Measurement experiment of thrust force using two conical roller bearings

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Following the previous experiment on homogenizing the mass density of materials, the next step was to try it with a lift turbine. We conducted an experiment to run a lift turbine with a rectangular PLA shaft, but the results were not as expected.

If the shaft is made to almost touch the inner diameter of the bearing in an attempt to improve precision, the following problems will likely occur.

- Since the shaft cannot move up and down, upward thrust (like that of a flexible structure) is no longer generated.Because there is no play between the shaft and the bearing, the larger bearing (17mm (outer diameter) x 6mm (inner diameter) x 6mm (thickness)) rotates in sync, and the effect of its rotational gravitational field is generated. (It is likely that in the previously published experiment, the shaft was slightly thinner, which allowed the bearing to spin freely, which was fortunate.)

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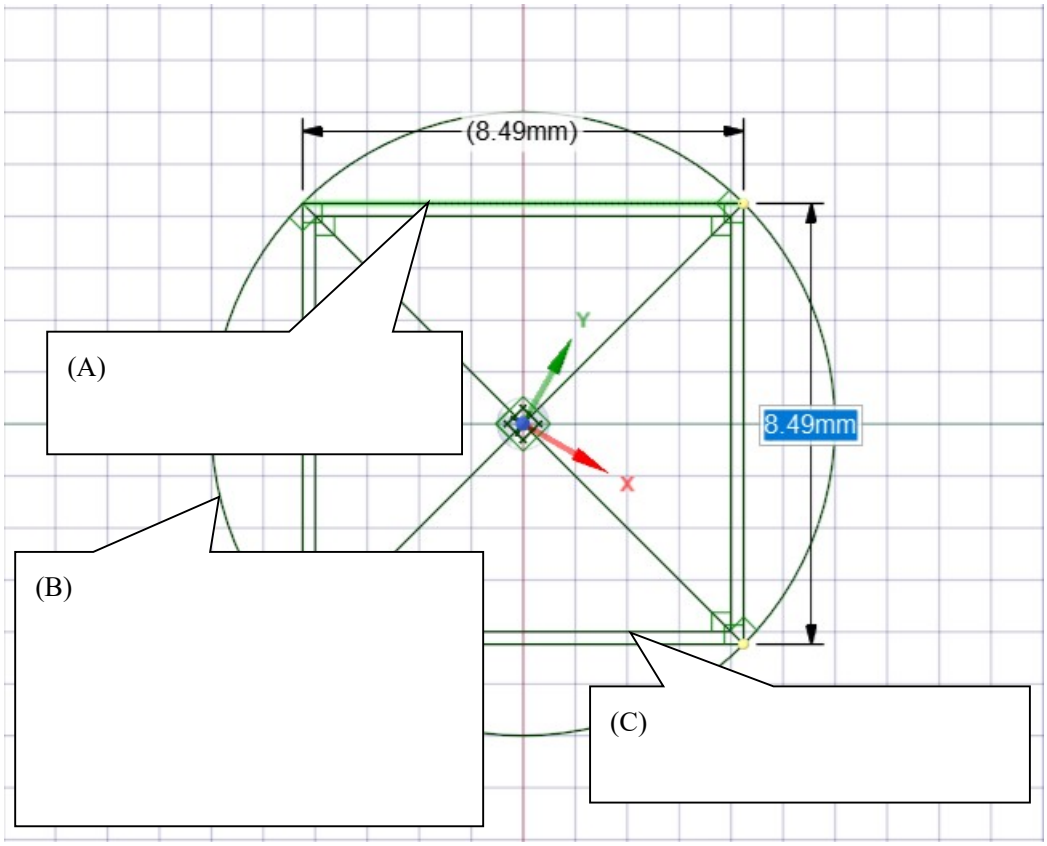

(A) The side length of an inscribed quadrilateral with a diameter of 6 mm appears to be precisely 8.49 mm.
(B) A shaft with a diameter of 6mm cannot pass through a bearing with an inner diameter of 6mm, so the inner diameter must be slightly larger than 6mm. You can't know for sure how these kinds of adjustments work without trying them.
(C) Last time, I made each side 8mm. (I adjusted it with masking tape.)

Because of this, instead of using high-quality bearings, I tried using pipes like water pipes (metal spacers) as bearings, but the friction caused the PLA shaft to melt, resulting in poor performance. I also tried small bearings (10mm (outer diameter) x 6mm (inner diameter) x 3mm (thickness)), but the inner diameter of the bearings was slightly too narrow, creating greater resistance when passing the shaft through.

I think the problem could probably be solved by making the shaft tighter (thicker) at the gear and shaft joint to improve rotational accuracy, and making the area around the bearing looser (thinner), but even then,

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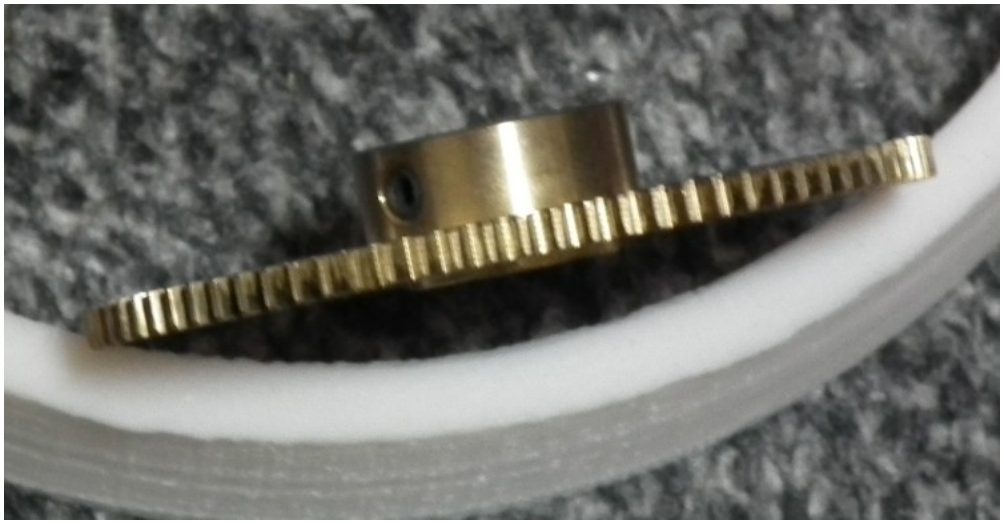
the influence of the bearing cannot be denied, and I've lost hope in such minor details. I can't deny that there are other reasons for the poor precision, such as the joining of the discs. I've wasted a considerable amount of filament up to this point.

There's a structural dilemma: if you make the shaft and hole sizes almost the same to improve precision, you won't be able to pass the shaft through the hole, but if the difference between the hole and shaft is too large, the precision suffers.

Even after trying the above methods, I feel like I can't expect much improvement, and I'm kind of stuck. In such cases, it's best to try a completely different approach.

Basically, what I wanted to do was to "rotate two heavy, metal-like discs of different sizes with high precision."

I have various metal gears that I used before, and I considered using them as discs, but the mass of the connector part of the rotating shaft is large, and the shape also generates restrictive lift, so it probably won't work. When I experimented, it didn't generate even 0.1g of thrust. Stacking multiple gears of the same type is also not effective.



So, since I had some tapered roller bearings of various sizes that I had impulsively bought some time ago, I decided to try using them as discs. (The photo below shows an NTN 30304 with an outer diameter of 52mm, and the ones used in the experiment were different sizes from the same 30000

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series. NSK also makes similar products, but I don't really understand the difference. There's no particular reason for using NTN products.) Since tapered roller bearings are a type of ball bearing, their main function is rotation, so they should rotate with good precision. Unlike the metal gears mentioned above, there is no large imbalance in mass parallel to the axis of rotation, and they are also donut-shaped. If the connecting parts are made from PLA, a 6mm bolt can also be used as a shaft. There is a wide variety of these bearings, and even quite large ones are sold cheaply as general-purpose off-the-shelf products, so they can be used if we need to scale up in the future. For now, the research and development costs are not large.



Incidentally, I tried turning a large, ordinary ball bearing with an outer diameter of 80mm, thinking that since I'm a specialist in rotation, I should be able to do it. However, when I tried to rotate it with the outside fixed in place, (surprisingly) the mechanical resistance was too high, and it couldn't be turned with the current gear ratio of the 370 motor, which has low resistance. If you were to use it for something, it might work as a heavy, donut-shaped disc without being used as a bearing.

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Anyone who can look at this structure and get some kind of insight is truly remarkable.

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<Theory>

■Does a conical roller bearing have any special capabilities?

What would happen if a Ferris wheel, like those found in amusement parks, were spun at high speed? Riders would likely feel weightless when going down and crushed by strong gravity when going up. You can have a similar unsettling experience on roller coasters and rides that resemble pirate ships.

If something like a Ferris wheel were to rotate not on Earth, but in a place like outer space where external gravity is negligible, a constant centrifugal force of gravity would act radially, making it actually more comfortable for those inside.

This difference depends on whether or not the rotating gravitational field of the Ferris wheel interacts with the Earth's gravitational field.

Similarly, a spinning top on Earth doesn't fall over due to the interaction between the Earth's gravitational field and the top's rotational gravitational field. This interaction is the result of the combined gravity of a space like the inside of a Ferris wheel on Earth, but even though it's called "inside," it's a specific location in the same three-dimensional space as the outside, and its gravity can easily vary depending on the location. The local gravitational field in the space inside a spinning top is completely different from the space outside the top. Since there are areas of high and low gravity inside the top, it can be thought that surrounding objects are attracted to areas of high gravity. Therefore, it can be thought that the top as a whole moves in the direction of "the top's movement (C)" shown in the diagram below. This can be easily verified with experiments using a spinning top. This movement in (C) occurs because of Earth's gravity; if you spin a top in the gravity-free space of outer space, it won't move because it doesn't know which way to go.

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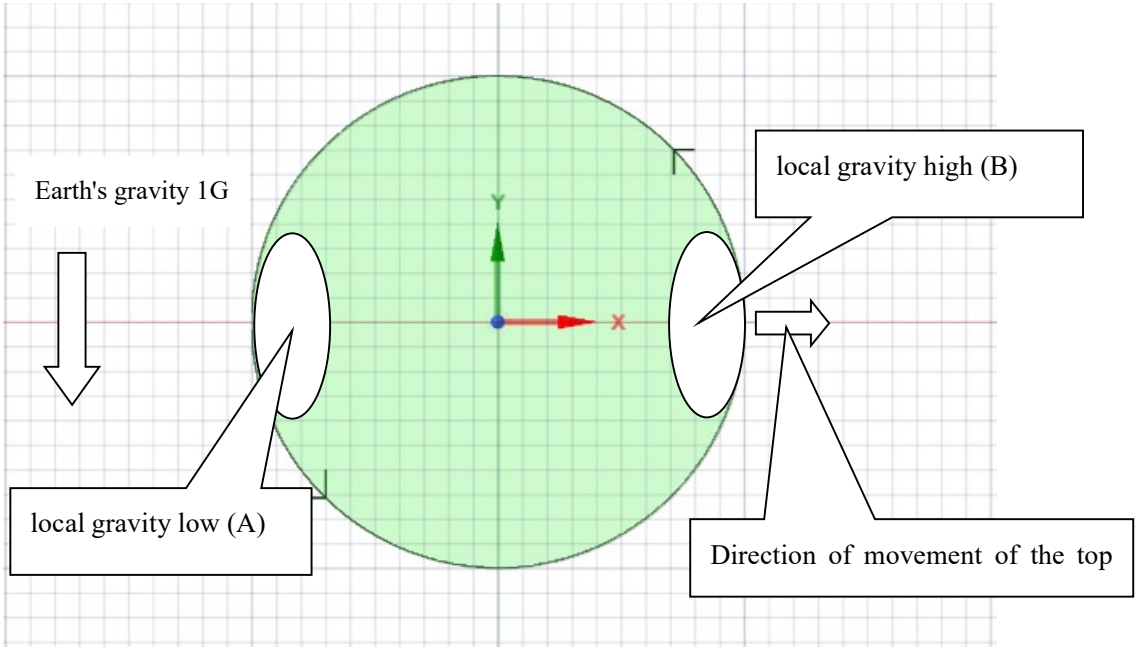
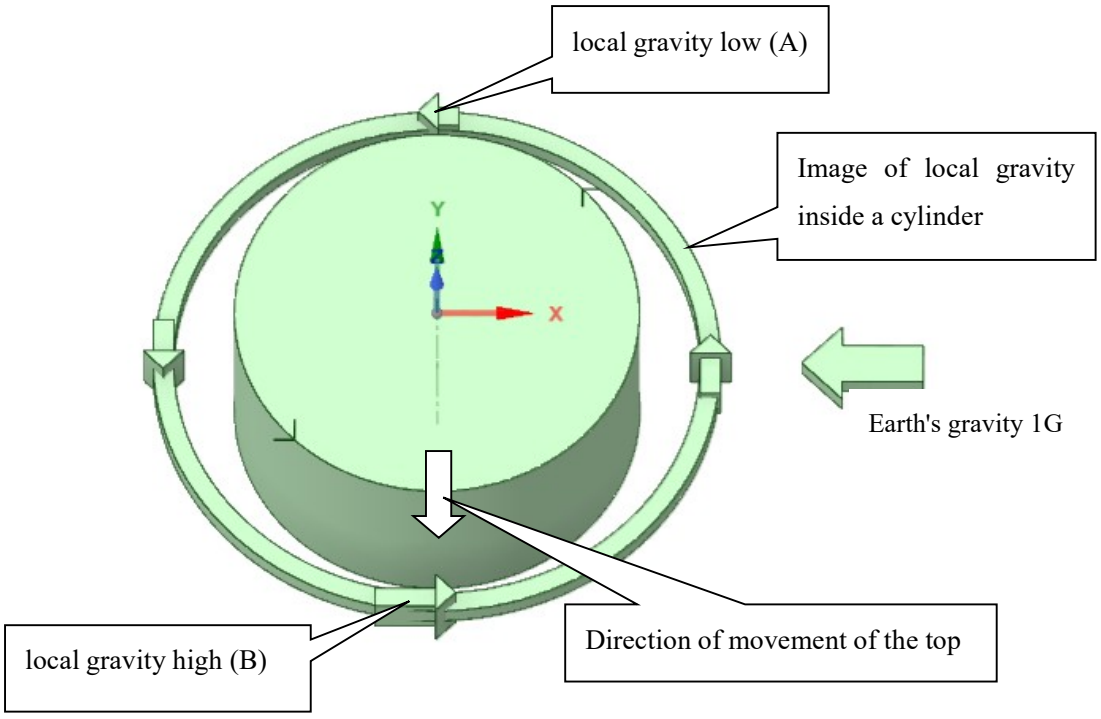


The diagram below shows the same thing in three dimensions.



What happens if you rotate a cylinder with its axis of rotation slightly tilted?

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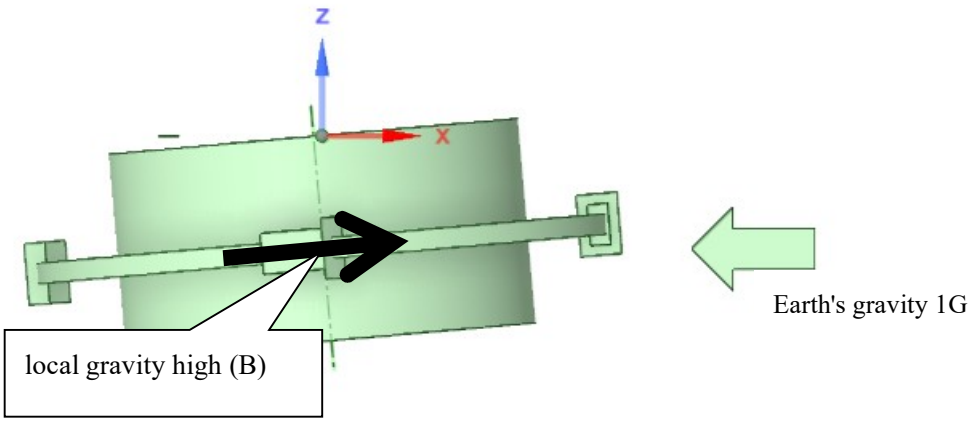

The local gravitational field is stronger in the foreground than in the background, and the overall resultant force rotates upwards and to the right. This force causes the spinning top to try to right itself in the gravitational field.

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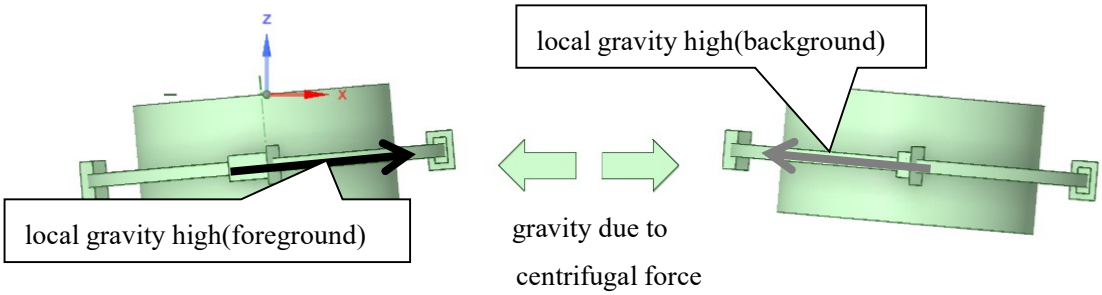
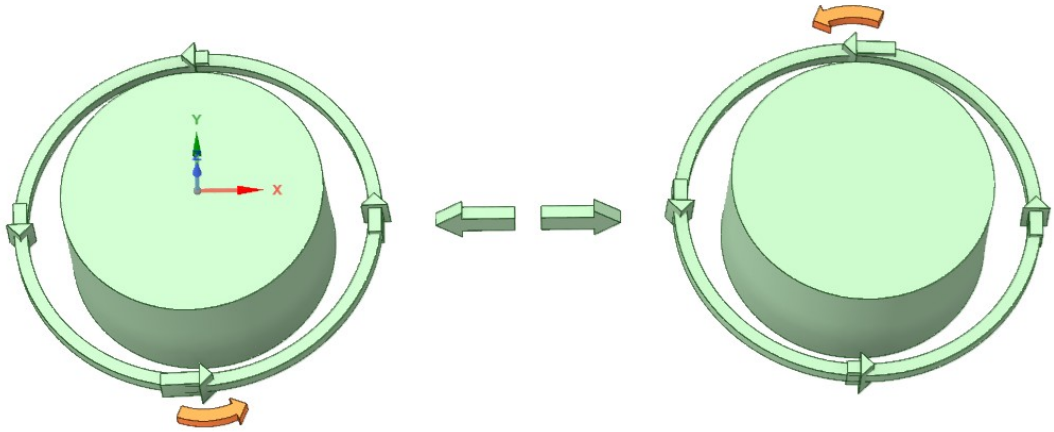
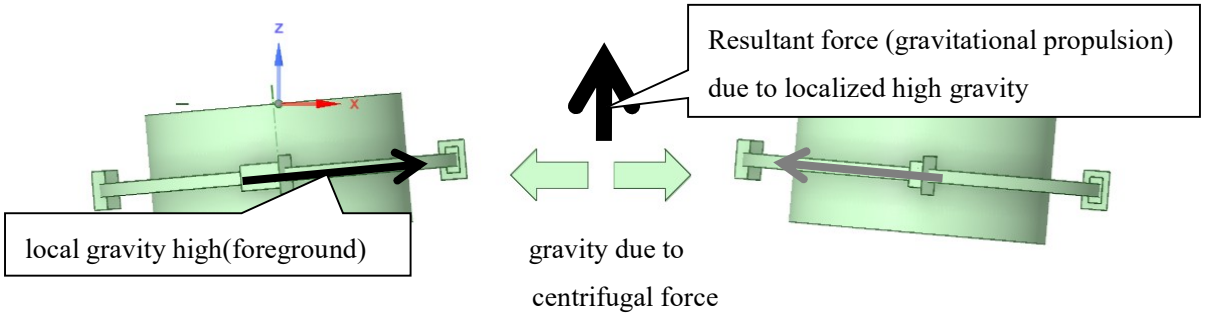
When a conical roller bearing is rotated, gravity acts on it due to centrifugal force.





In the photograph of the conical roller bearing above, a localized gravitational force of high magnitude is generated on each of the 13 rollers, and this force acts in a direction that causes each roller to stand up in a spiral shape. The direction of the resultant force of the localized gravitational forces on each roller is upward.



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In this way, the conical roller bearing generates thrust due to gravity.

Typically, conical roller bearings are designed to rotate while receiving thrust from propeller-driven aircraft, but the fact that a hidden gravitational thrust was occurring in the opposite direction (difficult to detect because it doesn't occur when the rotating shaft passes through the usual inner hole) is like overlooking a huge rough diamond right at your feet. (I myself have said that treasure isn't somewhere far away, but right at your feet, yet I've never noticed it until now. You never know where things are hiding, so you shouldn't assume you know everything. You won't find the truth by pretending to know things you don't, or pretending not to know things you do.)

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■ Energy can be amplified with forward rotation.

Things like ball bearings and conical roller bearings, and on a larger scale, things like planets, have a relationship between rotation and revolution that can be either forward or backward. The planets in the solar system, with the exception of those very far away, rotate forward. (Forward means in the expected direction.) The reason they rotate forward is that when you rotate something like a disk, the outer edges have to travel a greater distance, and if there are smaller disks there, it will naturally rotate forward.

This is another amusement park story, but in the old days, amusement parks had a ride called a teacup, which could be rotated by turning the handle in the center. The entire teacup moved as if it were revolving, but it could only rotate in the forward direction. (Even someone with great strength probably couldn't make it rotate in the reverse direction.) Previously, in my research on planetary engines using planetary gears, I said that energy could be amplified by rotating it forward because by rotating the outer ring, the direction of the thrust acting on the small disk (cylinder) and the direction of motion (orange in the diagram below) can be made to match.

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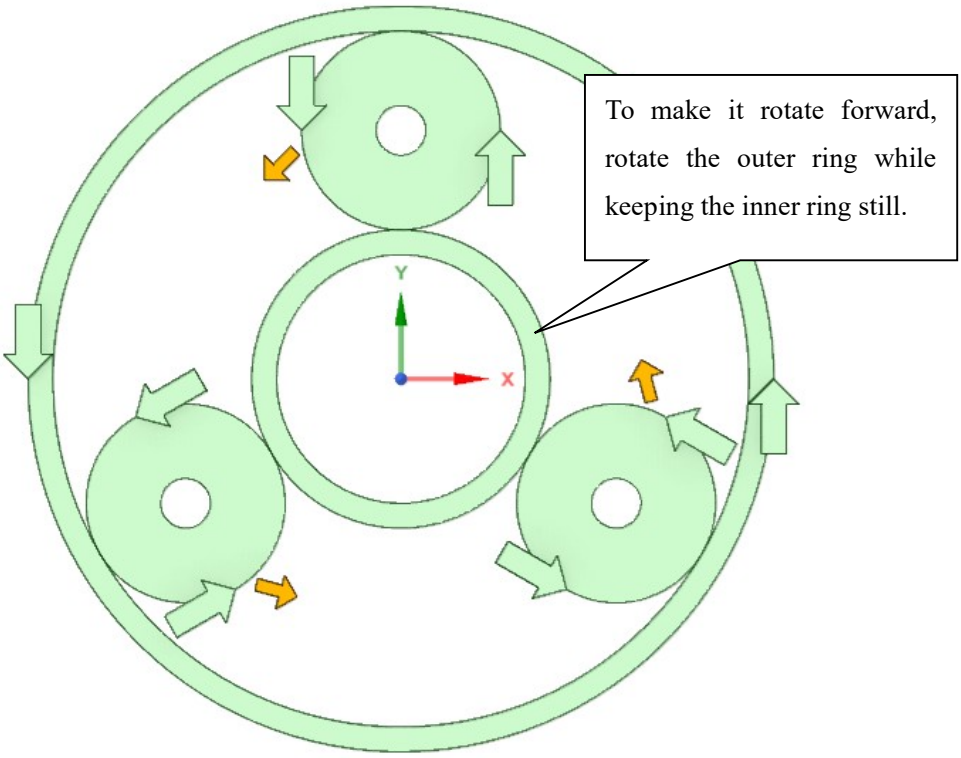

Normally, bearings have an outer ring fixed and a rotating shaft passing through the central hole. However, this causes the inner ring to rotate, resulting in the bearings rotating in the opposite direction, making it inefficient, and the propulsion force of the balls acts as a brake. Simply rotating the outer ring results in forward rotation, improving efficiency and creating a structure that allows for energy amplification.

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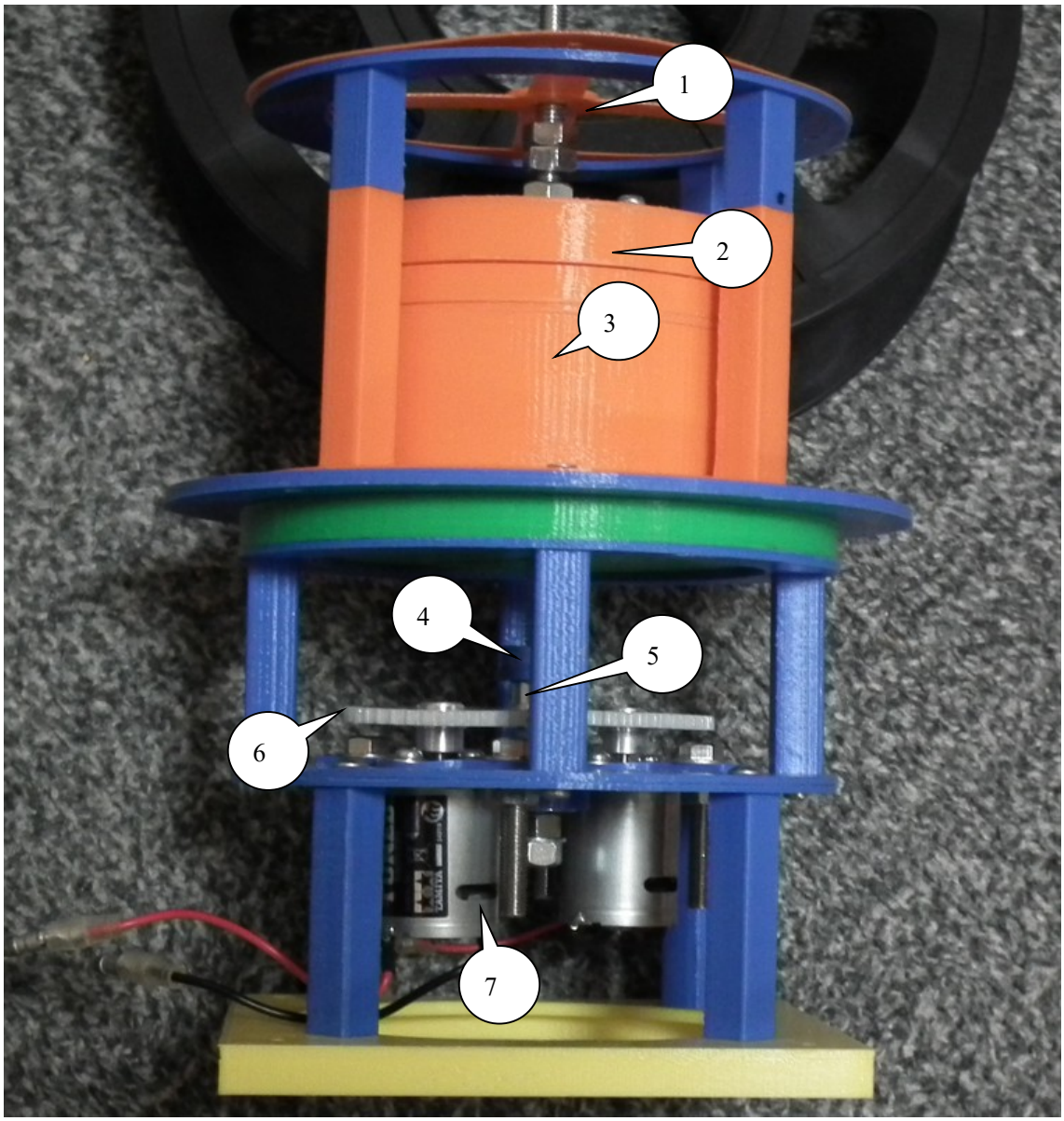
<Structure>

■Overall Configuration Diagram



① The two conical roller bearings are connected in a way that prevents them from sticking out from the top. (A leaf spring was intended, but it is not fixed because fixing it would increase the mechanical resistance too much.) The upper bolt is there to fix the inner hole of the conical roller bearing and is not connected to the motor.

② An outer disc equivalent to the conical roller bearing (NTN_30306) (outer diameter 72mm, inner diameter 30mm) is installed inside.

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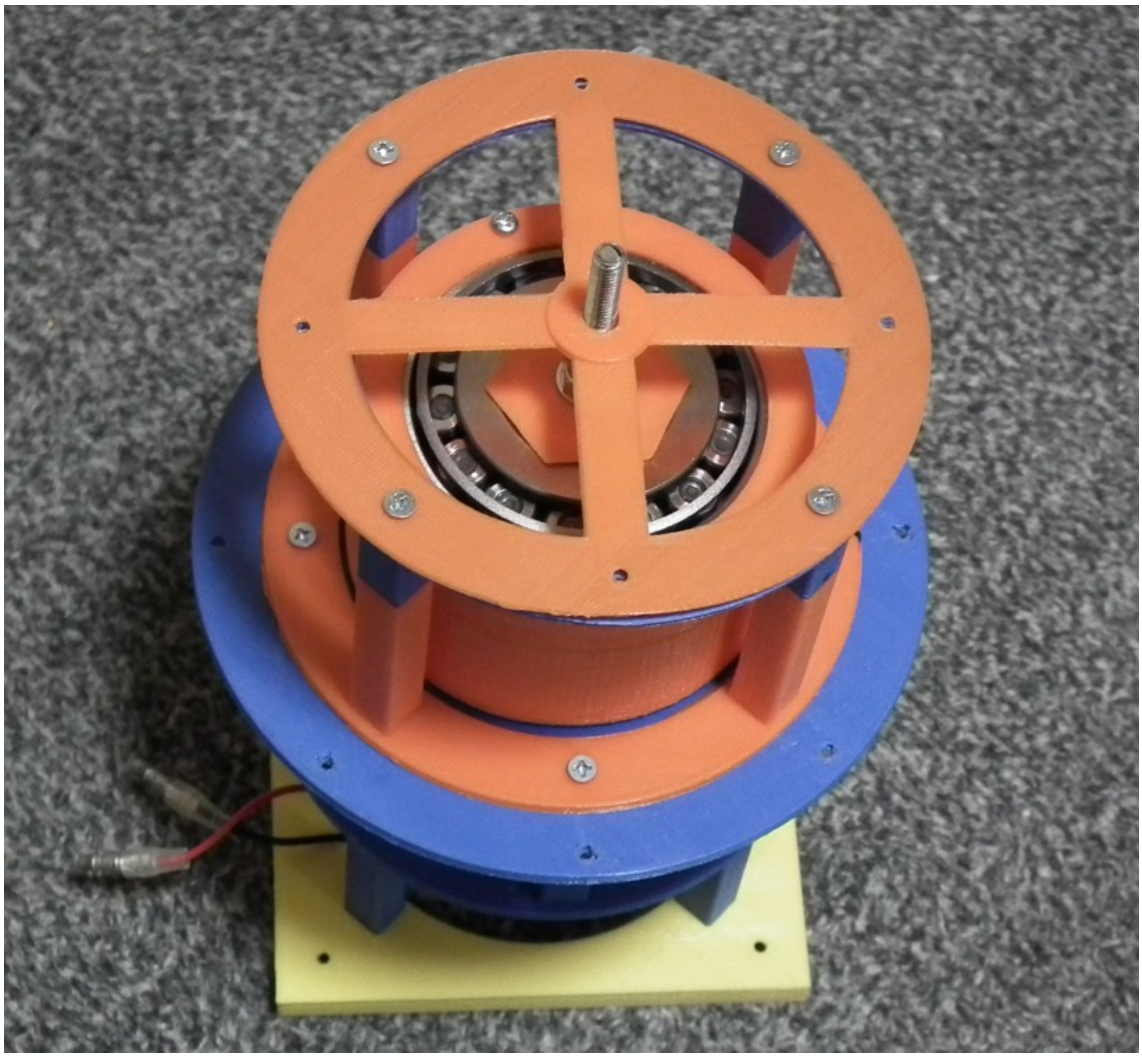
③ An inner disc equivalent to the conical roller bearing (NTN_30302) (outer diameter 42mm, inner diameter 15mm) is installed inside.

④ A nut for a 6mm bolt is installed inside, securing the gear from above and below. The cover is there because the tachometer may pick up reflections.

⑤ Reflective tape for measuring the tachometer.

⑥ The drive components, such as the motor, basically follow the previous structure, with the motor side having 35 teeth and the turbine side having 20 teeth, resulting in a reduction ratio of 1.75.

⑦ The Tamiya 370 Torque-Tuned Motor, despite its small size, can handle an input of about 6.6V and can reach nearly 10,000 RPM with just 4V.



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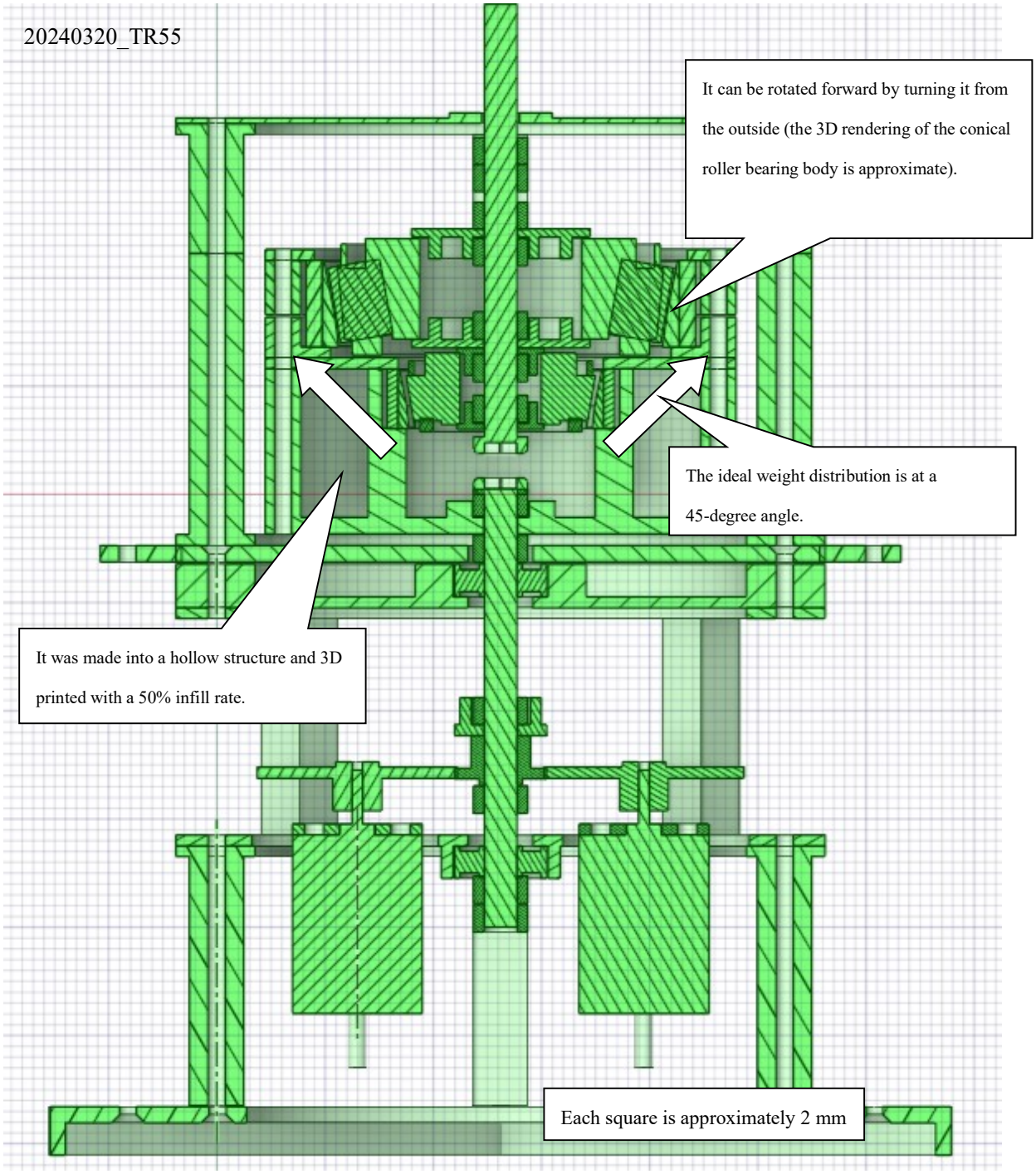

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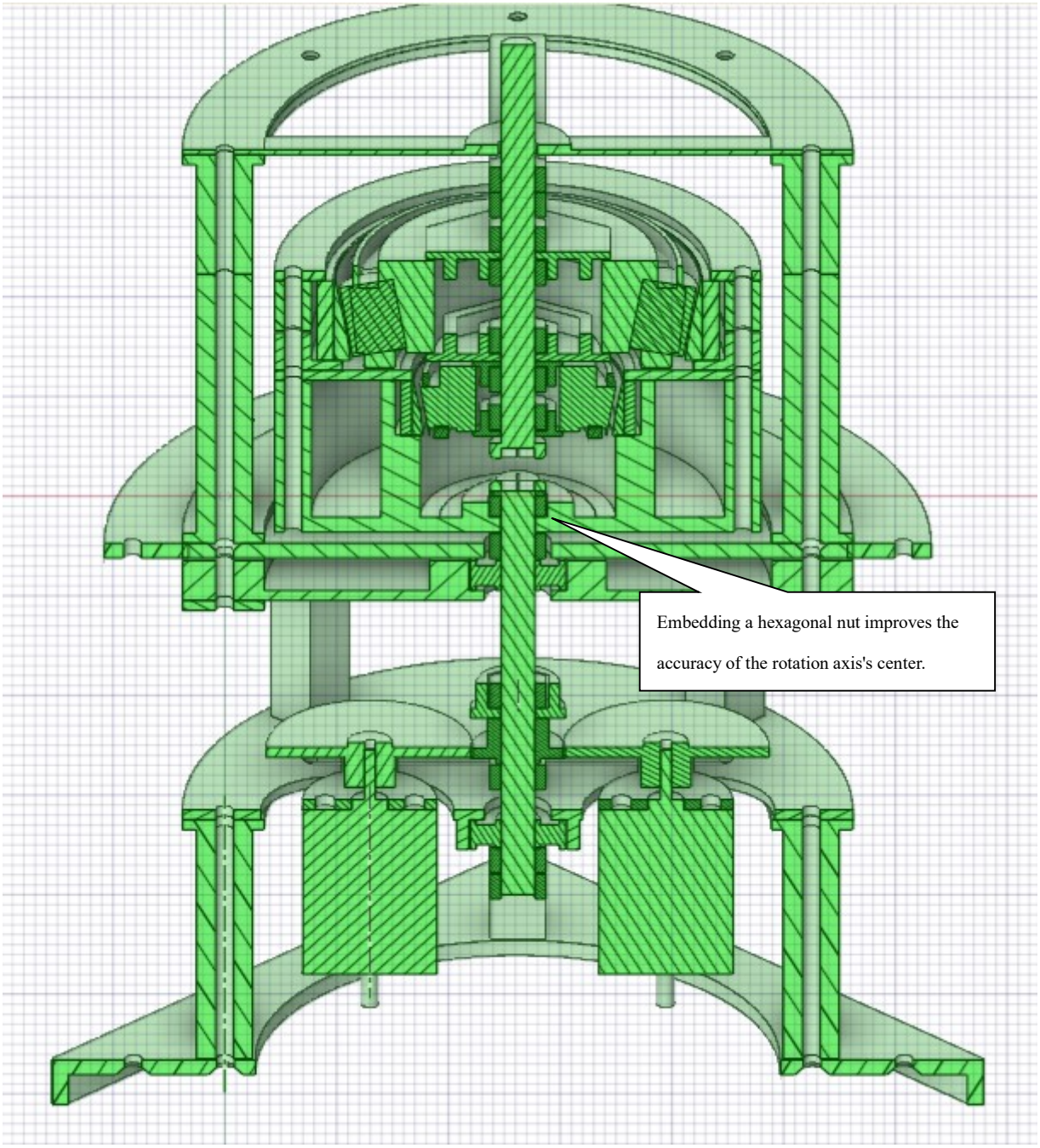

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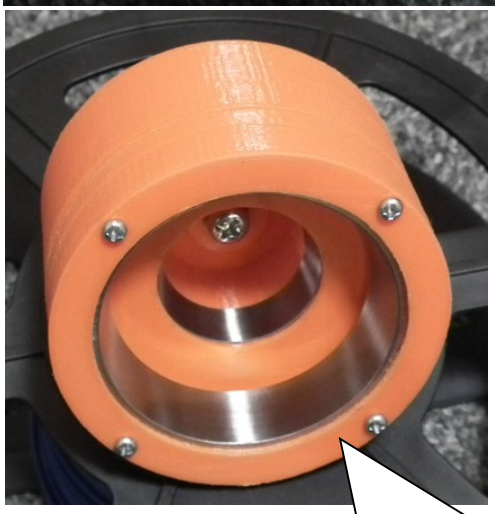
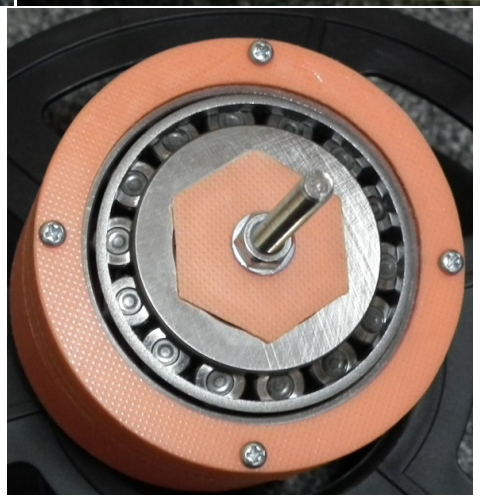
It is connected by a hole in the center of two conical roller bearings of different sizes.





It is desirable that thrust can be generated even with the turbine alone, without the main body of the conical roller bearing.

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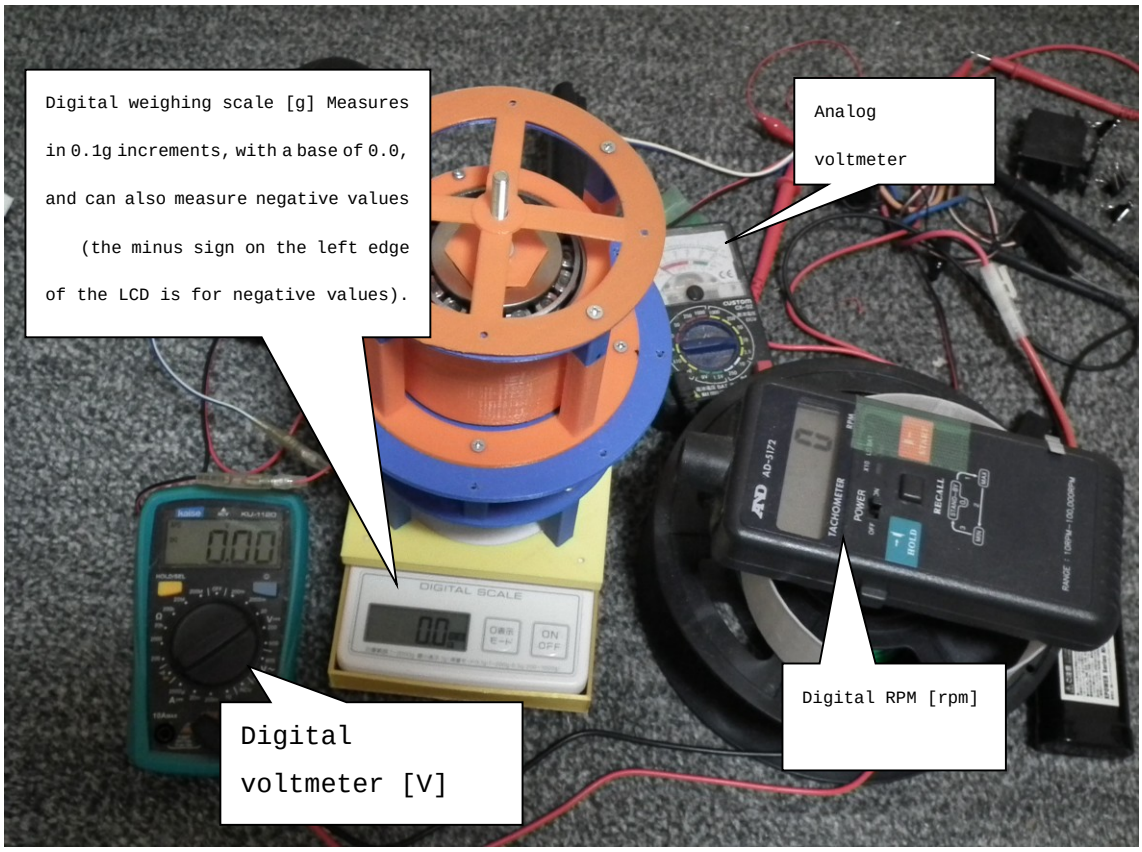
<Experiment>

■Experimental equipment



In the initial concept, the center of the conical roller bearing was bolted to the upper cross-shaped leaf spring equivalent and the outer part was to be rotated, but the mechanical resistance was large, so it was decided to experiment with the leaf spring equivalent removed. By rotating from the outside, forward rotation is achieved without fixing the inner part, so there is no particular need to fix it. Furthermore, it was decided that the thrust force of the lower turbine alone without the twin conical roller bearing body should also be measured, and the following three experiments were conducted.

(1) Experiment to measure the thrust force of a turbine alone without conical roller bearings.

(2) An experiment with a levitating twin conical roller bearing (it didn't happen intentionally, it just happened when we tried it).

(3)An experiment in which a leaf spring equivalent was added to prevent it from floating.

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■(1)Experiment to measure the thrust force of a turbine alone without conical roller bearings.



Although it's hard to see, there's a "-" at the left end of the scale, indicating that it's -2.2g lighter.

-2.2[g]、1:43、3.10[v]、3890.2[rpm]

Thrust force measurement of turbine alone (values obtained from recorded video [TR55/DSCF4782.mp4])				
No.	Voltage[v]①	Rotational speed[rpm]②	(Duration of video)	Weight[g]③
1	0.00	0	1:15	0.0
2	2.74	3227.8	1:39	−0.9
3	3.10	3890.2	1:43	−2.2
4	2.60	3825.2	1:58	−2.6
5	0.26	1128.1	2:25	0.0

No. 1: Experiment begins with a turbine alone without conical roller bearings.

No. 2: Immediately after upward thrust begins to be generated.

No. 3: Near maximum upward thrust (as shown in the photo above).

No. 4: An upward thrust of 2.0 g or more is maintained for more than 5 seconds.

No. 5: As the rotational speed decreases, the thrust returns to 0.0 g.

To continuously push the conical roller bearing upwards, the turbine alone needs upward thrust, and we measured the value of this thrust alone. (For the turbine shaft bolts to move upwards, sufficient upward thrust must exist. -2.6[g] is a fairly good output compared to previous experiments.)

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■(2)Experiment with a floating twin conical roller bearing



Although it's hard to see, there's a "-" at the left end of the scale, indicating that it's -96.8g lighter.

-96.8[g]、0:22、3.19[v]、2857.5[rpm]

Levitating twin conical roller bearing (Values obtained from the recorded video [TR55/DSCF4783.mp4])				
No.	Voltage[v]①	Rotational speed[rpm]②	(Duration of video)	Weight[g]③
1	0.00	0	0:00	0.0
2	3.19	2857.5	0:22	−96.8

No. 1 is the start of the experiment.

No. 2 is the state after surfacing (the state shown in the photo above).

The photograph showing the weight of the double-barreled conical roller bearing body shows it weighing 363.5g, so I didn't expect it to levitate before the experiment, and after it jumped about three times, I naturally stopped the experiment.

This experiment was significant because it confirmed that such things can actually happen. The combined force of the propulsion from the rollers must be quite large.

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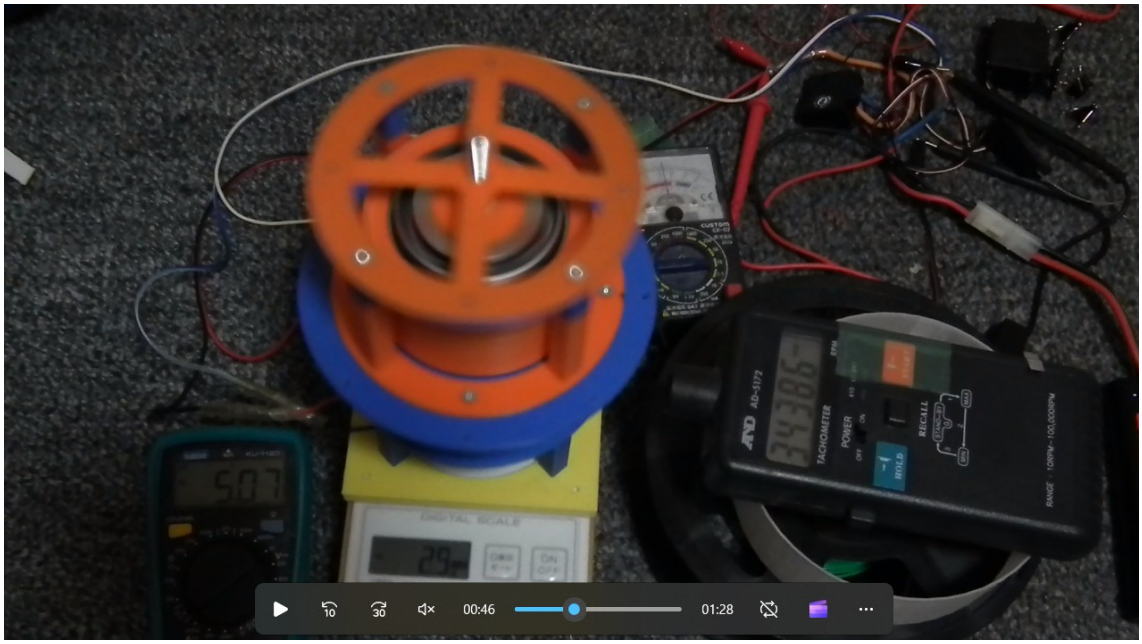
■(3)An experiment in which a leaf spring equivalent was added to prevent it from floating.



Although it's hard to see, there's a "-" at the left end of the scale, indicating that it's -2.9g lighter.

-2.9[g]、0:46、5.07[v]、3438.6[rpm]

Thrust force measured while preventing buoyancy (values obtained from recorded video [TR55/DSCF4786.mp4])				
No.	Voltage[v]①	Rotational speed[rpm]②	(Duration of video)	Weight[g]③
1	0.00	0	0:0	0.0
2	4.58	3257.9	0:30	−1.9
3	5.07	3438.6	0:46	−2.9
4	5.21	3370.2	0:58	−2.9
5	0.00	0.0	1:46	1.0

No. 1: Experiment started with a leaf spring equivalent added to the top to prevent it from floating.

No. 2: Immediately after upward thrust began to be generated.

No. 3: Nearly the maximum upward thrust (the state shown in the photo above).

No. 4: An upward thrust of 2.0[g] or more was maintained for more than 5 seconds.

No. 5: The rotation speed was 0 and the thrust did not return to 0.0[g] but remained at 1.0[g], but it seems that some vibration picked up the weight of the wire.

The upper leaf spring equivalent is not strong enough to withstand the thrust, and when the main body of the conical roller bearing floats, the acceleration of the roller rotation by the turbine below is lost, making it impossible to increase the thrust. Therefore, the experimental setup is quite poor. Most of the thrust is likely from the turbine itself, so the overall thrust cannot be evaluated.

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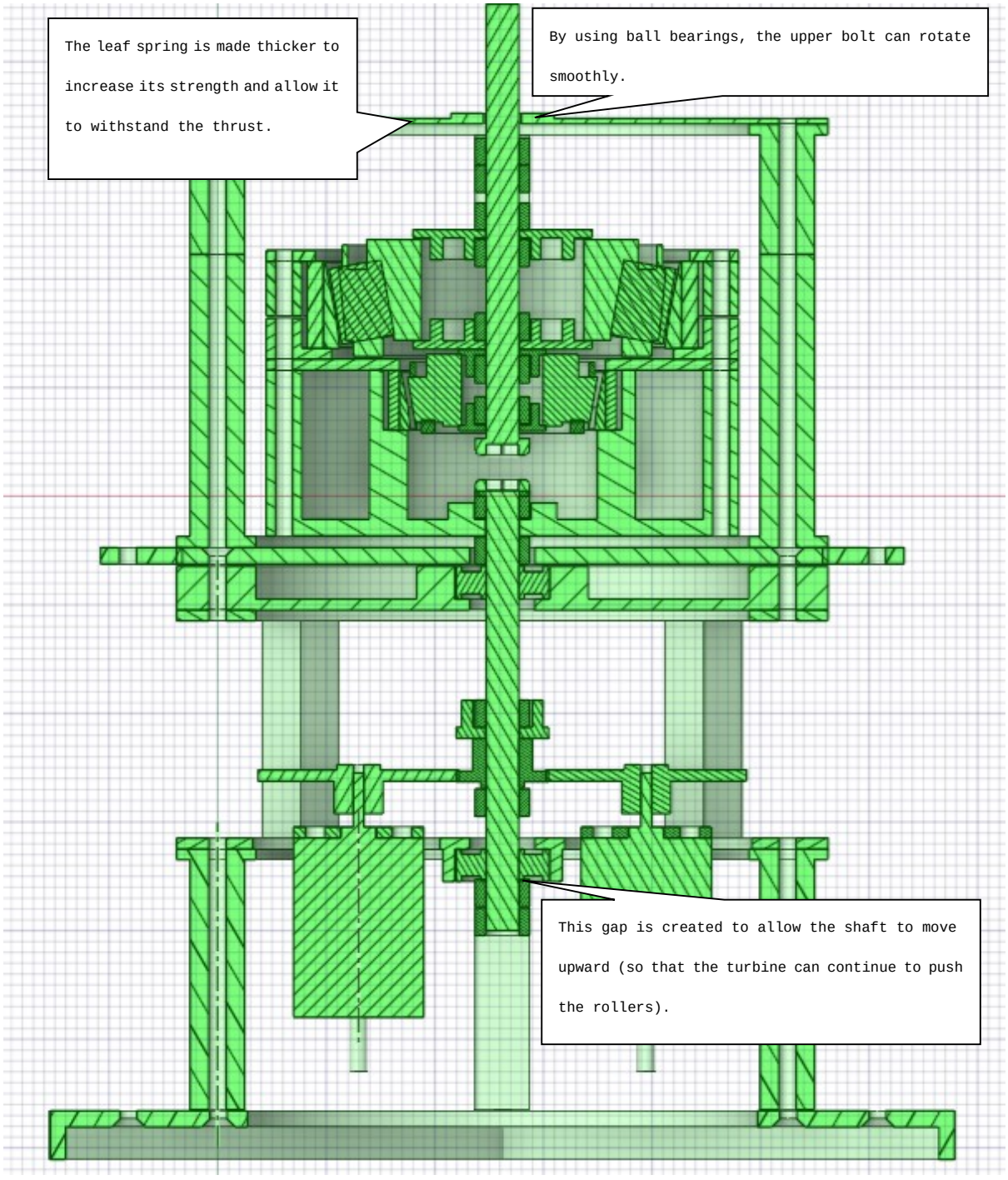
■Areas for improvement for next time



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■Conclusion for the next step

Next time, I'll try implementing the improvements mentioned above and experiment with them.

That's all.

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