Effect of Occurrence of Propulsive Force with no Reaction Mass Ejection

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Abstract:

The necessity to take into account friction forces momentum (impact losses) in the momentum equation of interacting deformable bodies is shown. Occurrence of propulsive force in devices with no reaction mass ejection is explained in terms of Newtonian mechanics exemplified by the so-called inerzoids, due to the gap between the efficiency coefficient (losses) in the process of expelling and addition of the same sloshing mass. The possibility of manifestation of this effect at the atomic level under the influence of inertial forces and the magnetic field in nature and in technology is considered as a hypothesis. A mechanical device creating propulsive force, in the form of an inerzoid, implementing oarer biomechanics for outer space is proposed.

1. Introduction

To fly in space, jet thrust is required, which is determined by energy and consumable reaction mass. If a space-flight unit (SFU) can obtain energy from an energy-intensive nuclear plant or the Sun, which is considered to be inexhaustible source of energy, then the mass of expellant, the consumable mass, is always limited. Basically, the energy (chemical) and the consumable mass are combined in the rocket fuel; these are its reserves on board of a SFU that limit its capabilities, especially for interplanetary flights. Therefore creation of the space jet engine with high specific impulse, even a small thrust, is of current interest.

In recent decades, numerous experimental studies confirmed possibility to create thrust in devices with no mass ejection. But the problem here is to explain this phenomenon or effect without violating the laws of conservation. Understanding the physics of the process of thrust occurrence would qualitatively raise its efficiency. Existing publications recognize this phenomenon and attempt to explain it and implement in the framework of state programs [1,2,3]. However, given that the scientific world is at the beginning of the way of knowing this process, it is advisable to carefully consider other versions, even at the level of hypotheses, which could

complement each other. Below we consider the explanation of this phenomenon in terms of Newtonian mechanics and its manifestation in nature and technology.

In paper the explanation of this phenomenon in terms of Newtonian mechanics and its possible implementation in technique is considered. The necessity to take into account friction forces momentum (impact losses) in the momentum equation of interacting deformable bodies is shown. Occurrence of propulsive force in devices with no reaction mass ejection is explained in terms of Newtonian mechanics exemplified by the so-called inerzoids, due to the gap between the efficiency coefficient (losses) in the process of expelling and addition of the same sloshing mass. A mechanical device creating propulsive force, in the form of an inerzoid, implementing oarer biomechanics for outer space is proposed. Also the possibility to apply the considered inerzoid mechanism to create propulsive force at the atomic level is considered.

2. Theoretical Principles and Concepts of the Effect Manifestation

In the applied gas dynamics [4] for a gas jet taking into account the friction force, the known momentum equation for sections 1-2 with constant area F and without performing work is written as follows:

$$(p_1 - p_2)F - P_{fr} = G(w_2 - w_1) \tag{1}$$

i.e. here friction force Pfr is taken into account, and p and w are the gas pressure and velocity, respectively.

The correlation to define the nozzle thrust [5] obtained for TJE using a common method from the momentum equation, introduces the speed ratio, taking into account the internal losses due to friction and compression shock waves.

For the thrust augmenting ejector [4], in which the active (ejecting) and ejected jets interact, the efficiency coefficient is introduced in the correlation determining the thrust augmentation ratio, taking into account the impact losses of the interacting masses.

$$\frac{P}{P_o} = \sqrt{(n+1)\eta} \tag{2}$$

Where P/P_0 is the thrust ratio with the thrust augmenting ejector and without it (thrust augmentation ratio);

$n = G_2/G_1$ is the ratio for the flow rate of the ejecting and the ejected gas (the coefficient of ejection);

η is the coefficient of the thrust augmenting ejector.

In works [4,5], the presented relations subject to the efficiency coefficient of gas mass interaction processes in the flow are confirmed by numerous experiments and are widely used in practice.

In the general physics [6], the law of conservation of momentum for two interacting solids (let us assume that solid m_2 is at rest before impact) under the inelastic impact is as follows:

$$w_1 m_1 = w_2(m_1 + m_2) \text{ or, } w_2(m_1 + m_2)/w_1 m_1 = 1 \tag{3}$$

There are no impact losses (friction during deformation); they are reflected only on the mechanical energy in the form of the efficiency coefficient of the interaction process. The work [6] demonstrates the experiment with a bullet hit in a sand box suspended as a pendulum which mass is 1000 times more than the bullet mass. It was found that the efficiency coefficient of the process is 0.1 per cent. The deflection of the box was measured; the force generated by the box was not measured. The question arises: how correct is the experiment and what would happen to the results if the box was filled with the material with different resistance to bullet penetration. Theoretically, all mechanical energy can be converted into heat and, will the momentum then also be preserved? Momentum is the presence of speed, speed is the mechanical energy. I.e. where no speed is, there is no momentum. This is qualitative assessment. And now let us mathematically estimate the validity of the above momentum equation (2) in terms of the energy conservation law. By inelastic impact some of the kinetic energy is converted into heat, i.e. the kinetic energy decreases. Thus, here, as in the thrust augmenting ejector [4] this ratio of kinetic energies can be taken for the efficiency coefficient of inelastic impact.

$$\frac{w_2^2(m_1 + m_2)}{w_1^2 m_1} = \eta \angle 1$$

(4)

Let us transform this relation for energies into the relation for the linear momentum. Let us extract the square root from the left and right sides of the equation:

$$\frac{w_2}{w_1}\sqrt{\frac{m_1 + m_2}{m_1}} = \sqrt{\eta}$$

(5)

and multiply by

$$\sqrt{\frac{m_1 + m_2}{m_1}}$$

(6)

We will get the ratio of the linear momentum

$$\frac{w_2}{w_1}\frac{(m_1 + m_2)}{m_1} = \sqrt{\frac{m_1 + m_2}{m_1}}\eta$$

(7)

unequal 1, which contradicts the equation (2). This ratio corresponds to (1), which is obtained in the same manner.

In view of the above, we can draw the following conclusion: for deformable bodies in which mechanical energy is converted into heat (but there are no absolutely solids in nature), it is necessary to introduce the friction force impulse into the momentum equation. And then, in the closed system, if multidirectional and unequal frictional forces are created (e.g., in the oscillatory process), then unbalanced (propulsive) force with no reaction mass ejection will arise.

Effect of occurrence (creation) of the propulsive force in unsupported motion with no reaction mass ejection can be considered by the example of the known mechanical device of an inerzoid (Figure 1) [7,8,9].
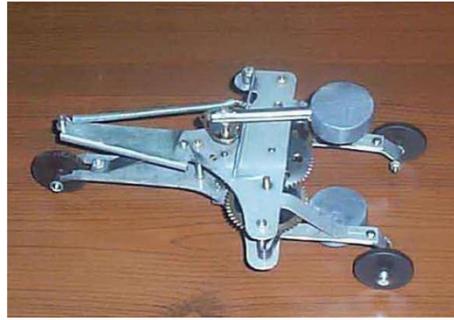
Figure 1. Inerzoid.

Creation conditions of motive force are realized within the laws of Newtonian mechanics and in particular the Meshchersky equation:

$$m\frac{d\overline{\upsilon}}{dt} = \overline{F} + \overline{u}_1\frac{dm_1}{dt} + \overline{u}_2\frac{dm_2}{dt}$$

(8)

where m is the variable body mass; υ is the variable-mass body velocity; u_1 is the relative velocity of separating particles; u_2 is the relative velocity of adjoining particles;

$\dfrac{dm_1}{dt}$ is the mass flow rate (expelling) per second;

$\dfrac{dm_2}{dt}$ is the mass input (addition) per second; F is the external force.

Here, for the inerzoid, the particular solution of the Meshchersky equation is interesting, when for a body the expelled mass is equal to the added mass, i.e. its mass is constant. In the actual practice, at the constant mass subject to the losses, it is possible to create a pulse when an unbalanced force occurs due to different efficiency coefficient values of the processes of mass expelling and adding.

The inerzoid mechanisms, in spite of their variety, can be brought to a simplified diagram (Figure 2).
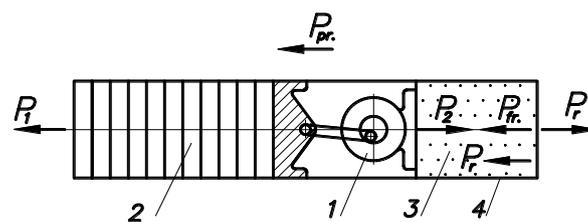

Figure 2. Diagram of propulsive device (inerzoid) with no reaction mass ejection: 1 – shock mechanism; 2 – perfect elastic body; 3 – non-elastic body; 4 – casing.

The diagram includes: 1 is the shock mechanism, 2 and 3 are the bodies of various elasticity located in casing 4. There are two main phases in the action of the shock mechanism: 1 – when there is its effects on bodies 2, 3 and 2 – (the opposite phase), when there is no impact. There is no wheel drive.

Let us consider the inerzoid loading pattern (Figure 2). For better understanding the physics of this process let us make the following assumptions:

- The mass determining the momentum is focused within the shock mechanism;

- Body 2 is perfectly elastic;

- Body 3 is non-elastic;

- There is no friction between the parts of the shock mechanism (it is not fixed on the casing), bodies 2 and 3 and casing 4 walls;

- $P_1 = P_2$ are the forces transmitted by the shock mechanism to body 2 and 3;

- $P_{fr.}$ is the frictional force generated at deformation in non-elastic body 3;

- $P_{r.}$ is the residual force transmitted by non-elastic body 3 to the right end face of casing 4.

Owing to perfectly elastic body 2, force P_1 is transmitted to the left end face completely. When the shock mechanism is in the opposite phase, when there is no action of the shock mechanism on body 2 and 3, $P_1 = 0$, $P_2 = 0$, the following equation of forces is not realized (there is no propulsive force).

For the assumed loading pattern the equation of the forces acting simultaneously on the end faces of the casing is written to determine only the instantaneous value of the propulsive force. We assume the direction of propulsive force $P_{pr.}$ as positive.

$$P_{pr} = P_1 - P_r \tag{9}$$

To determine the P_r. let us write down the equation of the forces acting on the non-elastic body

$$P_2 = P_{fr} + P_r \text{, then}$$

$$P_1 - P_2 + P_{fr} = P_{pr} \text{, and}$$

$$P_{pr} = P_{fr}$$

In theory it is possible that $P_r = 0$ (all mechanical energy transfers into heat), then

$$P_{pr} = P_1 \tag{10}$$

In bodies 2 and 3 during the shock mechanism operation in the oscillating process, mass addition can occur with an efficiency conditioned by the bodies' elasticity. Inerzoids are the mechanisms where due to asymmetric elasticity and accordingly different efficiency coefficients of the processes of adding and expelling solid mass in the oscillating process, the unbalanced force occurs.

If there were the possibility to manufacture the inerzoid mechanism from absolutely solid material, then no motion would occur.

It should be noted that such inerzoid was successfully tested in 1996 in LLC "Faraday" (Tula) [10]. In [10] it is noted that the idea of the experiment has long been known – it was reflected in the American journal "Popular Science" No. 126 of 1935. However, there was no theoretical justification of the equations in these publications.

Let us show how this simplified mechanism of creating propulsive force can be manifested in nature and implemented in technology. In this case, we will be guided by the following rules for obtaining scientific knowledge, established by I. Newton [11]:

a. Ontological assumption on the nature simplicity: do not allow more causes than are enough to explain visible acts of nature; this rule evolves a well-known principle

of simplicity by W. Occam, pointing to the necessity of searching for simple explanations;

b. Ontological idea of the uniformity of nature: one and the same phenomenon should as far as possible be explained by the same causes.

Since there was no there was no visible interaction with the ambient atmosphere in experiments with the inerzoids (Figure 2), new theories (gravitational, torsional fields, etc.) were suggested to resolve contradictions with the law of momentum conservation, which did not comply with the above-mentioned rules. However, the new theories did not give well-defined explanations of the effects achieved, and so they were subjected to criticism. The following, partly new scientific data can clear up the question:

a. PJSC "UEC-Saturn" (Rybinsk) has conducted tests of the experimental pulsejet engine with the thrust augmenting ejector based on a high-frequency slide valve constant volume (V=const) combustion chamber of a new type [7,8,9].

It was demonstrated that addition of gas mass inside the channel that increases the thrust can occur in the oscillating process, i.e., one and the same gas mass can create thrust first as an active and then as an additional mass. In this situation the kinetic energy (dynamic pressure) is converted to pulse. The additional mass can repeatedly participate in generation of thrust in the oscillating process; it is difficult to measure or to take into account. When determining the specific characteristics of the engine (attributed to the mass flow) may even be in conflict with the laws of conservation due to this "hidden" mass. I.e. by the indirect estimation the real additional mass can become "hidden".

b. At NASA Glenn Research Center during experimental research of a pulsejet thrust augmenting ejector with a resonance device at inlet [12], the ejecting process efficiency of 1.15 was obtained that contradicts the laws of conservation. The reverse gas flow at definite periods of time was observed. The authors of the research fell short in their efforts to offer an explanation for this phenomenon. The contradiction can be resolved provided one and the same air mass is used first as an active and then as an additional mass within the oscillating process, i.e. as in the previous case.

Under certain conditions, transformation of the active mass into the additional one is also possible in the single non-stationary cycle (with continuous efflux). This occurs when the flowing out gases lose gradually kinetic energy, e.g. due to friction, or when the power of the energy source increases (during the cycle), i.e. the subsequent masses of the gas have a greater velocity. This effect can be explained via such time-stretched visual unsteady single process as volcanic eruption. At the beginning of eruption, the first masses of erupted magma would remain near the crater creating momentum as an active mass. However, the subsequent flowing out of magma masses affects the previous ones driving them into motion and turning these masses into the additional ones increasing momentum. I.e. one and the same mass in the flow without pulsations participates in creating momentum twice – first as an active mass, then as the additional one.

The "hidden mass", "dark matter", "vacuum energy" – these usually related concepts are used to explain some technical and cosmic phenomena, when there are problems with application of laws, such as the laws of Newtonian mechanics. However, not everything has received explicit recognition.

To understand "the vacuum energy" ("the hidden energy"), such remarkable fact can be referred to from the unsteady gas dynamics [13], which is not immediately perceived even by the experienced specialists in gas dynamics.

When a vacuum vessel is filled with ambient air, the inside temperature increases by 115K, i.e. the internal energy increases. Moreover, vacuuming could be carried out arbitrary long ago, even in the time of the Big Bang. At first glance this phenomenon can demonstrate the so-called vacuum or the gravity energies, but there is fairly simple explanation based on the first law of thermodynamics, which in the absence of heat transfer will be written as follows:

$$Q = U_2 - U_1 + L_{out} = 0 \qquad (11)$$

When the vessel is filled, there is change in volume, and hence there is outer work L_{out}. This results in change in internal energy $U_2 - U_1$ (in more detail in [14]). Here, the source of increasing internal energy is the work previously spent on vacuuming the vessel.

It should be noted that the cyclic nature of the pulsojet operation assumes that each implemented cycle, as in the experiment with the vacuumed vessel, at the beginning receives parts of the energy (temperature increase) from the previous and then transfers it to the subsequent cycle [13].

The obtained results can help to solve technical problems arising in the study of unsteady gas-dynamic processes, especially in terms of understanding their physics. In addition, as noted above, it is advisable to consider them in relation to cosmology, where there is also the problem of the "the vacuum energy" and "the dark matter". The Big Bang theory, which explains the origin of the Universe, is now largely accepted. This assumes a starting point, i.e. a singular state in which the laws of physics do not apply. However, there is a point of view [14] that "the basic model of the Big Bang is not able to explain the three main features of the observable Universe. Such features encompass inability to explain the temperature observed in the modern Universe, existence of galaxies, and expansion of the Universe. If a new discovery is made that does not fit into the standard model of the Big Bang, then scientists introduce new substances wherein, for example, "the dark energy" and "the dark matter", the existence of which also needs to be proved. There are other theories, e.g. [14] "the cyclic one: endless series of compression and expansion of the Universes." And this can be accompanied by the phenomena caused by increase in temperature ("the dark energy") and occurrence of the additional mass ("the hidden mass"), due to the cyclical nature and the explained above. I.e. there is no "dark mass and dark energy", but there is the additional mass and the energy of the previous cycle. At mass interaction such phenomenon occurs as unstable accumulation of the additional mass and its uneven distribution in space [15].

Let us consider as a hypothesis possibility to apply the considered inerzoid mechanism to create propulsive force at the atomic level. It is known that all atoms of a solid execute thermal oscillations. There are strong interactions between atoms of a solid [16]. The nucleus in which the mass of the atom is concentrated oscillates in the system "the nucleus − the electronic shell". Asymmetry of this system can be created due to the following factors:

a. Under the influence of the magnetic field, it is possible to form the electronic shell and to generate an asymmetric system in which the force interaction is determined inversely to the square of the distance. As a result, the atoms as a set of

inerzoids in the oscillating process create total unbalanced propulsive force.

The so-called "impossible" electromagnetic rocket engine with no reaction mass ejection invented by Roger Schauer [17] and Leonov [18] can partly lend evidence to this phenomenon. The possibility to create such low-thrust engine is confirmed by NASA, papers highlight asymmetry in the electromagnetic system of the engine with a high-frequency magnetron, but there is no explanation for the mechanism of creating thrust.

It can also be accepted as a hypothesis that the gravitational force can be formed in this way, without the gravitational field. Then the well-known problem of creating the unified field theory is solved. It should be recalled what Newton said about his gravitation theory: "It says how bodies move. That should be enough. I've told you how they move, but not *why*". However, there were attempts to answer the "why", but they did not receive recognition.

b. Under the influence of acceleration, the nucleus, in which the mass of the atom is enclosed, together with the electronic shell can also form the asymmetric system described above creating propulsive force. The main interest for outer space and the technology is centrifugal acceleration. Numerous experiments [19] with rotating masses show encouraging results in the creation of antigravitational forces.

It is necessary to conduct research at the subatomic (quantum) level as to creating propulsive force from the influence of the magnetic field and inertial forces. Probably, these studies should result in creating a quantum gravitation theory (so far there are only hypotheses). This approach will be consistent with the hypothesis put forward at the University of Leiden (Holland), according to the results of the latest fundamental studies of the Universe, which indicates that the gravity is the temporary phenomenon and the side effect, but not the reason to what happens in the Universe. It can be assumed that at every point in the Universe, the magnetic field and acceleration will determine the gravitational force, its magnitude and the direction of action (without the gravitational field). That is, the gravitational constant at the periphery of the Universe can change dramatically, as Dutch scientists discovered.

c. The core can be shifted and made to oscillate more intensively due to the directed addition of energies, such as the acoustic or the vibration one.

Within the suggested hypothesis the known gravitation formula

$$F = \frac{\gamma mM}{r^2} \qquad (12)$$

remains unchanged, just γ should be called the gravitational constant, e.g. gravitation coefficient which at each point of the Universe will be different. Now the gravitational constant is determined empirically under the conditions of the earth surface, under specific conditions, but its constancy extends to the Universe. Proposals to measure it, for example, in the conditions of the Moon are considered to be unsubstantiated. And here the question arises, whether due to this accepted constancy γ we have to reckon such possible versions of the structure of the cosmic bodies: ferrum inside the Earth, the Moon should have hollowness, existence of planets being gas giants. Maybe each planet has its own gravitational constant, and their density does not differ much, and this will correspond to the above-mentioned ontological idea of uniformity of nature.

Attention should also be paid to the following facts:

a. Periodic measurements of the gravitational constant record its changes, which are attributed to the measurement error;

b. The Earth's magnetic field is changing; the North Pole is shifting at increasing speed (60 km per year in 2004).

Possibility of pole change is not excluded; it is assumed that this has already happened. That is, strong change in the Earth's magnetic field can change the effect on the mechanism of interaction of masses at the atomic level and accordingly change the gravitational constant.

There exists a hypothesis that the extinction of dinosaurs occurred at the reversal of poles. The square cube law known in technology (in relation to strength) is also valid for the musculoskeletal systems of living organisms. The force created by the muscle is proportional to the area of its cross-section (the square of the linear size) and therefore lags behind the mass (proportional to the cube of the linear size) when the size of a living organism increases. This reduces the ratio of the developed strength to the weight and makes the body less mobile and viable. It can be assumed that the change of poles has increased the gravitational constant and the living beings with small mass turned out to be more viable. It should be noted that the mass of some species of dinosaurs amounted to 70 tons.

The known phenomenon, i.e. short-time weight reduction in the human body and other living organisms under definite conditions called "levitation", has not received a well-defined explanation so far.

During the experiments on levitation, muscular trembling was observed with a human being that can be considered as a peculiar pulsating process. The analysis of the musculoskeletal system of a human being showed its similarity with the inerzoid. More powerful difference (asymmetry) in bones and muscles elasticity, compared to an inerzoid, is obvious. Therefore, it is reasonable to consider the causes of origination of the force reducing the human body weight as a result of the mass interaction in muscles (at their high-frequency contraction) and bones. It is known that some handball and basketball players can hover over in the air for a short time, i.e. create the force comparable to the weight. Probably, subject to knowledge of this biomechanics, it is possible to develop ability of the astronauts' organisms to control the movement of their body in space with the help of training.

3. Example of Possible Implementation of the Effect in Engineering

To fly in space, jet thrust is required, which is determined by energy and consumable reaction mass. If a space-flight unit (SFU) can obtain energy from an energy-intensive nuclear plant or the Sun, which is considered to be inexhaustible source of energy, then the mass of expellant, the consumable mass, is always limited. Basically, the energy (chemical) and the consumable mass are combined in the rocket fuel; these are its reserves on board of a SFU that limit its capabilities, especially for interplanetary flights.

At the same time, low-thrust rocket engines are used in space serving to stabilize the position of SFU, their movement to other orbits, as well as for movement of astronauts in outer space. Thrust of such engines usually does not exceed several kilograms, which is much lower in terms of energy consumption than physical capabilities of a human being.

It is proposed to use the principle of inerzoid motion in the device driven by muscular force to move a SFU in space. Oarers implement the muscular energy to the fullest extent possible (in boat racing). Here, all the major muscles of the legs, back and arms are involved in creating the effort. Figure 3 shows a device made in the form of an inerzoid with oarer biomechanics implementation in two positions: at the beginning and the end (the dashed line) of the forward travel.
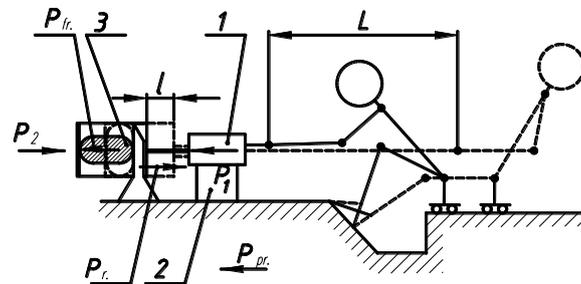

Figure 3. *Device for creating propulsive force in space with implementation of oarer biomechanics; 1 – pulley tackle; 2 – elastic body; 3 – non-elastic body.*

For better understanding of the device, its construction diagram is considered in the simplest conventional form. Given the sufficiently large forward travel of the oarer *L* (ca. 1.5 m) pulley tackle 1 is applied setting the working force, providing at the end of the motion small working travel l and corresponding increase in force (*L/l*) for optimal deformation of a non-inelastic body. The pulley tackle is rigidly fixed on SFU structure 2 and has a spring mechanism to bring the device to its original state (during the back travel). The given designations and the equations, respectively, are the same as those of the above-mentioned inerzoid. Non-elastic body 3 is shown here conventionally; it is easily deformable, it does not lose its properties in the work (e.g. something like plasticine). To bring the non-elastic body to its initial state (before the working travel), there is a mechanism for its reversal by 90^0 (not shown in Figure 3). The working process encompasses two cycles: the working travel with deformation of the non-elastic body and the return (preparatory) travel with rotation of the non-elastic body, i.e. similar to forging a hot metal work piece. As a result of this process unbalanced propulsive force is generated.

The non-elastic body can be of another design, e.g. in the form of a mechanism, and possibly with utilization of the released energy, but this requires special research. This device can simultaneously perform the function of a sports simulator for astronauts.

In [20] there is information that in Canada possibility of such method of movement on the water was confirmed on a specially created canoe, but the idea did not go any further. On this occasion, we can note the following:

a. Probably the canoe was moving very slowly and it did not arouse practical interest;

b. Understanding the physics of the process, it is possible to increase its efficiency (increase the propulsive force) through constructive measures;

c. In space, the small force created with no reaction mass ejection is also of great importance.

4. Conclusion

Exemplified by using the momentum equation in the applied gas dynamics, in particular, in the theory of the thrust augmenting ejector, the necessity to take into account losses on impact (friction) in the momentum equation of the interacting deformable bodies was mathematically proved.

The possibility of creating thrust with no mass ejection is shown on the example of a known mechanical device of an inerzoid using the momentum equation (subject to friction). This also corresponds to the partial solution of the Meshchersky equation, when the mass of expellant and the additional mass are equal (one and the same oscillating mass), and the efficiency coefficient of the processes is different.

As a hypothesis, the principle of inerzoid motion is transferred to the atomic level of a solid, where the oscillating nucleus with the electronic cloud under the action of inertial forces and the magnetic field can create an asymmetric system with the unbalanced force.

The possible manifestation of the identified propulsive force in nature, space, its implementation in technology, for example in the device implementing oarer biomechanics, is shown.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

The author carried out this research on a proactive manner without involving contributors.

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