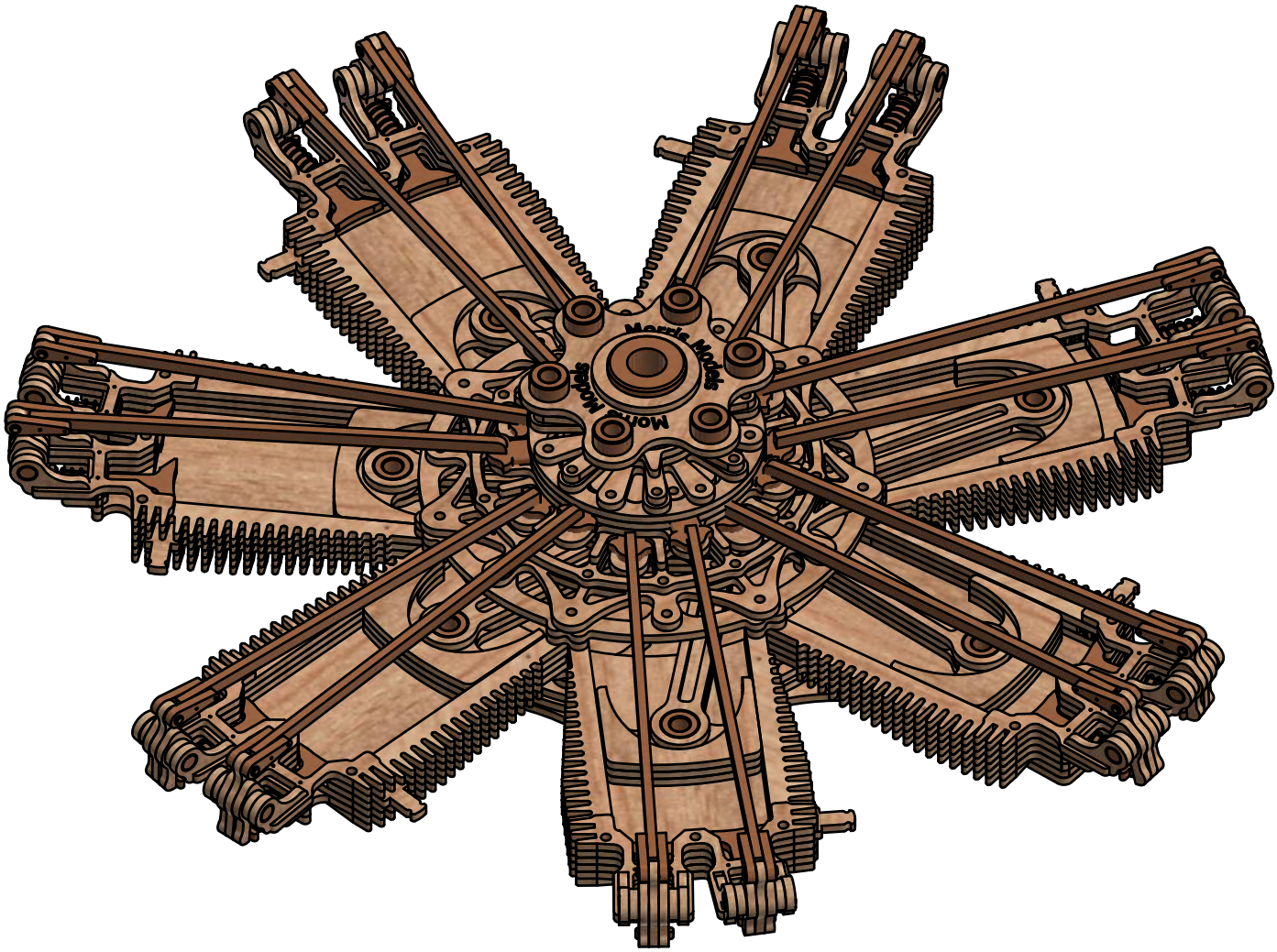
Morris Models Rotary Engine Assembly Manual



This model was heavily inspired by the Clerget 7z engine designed in 1913. It is not a true model in that many features are different. This model is intended for education and entertainment. Please take your time and enjoy the building process.

This plywood model has a dry weight under 2 lbs, and a diameter of about 16.25 inches. Because the entire engine spins, it is best demonstrated by bolting it to some sort of stand. By contrast to the plywood model, the Clerget 7z which inspired this model was about 36 inches in diameter, 234 pounds dry, had a staggering 725 cubic inch displacement, and produced some 95 hp at a maximum speed of 1300 rpm. This low rpm, coupled with an astonishingly low compression ratio of 4.3:1, are largely to blame for the low power output. Consider this low power output compared to the engine's size as you notice the relatively fragile interior parts of the engine.

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 piece is different. Because of this, the laser cannot cut every piece 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.

Many of the parts for this kit are cut from round dowel rods. These form most of the shafts. 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 and drill holes through the bodies of the 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 some other size 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. Unless told otherwise, you should remove the alignment pins after the glue has had a few minutes to dry.

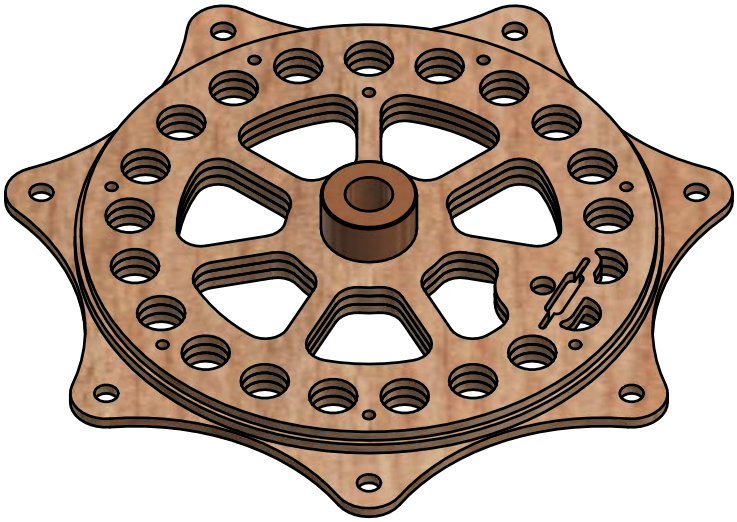
Many people ask if they can varnish, paint, or stain the engine. I do not recommend using paint or varnish, but oilbased finishes or stains are appropriate. Assemble the engine before using them. Another alternative is to use water-based markers. You can color each part before or after it is assembled. 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. I have also assembled quite a few of these engines without any wax. This also works. Just don't use wax on your engine before gluing the parts together, as this will interfere with the glue. It will also interfere with staining or painting the parts, so plan ahead.

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.

Section 1: the Base

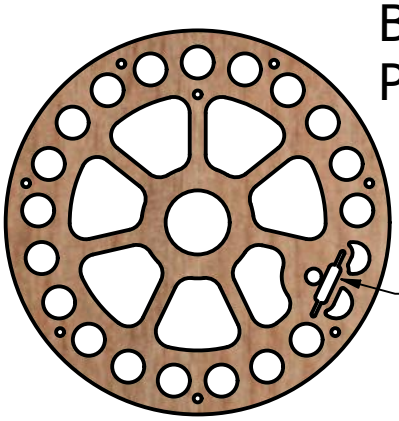
The base and crankshaft are the only stationary parts of this engine. Assemble the base carefully, as all other parts depend on it. It really doesn't matter which side of the base you choose as up and which side is down. I will show how I build mine.



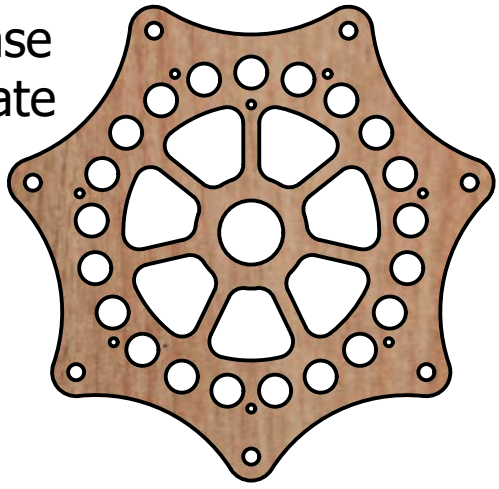
While you are building the base, you will notice a couple of strange looking cut-outs and an off-center hub. The cut-outs are to hold a magnetic reed switch should an individual wish to add an ignition system (not included). The off-center hub is for a drive gear that can be used for the ignition system and/or to motorize the model. The gear is optional, but is included.

Parts:

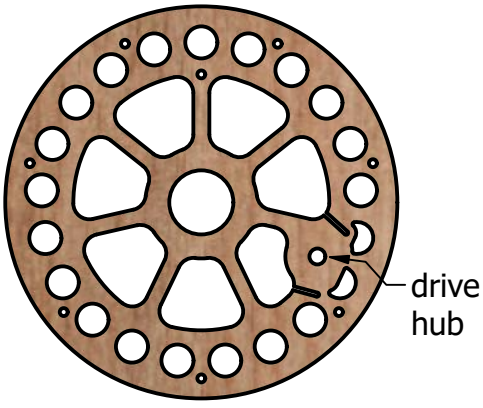
Front Base Plate

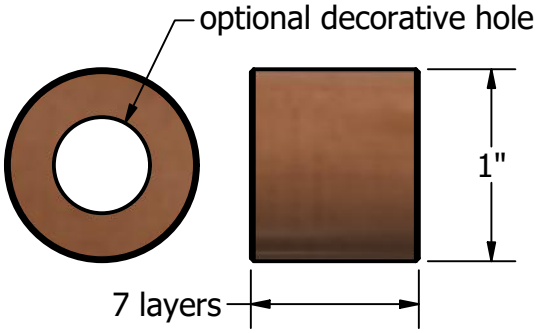


Rear Base Plate



Middle Base Plate

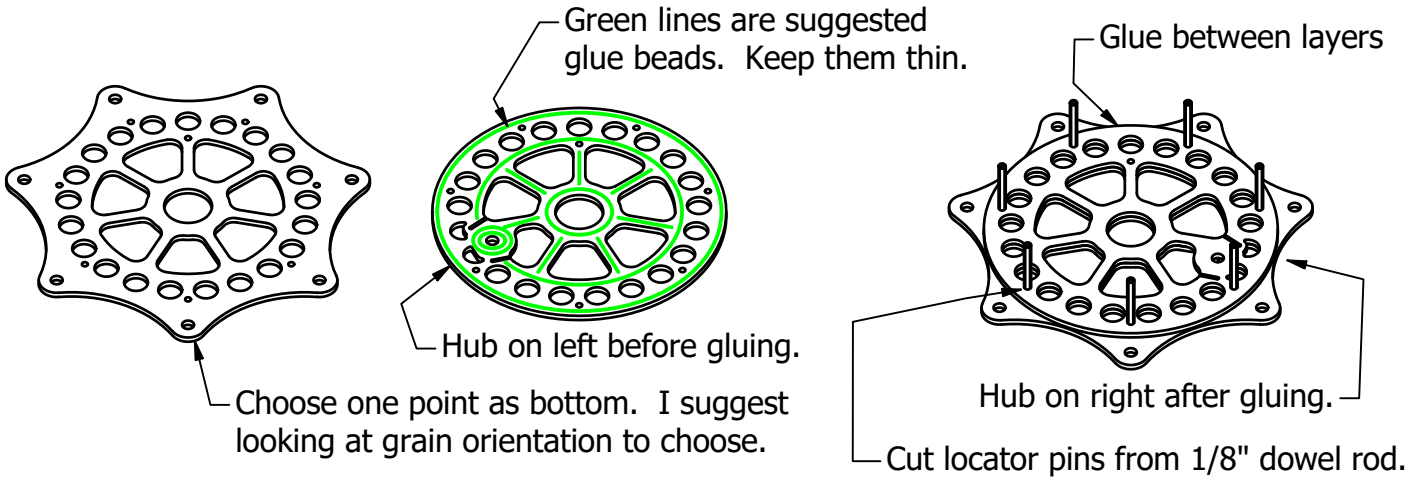




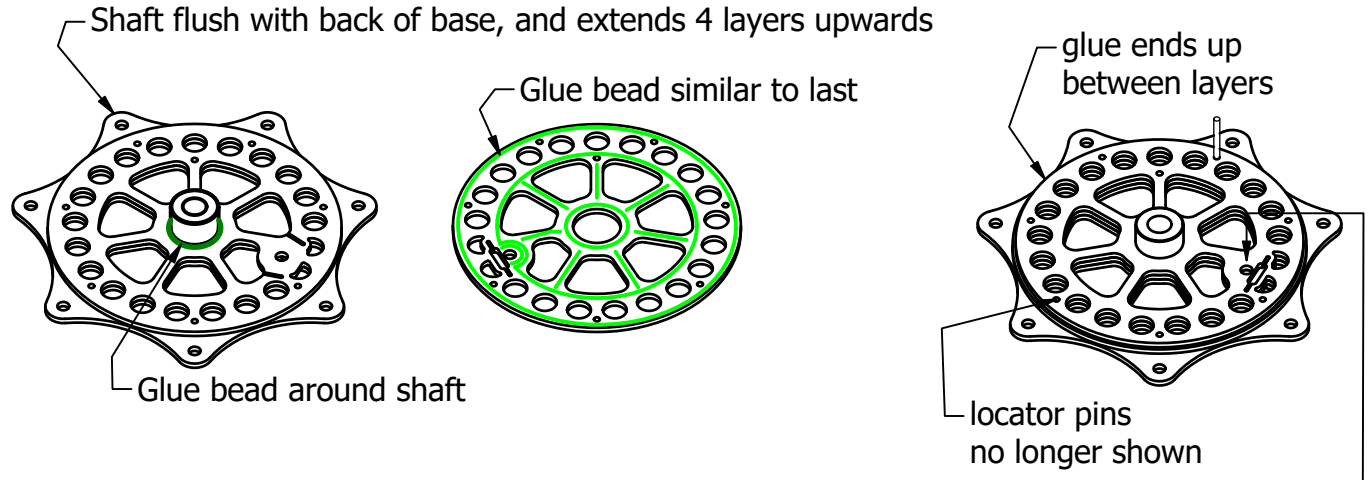
Rear Shaft (shown full sized)

1-1: Assemble the Base

Locate the back and middle base plates, and set them on the table in front of you as shown. Spread glue on the middle base plate, and then invert the plate and set it on the back plate, again as shown. Use 1/8" dowel rods as "locator pin" to help you line up the structure. Make sure these pins are not glued into the structure. Remove them as soon as practical. Locator pins are shown used wherever possible when gluing the structure. They are shown below, but will seldom be shown again.

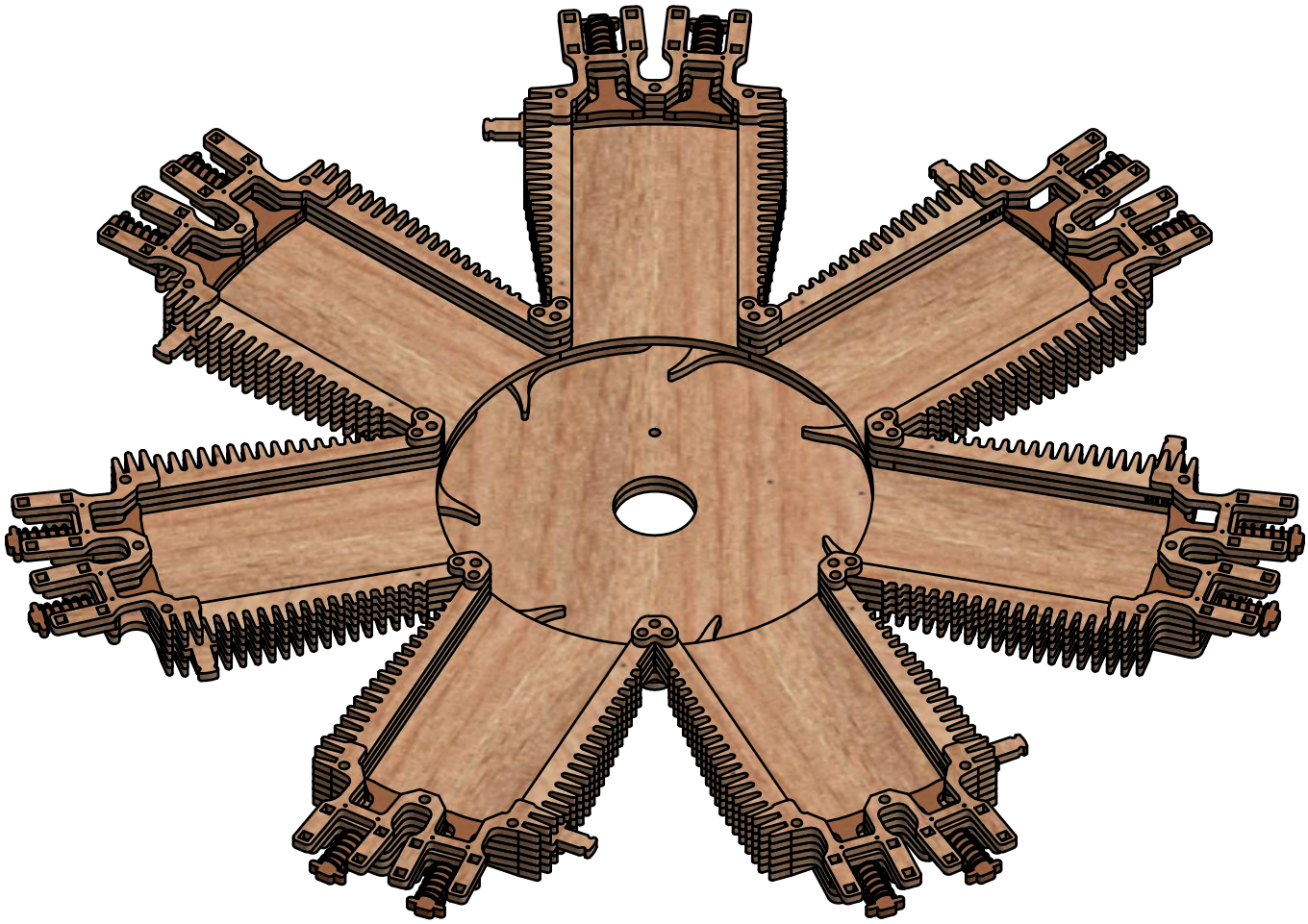


Insert the rear shaft into the base assembly, and lay a thin bead of glue around its edge. This bead of glue will hold it firmly in the base after the next layer is added. Lay out the front plate as shown, and apply a thin bead of glue to it. Invert it, and add it to the growing sandwich. Again, you should use locator pins to ensure that it is properly aligned. Remove the pins as soon as practical.



Allow the glue to dry completely before using the base. If you intend to drive the engine with the gear, drill through the off-center hub and through the back base plate so that a 1/4" drive shaft may be used.

Section 2: Cylinder Assembly



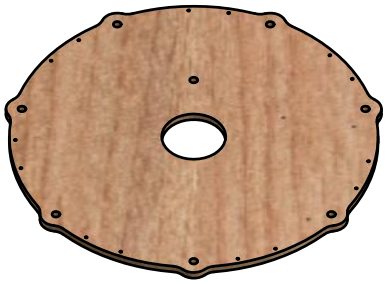
As the name implies, the cylinders and crankcase of a rotary engine rotated with the engine. This allowed them to do double duty as a massive flywheel - which helped these early engines to run much more smoothly than they would have otherwise. It also constantly moved the cylinders through the air, essentially giving them powered cooling. The fins were much smaller than the fins on comparably sized radial engines of later years - a testament to their low compression ratio, low power loading, and low total power output.

Rotary engines could not carry oil in the crankcase like a modern four-stroke, as centrifugal force would quickly drive it into the cylinders. Instead, they were fed oil mixed with in the gasoline like a more modern scavenging two-stroke engine. Fuel and air entered through the hollow crankshaft. Note the scoops on this engine that channeled the fuel and air up the intake tubes behind the cylinders and into the intake ports. Exhaust was unmuffled directly into the stream of air.

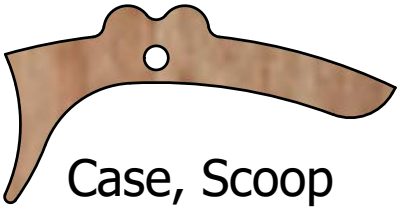
This is the largest and most important subassembly of the entire engine. Make sure that everything is straight and neat. The intake tubes on this model are invisibly blocked for structural reasons.

2-1: Begin the Cylinders

Parts:



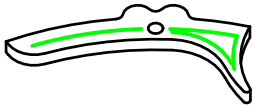
Case, Rear



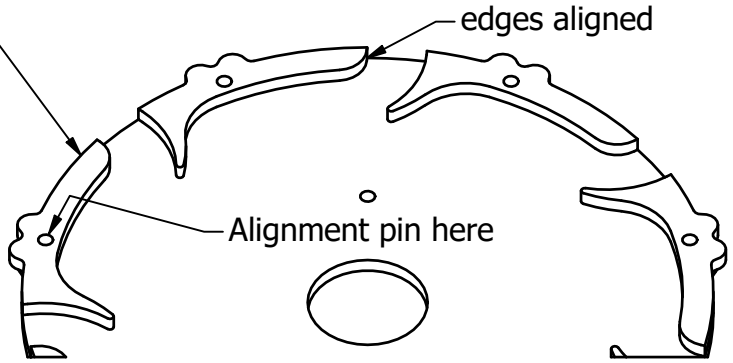
Case, Scoop
x 7
(shown full sized)

Cylinders,
Back Wall
x 7

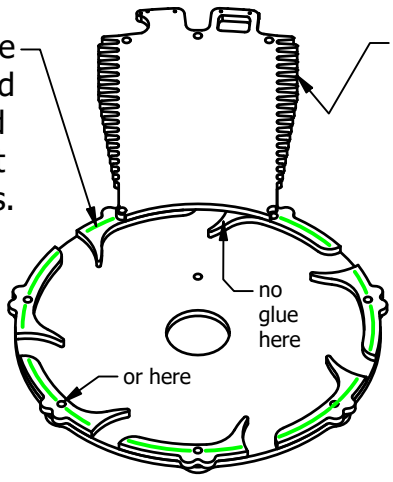
Spread a thin bead of glue as shown on the backs of the case scoop pieces, then turn them over and glue them to the front of the rear case as shown. Use a locator pin and carefully align the outside curve of the scoop with the outside curve of the rear case. Do this for all seven scoops.

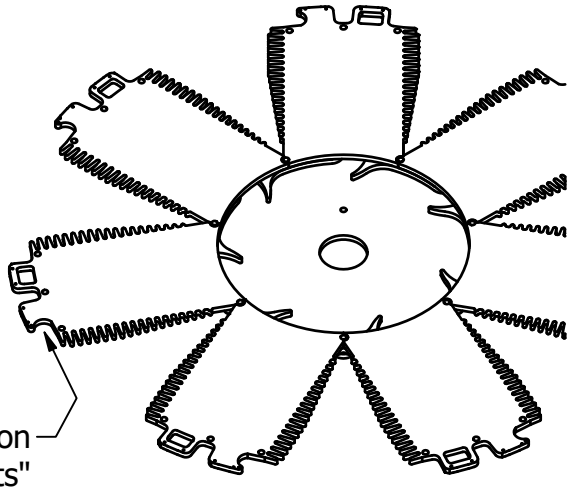


Scoop - suggested glue bead on back.



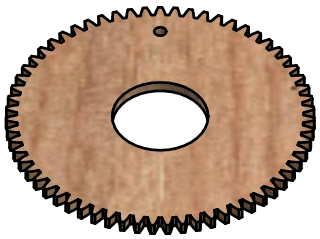
Spread a thin bead of glue around the rim of the scoops. Use alignment pins to help set the seven cylinder back walls in place around the edge of the case as shown. Let the glue dry before going on.



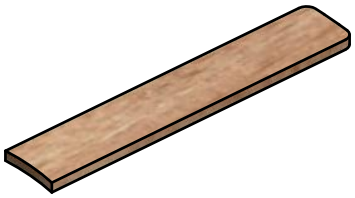


2-2: Behind the Cylinders

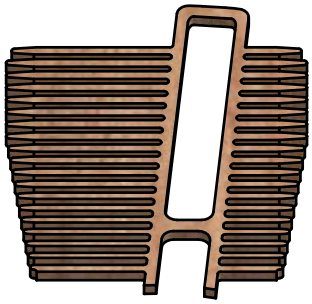
Parts:



Case Gear

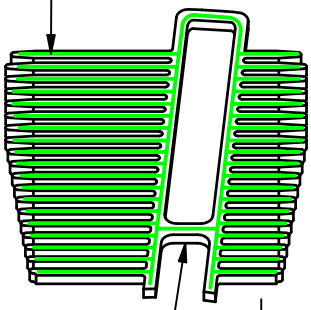


Intake Tube Cover x 7



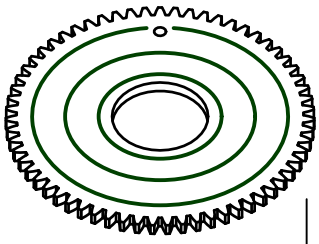
Rear Fins x 7

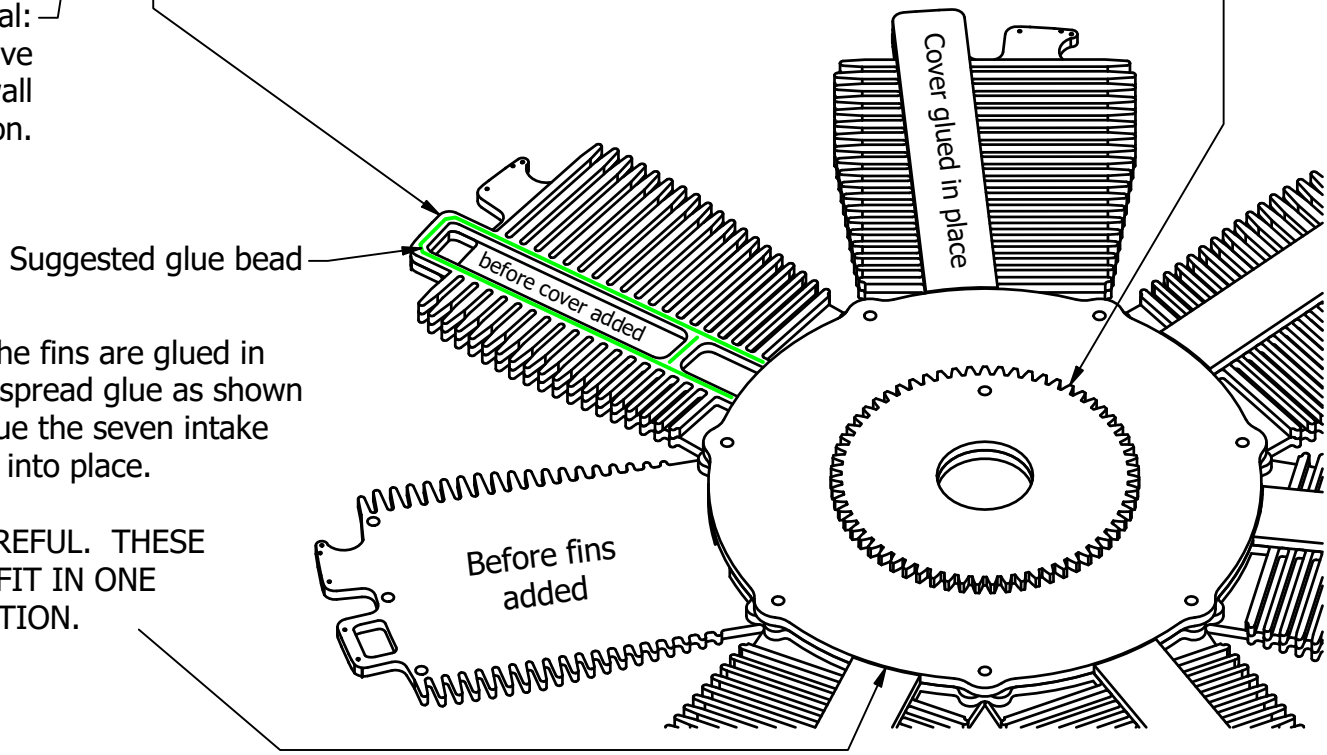
Take the cylinder wall assembly you built on the last page, and turn it over face down on the table in front of you. The parts shown above will be added to the back of the case. Let dry before going on.



Spread glue on the fins of each of the the seven sets of cylinder fins (one at a time), and glue them in place over the rear of each cylider wall. Pay attention to alignment, because there are no locator holes to help you.

Spread glue on one side of the case gear, then invert it and glue in place. Use a 1/8" alignment pin and a section of 1 inch shaft to locate the gear.



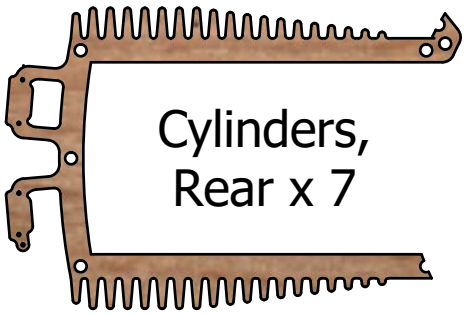


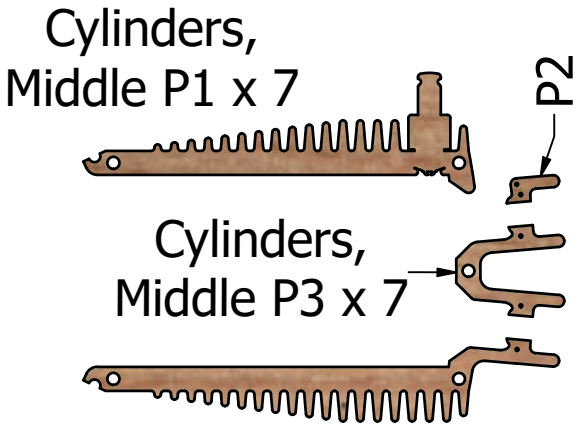
After the fins are glued in place, spread glue as shown and glue the seven intake covers into place.

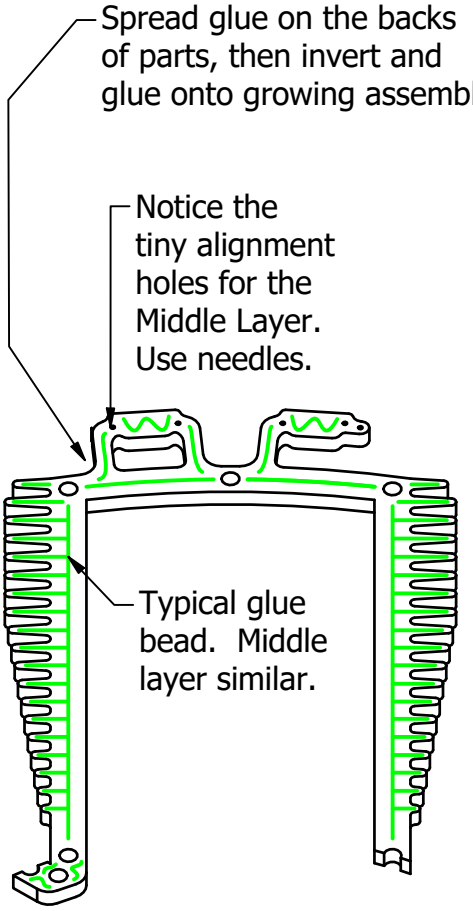
BE CAREFUL. THESE ONLY FIT IN ONE DIRECTION.

2-3: Begin Cylinder Walls

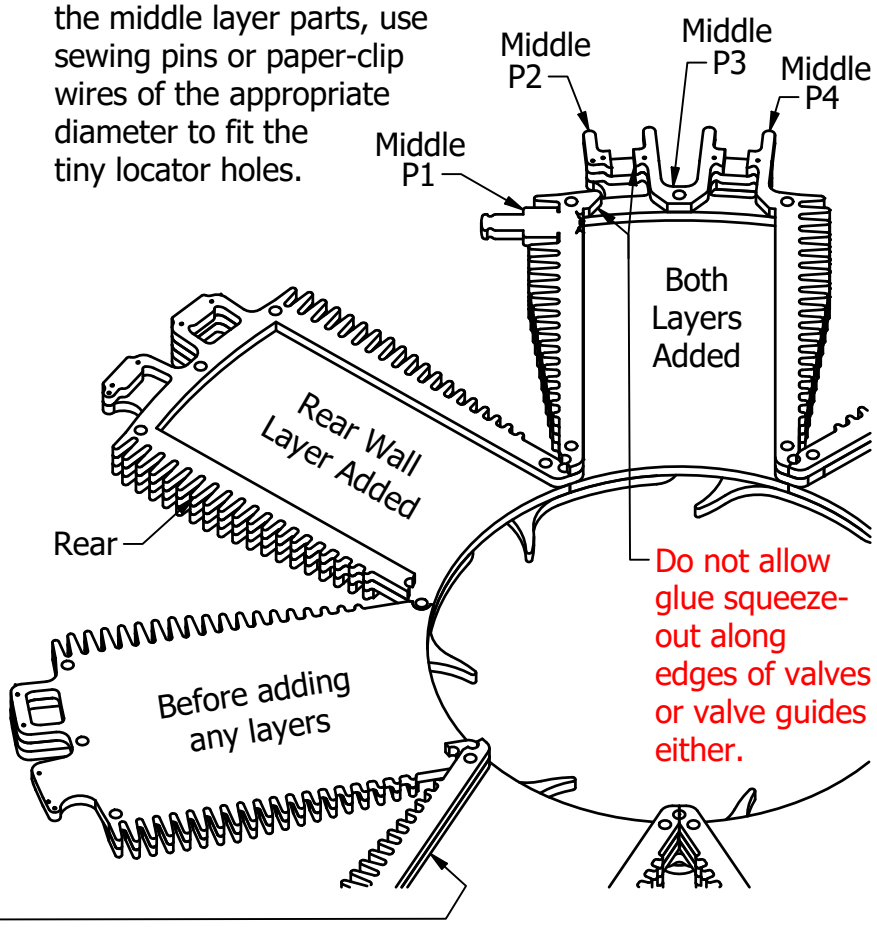
Parts:







The next two layers are added in a very straightforward manner. The rear layer is shown. The Middle layer differs only in that it is multiple pieces. Glue all seven of the rear layer pieces before adding the middle layer pieces. The rear parts can be added using 1/8" locator pins only. When adding the middle layer parts, use sewing pins or paper-clip wires of the appropriate diameter to fit the tiny locator holes.



Make sure that no glue squeezes out on the inside walls of the cylinder bore. Any drops of glue that squeeze out here must be removed. This is easiest before the glue sets.

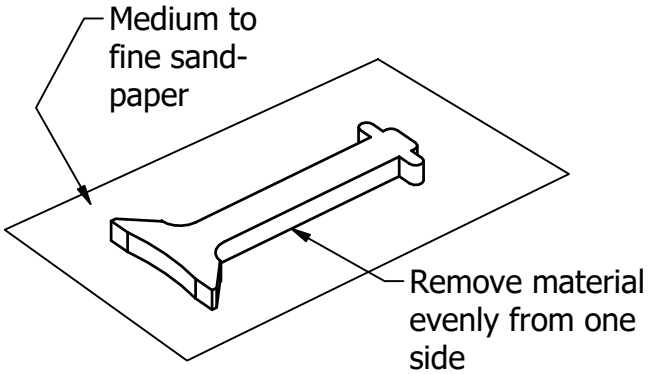
2-4: Prepare the Valves

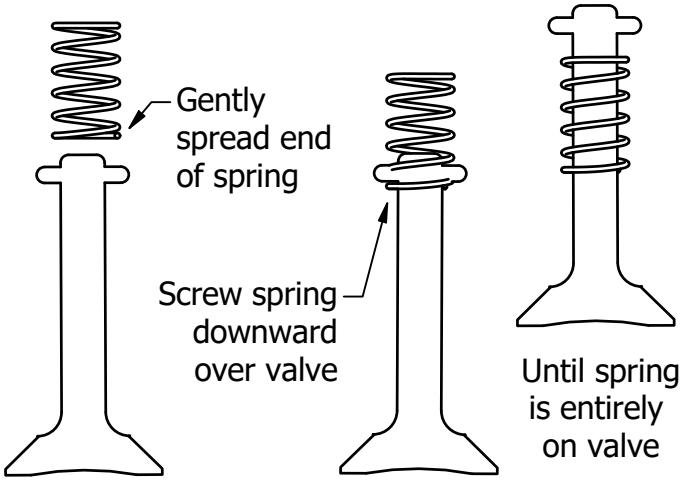
All of the plywood parts have the same thickness. The valves, however, must be free to slide in and out when they are installed. This means that they need to be a little bit thinner than the other plywood parts in the middle layer your just added.

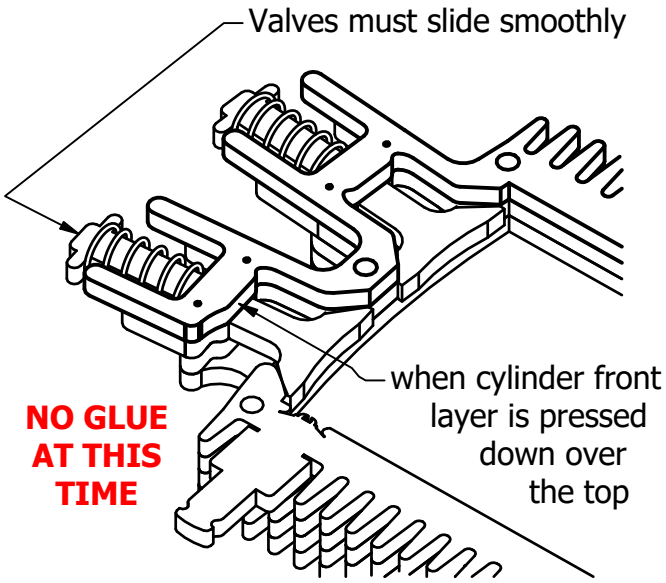
Thin the valves by sanding one of the faces until it is about 0.02 to 0.03 inches thinner (about a half millimeter).

Thread the spring onto the valves as shown, then slide the valve into position in the valve guide. Press the next layer down firmly over the top, and open the valve by pressing on the end. If the valve spring easily returns the valve to the closed position, the valve is thin enough. If not, continue sanding until the valve slides freely.

Sand and check all 14 valves. It is not possible to remove the valves and sand them once the engine is assembled.



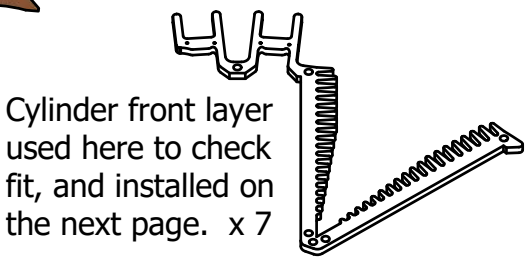




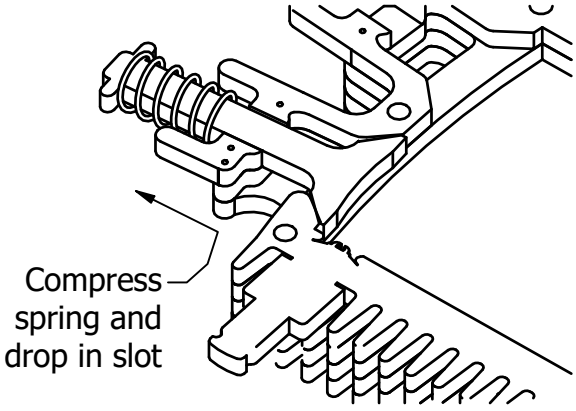
Parts:

Valves x 14

Springs x 14



Cylinder front layer used here to check fit, and installed on the next page. x 7



The spring tension should hold the valve in place. Check and insert all 14 valves before going on to the next step.

2-5: Finish the Cylinders

Parts:

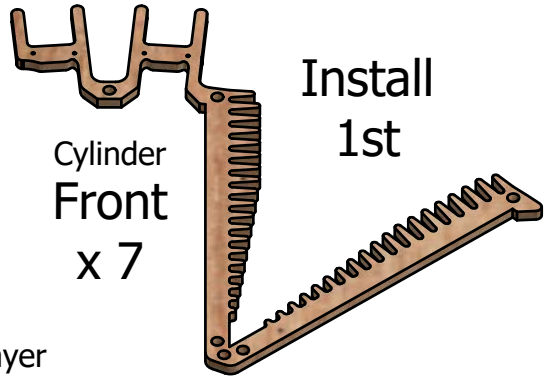
Cylinder
Inner Cap
x 7

(shown full size)

Install
Last

Install
2nd

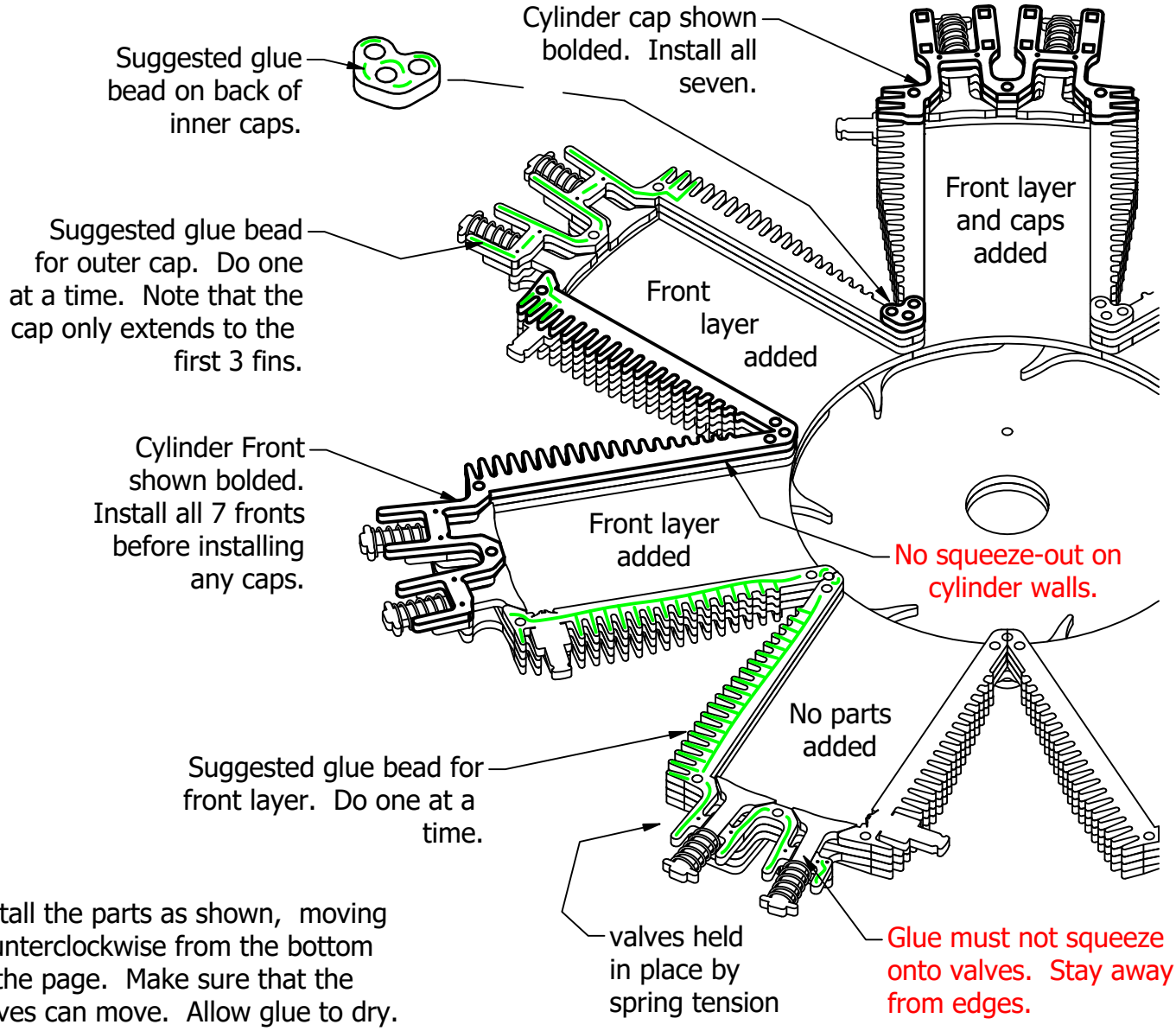
Cylinder
Outer Cap
x 7



Cylinder
Front
x 7

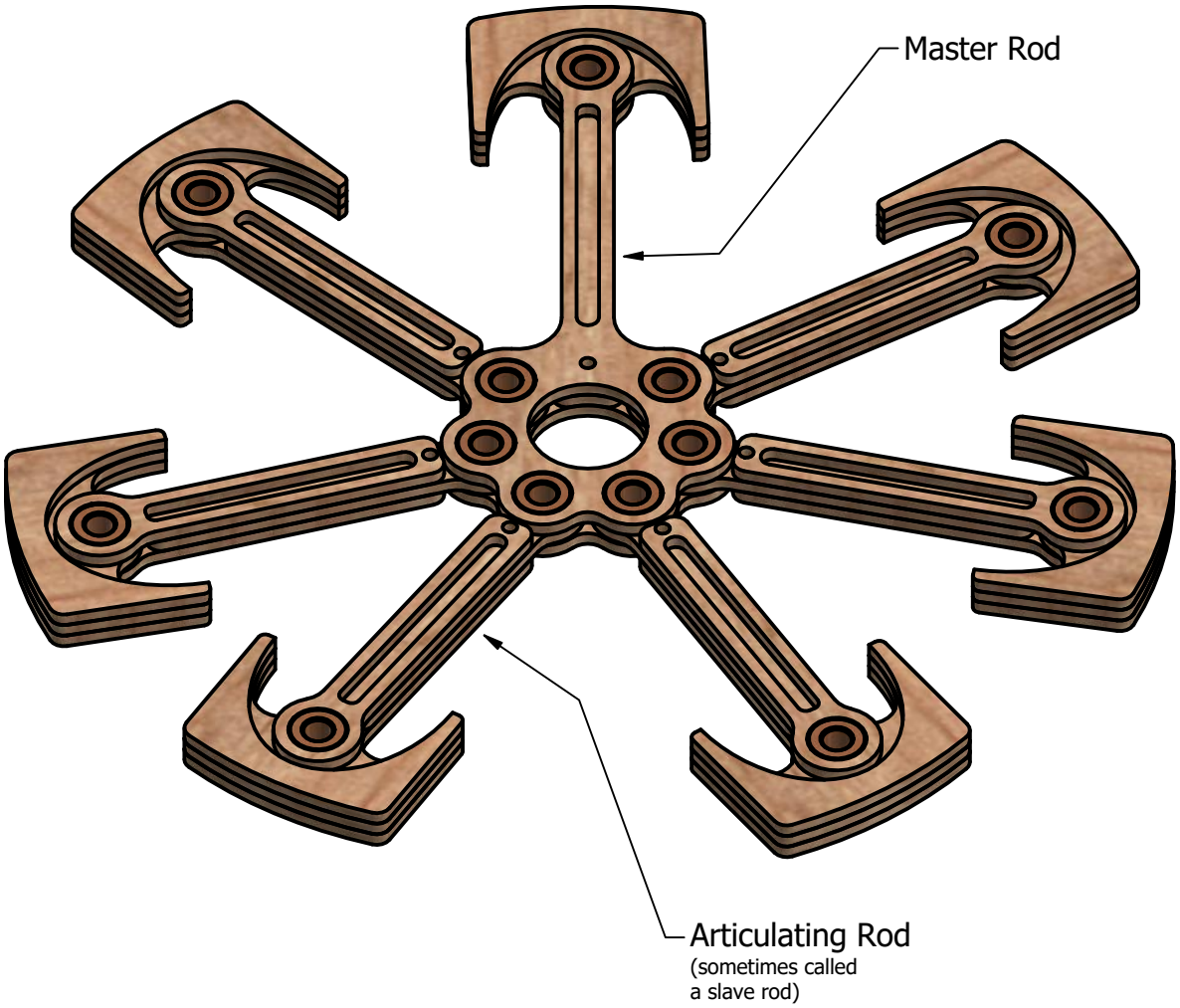
Install
1st

Spread the glue for the front layer and outer caps on the assembly, then add the part. Spread the glue on the inner caps, then add to the assembly.



Install the parts as shown, moving counterclockwise from the bottom of the page. Make sure that the valves can move. Allow glue to dry.

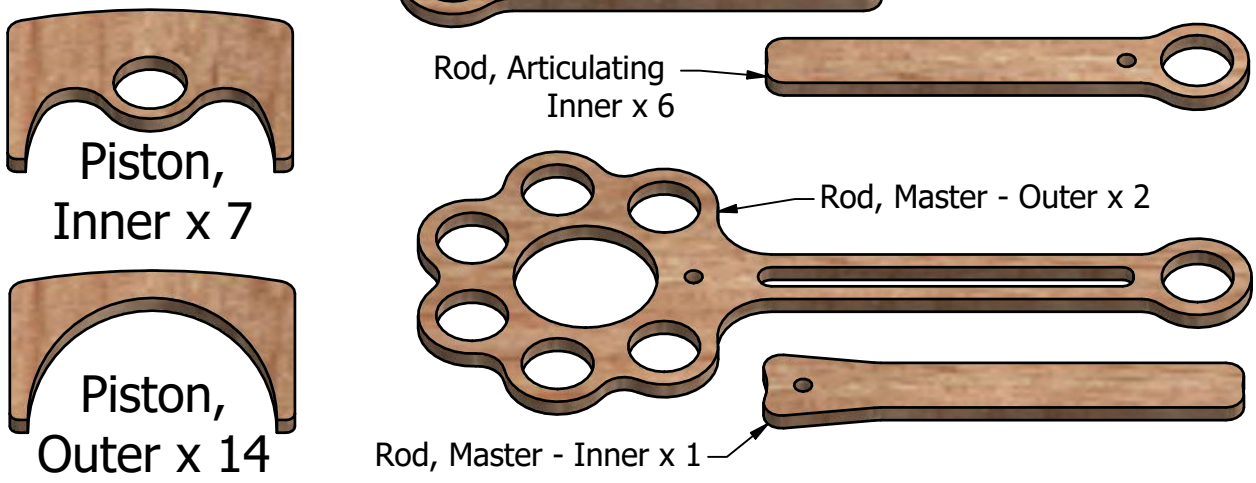
Section 3: Rods and Pistons



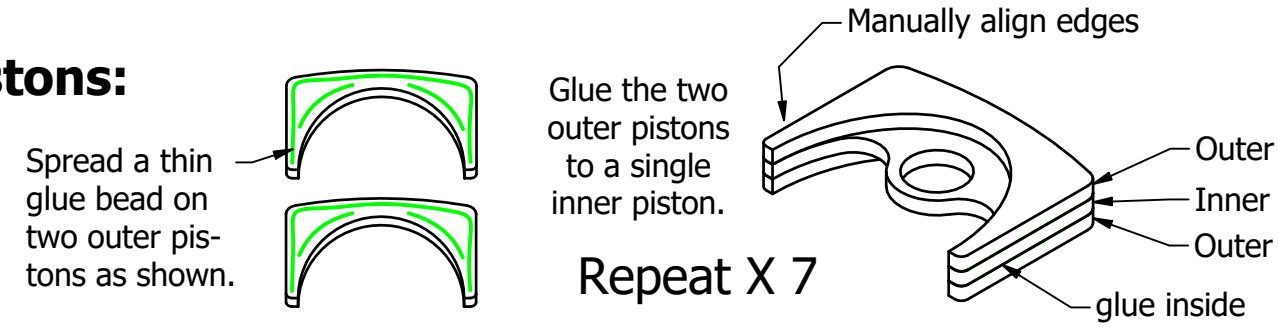
Most rotary engines had a single master rod and a number of articualting rods - an arrangement shared by our model and by most of the later radial engines. In a non-rotating engine, the weight of the rods and the pistons had to be countered by large conterweights on the crankshaft. This is not required in a rotary engine, because the assembly itself does very little oscillation - its movement is almost entirely rotational. This means that the entire assembly must be balanced, but its exact weight is not as important as that on later engine. The weight saving allowed by eliminating the counterweights is yet another reason the rotary engine was brilliantly designed for the requirements of the day.

3-1: Rods and Pistons

Parts:

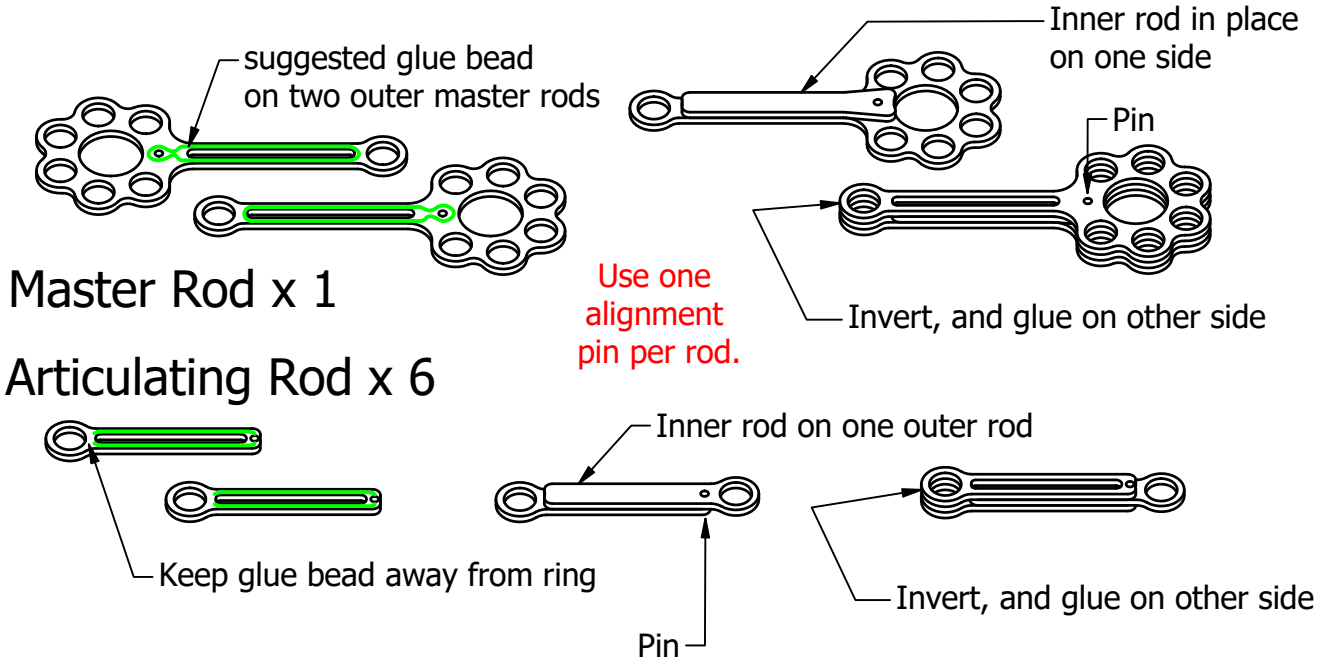


Pistons:



Keep your pistons neat, and don't allow glue squeeze-out - particularly on the edges.

Rods:

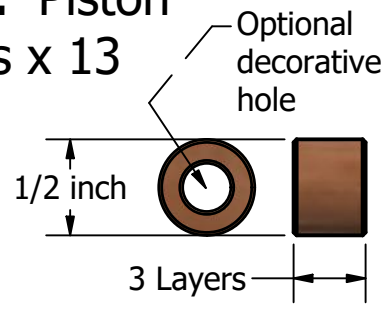


3-2: Rods and Pistons

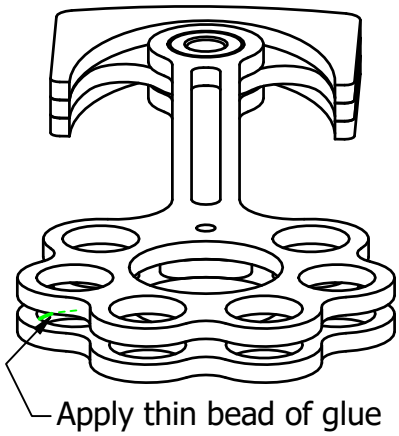
Pin the articulating rods into the waiting slots in the master rod hub. The rods must be free to pivot on the pins. I suggest using a minimal amount of glue on the rear side of the master rod hub, then inserting the pin in such a way that it wipes the glue out of the hole. This process is shown below.

Pin the seven pistons on the rod assembly in a similar fashion. Again, they must be free to pivot.

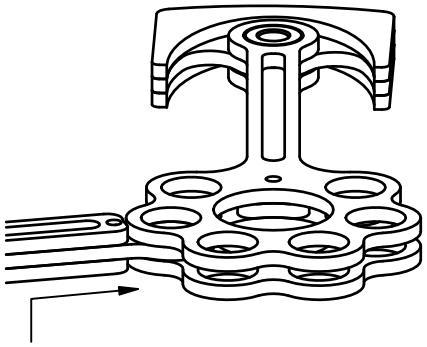
Parts: Piston Pins x 13



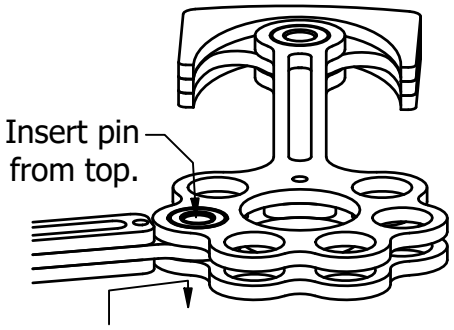
Note - these pins are identical to the prop dowel pins used on the flange in a later step.



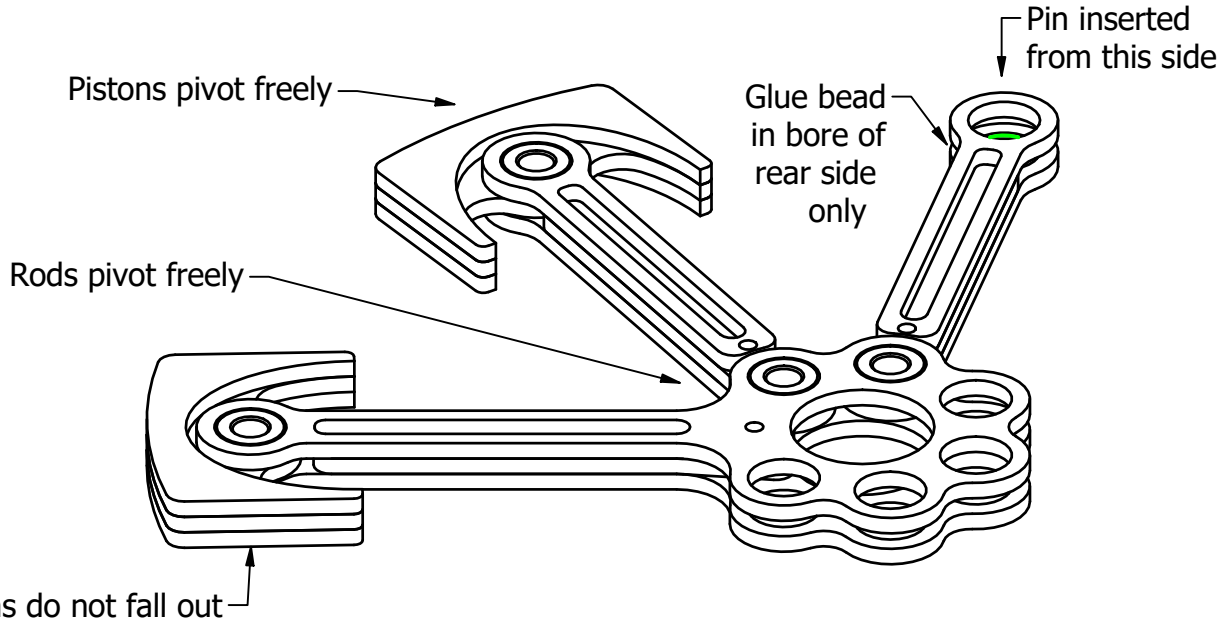
Apply thin bead of glue to the inside of the bore on the rear side only.



Insert rod socket into the slot. Align. No glue should touch the rod.



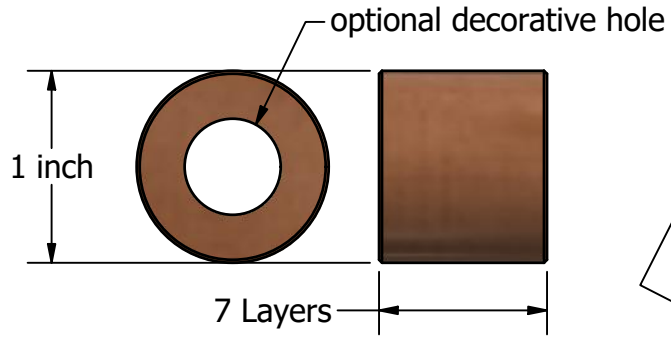
As pin is inserted, excess glue will be wiped out of joint. Clean excess, and allow to dry.



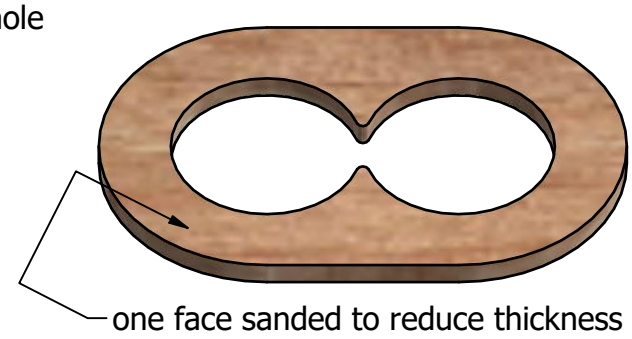
Section 4: Crank and Pistons

Parts:

Crank Throw



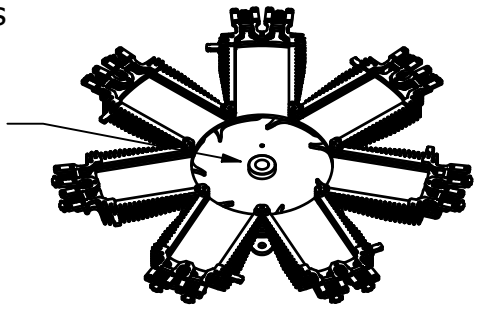
Crank, Rear Web x 2

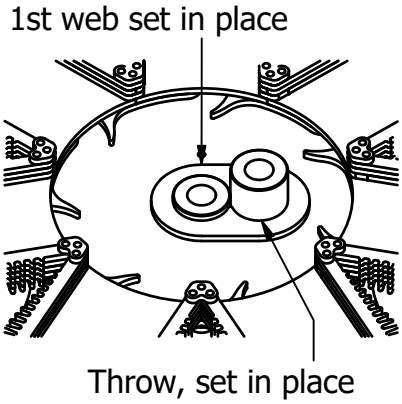


Begin by thinning one or both rear crank webs, in much the same way as you thinned the valves. The total thinckness of the pair should be reduced between 0.03 and 0.06 inches (1 to 2 mm). This will allow space for the moving parts to slide inside the crankcase.

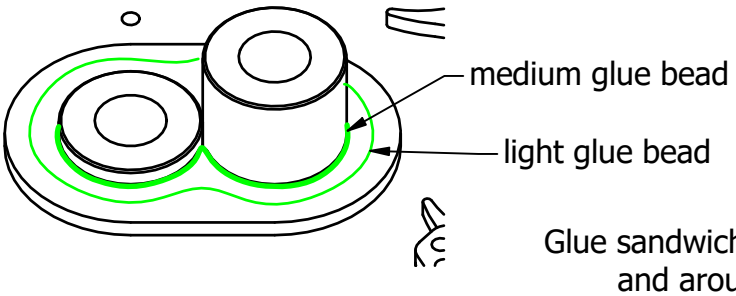
Next, set the base in front of you in the upright position. Wax the forward face of the base if desired, concentrating on the spokes and hub. Do not wax the shaft, as this will prevent glue from sticking. Set the cylinder assembly in place over the base, inserting the shaft through the hole.

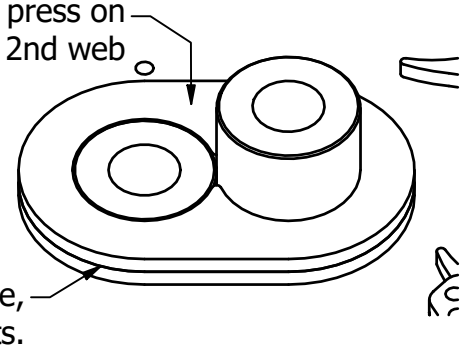
Important - if the shaft doesn't fit easily, sand out the bore until it does!



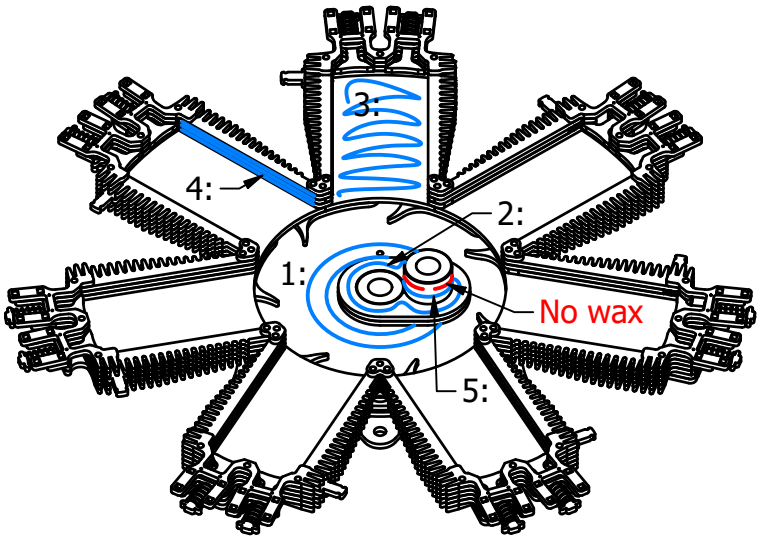


After thinning the crank web, optionally wax the rear if desired. Press in place over shaft, with the second hole directly to the right of the shaft. Make sure web is snug against rear wall. Add crank throw, also pressed against rear wall. Spread a medium bead of glue around both shafts on top of crank web as shown below. Then add the second crank web, completely covering the glue and permanently gluing both shafts in position.





4-1: Crank and Pistons



Optional: Prepare to install pistons and rods by waxing:

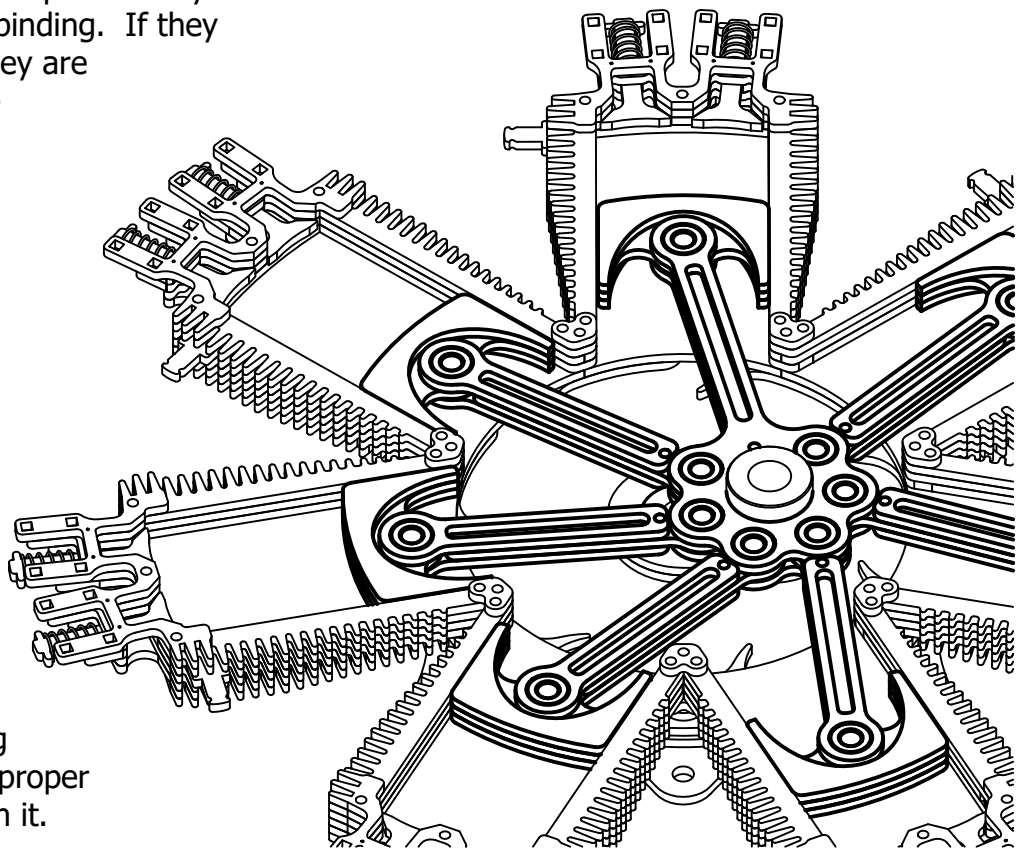
1. The back of the crankcase.
2. The front of the crank web.
3. The backs of the cylinders.
4. All 14 sides of the cylinders.
5. The throw as shown.

Rotate the case on the base as needed in order to do a thorough job. I have shown only a few lines, but if you are going to wax it, wax it throughly!

Don't wax the top 1/4 inch of the throw. It needs to be glued. This is the part of the shaft that can be seen in the diagram below.

Carefully align the rods and pistons with the cylinder walls, and lower the assembly over the crankshaft and down into the case and cylinders. I have shown the master rod in the top cylinder. However, since the entire engine spins, it does not matter which rod you place in which position.

Hold the base stationary, and pivot the cylinders. They should pivot without binding. If they are too tight, find where they are binding, and sand for more clearance. The most likely problem areas are where the crank throw fits into the master rod, and where the pistons fit against the sides of the cylinders.

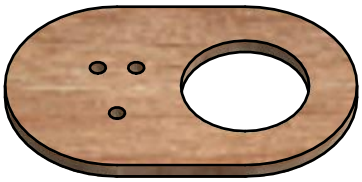


You did make sure there was no glue squeeze-out, didn't you?

Note: the engine spins in a more satisfying manner if you make the proper engine noises as you spin it.

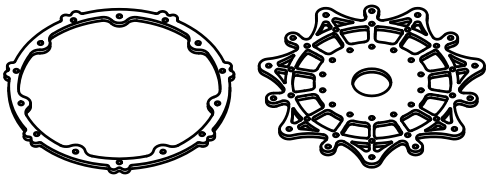
4-2: Crank and Pistons

Parts: Crank Web, Forward x 2



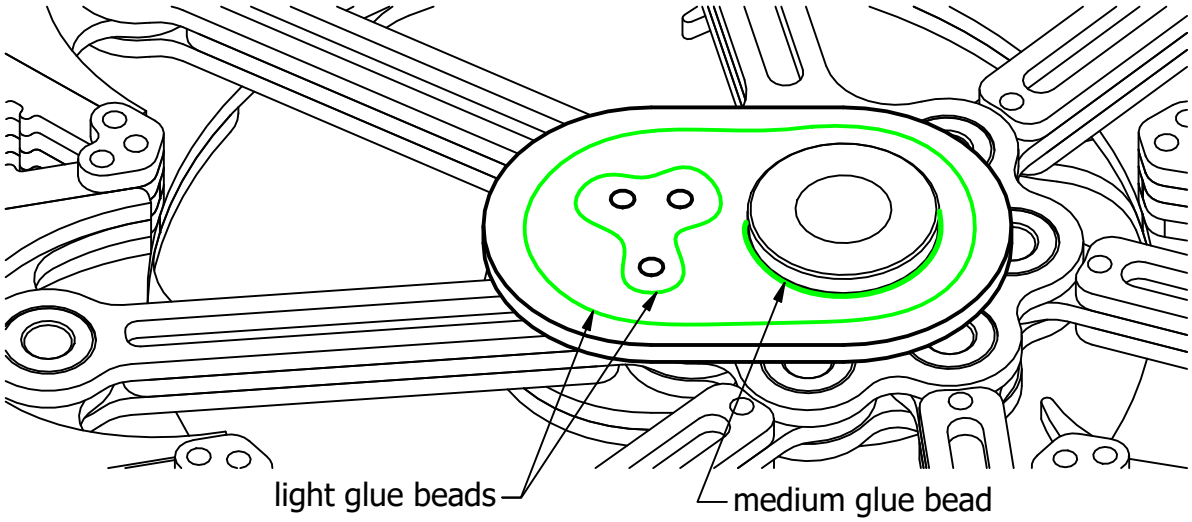
Crank, Forward Journal

Reference Aids



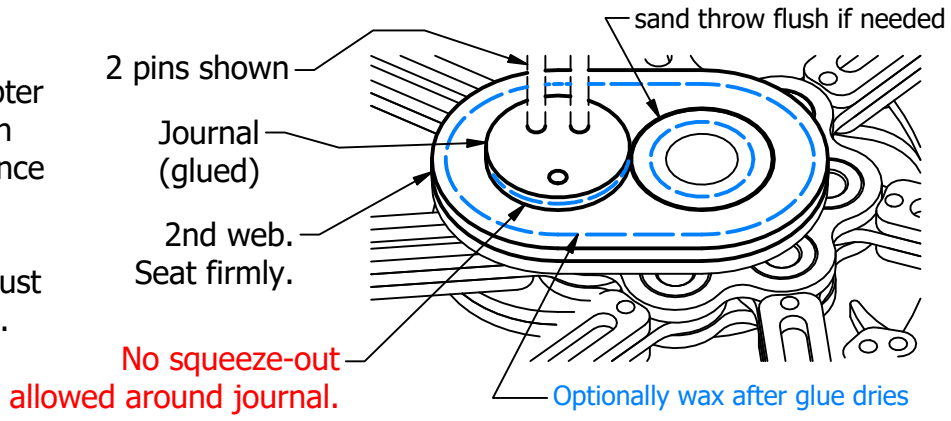
Note - alignment pins used on forward crank are glued in permanently.

Thin one or both of the forward crank webs, just as you thinned the other crank webs. Optionally, wax the back of one of the webs. (You can tell which side is the back by the orientation of the three holes.) Press the crank web down over the throw as shown below. Manually align the edges of the forward crank web with the edges of the crank web in the rear of the case. Spread glue as shown.

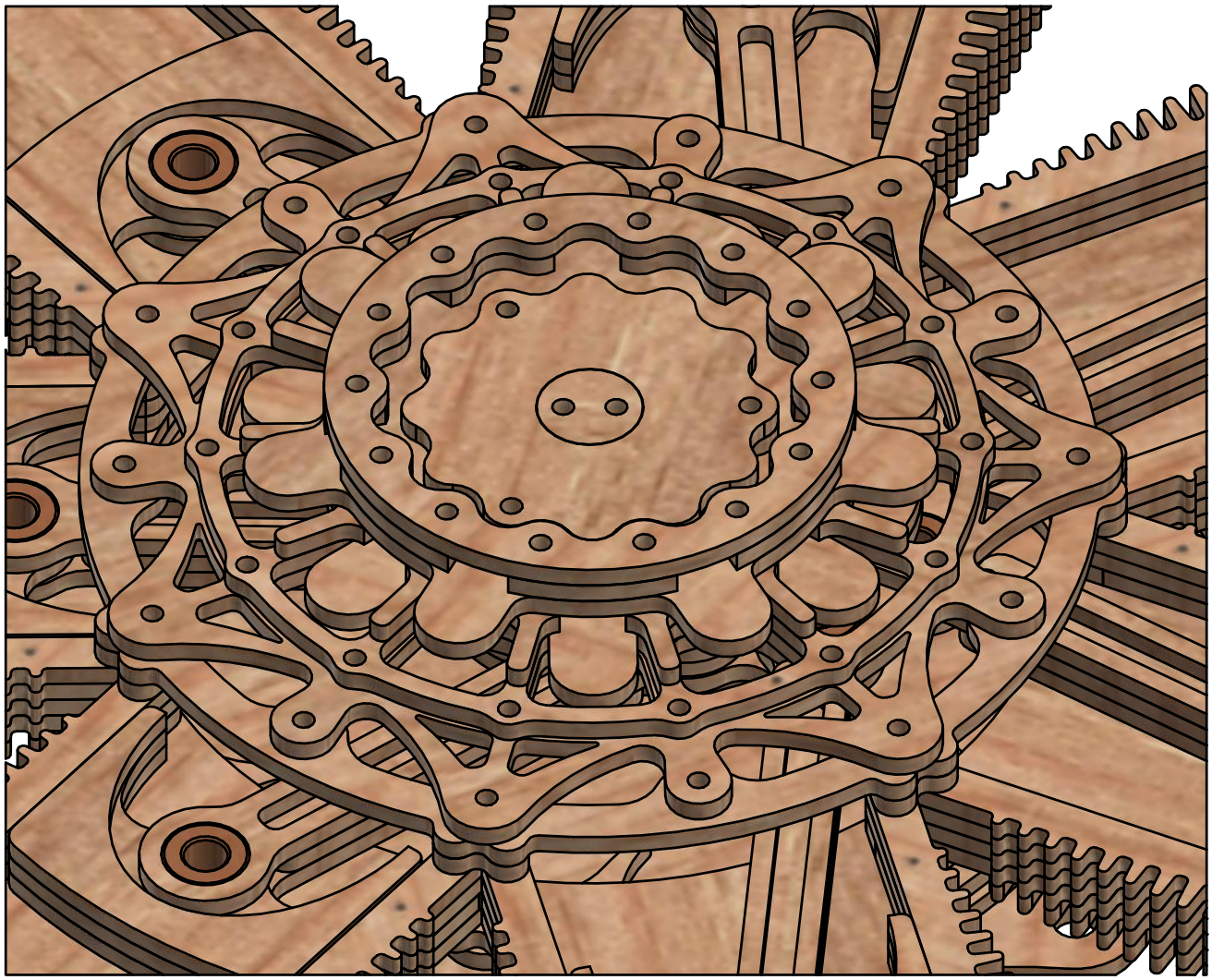


Place the second crank web over the first, sandwiching the glue. Use three 1/8" locator pins in the three holes. (They should be at least 3/4 inches long.) These become a part of the structure, so make sure they don't extend behind the web to interfere with the movement of the rods. Glue the forward crank journal down over the three pins in the position shown. Ensure at least some of the glue gets on the pins, to lock them in place.

Before the glue has a chance to set, dry fit the ring and valve adapter from the next page with locator pins (the reference parts shown). This will let you check the alignment of the crank. Adjust now if needed. Let dry.



Section 5: Valve Case



Rotary engine valves were often very innovative. LeRhone engines featured push/pull valve assemblies where a single rod activated both exhaust and intake valves. The Gnome Mono-soupape engine featured a single valve that did double duty as exhaust and partial intake. The Clerget series of engines - which our model most closely follows - used an internal gear with lobes on every fourth tooth. While ingenious solutions, all of these sytems suffered from shortcomings that relegated their use to these historic engines.

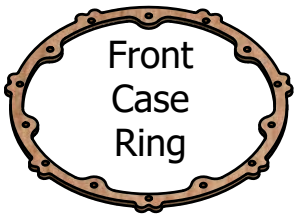
1. Push/Pull valve assemblies did not allow for valve overlap and high speed operation.
2. The single intake/exhaust valve did not allow for engine throttling. (Full throttle only!)
3. Both the Push/Pull rods and the Clerget system used on this model created excessive valve clearances and hammering action that limited speed and long-term reliability.

It is said that the Clerget engines often required rebuild at 5 hours. This type of TBO* was satisfactory when airframes were designed to last 25 hours. It was no longer acceptable when aviators came to expect long lives. The amazing diversity of design has given way to a much more reliable, but much more uniform and less colorful world.

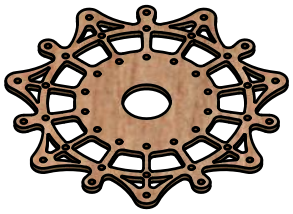
*TBO is the recommended "time before overhaul." Modern aircraft piston engines typically get about 2000 hours.

5-1: Valve Case

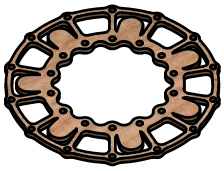
Parts:



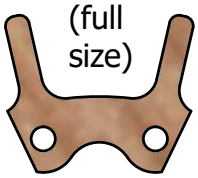
Valve Case Adapter

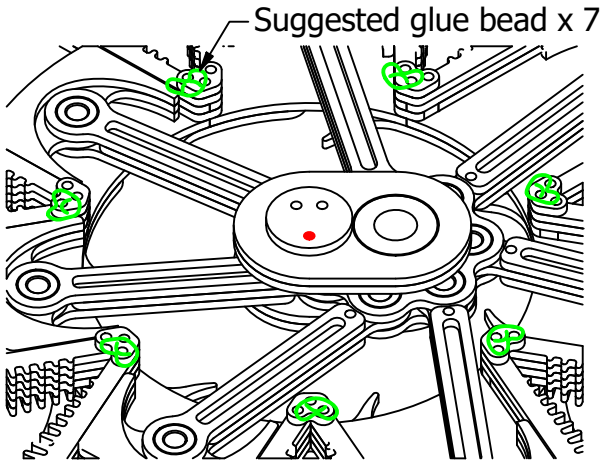


Intake Gear, External



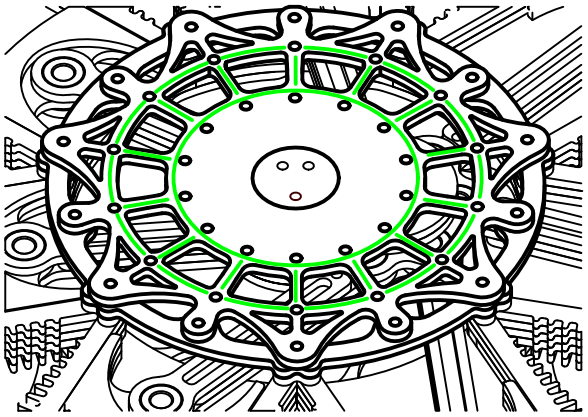
Intake Gear, Segment **x 7**



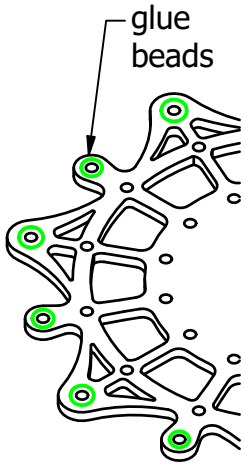


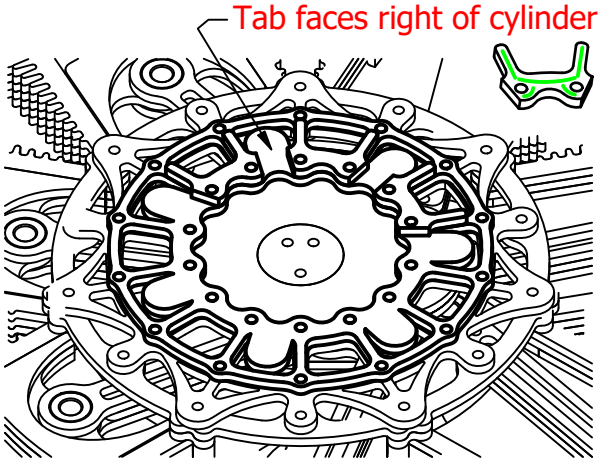
Trim the bottom alignment pin on the forward journal, and sand it flush. This is shown in red. Leave the other two locator pins (not shown) long at this time.

Add glue to the 7 inner cap pieces as shown. Glue the front case ring into place on top of them, using locator pins for alignment. Remove the pins as soon as it is practical to do so. The front case ring is shown in place on the next view.



Place thin beads of glue on the back of the adapter as on the right. Invert and glue down over the front case ring as on the left, using locator pins. Again, remove these pins as soon as it is practical. Check to make sure that the engine can still spin before the glue dries.



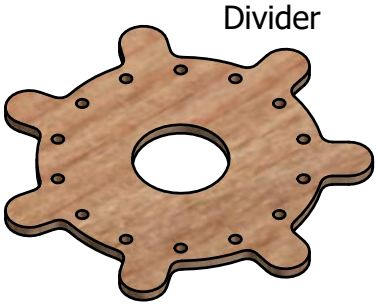


Right of cylinder is intake (non-scoop) side.

Based on the suggested glue bead in the middle picture, glue the intake gear down over the adapter ring. Make sure the tab faces to the right side of the top cylinder. Again, use and remove locator pins for alignment. Finally, add the seven intake gear segments to the growing valve case, spreading glue as shown, then inverting onto the stack. Three are shown in position on the left.

5-2: Valve Case

Parts:



Inner Valve
Gear x 2

Valve Actuator
x 2

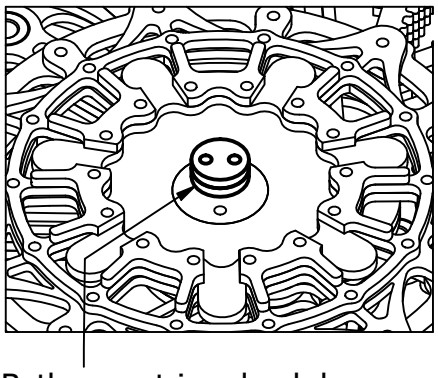
Valve
Eccentric
x 2
(Full Size)

Both inner valve gears will need to be thinned. Sand them the same way you sanded the valves and the crank webs. The valve actuators are then glued to the inner valve gears using three locator pins, and avoiding any squeeze-out. Do both, but only one of these will be used in this step.

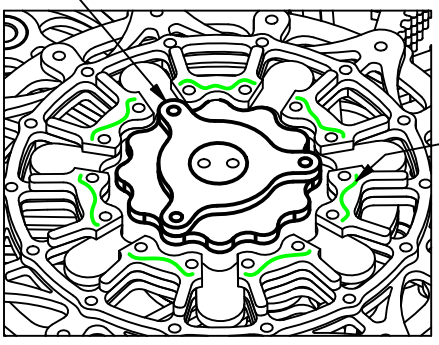
DO
x 2

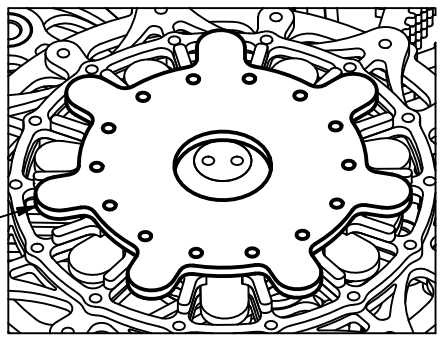
Apply glue to actuator as shown. Invert, and glue to inner gear, using locator pins for alignment.

Optionally wax the top of the actuator as shown. Also, wax the bottom and bore of the actuator. Then, glue the two eccentrics in place over the two locator pins still remaining in the crank journal as shown below. Avoid any glue squeeze-out.



Both eccentrics glued down. The two locator pins glued into the assembly are not shown, but are still jutting out. Don't trim them yet!





Warning - if the actuator is set in the wrong position, the valves won't work. You cannot change this later!

Valve case divider glued down over glue beads. Use locator pins to aid in alignment. Note that the tabs face the exhaust (left, scoop) side of the cylinders, and are staggered between the tabs already on the engine.

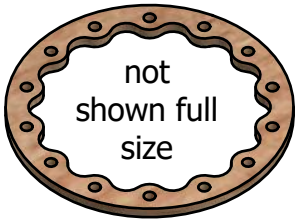
5-3: Valve Case

Parts:

Exhaust Gear Segment x 7

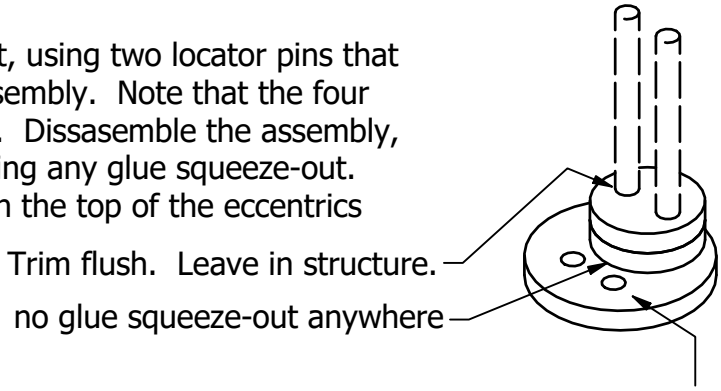
Valve Eccentric x 2

Eccentric Web

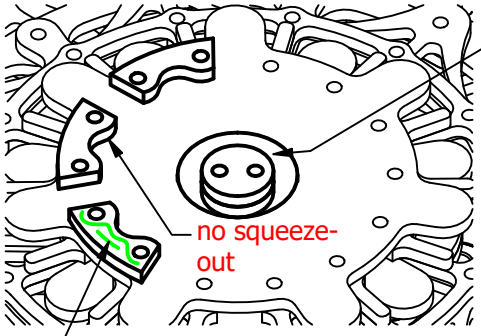


Exhaust Gear, Outer

Dry fit the asssembly shown on the right, using two locator pins that will become a permanent part of the assembly. Note that the four holes in the web are not interchangable. Dissasemble the assembly, and glue all of the parts together, avoiding any glue squeeze-out. Trim and sand the locator pins flush with the top of the eccentrics when the glue has dried.



suggested glue



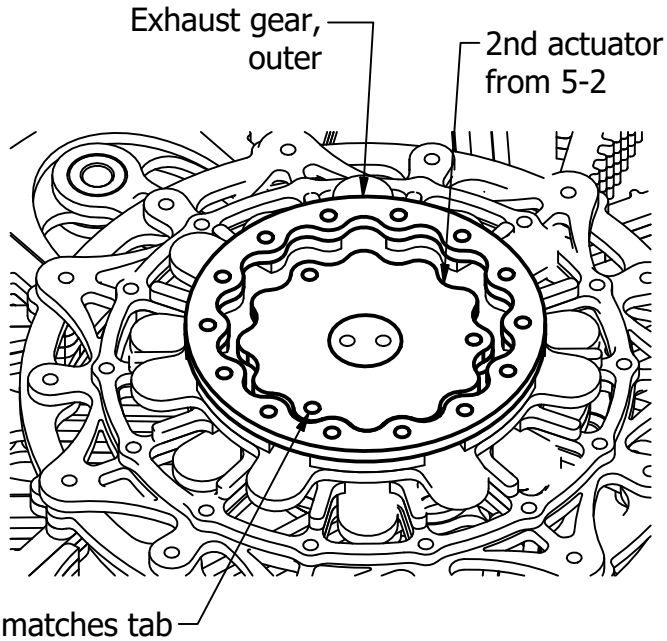
Not visible. Trim alignment pins and sand flush with the top of web on the eccentric assembly.

Set the eccentric assembly in place over the alignment pins still glued in the engine. (This part may be glued if desired, or simply set in place.) Trim the alignment pins flush with the upper surface of the web, so that the two pins engage firmly with the assembly you just made, but do not interfere with the actuator assembly shown in the diagram below. Sand flush.

Glue all 7 exhaust gear segments into position around the case divider. Use alignment pins. Make sure there is no squeeze-out. (3 are shown above.) Apply a thin bead of glue to the segments, and set the outer exhaust gear as shown on the right. Again, use your pins.

Optionally wax the top, bottom, and bore of the actuator as you did on the previous page, then set it as shown on the right. Note that it is up-side down compared to the last one.

The holes should match the tabs on the bottom, rather than the lobs on the top. Note there are two positions this can fit. This will be set later.



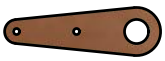
6-1: Valve Train

Parts:

Rocker Arm, Inner x 14

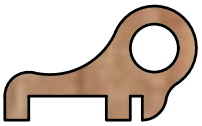
Rocker Arm, Outer x 28

Valve Lifter, x 14



Pushrod End, x 28

Spacer, x 28



Rocker Arm, Holder x 14

Pushrod, Intake x 7

Pushrod, Exhaust x 7

Rocker Arm, Pivot x 14

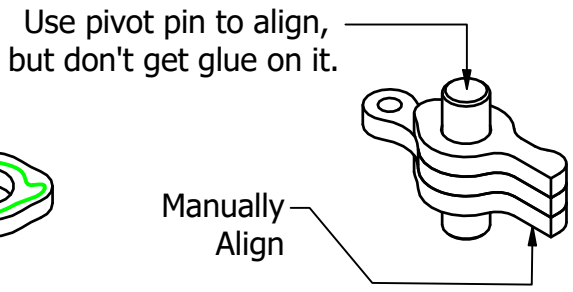
Pivot is 1/4" D by ~1 inch long

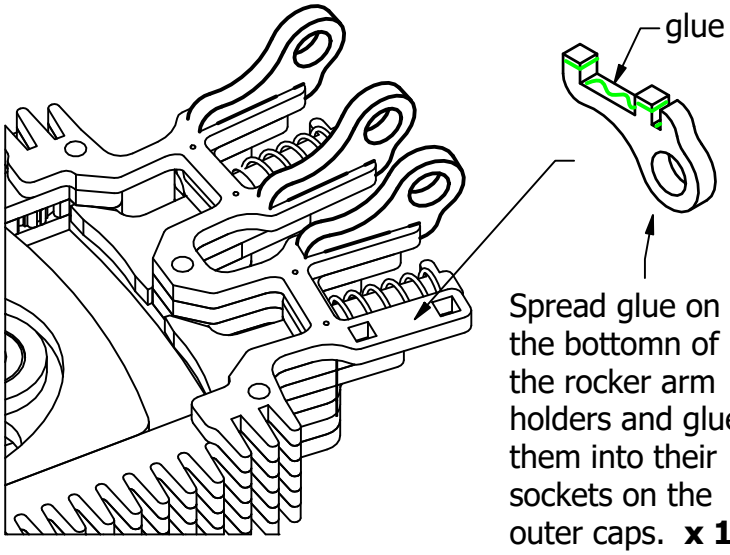
Note: Early models do not distinguish between the two types of rods. This results in a little extra sanding.

There are a lot of small parts in the valve train. Count them carefully. You should have extras.

Rocker Arms x 14:

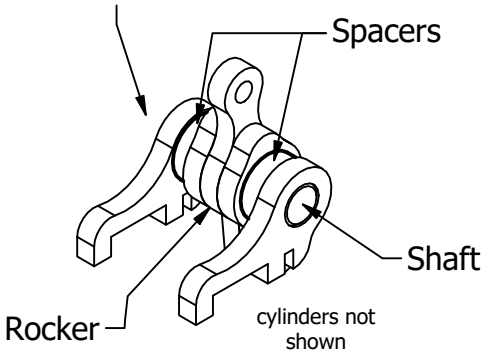
(this page and next)





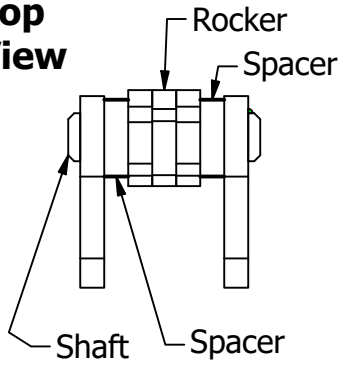
Spread glue on the bottomn of the rocker arm holders and glue them into their sockets on the outer caps. **x 14**

After the holders are glued to the caps, insert the shaft through one side, through a spacer, through a rocker arm, another spacer, and then through the other hole.

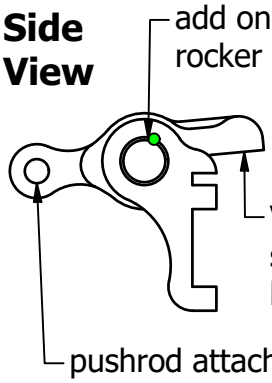


6-2: Valve Train

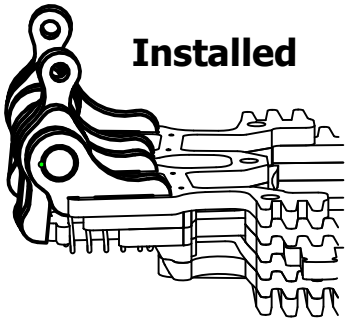
Top View



Side View



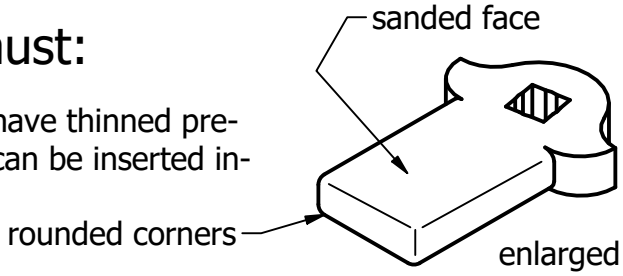
Installed



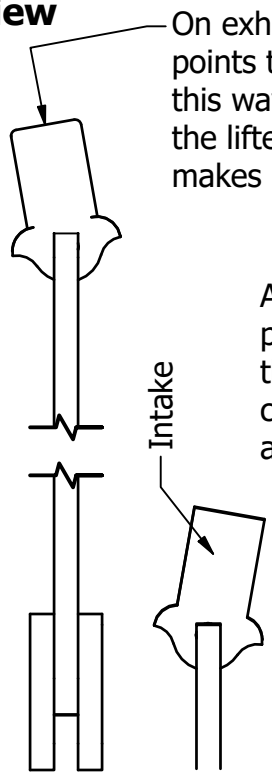
Once all 14 rockers are in position, place a small drop of glue at each side of the arm on the outside of the frame. Ensure rocker arms are orieted correctly to actuate valves.

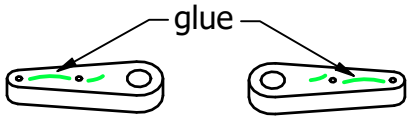
Pushrods - 7 intake and 7 exhaust:

Begin by thinning the valve lifters, much as you have thinned previous parts. Gently round the end, so that they can be inserted into the valve lifter slots in the valve case easily.

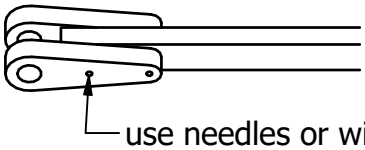


Top View





All the pushrods are terminated with a pair of pushrod ends. Put the glue on the ends, then use needles or cut paper clips as alignment pins to glue togther as shown on the right.



Once the ends are dry, glue the lifters to the pushrods. Make 7 of each kind, paying attention to the angle of the lifter to make sure you have the right type. Glue the end of the rod securely into the socket on the lefter. Let dry.

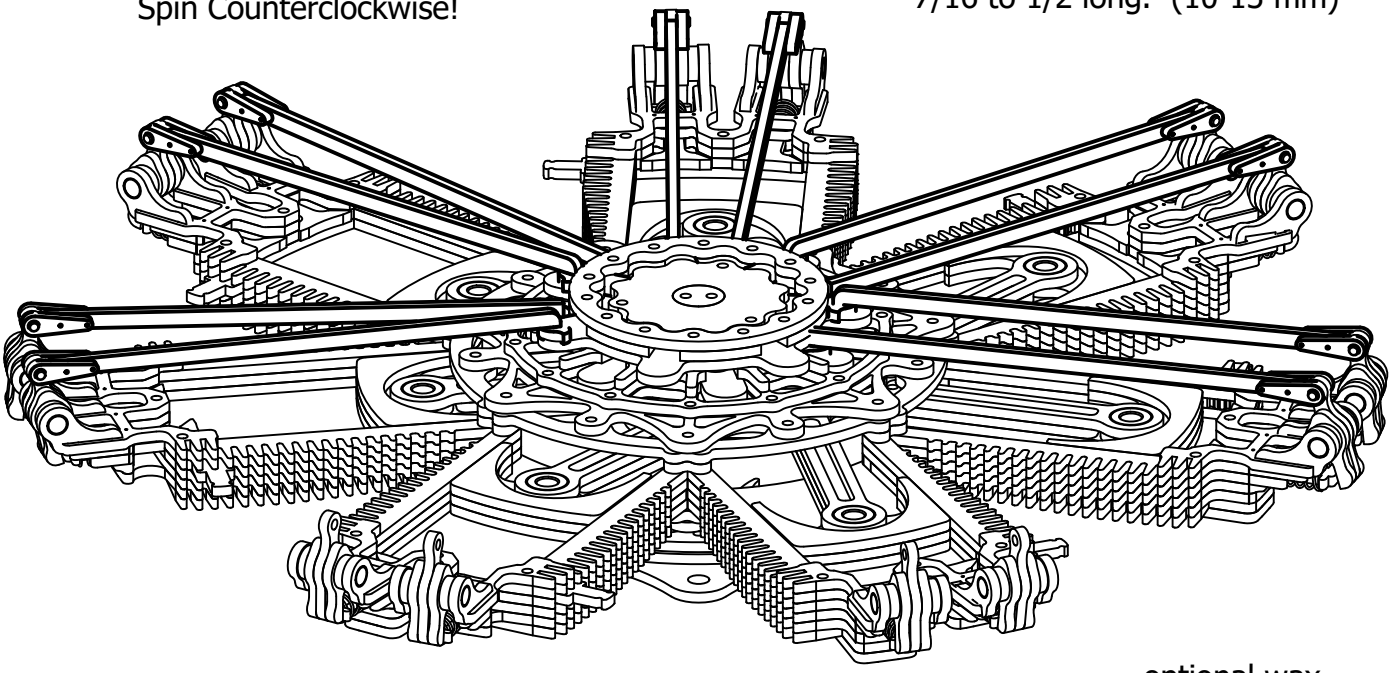
6-3: Valve Train

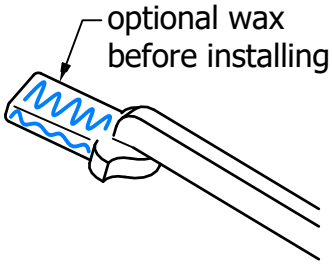
Fitting the Pushrods

Parts

Pin x 14
Cut from 1/8" dowel rod,
7/16 to 1/2 long. (10-13 mm)

Engine is designed to
Spin Counterclockwise!





Once the pushrods are done, they need to be fit to the engine. If you are waxing your parts, wax the top, bottom, and sides of the valve lifters. Then, beginning with the intake (lower) rods, insert the lifters into the slots above the tabs. Gently pull back on the rockers to allow the rods to slide past them when in the correct orientation. Not all of the lifters will go all the way into the valve case, as the actuators are installed. This is not proof that your engine is working. Pin the ends of the rods over the rocker arms using the pins you just cut. Do not glue the pins in place, as this will prevent adjusting the valves. Install all 14 rods.

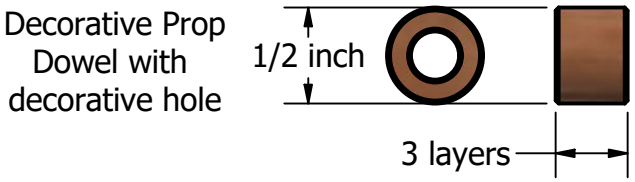
Now it is time to make sure your upper actuator is set on the proper tooth. Gently spin the engine, and follow a single cylinder on its path. You should clearly be able to see the four strokes in order - intake, compression, power, and then exhaust. The intake valve should open slightly before the exhaust valve closes - or at least immediately after. If the upper actuator is on the wrong tooth, the exhaust valve will open immediately after the intake. (This would make the engine run backwards.) Should this be the case on your engine, gently lift the upper actuator gear out of its socket, and then rotate it by two full teeth. Manually open the valves necessary to return the actuator to its position.

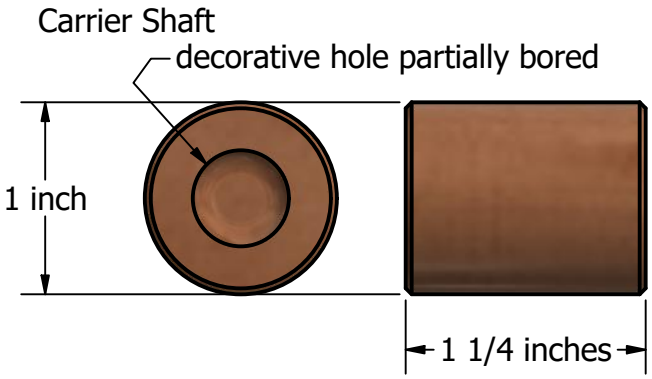
Note - if the actuator is off by one tooth instead of two teeth, none of the valves will open.

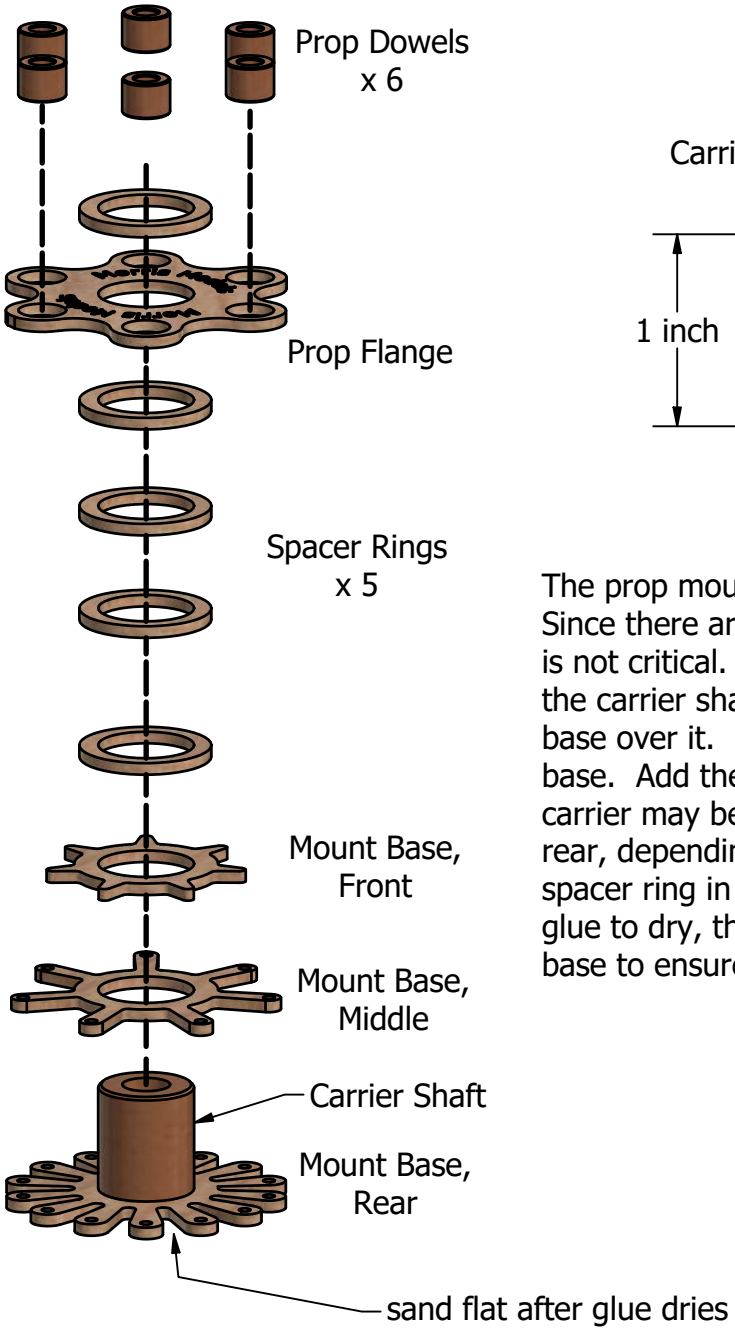
7: The Prop Mount

On rotary engines, the prop is secured directly to the crankcase. The mount is typically a light weight structure that extends the prop a little forward of the engine, often allowing for a semi-circular cowl to cover the top half of the engine.

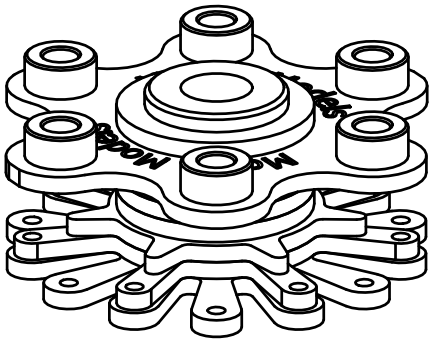
Parts:







The prop mount is assembled around the carrier shaft. Since there are no moving parts, how the glue is used is not critical. There is also no reason to use wax. Set the carrier shaft on a flat surface, and push the rear base over it. Glue the base to the shaft and the middle base. Add the front base and four spacer rings. The carrier may be installed with the test forward or to the rear, depending on your preference. Glue the forward spacer ring in place, and add the dowel pins. Allow the glue to dry, then sand the bottom face of the bottom base to ensure it is absolutly flat.



8: Complete the Model

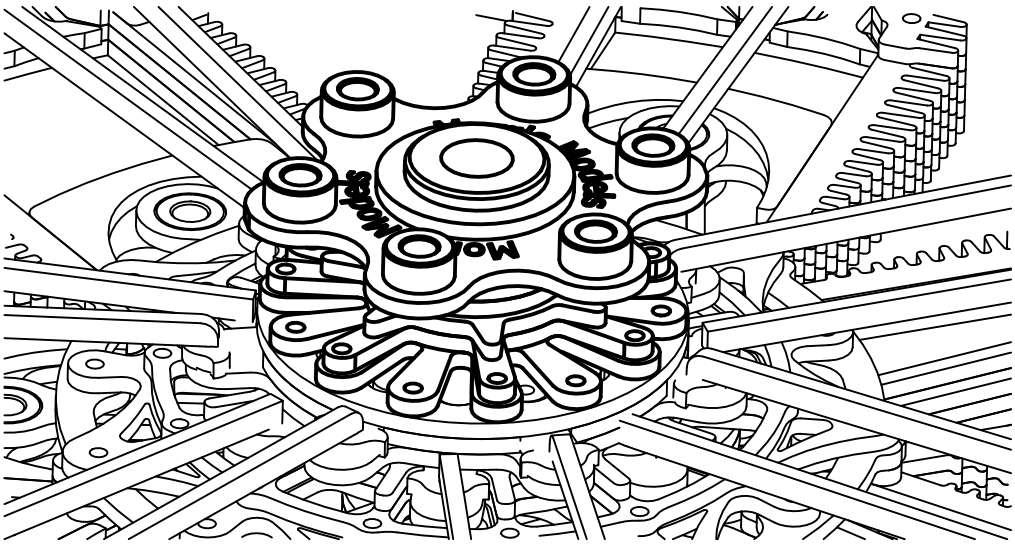
Temporarily attach the prep carrier to the front of the model, using small bits of dowel pins or a few #6 panhead wood screws (not included). Ensure that everything moves properly. Nothing should stick. If it does, gently sand and/or wax to make sure everything moves.

Once everything moves properly, carefully observe the valves. Because of the way the valve system works, the length of the pushrod affects each valve's timing. If the pushrod is slightly long, the valve will begin opening early, and will close late. If the pushrod is too short, the valve will open late and close early. The valves open and close properly when there are a few degrees of travel on the engine when both the intake and the exhaust valves are opened at the same time. This "valve overlap" is an important part of an engine's design, and allows the engine to breate easier and spin faster.

You can adjust the valve overlap on your engine by sanding material off of the end of the lifter. This will decrease the valve overlap. Gently sand the end of the lifter, making the pushrod shorter. Sand a little, and then do a trail fit. It is easy to sand material off, but much more difficult to put it back on. If you do sand too much off, either replace the lifter with a spare, or glue thin wood shavings to the end of the lifter. Then adjust again.

Once you are happy with the valve overlap, you may wish to glue the 1/8" pins that join the pushrods and the rockers. Use only a tiny dab of glue, set on the outside. I personally do not glue these on my engines. I have seldom had problems with them falling out.

When you are finally happy, it is time to attach the prop carrier. It may be glued in place for maintenance free operation. However, consider using a few pan head wood screws as described above. This will allow you to remove the prop carrier and demonstrate the historical valve mechanism.



Thank you for building this model. We hope it has been a fun and educational project. If you have enjoyed yourself, consider checking out some of our other models.