.

Resolving Equation 11 yields the following expression that describes the pressure of the gas during activation of the autonomous serial compression in each system as a function of the hydrostatic pressure P_h . It represents the pressure needed in order to cause the liquid to rise the full height h_t of the tube:

$$P_i = P_h \lambda^{-\left(\frac{\rho g V_i^2 \sin \alpha}{RTV_{tsp}}\right)_i} \quad (\text{Equation 12})$$

In the autonomous serial compression system there is no need for a motive column. The pressure differential between the system and the external surroundings is therefore enough to allow serial flow when the depth of immersion is sufficient to activate serial compression. Equation 12 is valid when the compression pressure is below or equal to 1 bar. Above that, the assumption whereby compression follows the perfect gas law no longer holds true. The effects of real gases, involving other parameters, need to be taken into consideration.

FIELD OF APPLICATION

Bore-holes and water wells

This invention can be applied in the field of water. It can replace all extraction systems used today for the production of water. The depth that the system can reach is beyond several hundred metres. A simplification of this application is depicted in Figure 9. The motive column corresponds to the well head. The head height of this motive column must be designed to satisfy the condition needed for initiating the depression and the serial flow when the tap [128] is opened. If the capacity of the aquifer [129] to produce water is great enough, the head height of the well head [127] can be increased in order to have a sufficient pressure head. The tap [128] may be replaced by a series of hydrants so that a great many individuals can be served simultaneously. The design of this pump needs to take account of the maximum rate at which the aquifer [129] can

deliver so as to avoid the bore-hole or well running dry. The delivery of the pump must therefore be below the maximum rate at which water flows into the well or bore-hole. With this pump, a tower standing a height H above the ground can be filled directly. All that is required is for the pump to emerge from the well to a height that allows the tap [128] to empty its water directly into the tower. Apart from the desire to create a reserve of water, this pump can operate without a tower. It can feed directly into water distribution mains networks for a village or a town. The limiting factor will be the rate of influx of water into the aquifer.

Autonomous production of electricity

This pump has solved the impossible problem of closed hydroelectric power stations as described hereinabove in the paragraph concerned with the prior art. Because the pump does not require external energy in order to raise water to any height above ground level, it is therefore able to create a hydroelectric energy production system in the form of a loop as shown by Figure 10. This device is made up of a reservoir [138] containing water [139]. The autonomous serial depression pump [131] is installed therein and covered at its apex by a motive column [132] containing water. The motive column is connected to the reservoir by a collecting pipe [133]. Connected to the end of this collector is a turbine [134] which in turn is connected to an electric alternator. Electrical cables [136] are connected to the alternator. When the valve [140] is opened, the water from the motive column [132] flows into the collecting pipe [133] and turns the turbine which then drives the alternator to produce electricity. The reduction in the amount of water in the motive column causes an extension of the gas [141] above the water. This expanding therefore creates a depression which activates the phenomena of depression and serial flow through the pump [131]. This pump draws water from the reservoir [138] and delivers it to the motive column. Perpetual flow is therefore obtained, driving the turbine [134] unendingly.

The design of the system has to satisfy the conditions necessary for this closed hydroelectric power station to operate. The electrical power generated by such a system is described by the following relationships:

$$Pkw = \rho Qhg \quad (\text{Equation 13})$$

$$h = H - \frac{Patm - Pex}{\rho g} \quad (\text{Equation 14})$$

Where Q is the flow rate, h is the effective head height of the drop and H is the head height [142] of the water in the motive column with respect to the shaft of the turbine [134]. This type of power station can be built on any scale from a small scale (sufficient to power a dwelling) to a large scale (sufficient to power a town). According to Equation 13, the electrical power is dependent on the head height h of the drop and on the flow rate Q . These two parameters will be under the control of the designer, so it will be possible to construct a system capable of generating possible amounts of power by adjusting the flow rate and the head height. To increase the flow rate Q it is possible to consider a design that uses several autonomous serial depression pumps in parallel as shown by Figure 11. In such an instance, Equation 13 becomes:

$$P_{kw} = \rho gh \sum_{j=1}^k Q_j \quad (\text{Equation 15})$$

Where k is the number of serial pumps placed in parallel and Q_j is the flow rate of each pump.

Liquid transport pipe line

In the equation describing the depression in each system (Equation 6), note the significance of the influence that the inclination has on pump performance. When the angle α ends towards zero, that is to say towards the horizontal plane, the depression in all the thermodynamic systems which make up the pump is the same. This amounts to the fact that this autonomous serial depression can be used to transport liquid over vast distances without supplying external energy. This property will allow the invention to be applied to the irrigation of large areas. The distribution of drinking water in built-up areas and also other liquids not connected with water. Water resource management will thereby be simplified. Figure 12 shows the configuration for switching from a vertical plane to a horizontal one.

Creation of works of art

These principles can be used to create autonomous public fountains or works of art of various kinds.

DESCRIPTION OF THE DRAWINGS

Plate 1/10:

This plate contains Figures 1 and 2. Figure 1 is a thermodynamic system with two compartments A and B in which there are gases at different pressures. The two compartments are separated by a fixed plug [101] of negligible weight held in position by a pin [100]. Figure 2 is the same system with the pins removed. The gas in compartment 2 expands, supplying work capable of moving the plug. At equilibrium, the pressure in the two compartments is the same.

Plate 2/10

Figures 3 and 4: depict a system as described in Figures 1 and 2 except that the two compartments are in communication by way of a tube [106] fitted with a valve allowing them to be isolated or placed in communication with one another. Here, the plug is replaced by a liquid capable of rising up the tube [106] according to whether or not the gas in compartment B extends.

Plate 3/10

Figure 5 depicts the serial depression or compression pump consisting of a series stack of devices as described in plate 2/10.

Figure 6 shows another way of arranging the tubes to allow the thermodynamic compartments to communicate with one another.

Plate 4/10

Figure 7: shows the motive column needed to create the depression that activates the serial depression.

Plate 5/10

Figure 8: showing the motive column and the serial depression pump fitted together.

Plate 6/10

Figure 9 showing the configuration allowing any fluid to be produced in a well.

Plate 7/10

Figure 10 describes a system that allows autonomous production of electrical energy. It comprises a reservoir, the autonomous pump, a turbine, an alternator and a collecting pipe.

Plate 8/10

Figure 12 showing a horizontal configuration for transporting liquid over the surface.

Plate 9/10

Figure 11 describing an autonomous electrical energy production station with a combination of several autonomous pumps placed in parallel.

Plate 10/10

Figure 13 showing the pump using autonomous serial compression.

CLAIMS

- 1 Pump equipped with a system (112, 114, 115) containing an enclosed gas placed in contact with an internal liquid, it being possible for the said enclosed gas to be placed at a depressed pressure or at a raised pressure in relation to the pressure of surroundings external to the said system by variations in level of the said liquid, characterized in that:
the said pump comprises a plurality of other systems (112, 114, 115) the respective liquid environments of which are connected continuously so that the compression or depression of the gas enclosed in one system (112, 114, 115) leads to successive variations in the levels of liquid in the other systems (112, 114, 115) following successive applications of raised pressure or depressed pressure to the gases contained in each of these systems (112, 114, 115) so as to allow the pumping of an external liquid in contact with the internal liquid of one of the said systems (112, 114, 115).
- 2 Pump according to Claim 1, characterized in that it consists in arranging the systems (112, 114, 115) in sequence by stacking these systems (112, 114, 115) vertically on top of one another.
- 3 Pump according to Claims 1 and 2, characterized in that a depressed pressure is maintained in at least one of the modules by using a vacuum pump or a motive water column.
- 4 Pump according to Claim 3, characterized in that the depressed pressure is created by a device comprising a column containing water and closed by a valve which, once opened, generates the depressed pressure.
- 5 Pump according to one of the preceding claims, characterized in that it exhibits partial immersion in the external liquid in order to supply the pressure necessary to activate the autonomous serial flow.
- 6 Device for producing electricity, characterized in that it comprises a pump according to one of Claims 1 to 5, and a turbine which is intended to be set in motion by the liquid pumped by the said pump.

- 7 Production device according to Claim 6, characterized in that it comprises the following equipments: a reservoir containing water, one or more pumps according to one of Claims 1 to 5, a motive column and a collecting pipe and a turbine.
- 8 Use of a pump according to one of Claims 1 to 5 for at least one of the following applications: transporting fluids over great distances, supplying a population with drinking water from a bore-hole or a well or by surface transportation, constructing and creating civil engineering or decorative structures, generating energy used to move a vehicle over land, over sea or through the air.