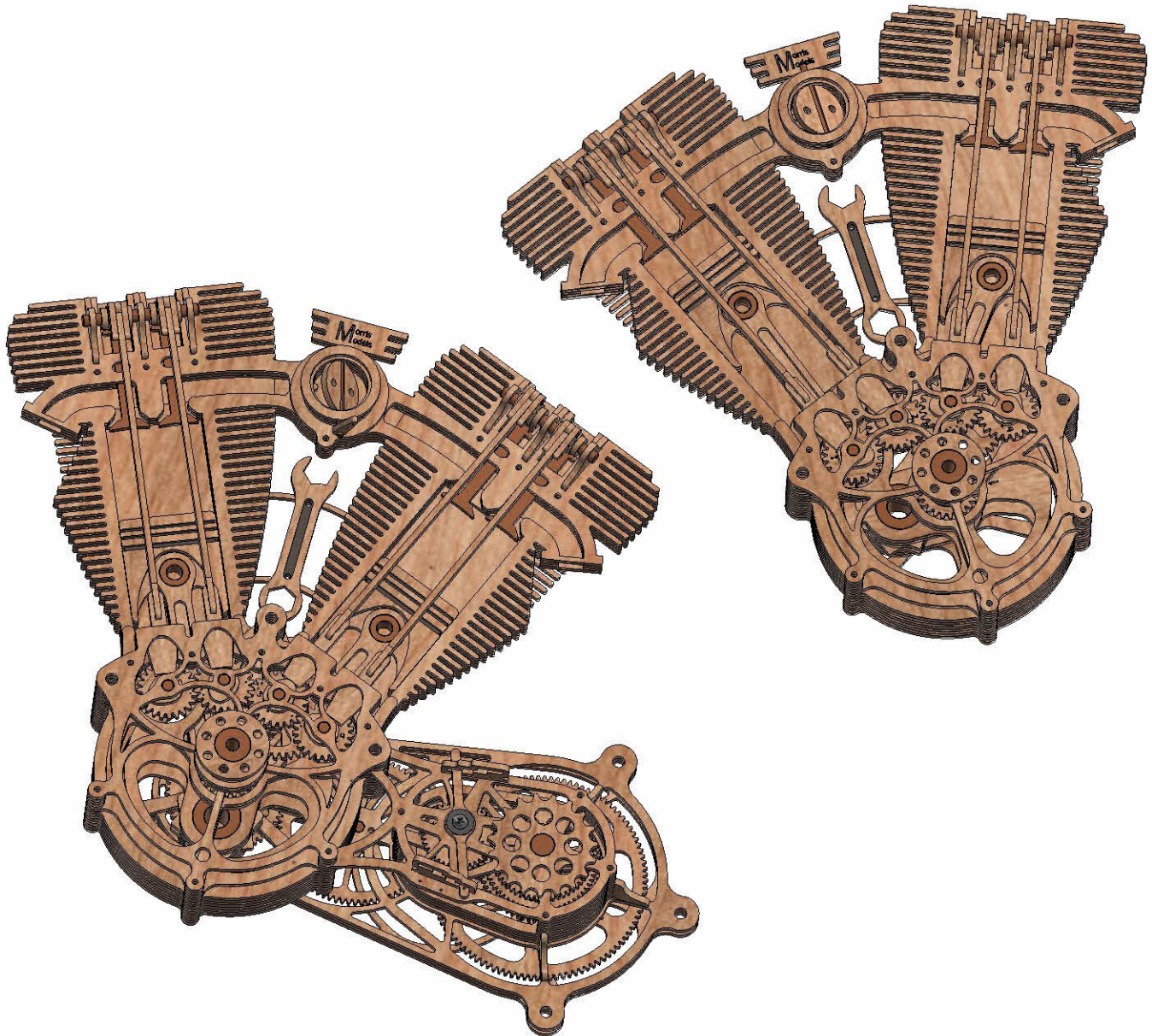


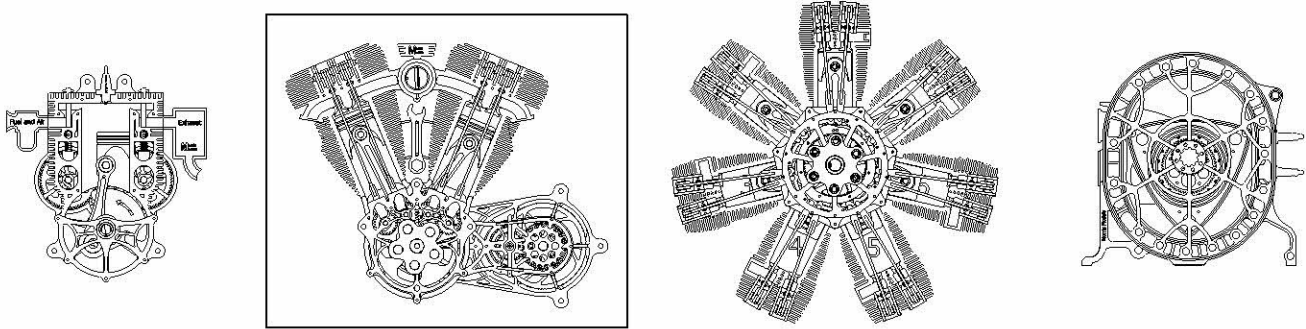
V-Twin Engine Assembly Instructions

Build your own "Sportster" style V-twin engine with functioning pistons and valve train. This model has been rearranged and flattened for wall display.



This kit may be assembled with or without the optional three speed functional transmission. Almost all of the engine parts are identical.

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 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.

Many of the parts for this kit are cut from round dowel rods. These form the engine and transmission 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 1/4" 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.

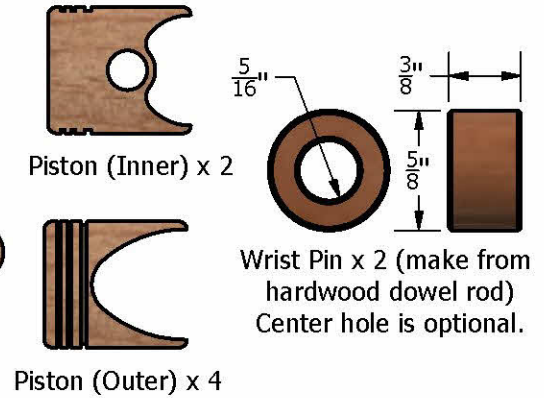
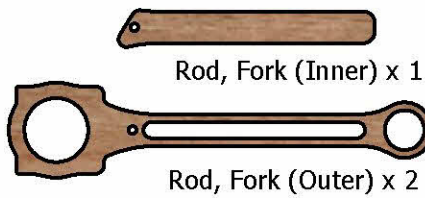
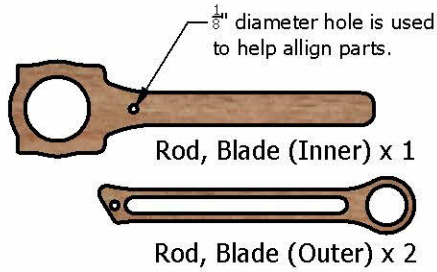
Real engines use oil to keep them sliding smoothly. This wooden engine model would be ruined with oil. Most people use wax when assembling these wooden engine kits to help the parts slide smoothly. This step is optional. I have used candle wax and I have used colored crayons. Either of these will work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

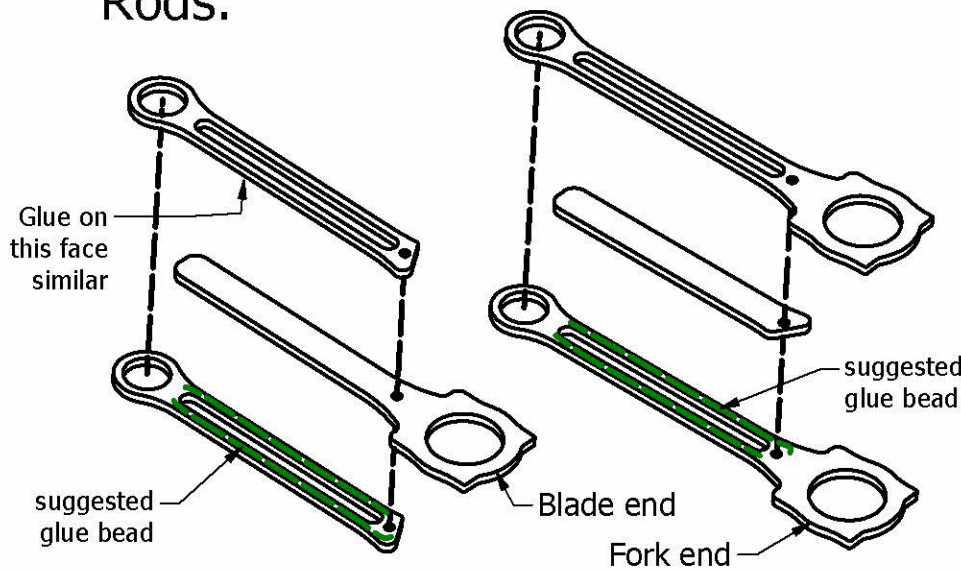
I hope you enjoy building this kit. If you do, you may want to consider building some of the other model kits. We have several more models available on the web site, and we add another model every few months - so check back.

1) The Rods and Pistons

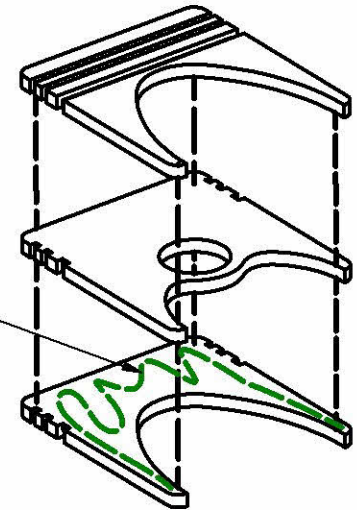
Parts:



Rods:



Pistons x 2:

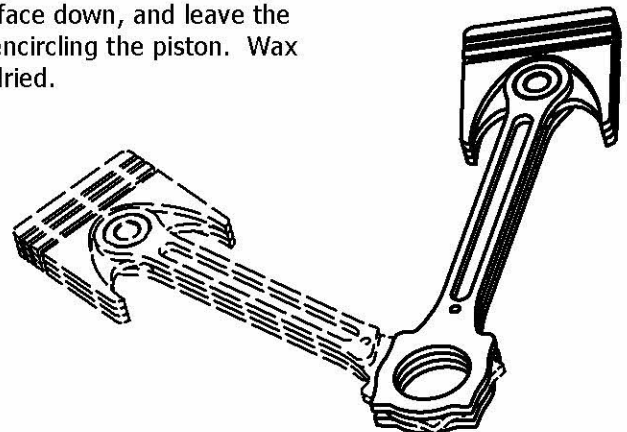


1st Rods should be assembled over a 1/8" dowel (small hole) and wrist pin (large hole) for alignment. Dowel may be permanently glued in place in the assembly, or it may be removed after the glue has dried. Spread glue on the outer rods, and not the inner ones. Wax blade and fork areas of the rods after the glue dries.

2nd Assemble pistons as shown. Turn one engraved piston face down, and leave the other facing upright. This will give the illusion of rings encircling the piston. Wax the entire surface of the piston assemblies after the glue has dried.

3rd Fabricate the wrist pins from 5/8" Diameter dowel rod, cut to 3/8" long. Drilling a 5/16" hole in the center of the pin will make it look much more like the real thing.

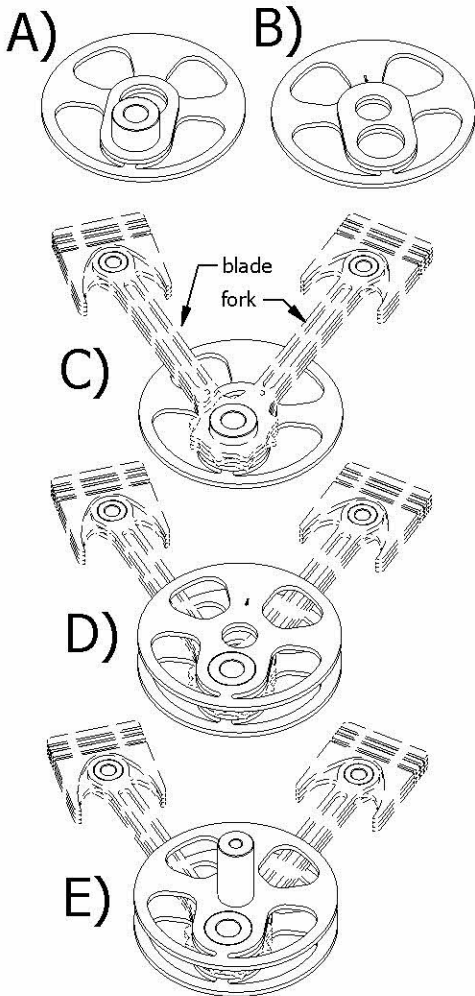
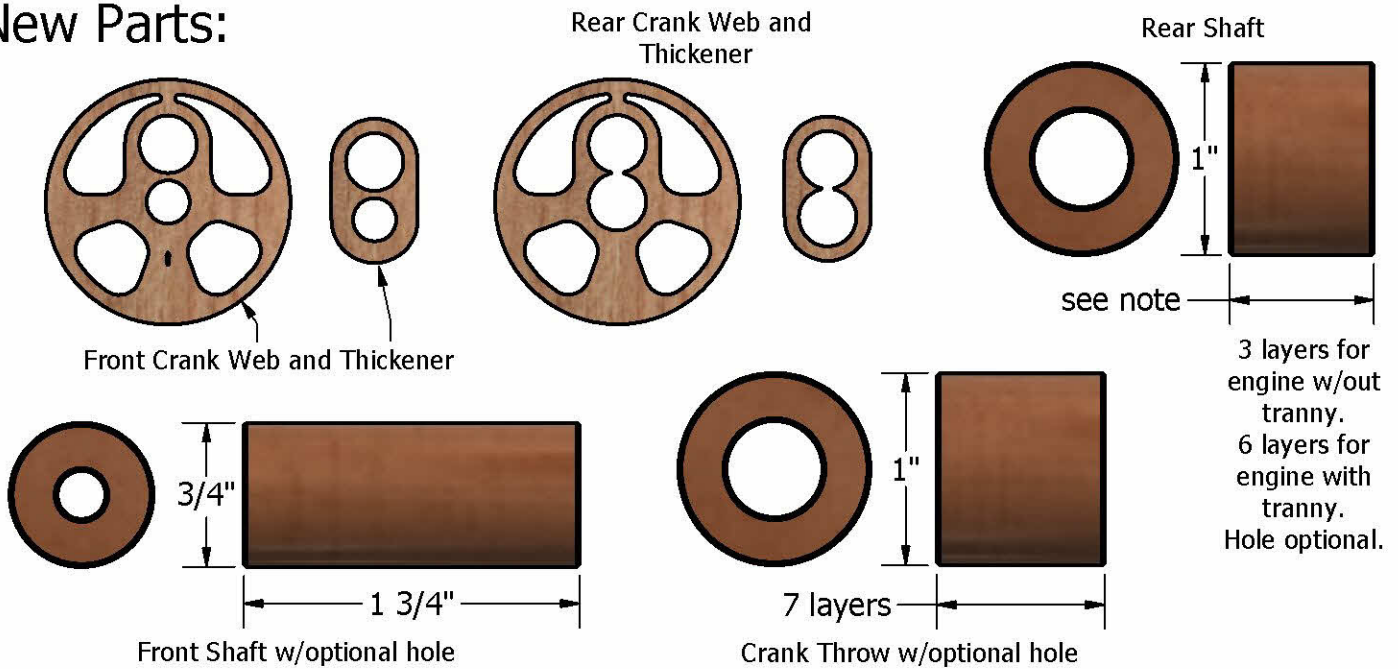
4th Assemble pistons and rods as shown, inserting the blade into the fork and gluing the wrist pins to the rear of the rod only. Pistons should be able to pivot freely.



Assembly:

2) The Rotating Assembly

New Parts:



Both web thickeners should have a thin layer sanded off before assembly, leaving them about 1/32" thinner. This will allow clearance for the rods in the engine. Spread glue on the web thickeners, and then glue them to the crank webs as noted in A (the rear) and B (the front). Carefully glue crank throw into the position shown in the rear assembly, also seen in A. Take care to minimize glue squeeze out. Make sure that any glue squeeze-out is removed from both sides before continuing. This is easier to remove before it dries.

After the glue on the crank throw has dried, wax the face of both the front and rear web thickeners. Place the rod and piston assembly from the last step over the throw, noting the orientation shown in C. The blade rod should be towards the left, and the fork rod should be towards the right.

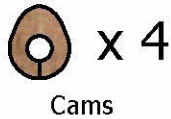
Next, put a few dabs of glue into the throw socket on the front web and thickener. Working carefully to avoid gluing the front web and thickener to the rods, bring the front web and thickener down over the crank throw. Twist gently from side to side. When the assembly bottoms on the rods, add a little glue to the upper surface, if practical. Your assembly should now look like D. Make sure that the front and rear webs are aligned perfectly before allowing the glue to dry. Also, make sure that the rods can pivot on the throw, and no glue has stuck them in place. Move them every few minutes while the glue dries to ensure they remain free.

After the glue has dried, make sure that the rods can move freely, and that the crank throw does not protrude beyond the surface of either the front or rear web. Should it protrude even a tiny bit, sand the entire surface of the web until it is flat.

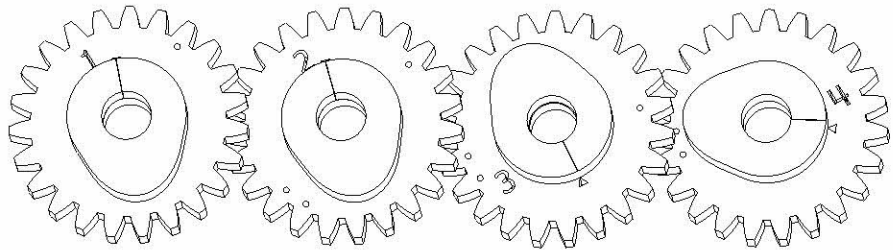
Finally, glue the front shaft into its socket and the rear shaft into its socket. The front shaft is visible in E. Take care that the glue is not pushed down inside either socket so that it contacts the rods. The shafts must be firmly glued to the webs, but may not be glued to anything else. Clean up any glue from around the edges of the shaft. The entire assembly should be checked for straightness, and set aside to dry.

3) Cams and Cam Driver

Parts:



Cam Gears
numbered 1-4



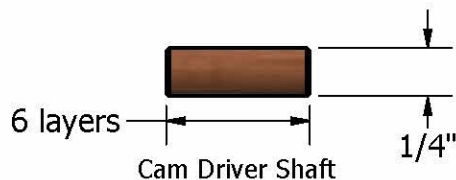
See section on timing for more views

Assembly:

Cams and cam gears may be temporarily placed over a 1/4" dowel rod for alignment while assembling. Spread glue on the back of cams, and glue to each of the timing gears as shown. Take care to avoid glue squeezeout in the bore of the gears. The line on the cam opposite the lobe should align with the arrow on each gear - best seen on cam 3 in the figure above. Make sure not to glue the cams to the backs of the gears. The numbers and marks go all the way through. Look at which way the numbers face to tell which is the front.

When complete, wax sides and front face of cams, rear face of gears, and bores of gears 1,2, and 4. DO NOT WAX BORE OF CAM/GEAR 3. Cam gear 3 must be glued to its driven shaft at a later time.

Parts:

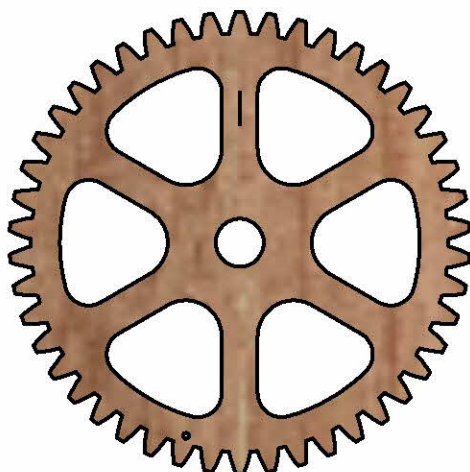


Assembly:

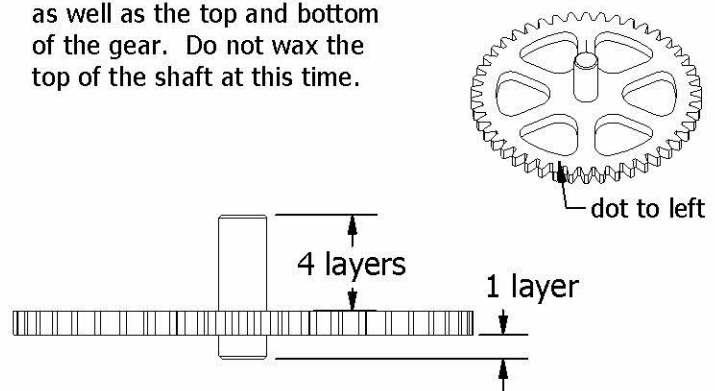
Glue the driver shaft into the gear bore, taking care not to allow any glue squeeze out on either side. Make sure the cam driver gear is right side up, which you can see from the dot shown on the bottom left of the gear. Identify the top of the gear by the line cut in the gear spoke.

Make sure that the shaft is glued tightly. If this joint fails, the valves will no longer move. When the shaft is in place, it should extend four layers above the gear, and 1 layer below the gear. Allow the glue to dry.

Wax the bottom of the shaft as well as the top and bottom of the gear. Do not wax the top of the shaft at this time.



Cam Driver Gear



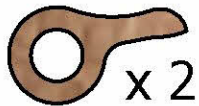
4) Rocker Arms and Pushrods

(Instructions for 1 - build 4 of each)

Parts:

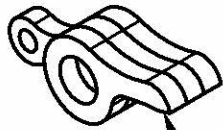


Rocker Arms, Inside



Rocker Arms, Outside

Assembly:



cam lobe face

Rocker arms should be assembled over a 1/4" dowel rod to aid in alignment. Spread glue on the outside arms, and glue to the inside. Avoid glue squeeze-out in the bores. Wax the bores after the glue dries. Wax on the cam lobe face is also good.

Parts:

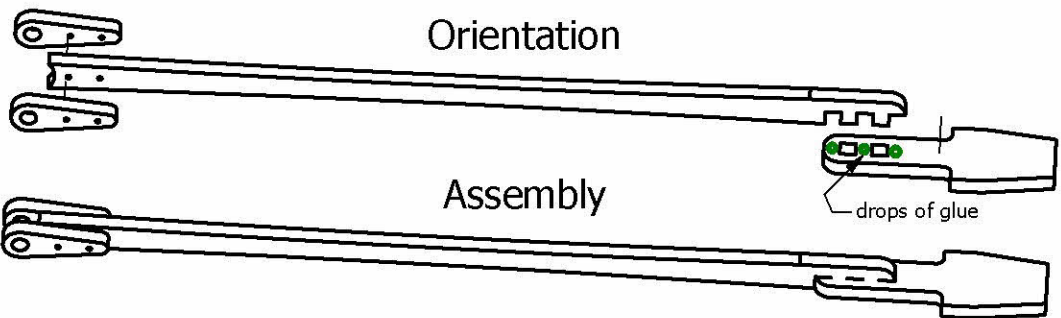


Pushrod



Pushrod Ends

Assembly:



drops of glue



Valve Lifter
(Tappet)

The pushrods and pushrod ends have 1/32" holes for alignment purposes. These holes are likely to be full of debris, which must be pushed out before assembly. A small piece of wire or an unfolded paper clip works well.

Spread glue on the rod ends, but avoid the area around the 1/8" holes, which must be able to engage the holes on the rocker arms. Assemble the rod ends using small wire nails or the end of a straightened paper clip as appropriate. Alignment is also helped by the use of a short section of 1/8" dowel rod. Clamping with a rubber band is quite effective for these parts.

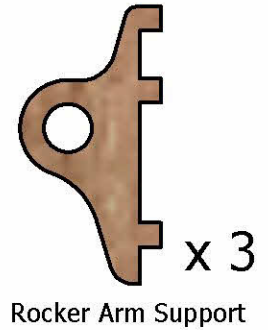
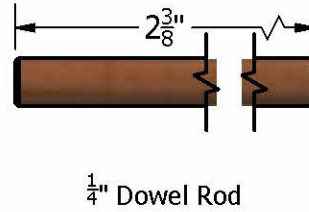
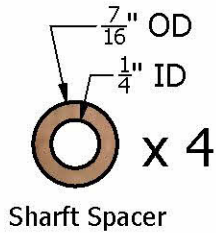
Secure the valve lifters to the end of the pushrods by means of 4 small drops of glue - one on the curving side of the lifter, and the other three on the face of the lifter where the rod will contact. Rubber bands are also effective clamping devices here.

Note: The valve and lifter assemblies are deliberately cut slightly long for the engine. This will allow them to be adjusted for valve clearance in the final fitting. Unlike real valve lifters, these lifters have tapered sides. This allows them to function more easily without oil. Wax the sides, front, and back of the valve lifters after the glue has dried.

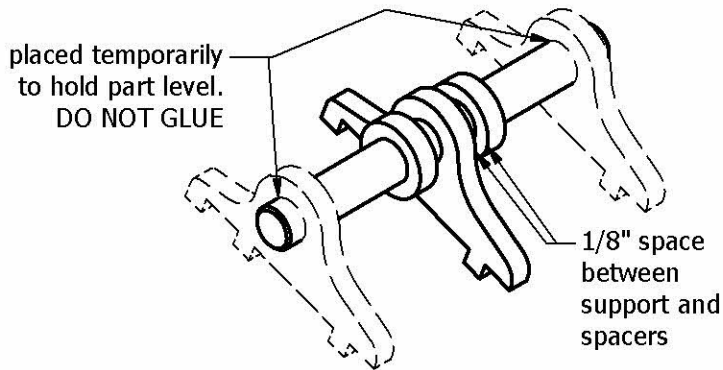
5) Rocker Arm Supports

(Instructions for 1 - build 2)

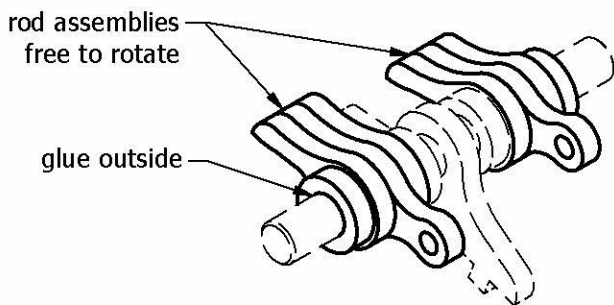
Parts:



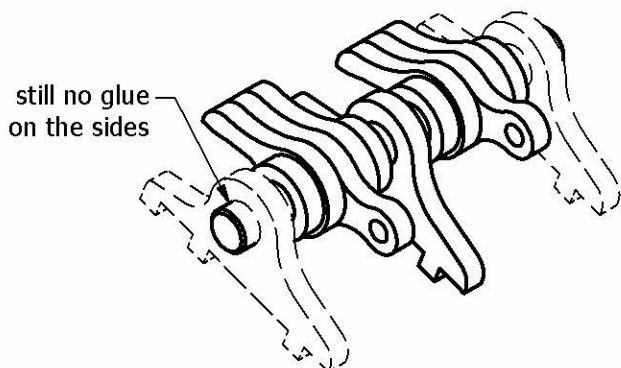
Assembly:



1st Glue one support to the center of the dowel rod. Glue shaft spacers onto each side of support, leaving a 1/8" space between the support and the spacers on each side. Slip the other supports onto each edge while the glue dries. Make sure that the dowel rod has no glue in the area where the rocker arms will go.



2nd After the glue dries from the last step, slip one rocker arm over the dowel rod on each side. Pay careful attention to the direction. The arm with the hole should be on the side with one nub. Glue another spacer to each side, so that the rocker arms can pivot, but can't move from side to side.

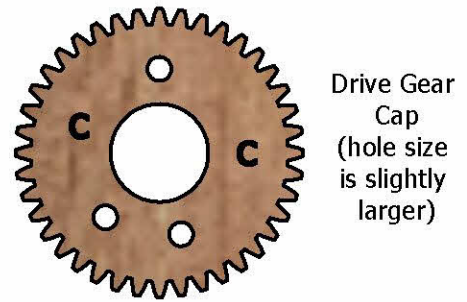
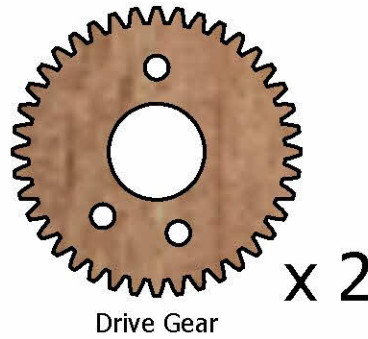
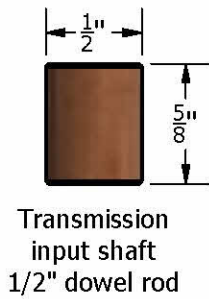


3rd Slip a support back over each side. Do not glue at this time, as final spacing will be set later.

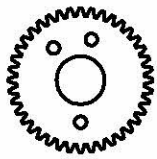
6) Transmission Gear Prep

(for transmission models only)

Parts:



Assembly:



Place drive gear upside down on a piece of waxed paper as shown. Note holes for orientation.



Glue shaft into the drive gear.



Use three 1/8" rods to align the second drive gear on the shaft. Glue to both the first gear and the shaft.

rods extend 1 layer below face



Glue cap gear over the rods. Make sure no squeeze-out enters the bore of the cap gear.

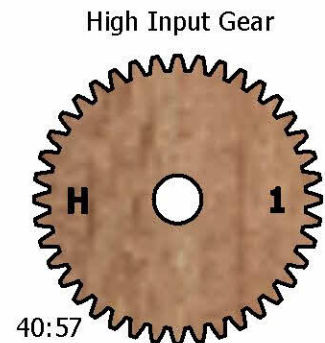
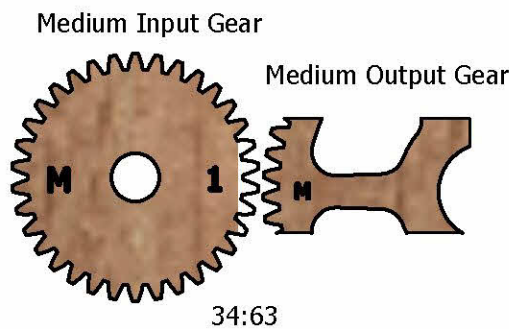
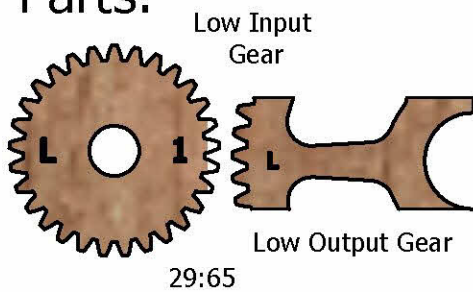
end of final drive shaft will ride in this socket

Wax front and rear of gear assembly, and also in final drive socket. DO NOT WAX INPUT SHAFT.

Bevel Gears

All six of the gears shown here should be sanded to a slight bevel around the edges. This will allow them to run smoothly. These gears will now be called L-1, L-2, M-1, M-2, H-1, and H-2.

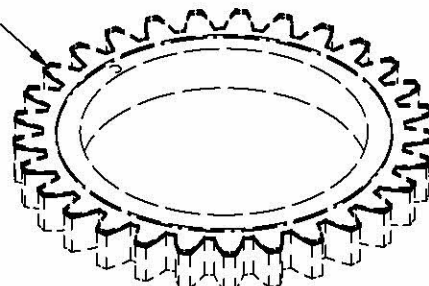
Parts:



Low input gear shown as a typical example. Sand the edges to about 5°, and extend past the edge of the teeth.



Remove less than one plywood layer

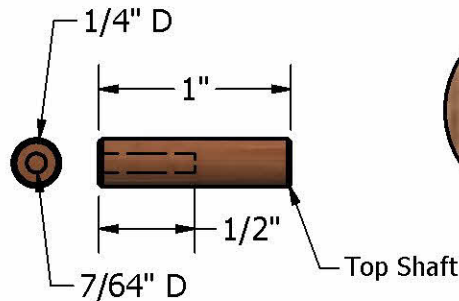
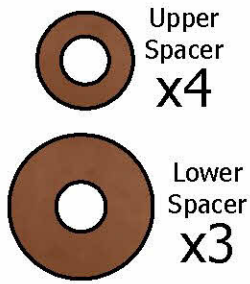


Your bevels will likely be much more round than these computer generated views. This is not a problem.

7) Moving Gear Tree

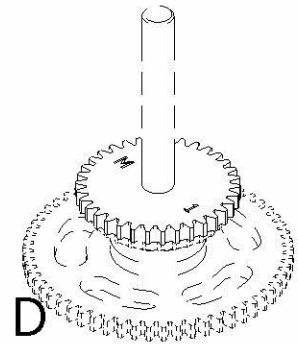
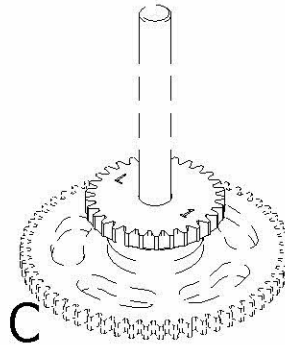
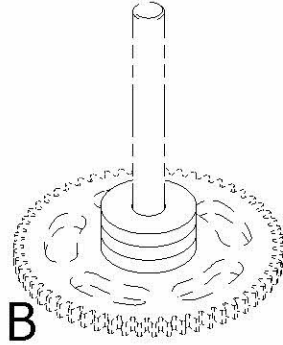
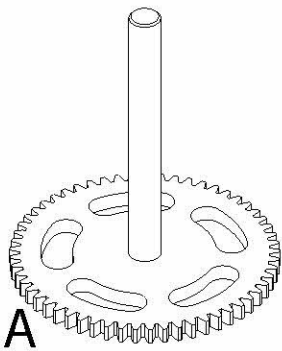
(Transmission Models Only)

Parts:

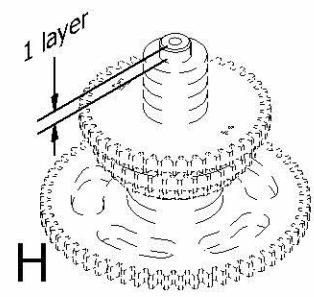
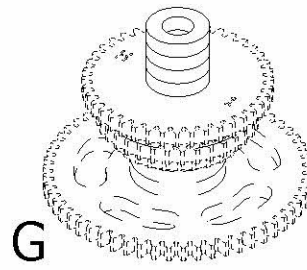
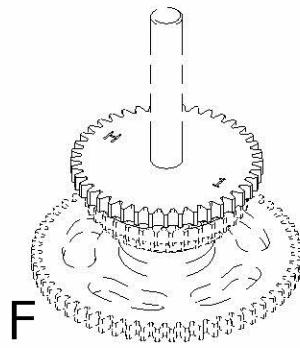
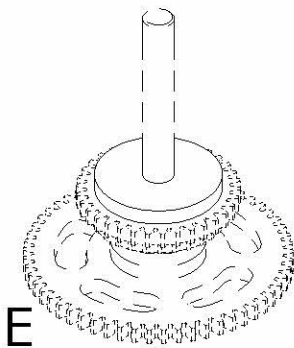


Assembly:

You will also use L-1, M-1, and H-1 Input Gears, beveled as in step 6.



Slip a piece of 1/4" dowel into the slider gear, as in A. Try not to glue any of the parts to the dowel rod, as it will be removed from the final assembly. Glue 3 lower spacers to the slider gear and to each other, but not to the shaft (B). Glue on the L-1 gear (C) and L-2 gear (D).



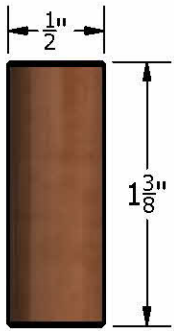
Continue gluing parts to the assembly: the gear spacer (E), the H-1 gear (F), and the 4 upper spacers (G). Before the glue has a chance to dry, remove the 1/4" dowel rod (also G). Allow assembly to dry before gluing the top shaft (H) into the space left by the dowel rod. The small hole should face upwards, and it should stick out 1 layer above the top upper spacer. All of the glue should be inside the assembly - there should be no squeeze-out visible on top of the upper spacer. Again, allow the glue to dry.

8) Fixed Gear Tree

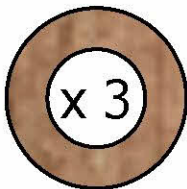
(Transmission Models Only)

Parts:

L, M, and H Output Gears, bevelled as per page 6



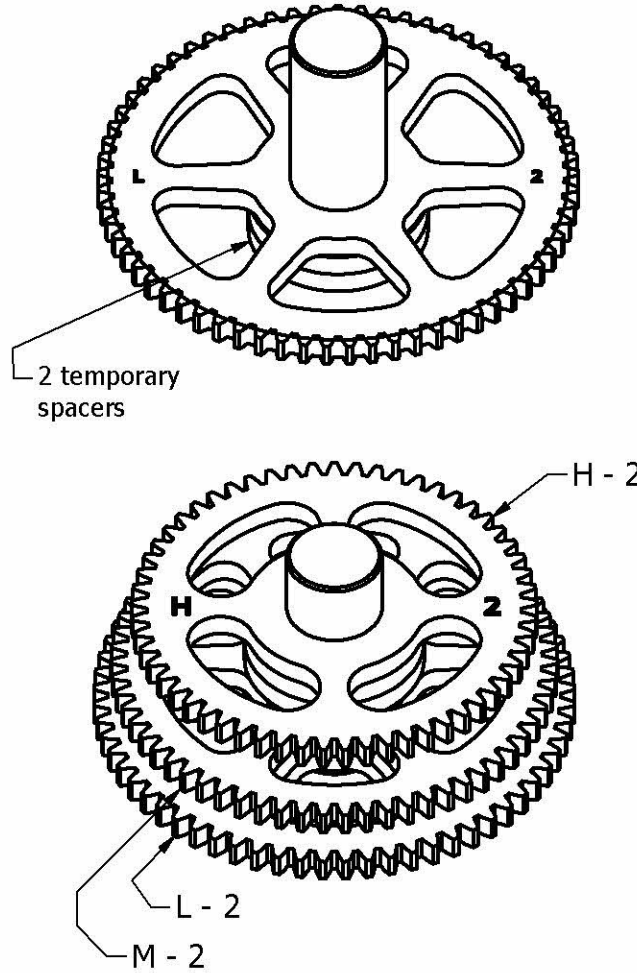
Shaft - $\frac{1}{2}$ " dowel rod



Rear Shaft Spacer

(use 2 more as temporary spacing tools.)

Assembly:



Using 2 spacers as a depth guide, glue the largest gear (L - 2) to the shaft. Make sure the two spacers don't get glue on them, and can come back off.

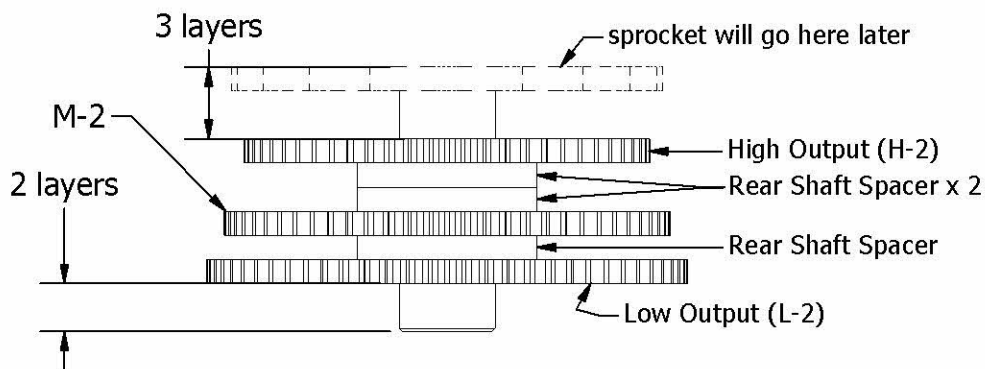
Glue a spacer (S-1 in the diagram below) over the shaft and the largest gear.

Glue the medium sized (M - 2) gear to the stack.

Glue two more spacers to the stack.

Glue the final (H - 2) gear to the stack. Make sure that there is no squeezeout on the shaft.

Remove the two bottom temporary spacers, and set assembly aside to dry.



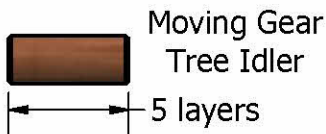
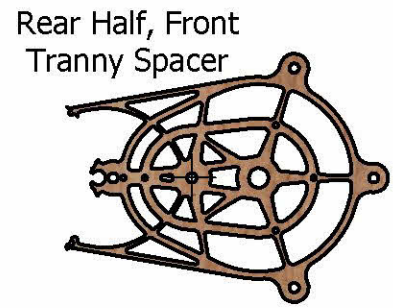
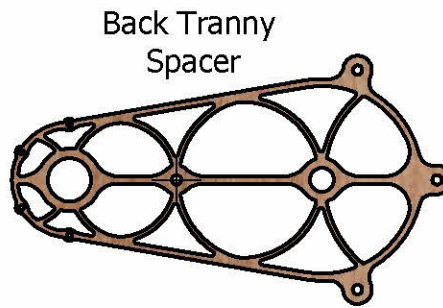
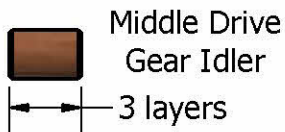
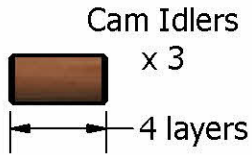
Wax $\frac{1}{4}$ " extending shaft, base of other side shaft, and both outside gears. DO NOT WAX area where sprocket will attach later.

9) Idler Shafts

(Cam base only for engine w/out tranny.)

Parts:

Note: All idler shafts are undrilled 1/4" dowels.



Assembly:

Set the Cam Base flat on the table in front of you, oriented as shown. Carefully glue the 3 cam idler shafts into the sockets shown. Avoid any glue squeeze out. If you are building the transmission engine, do the same for the Back Tranny Spacer and Front Rear Half Tranny Spacer.

