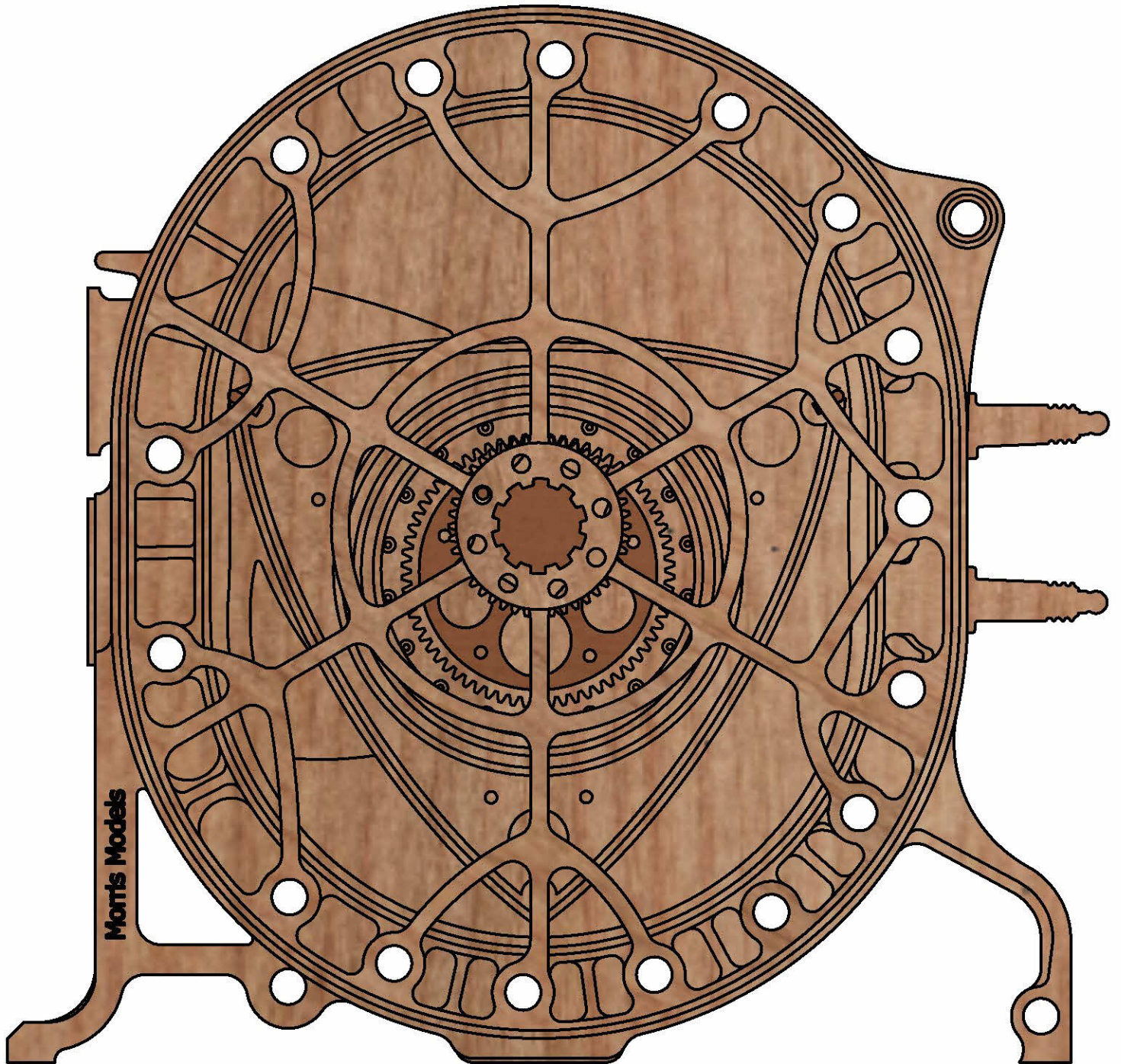


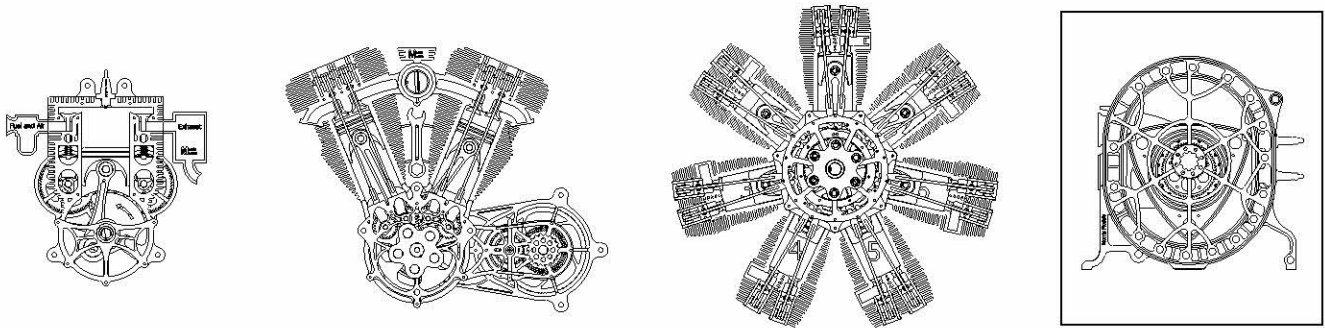
Flat Wankel

Manual

Build a stylized flattened cutaway Wankel engine to help understand and illustrate how a Wankel works.



Before you begin



Most of this kit was cut out of baltic birch plywood on a laser cutter. Plywood is a natural product, and every peice is different. Because of this, the laser cannot cut every peice perfectly. This means that in some places, there is smoke and scorching. In other places, the wood did not cut completely and there are splinters hanging on the edges. The more time you spend preparing your parts, the better your completed model will be.

You should begin by making sure that none of the parts are missing. Look over the rest of the steps in this manual, and find all the parts for each step. Check the parts to make sure that they are in good condition. Minor damage can be repaired with glue. Splinters should be removed using an X-acto type knife and sandpaper. Scorched marks can be lightly sanded off. If any parts are badly broken or are missing, you can get replacement parts from www.morrismodels.com.

Two of the parts for this kit are cut from round dowel rods. These form the engine shaft. These also should be sanded for splinters. If you have access to power tools, they can be made to look a little more realistic if you bevel the front of each shaft. The parts shown in this manual have had this done, but this step is for appearance only, and is completely optional.

This engine is designed to be assembled with any type of wood glue. I personally use Elmer's "Glue-All" glue. Do not use Elmer's "School Glue." It will not work. Whatever glue you use, use only enough glue to stick the parts together. Extra glue will squeeze out from between the parts and stick the engine together in places where it should not. Any glue that does squeeze out from between parts should be wiped up with a damp cloth while it is still wet.

Most of the plywood parts have 1/8" or 3/8" holes. These holes are to help line up the layers. As you work, try to keep the glue away from these holes. When you put on a new layer, push short dowel pins into the layers to help line them up. These are called alignment pins. You should remove the alignment pins after the glue has had a few minutes to dry.

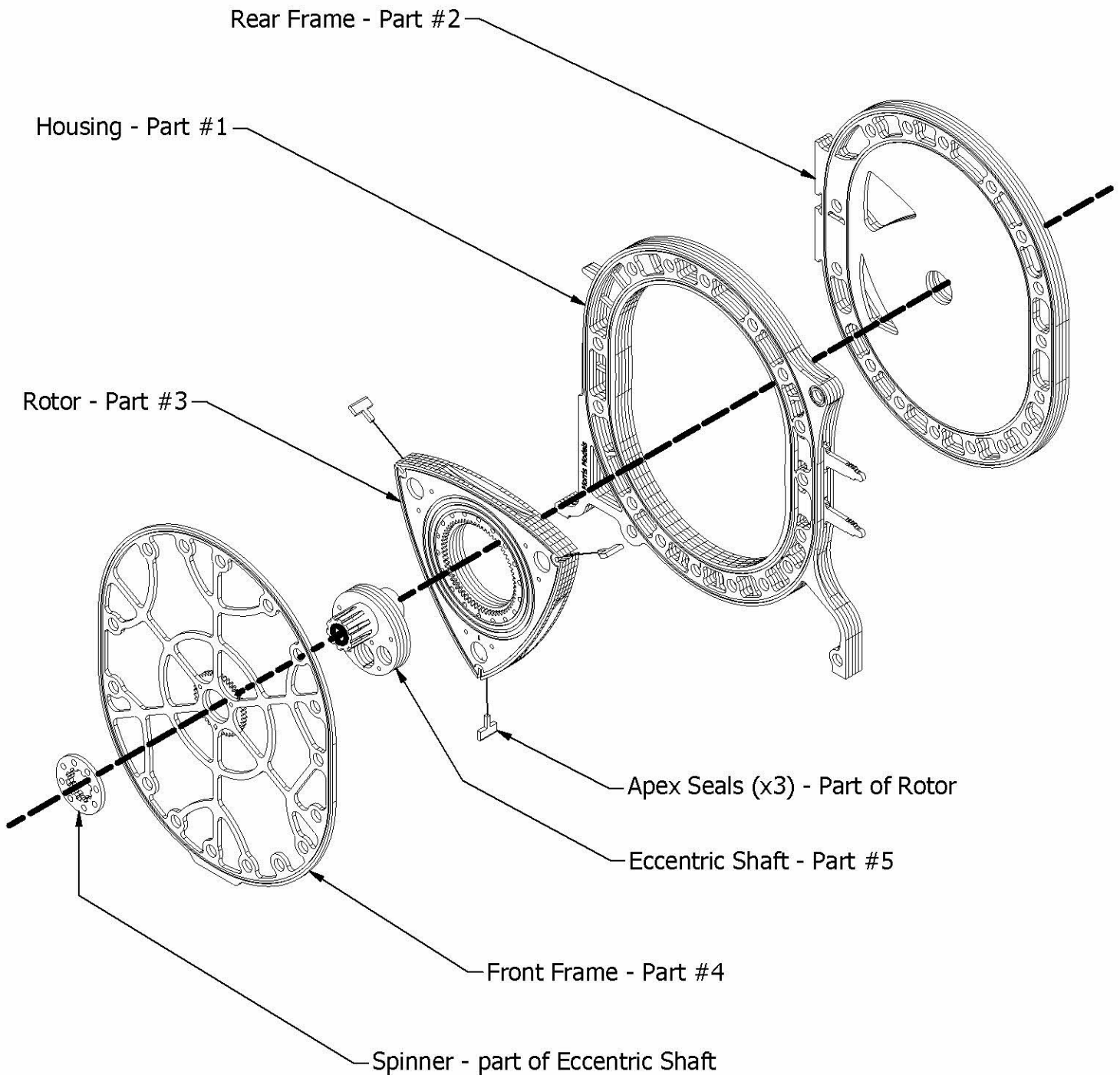
Many people ask if they can varnish, paint, or stain the engine. I do not recomend using paint or varnish, but oil-based finishes or stains are appropriate. Assemble the engine before using them. Another alternative is to use water-based markers. You can color each part before or after it is assembled. These parts absorb a lot of marker ink, so it will take quite a few markers to do the job.

Real engines use oil to keep them sliding smoothly. This wooden engine model would be ruined with oil. Most people use wax when assembling these wooden engine kits to help the parts slide smoothly. This step is optional. I have used candle wax and I have used colored crayons. Either of these will work fine. So does paraffin wax.

This manual shows how to build the engine step by step. Sometimes it is hard to explain things in a manual, but easy to understand it on a video. At the www.morrismodels.com web site, you can find a link to an assembly video that shows the same steps that are in the manual. Use this video if you prefer, or use the video to view any steps where you have trouble understanding the manual.

I hope you enjoy building this kit. If you do, you may want to consider building some of the other model kits. We have several more models available on the web site, and we add another model every few months - so check back.

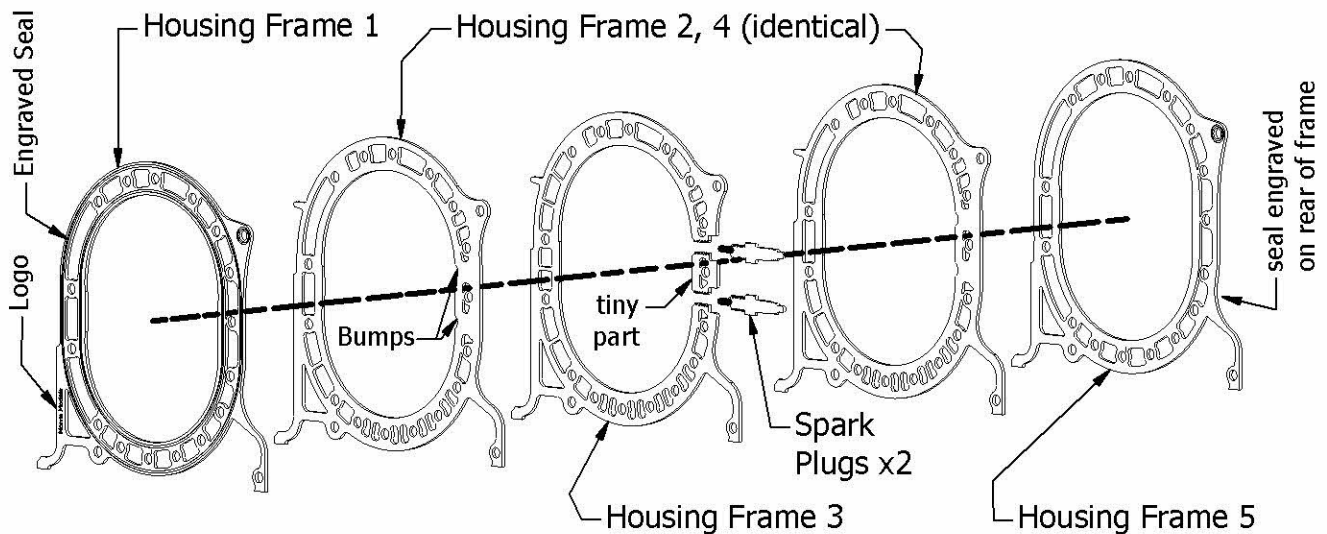
Exploded View



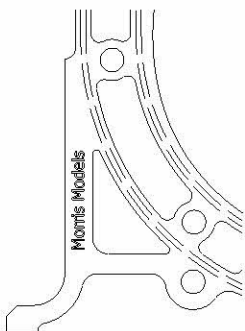
The parts shown above may be glued together, bolted together, or left as separate parts. This manual will assume that you are going to leave the engine as separate parts, which can easily be assembled or disassembled to further demonstrate the nature of the Wankel engine.

Part 1: the Housing

5 layers, 8 parts

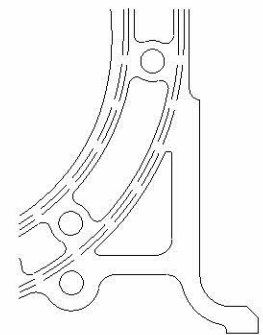


The housing of a Wankel engine has a unique shape called a trochoid. This shape can be drawn with a spirograph. Our version is liquid cooled, so it is surrounded by coolant passages. It bolts to the end frames through the round holes around the edge. Many Wankel engines contain two housings and two rotors, but our version only has one. Identify the frames as shown.

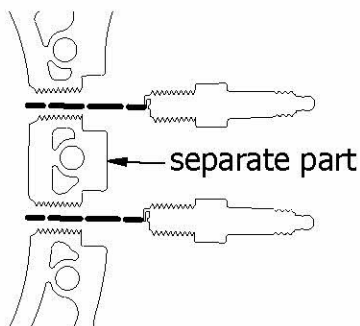


Front view, Frame 1
note seals

The front and rear housing frames 1 and 5 can be identified by the etched seals around the rims. The front frame also has "Morris Models" etched on the leg where a casting identifier would be on the real part. The etched seals on the rear frame face the back of the part, and so can't be seen in the view above, but can be seen on the right. The seals are shown in the side views as dotted lines.



Rear view, Frame 5
note seals

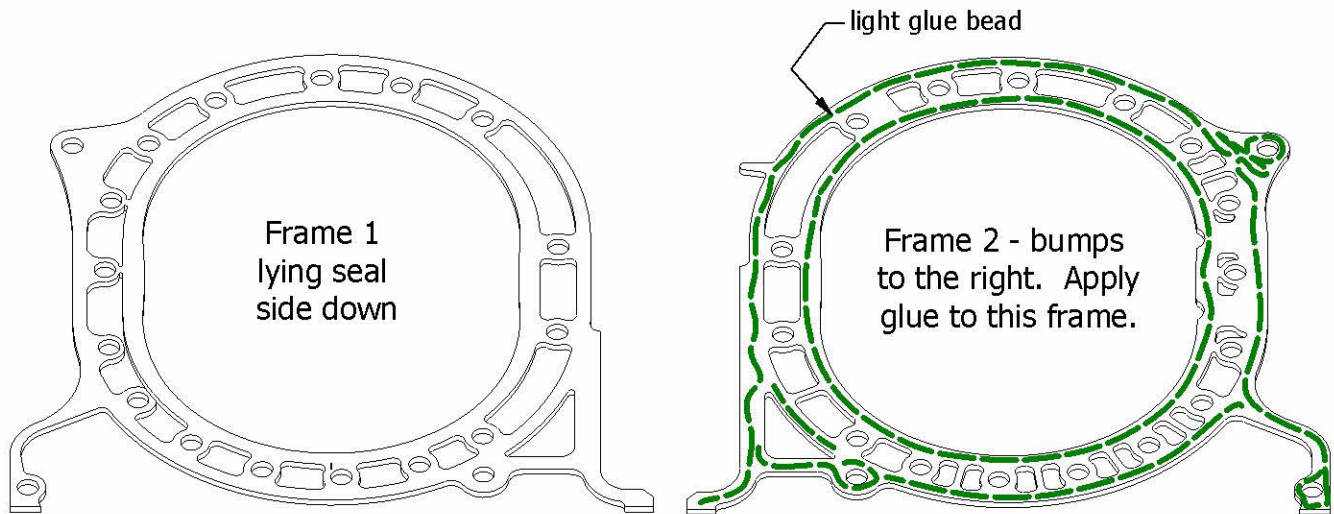


Front view, Frame 3
note spark plugs

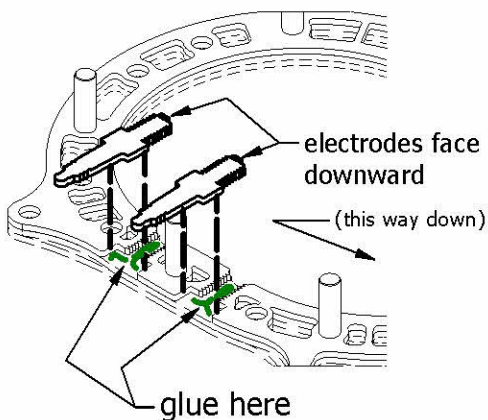
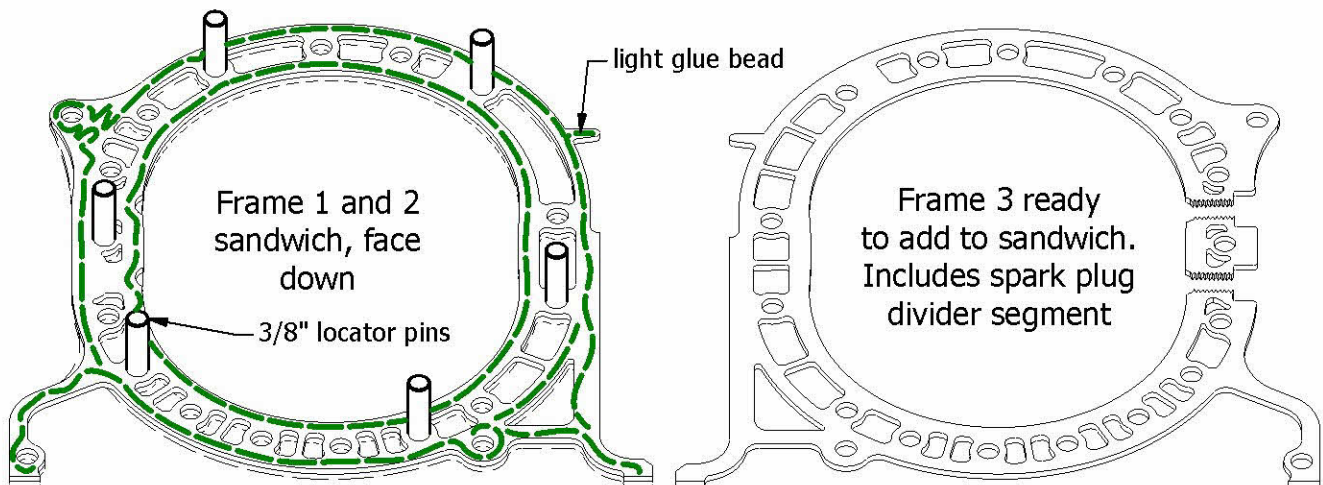
Frame 3 can easily be located by the missing section, which must be located separately. It also includes two separate spark plugs, both of which are identical. Note the direction of the electrodes on the spark plugs - they must face downwards.

Frames 2 and 4 can easily be located by the fact that they neither have engraved seals (front or back), nor do they have a section removed. They do, however, have two small bumps in the smooth surface of the trochoid - part of the spark plug cavities. These are easily seen in the top drawing.

Assemble the Housing: 1



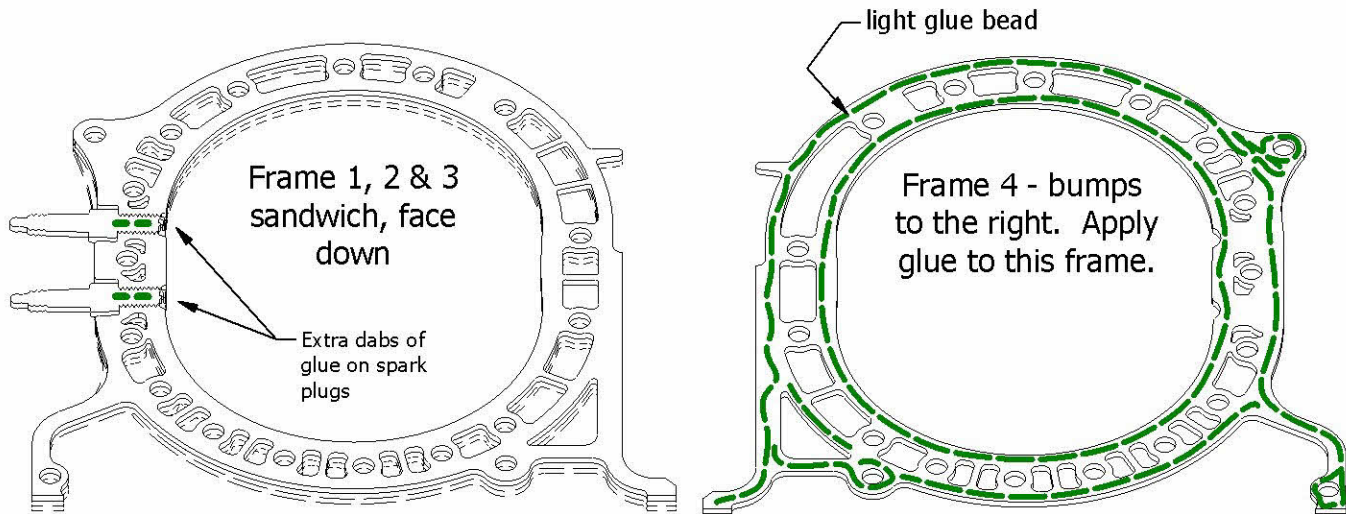
1st: Set frame 1 seal side down on the table in front of you. Set frame 2 with the bumps to the right next to it. Apply a thin bead of glue as shown. Turn frame 2 over, and press it down onto frame 1. Use several 3/8" locator pins to ensure alignment.



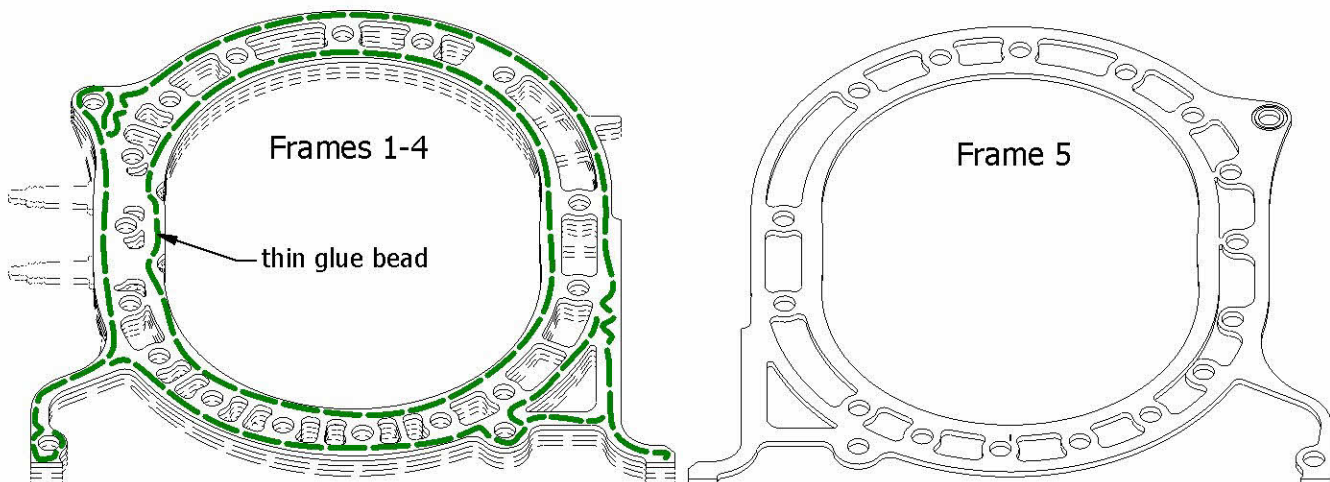
2nd: Spread a thin bead of glue on the back of frame 2 on the sandwich you just made. Take care to avoid getting the glue onto the locator pins and in the locator pin holes. Thread frame 3 over the locator pins, and add it to the sandwich. Add the spark plug divider segment as well.

3rd: Glue the two spark plugs into the sockets on each side of the segment. If the spark plug sockets are not the same size, you probably have the divider segment on backwards.

Assemble the Housing: 2



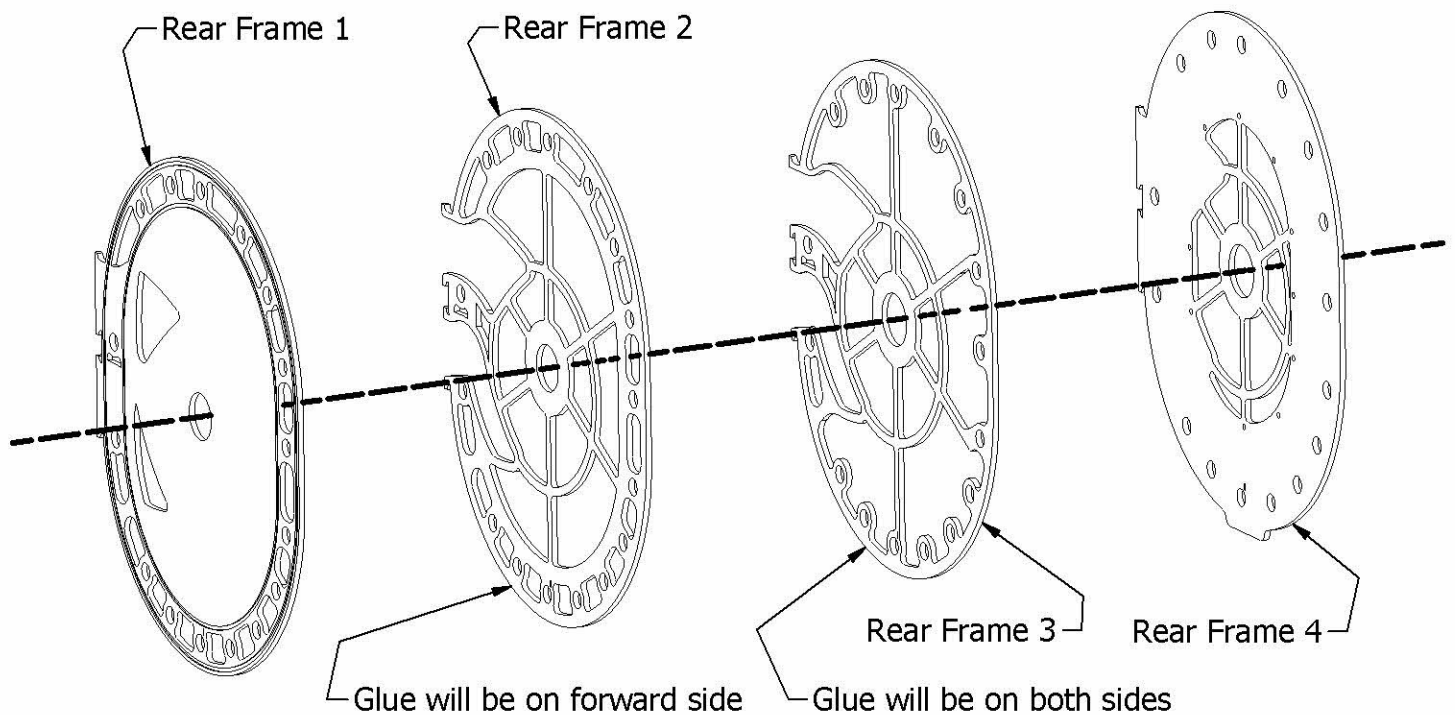
4th: Similarly to step one, set the growing sandwich face down on the table in front of you. Locate frame 4, and set it out with the bumps to the right as shown. Apply a thin bead of glue as shown. Add a small dash of glue over the spark plug barrels on the sandwich. Turn frame 4 over, and thread it over the locator pins and press it down on top of the sandwich.



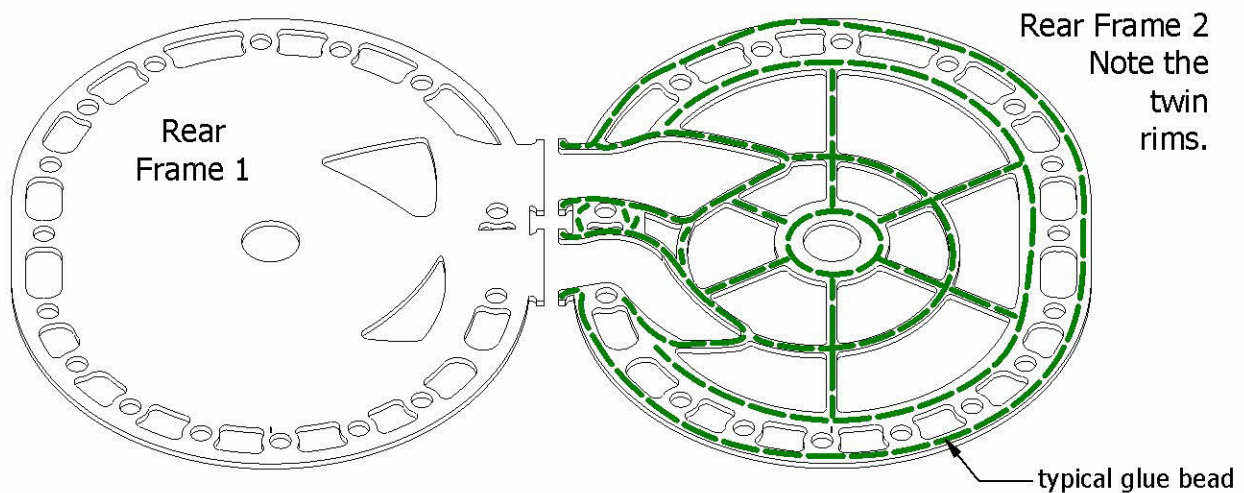
5th: Complete the housing by spreading a thin bead of glue as shown around the rear rims and legs, then threading frame 5 down over the locating pins. Examine the resulting sandwich and add clamps or weights as necessary to make sure the glue dries properly on all layers. You may remove the locator pins before the glue dries as long as you are careful to maintain alignment. If you remove the pins, a heavy weight can be used to clamp the frames together while they dry. Set the assembly aside, and allow the glue to dry completely. NOTE: locator pins not shown on drawings on this page.

Part 2: the Rear Frame

4 layers, 4 parts



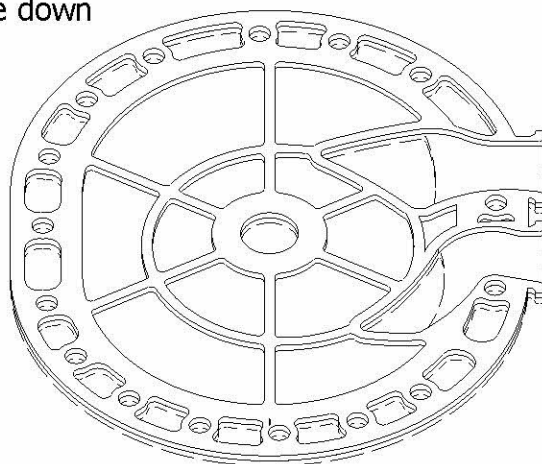
Assemble the Rear Frame: 1



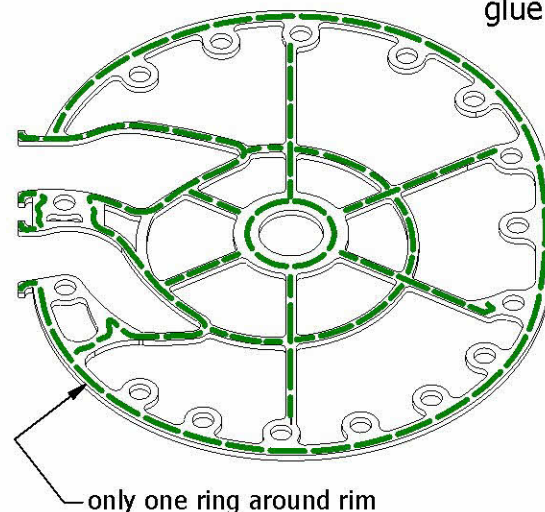
1st: Lay frame one with its ports face down (engraved side down) on the table. Locate frame 2, and orient it as shown. Spread glue as shown, then invert it and set it on top of frame one. Locate it with several locator pins (not shown), and press firmly.

Assemble the Rear Frame: 2

Frames 1 & 2,
face down

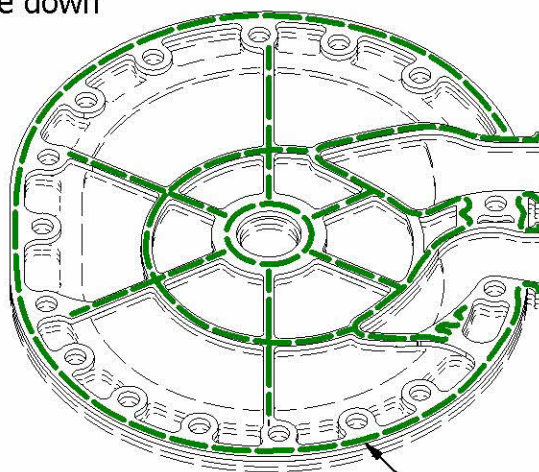


Frame 3 & suggested
glue bead

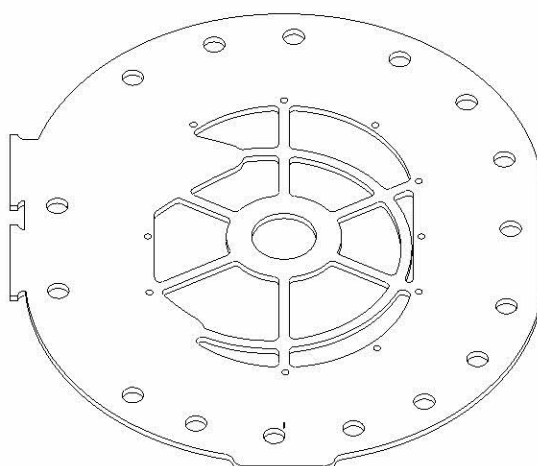


2nd: Continue the by-now familiar process of adding a glue bead to the next frame and adding it to the sandwich. Note the orientation and the suggested glue bead. Apply a glue bead to frame 3, and then invert it and press it down over the (not shown) locator pins.

Frames 1 - 3,
face down



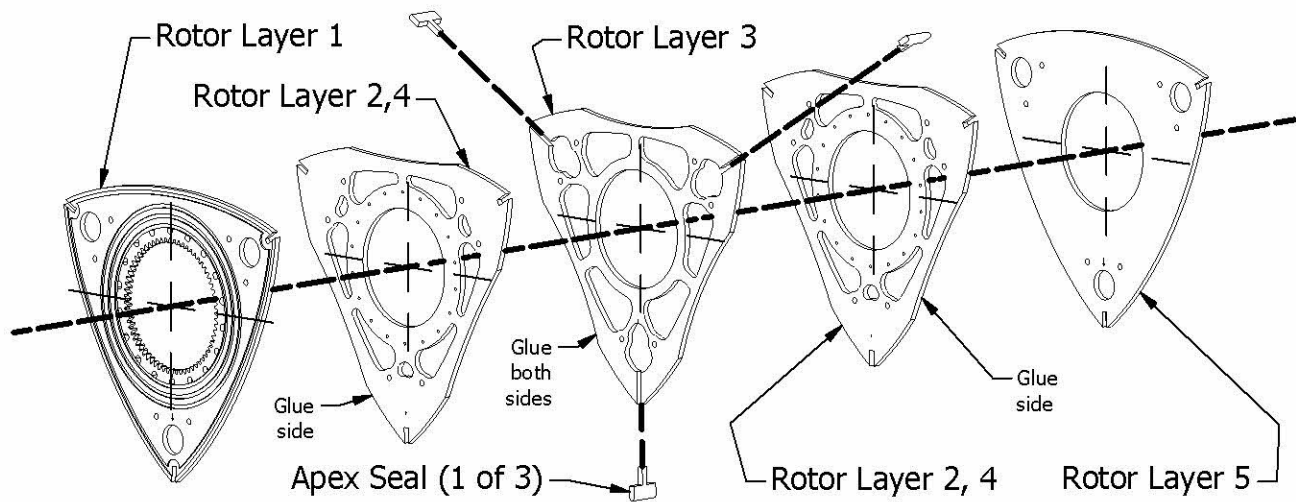
Frame 4



3rd: Complete the rear frame by spreading a thin bead of glue as shown around frame 3, then threading frame 4 down over the locating pins. Examine the resulting sandwich and add clamps or weights as necessary to make sure the glue dries properly on all layers. Again, you may remove the locator pins before the glue dries as long as you are careful to maintain alignment. Set the assembly aside, and allow the glue to dry completely.

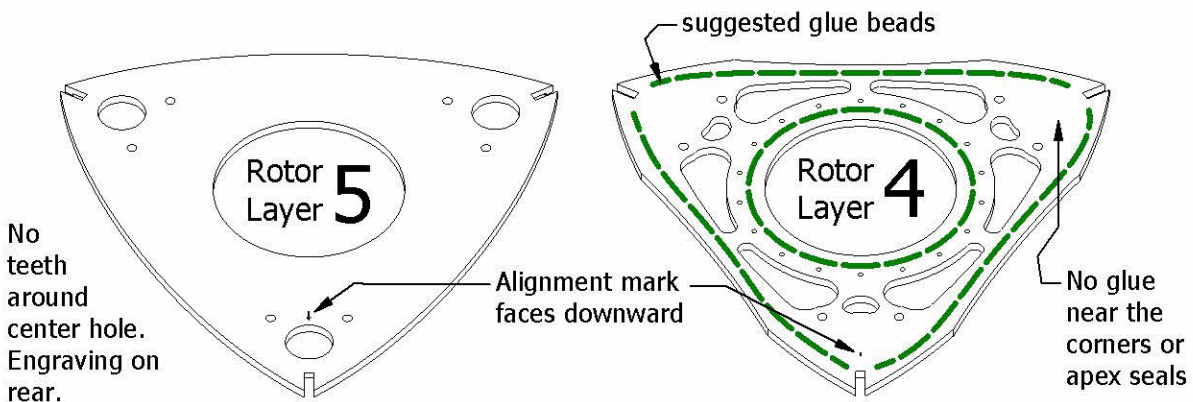
Part 3: the Rotor

5 layers, 8 parts



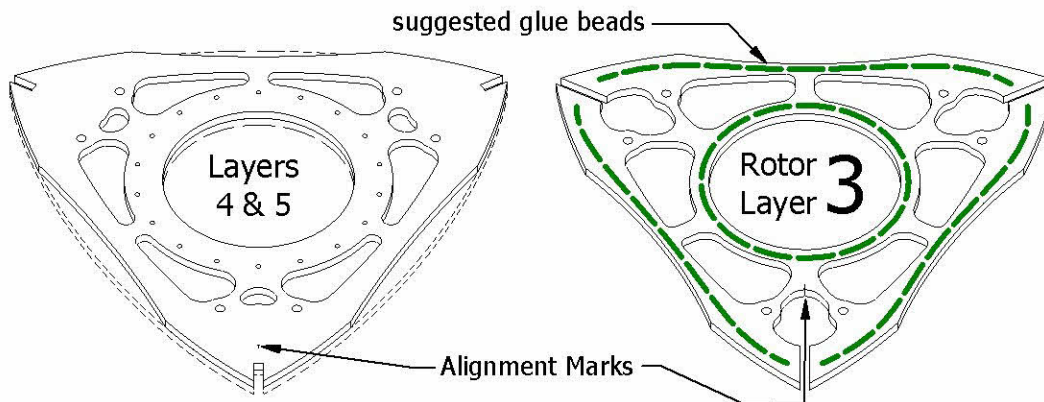
Assemble the Rotor: 1

The triangle-shaped rotor consists of 5 main parts with 3 small seals. The only difference between layers 1 and 5 are the gear teeth on layer 1. Layers 2 and 4 are identical. All of the apex seals are identical as well. There are extra rotor pieces, so only use the best ones.

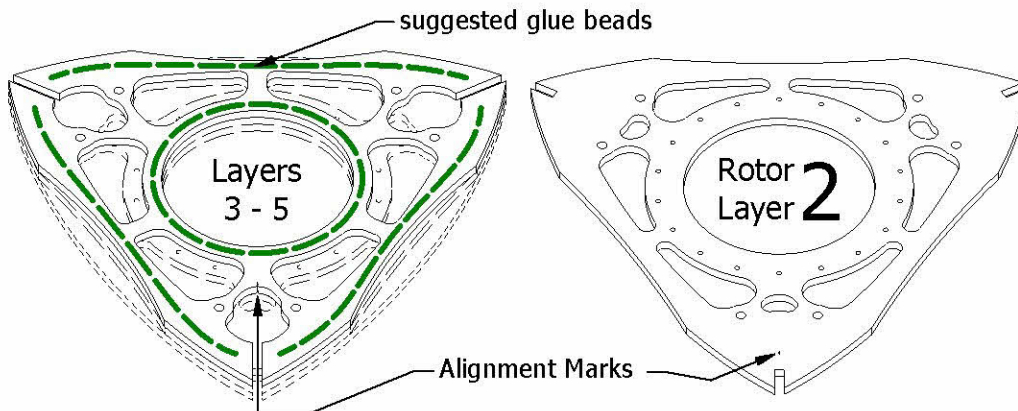


1st: Lay part 5 (the back) face down (engraved side down) on the table. Locate part 4, and orient it as shown. Spread glue as shown, then invert it and set it on top of part 5. Locate it with several locator 1/8" pins (not shown), and press firmly.

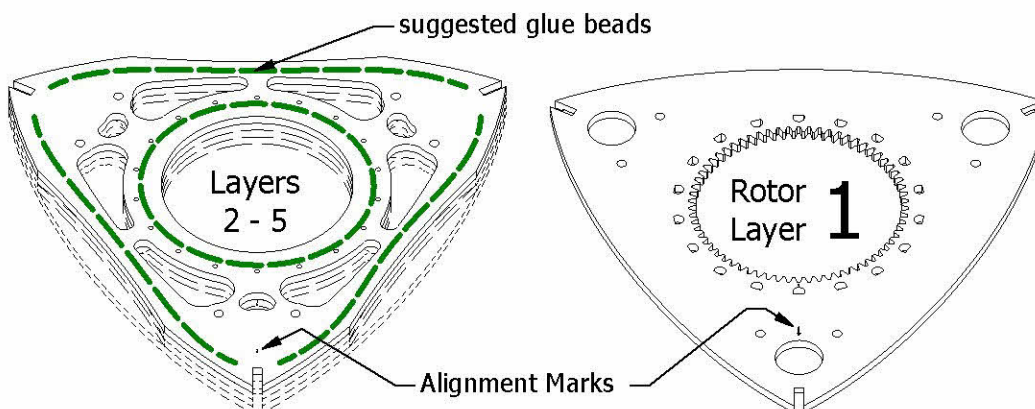
Assemble the Rotor: 2



2nd: Lay the rotor sandwich engraved side down in front of you. Spread glue on layer 3 as shown, then invert it and set it on top of the sandwich. Locate it with several locator 1/8" pins (not shown), and press firmly.

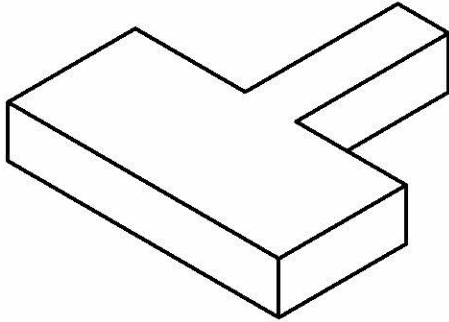


3rd: Similar to before. Glue on the back of the sandwich. Invert, locate, and press.

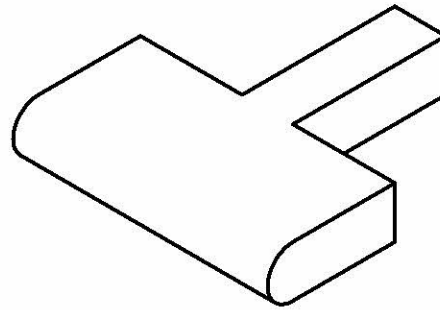


4th: Glue on the back of the sandwich. This time, hold the inside bead near the little holes, as the gear teeth will expose some of the face near the edge. Invert, locate, and press.

Assemble the Rotor: 3

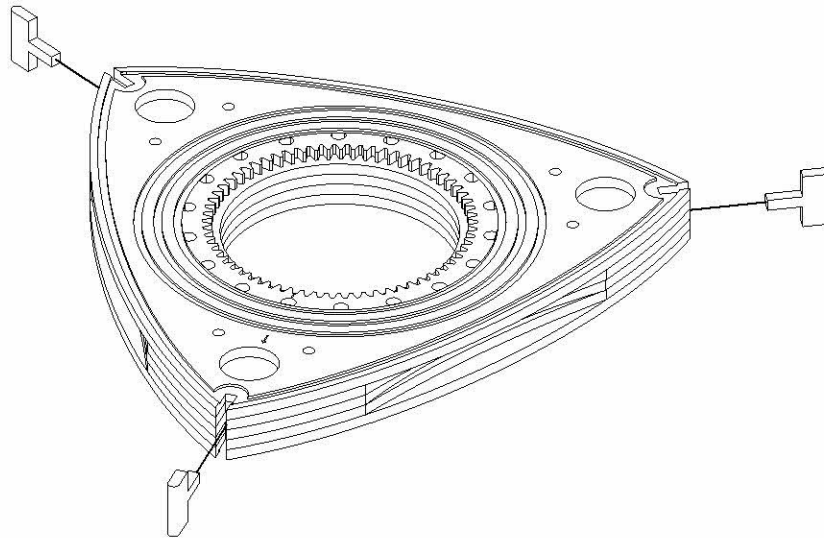


Apex Seal - Unsanded

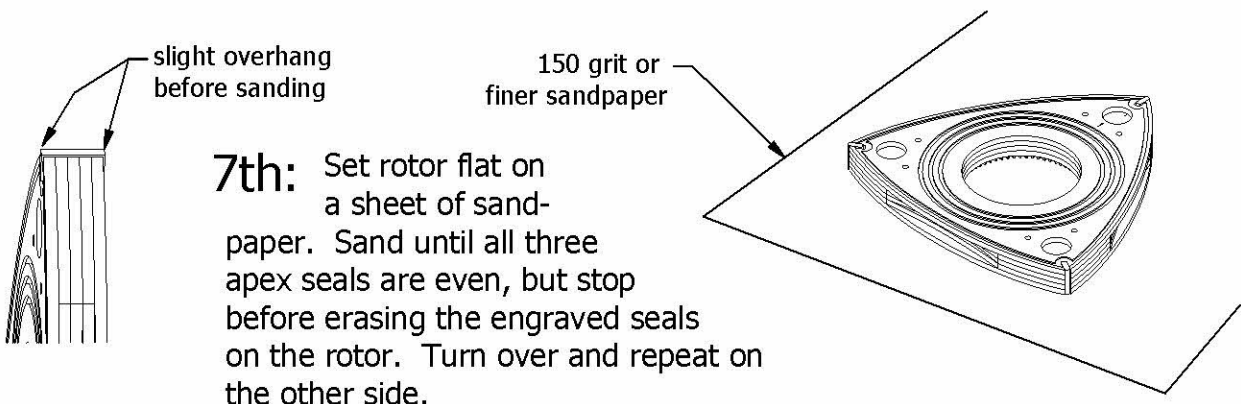


Apex seal, sanded to rounded shape

5th: Sand the forward corners of the apex seals into a rounded shape as shown.



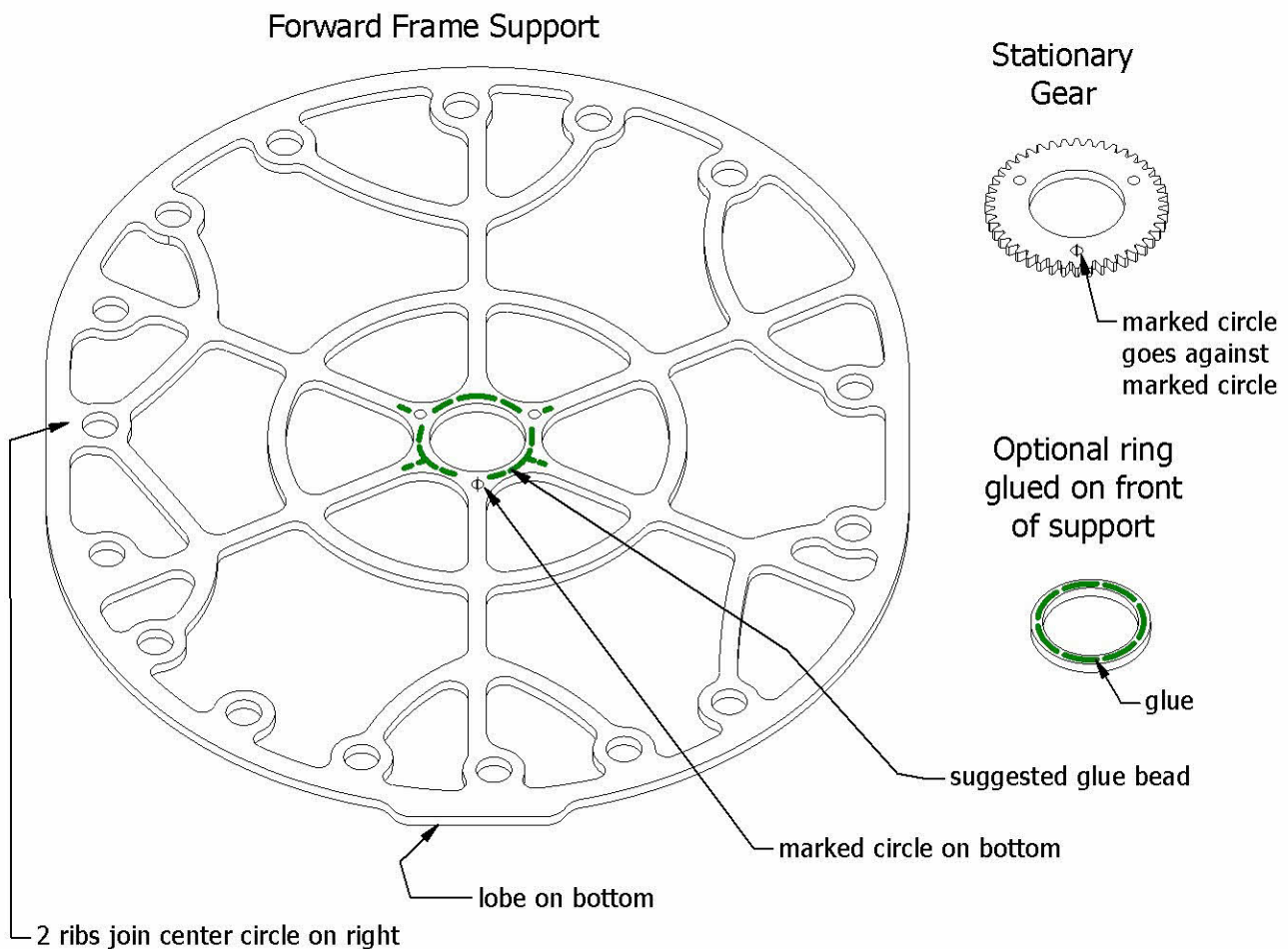
6th: Insert the three apex seals as shown. They should slide smoothly into the sockets. They are cut slightly over-width, so they will extend past the front and rear of the rotor.



7th: Set rotor flat on a sheet of sandpaper. Sand until all three apex seals are even, but stop before erasing the engraved seals on the rotor. Turn over and repeat on the other side.

Part 4: the Forward Frame

2-3 layers, 2-3 parts

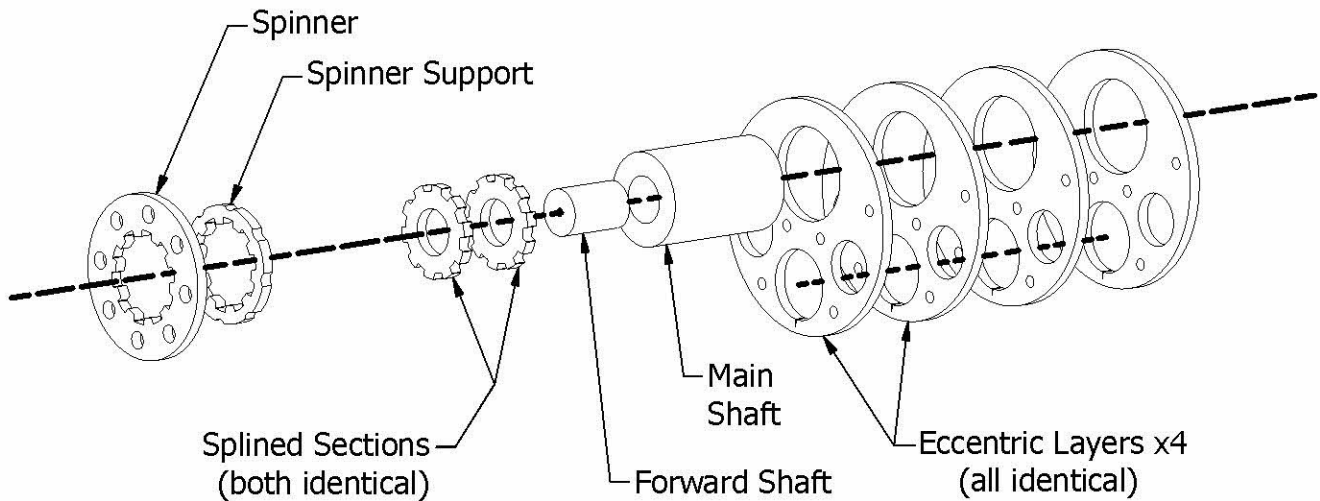


1st: Orient the forward frame support as shown. The engraved seal should face down. Locate the stationary gear, and note the marked 1/8" hole in the gear and on the forward frame. Spread a thin bead of glue on the frame as shown, then glue the stationary gear downwards, using three 1/8" locator pins.

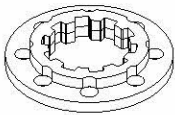
Optional: Locate the small ring, and spread glue on it as shown. Turn the forward frame with its gear over, engraved side up. Glue the ring around the center bore. This is a decorative touch that is strictly optional.

Part 5: the Eccentric Shaft

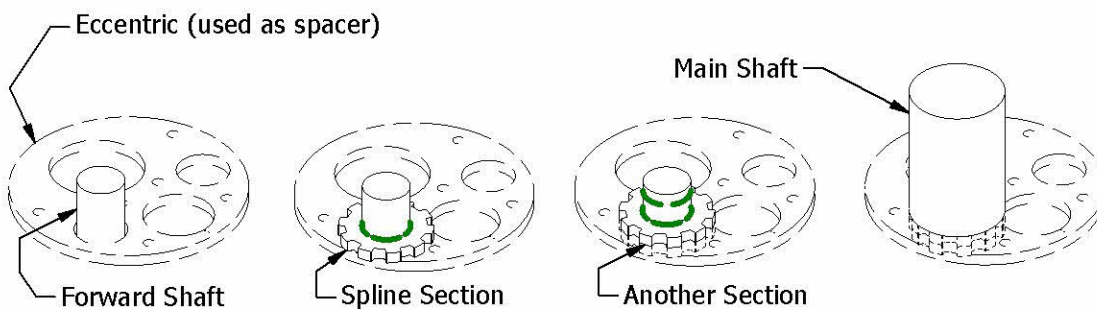
10 parts including 2 dowel pins



Assemble the Eccentric Shaft: 1

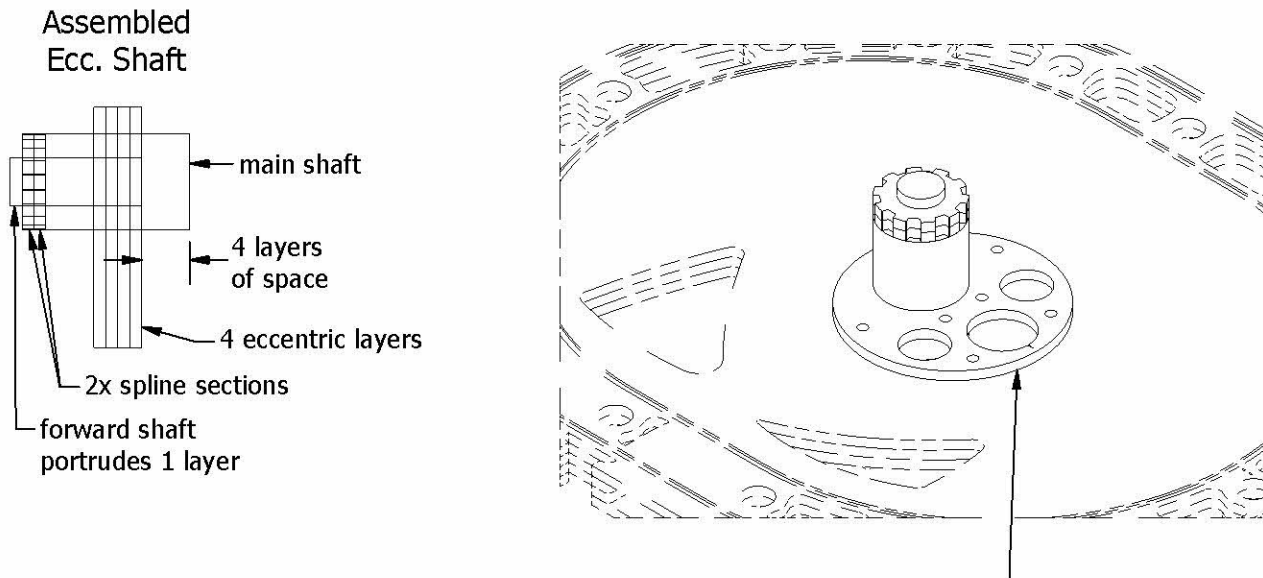


1st: Assemble the spinner. Spread glue on the worst face of the spinner support. Glue this face to the worst face of the spinner. Set these parts aside to dry. They can not be glued to the rest of the assembly until after the engine is assembled.

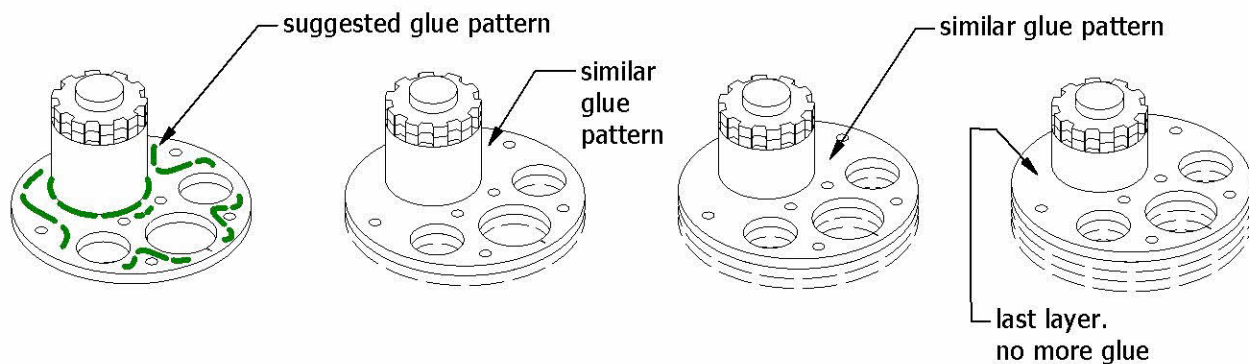


2nd: Set one of the eccentric layers on the table in front of you to use as a spacer. Set the forward shaft upright in one of the holes. Place a spline section over the shaft with the worst side upwards. Spread a bead of glue on the joint between the spline section and the shaft. Set another spline section down into the glue, and orient it so that the bumps form a continuous line. Spread another bead of glue on top of the second spline section, and a small amount of glue on the shaft above it. Carefully lower the main shaft down over the forward shaft, pressing it into the glue layers. Set aside to dry.

Assemble the Eccentric Shaft: 2

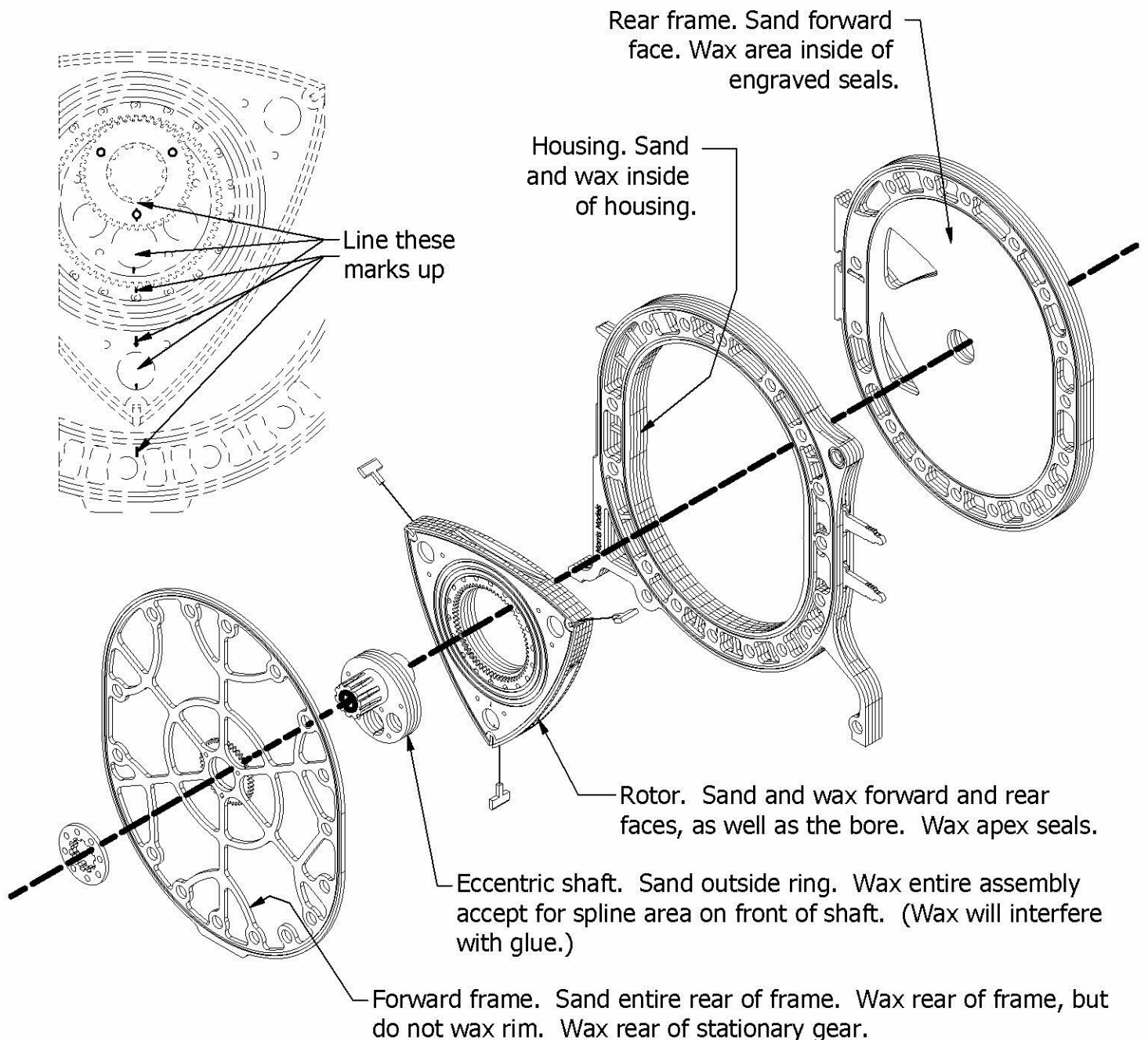


3rd: Set the rear frame face up on the table in front of you, and place the shaft into the center bore, spline side up. Place one of the eccentric layers over the shaft as shown. Do not allow any glue to damage the rear frame.



4th: Place a thin bead of glue around the upper face of the eccentric shaft and on the upper surface of the eccentric layer as shown. Add another eccentric layer, and add a couple of 1/8" locator pins. Spread glue in the same pattern, and add the third layer. Spread glue in the same pattern again, and add the fourth layer. Do not add any glue to the fourth layer. Remove the eccentric shaft, and set it aside to dry.

Assemble the Parts



In order to make the engine run smoothly, sand the surfaces shown lightly with 200 grit sandpaper. After sanding, rub candle wax onto the surfaces as shown. Then, assemble the engine, taking care to align all of the marks shown. You may glue the parts together permanently, bolt the engine together with 3/8" bolts (not included), or you may stick the engine together with 3/8" locator pins, which allows for easy disassembly and reassembly.

If you chose to glue or bolt the engine together, lightly glue the spinner in place on its splines. This will allow it to be pried off should it become necessary. If you have chosen to leave the engine so that it can be easily disassembled, I recommend that you do not glue the spinner in place.