On a New Reaction-less Mechanism for Thrust Production and the Explanation of the Working of the EmDrive

Mutasim A. Ahmed

October 16, 2016

Abstract

We propose here a totally new mechanism for thrust production. To explain the working of the two reaction-less drives. Namely the EmDrive invented by Roger Shawyer. And the Cannae drive invented by Guido Fetta. The explanation based on a hypothesized directional change of center of mass of the drive. Due to the increase in the mass of the dielectric resonator attached to one of the two ends of the drive. Due to the increase in energy in the form of concentrated resonating microwave photons. Which is in principle and according to special theory of relativity is equivalent to a certain mass. Using the famous mass energy relation. This energy is contained inside the dielectric and can be absorbed by the dielectric atoms. And can be added to the rest energy of the dielectric and manifest as a kinetic energy.

We assumed that the combined effect of the change of center of mass, and the conversion of the microwave energy to kinetic energy. Is equivalent to the effect of a genuine pull exerted by an external force in the direction of center of mass change. And by a continuous addition of microwaves to the dielectric resonator the process will be repeated again and again. And according to the equivalence of inertial frames dictated by special relativity. The system will be accelerating. And a true reaction-less thrust will ensue. This thrust as we will show is in perfect agreement with the special theory of relativity.

Introduction

Two inventors a British Roger Shawyer. And an American Guido Fetta independently invented two devices. The EmDrive and the Cannae drive. The two devices as claimed by the two inventors produced directional thrust. Powered by electricity to generate microwaves using a magnetron. All kept in a perfectly sealed containers. Apparently in a complete contradiction to a well established law of physics. Namely the law of conservation of momentum. Or to put it

another way, the two devices defy Newton's third law of motion. Which states that, for every action there is an equivalent reaction in the opposite direction.

Two different theories have been proposed by the two inventors. And they insist on their peculiar designing of the two drives. And everyone of the two claimed that the produced thrust is due to the unique design of his invention. But now we will see that the design of the functioning drive rely mainly on three factors. First the distribution of the mass of the drive. And the second factor is a high quality dielectric resonator well placed at a proper location. And the third factor is an efficient continuous supply of microwave radiation to the dielectric resonator.

We considered the testing done by the NASA's Eagle-works team led by Harold White to the two drives and their announcement that they detected a thrust. We considered this announcement to be a confirmation of the production of a directional thrust. And now we add the confirmation by the American Institute of the Aeronautics and Astronautics (AIAA) of the acceptance of a peer reviewed paper presented by the Eagle-works team. Therefore an explanation is needed. The explanation depends on exploiting the mass energy relation discovered by the great physicist Albert Einstein. And the dependence of the kinetic energy of an object with a certain mass on the state of the total energy of that object.

Consider an object of mass m which is at rest for an observer at certain inertial frame of reference. According to the mass energy relation, the energy contained by this object is given as: $E = mc^2$ the object will remain at rest forever if not acted upon by an external agent. This is what is known as the rest energy or the total energy at rest. Hence rest energy will not participate in moving the object. Now if we exert a force on this object to move its center of mass with a certain velocity v . And according to special theory of relativity the total energy of this object will be: $E_v = \dfrac{mc^2}{\sqrt{1-\dfrac{v^2}{c^2}}}$ where E_v is the total energy of the object, and v is the velocity by which the object moves and c as usual is the speed of light. Now contemplating this we conclude that. For an object to move with a certain velocity v , additional energy must be supplied to this object to increase its total energy. Now we know of various means by which to supply energy directly to an object and therefore increasing its total energy. But our experience informs us that no matter how large the amount of energy we supply, we can't induce motion or force the object to move with a certain velocity by this means. We have to assign a direction to this supplied energy to initiate movement. Otherwise all the directions are equal for the center of mas of the body. To truly set this body in motion, one have to move the center of mass and at the same time add the required energy to the rest energy. This is usually performed simultaneously. For example by pushing an object you supply energy and at the same time you move the center of mass of the body allowing it to move in a certain direction. Now one may conclude that if these two requirements are fulfilled. That is increasing the internal energy of the body

and at the same time moving its center of mass. The body can move in a specific direction.

These above mentioned two requirements for the initiation of movement, are usually performed by external forces. And the conservation of momentum can be clearly observed. But what if we can increase the internal energy of an object and at the same time change its center of mass without any external intervention ?!. In fact this can be achieved for a system of two masses connected by an ideal rigid rod with a negligible mass. As we will demonstrate.

Now my single working assumption or postulate will be stated as: (if we can supply a certain amount of energy to the rest energy of an object with a known mass connected to a second mass by a rigid mass-less rod. Then the added energy according to to the mass energy relation will shift the center of mass of the system. And the simultaneous effect of adding energy to the rest energy and the change of center of mass, is equivalent to the effect exerted by a real external force pulling the system in the direction of change of center of mass. And the added energy will change to kinetic energy.)

So this will be my basic working postulate. And one more thing about why we think this effect is equivalent to a pull. The distinction between the push and a pull is quite intuitive. In the case of a push you exert a force on the surface of the object near you to move it away from you. And as for a pull you exert a force on a side of an object near you to move it towards you. And one can appreciate that the effect produced is similar to a pull exerted by an imaginary invisible being, a phantom. Therefore the drive produced this way will be a phantom's pull drive. In fact this is a drive that operates by raising the total energy directly, to create motion. As we will see in the following section.

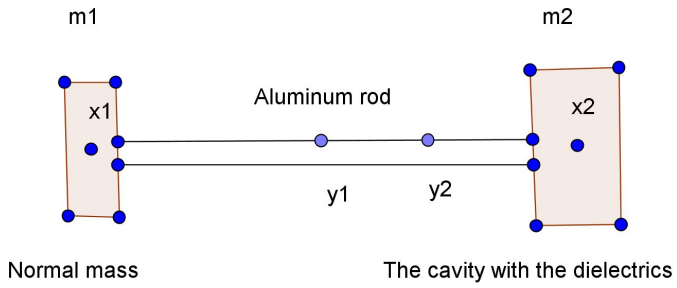
The Phantom's Pull Drive

Consider the figure bellow. A perfectly homogeneous disc of mass m_1 attached to the left end of a rigid rod with a negligible mass from its exact center. Situated at point x_1 along the x axis. At the right end also attached a perfectly homogeneous short cylinder of mass m_2 composed of a number of dielectric resonators discs of high Q value with a necessary mechanism to supply microwaves efficiently to the dielectric. This cylinder is situated at point x_2 . The short cylinder is made of aluminum to work as a resonant cavity with minimum mass. The system have to be designed such that the center of mass of it must lie on the axis of the cylindrical rod. Now the center of mass of this system can be given as:

$$y_1 = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} \tag{1}$$

Now let microwaves be supplied to the dielectric resonators. A certain amount of electromagnetic energy is stored in the form of standing waves. And these standing waves are confined to the dielectric. Now this energy in prin-

Figure 1: Showing the ideal design of an EmDrive for producing maximum thrust by concentrating on the basic principle behind its working. $m_1$is an ordinary mass connected by aluminum rod to the mass m_2 composed of a suitable number of dielectric resonators discs inside a sealed aluminum resonant cavity. y_1 is the center of mass of the system before the addition of the microwaves and y_2 is the new center of mass after the addition of the microwaves photons. x_1 and x_2 are the coordinates of the centers of the two masses m_1 and m_2 respectively.



ciple and according to the special theory of relativity's mass energy relation is equivalent to a mass Δm which will be added to m_2 and one can write:

$$\Delta m = \frac{E}{c^2} \tag{2}$$

Where E is energy possessed by the photons of the microwaves confined to the dielectric resonators. Now the addition of this mass to m_2 will change the center of mass of the system towards the right end. The new center of mass will be:

$$y_2 = \frac{m_1 x_1 + (m_2 + \Delta m) x_2}{m_1 + (m_2 + \Delta m)} \tag{3}$$

Note that in the figure the distance between y_1 and y_2 is exaggerated for the purpose of explanation. Actually this distance is extremely small. But no matter how small is the distance, the center of mass has shifted. And according to our postulate the situation is similar to an external pull applied in the direction of center of mass change. Because the energy of the microwave photons confined in the dielectric will be absorbed by it and converted to kinetic energy. And so one can write:

$$\Delta m c^2 = \frac{1}{2} m_t v^2 \tag{4}$$

Where m_t is the total mass of the system. In our case $m_t = m_1 + m_2$. Now solving equation (4) for Δm we can write :

$$\Delta m = \frac{1}{2} \frac{m_t v^2}{c^2} \tag{5}$$

And solving it for v we get :

$$v = c \times \sqrt{\frac{2\Delta m}{m_t}} \tag{6}$$

Equation (6) shows clearly that the velocity by which the system moves depends on the square root of Δm . Therefore to increase the efficiency of the system one have to increase this quantity. But the velocity is inversely proportional to $\sqrt{m_t}$ which means that the lighter the drive the more the value of the velocity will be. Needless to say this system which we have discussed above is nothing but either the EmDrive or Cannae drive. But more simple and many times efficient. Because now we can concentrate on how to make it lighter. And how to increase the value of Δm . Because to make this drive more efficient we have to create a lighter dielectrics with higher Q values, and reduce the size of magnetrons, or find an alternate way for supplying microwaves. If we achieve these goals then a highly efficient small drives can be designed. And by integrating a large number of these light and small drives, a powerful drive can be constructed.

In a total agreement with the drive discussed above, both EmDrive and Cannae drive use a dielectric resonator. In both drives the observed thrust is

towards the end near the dielectric. There is no need for the large resonant cavity of any shape in EmDrive. A relatively smaller resonant cavity should be restricted to the end of the drive where the dielectric resonator is attached. And we need just an efficient mechanism for supplying microwaves to the dielectric. And all the requirements for that have to be attached to the dielectric end. At the other end only we need to attache an object with mass m_1 where $m_{1\geq}m_2$. This is the condition for a greater value of $\Delta y = y_2 - y_1$. Where Δy is the distance traveled by the center of mass. The maximum value of Δy can be achieved when $m_1 = m_2$. On the other hand the Cannae drive can be made more efficient by placing the dielectric exactly at the end and not near the middle as in the actual drive. And also the mass at the other end is not sufficient to fulfill the above mentioned condition for Δy . In cases where a thrust was claimed even without inserting a dielectric, when using high power. This may be due to absorption of microwaves by the cavity wall. Because absorption can also increase the total energy. In fact we need to perform experiments where a good microwaves absorber is attached instead of the dielectric resonator. And we need experiments with more energetic photons like ordinary light or even ultraviolet radiation.

This drive works on something that is missing in Newton's mechanics. Namely the energy possessed by any mass even when it is at rest. Then exploiting this we can create motion by directly increasing the total energy of one part of a system, as described above. Nothing like this is encountered in Newton's mechanics. Therefore this drive mustn't be expected to obey the conservation of external momentum. Because in Newton's mechanics we deal only with differences between external quantities and interactions.

Now let us again return to the working of this drive. After supplying microwave photons to the dielectric resonator and the system moves as described. Let the magnetron be turned off. The system will be moving with a constant velocity. For an observer moving with the drive's inertial frame of reference the drive is at rest with no additional energy. Because the energy of the microwave photons has been absorbed and consumed by the dielectric and converted to kinetic energy as judged by an observer at rest at the first frame. For an observer in the second frame moving with the drive the system now is at rest according to equivalence of inertial frames dictated by special relativity. By adding microwave photons to the dielectric the process will be repeated in the third frame of reference, and so for higher inertial frames. The process will be repeated again and again. From an inertial frame of reference to another. And always an observer moving with the drive will claim to be at rest with the drive for a short period of time, and the dielectric is ready to take energy again. For an observer at rest in the first frame the drive is accelerating continuously. This is also true for an observer traveling by the drive the drive is accelerating continuously. In fact this acceleration can only be limited by special relativity's rule for an object with rest mass. This is a new and a profound way of obtaining a reaction-less thrust, based on relativity mechanics.

As mentioned by the two inventors and by NASA scientists the applications of this drive can only be limited by our imagination. From highly efficient

spacecrafts to a vertical take off and landing of planes, to flying cars. And even highly efficient motors and dynamos. No limit to this extraordinary drive. Only we have to be more imaginative.

Perpetual Motion Machine or Unlimited Clean Energy

With all the denial of the two inventors of the extraordinary drives. That their drives couldn't act as a perpetual motion machines. In fact yes a drive constructed as discussed above is nothing but a perpetual motion machine of the first kind. because as it is well known that any device with a thrust to power ratio greater than the photon rocket will operate as a perpetual motion machine of the first kind. And for the EmDrive this was proved by the NASA's Eagleworks scientists to be the case. By conducting direct experiments on the drive. They found a thrust more than thousand times greater than that of the photon rocket. In fact this number can be increased after knowing the mechanism by which it works. Now as history informs us. When a good experiment contradicts a theory, accept the result and check the theory. This may not prove the theory is wrong. But may point to the limitations of the theory.

Now this fact can be exploited to generate limitless energy. Imagine a dynamo constructed such that two drives of equal power, connected to a rigid disc attached to a rigid axle where a magnet is attached. Surrounding the magnet is a fixed coil made of copper arranged as usual to generate electricity once the magnet start rotating. By activating the two drives the magnet start rotating and electricity will be produced. But the two drives velocity will increase steadily. And at some point the electricity produced will exceed the input. Now we can feed the drives from the electricity produced by the dynamo. But the drive continue to accelerate and at some point we need to do something to decelerate this motion.

Yes the dynamo discussed above will contradict the first law of thermodynamics. But works in perfect agreement with special theory of relativity. And again we need to say that the first law of thermodynamics has been derived on the basics of Newton's mechanics. But this drive works on the basics of special theory of relativity. Special relativity can be replaced by Newton's mechanics at low velocities as compared to light velocity. This works finely when we consider only the external interactions and we neglect the internal properties of matter. We can't reduce to nothing the rest energy which is absent in Newton's mechanics. We can't reduce it as a low velocity approximation. The rest energy is there even when the body is at rest. Newton's mechanics deals with external interactions between objects, and energy differences between different states. While special relativity hints at internal properties of matter of which we knew still a little.

Conclusion

So as discussed above we are on a verge of an extraordinary breakthrough for producing unlimited clean and cheap energy. Therefore sufficient funding for further research must be given to physicists and engineers working to improve this new kind of a reaction-less thrust producing drive. Also large companies like Boeing, Lockheed, and others, must participate to accelerate the improvement of this drive. Because this is a drive that can revolutionize our concept about transportation. And makes the fiction a reality. Perhaps this application of the special relativity will prove to be the most important of all the applications of the theory. As far as clean, cheap and efficient energy production is concerned.

Finally this is a suggestion for building an efficient version of the EmDrive. If the total mass of the current EmDrive is 7kg. Then we can build a drive where $m_1 = 4\,kg$, and about 2kg made of a suitable number of dielectric resonators discs and only 1kg or less for the aluminum cavity resonator to encase the dielectric resonators end only with the magnetron. This way we will allow the resonating photons in the cavity to increase the value of Δm . The two ends have to be connected by an aluminum rod to minimize the weight. The maximum number of dielectric resonators discs for maximum thrust have to be found experimentally, so if NASA's Eagle-works scientists are interested, they may try to construct and test this version.