ISSN 1454 - 8003
Proceedings of 2024 International Conference on Hydraulics and Pneumatics - HERVEX
November 13-15, Băile Govora, Romania

WATER RUNNING ENGINE

Nicușor NICULAE[1]

[1] National Institute for Research and Development for Land Improvements, Bucharest, Romania (INCDIF- „ISPIF”), bcdispif@gmail.com

Abstract: *The present paper relates to a mechanism which can produce additional mechanical work by recirculation a quantity of water or other heavy and incompressible fluid. The mechanism is similar to the thermal engine because the mechanical work is obtained from the rectilinear - alternative stroke of a floating body with a very low density in relation to the density of water. The mechanism is complex being made up of many mechanical elements of connection and maintenance of the operating cycle. These mechanical elements are: levers, rods, taps, connecting hoses etc. However, its most important components are a water tank with a floating body inside and a water exhaust pump. The exhaust pump is positioned in the immediate vicinity of the tank, below its lower surface and together with the tank are fixed on a general frame of the mechanism. The tank is provided to have from construction, inside, some rollers arranged obliquely on certain generators equidistant at a certain number of degrees between them. The floating body being cylindrical like the tank, will have a spiral on the outer surface, spiral that must be in constant contact with the rollers so that it is imprinted to the floating body and a rotational movement in addition to the movement simple of ascension. This constructive solution was used so that when the water level rises in the tank, the floating body rotates, at the same time, obtaining an additional force from the floating body stroke compared to the simple Archimedes force. In this way the floating body also works as a force multiplier.*
This mechanism has, like the thermal engine, an operating cycle:
Time 1 - filling the tank with water;
Time 2 - emptying the water from the tank into the exhaust pump;
Time 3 - pumping water from inside the exhaust pump outside.
The water engine is not designed to be powered by any external power source (electrical mains) or to be powered by fuel, it operates only the basis of mechanical work obtained from the stroke of the floating body.
Can be used as engine as well as pump, as follows:
1. In case of use as an engine, the ballast or springs equipping the exhaust pump need to be calculated so that drain pump creates a pressure on the water inside the pump body only to pump water to the upper level of the tank, to benefit from a greater mechanical work.
2. When used as a pump, the weight or springs need to develop a maximum force on the water inside the pump, so that the pump can pump water to a height as high as possible.
The benefits of this mechanism can be anticipated, like as:
- zero pollution;
- low production costs compared to the thermal engines, because most of its components can be made of plastic and not metal as in the case of the thermal engine;
- can be a solution to the current and future energy crisis, or the crisis of non-renewable resources.

Keywords: *Cylindrical water tank, floating body, exhaust pump.*

1. Introduction

This paper is aimed to the engineers and physicists whose object of activity is the study of mechanism and devices that work with water or other heavy and incompressible fluids (the name of the field in the university environment being fluid mechanics and hydraulic machines), as well as other persons possessing solid knowledge of mathematic, physics and mechanic.
This paper presents the necessary and sufficient details to be making an engine mechanism what consists as main parts from a cylindrical water tank 20 (Figure 2) with a floating body 21 (Figure 2), also cylindrical, inside and an exhaust pump with flexible membrane 27 (Figure 2), pump situated next to the tank and positioned below its lower surface.
The exhaust pump with flexible membrane, of the water, exhaust carried out after filling the tank with water at the capacity allowed by the floating body inside it, works driven by the elastic force of some

springs 5 (Figure 2) or by a weight/ballast. The connection between the tank with the floating body inside it and the exhaust pump with the flexible membrane located next of the tank, will be assuring by a lever 28 (Figure 2), another component of the mechanism. This mechanism is complex, consisting of many other mechanical elements for connecting and maintaining movement and performing an operating cycle, such as: mechanically controlled taps, tensioning and supporting parts springs, in the tensioning position, parts for printing a rotational movement of the floating body inside the tank etc.
The usefulness of this engine mechanism is only predictable, it being an engine not yet realized and consequently untested. It is expected to be able to operate near all courses and accumulations of water if it is intended to function as a pump for pumping water. In this case, it can convert the hydrostatic pressure, from a certain depth of a water source, into pressure inside the exhaust pump with flexible membrane, pressure necessary to pump water to the exhaust.
If this engine mechanism is to function as an engine, like existing engines known and studied today (the thermal engine and the electric engine), it can produce the mechanical work by recirculating a quantity of water or other heavy and incompressible fluid.
The mechanism works in locations located below the water source and as an operating condition would be that the free surface of the water (FSW) in the water source is at the upper part of the floating body inside the tank, in the relaxed state of the mechanical system (then when the floating body inside the tank is at the bottom).
The mechanism works like the thermal engine based on a stroke and a force.
As is known, a body immersed in a liquid (water) is pushed from the bottom up with an Archimedes force. Suppose we have a cylindrical-shaped body with a determined volume of 1 m^3. If we determine that his height is 2 m, it follows that the radius of his base should be 0,4 m. If we push this body into a water accumulation, up to half, assuming it has a very small weight, it follows that we will perform a mechanical work on it: MW=500 kgfx1m. This fact in physics is called action. If we position this floating body in a water tank located in the immediate vicinity of a water source and located below the level of the free surface of the water in the water source, and we open a tap that connects the water in the water source with the tank, the level the water in the tank increases, the floating body inside the tank is pushed vertically upwards. A floating body race is thus obtained, called in physical reaction (reaction of the opening of the tap and subsequently of the increase of the water level inside the tank). Based on this fact the water engine works.
One might ask a legitimate question: why not push this floating body more or less into water? What would be the problem?
Answer: as long as the mechanism of the water engine exploits the reaction, namely the mechanical work done by the floating body resulting from rising the water level in the tank, if we push the floating body more than half (or completely) into the water, we could not benefit from the stroke of the floating body. If on contrary, we do not push this floating body into the water at all, we would the maximum stroke but not and the force. Therefore, only in the situation of, up to half, the maximum mechanical work can be getting. This will also result in the physical explanation of the process, namely that during the filling of the tank with water it is as we are pushing the floating body into the accumulation of water.
Suppose this floating body also has its own weight of about 10 kgf, it follows that we will perform for his a mechanical work of 490 kgfx1m to push his into the water to the middle of its height, vertically. It is obvious that this stroke and force have nothing to do with the principles of thermodynamics.
We will put this floating body in a water tank, which will have the shape almost identical to the floating body, being both cylindrical, between them being a very small space. The floating body can be made of plastic material and will have from construction practiced on the side surface a helix 37 (Figure 1) surrounding this lateral surface of it, in the form of thread.
The water tank will have inside, on several generators arranged at equal angles to each other on the circumference (for example, for 2 generators they will be arranged 180^o between them and for 3 generators they will be arranged 120^o between them) some rollers 41 (Figure 1) from place to place, at equal distances from each other on height, these rollers will be in contact with the helix made on

the side surface of the cylinder so that, when is moving the floating body inside the tank, will be imprinted it with a rotational movement in around own vertical axis.
The floating body will thus also work as a force multiplier, compared to the simple ascending Archimedes force (of 490 kgf in our case) This will result in an Archimedes force superior to the simple force, the force that will be called in continuation, the complementary Archimedes force (CAF), for abbreviation.
The floating body will have inside positioned in its center, vertically, to be able to be assembled in it a constructive element type: Mechanism of Screw Steering and Ball Oscillating Nut. This mechanism is known at the stage of the technique and is use because it has very small running rubbings in utilization. It will be termed the SDMON (screw drive mechanism and oscillating nut) for abbreviation. The oscillating nut 35 (Figure 1) of this mechanism will be stiff fixed with the floating body at the top of it. The screw of this mechanism (the worm axle 17 (Figure 1)) will have the pitch of the helix inversely to the pitch of the helix surrounding the floating body (if suppose that the pitch of the floating body´s helix is on the right, the pitch of the worm axle will be on left, or vice versa). We have resort to this SDOMN mechanism because by rotating the floating body inside the tank, the amplification and of the stroke to be getting, as will be seen below. This mechanism (SDMON) will work as a stroke multiplier. Since the floating body rotates in operation the axle 17 must be secured against rotation, this condition can be fulfilled by a special construction of the upper extremity of the axle and the right extremity of the lever 28 with which this axle comes into contact (This construction of the two extremities can be seen in Figure 4).
The set of these parts is shown in Figure 1.

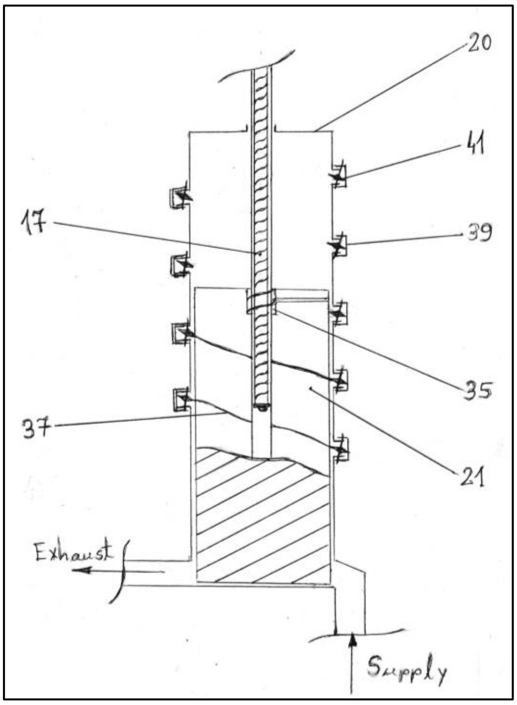

Fig. 1. Ensemble: water tank, floating body

2. Operating cycle times and displacements of parts in relative motion during those times

The engine mechanism components with the three periods of the working times cycle and the mechanical components in the movements at the strokes ends (the cinematic scheme), will be presented below. Let consider that mechanism carries out a full operating cycle during the time T_1-T_2 and the little intervals of times T_1-t_1; t_1-t_2; t_2-T_2. At the initial time, during T_1, the mechanism shows as in Figure 2.

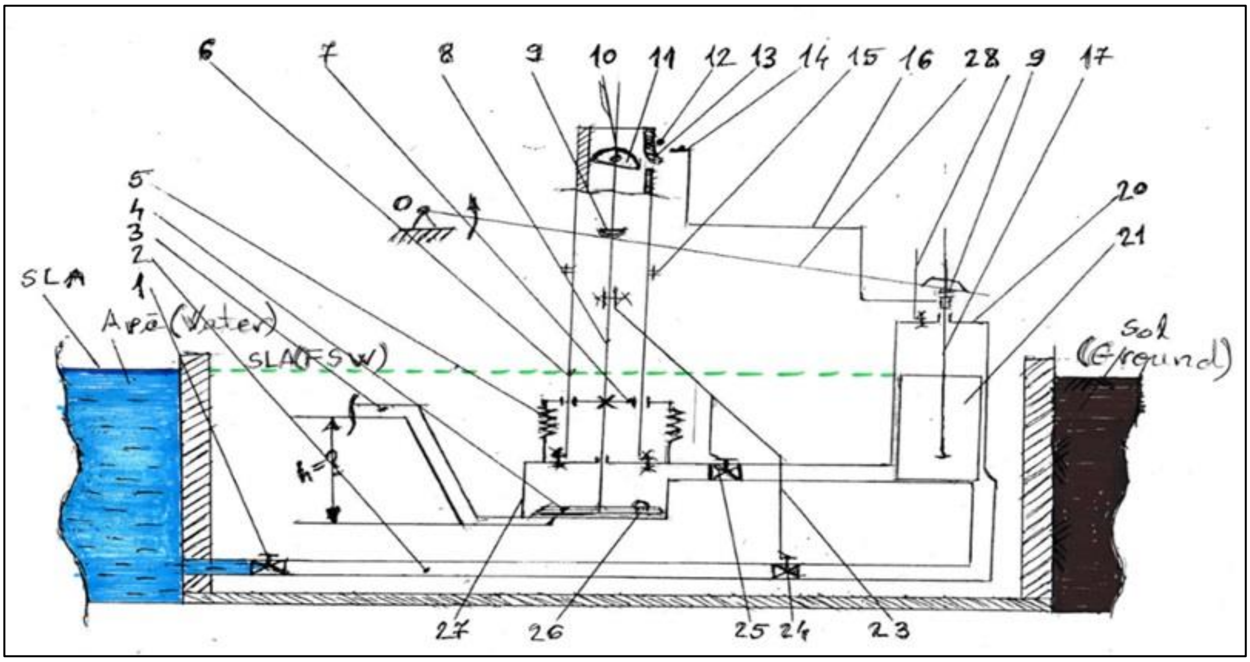

Fig. 2. Position of the component parts at the initial moment T_1

The operating time T_1-t_1 (water tank filling) shown in Figure 3. During this time functioning we have main production of mechanical work, obtained from the stroke of the floating body and therefore will be called during this work, and main active stroke (MAS) for abbreviation. We open the tap 1, supply of the tank, the water from the accumulation, according to the principle of communicating vessels, penetrates into the tank 20 through the supply pipe 2. During this time, the tap 24 is opened and the tap 25 is closed (these taps are mechanically controlled but can also be of another type), thus the water level in the tank, by connecting with the water source, increases. Inside the tank, the floating body 21 is lifting by CAF. This force will act on the right-hand extremity of lever 28, by worm of the axle of the SDMON mechanism, which is assure against rotation to realize its „effect" for which it is assembled there (as in Figure 4). We will therefore, have on this stroke, a mechanical work of the complementary Archimedes force (CAF) on the height of approximately 3m (2m from the stroke of the worm axle inside the floating body, this stroke will depend on the pitch of the worm axle to be in a certain relation to the pitch of the helix that surrounding the floating body+1m from the stroke floating body. Following this floating body stroke will put on moving the following components of the mechanism: lever 28 rotates in a trigonometric sense around the „O" joint, is moving through this lever also the taps control rod 23, the support 7 of the springs, the exhaust pump piston 4 and its rod 8, as well as the lever 16. Lever weight can be reduced by using a counterweight placed on lever, in the side left of the joint „O". The main force needed during this operating time, however, is the tensioning force of the exhaust pump springs or the lifting of the weight (in the case of the use of the exhaust pump with ballast). It also results from this displacement of the floating body: the rod 8 is lifting by means of the nut on it (the nut with hemispherical head to better taking over the arc of the circle described by lever 28 in operation). This springs 5 are tensioning by means of rod 8 and of the support of the springs 7. Also here, the ratchet with symmetrical double end and torsion spring 11, located at the end of the rod 8 and articulated with it by the bolt 10, moves upwards, until it comes out inside the pipe 6 where, after out, due to the spring of torsion (which is not represented in the Figure 3, being in the back) is brought in the horizontal position, to block the return of the rod 8. During this time T_1-t_1 will also occur the liberation of mechanical work, which will be capturing by another type of mechanism compared to the connecting rod-crank mechanism of the thermal engine. During this time, at the upper point, thanks to the ratchet 11 and the rod 8, which is fixing the springs support 7, the springs 5 remains tense. The plunger 4 of the exhaust pump, which is fixing with rod

8, remains at the top of the pump. The control arm 23 of the taps closes the tap 24 after the tank 20 has filled with water, interrupting the connection of the mechanism to the water source, and opens the tap 25, allowing the water in the tank to empty into the exhaust pump.

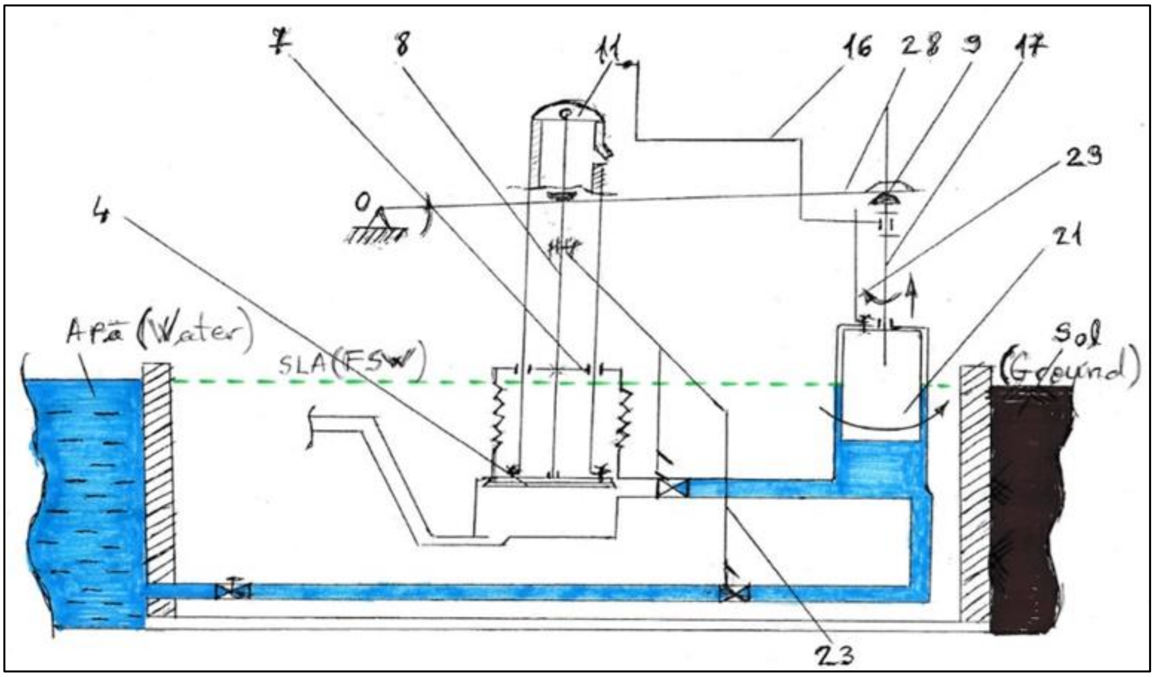

Fig. 3. Water tank filling

The operating time t_1-t_2 (empting water from the tank into the exhaust pump) shown in Figure 5. During this time the water from the tank drains into body of the exhaust pump, the tank is empting. The floating body descends at the same time as the water level in the tank decreases (under the action of its own weight of 10Kgf), the rod 17 also descends (this working time is the only and total inefficient of the water operating cycle).

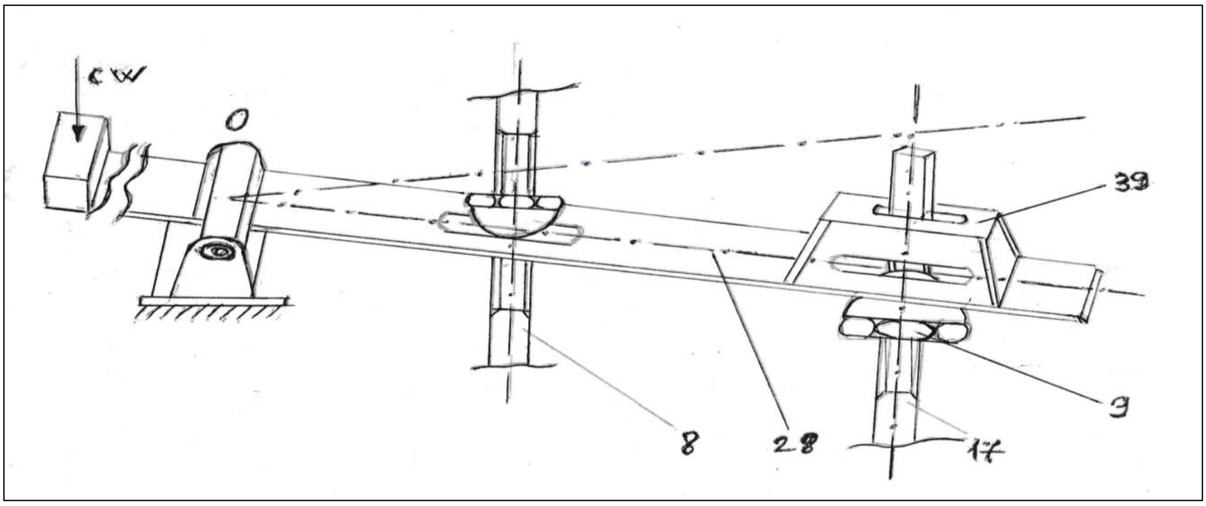

Fig. 4. The lever 28

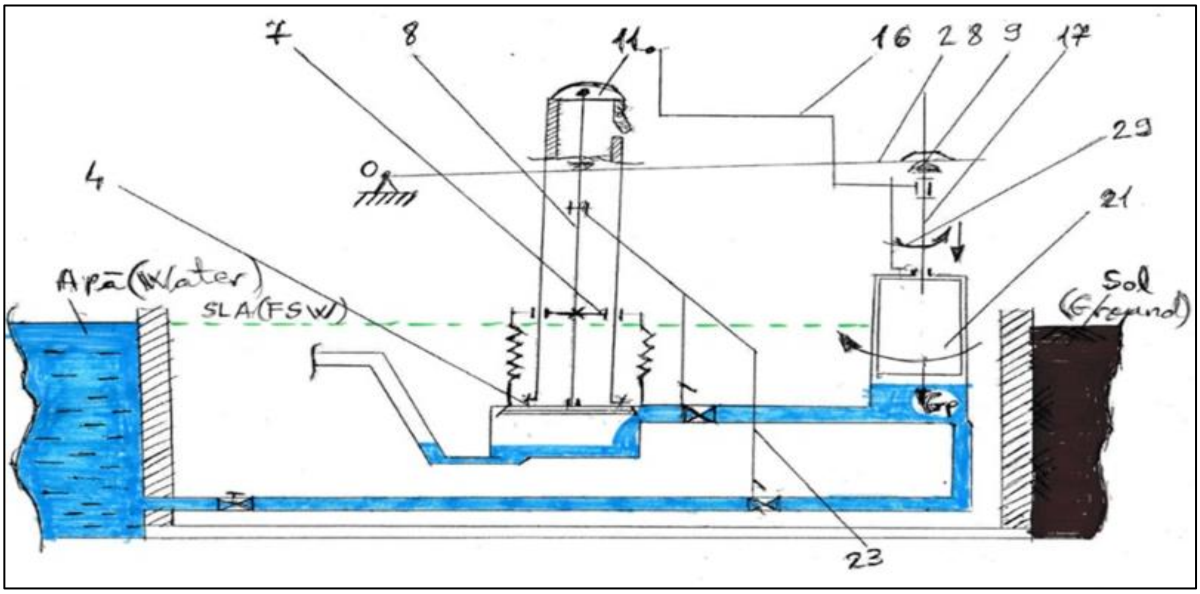

Fig. 5. Empting water from the tank into the exhaust pump

The operating time t_2-T_2 (pumping water from the exhaust pump) shown in Figure 6.
The arm 16 touches at the end of the floating body stroke at the bottom (that descend) the piece 13 that rotate clockwise and unlock the ratchet 11. Unlocking rod 8 release the springs 5 and so resulting the water compressing from the exhaust pump 27, water that is discharged at height „h" (we will see what condition must be imposing to drain it back into the water source) through pipe 3. At the bottom end of rod 8, through the control arm 23, the tap 24 is opening and the tap 25 is closing, thus resuming the operating cycle. It should be noted here that in the drawings in Figures 3, 5, and 6 representing the operating cycle times were numbered only the pieces that are moving during that time, in order to better understand the operation of the mechanism.

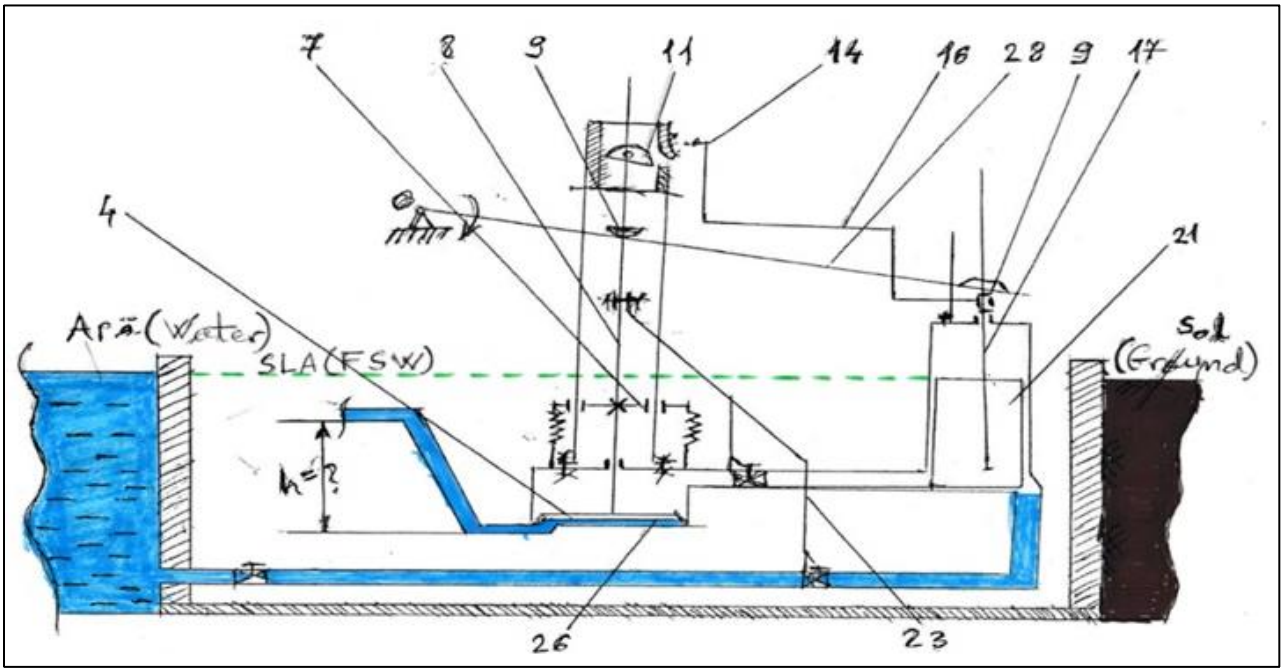

Fig. 6. Pumping water from the exhaust pump

3. Balance of mechanical work during an operating cycle

Because was presented in the description as an engine-mechanism, the following observation shall be required:
The main question is: will he be able to take water back to the water source? (perpetuum mobile function). Let us walk in the different work times, described in the functioning cycle (the three) vertically, with the forces and the strokes we have, comparing them to the free surface of the water (FSW).
- During T_1-t_1 we have the mechanical work obtained: MW=CAFx3m (1m the floating body stroke+2m the floating body axle stroke) above FSW;
- During t_1-t_2 we have a loss of mechanical work of 500kgf (the volume of water dislocated by the floating body, when we push it into the water up into half and which we initially find inside the tank, then inside the exhaust pump) at a depth of about 0,3 or 0,4m (depending on what the exhaust pump will look like)=floating body height of 2m, i.e. 2,3 or 2,4m;
- During t_2-T_2 we will need a mechanical work (performed by the exhaust pump) of 500kgfx2,4m (let take the worst variant) to get water back into the water source.
The resulting inequality will be: the mechanical work during T_2-t_2 time>the mechanical work during t_2-T_2 time, in our case : CAFx3m>500kgfx2,4m.
But CAF cannot be less 500kgf because it is a force multiplier.
It results only the multiplication of the stroke we have the mechanical work necessary to bring/pump water to a high height than FSW, mechanical work available throughout out the length of the lever 28. The CAF will be depending on the pitch of the helix on the lateral surface of the floating body (smaller pitch-higher CAF).
In order to better understand the operation of the mechanism let see a scheme of operation of the taps of the mechanism.
We will use the following symbols:
W.S. – water source;
W.T. – water tank (the tank with the floating body inside);
E.P. – exhaust pump;
T1 – the coupling tap between W.S. and W.T.;
T2 – the coupling tap between W.T. and E.P.
Cycle times:
t_1 – filling water tank (W.T.) with water;
t_2 – exhaust W.T. in E.P.;
t_3 – pumping water out from E.P.
In times t_1, t_2, t_3 we have the position of taps T1, T2:
t_1 – T1 opened, T2 closed;
t_2 – T1 closed, T2 opened;
t_3 – T1 opened, T2 closed = t_1.
This also results in the cycle of the operation of the mechanism.

4. Physical-mathematical calculation model for the sizing of the main components of the mechanism (the exhaust pump respectively the tank with the floating body)

In order for the mechanism to become functional, it is necessary that the design service involved in calculating the dimensions of the component parts takes into account the observance of certain rules, dimensions and formulas in geometry.
Next I will develop this topic, namely what relationships need to be respected between: height h_1 of the floating body (21), radius of the base of the floating body r_1, stroke of the axle (17) of the floating body h_3, stroke of the rod (8) of the exhaust pump h_2, length l of the lever (28) for taking over mechanical work, radius of the base of the cylinder of the exhaust pump r_2, distance from joint „O" to rod (8) of the exhaust pump on the horizontal (quota „b" in Figure 7).
I will use Figure 7 for this example.

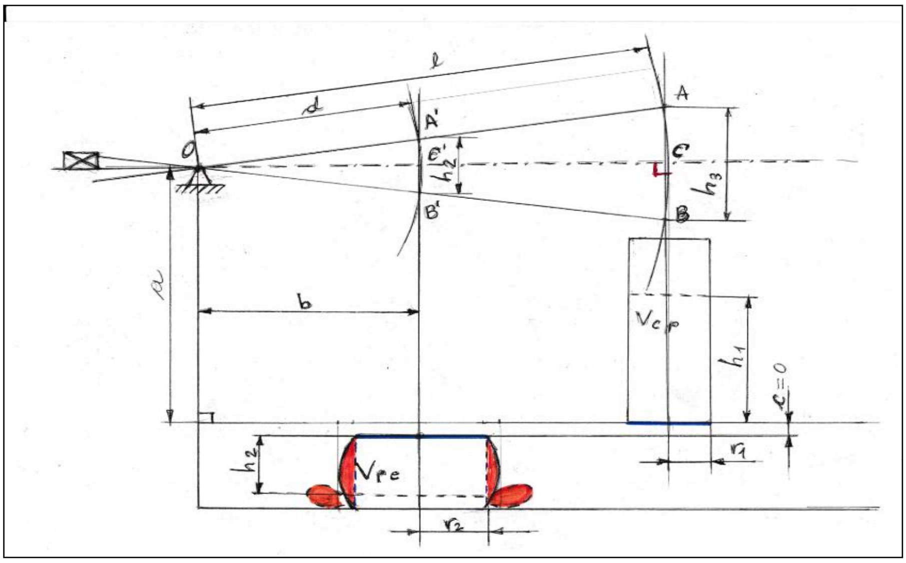

Fig. 7. Geometric model for calculating the dimensions of the main component parts

Figure 7 shows the geometric place of lever (28) in operation as well as where it comes into contact with the axis of the floating body (17) and the piston rod (8) of the exhaust pump.
There needs to be a correlation between the volume of the floating body, the volume of the exhaust pump, the distance between the vertical of joint „O" and the vertical of the center of the exhaust pump (quota „b"). I will continue to provide these relationships with the help of geometry (the only mandatory quota that must be respected regardless of the scale at which the mechanism will be made and the values of the dimensions of the other pieces and quotas (r_1, h_1, r_2, h_2, h_3, l) is the quota „c" that must have the value 0, as seen in Figure 7, if this quota had a numerical value it follows that the exhaust pump should perform a bigger mechanical work.
As we have established from the beginning, an essential condition for the operation of the mechanism is that the volume of the floating body is twice the volume of the exhaust pump.
This result in a first relationship:

$$V_{fb} = V_{ep} \tag{1}$$

These two bodies are cylindrical in shape.
The volume of the cylinder is:

$$V = \pi r^2 h \tag{2}$$

where:
r - radius of the base of the cylinder and
h - is this height.
Let`s note with:
r_1 - radius of the base of the cylinder of the floating body;
h_1 - height of the cylinder of the floating body;
r_2 - radius of the base of the exhaust pump;
h_2 - height of the cylinder of the exhaust pump.
From formula (1) result:

$$\pi r_1^2 h_1 = 2\pi r_2^2 h_2 \tag{3}$$

After simplifying by π the relationship becomes:

$$r_1^2 h_1 = 2r_2^2 h_2 \tag{4}$$

So results in a first relationship (1) that must be respected.
Figure 7 shows: the lever 28 moves around the „O” joint describing an arc of circle, on the stroke between points A and B of the axis (17) of the floating body. This triangle can be isosceles by adjusting the dimension „a” in Figure 7 (in fact, this quota and many other dimensions can be determined by the adjustment possibilities can you see in the photo with the mock-up that you find at the end of this article).
One solution for this triangle to be isosceles is as follows:

- an h_3 value is chosen for the stroke of the floating body (which is depending on the floating body construction and whether or not a stroke multiplier is chosen - in this case let's assume it is with a stroke multiplier);
- on the axis of the floating body we determine the half of h_3 (point „C");
- from this point „C” we draw a horizontal with a help of a square and determine at what point this horizontal meets the vertical of the joint „O”;
- then adjust the quota „a” according to Figure 7 so that the angle OCB is 90^o.

After making this adjustment, so that this OAB triangle is isosceles, we are also interested in positioning the exhaust pump on the right side of the „O” joint (distance between the vertical of the „O” joint and the vertical of the center of the exhaust pump cylinder - „b” quota).
It follows, from Figure 7, points A'B' between the piston rod (8) of the exhaust pump and lever (28).
It will result in alike triangles:
$\Delta OAB \sim \Delta OA'B'$, where:

AB - represents the stroke of the axle 17 of the floating body (noted in Figure 7 by h_3);
A'B' - represents the stroke of the piston rod of the exhaust pump (noted in Figure 7 with h_2).
From the alike of the triangles OAB and OA'B' result:

$$\frac{OA}{OA'} = \frac{OB}{OB'} = \frac{AB}{A'B'} \tag{5}$$

But in the isosceles triangle OAB we have OA=OB - lever length (28).
In the isosceles triangle OA'B' we have OA'=OB' - another equal numerical value, let's note it by d.
It follows like this:

$$\frac{l}{d} = \frac{l}{d} = \frac{h3}{h2} \tag{6}$$

That is:

$$\frac{l}{d} = \frac{h3}{h2} \tag{7}$$

Another relationship to be respected.
In the right triangle OA'C' of the formula of Pythagora results:

$$OA'^2 = A'C'^2 + OC'^2 \rightarrow d^2 = \left(\frac{h_2}{2}\right)^2 + b^2 \tag{8}$$

Results:

$$b^2 = d^2 - \left(\frac{h_2}{2}\right)^2 \tag{9}$$

Substituting formula (2) in formula (3) results:

$$b^2 = \left(l\frac{h_2}{h_3}\right)^2 - \left(\frac{h_2}{2}\right)^2 \tag{10}$$

From where:

$$b = \sqrt{\left(l\frac{h_2}{h_3}\right)^2 - \left(\frac{h_2}{2}\right)^2} \tag{11}$$

How does quota „b" help us?
On r_2 we can choose it by the construction of the upper movable disc 4 (the piston) and lower disc fixed to the frame of the mechanism (see Figure 9). A condition for r_2 is that it must be greater than r_1.
Figure 7 shows an orange volume V_s, V_s being that difference in volume required for the water in the tank to empty completely into the body of the exhaust pump.
With r_2 established from the construction, the „b" dimension helps us determine the distance from the „O" joint to the piston rod of the exhaust pump.
Why physics knowledge is needed?
Knowledges of physics is needed most! There are many questions like: „based on what kind of energy does the mechanism work?" If we made a comparison at the beginning with the thermal engine and the electric engine (almost none), let's first see what kind of energy the thermal engine works? Based on no kind of energy.
The thermal engine works by burning a quantity of fuel inside the cylinder and produces mechanical work through the piston stroke not „an energy".
CAF force depending on the pitch of the whirl on the side surface of the floating body.
Because we will need a mathematical model for future calculations, suppose that the CAF force will double the simple achimedic force of 490Kgf. For this is necessary that the pitch of the whirl on the outer surface of the floating body be executed at a quota such that the CAF force doubles the simple archimedic force. We have thus identified another variable of the mechanism - the multiplication of the CAF force according to the pitch of the whirl on the lateral surface of the floating body.
Through this multiplication we will obtain a CAF force of approximately 1000Kgf which we will take consider below.
With the CAF force setled at 1000Kgf let's return to the situation presented above, these about which I mentioned that knowledges of geometry is needed to understand the operation of the mechanism.
From the rule of using the lever and with the force multiplication coefficient introduced by it, according to Figure 8 and the related formula (l. m. - lever multiplier) below, the situations from the „geometry knowledge chapter" result:

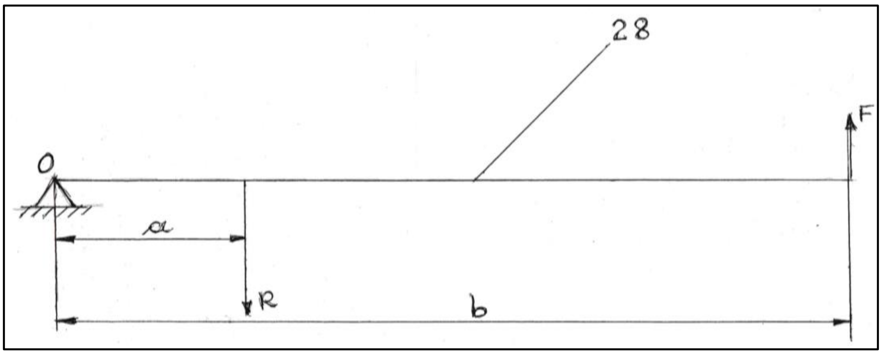

Fig. 8. Lever 28

In Figure 7: $a = b$, $b = l$ and F=CAF:

$$Rxa = Fxb \tag{12}$$

Note: using the lever (28) does not multiply the mechanical work, but only keeps it constant (along the length of the lever from the right extremity to the left „O" joint, the force increases but decreases the stroke, so the mechanical work remains constant.
These values above are important for:
1) Knowledge of the force that is available at the point of contact between the lever (28) and the nut (9) on the rod (8) of the exhaust pump piston. The ratchet with symmetrical double end and torsion spring (11) shall be designed to lock/release this force.

5. Conclusions

By pushing a floating body into a quantity of water (the action) a mechanical work is performed on it. By rising the water level in a tank inside which a floating body is located, the floating body will move upwards resulting reaction (reaction of rising water level in the tank). If the floating body rotates at the same time as the upward movement, an additional mechanical work will be obtained due to this stroke of the floating body, mechanical work exploited by the engine mechanism of the water engine. We cannot talk about „energy" in the case of the water engine because in its case an energy study has not yet been done (mechanical work carried out during an operating cycle). Also, there can be no talk of efficiency. The water engine converts the mechanical work obtained from the stroke of the floating body during T_1-t_1 of the operating cycle into mechanical work performed by a flexible membrane exhaust pump during t_2-T_2 of the operating cycle. From the estimated calculations presented earlier in this article, it follows that this mechanism can have supraunitary efficiency (because it is not dependent on friction like the thermal engine).
For a better understanding of the construction of the mechanism, a photo of a model of the mechanism will be offered in the continuation of this article. Also, those interested I can offer the entire project which totals about 80 pages.

Fig. 9. The experimental model (with a mock-up)

References

[1] Niculae, Nicușor. *Water running engine/Motorul care funcționează cu apă*. Craiova, SITECH Publishing House, 2020, ISBN 978-606-11-7467-6.