Propulsive Forces From Rotating Objects

Michael B. Saguirel *
Rielles Aerospace Ventures Inc.†*, Cebu, Philippines*

Thrust is generated when a particle with momentum interacts with a rotating medium and becomes unbounded from the constraints of the rotation.

I. Introduction

THE quest for innovative propulsion technologies has always been at the forefront of scientific exploration. While current propulsion systems have undergone numerous refinements over the years, there remains a promising yet underexplored method of generating thrust using rotating objects. This paper presents a novel approach to propulsion that has the potential to transform transportation across various mediums, including land, water, air, and space.

II. Objective

This paper aims to present a new technological concept and to solicit funding for its further validation and development.

III. Target Audience

The primary audience for this paper includes propulsion research institutions, physicists, aerospace engineers, photonic engineers, and others with a foundational understanding of the physics concepts discussed.

IV. Technical Background

Consider a stone tied to a string, spun overhead. If the string breaks, the stone will move in a straight line, tangential to its previous circular path, as shown in Fig. 1 by v.

This motion is indicative of a reactionary force in the opposite direction, represented in Fig. 1 by F. If one were to argue against this reactionary force, it would contradict Newton's Third Law of Motion. For instance, in a hypothetical scenario in space (Fig. 2), repeatedly hurling the stone inside a closed container would cause acceleration if reaction force is absent. To achieve movement in a specific direction (Fig. 2, denoted by E), one must release the stone outside the container or let it bounce off an internal wall and exit (Fig. 2, denoted by W). Assuming no energy loss, both actions would accelerate the container equally. This principle underpins the operation of the Rielles Drive [1], which uses momentum-carrying particles as propellant.

*Inventor, Founder / CEO
†www.rielles.com

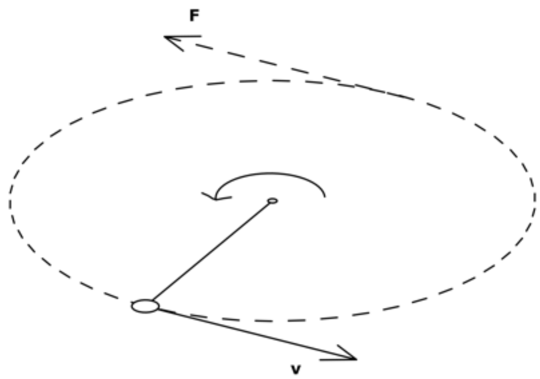

Fig. 1 Rotating stone

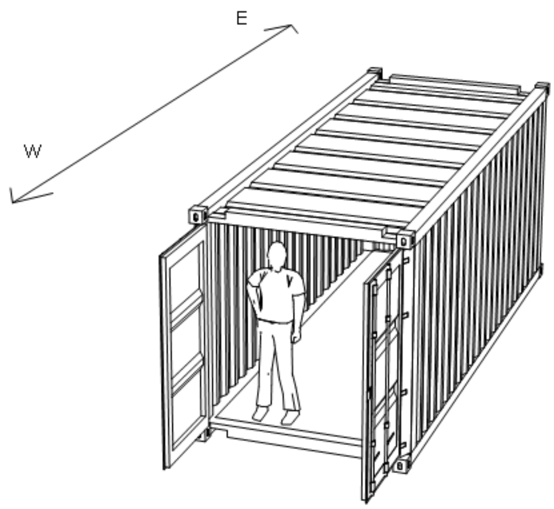

Fig. 2 Shipping container in space

V. Invention

The Rielles Drive is an advanced propulsion system designed to rotate propellants. It is categorized into seven distinct variants:

1) Rielles Drive 1.0

As shown in Fig. 3, the propellant (water) is fed through duct **10** and released via exit port **20**. The release of water is regulated by valve **15**, which is actuated only when the drive achieves the desired angular velocity and the spatial orientation of exit port **20** is at an optimal angle for thrust generation. The propellant is pressurized to avoid cavitation.

Suppose a Rielles Drive 1.0 has a diameter of one meter, rotates at 10,000 RPM in an in a frictionless environment with no energy loss, and expels 2 milliliters (equivalent to 2 grams) of water via a singular exit port during each rotation, the thrust can be computed as outlined below:

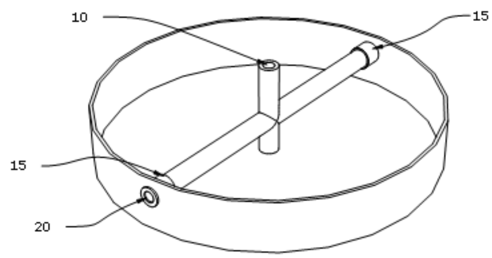

Fig. 3 Cutaway illustration of Rielles Drive 1.0

1) **Calculation of Linear (Tangential) Velocity**:

   Given the angular velocity ω in terms of RPM, we will convert it to radians per second:

$$\omega = 10,000 \times \frac{2\pi}{60}$$

$$\omega \approx 1,047.20 \text{ rad/s}$$

   The linear velocity v of a point (or the propellant, in this case) on the rim of the rotating member with a 1-meter diameter is:

$$v = r \times \omega$$

   Where r is the radius, which is half of the 1-meter diameter, so $r = 0.5$ m.

$$v \approx 0.5 \text{ m} \times 1,047.20 \text{ rad/s}$$

$$v \approx 523.60 \text{ m/s}$$

2) **Calculation of Thrust**:

   Given that 2 ml of water is 2 grams or 0.002 kg is ejected per revolution, the mass flow rate $\dot{m}$ (mass ejected per unit time) is:

$$\dot{m} = 0.002 \text{ kg/revolution} \times \frac{10,000 \text{ revolutions}}{60 \text{ seconds}}$$

$$\dot{m} \approx 0.33 \text{ kg/s}$$

   The thrust T is then:

$$T = \dot{m} \times v$$

$$T \approx 0.33 \text{ kg/s} \times 523.60 \text{ m/s}$$

$$T \approx 172.79 \text{ N}$$

With a diameter of one meter, rotating at 10,000 RPM, and ejecting 2 ml of water per revolution, the Rielles Drive produces a thrust of 172.79 N.

Suppose this is attached to a 50 kg vehicle, the acceleration would be:

$$a = \frac{F}{m}$$

$$a = \frac{172.79 \text{ N}}{50 \text{ kg}}$$

$$a \approx 3.46 \text{ m/s}^2$$

Three Rielles Drive 1.0 with the given parameters are already enough for a 50 kg vehicle to lift off vertically from the ground.

Going back to the space-based shipping container analogy where the stone is directed to impact the wall opposite the open side: a similar setup can be implemented to a Rielles Drive 1.0 by attaching a parachute-like contraption near the water exit port in order for the water to collide to the contraption (analogous to a thrust reverser [2] in an aircraft). With this, we can then calculate the acceleration of the 50 kg vehicle using Collision equation.

Given:

$$\text{Mass of propellant (Object A)}, m_A = 2\,\text{grams} = 0.002\,\text{kg}$$
$$\text{Initial velocity of Object A}, v_{A1} = 523.6\,\text{m/s}$$
$$\text{Mass of vehicle (Object B)}, m_B = 50\,\text{kg}$$
$$\text{Initial velocity of Object B}, v_{B1} = 0\,\text{m/s}$$

Using the equations for a one-dimensional elastic collision:

$$v_{A2} = \frac{m_A - m_B}{m_A + m_B} v_{A1} + \frac{2m_B}{m_A + m_B} v_{B1} \tag{1}$$

$$v_{B2} = \frac{2m_A}{m_A + m_B} v_{A1} + \frac{m_B - m_A}{m_A + m_B} v_{B1} \tag{2}$$

Substituting the values:

$$v_{A2} = \frac{0.002 - 50}{0.002 + 50} \times 523.6 + \frac{2 \times 50}{0.002 + 50} \times 0 \tag{3}$$

$$v_{A2} \approx -523.6\,\text{m/s} \tag{4}$$

$$v_{B2} = \frac{2 \times 0.002}{0.002 + 50} \times 523.6 + \frac{50 - 0.002}{0.002 + 50} \times 0 \tag{5}$$

$$v_{B2} \approx 0.0209\,\text{m/s} \tag{6}$$

Now, we find the change in velocity for Object B:

$$\Delta v_B = v_{B2} - v_{B1} = 0.0209\,\text{m/s}$$

Since this collision happens 166.67 times in a second, the total change in velocity over one second for Object B is:

$$\Delta v_B \times 166.67 \approx 3.48\,\text{m/s}$$

The acceleration of Object B is the change in velocity over time:

$$a_B = \Delta v_B \times 166.67 \approx 3.48\,\text{m/s}^2$$

The energy consumption of the Rielles Drive 1.0 is determined by the amount of energy the propellant extracts from the system during each rotation. A rotating object retains its rotational energy, provided there is no energy loss to heat from factors like drag or friction. This principle is the basis of a flywheel energy storage system [3]. This underscores the efficiency of the Rielles Drive in translating rotational motion into thrust. The thrust can be quantified by the mass flow rate combined with the velocity of the propellant, mirroring the dynamics when the propellant is released from its rotational state. The energy imparted to the propellant can be computed as follows:

1) **Energy Carried Away by Propellant:**

$$KE = \frac{1}{2}mv^2$$

$$KE = \frac{1}{2} \times 0.002\ \text{kg} \times (523.6\ \text{m/s})^2$$

$$KE = 274.16\,\text{J}$$

2) **Power Consumption:**

$$P = KE \times 166.67 \text{ revolutions/second}$$

$$P = 274.16\,\text{J} \times 166.67 \text{ revolutions/second}$$

$$P = 45{,}694.24\,\text{W}$$

The specific impulse, I_{sp}, can be calculated as follows:

$$I_{sp} = \frac{T}{\dot{m} \times g_0} \tag{7}$$

$$T = 172.79 \text{ N}$$

$$\dot{m} = 0.002 \text{ kg} \times 166.67 \text{ revolutions/s} = 0.33 \text{ kg/s}$$

$$I_{sp} \approx \frac{172.79 \text{ N}}{0.33 \text{ kg/s} \times 9.81 \text{ m/s}^2} \approx 53.37 \text{ s} \tag{8}$$

The specific impulse of the Rielles Drive 1.0 is not predominantly determined by the type of propellant used. Instead, it is influenced by the amount of energy applied to the propellant and the drive's capacity to withstand g-force loads. It is inferred that the Rielles Drive has the potential to surpass the specific impulse of today's best chemical rocket engines, as shown in Fig. 4.

2) Rielles Drive 0.5

The simplest variant (Fig. 5) uses radially opposing tubes to rotate the water propellant. The water, once expelled, impacts the external circular boundary. However, there is a designated segment where the water is allowed to exit unimpeded. In areas where the water ricochets, the resulting thrust is counteracted. The deflected water is then captured, cooled, and reintroduced into the reservoir.

3) Rielles Drive 2.0

This conceptual variant uses photons instead of water as propellant, hypothesized to offer enhanced thrust due to the Doppler effect and radiation pressure. The increase in photon's energy is analogous to the increase of kinetic energy of the expelled water in Rielles Drive 1.0.

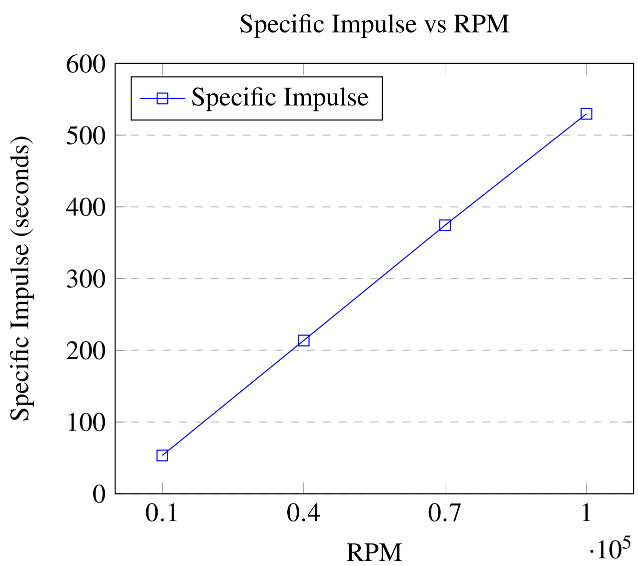

Fig. 4 Specific Impulse vs RPM

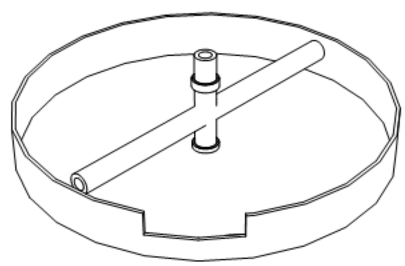

Fig. 5 Cutaway illustration of Rielles Drive 0.5

4) Rielles Drive 3.0

In this variant, the traditional rotating tubing with a shaft is substituted by a compact capsule **35**. This capsule is constrained and set into motion by electromagnetic forces within an electromagnetic array setup **25**, as depicted in Fig. 6. This can be conceptualized as a Maglev train [4] operating in a circular trajectory or akin to a shaftless turbine. This design offers the advantage of reduced g-force stresses and more stabilized vibration management for the drive. The propellant is introduced to the capsule using a strategic non-contact approach, represented by **30**. As the propellant is released, the reactionary force is transmitted via the electromagnetic confinement back to the drive. By modulating the confinement power at the moment of propellant discharge, there is an option to augment the thrust by transferring additional kinetic energy to the propellant.

5) Rielles Drive 4.0

This is similar to Rielles Drive 3.0 but uses photons as propellant.

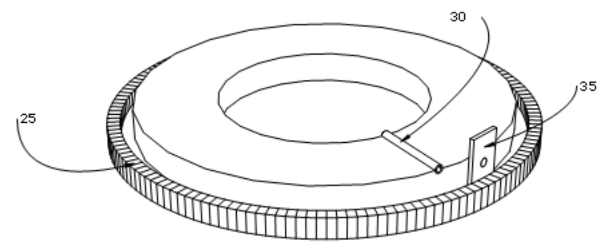

Fig. 6 Cutaway drawing of Rielles Drive 3.0

6) Rielles Drive 5.0

This is similar to Rielles Drive 3.0 but the tiny rotating capsule is replaced with an actual particle that generates photons when triggered.

7) Rielles Drive 6.0

This variant is similar to the Rielles Drive 3.0 in design. However, within the capsule, atomic fission and/or fusion processes take place. The slight reduction in mass, resulting from the conversion of matter to energy, leads to an alteration in the capsule's angular momentum which is similar to the operational principles of Rielles Drive 3.0.

For all Rielles Drive variants, when multiple drives are integrated into a vehicle, a counter-rotating configuration is necessary. This arrangement neutralizes the reactionary angular momentum, preventing the vehicle from becoming unstable or tumbling during motion.

VI. Expected Outcome

This technology once developed could be a viable alternative to traditional rocket engines and propulsion mechanisms in satellites and deep space probes. It could also offer an alternative to propeller-driven systems in vertical take-off and landing (VTOL) aircraft.

Advancements in techniques focused on optimizing photon momentum transfer are also expected. Additionally, there exists a potential for an alternative approach wherein, rather than the photon accruing increased momentum from the drive, it imparts momentum to it.

VII. Conclusion

The Rielles Drive system introduces a groundbreaking approach to propulsion, leveraging its capacity to impart momentum to its propellant. When these propellants are freed from the rotational force, they exhibit a tangential motion due to inertia. This motion, in turn, produces a reactionary force in the opposite direction, a principle that the Rielles Drive capitalizes on. The system's versatility is evident in its ability to utilize a wide range of propellants, as long as they possess momentum. Furthermore, the specific impulse of the drive is not solely dependent on the propellant type but is significantly influenced by the energy input to the system. To ensure stability and efficiency, especially in multi-drive configurations, the counter-rotating design is necessary, effectively neutralizing any unwanted reactionary forces. This innovative propulsion mechanism holds promise for revolutionizing transportation across various domains, from terrestrial applications to space exploration.

References

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