RECOMMENDATIONS FOR CONSTRUCTION AND EFFICIENCY MEASURING OF THE TWO-STAGE MECHANICAL OSCILLATOR

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ABSTRACT

The goal of this work is to summarize the findings from previous papers along with some additional comments and also to answer two basic questions:

- How to construct an efficient Veljko Milkovic two stage oscillator,
- How to measure the quotient of efficiency of the constructed oscillator.

Key words: pendulum, pivot point, over unity, energy, centrifugal force.

INTRODUCTION

After publishing a previous paper [1] in which the length of the pendulum rod on improved efficiency had been discussed, there were still questions raised. Some people were asking for construction recommendations for the oscillator with a manual water pump [2]. Others were asking questions about the possibility of attaching an electric generator to the oscillator. And still there are critics as to why the return loop hasn't been closed yet if there is an energy surplus in the system.

The busy author lives in a different city than Mr. Milkovic but has accepted his promise to consider a new model utilizing the author's latest findings. Besides that, the important question of the accurate measurement of the efficiency of the machine still exists. Although we do not have competent scientific devices for efficiency measurement, in the course of time, a method became clear that can remove all uncertainties previously shown in the measurements and calculations.

The goal of this paper is to explain all the facts about construction and measuring in order to facilitate other people's efforts towards a replication embodying a high efficiency quotient.

THE PHYSICS OF THE TWO-STAGE MECHANICAL OSCILLATOR: A SUMMARY OF ITS KNOWLEDGE

The Balance of Mechanical System and the Work of Gravitational Force

Let's look at the seesaw in *Figure 1*. It can be balanced in two ways, either with equal masses and equal lever arms (case A) or with different masses and different lengths of lever arms (case B).

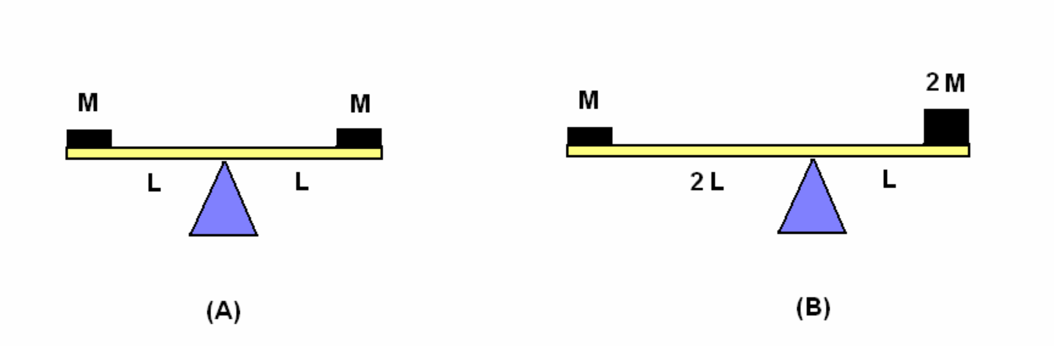

Figure 1

This means that for seesaw balance, it is only important to balance the moment of forces on the left and right side of the lever fulcrum. The moment of force is equal to the product of the force and its distance from the fulcrum.

Figure 2 illustrates an unbalancing of the seesaw and the work of gravitational force for the case displayed in *figure 1 B*.

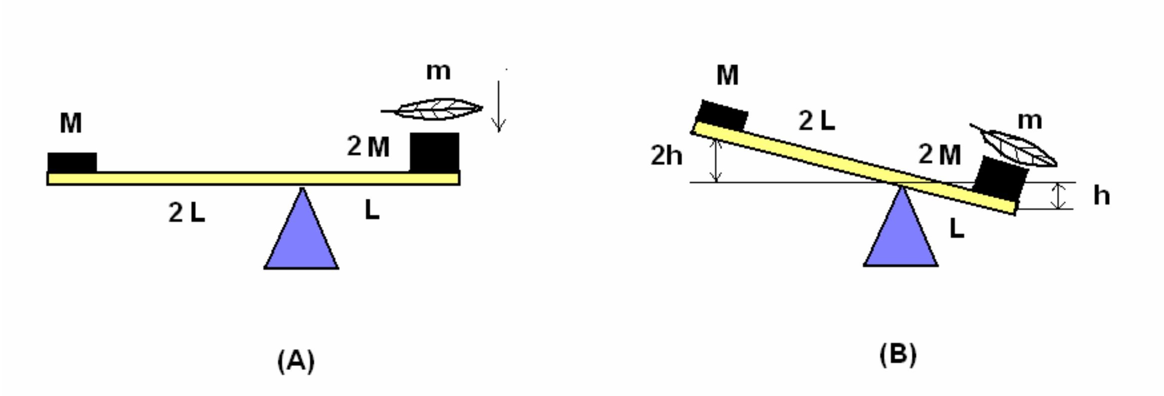

Figure 2

Figure 2 A displays a disturbance of the balance of the system by dropping a feather**,** with small mass *m***,** on the right hand arm of the lever. After some time the system will come into the position displayed in *figure 2 B*. The question can be asked how large is the total work of the gravitational force for the system displayed in *figure 2 B*? It is obvious that the system gained energy from the gravitational force, equal to the decrease of potential energy of the feather with mass *m*. The reason is the fact that the potential energy decrease for mass *2M* on the right side is equal to the potential energy increase for mass *M* on the left side, because the mass on the left side has performed work against gravitational force and thus increased its potential energy.

The total work performed by gravitational force for the system displayed in *figure 2* is equal to potential energy decrease of the feather with mass *m*:

$$A = m\ g\ h \tag{1}$$

Of course, we could take off mass *M,* from the system in *figure 2 B,* in its upper position, and claim that we got useful work by help of the feather. However, we could do it only once. In order to repeat the process we have to invest the same amount of the work to set the system in its initial position, as displayed in *figure 2 A*. This means that for the work of gravitational force utilized by the seesaw**,** the law of conservation of energy is perfectly valid.

The question could be asked**,** what if instead of the feather**,** with mass *m,* we employed another force on the right side of the lever**,** to push the arm downwards? We could then claim that we have an energy surplus under the condition that the action of a foreign force cost us less than the performed work on the left side of the lever arm.

It is necessary to note that the system in *figure 2* has a shorter by half lever arm on its right side, and as a consequence, half the change of the height on its right side than on its left side. For construction of a two-stage mechanical oscillator it is necessary to use the same logic and shorten the arm on the side with the pendulum. The reason is the fact that the change of the height and acceleration of the pivot point of the pendulum, negatively affects the behaviour of the oscillator. We shall discuss this in more detail latter.

It is known from practice that the best proportion for lever arms is that the arm with the counterweight has a length 3.5 times longer than the arm with the pendulum.

Forces Acting on a Two-stage Mechanical Oscillator and Their Work

In *figure 3* is displayed a two-stage mechanical oscillator without an external load and which works as a hammer. The system in *figure 3* is different than the system in *figure 2* because it doesn't have a fixed mass on the right side, but rather the pendulum. The pendulum in *figure 3* is different than the mathematical pendulum because its pivot point is moving along an arc made by the tip of the lever arm on which it is hung. The vertical path of the pivot point is much longer than the horizontal shift, because the lever has a small angle of movement along the circular path, thus we will disregard this horizontal movement of the pivot point.

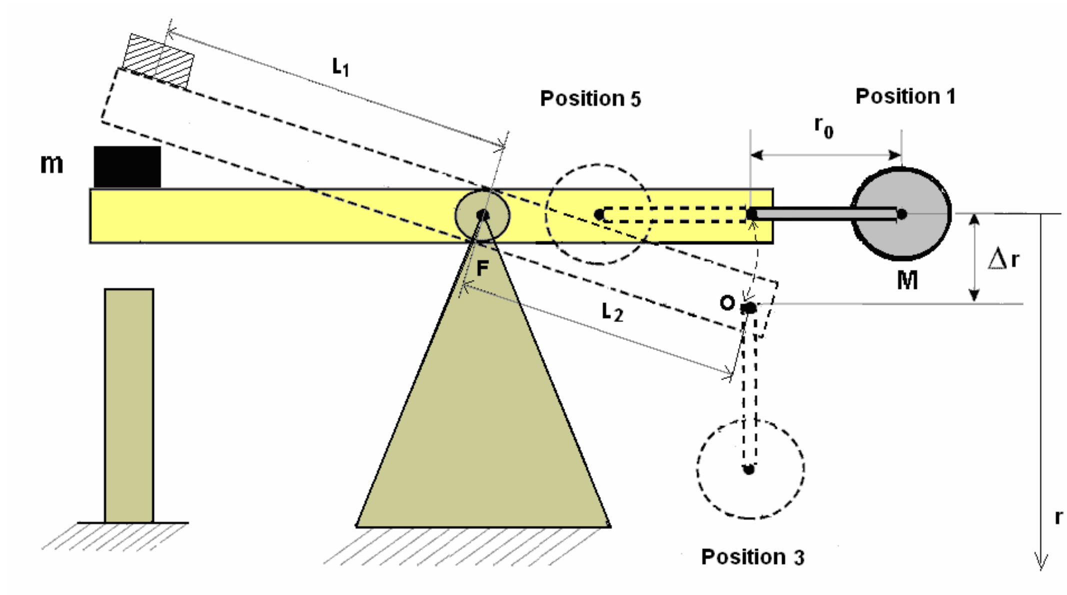

Figure 3

It is known that centrifugal force acts on a moving pendulum along with its weight. In classical Newtonian mechanics centrifugal force is not taken into mathematical calculation because it is a reaction force against centripetal force. Centripetal force acts perpendicular to the direction of the velocity of the pendulum bob and has direction towards the center of the curvature of the trajectory of the pendulum bob. Weight and tension force in the pendulum rod are the only external forces taken into the calculation of the movement of the pendulum. The magnitude of the tension force in the pendulum rod is equal to the centrifugal force increased by the influence of the weight in that direction. At the low point of the pendulum, in position 3, the magnitude of the tension force is exactly equal to the sum of the centrifugal force and the weight. Mathematical calculation for the pendulum can be found in the author's previous paper [3] about the oscillator and university book [4] and will not be repeated here.

The question can be asked, how centrifugal force can perform work if it is a reactive force, and what happened to the law of conservation of energy?

The formula for centrifugal and centripetal force is:

$$F_c = \frac{M v^2}{r} \tag{2}$$

where *r* is the radius of the curvature, which is equal to the distance of the body from its center of rotation only in the case of circular paths. The radius of curvature will increase when the pivot point is allowed to move downwards and it will weaken centrifugal force.

We shall first analyze the pendulum with a fixed pivot point, in order to better understand the behaviour of the pendulum once its pivot point is allowed to move and perform work by the tension force in the pendulum rod.

Work of a Driving Pendulum

In *figure 4* is displayed a pendulum with fixed pivot point. It is designed to be raised and then dropped from its initial position which is 90 degrees from a vertical line, position 1 or position 5. Because in those positions, the pendulum was raised in height equal to the length of its rod r_0, it has potential energy equal to:

$$E_p = M\, g\, r_o \tag{3}$$

When the pendulum is allowed to drop downwards it keeps loosing its potential energy but it gains velocity and in that way it transforms potential energy into kinetic. When a body is moving along a curved path it is subject to both, centripetal and centrifugal force as per formula (2). They have the same intensity but the opposite directions. Weight force *Fg* also acts on a pendulum which is a consequence of gravitational influence on the mass of the pendulum. The vector sum of the weight and centrifugal force is equal to the tension force in pendulum rod. In *figure 4,* the tension force is marked as *T* and its reaction acting on the pivot point is marked as *T'*. In practice, they are the same forces but we will use only force *T*.

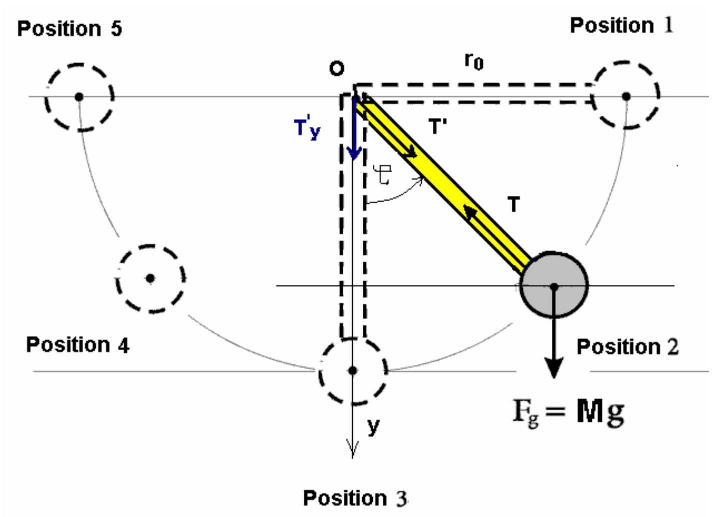

Figure 4

The formula for the tension force in the pendulum rod, with fixed pivot point**,** is shown below:

$$T = Mg\ (3\cos(\varphi) - 2\cos(\varphi_O)) \quad (4)$$

where φ_O is the angle of initial position 1, and φ is the angle from a vertical line i.e. from the low position 3 and towards position 1. Details about the formula (4) are given in the book [4], as well as in the author's first paper about the oscillator [3].

It can be seen that the magnitude of tension force *T* and also of the centrifugal force doesn't depend on the length of the pendulum rod r_0 although the length exists in the formula (2). The reason is the fact that the pendulum's velocity depends on the potential energy being transformed into kinetic and potential energy depends on the length of the pendulum rod, thus this variable cancels itself out in the formula (2).

Because the pivot point can move only vertically, only the vertical component of the tension force T_y commits the work. That component will also decrease with the increase of the angle φ, independently from the decrease of tension force *T. The* formula for the vertical component of the tension force is:

$$T_y = T\cos(\varphi) = Mg\ (3\cos(\varphi) - 2\cos(\varphi_O))\cos(\varphi) \quad (5)$$

Below is given a table with magnitudes of forces *T* and T_y in dependency on the initial angle φ_O. Forces are calculated for angles of zero degrees, 30 degrees and 45 degrees. For zero degrees (position 3) forces *T* and T_y are the same. For zero degrees, one of '*Mg'* in tension force belongs to the weight, and the rest to the centrifugal force.

φ_O	60	90	120	180
T (0), T_y(0)	2 Mg	3 Mg	4 Mg	5 Mg
T (30)	1.6 Mg	2.6 Mg	3.6 Mg	4.6 Mg
T_y(30)	1.4 Mg	2.3 Mg	3.1 Mg	4 Mg
T (45)	1.1 Mg	2.1 Mg	3.1 Mg	4.1 Mg
T_y(45)	0.8 Mg	1.5 Mg	2.2 Mg	2.9 Mg

Table 1

Also in *figure 4* is displayed the pendulum in position 2. Position 2 represents an angle when force T_y become strong enough to overcome the pull of mass *m* on the left side of the lever, (see *figure 3*) and starts to raise it upwards, i.e. when the pendulum pivot point starts moving downwards. That angle we have named as the *critical angle*.

Force T_y will rapidly become weak with the increase of the critical angle i.e. angle of position 2. If the pendulum was allowed to overcome mass *m* in a large critical angle, then the very weak tension force T_Y will perform work with the movement of the pivot point downwards, and consequently the output work of the tension force will be small for a fixed movement of the pivot point, Δr. Because decreased potential energy of the pendulum must be compensated, it means that the quotient of efficiency has become smaller, under the condition that centrifugal force really performed over unity work. If it doesn't do extra work, but only transfers potential energy of the pendulum to the left side of the lever, as the weight of the pendulum does, then the quotient of efficiency is independent from the work of centrifugal force.

We must assume that centrifugal force performs over unity work in order to try to construct an oscillator with the best performances. If it doesn't do extra work then there is no sense to talk about construction of good oscillator, because for any construction, the law of conservation of energy would be valid.

If we look in table 1 for the tension force T_Y for angle of 45 degrees and with initial angle of the pendulum of 60 degrees we can see that the force is equal to *0.8 Mg*. It means that the starting working force is smaller than the weight of the pendulum alone. Because the mass of the pendulum must be raised up latter, in order to compensate for the lowered pendulum for Δr (due to the lowered pivot point), it means that here exists a loss at the very beginning of the work, therefore the final quotient of efficiency will not be great.

It means that it mustn't be allowed that position 2 is high, i.e. mass of pendulum M must be small enough in order not to overcome mass m on the lever too early and in that way to decrease the quotient of efficiency of the oscillator.

Centrifugal Force and Angular Momentum

When no external torque acts on a body with circular motion, as in the case of central forces like the rotation of planets around the Sun, then there is valid conservation of angular momentum. That law says that if the distance between the body and the center of rotation *r* is increased then velocity of the body *v* will be proportionally decreased, and vice verse. Because in formula (2) for centrifugal force we have velocity squared, and centrifugal force is also decreasing with the increase of the distance, we finally have that centrifugal force is decreasing with r^3. Because kinetic energy depends on velocity squared, and velocity is decreasing proportionally with the extension of radius *r,* it means that the kinetic energy is decreasing with the distance squared.

It is demonstrated in the author's paper [5] that the total work of a variable centrifugal force in position 3, if the pendulum bob was suddenly lowered, there would be an equal to potential energy loss of the pendulum bob, which means that the law of conservation of energy is preserved in this case. If the velocity of the pendulum didn't change, then the change of centrifugal force wouldn't be so important, because any work of the centrifugal force would be over unity work.

Conservation of angular momentum is not valid on the left and right side from the low position 3. The reason is the fact that on the right side of position 3 there acts weight torque which keeps adding velocity, i.e. it transforms potential energy into kinetic. Because velocity is increasing with the square root of the change of height, total velocity will decrease with a slower rate than usual as does also centrifugal force, which performs the work.

On the left side of position 3, the pendulum bob is moving upwards around the pivot point, but the pivot point is still moving downwards, thus total height of the pendulum bob will change at a slow rate. Because of this slow change in the distance there is no big decrease of centrifugal force, which performs useful work. This happens because the total height is changing at such a slow rate**.** The same happens with the transformation of kinetic energy into potential and also with decreasing velocity.

As we have seen, there are three different zones of work resulting from centrifugal force. One is in low position 3, where the law of conservation of angular momentum is valid. The second zone is between position 2 and position 3 where the positive torque of the weight keeps adding velocity and stabilizes the centrifugal force. The third zone is from position 3 till position 4 where weight torque keeps the velocity decreasing at a slower rate than normal because the height of the pendulum bob doesn't change quickly. This also stabilizes centrifugal force.

As we said, work performed by gravitational force acting against mass on the right side of the lever, as displayed in *figure 2,* must be compensated for, in order that the system can be set into its initial position. The same with the mass of the pendulum in *figure 3*. Lowering the pivot point for Δr causes lowering of the pendulum bob for the same distance and that work must be returned back into the system. It means that gravitation here can not perform useful work directly.

The only chance to draw extra energy from the centrifugal force is that we minimize its decrease along path of its movement, not so much because of the force itself but because of possible minimization of velocity change and kinetic energy loss.

In that case, the extra work of the centrifugal force could exist in the vicinity of low position 3. When the pendulum goes into its end position 1 or 5, its velocity becomes zero and the tension force in pendulum rod also becomes zero, thus allowing mass *m* on the lever to return back to its initial position without fighting with the tension force. It means that the work of the centrifugal force, in the vicinity of low position 3, is the only one to be credited for possible existence of an energy surplus in the two-stage mechanical oscillator.

Minimization of Centrifugal Force Change

It has been said that the magnitude of centrifugal force keeps decreasing by movement of the pivot point downwards because of the increasing of the radius of curvature of the trajectory of the pendulum bob, *r*. Centrifugal force decrease comes also due to the velocity decrease of the pendulum. In the author's previous paper [1] there is given a formula for centrifugal force in position 3, if the pivot point was suddenly moved downwards for length *Δr.*

$$F_c = 2M\,g\,\frac{r_0^3}{(r_0 + \Delta r)^3} \tag{6}$$

The formula above is valid for the initial angle φ_0 of 90 degrees. For any another initial angle, the only change would in number *'2',* behind the equal sign, so the analysis of the formula and conclusions would be the same.

Centrifugal force performs work due to movement of the pivot point. It is equal to the product of centrifugal force F_c and path passed *Δr*. In order to increase work we should either increase the centrifugal force or the movement of the pivot point. The problem is the fact that motion of the pivot point decreases centrifugal force with power 3 and also the velocity of the pendulum and its kinetic energy. It means that the path of the pivot point should only be increased if absolutely necessary.

For a pendulum with a long rod, r_0, and where the movement of the pivot point Δr is fixed, the change of trajectory of the pendulum bob is proportionally small, in comparison with the length of the rod. This means that the movement of the pivot point will have a very small influence on the decrease of centrifugal force, due to the increase of radius of curvature and velocity decrease.

Below is a table showing the influence that the length of pendulum rod has in stabilization of the centrifugal force for movement of the pivot point *Δr* of 1cm, 2cm, 3cm, 5cm and 10 cm. We shall calculate variable part of the formula (6) with various lengths of pendulum rod r_0.

$$\rho = \frac{r_0^3}{(r_0 + \Delta r)^3} \tag{7}$$

r_0	0.25m	0.5m	0.75m	1m	2m	3m
ρ(1cm)	0.889	0.942	0.961	0.971	0.985	0.990
ρ(2cm)	0.794	0.889	0.924	0.942	0.971	0.980
ρ(3cm)	0.712	0.839	0.889	0.915	0.956	0.971
ρ(5cm)	0.578	0.751	0.824	0.864	0.929	0.951
ρ(10cm)	0.364	0.578	0.687	0.751	0.864	0.906

Table 2

From the table above it is obvious that there exists an improvement of parameter ρ for a longer pendulum rod r_0, *and* also a decrease of negative influence on the centrifugal force. In order that the weakening of centrifugal force would be less than 10%, the length of pendulum rod r_0 should be taken where ρ is greater than 0.9.

The important thing to be understood is that even if we were able to keep the centrifugal force constant, it still is not a certainty if the work of centrifugal force would be over unity work or centrifugal force would take kinetic energy from the pendulum for its work. The author can not guess the answer and so it must be checked by experiment, which will be explained in the second part of this paper.

Pendulum Velocity and Critical Angle

When the pendulum pivot point starts to move, it has some measurable acceleration *a*. Its movement downwards starts in position 2 and lasts until position 4, when the tension force becomes weak enough that mass *m* on the left arm overcomes it and pulls the pivot point upwards.

Acceleration of the pivot point *a* affects the velocity of the pendulum bob the following way. In mechanics the existence of acceleration determines the existence of a force. If the pivot point accelerates downwards, the effect is the same as if the pendulum bob had an additional force acting upwards. The result of this force on the mathematics of the pendulum is such that all equations have the same form, except that the gravitational acceleration *g* has decreased for *a*, i.e. we have effective gravitational acceleration $g' = g - a$.

That effect is negative on the pendulum because its bob will accelerate slower and the pendulum will lose some energy, also its period of oscillation will be extended. If acceleration *a* were the same as gravitational acceleration *g* then the period of the pendulum's oscillation would be infinite, i.e. the pendulum would never swing. The example is the pendulum dropped down to fall freely, where acceleration of the gravitation *g* acts on both the pendulum bob and the pivot point. It is obvious that the pendulum will never swing around the pivot point.

If the pivot point accelerates upwards the pendulum will swing faster than normal i.e. it will receive additional energy. The effect is the same as if gravitational acceleration changed to $g' = g + a$.

The situation in the case of the two-stage oscillator is better from position 3 till position 4, because the pendulum starts rising up and acceleration of the pivot point has the opposite direction than the direction of the pendulum bob. More details about experiments with influence of the pivot point on the pendulum velocity are described in the author's paper about the theory of gravitational machines [6], and will not be repeated here.

The kinetic energy of the pendulum is determined by the velocity of the pendulum bob. When the pendulum comes close to low position 3, it means that it transformed most of its potential energy into kinetic energy. Then the pendulum will not be able to lose much energy due to the acceleration of its pivot point downwards.

If position 2 was high then the pendulum will start losing energy and the remaining potential energy will not be transformed into the kinetic energy of the bob. Because potential energy can not disappear into nothingness, it is transferred by the lever directly to the mass *m* on left side and raises it up further. Then the system works as single lever as displayed in *figure 2 B,* and further increase of centrifugal force is disabled.

In order to improve the situation from position 2 till position 3, it is better that position 2 is fixed as low as possible, because in that case most of potential energy will be transformed into kinetic, and velocity will have horizontal direction, thus acceleration of the pivot point will not be able to affect velocity of the pendulum negatively and decrease its kinetic energy.

We shall now try to find the maximal acceleration of the pivot point *a,* for an initial angle (position 1) of 90 degrees. For the case of simplicity, we shall examine the case where the length of lever arms L_2 and L_1 are equal.

Force T_y in position 3 is maximal and is the same as *T,* which for our case is equal to *3Mg*. It is transferred to the mass *m* by the lever, thus mass *m* is influenced by two forces, its weight F_g and *T.* According to Newton's second law, if mass *m* is moving with acceleration *a,* then it is influenced by some outside forces who's vector sum is equal to the resultant force with magnitude equal to the product *ma*. It means that we have:

$$
\begin{aligned}
m\,a &= T - F_g \\
m\,a &= 3Mg - m\,g \\
a &= (3M/m - 1)\,g
\end{aligned}
\tag{8}
$$

Mass *m* on the lever must be designed in such a way that its weight equals tension force T_y in position 2. If we chose position 2 to be at 45 degrees, than in table 1 we can easy find that $T_y(45) = 1.5Mg$. This means that in this case we must choose mass $m = 1.5\,M$. Then we exactly have that $a = g$.

It means that the acceleration of the pivot point is growing, from zero in position 2, until its maximum in position 3, which is equal to the gravitational acceleration. This means that acceleration *a* can not be disregarded and that's why position 2 mustn't be too high.

CONSTRUCTION AND MEASURING OF EFFICIENCY OF THE OSCILLATOR

As we have already said, the oscillator must be constructed respecting the above factors concerning keeping the centrifugal force constant. The oscillator, with short pendulum rod and large movement of the pivot point doesn't have a chance to show any over unity behaviour.

Universal recommendations for the proportion of the masses for the lever and the pendulum can not be given here, because it depends on the proportion of the lengths of the lever arms, as well as initial and critical angles of the pendulum. The greater the initial angle of the pendulum, the greater will be the centrifugal force and a smaller mass of the pendulum bob. If the mass of the pendulum were greater than necessary, then there will be a greater critical angle of the pendulum and also a greater movement of the pivot point, which is not good. Also, if we shortened the lever arm on the pendulum side, then by the same proportion the mass of the pendulum must be increased in order that it can overcome the mass on the lever.

Construction of the Two-Stage Mechanical Oscillator

The output power of the oscillator must first be determined, that is, the working mass on left side of the lever. Latter, we will see that the power delivered by the mass is much smaller when the mass is moving upwards than when it moves downwards. Here we shall assume that the lever should have a pressure of $m = 12kg$. In order to determine the mass of the pendulum, the first thing to do is to fix the proportion of lengths of the lever arms. That proportion can be corrected latter if the mass of the pendulum can also be changed.

It has been said already that the best proportion for lengths of the lever arms, the side with the lever mass against the side with the pendulum, is 3.5:1. If we increase that proportion to 4:1 the oscillator efficiency will be the same as for 3:1. These proportions were determined for an oscillator which worked as a hammer. For a load attached, like a water pump, these proportions should be tested.

What the real reason is for no further improvement of the oscillator's behaviour beyond the proportion of 3.5:1, is not yet determined. The reason could be the unbalanced masses of the lever arms. Previously the mass of the lever has been disregarded in analysis. For the lever with equal arm lengths, the mass of each arm will balance each other, like the seesaw from *figure 1 A*. However, if the arm on the pendulum side is very short then the opposite side of the lever, even with small mass, will have a significant moment from the weight force. This moment must be taken into the account, otherwise it will stay unbalanced and the pendulum must invest additional force to overcome it.

Here we shall assume that for our project it is enough if the movement of mass on the lever is equal to *h = 7cm.* If for example we plan to put a piston water pump on the oscillator, assuming the piston and its cylinder is wide so that a working area of 7cm is enough, then with the proportion of arms of 3.5:1, the movement of the pivot point will be 2cm. In table 2 we can see that for this movement it is good enough to take the length of the pendulum rod *r = 75cm.* This way, the total area necessary for the pendulum work is 1.5m. For such a swing of the pendulum we can chose to use a full circle swing and in one direction only. This area can be accomodated in most laboratories for the construction of the oscillator. If we make the total length of the lever to be 2m, then we can chose the length of the lever arm on the mass side as $L_1 = 140\ cm$ and on the pendulum side $L_2 = 40\ cm$, where we have left a space of 5 cm behind the shaft of the pendulum and 15cm in front of lever mass, see *Figure 5*.

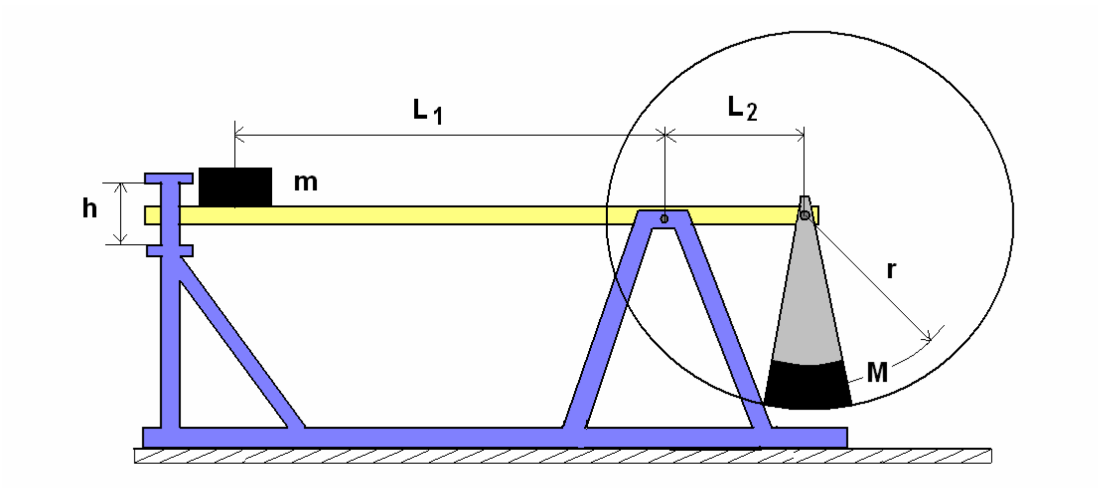

Figure 5

Now we shall find the mass of the pendulum**.** But first, for the case where both lever arms have equal lengths; then the mass of the pendulum *M* must be smaller then 12kg in order to allow the mass on the lever to prevail in the state of the rest and go into the initial position. For an initial angle of 180 degrees (full circle) maximal tension force in position 3 (table 1) is equal to *5Mg*. For the critical angle (position 2) of 30 degrees, we can see in the same table that the vertical component of tension force T_y is equal to *4Mg*. Torque for T_y must be equal to torque for weight *mg* on the lever in order that from position 2 tension force shall prevail over the mass on the lever. It means that for the same length of the arms the pendulum should have mass of 3kg. This way the tension force in position 2 would be exactly 12kg and would start to raise mass *m* on the lever. Tension force in position 3 would have magnitude of 15kg, and that is only 3kg more than mass on the lever. However, once tension force T_y becomes zero the mass on the lever will perform work downwards with full 12kg. It is necessary to note that force T_y will be zero for angle of 90 degrees (formula 5), even if tension force *T* is not zero.

Because the proportion of lengths of the lever arms was 3.5:1, we should take the mass of the pendulum to be *M = 3.5 x 3 = 10.5kg*. It is preferable to use two parallel pendulums with masses of 5.25kg each, on each side of the pendulum shaft in order that the pendulums can swing full circle around the stand of the oscillator, see *Figure 5*.

Problems in Measuring

Mr. Milkovic has frequently claimed that it is not the same thing if we measured the efficiency of the oscillator when the pendulum was raised in its initial position and allowed to swing to the end, in comparison to when we keep adding energy to the oscillator and in this way maintain the same amplitude of the pendulum and of the lever. The last one he deemed to be better.

There are two reasons why his claim has some sense. The first reason is the remaining energy in the pendulum, when the amplitude of the swing drops so low that the pendulum can not move the lever and perform any further work. Of course, this reason could be eliminated by measuring maximal height of the pendulum and a calculation of energy remained there.

The second reason is more important and became obvious to the author when it became obvious that the magnitude of the centrifugal forces does affect the quotient of efficiency of the oscillator, assuming that centrifugal force performs over unity work. The stronger centrifugal force will perform greater work for the same movement of the pivot point, and because loss of potential energy caused by the motion of the pivot point is the same, this means that the quotient of efficiency for the machine is larger for a stronger centrifugal force. Details are given in the author's previous paper [1], and will not be repeated here.

For the oscillator left to swing to the end (with no further input) the height of the pendulum bob is dropping down all the time, which means that the initial position 1 or 5 is dropping down too, and also the centrifugal force. The result is that every half period of the swing has a smaller quotient of efficiency. It means that the total quotient of efficiency of the machine is smaller than in the case when we keep adding energy to the pendulum continuously and thus keep its amplitude at its maximum.

The quotient of efficiency of the oscillator is the same if we measured input and output energies only for the first half period of the pendulum swing, or we maintained the pendulum amplitude constant and kept measuring energies for a longer period of time.

The next important thing to be determined is the procedure for measuring. Mr. Milkovic has always preferred to measure energy by measuring forces and the path passed by the forces instead of measuring the potential energy of the masses. The reason was because of a variable force on the output of the oscillator and we shall discuss it below.

We know that the pivot point moves downwards from the critical angle in position 2. There the vertical component of the centrifugal force overcomes the weight of mass *m* which starts moving upwards. This is the same case as the one in *figure 2,* when the feather disturbs the balance. At that time the output energy, which mass *m* can to deliver to a load is small, regardless of the path passed by the mass, because the net force against the mass was weak. The resulting force keeps increasing until the pendulum comes into low position 3, and after that it starts decreasing again until position 4, when the weight overcomes the pendulum force and mass *m* starts moving downwards.

In practice however, nothing can be done with such a resulting force of the mass if the load demands a constant force for its work, such as a water pump, which needs strength to pump water to a determined height, or driving a generator of electric current with constant output power. This weak force can be used only by air compressors, but only at the beginning when the pressure is small. It means that if we can not use the small starting energy on the output, then it is the same as if it doesn't exist. However, accurate measuring of the oscillator performance is more important for the proof whether the machine can deliver an energy surplus or not then for practical usage.

Method of Measuring

The method which the author proposes and some other people have already proposed similar methods, solve all the above problems and doesn't need expensive equipment for measuring of forces, velocities and accelerations.

We shall take mass m as an external load which spends energy doing work against gravitation.

Regardless of the existence of weak force in position 2 the same force will start raising the mass *m* upwards, and the mass will perform work against gravitation. The stronger force will accelerate mass *m* more and the mass will have greater velocity and pass a longer path. So, with regarding mass *m* on left side of the lever as an external load we can measure the total work performed by the variable tension force. Of course, there is a condition, to not allow mass *m* to return to its initial position and thus to return energy back into the system. In *figure 6* is displayed the initial position of the method.

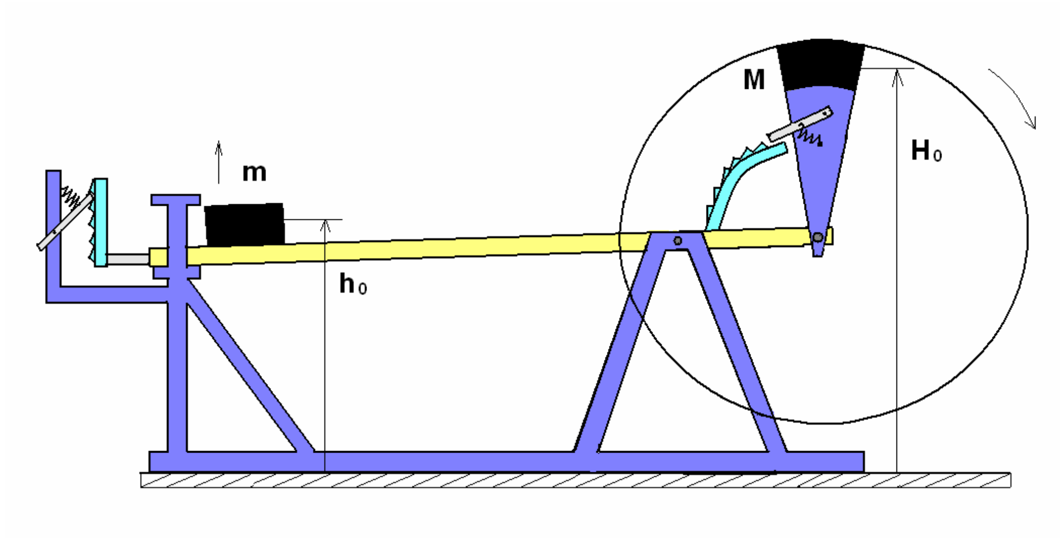

Figure 6

The method proposed measures the heights of both masses on both sides of the lever, which must be locked in its upper positions by a ratchet mechanism as displayed in *figure 6*. The end position of the measuring process is displayed in *figure 7*.

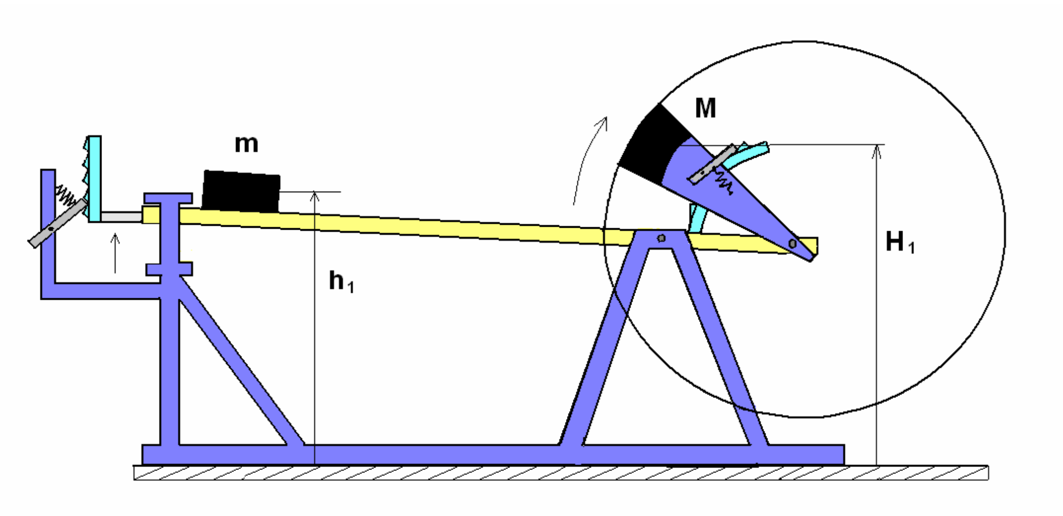

Figure 7

Energy spent by the pendulum is equal to $Mg\ (H_0 - H_1)$ and output energy of the system is $mg\ (h_1 - h_0)$. Quotient of efficiency ε is:

$$\varepsilon = m\ (h_1 - h_0)\ /\ M\ (H_0 - H_1) \quad (9)$$

If the oscillator can deliver extra energy with the help of centrifugal force, then ε must be greater than one otherwise the oscillator is not an over unity machine but simply an accumulator of energy.

In order to measure energy returned back into the system when mass *m* is going down towards its initial position, the ratchet mechanism on the left side should be released to allow mass *m* to fall down. It would be logical to expect that in this case the pendulum bob goes more upwards, i.e. it loses less energy. Energy loss of the pendulum would correspond to losses of energy transformed into heat and sound once the lever strikes its bottom boundary.

It would be not only interesting but also important to measure independently the energetic efficiency on two sides of the pendulum trajectory. The first one is from position 2 until low position 3 and the second one is from position 3 until position 4. We have seen that these two quarters of the period of the oscillation are not the same and can not have the same energetic efficiency. It could be done by locking the lever, the first time when the pendulum reaches position 3, and the second time the lever must be initially locked until the pendulum comes into position 3 and is then unlocked. The ratchet mechanism on the pendulum should work as usual.

CONCLUSION

As we said, we must initially assume that centrifugal force performs over unity work in order to construct the oscillator with strong centrifugal force which doesn't decrease quickly, along with the movement of the pivot point. The crucial thing for it is the relatively small path passed by the pivot point in comparison to the length of the pendulum rod. This way the oscillator could have a good quotient of efficiency.

The method of measuring proposed in this paper solves all existing concerns as the remainder of energy in the pendulum when it can not drive the lever anymore, decrease of efficiency quotient caused by decreasing of centrifugal force, as well as the variable magnitude of output force on the lever of the oscillator.

The author however can only guess if the constant centrifugal force would perform over unity work or the performed work would be on account of the kinetic energy of the pendulum. We have concluded that at the low point of the pendulum, the law of conservation of angular momentum is valid and there, centrifugal force performs work on account of the pendulum's kinetic energy. However, it is not obvious what happens on the left side and the right side from position 3. It simply must be measured. Any further discussion about it is futile and a waste of time.

If, in the proposed method of measuring, it appears that the quotient of efficiency is smaller than one, then this machine is not an over unity machine, but simply an energy accumulator. In that case any machine working on centrifugal force can not be an over unity machine. Then the quotient of efficiency depends very little on the construction of the machine, because we have disregarded friction. In that case, this machine can be used to drive pumps manually. The author has tested a piston pump unit, with great friction and noticed a big difference between manually pumping water and pumping water using the oscillator. The ease of working with the pendulum was fascinating. Such a pump could be also driven with a weak motor connected to a battery and/or a solar panel.

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