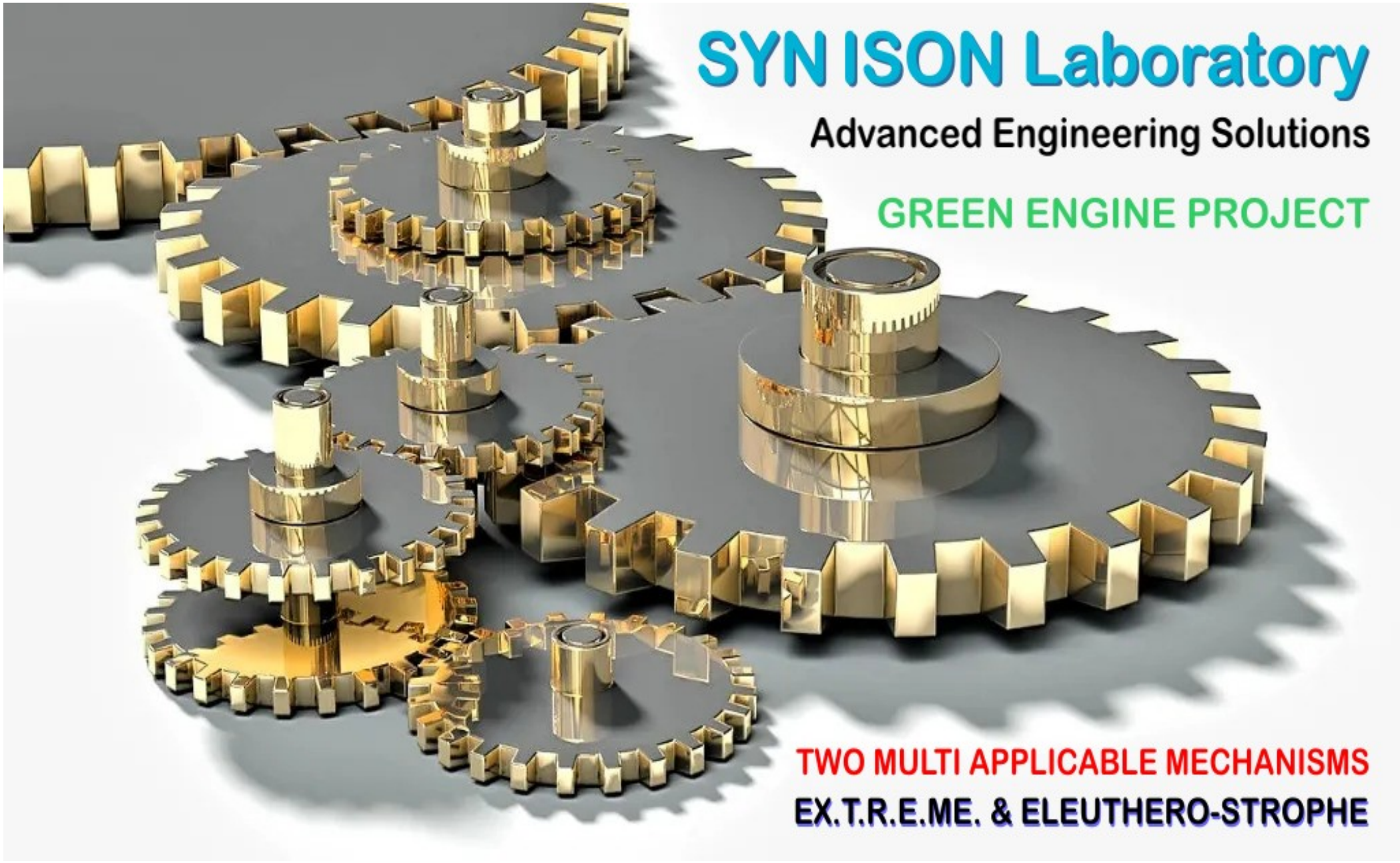

SYN ISON Laboratory
Advanced Engineering Solutions
GREEN ENGINE PROJECT
TWO MULTI APPLICABLE MECHANISMS
EX.T.R.E.ME. & ELEUTHERO-STROPHE

Our Technology

1) ***EXTREME***: speed reducer or speed increaser; a **non-friction-based**, purely mechanical mechanism, which achieves **extreme transmission ratios** with **one only moving part** between its input and its output

- **WO/2021/165707**: a **US** granted patent **US11940034B2** and **EP** & **IN** pending applications
- unlimited applications as reducers & increasers / 1,024:1 functional prototype / 1,000,000:1 & 1:400 & 1:900 (**INCREASEST**) under development

2) ***ELEUTHERO-STROPHE***: a purely mechanical mechanism for power transmission from an endlessly rotating shaft onto a frame to an endlessly rotating shaft onto an endlessly rotating carrier, independently of the rotation of the carrier

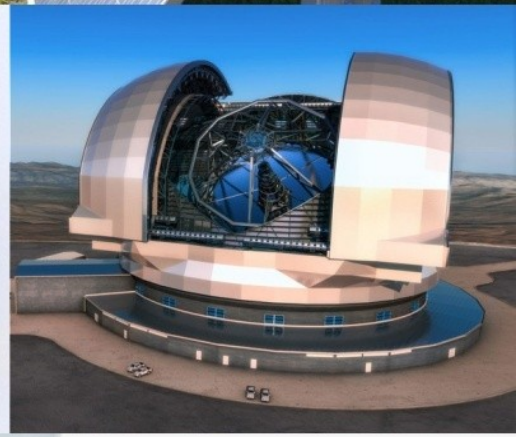
- **WO/2021/260400**: a **US** granted patent **US12092077B2** & a **RU** granted patent **RU2837742C1**, an almost granted patent (NoA) in **KR**, and **EP**, **IL**, **IN**, **CN**, **HK** & **JP** pending applications
- main applications in transportation: sea (**AZIMUTHRUSTER**) & land (**THRUSTEER**) / excavators / wind turbines

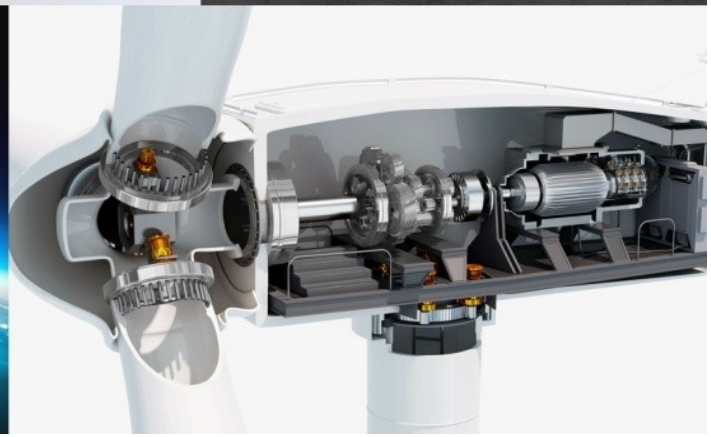
1) ***EX.T.R.E.ME.***: ***EX****treme* ***T****ransmission* ***R****atio* ***E****fficient* ***ME****chanism*

the **simplest** ever such a mechanism, using the least number of moving parts, being the **most compact** one and, moreover, having coaxial input & output, having, also, low cost construction, easy maintenance and the **highest efficiency**, while as an increaser is the **world's first** one to exceed the ratio 1:200 for a considerable amount of power

The ***EXTREME*** spectrum of applications

- a necessary supplement for any high-speed electric motor of any type and size, from 1 W up to 1 GW, as a speed reducer
- there are many other significant applications of moderate quality, such as trackers for solar panels
- applications in robotics and in any industrial sector where extreme precision is required, in Space Technologies (NASA, ESA, ESO, ISS etc) for example, where our 1,000,000:1 reducer will give precision **1,000 times higher** than currently in use
- a necessary supplement for any slow work-generating device, as a speed increaser; to increase the speed of the propeller of a wind turbine or the speed of the shaft of a Stirling engine, for example
- a smart, purely mechanical energy storage unit of great capacity, as a speed increaser/flywheel





IMPACT

- achieves the same transmission ratio as currently in use reducers do, but with **three only moving parts in total**, while the competition needs tens of such moving parts
- as an increaser achieves transmission ratios that **the competition cannot achieve in any way**

Gains and Benefits

• reducers: even up to 50% construction & maintenance cost reduction, even up to 25% efficiency increasing, for any type and size of normal precision and use, and thus we aim at a very large market

• reducers: there is a rather small market in product units but very promising in revenues, the market of Space Technology (Radio Telescopes, Optical Telescopes, Satellites, International Space Station, Spacecrafts etc), where the extreme precision that our 1,000,000:1 reducer can achieve is quite necessary

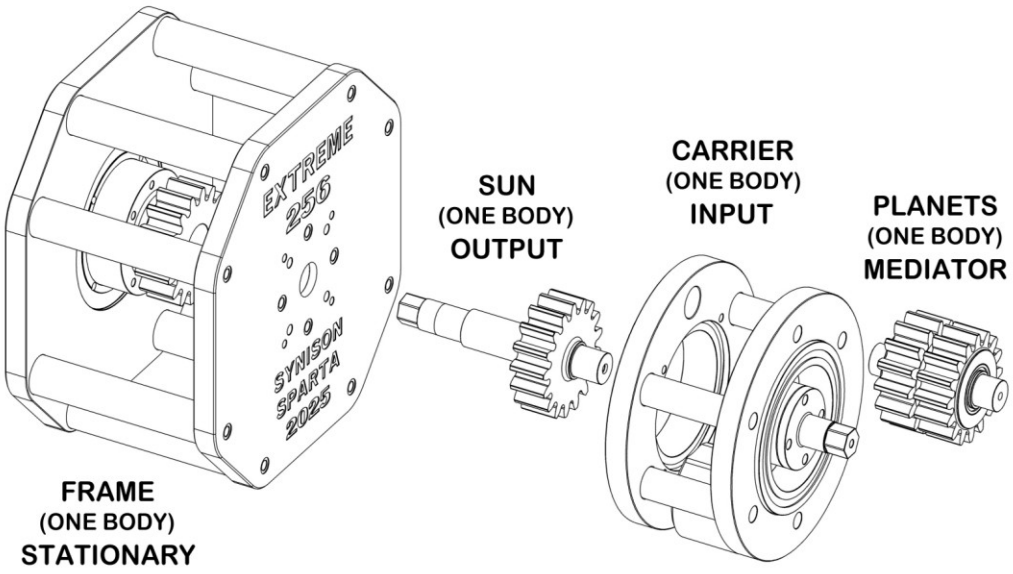
• reducers: there is, also, a very specific use in electric vehicles (manned and unmanned/drones), using a very compact motor, of small size and light weight, but of very high speed and thus very powerful, which drastically increases the efficiency and range of these vehicles, and in this way we aim at a very large market, as well, which at the same time is totally new/fresh

• increasers: **there is almost no competition!**

About the Invention

- Title: ***EXTREME TRANSMISSION RATIO EFFICIENT MECHANISM***
- PCT Publication Number: WO/2021/165707
- PCT Filing Date: 22.02.2021
- PCT Publication Date: 26.08.2021
- Priority Date (Greece): 20.02.2020
- **US** granted patent **US11940034B2** and **EP** & **IN** pending applications
- Applicant & Inventor: Our Co-Founder *Panagiotis ZARAPHONITIS*
- Further Development:
  Reducer: Optimization of Size/Weight/Construction-Cost under development
  Increaser: Achieving of 1:400 & **1:900** for wind turbines under development

About the Engineering / Drawings



Part of Page 5 of Description of PCT Application with Publication Number: WO/2021/165707

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The Drawings present:

"FIGURE 1": the mechanism with **one planetic unit** and **a counter-weight**.
"FIGURE 2": a more complete version of the mechanism with five planetic units.
"FIGURE 3": the mechanism with five planetic units in an exploded view without bearings and bolts.
"FIGURE 4": a **side view** and the **section A-A** of the mechanism with five planetic units; for better understanding of this Drawing, **where the parts are rigidly connected together, their cross-hatches are the same in density and angle**.
"FIGURE 5": a front view and the section B-B of the mechanism with five planetic units.

In these Drawings, the Parts are denoted as follows:

Body "0": Stationary Frame
0a: Frame in general
0b: Reaction Sun
0c: Bolt that rigidly connects the Reaction Sun to the Frame

Body "1": Rotating Carrier
1a: Carrier Disk with the Toothing for peripheral external connection
1b: Bar which rigidly connects the two Disks of the Carrier
1c: Carrier Disk with the Pulley for peripheral external connection
1d: Carrier Flange for axial external connection

Body "2": Rotating Planetic Unit
2a: Reaction Planet
2b: Planetic Shaft
2c: Action Planet
2d: Bolt that rigidly connects the Reaction Planet and the Action Planet to the Planetic Shaft

Body "3": Rotating Action Sun
3a: Shaft for external connection of the Action Sun
3b: Action Sun
3c: Bolt that rigidly connects the Action Sun to its Shaft for external connection

4: Starter - it can be an Electric Motor only, or an Electric Motor or an Electric Generator, alternatively

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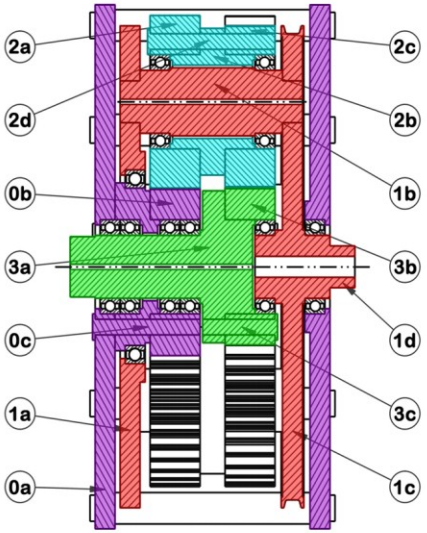

FIGURE 4

About the Engineering / Abstract

A planetary mechanism has a stationary frame on which are supported a first gear with a central axis of rotation, a second gear and carrier. The second gear and the carrier are configured to rotate freely and endlessly about the central axis of rotation. Planetic shafts are supported on the carrier coaxially with respective planetic axes equally angularly distributed around the central axis of rotation. The planetic shafts are configured to undergo rotation freely and endlessly about the respective planetic axes. Third gears cooperate with the first gear and are connected to respective first ends of the planetic shafts. Fourth gears cooperate with the second gear and are connected to respective second ends of the planetic shafts. The first gear, the second gear, each of the third gears, and each of the fourth gears have a teeth number Z1, Z4, Z2 and Z3, respectively, satisfying the relation: $(Z1-Z2)*(Z4-Z3) > 0$, while when the teeth numbers satisfy the relations: $(Z1-Z2)*(Z4-Z3)*(Z4-Z1) = 1$ or: $(Z1-Z2)*(Z4-Z3)*(Z1-Z4) = 1$ the resulted transmission ratio is the maximum possible for this area of teeth numbers.

Industrial Development

- Applied in many industrial sectors, where the speed gear-boxes are necessary
- Functional prototypes developed for reducer applications
- Industrial prototype currently under development for a light-weight reducer
- Industrial prototype currently under development for an 1:225 increaser

2) *ELEUTHERO-STROPHE*:

a mechanism that transmits power on an endlessly rotating shaft (***STROPHE***) supported on an endlessly rotating carrier, in such a way that the rotation of the shaft is independent (***ELEUTHERO***) of the rotation of the carrier,

meaning that this mechanism **kinematically and dynamically decouples two inherently strongly coupled rotations**, while **it returns the produced reaction torque to the frame**

The ***ELEUTHERO-STROPHE*** spectrum of applications

• **world's first** single engine **holonomic vehicle**, such as a Lunar or Mars rover, where endless rotation is transmitted from a single engine or motor to all drive and all steering wheels

• **world's first** front wheel **supercar**, where endless rotation is transmitted from an engine or a motor to drive wheels via robust gears, instead of the delicate current ball-bearing constant velocity joints

• **agricultural tractor** or **firefighting vehicle** or **military vehicle** with very high clearance from the ground and/or with even all wheels steering, even with a 360 degrees steering angle

• **excavator** or **battle tank**, where endless rotation is transmitted purely mechanically between the chassis and the endlessly rotating turret

• **azimuth thruster**, where endless rotation is transmitted purely mechanically from an engine or a motor inside the hull of a vessel to the propeller in the water

• **horizontal axis wind turbine**, mainly of medium or small size, especially an offshore floating one, where the endless rotation of the propeller shaft is transmitted to the generator on the base of the stationary tower, thus drastically lowering its center of gravity

• **wind turbine** of any type or **propeller-driven aircraft** or **craft**, where propeller pitch adjustment is achieved independently of the endless rotation of their propeller hub


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IMPACT

• there were **mechanical power transmission problems stubbornly resisting for centuries**, which were solved rather recently using electric or hydraulic means, while our mechanism solves them directly and purely mechanically using **four** only additional moving parts, being at the same time very simple in construction and maintenance and very efficient and reliable in hard use

• this mechanism renders many types of other existing mechanisms to be more easy in construction and maintenance, much more efficient, reliable, harmless and **environmentally friendly**, avoiding the use of electricity under water or toxic hydraulic fluids in land and sea use, for example

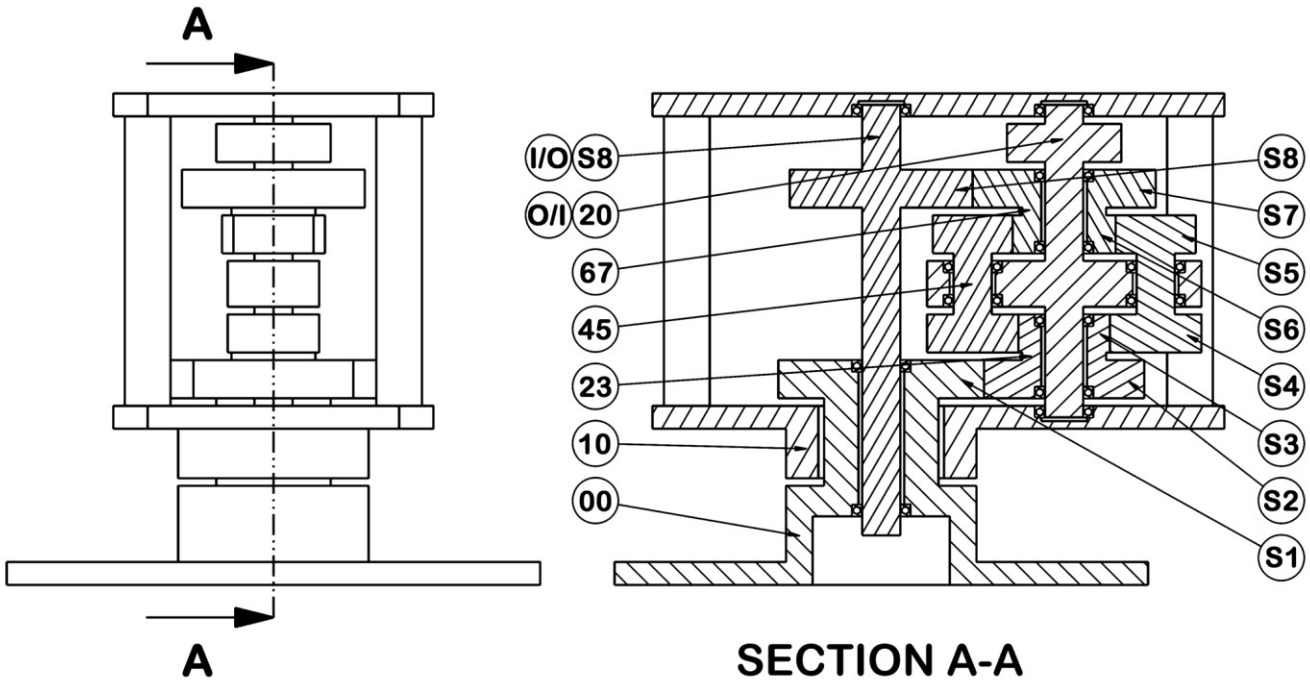
Gains and Benefits

- replacing the ball-bearing constant velocity joint, we aim at a whole large market (cars, trucks, tractors, ATVs, military and other special vehicles)
- replacing the environmentally dangerous hydraulic means for the movement of the chassis of an excavator in space thus increasing its efficiency, and lowering its center of gravity thus increasing its safety, we aim at a very large market
- avoiding the environmentally dangerous hydraulic means by using a light servomotor for the steering of the azimuth thruster thus increasing its **efficiency**, **reliability** and **speed of maneuverability**, and avoiding the use of an electric motor in the water which for any repair needs dry dock, we aim at a very large market
- there are, also, other applications (blade pitch adjustment etc) with markets of smaller size

About the Invention

- Title: ***TRANSMISSION OF ENDLESS ROTATION TO A SHAFT ON AN ENDLESSLY ROTATING CARRIER INDEPENDENTLY OF THE ROTATION OF THE CARRIER***
- PCT Publication Number: WO/2021/260400
- Filing Date: 23.06.2021
- Publication Date: 30.12.2021
- Priority Date (Greece): 23.06.2020
- **US** granted patent **US12092077B2**, **RU** granted patent **RU2837742C1**, almost granted patent (NoA) in **KR**, and **EP**, **IL**, **IN**, **CN**, **HK** & **JP** pending applications
- Applicant & Inventor: Our Co-Founder *Panagiotis ZARAPHONITIS*
- Further Development:
  Single propeller azimuth thruster without reaction torque under development
  Single engine 4x4x4 vehicle with endless steering angle under development
  Small size (50 kW) wind turbine with generator on the stationary base under development

About the Engineering / Drawings



SECTION A-A

FIGURE 01

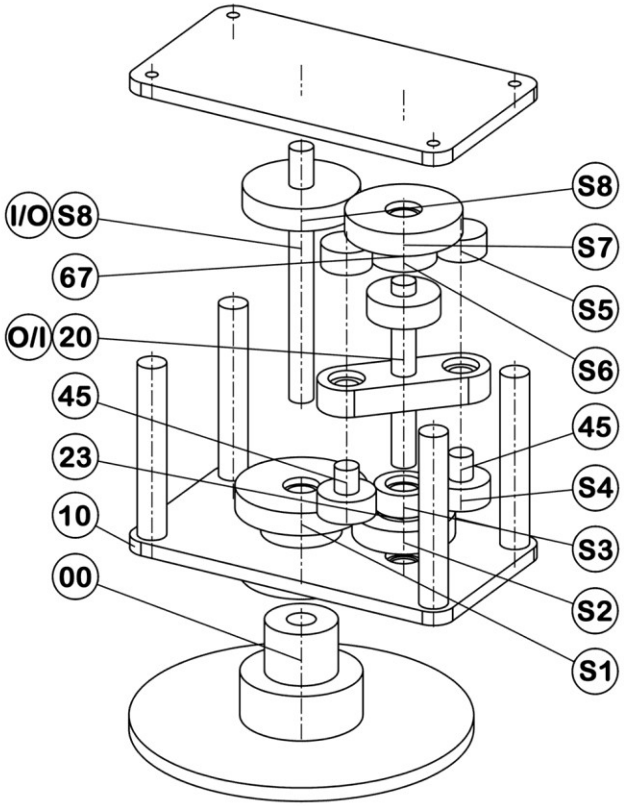


FIGURE 03

About the Engineering / Abstract

For the transmission of endless rotation from stationary frame to endlessly rotating carrier, or vice versa, independently of the rotation of the carrier, an efficient mechanical mechanism is missing.

A Compound Planetary Mechanism, named "Eleuthero-Strophe", is proposed, with the already existing central carrier, two suns with teeth numbers Z_{S1} or Z_{I1} and Z_{S8} or Z_{I8}, an eccentric planetary carrier on which an eccentric satellite shaft rests, bearing two satellites with teeth numbers Z_{S4} or Z_{B4} and Z_{S5} or Z_{B5}, and four planets with teeth numbers Z_{S2}, Z_{S3} or Z_{B3}, Z_{S6} or Z_{B6} and Z_{S7} which cooperate with the suns and the satellites, where the teeth numbers of all gears meet this Independence Condition:

$K*L = 1$ or: $(1-K)*L = 1$, where:

$K = Z_{S1}/Z_{S2}*Z_{S7}/Z_{S8}$ or: $K = -Z_{I1}/Z_{S2}*Z_{S7}/Z_{S8}$ or:

$K = -Z_{S1}/Z_{S2}*Z_{S7}/Z_{I8}$ or: $K = Z_{I1}/Z_{S2}*Z_{S7}/Z_{I8}$ and:

$L = Z_{S3}/Z_{S4}*Z_{S5}/Z_{S6}$ or: $L = -Z_{B3}/Z_{B4}*Z_{B5}/Z_{B6}$.

Industrial Development

- Applied mainly in automotive, excavator, azimuth thruster and wind turbine industries
- Functional prototypes developed for an azimuth thruster (without reaction torque), wind turbine (with stationary generator) and 4x4x4 vehicle (with endless steering angle)
- Industrial prototype currently under development for a vessel with an azimuth thruster without reaction torque
- Industrial prototype currently under development for a wheel unit where the wheel is driven by robust gears (and not by a ball-bearing constant velocity joint) and the steering bracket steers endlessly

Combining the two Mechanisms 1 + 2

Because the conceptual structure of the *ELEUTHERO-STROPHE* is similar to the one of the *EXTREME*, we can achieve independent power transmission from an endless rotating shaft onto a stationary frame to an endlessly rotating shaft onto an endlessly rotating carrier, or vice versa, with any transmission ratio of reduction or increasing, even an extreme one, without inserting any other moving part

A more detailed presentation of the land applications of the mechanisms

1) We propose the use of an **electric motor of very high speed** (over 100.000 RPM) in combination with our **reducer (*EXTREME*)** with high transmission ratio, for any electric vehicle for land, sea or aerial use, **manned** or **unmanned**.
In this way the motor is very compact, yet very powerful, and since our reducer is compact as well, their total volume is smaller and their weight is lighter than the currently in use proposals, while the **efficiency is much higher**.

Other applications of the ***EXTREME*** are where extreme precision is required, such as in **robotics** as well as in **dynamic positioning** and **targeting** systems, for example for azimuth and inclination setting of a **telescope** or a **rocket launcher**.

2) We propose, also, the use of our second mechanism (***ELEUTHERO-STROPHE***) in order to **supersede** the currently in use **delicate constant velocity joint** as the final power transmission to the wheels of a vehicle, fossil fuel powered or electric, **in many applications**, like these:

a) a **military** vehicle, like Hummer H1, where the 2 or even the 4 wheels are simultaneously driving and steering, with a steering angle of even 360 degrees (practically endless), **which will be globally the first holonomic vehicle with a single ICE or a single electric motor***,

b) a firefighting vehicle with a very high clearance from the ground,

c) an agricultural tractor with a very high clearance, also, from the ground (like Massey Ferguson 9310 model, for example: **https://www.farmmachinerysales.com.au/editorial/massey-ferguson/mf-9310-plus/**).

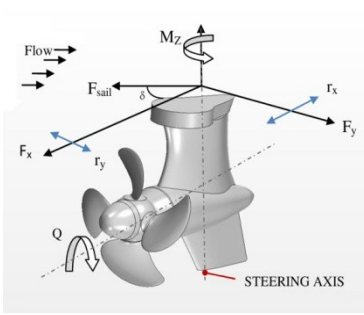
d) a family car where the 2 front wheels are simultaneously driving and steering, via our mechanism, while the angle of steering can be 90 degrees or even more, for an **easy parking process**, and

e) a FWD supercar, since our mechanism can transmit a huge amount of torque to the -drive and steering at the same time- wheels via robust gears instead of **the delicate balls of the constant velocity joint**; in this way **this supercar will be the first one in the world***,

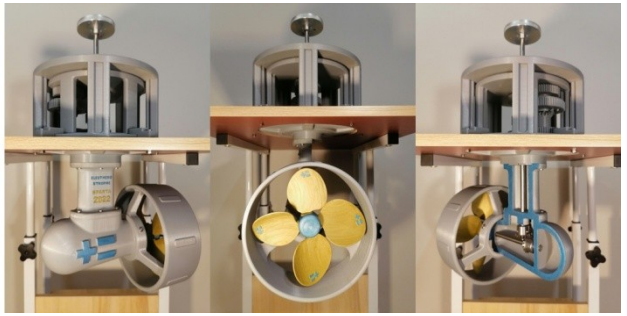
Other applications of the ***ELEUTHERO-STROPHE*** are in an **excavator** or a **battle tank**, where a power transmission can be achieved between the chassis and the rotating turret **in a purely mechanical way**, meaning that there is **the need of one only engine**, preferably ICE, and these vehicles can be protected from special weapons like an **electromagnetic pulse**.

***except** the huge scientific interest for such an effort, **here is a great opportunity to make history**; literally.

A more detailed presentation of the sea applications of the mechanisms





1) We propose that our first mechanism (*EXTREME*) will replace every winch on a vessel of any type and size.

These winches are many in number and they are used for many different purposes.

2) We propose, also, the use of our second mechanism (*ELEUTHERO-STROPHE*) to drastically improve the efficiency and maneuverability of the azimuth thruster of a vessel or a submarine of any type and size, manned or unmanned, as well.

The fundamental problem of the azimuth thruster which our second mechanism (*ELEUTHERO-STROPHE*) solves:

The azimuth thruster is the best way to control the direction of a vessel, of any type and size, and offers the most flexible and smart maneuvering of this vessel especially in narrow places and small ports.

In fact, the azimuth thruster is the combination of the propeller with the rudder.

However, the relocation of the support of the propeller shaft from the frame of the vessel onto a case/pod, which in fact is a carrier, rotatable with respect to the frame about an axis almost perpendicular to the one of the propeller, automatically generates a problem:

Now there is a redundant degree of freedom for the whole mechanical drivetrain from the engine shaft up to the propeller shaft: the rotation of this carrier with respect to the frame.

The drive torque (**Q** in figure, above) **that rotates the propeller shaft about its own axis produces also a torque which has the direction of the axis of rotation of the carrier, applied on the carrier and forcing it to rotate with respect to the frame.**

This second torque (**M_z** in figure, above) is an undesired **reaction torque**, and **the next bad news is that the magnitude of this torque is directly comparable** and **even greater** -depending on the overall transmission ratio of the drivetrain of the azimuth thruster- **than the one of the useful drive torque of the propeller shaft**.

In vessel steering process the total torque, which the steering mechanism has to overpower, is the sum of a torque due to inertial forces exerted on the whole vessel when changing its direction, plus a torque due to hydrodynamic forces exerted on any component of the rotatable part of the azimuth thruster under the water, plus this reaction torque.

In steady state, that means when the vessel moves in a straight line (with constant direction) and with symmetrical - referring to the axis of symmetry of the vessel- water relative flow, **the steering torque is exclusively just the reaction torque**, but its magnitude, as it is described above, **can be huge**.

The **steering system**, even when does not produce any movement and consequently any work, **consumes power for friction losses to maintain the required position under high torque** on its output; **when the magnitude of this torque is huge the amount of the corresponding consumed power is certainly comparable to that the propeller shaft consumes for the useful work of the vessel movement** and in a continuous operation results in a drastic reduction of the overall efficiency of the azimuth thruster.

Trying to solve the problem of the reaction torque presence, since the first years of yet experimental use of this kind of propulsion, in the middle of the 19th century, many solutions were proposed; however, since those solutions have their own problems, mainly because of their complicated structure, the last years, when a spectacular comeback of this idea took place, there are in use these four main configurations:

a) a mechanical azimuth thruster, with either a **Z-drive** or an **L-drive** configuration, based on the logic of brute force, where the undesired reaction torque is overpowered by a strong, heavy and expensive steering system, either in a continuous operation resulting in a drastic reduction of the overall efficiency as described above, or in an interruptible operation via on-off or servo hydraulic valves, or clutches/brakes mechanism, resulting in an irrational complexity and a severe reduction of the vessel maneuverability,

b) a mechanical azimuth thruster, with either a Z-drive or an L-drive configuration, with a more sophisticated technique, where the undesired reaction torque of the propeller is counterbalanced by the reaction torque of another propeller, which stands at the same or at the opposite side of the carrier and rotates in opposite direction of that of the first one, while the shafts of these propellers are coaxial and the one shaft penetrates the other, a hollow one, a configuration named "**contra-rotating propellers**" or simply CRP, resulting in an irrationally, also, complex and expensive configuration in construction and maintenance, while another severe problem of the CRPs is that their design has carried out for a specific relative speed of the propellers with respect to the water and when this relative speed of the propellers, in real conditions, varies up and down of the specific value, strong, noisy and even destructive vibrations are produced, being exerted on the whole structure of the azimuth thruster.

c) a hydraulic azimuth thruster which achieves a low overall efficiency, as it needs a transformation of mechanical power -of an ICE onto the hull- to hydraulic one, via a hydraulic pump, a doubtful transmission of hydraulic power to the endlessly rotating carrier of the azimuth thruster, via an expensive **hydraulic rotary union**, and another transformation of hydraulic power to mechanical one, via a low efficiency hydraulic motor, while during its operation always causes sea pollution working with a very little -but not negligible- hydraulic fluids seepage and is always, also, under the possibility of a dangerously massive hydraulic fluids leakage, and

d) an electric azimuth thruster which requires an expensive construction and maintenance, always in dry dock in case of a damage/failure of the motor; since **the day when a vessel, especially not a small one, will use exclusively electric energy from batteries is still decades far**, it achieves a rather low overall efficiency, as it needs a transformation of mechanical power -of an ICE onto the hull- to electric one, via a generator, a doubtful transmission of electric power to the endlessly rotating carrier of the azimuth thruster, via slip rings, and another transformation of electric power to mechanical one, via a motor, while, additionally, the possible/necessary use of a reducer renders the whole configuration irrationally complicated, inefficient and bulky.

Studying carefully from the very beginning the situation, very soon we realize that the mechanical azimuth thruster, especially the Z-drive, is the most promising base for further development, provided that the main engines of the majority of the vessels, worldwide, will burn fossil or eco-composite fuels for the next many decades.

Taking this in account, the hydraulic and electric azimuth thrusters will be always much lesser efficient than the mechanical one, since both need one transformation from one kind of energy to another, in order to pass this energy neutrally through the axis of rotation of the carrier which supports the propeller shaft, independently of this rotation, and then the reverse transformation to mechanical work in order to drive the propeller against the water.

So, since the azimuth thruster offers the best and most efficient way of maneuvering of a vessel, any improvement on it, concerning its efficiency and environmentally friendly behavior, renders the **azimuth thruster** as **the most ecological solution for today sea transportation of people and goods***.

Our mechanism solves the aforementioned problem since it **achieves kinematically and dynamically the independence** between the rotation of the pod and the rotation of the propeller and **absolutely eliminates the reaction torque**, and thus renders the maneuverability of the azimuth thruster even more efficient and much faster, **using a rather small electric servomotor which can execute any command of the captain in seconds**.

***except** the huge scientific interest for such an effort, **here is a great opportunity to make history**; literally.

What we offer

- We could assign/transfer all patent rights, for all or some designated countries

- We could license the patent rights,
  - in form of exclusive or non-exclusive rights,
  - for some or all the designated countries,
  - for some or all applications

- We can also transmit the relevant know-how under agreed conditions

What we are looking for

Both of these mechanisms have plenty of very promising applications, almost ready for a profitable exploitation.

We are seeking collaboration with

- at least one **Business Partner** from the military, automotive or the unmanned vehicles industry and
- at least one **Academic Institution**, preferably a university.

We plan to carry out a more mature design process, improve prototypes, test them exhaustively and, as an outcome, to create almost ready to sell products. This cycle will have at least two complete iterations and the need of sufficient funding is obvious.

The Company

SYNISON Laboratory Ltd

Contact: **director@synison.com**

The Profile

- Founded in: Sparta - Greece / Annex in Chicago - Illinois - USA
- Business Activity: Invention Generation, Invention Engineering, PoC Prototyping, Patent Rights Exploitation
- People: *Panos Zaraphonitis*, *Yannis Andriotis*, *Giorgos Haniotis*, *Nikos Alexandropoulos*, *Vicky Katsichti*
- Key partners: INTELLEX, NTUA, CERTH, ELLENIC VEHICLE RESEARCH, AIR ACTION
- Current R&D projects:
  Advanced Holonomic Vehicle (recovery of all DoFs and optimization of Scrub Radius)
  Innovative Rotary ICE (with very High Compression Ratio, thus High Power Density)

The Team

• The Inventor:

Panos Zaraphonitis: Mechanical Engineer NTUA, MSc NTUA, PhD NTUA (Vehicle Design/4WS - not completed), Number Theory, Group Theory, Topology, Differential Calculus, Physics, Mechanics, Engineering, C++ Programming, CAD/CAM/CAE, G-Code Direct Programming, 3-D Printing, History of Science, Physiology of Invention, Methodologies for Idea Conception / Synthesis / Analysis

• The Core Team:

Yannis Andriotis: Bio Mechanics R&D, International Power Waste to Energy / WtE, NASA Research Labs, Sandia Labs, USA Naval Institute, AECOM, Seajets

Giorgios Haniotis: Mechanical Engineer NTUA, MSc Aeronautics, MSc Solid Mechanics FEA, Expert in PTC/Creo CAD/CAM/CAE & ANSYS Mechanical including Topology Optimization (Light Weighting) & Rapid Prototyping, Technical Consultant & Group Leader at Philips Health/Medical

Nikos Alexandropoulos: Lawyer, Legal Services

Vicky Katsichti: PR, Marketing, Scientific Support, Analytical Instrumentation, Laboratory Testing / Materials, Applied Archaeological Sciences / Archaeometry

The Perspectives

- Exploitation of already Granted Patents
- Invention Generation, Engineering, PoC Prototyping, Patent Granting, in order to solve specific Scientific Problems
- Visionary Searching for Unsolved Iconic Scientific Problems


LINKS:
https://engine.green
https://increasest.com
https://thrusteer.com
https://azimuthruster.com