

Glass Tumbler – Explanation, Troubleshooting & Maintenance Guide

This machine is a **glass tumbler**. It slowly rotates a drum filled with glass so the glass becomes nice and smooth for reuse and recycling.

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1. How to use the Tumbler

Check the Tumbler Quick Start Guide. If it no longer is hanging at the site, scan the QR code or click on one of these links to access it:

English version:

<https://drive.google.com/file/d/1TQ18JokD9Fe5hBM TUtoVwROxLkmiMObd/view?usp=sharing>



Chichewa version:

<https://drive.google.com/file/d/13uOljStJgG59sIY-auy 8T9FL2mMn2Uus/view?usp=sharing>



2. Troubleshooting Guide

Problem: Motor Does Not Turn

Possible Cause	Signs	Solution
Not enough sunlight	The voltage shown on the output for the motor is far below 24V, and the voltage shown for the solar panels is far below 40V	Tilt the solar panel to a better angle Add the second solar panel Wait for there to be sun
Circuit breakers turned off	They are in the “green” position	Turn all three of them to the “red” position. If the breaker switches off immediately again, suspect mechanical obstruction or electronics fault.

<p>Power switch not turned on</p>	<p>The switch is in the off (O) position. There is no value displayed for the speed percentage</p>	<p>Turn the switch to the I (on) position</p>
<p>Speed adjustment knob not turned up</p>	<p>There is no value displayed for the speed percentage</p>	<p>Rotate the knob until there is a value displayed, and then until it reaches 70%</p>
<p>Bad MC4 connection between the electronics box and the solar panels</p>	<p>There is no sound coming from the DC DC converter's fan, and none of the lights are on in the electronics box</p>	<p>Check all the MC4 connections by pulling on them. If one comes loose, it's a bad connection. Remove all dirt, debris and water from the inside and reconnect.</p> <p>If the MC4 connectors are completely bad and cannot be saved, check the chapter in this document on replacing MC4 connectors.</p>
<p>Mechanical obstruction (jammed drum or chain)</p>	<p>With power OFF, manually rotate the drum or motor shaft — it should move smoothly. If it doesn't, there might be some jamming happening.</p>	<p>Inspect the drivetrain and see if you can see where it is jamming. Inspect the chain and sprockets for misalignment or debris.</p>
<p>Loose connection in electronics box</p>	<p>Some displays don't show anything although they should.</p>	<p>Inspect all red (+) and black (-) connections. Make sure every wire is fully seated and screws or terminals are tight. Pull on the cables to see they are properly connected. The connection that is most likely to fail is between the circuit breakers. To fix that, put the cable pack in and use a screwdriver to tighten the screw. Check connections to the motor, motor controller, and DC-DC converter.</p> <p>Loose wires can cause intermittent or no power. Simply reconnecting or tightening often fixes the problem.</p>

One of the electronic components is broken	Look for burnt smell, discoloration, or damaged components. If all wires are tight but the motor still does not turn, the DC–DC converter or motor controller may be faulty.	Contact Emma (+41 76 483 20 00) to organize a replacement. These parts can't be bought in Malawi and have to be imported.
Blown Fuse	There is no sound coming from the DC DC converter's fan, none of the lights are on in the electronics box, and all of the other connections seem fine. When you remove the fuse, you can see that the wire was burnt through.	Remove the tape from the top of the fuse protection box and remove the fuse. Find someone who knows how to solder a new 10A fuse (they are very cheap to buy). Fuse supplier in Blantyre: Fashion world (+265 999 84 52 90)
Motor itself is broken	Everything else seems to be working fine, this is the only possible option	Replace the motor with the replacement motor. To do so, you need to attach the sprocket to the new motor, and re-do the fine adjustment of the chain. Maurice (+265 892 70 90 52) knows how to do that.

Problem: Motor Turns but the tumbler does not

Possible Cause	Signs	Solution
The weld between the sprocket and the shaft has likely broken	If the chain is moving but the tumbler isn't	Contact Kadulo the welder for help fixing this: +265 999 28 58 54
The sprocket that is attached to the motor has become loose	If the chain is not moving	The screw attaching the sprocket to the motor shaft must be tightened

Problem: The chain is making excessive noise

Cause	Solution
<p>The chain is touching the metal beam during rotation because the tumbler has “slid back” too far.</p>	<p><u>Short term:</u> empty the tumbler and while you are doing so, shake it. This will make the tumbler “slide” back away from the back plate. <u>Long term:</u> There is a small wheel that keeps the tumbler from sliding back too far. If it still does, then the position of this wheel needs to be adjusted (needs to be slid further forwards)</p>
<p>The chain isn’t aligned nicely</p>	<p><u>Short term:</u> Clean and lubricate the chain. <u>Long term:</u> Loosen the motor screws and adjust the motor position so that the chain is perfectly aligned again.</p>
<p>The chain tensioning plate is vibrating</p>	<p>A small amount of vibration is normal and comes from the imperfections in alignment of the device. Only try to address this issue if the vibration becomes excessive. Adjust the position of the chain tensioner. Clean and lubricate the chain.</p>
<p>The chain is too loose or too tight</p>	<p>Adjust the position of the chain tensioner</p>
<p>The rubber bit from the chain tensioner has been completely worn off, and now the chain is rubbing against the screw</p>	<p>The rubber bit needs to be replaced. It wearing off is a natural part of the process. It’s fine if it’s just rubber, but the chain rubbing against metal is not good, because the metal bits can get clogged in the system and cause further damage.</p>

3. Preventive Maintenance

Regular Inspection (Every Use)

- Visual check of chain alignment
- Listen for unusual noises

Weekly Maintenance

Clean chain and sprockets

Mainly you need to clean the rubber particle buildup from the chain tensioner.

Use the dual toothbrush chain cleaning tool to do this while slowly rotating the tumbler.



Lubricate chain

Slowly add a small amount of automatic transmission fluid (ATF) to the chain
Do NOT use the grease. This is way too thick.



Lubricate wheels

Add some of the grease to the three wheels that are constantly rotating (two in the front of the tumbler and one at the back).

Check chain tension

If it seems far too low, adjust the chain tensioner.

Note that since this drivetrain is motor operated (which means it always moves smoothly), the chain tension doesn't need to be perfect. A slightly loose chain works fine too.

Check all the nuts and bolts

Especially those in the bearings.

If any are loose, tighten them using a 13 mm spanner as well as the 13 mm socket wrench (from the socket wrench set).



If there are any that keep coming loose, put some epoxy glue in the nut before re-attaching the nut. Keep in mind that then this will be secured in place and will not be easily removable at all. Only do this for bolts you know you don't want to ever remove.

Monthly Checks

- Check for bearing play in motor and drum
- Inspect sprocket teeth for wear

4. Detailed System Description

High-Level Description

The glass tumbler is a solar-powered rotating drum system designed to tumble glass to create nicely smoothed sea glass for reuse and recycling.

The system has five functional stages:

1. Solar panels -> generate electricity
2. Electronics box -> stabilizes and controls the electricity
3. Motor -> converts electrical to mechanical energy
4. Chain -> transmits the power from the motor to the drum
5. Drum with glass





Energy flow: Sunlight → Electrical energy → Controlled electrical energy → Rotational motion → Drum rotation

A problem in any stage affects all stages downstream.

Solar Panels

Solar panels convert light energy into direct current (DC) electricity. DC electricity flows in one direction.

This system has two solar panels, which can be used either individually or together.

-  /  **Sunny or partially cloudy conditions:**
One panel is often sufficient to run the drum at normal speed. One panel provides 260W of energy in ideal conditions.
-  /  **Very cloudy or rainy conditions:**
Two panels should be connected to provide enough power. Two panels provide 520W of energy in ideal conditions.

The drum requires around 70W of energy to rotate when it is filled. However, cloud cover *drastically* reduces the output. Remember that the solar panel ratings are in perfect conditions with full sunlight, so don't be shocked when the 260W panel doesn't even provide 70W.

A key thing to understand is that the solar panels do *not* produce a fixed voltage. The voltage and power produced depends on the available sunlight. In good sunlight, the panel voltage is typically above 40 V. When sunlight weakens or the drum load increases, this voltage drops.

Because the system has no battery, it reacts immediately to weather changes. Slower operation or stopping under clouds is normal behavior, not a fault.

⚠ Keep panels fully exposed to the sun whenever possible. Even a small shadow on a solar panel can drastically reduce its power output. Shaded sections act like a block as they stop electricity from flowing through the entire panel.

Solar Panel Fuses

Each solar panel cable includes a fuse, housed inside a small protective container (repurposed shampoo bottles).



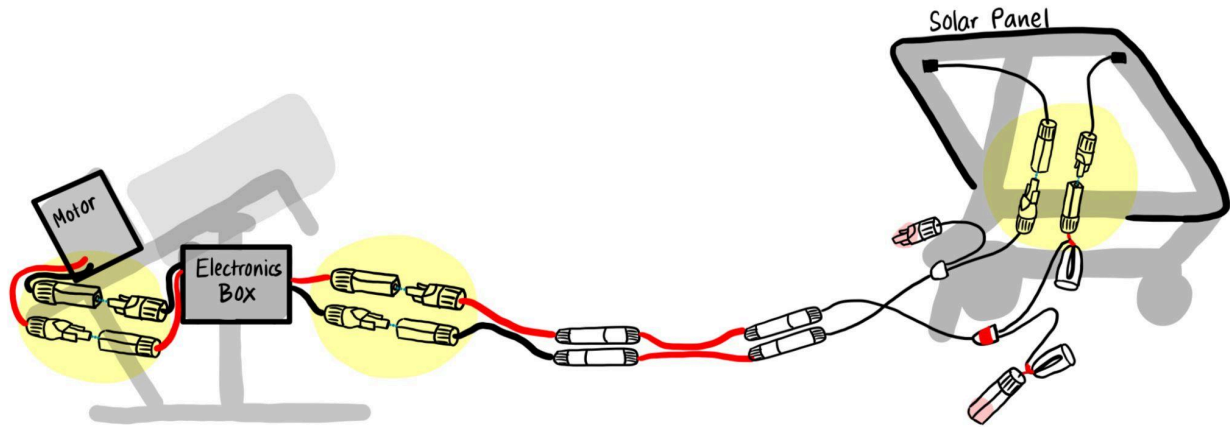
A fuse is a deliberate weak point. If too much current flows, the fuse melts and breaks the circuit before wires overheat or components are damaged.

It is critical that the **fused solar cables are always used**. Using unfused cables removes this protection and creates a real fire and damage risk. If a fuse blows, it must be replaced with one of the same rating — never bypassed.

Cabling

With just one solar panel, there are three connections that need to be made:

- Motor to electronics box
- Electronics box to fused cables
- Fused cables to solar panel



The fused cable ends also have two ends for adding another solar panel, but if these are not used, it's best to cover them with electrical tape for protection (so no dust, dirt or water gets inside).

With two solar panels, there are four connections that need to be made:

- Motor to electronics box
- Electronics box to fused cables
- Fused cables to solar panel 1
- Fused cables to solar panel 2

Black and Red Wires

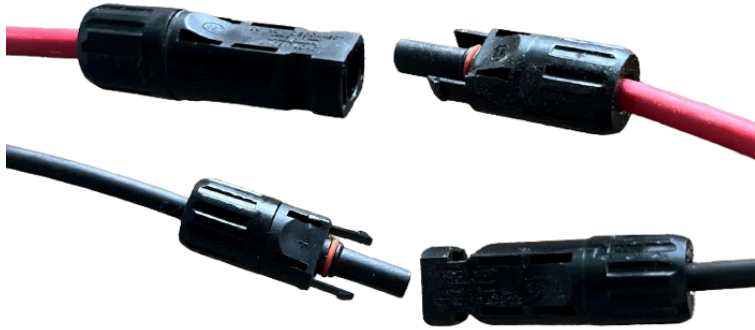
Every electrical connection in this system uses **two wires**:

- **Red cable** = positive (+)
- **Black cable** = negative (-)

The coloring of the cables is consistent in the electronics box and for the motor. For the solar panel, both cables are black (although the + side has some red electrical tape on it to distinguish it). For part of the extension cable, both + and - are red because that was the cable that I could find.

Electricity must always flow in a **closed loop**. It leaves the red wire, passes through a device, and returns through the black wire. If that loop is broken or weak (loose connection, corrosion, wrong cable), the system will behave unpredictably.

MC4 Connectors



The solar panels are connected to the electronics box using MC4 connectors. These are the standard connectors used in solar systems and are designed to be safe, reliable, and weather-resistant.

How to connect MC4 connectors:

1. Check the connectors for dust, debris or moisture inside, and remove
2. Align the male and female connectors
3. Push them together firmly
4. You should feel and hear a **click** when they lock. A properly connected MC4 plug cannot be pulled apart by hand. It should feel solid, not loose or wobbly.

MC4 connectors are designed to be connected and disconnected only when there is no load.

⚠ Always turn the system **OFF** at the circuit breakers before connecting or disconnecting MC4 connectors

⚠ Never disconnect MC4 connectors while the motor is running. That can be very dangerous.

How to replace MC4 connectors:

1. Collect all the necessary tools:
 - a. Crimping set (left)
 - b. MC4 connector (middle)
 - c. Wire stripper (right)
 - d. Wire cutter (not pictured here)

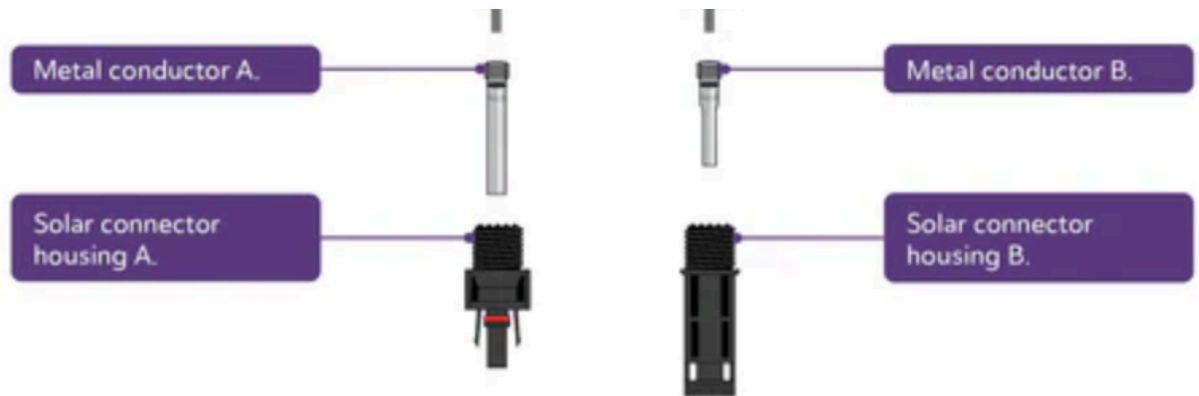


2. Cut off the old MC4 connector that doesn't work anymore. Remember on which wire there was the female connector and on which wire there was the male connector.



3. Strip the insulation from the wire using the wire stripper. The wire stripper doesn't work great for such thick wires, you may also want to use some knife to help. Just make sure that you don't cut off the metal wires; only the insulation.
4. To crimp on the connectors, it's best to watch a tutorial, like this one: <https://youtu.be/YFAKK491wj0?si=pFSx48pVghkL1dWs&t=75> .

The most important part is that you match the correct metal conductors to the solar connector housings.



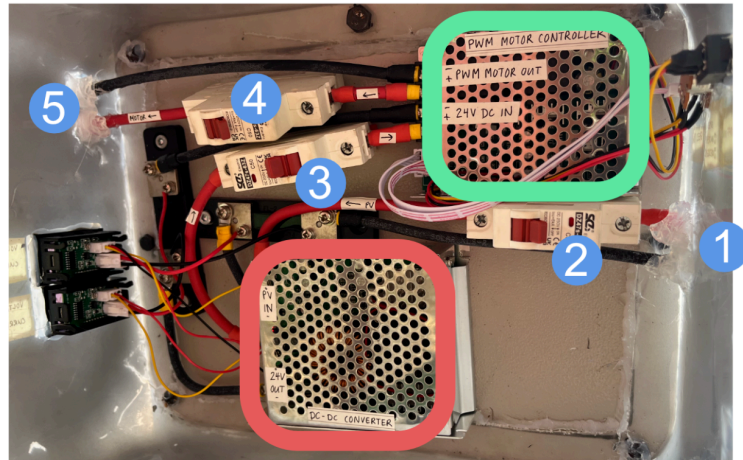
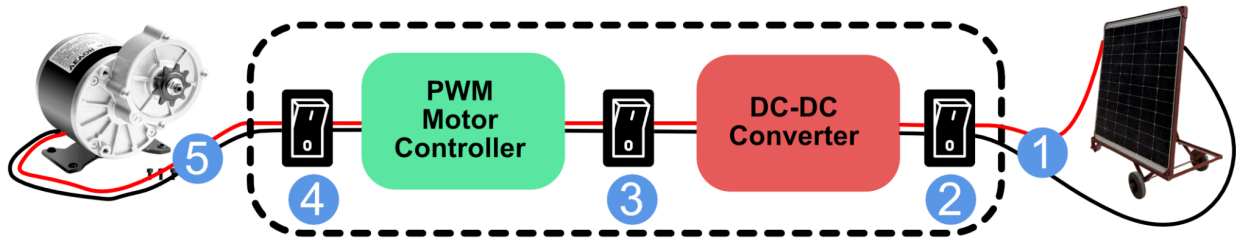
For the crimping, use the “open barrel terminal” 4-6 size.

5. Fully tighten the plastic end cap to secure the housing in place.

Electronics Box

This box is the heart of the system: it receives power from the solar panels, protects the system from damage, controls voltage and speed, and sends power to the motor.

⚠️ ALWAYS protect electronics from moisture and rain. Water can cause short circuits and damage electronics. The electronics box is a protective cover, but it is not fully waterproof (there are some holes that could not withstand the torrential Malawian rainfall). If it suddenly starts to rain heavily, remove the electronics box and place it inside the office, or cover it with a big plastic bucket.



Circuit Breakers

Circuit breakers are automatic safety switches inside the electronics box (see 2, 3, 4). When switched to the “red” position, they allow power to flow. If the current becomes too high, they trip and disconnect power.

When switched to the “green” position, they don’t allow power to flow. It’s good practice to always switch them to the green position when the tumbler isn’t being used.

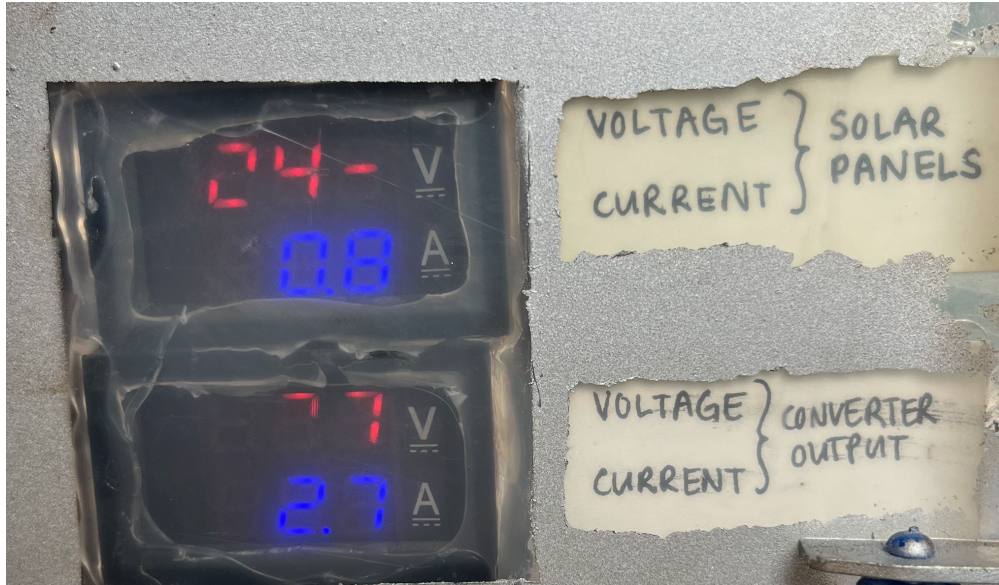
It’s especially important to switch them to the green position before disconnecting the MC4 connectors.

If you ever turn on the motor and nothing happens, always check the circuit breakers. It’s easy to forget that they might still be in the “green” position.

DC-DC Converter

The voltage coming from the solar panels is too variable and too high to power the motor directly. The DC-DC converter takes this unstable input and produces a controlled output voltage.

The left side of the electronics box contains a display that shows both the input voltage (from the solar panels) and the output voltage that the DC DC converter produces.



These numbers tell you a lot about what the system is doing.

- Input (solar panels): typically above 40 V in good sun
 - Solar voltage dropping toward or below 24 V means there is not enough power available
- Output (to motor controller): 24 V nominal
 - 24 V (or slightly below) indicates normal operation
 - Output above 24 V is not good for the motor. It indicates the DC–DC converter is set too high and must be adjusted.
 - Output significantly 24 V means insufficient power, not a fault

Before assuming something is broken, always look at this display.

The converter includes an adjustment screw. Turning this screw changes the output voltage. Under normal operation, this should be set to 24 V, and shouldn't change.

The DC DC converter can handle 1000 W of input, so you should not worry about it breaking due to overload. It can get hot during operation, which is why it has a fan. Whenever you connect the solar panel to it, you should be able to hear the fan (which means it is working properly). To enable proper cooling, it's good practice to remove the lid from the electronics box for increased air flow.

PWM Motor Controller

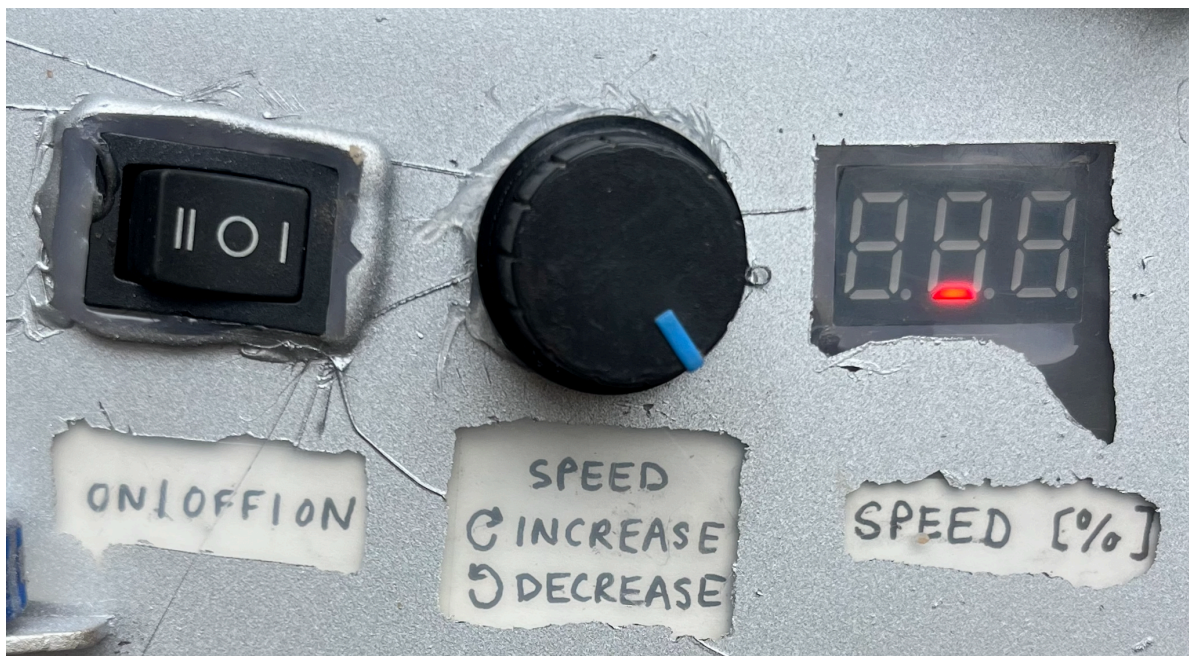
The motor controller controls how fast the motor turns. It does this using a method called Pulse Width Modulation (PWM). Instead of lowering the voltage smoothly, the controller switches the 24 V supply on and off very quickly. By changing how long the power stays on during each cycle, it controls the average power delivered to the motor. The speed knob simply adjusts this on–off ratio.

On the right side of the electronics box, there are the controls.

The on/off switch has three positions:

- **II: on**, rotating backwards. This position is not good for the chain, so please avoid it. You will notice that the tumbler starts making weird sounds if you turn it on in this position.
- **O: off**
- **I: on**, rotating the correct way.

The knob adjusts the speed, which is displayed on the right. For normal tumbling operation, turn the dial until the speed display shows 70%. The fastest the motor can spin is 100%.



How to Charge your Phone

Since the tumbler only needs 70W to run, when there is enough sun, there is extra power from the 260W solar panel to also charge devices.

Motor

The motor used is a 350W vevor e-bike motor with an attached planetary gearbox. The motor itself spins at a very high speed, and the gear box reduces it by a factor of 10x so it can power the tumbler.

Since the drum needs around 70W of power to rotate, the motor is more than powerful enough to run the tumbler (5x more!), even when completely filled. You do not need to

worry about the motor not being able to turn the drum. If the drum doesn't turn, there just isn't enough sunlight, it is not a motor limitation.

⚠ The motor gets very hot during operation. This is normal, as not all energy is perfectly converted. The remaining energy is lost as heat due to internal resistances, magnetic losses, and friction.

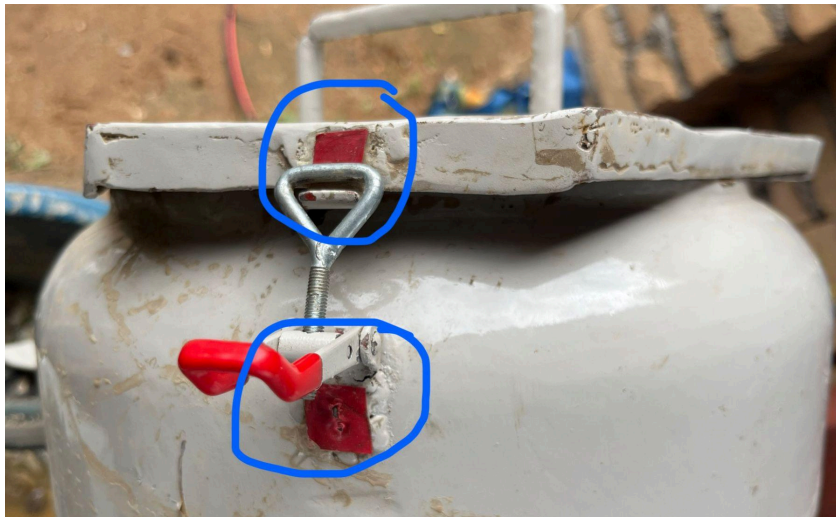
Tumbler

Tumbler Lid

Closing the Tumbler Lid

The lid has three toggle hatches that are used to securely attach it to the tumbler. Because it is not perfectly symmetrical, the lid only fits on nicely in one way.

To identify the correct orientation of the tumbler lid, find the red mark on the lid and on the tumbler and match them up.



Sealing Replacement

In case the lid sealing starts to come off (you would notice this if it starts dripping a lot of water while running), it can be replaced with the extra door sealing that was left over (stored at the office)



Adjusting the Lid Tightness

To adjust the tightness of the lid, you can rotate the individual screws that are part of the toggle hatches. Rotating them in one way will shorten the distance and make the seal tighter. If you rotate them too far, you won't be able to close them (or if you use too much force you might break them).

Tachometer

The user manual of the tachometer can be found on this website:

<https://www.decathlon.co.uk/p/second-life-120-wireless-cyclometer-good/346167-C/m8799862-C>

(scroll down to “usage and care” and click on “download pdf”).



The purpose of the tachometer is to be able to keep track of how long glass has been tumbling. Tracking the time on its own is not enough, since the tumbling process stops whenever there is a cloud coverage. Hence, turning the tumbler on for 10h on a sunny day doesn't lead to the same amount of tumbling as if you turn it on for 10h on a cloudy day.

So, to keep the tumbling process consistent, the tachometer keeps track of the **TOTAL ROTATIONS**. This is a more accurate measure of the tumbling process. Since it is a tachometer originally made for bikes, it shows this in the number of total kilometers ridden.

Before every batch, when this value is reset, it will start measuring the “distance” that the tumbler runs.

Speed and Tumbling Duration

⚠ To achieve a good tumbling performance, the tumbler should be run for at least 10 hours at a speed of 70%. This is equivalent to 64km displayed on the tachometer.

It is the same as running the tumbler for ONE FULL DAY on a sunny day, and around TWO FULL DAYS when there are a lot of clouds.

Full Sun Tumbling Time (h)	Distance (km)	Total Rotations
10	64	25,600
12	77	30,720
14	90	35,840
16	103	40,960
18	115	46,080
20	128	51,200

Rather than keeping track of the time the tumbler has been running, keep an eye out on the tachometer.

Running it for longer doesn't harm the process (it actually further smooths the glass!). It's just that after 10 hours the glass has reached a point where it's smooth enough to use for most applications, so it's better to move on to the next batch.

If you have customers who want VERY smooth glass, tumble it for 20 hours (so 128km).

If after a full day of tumbling, it has not yet reached 64km, leave the glass in overnight and keep running it the next day until it reaches 64km.

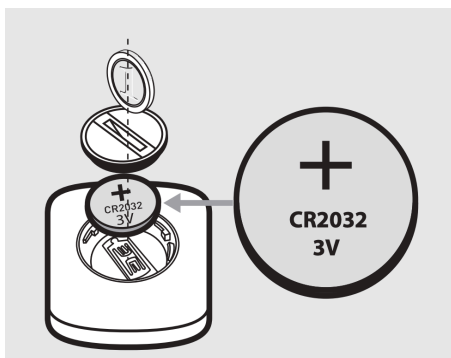


Here is a table that shows the different motor speeds and how that translates to the speed you see on the tachometer and the actual RPM (rotations per minute) of the tumbler drum:

Motor Speed (%)	Speed (km/h)	RPM
50%	4.6 km/h	30 RPM
60%	5.5 km/h	37 RPM
70%	6.4 km/h	43 RPM
80%	7.3 km/h	49 RPM
90%	8.2 km/h	55 RPM
100%	9.1 km/h	61 RPM

Tachometer Battery Replacement

When the battery runs out (which it eventually will), either get someone to replace it (CR2032 battery), or just leave it.



You can also run the tumbler without the tachometer, just make sure you run it for long enough to create smooth enough sea glass.

It will take 1-2 days depending on the weather.

6. Revision Notes

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