Comparing speed ratio, relative speed of rotation, input speed, and area of transmissions

The following pages contain mathematical calculations with comparisons between my system (Patent: EP 3123599 B1) to other scenarios and chosen competitive systems - with several aspects of comparison, which are as follows: speed ratio and relative speed of rotation between a stator and a rotor elements of a generator, input speed, and total area of transmissions.

The first part of this document includes three scenarios of comparisons between my system to a system that uses transmissions of increasing speed and a static stator or rotor in its generator.

The second part of this document includes comparisons between my system to three chosen competitive systems that use transmissions of increasing speed and counter-rotating stator and rotor in their generators.
The chosen competitive systems are preexisting patents taken from, and reflecting most of the dozens of preexisting patents and technology that were found by the searches of the PCT and patent offices in the various countries where I issued my patent, and which my patent has successfully surpassed all of them, and been granted.

As you can see, these mathematical calculations prove that my system achieves the best results in all the scenarios, and also in comparison to the competitive systems.

The comparing are:

The terms, calculations and drawings that are used and presented in this document are for explanatory purposes only, and are not limiting in any way, the full scope of my patented invention EP 3123599 B1.

For convenient, the official documents of the patents can be found in the following 4 links (copy & paste the blue links):

My patent: https://www.ezoory.com/patents/ep3123599b1.pdf
Kirschbaum: https://www.ezoory.com/patents/us4291233.Kirschbaum.pdf
McCombs: https://www.ezoory.com/patents/us5506453.McCombs.pdf
Wadehn: https://www.ezoory.com/patents/us8536726b2.Wadehn.pdf

Comparing a system with a static stator or rotor to my system:

Scenario 1 - Comparing speed ratio and relative speed of rotation:

I am going to prove by simple mathematical calculations that the maximum speed ratio and relative speed of rotation that can be achieve by a system that uses transmission trains to rotate a stator or a rotor element of a generator while the other of the stator or rotor element of the generator is static, is always going to be lower than the speed ratio and relative speed of rotation that can be achieve by my patent that uses transmission trains to create counter-rotation at high speed ratio between a stator and a rotor elements of a generator, while both systems are using a similar number of transmission trains and similar gear ratios of increasing speed in these transmission trains.

For the comparing, I will use three basic assumptions for both systems, which are:

1. The number of transmission trains is two;
2. The gear ratio of increasing speed of each of the two transmission trains is 1:2;
3. The input rotational speed of the power source (turbine propeller for example) is “X”.

Figures 9 and 10 from the patent documents are used as illustration model for the calculations:

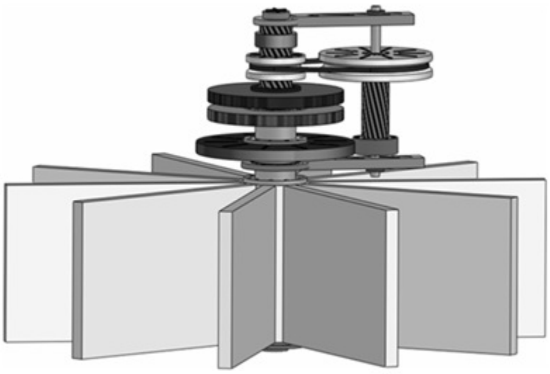


Figure 9

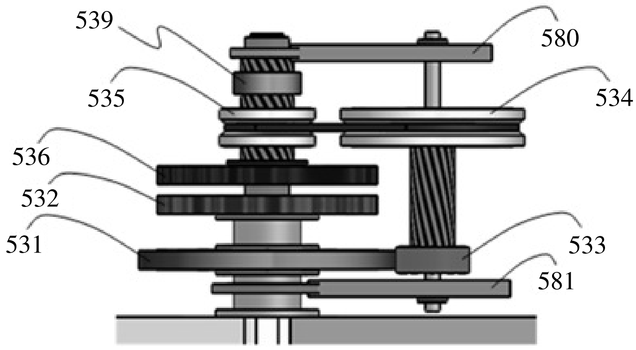


Figure 10

The stator and rotor of the generator are presented by the elements 532 and 536. I will assume for the comparing that the stator is presented by the element 532, and the rotor is presented by the element 536, although that these elements can also be the other way around.

When the input rotational speed of the turbine propeller is “X”, then:

The first transmission train has the wheel 531 fixed to and rotated by the turbine propeller so its rotational speed is X as well, and has the wheel 533 rotating at speed of 2X (as the gear ratio of the first transmission train is 1:2). The second transmission train has the wheel 534 fixed to and rotated by the wheel 533 so its rotational speed is 2X, and has the wheel 535 rotating at speed of 4X (as the gear ratio of the second transmission train is also 1:2).

Wheel 535 is rotating in direction counter to the turbine propeller and wheel 531.

The rotor 536 is fixed to and rotated by the wheel 535 so its rotational speed is 4X.

<u>In case of a system with a static stator or rotor</u>: then, the stator 532 rotational speed is 0 (zero), and so the relative speed of rotation between the stator and rotor of the generator is 0 + 4X = **4X**, and the overall speed ratio = **1:4**.

<u>In case of my patent</u>: then, the stator 532 is fixed to and rotated by the turbine propeller and/or wheel 531 so its rotational speed is X, and so the relative speed of rotation between the stator and rotor of the generator is X + 4X = **5X**, and the overall speed ratio = **1:5**.

Result: My patent increases by 25% the speed ratio (from 1:4 to 1:5) and relative speed of rotation (from 4X to 5X) in comparison to a system that uses a static stator or rotor.

Note: the location of the stator and rotor with respect to the transmissions can be either before, after or between the transmissions. More transmission trains and/or different ratios for the comparing will provide of course different results, but my patent will always provide the highest results.

Scenario 2 - Comparing input speed:

I am going to prove by mathematical calculations that the input rotational speed that is required to operate a generator at a given relative speed of rotation between its stator and rotor elements is lower when using my patent than in a system that uses a static stator or rotor, while both systems are using a similar number of transmission trains and similar gear ratios of increasing speed in these transmission trains.

For the comparing, I will use three basic assumptions for both systems, which are:
1. The number of transmission trains is two;
2. The gear ratio of increasing speed of each of the two transmission trains is 1:2;
3. The required relative speed between the stator and rotor is 100 RPM.

Based on figures 9 and 10 and the explanations from the previous page, then:

In case of a system that uses a static stator or rotor, then:
The speed of each of the rotor 536 and wheel 535 must be 100 RPM; therefor,
The speed of each of the wheels 534 and 533 is 50 RPM; therefor,
The speed of each of the wheel 531 and turbines propeller input speed is 25 RPM, while the speed of the stator 532 is 0 (zero). Hence: **Input speed = 25 RPM**.

In case of my patent, then:
The speed of each of the rotor 536 and wheel 535 is “Y”; therefor,
The speed of each of the wheels 534 and 533 is 0.5Y; therefor,
The speed of each of the wheel 531, stator 532 and turbines propeller input speed is 0.25Y;
Calculation: Y + 0.25Y = 100 RPM; Hence: Y = 80 RPM; Hence: **Input speed = 20 RPM**.

Result: My patent reduces by 20% the required input speed (from 25 RPM to 20 RPM) in comparison to a system that uses a static stator or rotor.

This advantage increases safety, decreases environmental damage, and expands implementation of green energy turbines.
Another advantage is that the speed of the fastest elements which are the wheel 535 and rotor 536 are rotating in my system at speed of 80 RPM which is 20% less than the speed of 100 RPM of these elements when the stator or rotor is static. This can reduce heat and total centrifugal forces.

More transmission trains and/or different ratios for the comparing will provide of course different results, but my patent will always provide the lowest (input rotational speed) results.

Scenario 3 - Comparing area of transmissions:

I am going to prove by mathematical calculations that the total area of transmissions materials that are required to achieve any given relative speed of rotation between a stator and a rotor elements of a generator is smaller when using my patent than in a system that uses a static stator or rotor, while both systems are using a similar number of transmission trains and similar input rotational speed.

For the comparing, I will use five basic assumptions for both systems, which are:
1. The number of transmission trains is two;
2. The speed ratio (gear ratio) of one of the transmission train is 1:2;
3. The perimeter of the smallest gear wheel cannot be below 10 centimeters for instance (Radius = 1.59154943091895 centimeters);
4. The input rotational speed is 16 RPM.
5. The required relative speed between the stator and rotor of the generator is 100 RPM.

Based on figures 9 and 10 from the previous page - I will calculate the perimeter of each of the rest of the wheels in each system, then, calculate the radius and area of each of the wheels in each system, then, sum the area of the wheels in each system, and then, compare the results.

In order not to complicate, then, the calculations will not take into account the thickness of all the elements, only their area, and will not include the area / thickness of the belt.

Calculations of perimeter and speed:
The perimeter and speed of the wheels are as follow:
The perimeter of 535 is 10 cm, and its speed is “Z”; therefor,
The perimeter of 534 is 20 cm (as the gear ratio is 1:2), and its speed is 0.5Z; therefor,
The perimeter of 533 is 10 cm, and its speed is 0.5Z as well (rotate together with 534).
The perimeter of 531 is “P”, and its speed is 16 RPM.

In case of a system that uses a static stator or rotor, then:
The speed of 535 must be Z = 100 RPM;
Hence, the speed of 534 is 50 RPM, and so the speed of 533 is 50 RPM as well;
Since the speed of 531 is 16 RPM, then, the gear ratio between 531 and 533 is 1:3.125 (from 16 RPM to 50 RPM), and so **the perimeter of 531 is P = 31.25 cm**.

In case of my patent, then:
The speed of 535 (Z) and the perimeter of 531 (P) can be calculated as follow:
The speed of 535 plus the speed of 531 must be 100 RPM. That is Z + 16 RPM = 100 RPM;
Hence, the speed of 535 is Z = 84 RPM;
Hence, the speed of 534 is 42 RPM, and so the speed of 533 is 42 RPM as well;
Since the speed of 531 is 16 RPM, then, the gear ratio between 531 and 533 is 1:2.625 (from 16 RPM to 42 RPM), and so **the perimeter of 531 is P = 26.25 cm**.

We now have the perimeter of each of the wheels involved in each system, and we proceed to calculate the radius and area of each of the wheels in each system, and then, sum the area of the wheels in each system, and then, compare the results.

My System	**Perimeter $= 2\pi R$**	**Radius $= R$**	**Area $= \pi R^2$**
Wheel 535	10.00	1.592	7.958
Wheel 534	20.00	3.183	31.831
Wheel 533	10.00	1.592	7.958
Wheel 531	26.25	4.178	54.834
			______
			102.580

Static stator or rotor	**Perimeter $= 2\pi R$**	**Radius $= R$**	**Area $= \pi R^2$**
Wheel 535	10.00	1.592	7.958
Wheel 534	20.00	3.183	31.831
Wheel 533	10.00	1.592	7.958
Wheel 531	31.25	4.974	77.712
			______
			125.459

Result: My patent reduces by more than 22% the required area of transmissions (from 125.459 cm to 102.580 cm) in comparison to a system that uses a static stator or rotor.

This advantage of reducing the area of transmission leads to reduce size, volume, weight and cost.

Other types of transmission trains can be use, for instance a planetary structure, different number of wheels in each transmission train, with or without a belt, etc. that will provide different results, but my patent will always provide the smallest (area of transmissions) results.

The next pages contain comparisons of my system to three chosen preexisting patents, all using transmission trains to increase the relative speed between counter-rotating stator and rotor of a generator. It can be seen that my patent archives the best results in all parameters.

Comparing US 4291233 (Kirschbaum) to my system:

Kirschbaum presents in his patent a formula and a calculation for three transmission trains (gear stages) with gear ratios of increasing speed of: 1:3, 1:3 and 1:8, running counter-rotating stator and rotor. **Kirschbaum** got to an overall gear ratio increase of 1:54 between the counter-rotating stator and rotor, and when using an input turbine shaft rotational speed of 22.2 RPM - he got to 1,200 RPM generator speed (the relative rotational speed between the counter-rotating stator and rotor).

However one needs to remember that if a person would use a gear system with a static stator, and with three transmission trains, and with similar gear ratios of: 1:3, 1:3 and 1:8, as **Kirschbaum** uses, then, he could achieve a maximum overall gear ratio between the rotor and the static stator of 1:72 ($3 \cdot 3 \cdot 8 = 72$), which is a much better result than **Kirschbaum's** result of 1:54, and this is also without the complexity needed for running a non-static stator.

In my Specifications, in my Description regarding figure 18 of my Drawings, I present using formulas, the relative speed of rotation achieved between counter-rotating stator and rotor for two, four, six and eight transmission trains (gear stages), when "N" presents the input rotational speed of the turbine rotor, and "Gi" presents the gear ratio of each transmission train:

For 2 transmission trains = $N + N \cdot G1 \cdot G2$
For 4 transmission trains = $N \cdot G1 \cdot G2 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4$
For 6 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 \cdot G4 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6$
For 8 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6 \cdot G7 \cdot G8$

The analogous case for different number of transmission trains for my system can be easily derived from the formulas of the two, four, six and eight transmission trains presented there, so the formulas for relative speed of rotation achieved between counter-rotating stator and rotor when using two transmission trains and up to eight transmission trains for example, would be:

For 2 transmission trains = $N + N \cdot G1 \cdot G2$
For 3 transmission trains = $N \cdot G1 + N \cdot G1 \cdot G2 \cdot G3$
For 4 transmission trains = $N \cdot G1 \cdot G2 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4$
For 5 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5$
For 6 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 \cdot G4 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6$
For 7 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6 \cdot G7$
For 8 transmission trains = $N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6 + N \cdot G1 \cdot G2 \cdot G3 \cdot G4 \cdot G5 \cdot G6 \cdot G7 \cdot G8$
and so on ….

If we put **Kirschbaum's** three transmission trains values (1:3, 1:3, 1:8) in my above formulas for three transmission trains, then, and depending on which gear ratio we use for the first transmission train G1 (1:3 or 1:8), the overall gear ratio increase would be:

$N \cdot (G1 + G1 \cdot G2 \cdot G3) \Rightarrow N \cdot (3 + 3 \cdot 3 \cdot 8) \Rightarrow N \cdot (3 + 72) \Rightarrow N \cdot (75) \Rightarrow$ 1:75
or:
$N \cdot (G1 + G1 \cdot G2 \cdot G3) \Rightarrow N \cdot (8 + 8 \cdot 3 \cdot 3) \Rightarrow N \cdot (8 + 72) \Rightarrow N \cdot (80) \Rightarrow$ 1:80

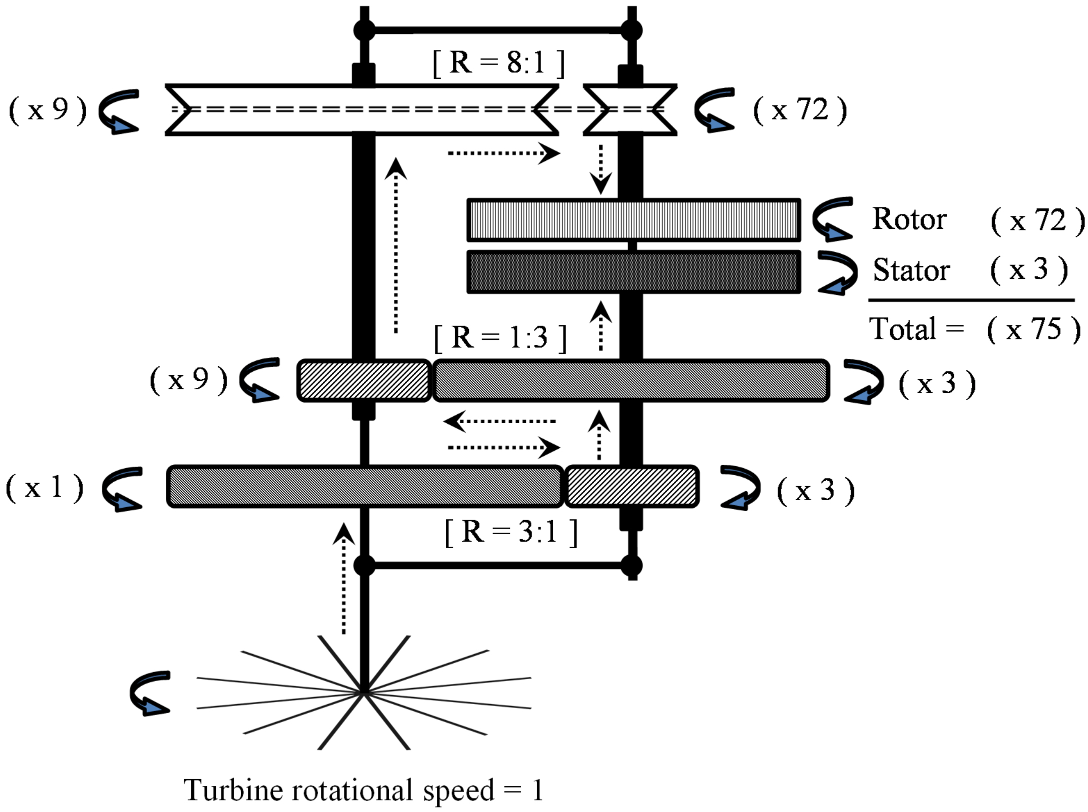
Meaning, an overall gear ratio increase of 1:75 or 1:80 is achieved, which in both cases, are much higher than **Kirschbaum's** result of 1:54, and, are also higher than the maximum result for those three transmission trains when used with a static stator, which is 1:72.

If we use an input turbine shaft rotational speed of 22.2 RPM on my model, as **Kirschbaum** uses in his, then, we would be able to get to a generator speed of 1,665 RPM or 1,776 RPM, which in both cases, are much higher than **Kirschbaum's** result of 1,200 RPM.

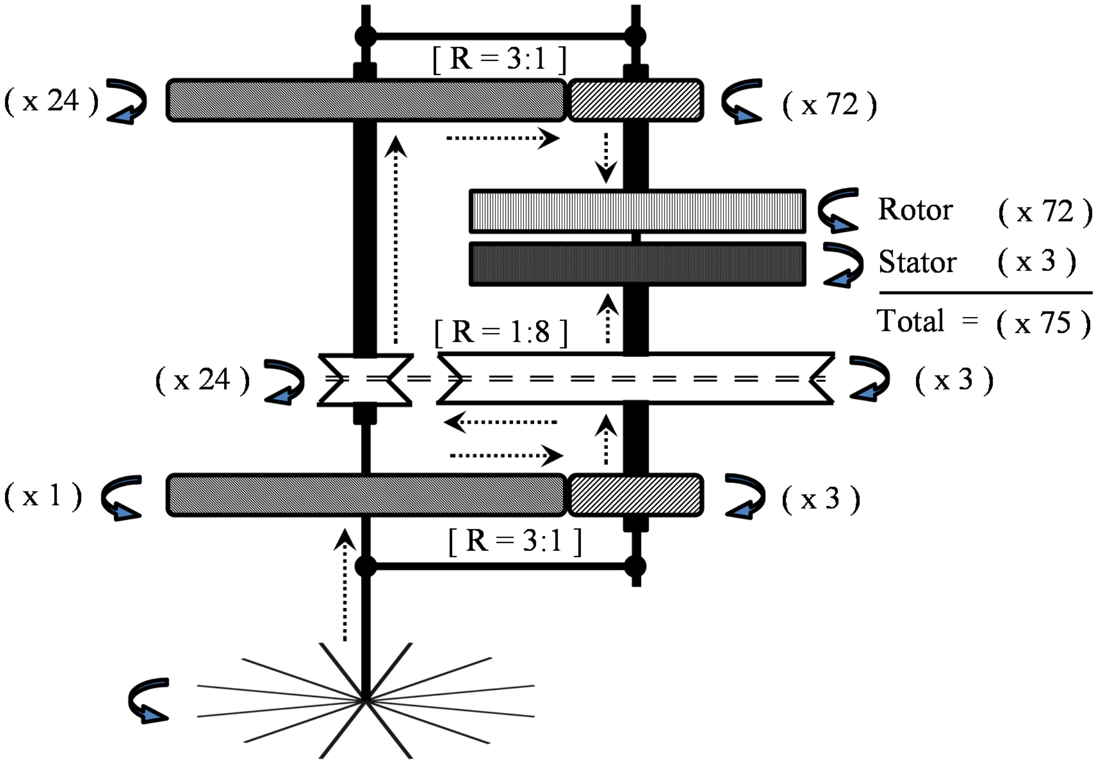
In my model and formula, I am showing an improvement of 38% up to 48% on **Kirschbaum's** model and formula.

Following are five figures that show five different examples (options) of how I am able to reach an overall gear ratio increase of either 1:75 or 1:80, by using the principle and mathematic techniques of my models, and, by using three transmission trains and similar gear ratios (R) of 1:3, 1:3 and 1:8, as **Kirschbaum** uses, where the turbine rotational speed is "1":

Example #1

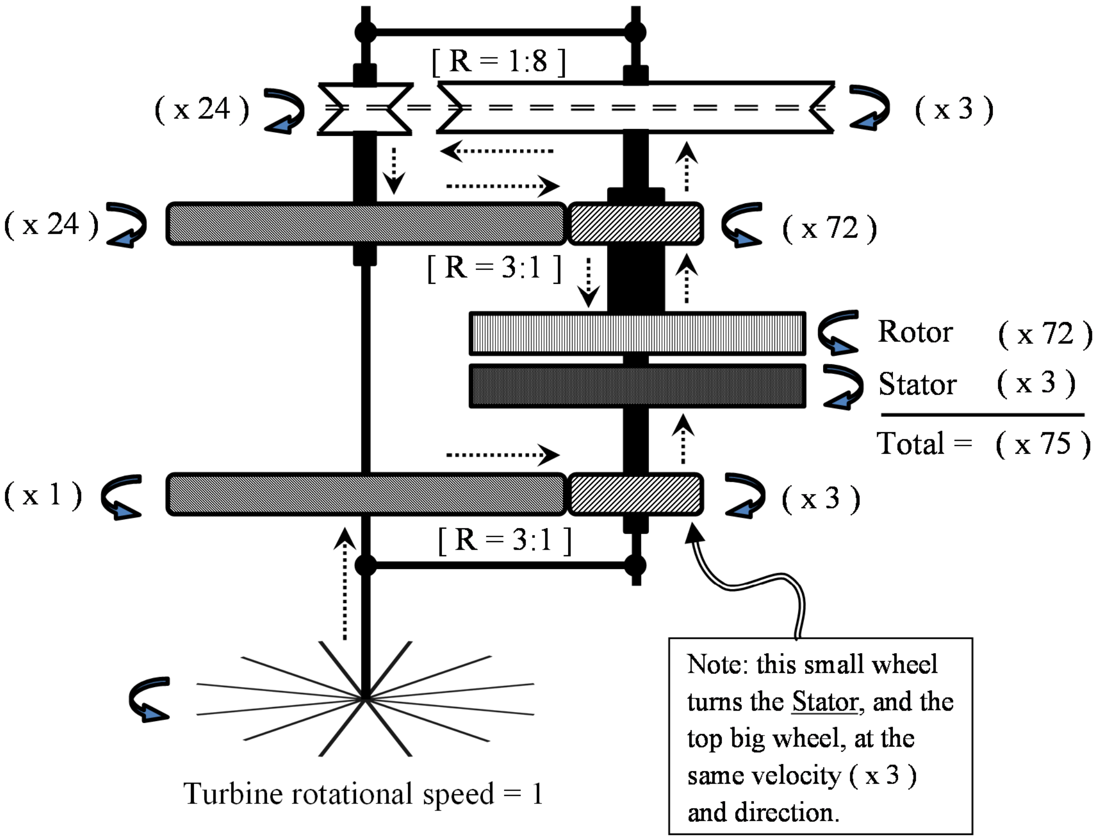

[R = 8:1]
(x 9)
(x 72)
Rotor (x 72)
Stator (x 3)
Total = (x 75)
[R = 1:3]
(x 9)
(x 3)
(x 1)
(x 3)
[R = 3:1]
Turbine rotational speed = 1

Example #2

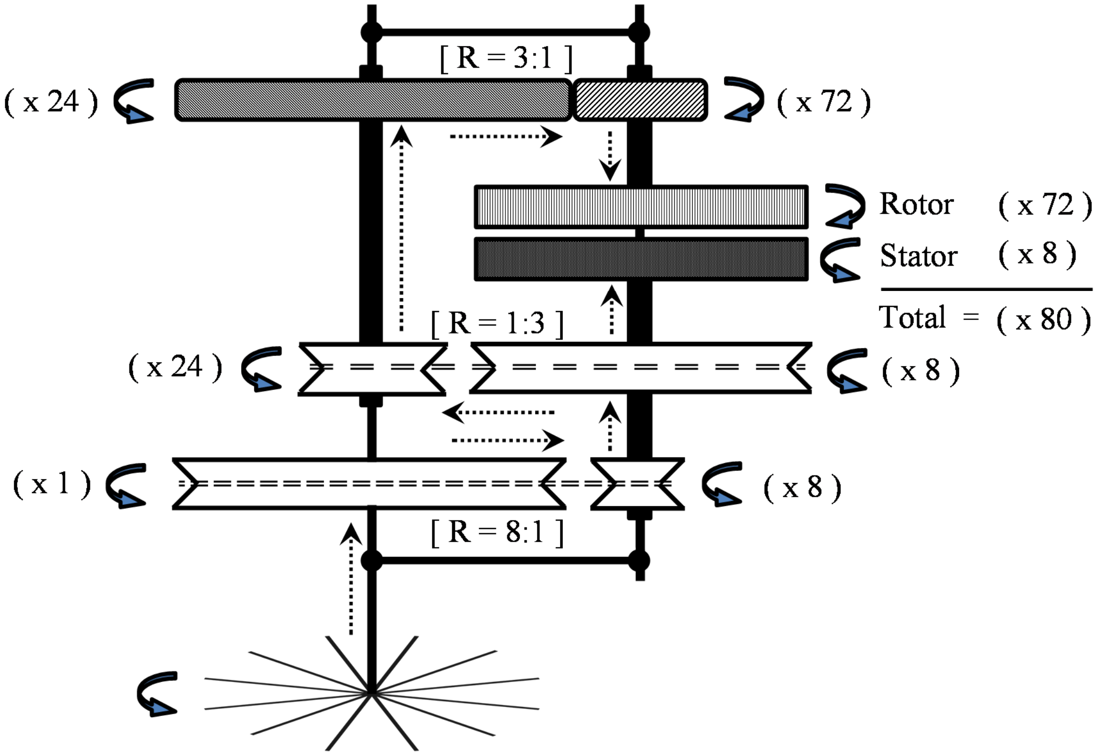


Turbine rotational speed = 1

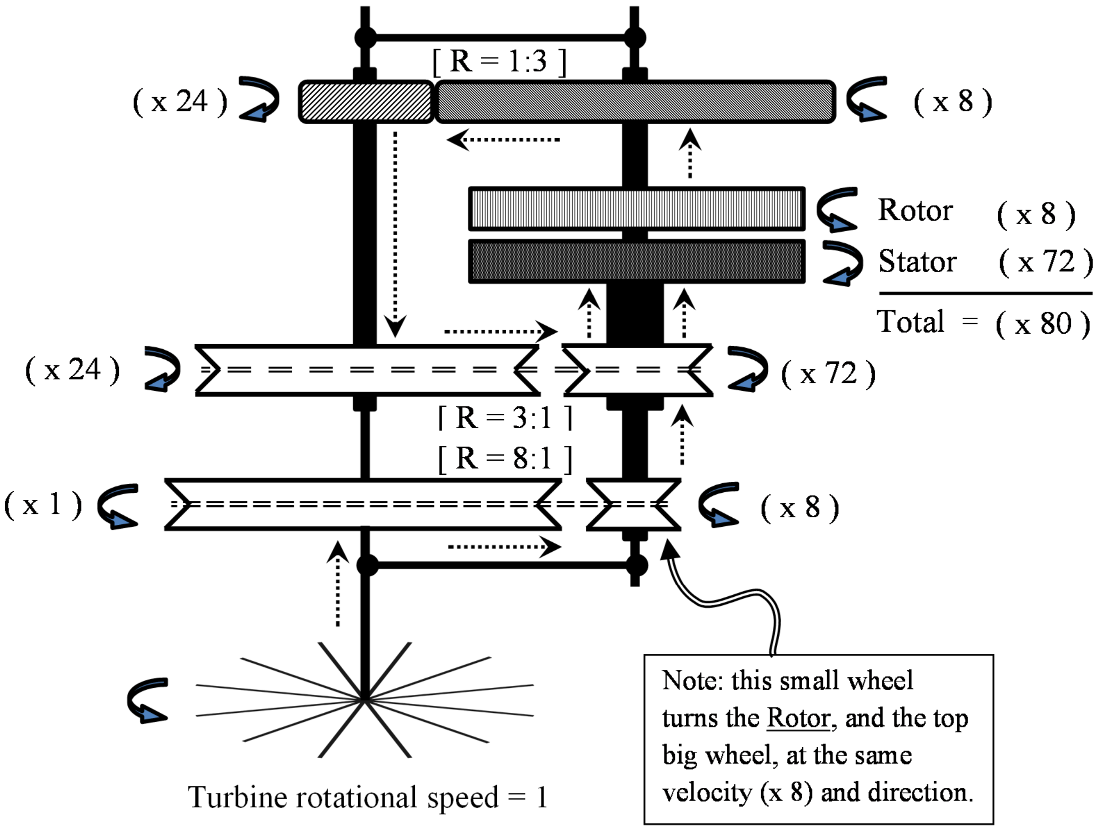
Example #3


[R = 1:8]
(x 24)
(x 3)
(x 24)
(x 72)
[R = 3:1]
Rotor (x 72)
Stator (x 3)
Total = (x 75)
(x 1)
(x 3)
[R = 3:1]
Note: this small wheel turns the Stator, and the top big wheel, at the same velocity (x 3) and direction.
Turbine rotational speed = 1

Example #4


[R = 3:1]
(x 24)
(x 72)
Rotor (x 72)
Stator (x 8)
Total = (x 80)
[R = 1:3]
(x 24)
(x 8)
(x 1)
(x 8)
[R = 8:1]
Turbine rotational speed = 1

Example #5



[R = 1:3]
(x 24)
(x 8)
Rotor (x 8)
Stator (x 72)
Total = (x 80)
(x 24)
(x 72)
[R = 3:1]
[R = 8:1]
(x 1)
(x 8)
Note: this small wheel turns the Rotor, and the top big wheel, at the same velocity (x 8) and direction.
Turbine rotational speed = 1

<u>Comparing US 5506453 (McCombs) to my system</u>:

I am going to prove by mathematic calculations that my system achieves higher results than the system of **McCombs** in terms of increasing the speed ratio and relative speed of rotation between counter-rotating stator and rotor of a generator.
I am also going to prove that the system of **McCombs** achieve even lower results than a system that uses a static stator or rotor - in terms of increasing the speed ratio and relative speed of rotation between the stator and rotor, while the system with the static stator or rotor does not even include the complexity of running counter-rotation stator and rotor.
Part of the conclusion of these calculations will be that even splitting the input power source into two sources - as **McCombs** did - will still achieve lower results than my system achieves, and even lower than a system that uses a static stator or rotor.

Assumptions:
For the comparing to be simple as possible, and still accurate, I will make several assumptions:
All systems are using similar number of transmission trains and similar gear ratios of increasing speed in these transmission trains, and having similar input rotational speed.
As an example, I will present calculations for two, four and eight transmission trains involved that will be used for the comparing, while all systems are having at each of the transmission trains an increasing speed gear ratio of 1:5, and having an input rotational speed of 6 RPM.

The comparing is between a system that uses a static stator or rotor, my system, **McCombs** system.
The overall speed ratio ("SR") is presented in brackets next to each relative speed result.

<u>In case of a system that uses a static stator or rotor</u>:
The maximum relative speed of rotation between the stator and rotor of the generator when:
A. using <u>**two**</u> transmission trains is: $6 \cdot 5^2 = 6 \cdot 25 =$ **150 RPM**. (SR = 1:25).
B. using <u>**four**</u> transmission trains is: $6 \cdot 5^4 = 6 \cdot 625 =$ **3,750 RPM**. (SR = 1:625).
C. using <u>**eight**</u> transmission trains is: $6 \cdot 5^8 = 6 \cdot 390{,}625 =$ **2,343,750 RPM**. (SR = 1:390,625).

<u>In case of my system</u>:
Based on the calculations that are presented in my Specifications regarding figures 17 - 18, then:

A. If I use <u>**two**</u> transmission trains with the structure of figures 17 - 18 (or as in figures 9 - 10) in my Drawings, then,
The plates 5911 and 5921 present the rotor and the stator elements (respectively) of the generator that is operated by two transmission trains (5901 - 5941, 5951 - 5931).
The relative speed of rotation between the generator plates 5911 and 5921 is as follow:
The rotational speed of the generator rotor 5911 is:
6 RPM (as the RPM of the turbine propeller and wheel 5901).
The rotational speed of the counter-rotating generator stator 5921 is:
$6 \cdot 5^2 = 6 \cdot 25 = 150$ RPM (as the RPM of wheel 5931).
Hence, the relative speed of rotation is: 6 RPM + 150 RPM = **156 RPM**. (SR = 1:26).

B. If I use <u>**four**</u> transmission trains with the structure of figures 17 - 18 in my Drawings, then,
The plates 5912 and 5922 present the rotor and the stator elements (respectively) of the generator that is operated by four transmission trains (5901 - 5941, 5951 - 5931, 5902 - 5942, 5952 - 5932).
The relative speed of rotation between the generator plates 5912 and 5922 is as follow:
The rotational speed of the generator rotor 5912 is:
$6 \cdot 5^2 = 6 \cdot 25 = 150$ RPM (as the RPM of wheel 5902).
The rotational speed of the counter-rotating generator stator 5922 is:
$6 \cdot 5^4 = 6 \cdot 625 = 3{,}750$ RPM (as the RPM of wheel 5932).
Hence, the relative speed of rotation is: 150 RPM + 3,750 RPM = **3,900 RPM**. (SR = 1:650).

C. If I use **<u>eight</u>** transmission trains with the structure of figures 17 - 18 in my Drawings, then,
The plates 5914 and 5924 present the rotor and the stator elements (respectively) of the generator that is operated by eight transmission trains (5901 - 5941, 5951 - 5931, 5902 - 5942, 5952 - 5932, 5903 - 5943, 5953 - 5933, 5904 - 5944, 5954 - 5934).
The relative speed of rotation between the generator plates 5914 and 5924 is as follow:
The rotational speed of the generator rotor 5914 is:
$6 \cdot 5^6 = 6 \cdot 15{,}625 = 93{,}750$ RPM (as the RPM of wheel 5904).
The rotational speed of the counter-rotating generator stator 5924 is:
$6 \cdot 5^8 = 6 \cdot 390{,}625 = 2{,}343{,}750$ RPM (as the RPM of wheel 5934).
Hence, the relative speed of rotation is: 93,750 RPM + 2,343,750 RPM = **2,437,500 RPM**. (SR = 1:406,250).

<u>In case of US 5506453 of **McCombs**</u>:

A. We will use one transmission train in each transmission mechanism 34, for each of the two propellers 16 and 18, and as per **McCombs** Specification, <u>each propeller rotating at least one transmission train</u>.
It will be a total of **<u>two</u>** transmission trains.
We use one transmission train in the transmission mechanism 34 - that is driven by shaft 26 that is driven by propeller 16 - to drive the shaft 36 which rotates the generator element 82 in one direction, and we use one transmission train in the other transmission mechanism 34 - that is driven by shaft 28 that is driven by propeller 18 - to drive the shaft 38 which rotates the generator element 90 in the opposite direction to generator element 82.
In this case:
The rotational speed of each of both shaft 36 and generator rotor 82 is:
$6 \cdot 5 = 30$ RPM.
The rotational speed of each of both shaft 38 and generator stator 90 is also:
$6 \cdot 5 = 30$ RPM.
Hence, the relative speed of rotation is: 30 RPM + 30 RPM = **60 RPM**. (SR = 1:10).

This is lower than 156 RPM (SR = 1:26).that comes in my system, and also lower than 150 RPM (SR = 1:25).that comes in a system with a static stator or rotor, when all systems are using the **<u>two</u>** transmission trains.

B. If we use two transmission trains in each of the two transmission mechanisms 34, for each of the two propellers 16 and 18, then,
It will be a total of **<u>four</u>** transmission trains.
In this case:
The rotational speed of each of both shaft 36 and generator rotor 82 is:
$6 \cdot 5^2 = 6 \cdot 25 = 150$ RPM.
The rotational speed of each of both shaft 38 and generator stator 90 is also:
$6 \cdot 5^2 = 6 \cdot 25 = 150$ RPM.
Hence, the relative speed of rotation is: 150 RPM + 150 RPM = **300 RPM**. (SR = 1:50).

This is much lower than 3,900 RPM (SR = 1:650).that comes in my system, and also much lower than 3,750 RPM (SR = 1:625).that comes in a system with a static stator or rotor, when all systems are using the **<u>four</u>** transmission trains.

C. Even in case that we use three transmission trains in the transmission mechanisms 34 with one propeller, and another one transmission train with the other transmission mechanisms 34 of the other propeller, then,
It will still be a total of **four** transmission trains,
In this case:
The rotational speed of each of both shaft 36 and generator rotor 82 is:
$6 \cdot 5^3 = 6 \cdot 125 = 750$ RPM (operated by three transmission trains).
The rotational speed of each of both shaft 38 and generator stator 90 is:
$6 \cdot 5 = 30$ RPM (operated by one transmission train).
Hence, the relative speed of rotation is: 750 RPM + 30 RPM = **780 RPM**. (SR = 1:130).

This is still much lower than 3,900 RPM (SR = 1:650).that comes in my system, and also still much lower than 3,750 RPM (SR = 1:625).that comes in a system with a static stator or rotor, when all systems are using the **four** transmission trains.

D. If we use four transmission trains in each of the two transmission mechanisms 34, for each of the two propellers 16 and 18, then,
It will be a total of **eight** transmission trains.
In this case:
The rotational speed of each of both shaft 36 and generator rotor 82 is:
$6 \cdot 5^4 = 6 \cdot 625 = 3{,}750$ RPM.
The rotational speed of each of both shaft 38 and generator stator 90 is also:
$6 \cdot 5^4 = 6 \cdot 625 = 3{,}750$ RPM.
Hence, the relative speed of rotation is: 3,750 RPM + 3,750 RPM = **7,500 RPM**. (SR = 1:1,250).

This is much lower than 2,437,500 RPM (SR = 1:406,250).that comes in my system, and also much lower than 2,343,750 RPM (SR = 1:390,625).that comes in a system with a static stator, when all systems are using the **eight** transmission trains.

E. Even in case that we use seven transmission trains in the transmission mechanisms 34 with one propeller, and another one transmission train with the other transmission mechanisms 34 of the other propeller, then,
It will still be a total of **eight** transmission trains,
In this case:
The rotational speed of each of both shaft 36 and generator rotor 82 is:
$6 \cdot 5^7 = 6 \cdot 78{,}125 = 468{,}750$ RPM (operated by seven transmission trains).
The rotational speed of each of both shaft 38 and generator stator 90 is:
$6 \cdot 5 = 30$ RPM (operated by one transmission train).
Hence, the relative speed of rotation is: 468,750 RPM + 30 RPM = **468,780 RPM**. (SR = 1:78,130).

This is still much lower than 2,437,500 RPM (SR = 1:406,250).that comes in my system, and also still much lower than 2,343,750 RPM (SR = 1:390,625).that comes in a system with a static stator, when all systems are using the **eight** transmission trains.

It can be seen that the system of **McCombs** achieves lower results - in terms of increasing the speed ratio and relative speed of rotation between the stator and rotor of a generator - than the results of a system that uses a static stator or rotor, and that both the system of **McCombs** and the system that uses a static stator or rotor achieve lower results than the results that my system achieves.

Comparing US 8536726 B2 (Wadehn) to my system:

I am going to calculate the area of transmissions materials that are needed for the operation of each of the systems of **Wadehn** and my system, I am going to compare the results and I am going to prove that my system uses less area (which leads to less size, volume, weight and cost) than **Wadehn**, while still producing either the same or higher range of speed ratio (gear ratio) than **Wadehn**, where higher range of speed ratio provides higher relative speed of rotation between counter-rotating stator and rotor of the generator.

For the calculations I will use a method that will allow to make a decent comparison between the systems. I will draw some illustrations of the models and will make the calculations on them.

For the comparing, I will use four basic assumptions, which are:

1. The number of transmission trains is two;
2. The perimeter of the smallest gear wheel cannot be below 10 centimeters for instance (Radius = 1.59154943091895 centimeters);
3. The speed ratio (gear ratio) of one transmission train is 1:2;
4. The speed ratio (gear ratio) of the other transmission train is 1:2.5;

Based on the above assumptions - I will make the calculations for the perimeter of each of the rest of the wheels, then, calculate the radius and the area of each of the wheels, and then, sum the area of the wheels in each system, and then, compare the results.

In order not to complicate, then, the drawings will not show the turbine propeller and the counter-rotating stator and rotor of the generator.
Also, the calculations will not take into account the thickness of all the wheels, only their area, and will not include the area / thickness of the belt and the prominent margins of the outer rim.

The comparing will be presented in the next two pages.

- **The first comparing** - is for the case where **Wadehn** uses four planet gears (total of six wheels), as in his Description, Drawing and Claims.

- **The second comparing** - is for a case where if **Wadehn** would had used only one planet gear (total of three wheels) instead of his original four planet gears.

A third comparing with slightly different assumptions will be presented after the first and the second comparing.

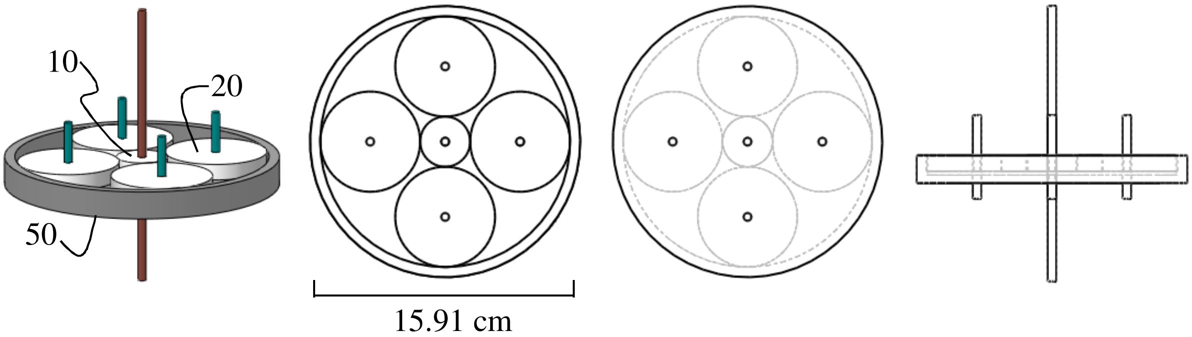
All the models in the following drawings are in the same equal scale, and, the biggest wheel (painted in GRAY) in each of the models is the one who is rigidly attached to and rotated by the input power source, and, it is also the one who motivates the rest of the wheels.

<u>**Wadehn** system - in compare to my system</u>:

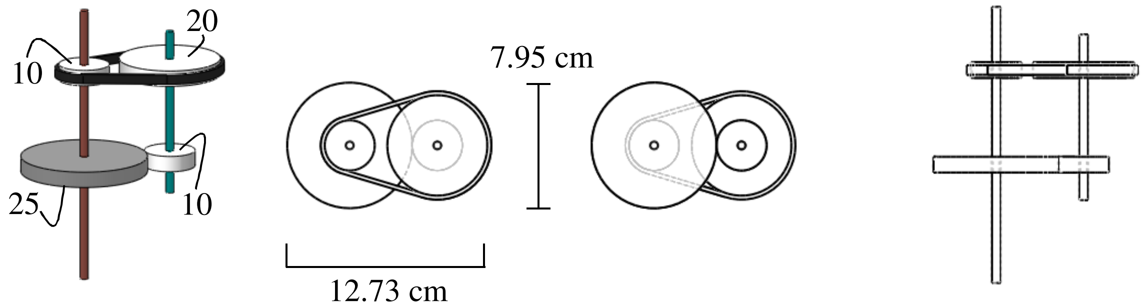
When the smallest wheel is with a 10 cm perimeter, and the gear ratios are 1:2 and 1:2.5, then:
Wadehn system will use one wheel with a 10 cm perimeter, another four planet wheels with a 20 cm perimeter each, and another one wheel including an outer rim with a 50 cm perimeter.
My system will use two wheels with a 10 cm perimeter each, another one wheel with a 20 cm perimeter, and another one wheel with a 25 cm perimeter.

3D | TOP | BOTTOM | RIGHT

<u>Wadehn</u>:



<u>My System</u>:



My System	**Perimeter = 2πR**	**Radius = R**	**Area = πR²**
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 10	10	1.592	7.958
Wheel 25	25	3.979	49.736
			97.482

Wadehn	**Perimeter = 2πR**	**Radius = R**	**Area = πR²**
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 20	20	3.183	31.831
Wheel 20	20	3.183	31.831
Wheel 20	20	3.183	31.831
Wheel 50	50	7.958	198.944
			334.225

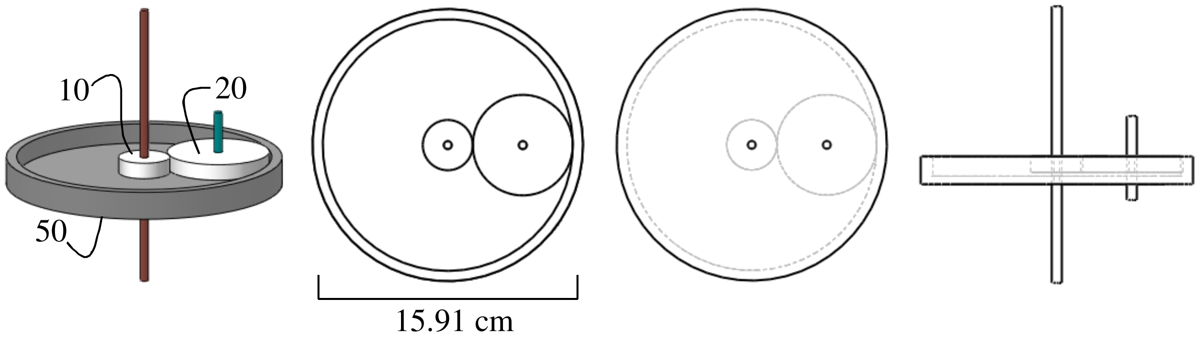
It can be seen that the total area of all the four wheels in my system is **97.482**, while the total area of all the six wheels in **Wadehn** system is **334.225**, which is more than three times bigger than in my system. This is one improvement. Furthermore, if I increase the perimeter of my wheel 25 into 40 for instance - which will change my total area from 97.482 into 175.070 - which is still less total area than the 334.225 of **Wadehn** - then, I can even achieve much higher overall speed and gear ratio than **Wadehn**, because that my gear ratios will then be 1:2, and another one with 1:4 instead of 1:2.5, and this is another improvement.

Wadehn system (*) with only one planet wheel - in compare to my system:

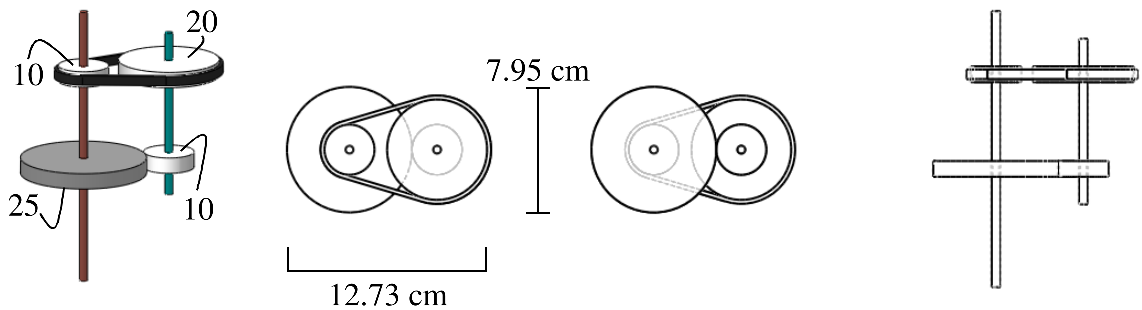
(*) In this comparing, I will use for **Wadehn** only one planet wheel instead of his four.
When the smallest wheel is with a 10 cm perimeter, and the gear ratios are 1:2 and 1:2.5, then:
Wadehn system will use one wheel with a 10 cm perimeter, another one planet wheel with a 20 cm perimeter, and another one wheel including an outer rim with a 50 cm perimeter.
My system - as in the comparing before - will use two wheels with a 10 cm perimeter each, another one wheel with a 20 cm perimeter, and another one wheel with a 25 cm perimeter.

3D	TOP	BOTTOM	RIGHT

Wadehn (*) - with only one planet wheel:



My System:



My System	**Perimeter = 2πR**	**Radius = R**	**Area = πR^2**
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 10	10	1.592	7.958
Wheel 25	25	3.979	49.736
			97.482

Wadehn (*)	**Perimeter = 2πR**	**Radius = R**	**Area = πR^2**
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 50	50	7.958	198.944
			238.732

It can be seen that the total area of all the four wheels in my system is **97.482**, while the total area of all the three wheels in **Wadehn** system (*) is **238.732**, which is more than twice bigger than in my system. This is one improvement as before. Also, and as before, if I increase the perimeter of my wheel 25 into 40 for instance - which will change my total area from 97.482 into 175.070 - which is still less total area than the 238.732 of **Wadehn (*)** - then, I can even achieve much higher overall speed and gear ratio than **Wadehn**, because that my gear ratios will then be 1:2, and another one with 1:4 instead of 1:2.5, and this is another improvement.

<u>Third comparing between Wadehn system to my system</u>:

In continue with my two previous comparing between **Wadehn** system to my system, I am going to make now a third comparing of calculating the total area of transmission materials that are needed for the operation of the different systems, when this time my system uses in one of my transmission trains a planetary structure instead of a belt for instance, in order to still achieve a co-rotation in this transmission train.

Using planetary gears is supported by my Specification.

I am going to prove that my system can use less area (which leads to less size, volume, weight and cost) than **Wadehn**, <u>and</u> at the same time to produce higher range of speed ratio (gear ratio) than **Wadehn**, and even if **Wadehn** would had used only one planet gear (total of three wheels) instead of the four planet gears (total of six wheels) that are in his Specifications.

However, in this comparing, and specifically for my system, some further calculations and adjustments need to be done, since not all the four original assumptions that were written regarding the previous first and second comparing between **Wadehn** system to my system can still be in place, and this is because that the fourth assumption which speaks about a gear ratio of 1:2.5 in one of the transmission trains needs to be change into a ratio of 1:4, in order to fit into the planetary structure with the other ratio of 1:2 and to allow the other three assumptions to still be in place. (**)

What will be seen in the comparing on the next page in the illustration of my system is that the perimeter and so does the area of the wheel that includes the outer rim in my first transmission train had been reduced into 40 cm perimeter - with respect to the wheel that includes the outer rim in **Wadehn** which is 50 cm perimeter - where this is one improvement, while together with it, the gear ratio of that first transmission train had been increased from 1:25 into 1:4, and this is another improvement.

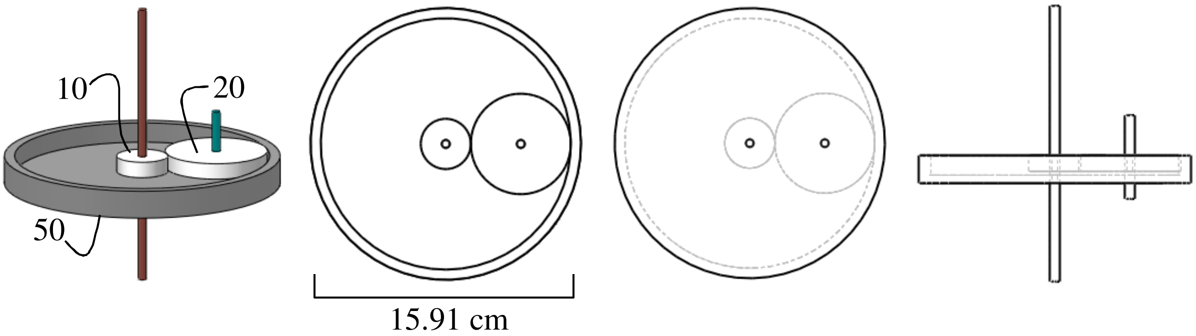
(**) In my following illustration of my system on the next page, in my first transmission train - I could have used a 50 cm perimeter as **Wadehn** uses in the wheel that includes the outer rim - instead of the 40 cm perimeter that I am using - to be meshed with wheel (10), while together with that, in my second transmission train - to set apart the two wheels (20) and (10) from each other and to connect them by cross belt for instance to still create the needed counter-rotation between the two wheels (20) and (10). If I had done that, then, the total overall speed ratio (gear ratio) in my system would have "jumped" dramatically since it will involve ratios of 1:2 and 1:5, instead of ratios of 1:2 and 1:2.5, which is very good, but, on the other hand, it will increase the total area of my system, more than the "thin" version of **Wadehn (*)** (although it will still be less than his original structure with the 6 wheels), so, it is not a very good example to use because that I will need to decide what is more important - the total ratio or the total area. So, I decided to use an example that will give a definite conclusion, which will improve both the total ratio (increasing it) and the total area (decreasing it), with respect to the "thin" version of **Wadehn (*)**.

Wadehn system (*) with only one planet wheel - in compare to my system:

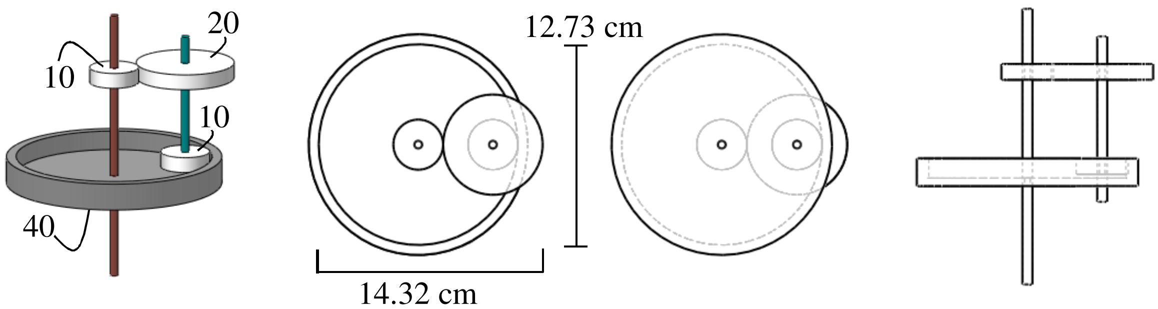
(*) In this comparing, I will use for **Wadehn** only one planet wheel instead of his four.
When the smallest wheel is with a 10 cm perimeter, and the gear ratios are 1:2 and 1:2.5, then:
Wadehn system will use one wheel with a 10 cm perimeter, another one planet wheel with a 20 cm perimeter, and another one wheel including an outer rim with a 50 cm perimeter.
My system will use two wheels with a 10 cm perimeter each, another one wheel with a 20 cm perimeter, and another one wheel including an outer rim with a 40 cm perimeter, such that the gear ratios in my system will be 1:2 and 1:4, instead of 1:2 and 1:2.5 as in **Wadehn**.

3D | TOP | BOTTOM | RIGHT

Wadehn (*) - with only one planet wheel:



My System - with a planetary structure:



My System	Perimeter = $2\pi R$	Radius = R	Area = πR^2
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 10	10	1.592	7.958
Wheel 40	40	6.366	127.324
			175.070

Wadehn (*)	Perimeter = $2\pi R$	Radius = R	Area = πR^2
Wheel 10	10	1.592	7.958
Wheel 20	20	3.183	31.831
Wheel 50	50	7.958	198.944
			238.732

It can be seen that the total area of all the four wheels in my system is **175.070**, while the total area of all the three wheels in **Wadehn** system (*) is **238.732**, which is bigger in more than 36% than in my system. This is one improvement. Also, I will even achieve higher overall speed and gear ratio than **Wadehn**, because that my gear ratios are 1:2 and another one with 1:4, instead of 1:2 and 1:2.5 as in **Wadehn**, and this is another improvement.