

American Stirling Eco-Power Stirling Engine Kit

www.stirlingengine.com

(SKU=Eco-Power)

Power this engine with nothing more than a cup of steaming hot coffee. The Eco-Power engine is perfect as a fascinating and thought provoking gift and ideal for educational demonstrations from middle school science to college thermodynamics classes.

Tools and Supplies

needed to complete this kit.

Hammer

1/16th" Drill Bit

Epoxy

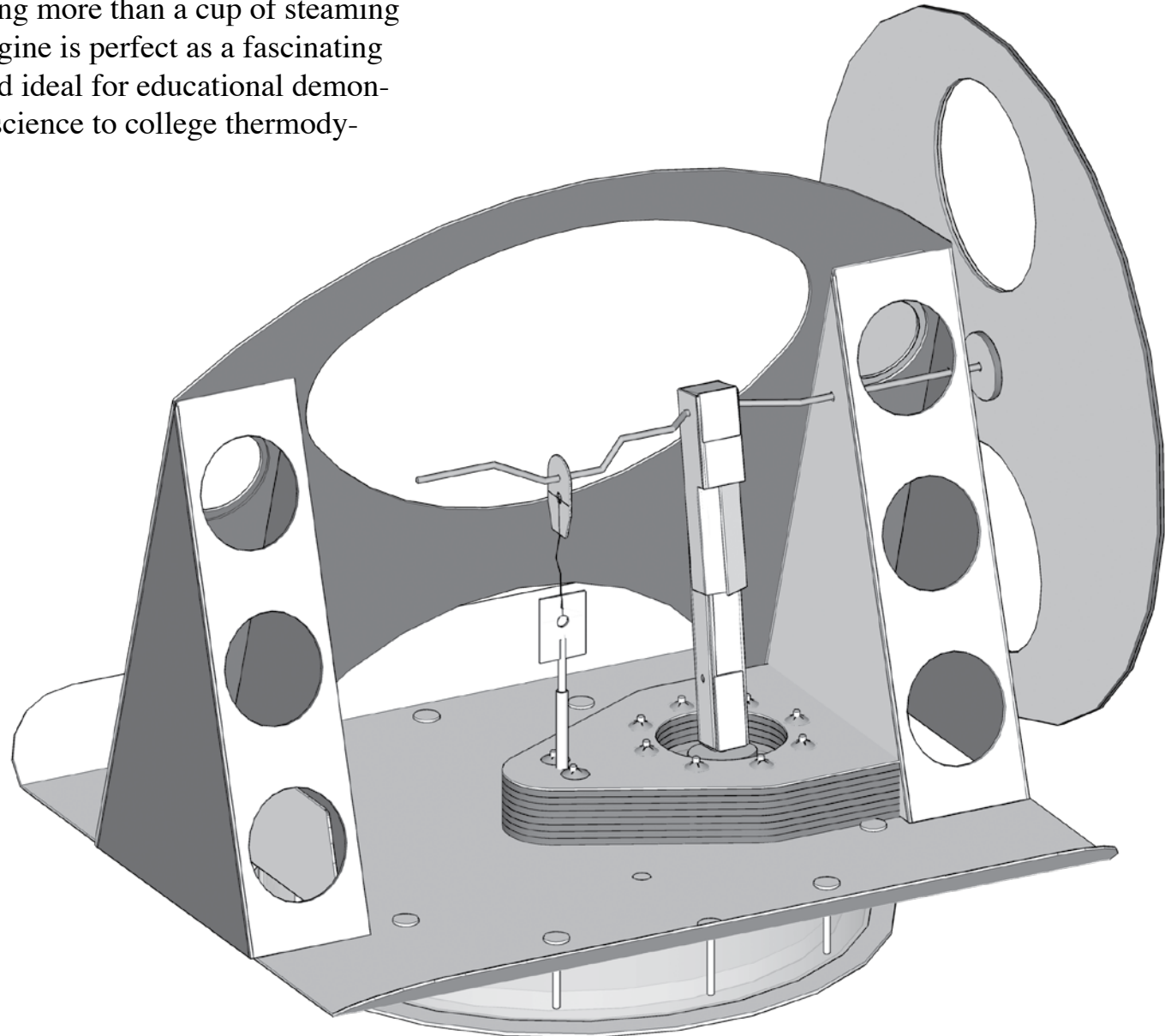
White Glue

Cyanocrylate Glue

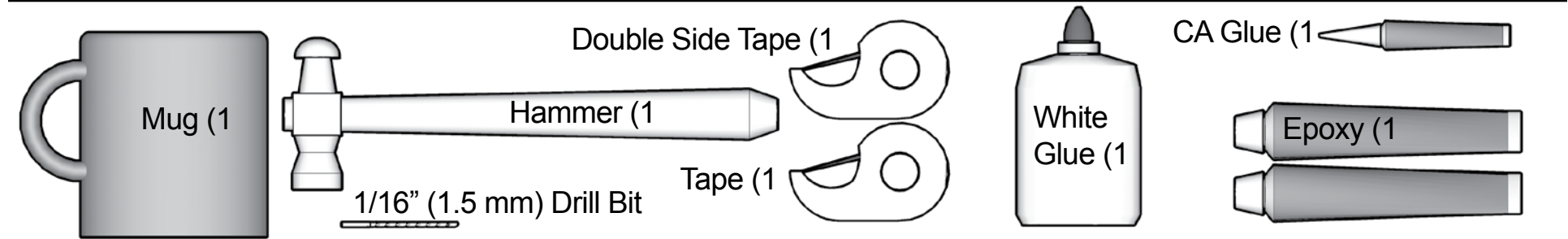
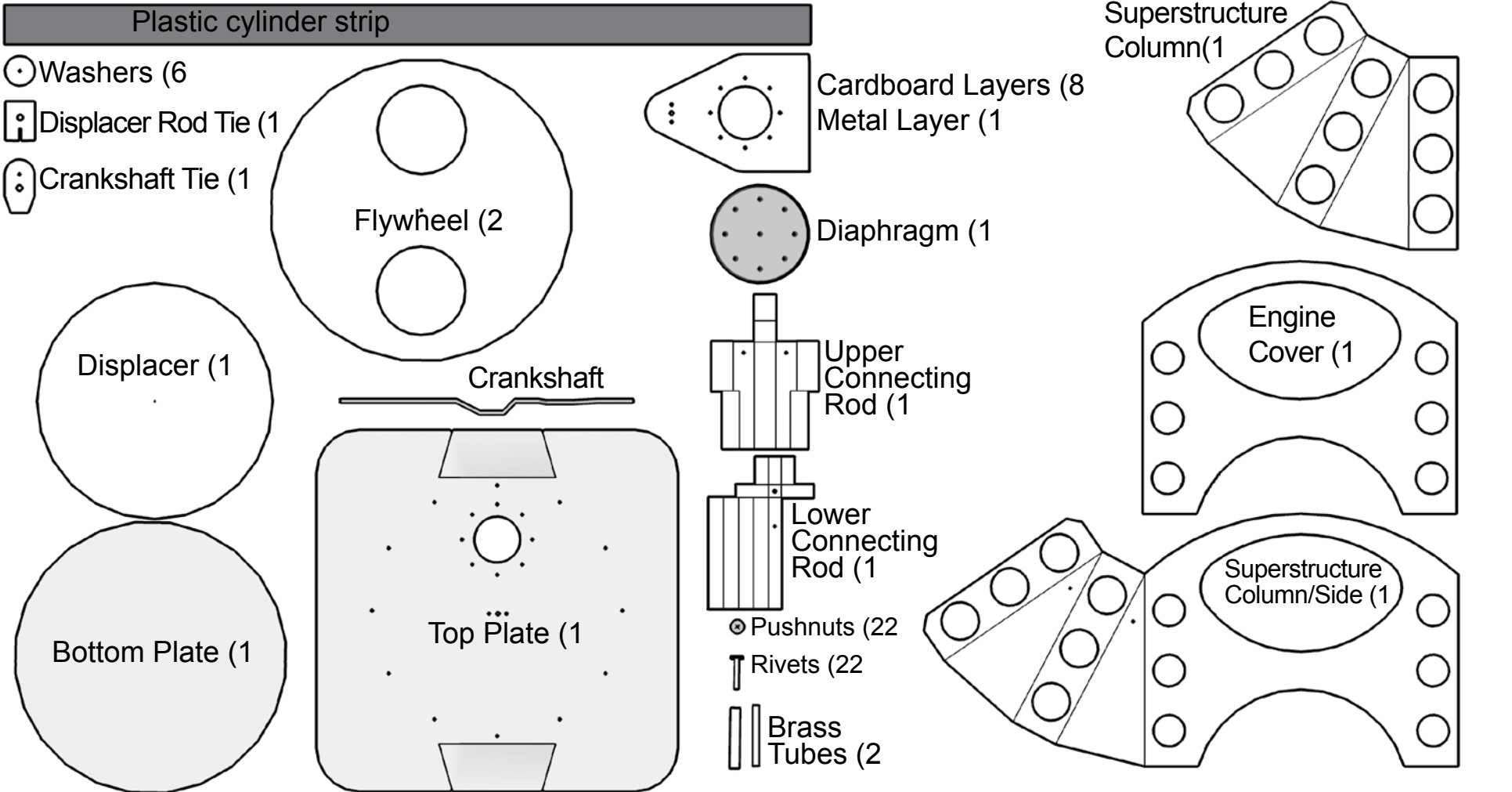
Double Sided Tape

Tape

A Mug



0) Engine Parts and Necessary Tools

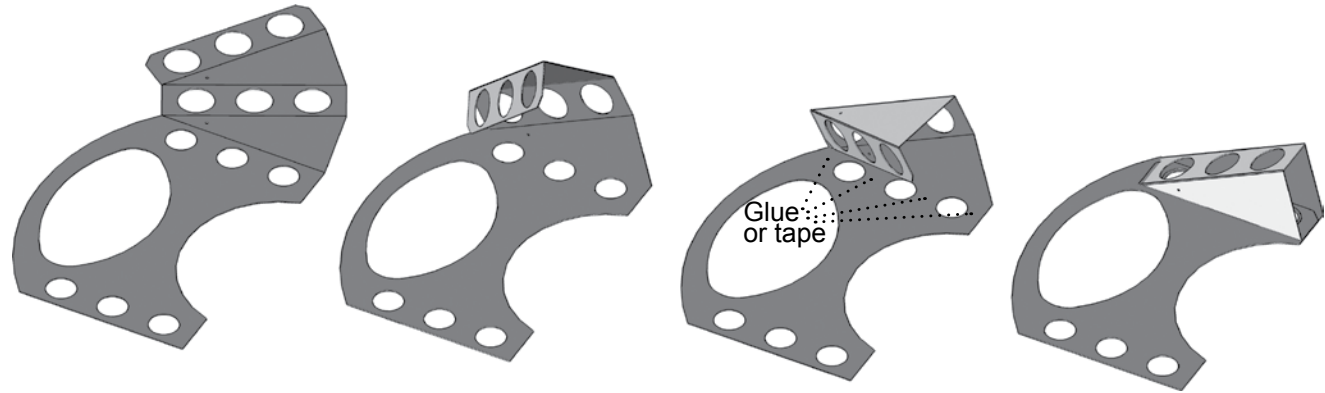


1) Assembling the Superstructure and Flywheel

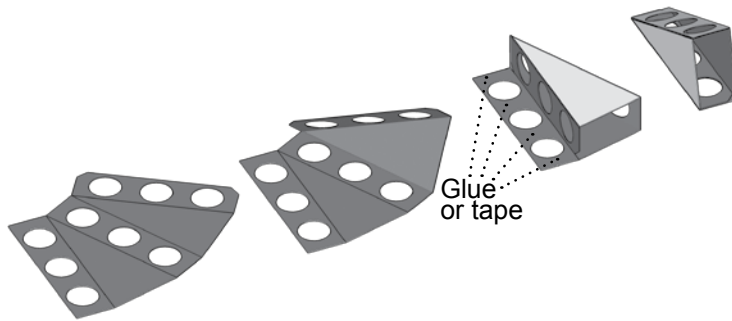
After popping the parts from the cardboard sheets, it is time to assemble the superstructure.

With the smooth side down, fold on the scored lines to make a triangular box on the end of the piece.

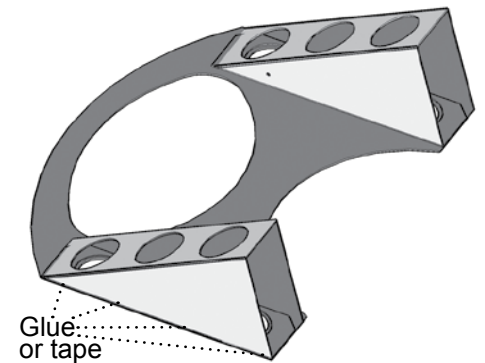
Add some drops of white glue or pieces of double-stick tape to secure it. You can use a paper clip to secure it while drying.



Repeat these steps for the other part.



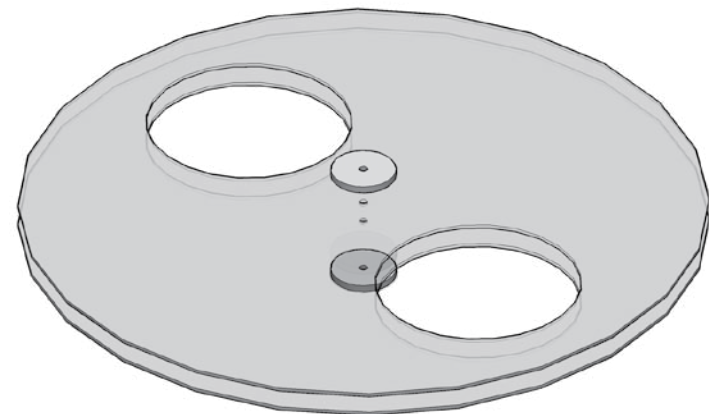
When both parts are dry, glue (or use double-stick tape) to mount the smaller piece onto the larger one as in the drawing to the right.



To assemble the flywheel, put one of the large disks smooth side down and place 8 small drops of glue (or double-stick tape) around the edge of the disk, and then stack the other large disk smooth side up on top, using the holes to align the two. A book can be carefully placed on top to hold them flat while they dry.

When the glue has dried, two of the small cardboard washers can be glued (shiny side out) to the centers of either side of the large disk assembly. The displacer rod or crankshaft can be inserted temporarily to align the disk assembly and washers.

Be sure to wipe the rod clean of any glue when you are done aligning and have removed the rod.



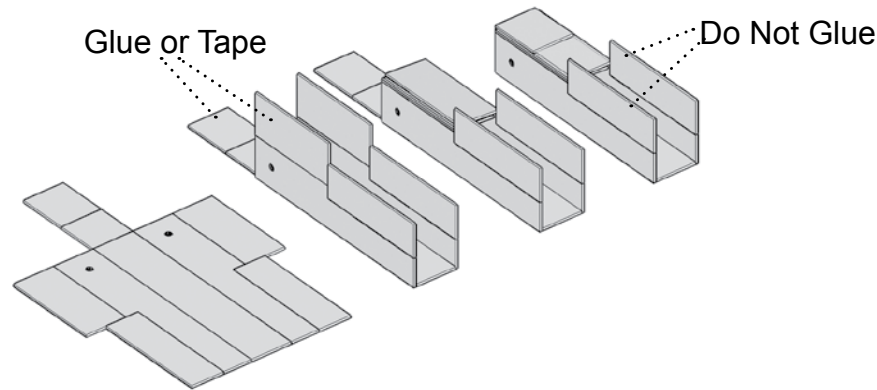
2) Assembling the Connecting rod and Diaphragm Assembly

Now it is time to assemble the Upper Connecting Rod.

With the smooth side down, fold on the scored lines following the drawing to the right.

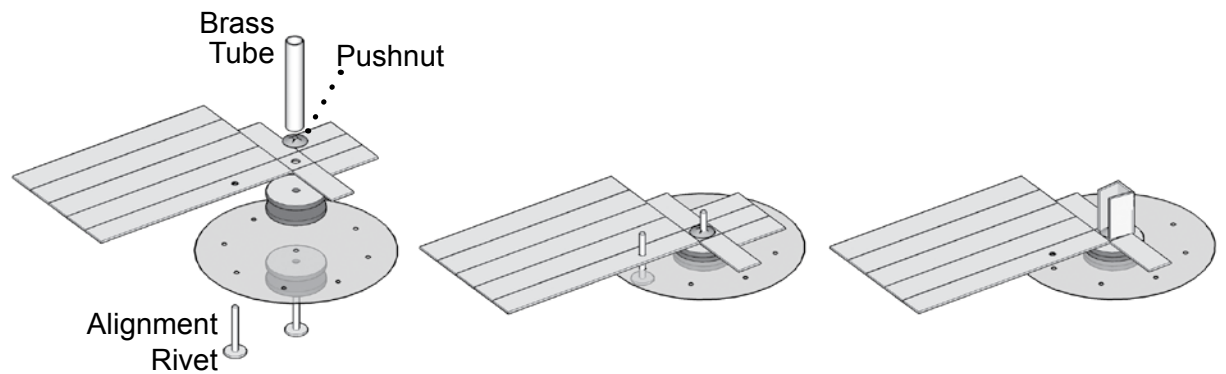
Add some drops of white glue or pieces of double-stick tape to secure it. You can use a piece of regular tape to secure it while drying.

Do not glue down the bottom flaps as they will be needed later.



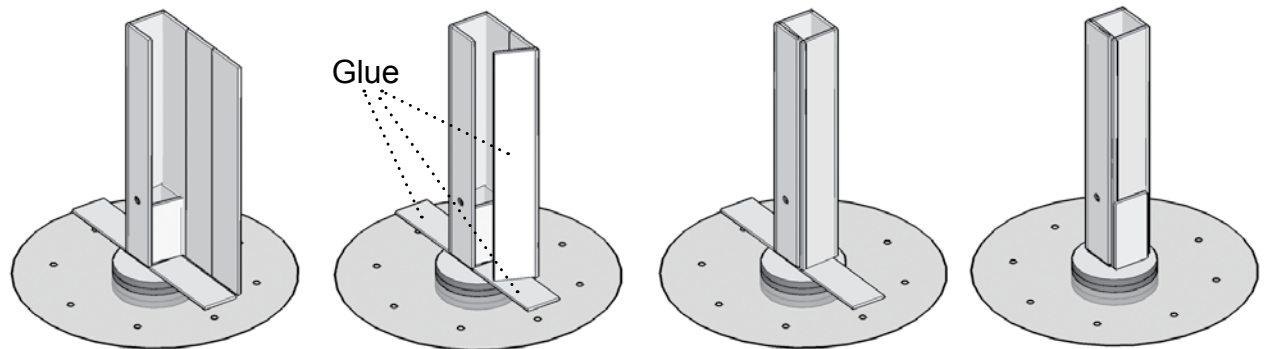
To construct the Lower Connecting Rod and Diaphragm assembly, start by stacking 2 washers (white side out) on a rivet. Then add the diaphragm and 2 more washers to the stack. Add the cardboard connecting rod part (smooth side down) and the second rivet to align the diaphragm to the connecting rod.

Use the larger brass tube and a hammer to gently tap a pushnut onto the rivet. Remove the alignment rivet and set it aside. The alignment step is very important! Fold up the 3 upper arms of the connecting rod as in the drawing.



Fold the rest of the panels of the connecting rod as in the drawing and add some drops of white glue or pieces of double-stick tape to secure it.

You can use a piece of tape to secure it while drying.



3) Mounting the Diaphragm on the Top Plate

Pop the parts from the cardboard sheets.

Starting from the bottom of the stack, insert 10 rivets into the Top Plate as per the drawing and secure them with a couple of pieces of tape. Turn the plate over, so the points of the rivets are up and insert one more rivet with its point facing down.

Moving the Top Plate so the 1 rivet facing down is hanging off your worktable will make the rest easier.

Take 4 of the cardboard layers and push them all the way onto the rivets

Take the Lower Connecting Rod Assembly and guide the holes in the diaphragm onto the rivets. It should be loose.

Take 4 more of the cardboard layers and push them all the way onto the rivets to sandwich the diaphragm between them, and place the metal layer on top.

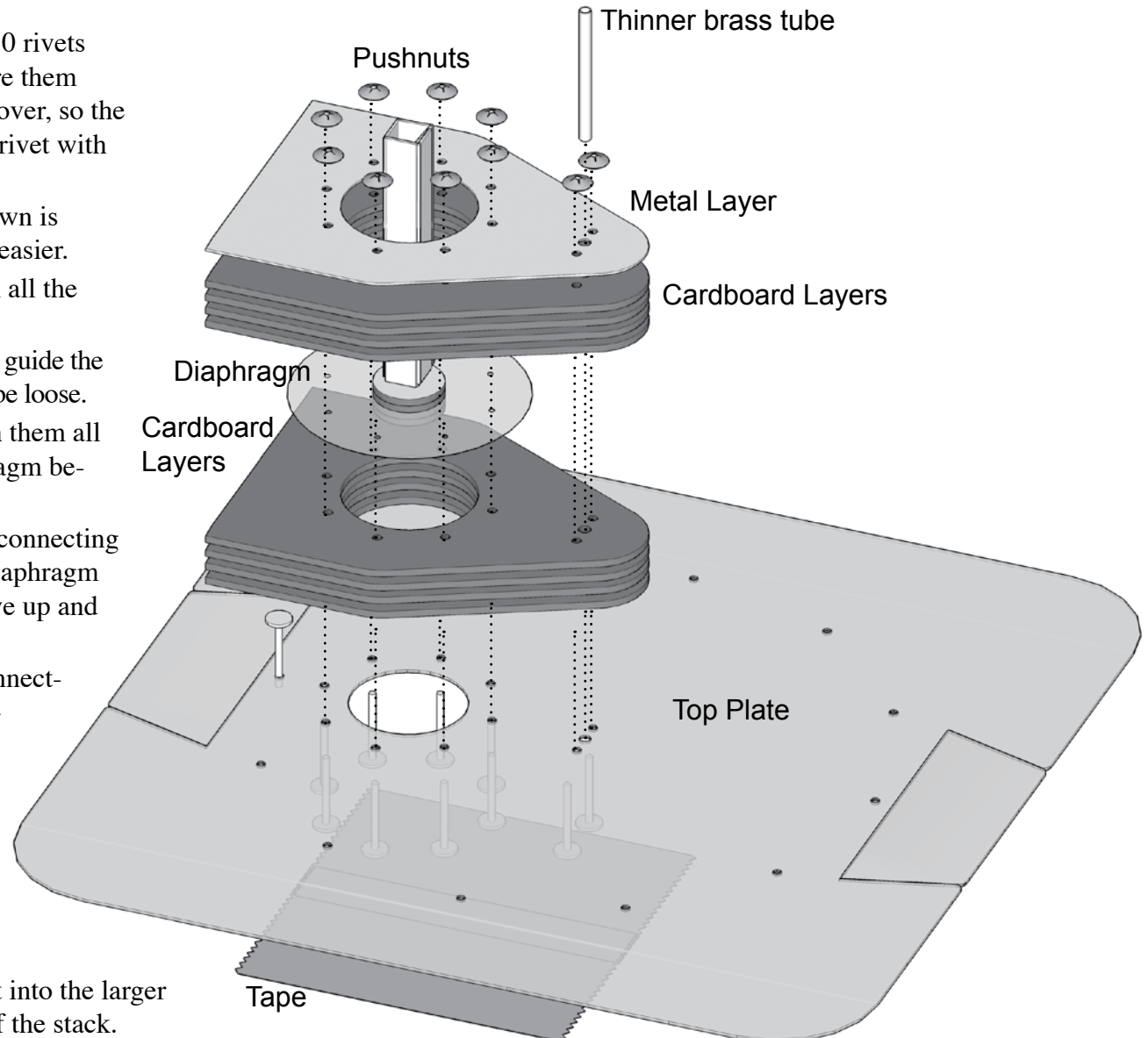
Pressing down on the stack, firmly move the connecting rod up and down several times to stretch the diaphragm into the correct shape. It should be able to move up and down with little resistance.

It is very important you install the Lower Connecting Rod Assembly as shown. The Lower Connecting Rod “box” needs to be square with the Top Plate. Double check to make sure this is correct. If it isn't then remove the assembly and rotate it to the correct position.

Finally, using the larger brass tube and the hammer, gently tap 10 pushnuts onto the upward facing rivets.

Take the Thinner Brass Tube and gently tap it into the larger hole (between the two pushnuts) at the point of the stack.

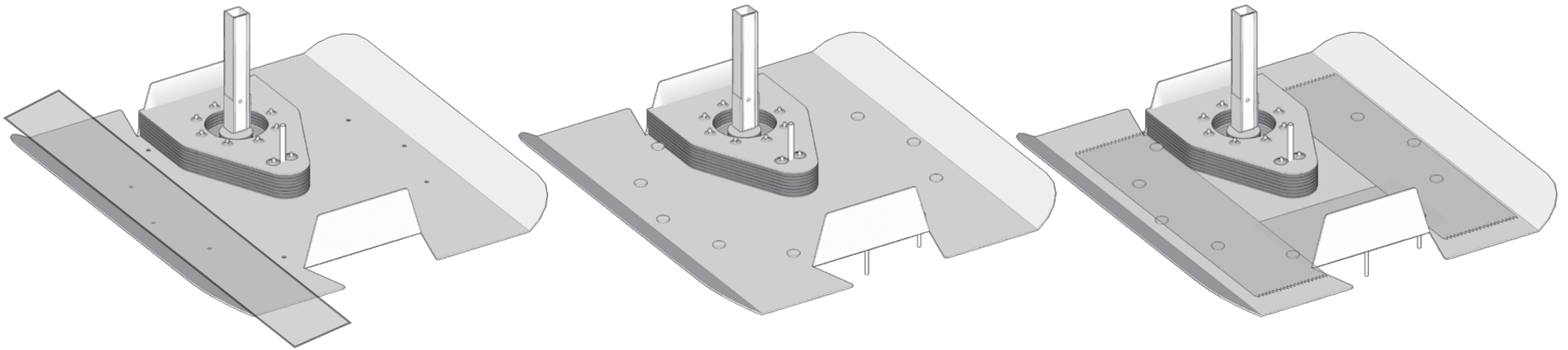
Put some dots of white glue covering the pushnuts on the top of the stack.



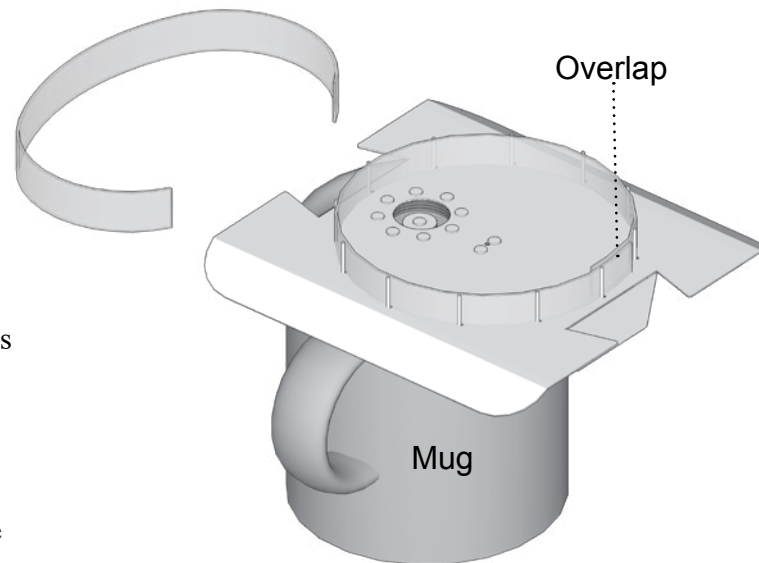
4) Assembling the Cylinder

To prepare the Top Plate for mounting the cylinder bend the 2 flaps at the ends of the top plate, and using a ruler or spine of a book bend the sides of the plate up. Make sure the bend is outside all of the holes in the top plate.

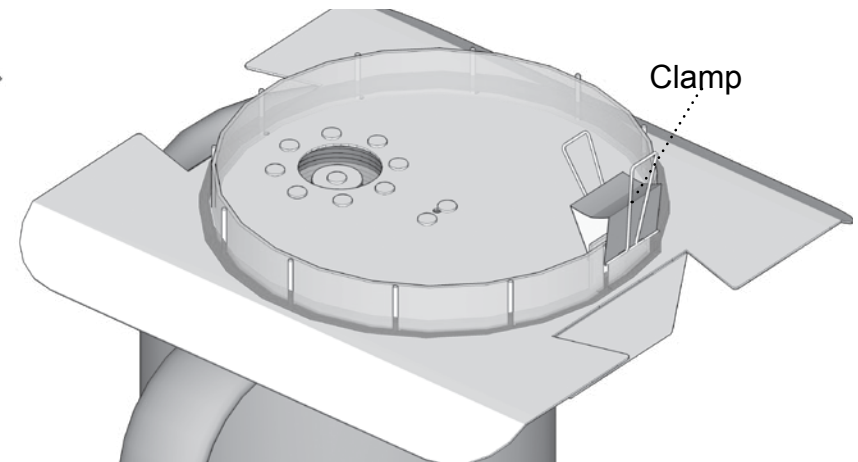
Once the sides are bent up, insert 11 rivets in the holes that describe the cylinder edge, and put pieces of tape over the heads of the rivets to hold them into position.



Now turn over the top plate, being careful not to squash the connecting rod. Find a large mug or small bowl and flip the Top Plate over so the rivet points are facing upwards and the stack of cardboard around the diaphragm is inside the mug. Remove the protective covering from the plastic strip and bend the strip into a circle inside the rivets.



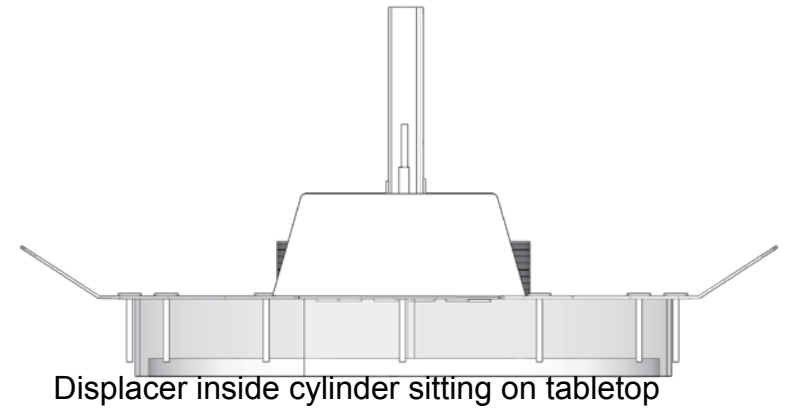
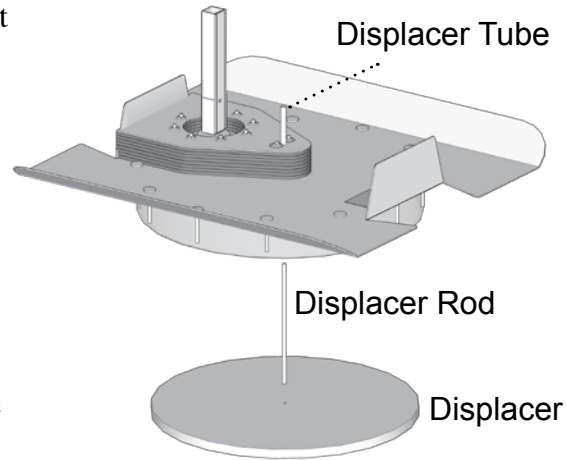
Mix up a batch of epoxy and spread some where the strip overlaps itself and clamp the overlap with the clip. Make sure the strip is touching all the rivets and spread a bead of epoxy all around the **outside** of the cylinder where it touches the top plate, making sure to leave no gaps. Better too much epoxy than not enough.



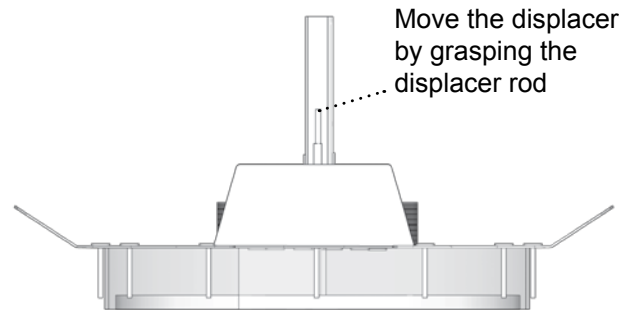
5) Assembling the Displacer

Take the Displacer Rod and insert it into the hole in the foamcore Displacer to make sure it fits. Remove the rod and apply a tiny dot of epoxy on the end of the rod.

After wiping off any excess epoxy, gently partially insert the rod into the Displacer Tube and lay the whole assembly on the table so the Displacer Tube can keep the displacer rod vertical while the epoxy cures.



Once the epoxy has cured, try lifting the displacer rod and releasing it to make sure that the displacer moves freely. If the displacer binds, try rotating the displacer by twisting the rod slightly and repeat the lifting and releasing.

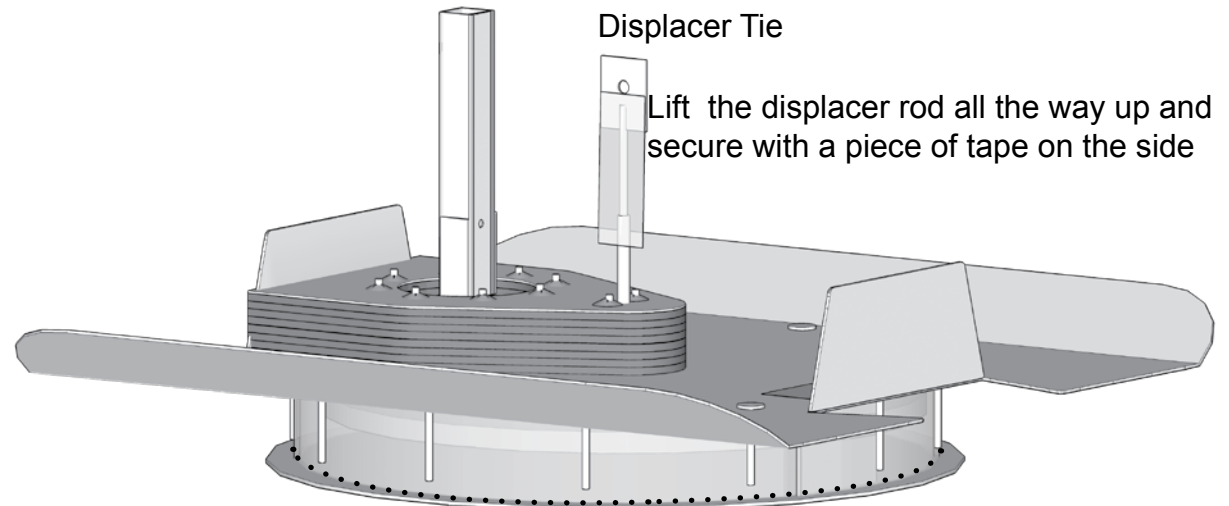


If you can't find an orientation where the displacer moves freely, turn the assembly over and mark with a pen on the bottom of the displacer where it contacts the side of the cylinder. Remove the displacer and **gently** sand the marked side. Repeat these steps until you have a displacer that moves freely up and down.

6) Mounting the Bottom Plate and Superstructure

Once you have found an orientation of the displacer where it moves up and down freely, position the Displacer Tie on the top of the Displacer Rod and wrap a piece of tape around it to attach it to the Displacer Rod. Then pull the displacer into its highest position and temporarily secure it with another piece of tape on the side of the displacer rod as in the drawing.

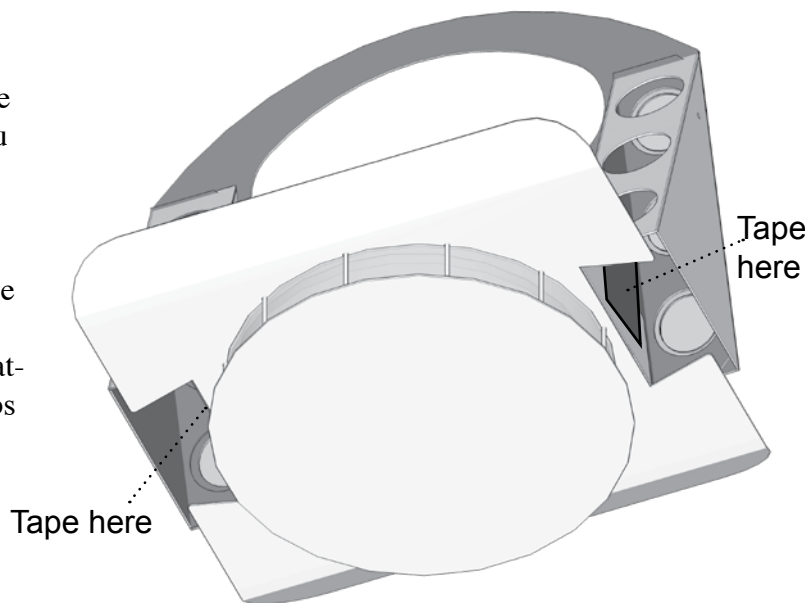
With the displacer secured in the high position, center the cylinder on the bottom plate, and mix a batch of epoxy. Apply the epoxy all around the base of the cylinder. Once again, too much epoxy is better than too little.



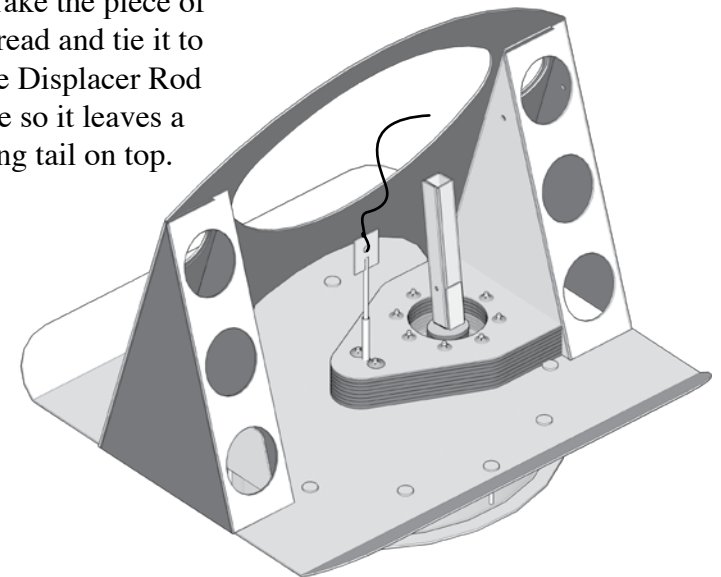
Lift the displacer rod all the way up and secure with a piece of tape on the side

Center the cylinder on the bottom plate before applying epoxy where indicated by the dotted line.

Once the epoxy has cured, take the Superstructure assembly that you created in step 1 and fit it over the metal tabs on the top plate. Use tape on the inside of both columns to attach the metal tabs to the columns.

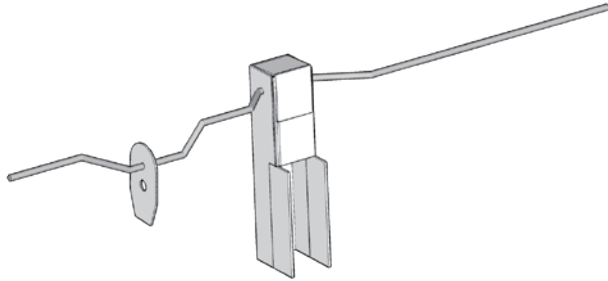


Take the piece of thread and tie it to the Displacer Rod Tie so it leaves a long tail on top.



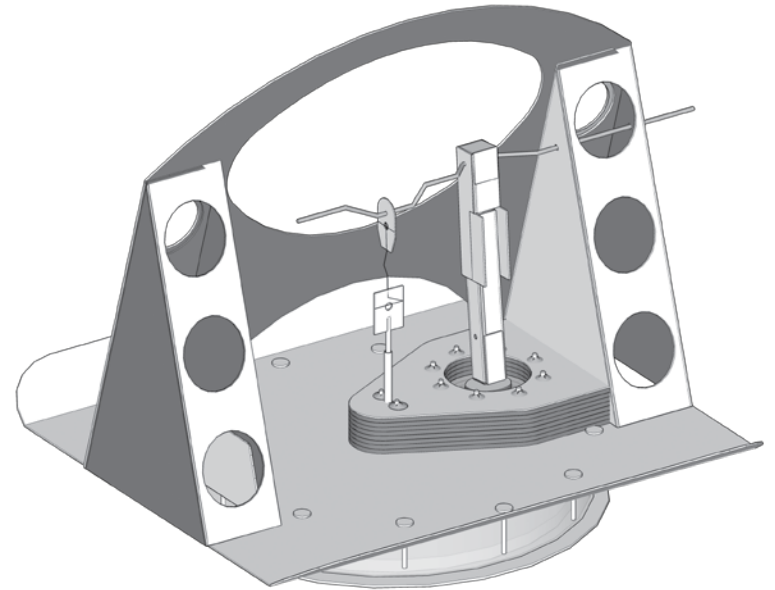
7) Mounting the Crankshaft and flywheel

Put a drop of CA glue on each of the holes in the Crankshaft Tie and the Upper Connecting Rod. Let the glue dry. Thread the Top Connecting Rod and the Crankshaft Tie onto the Crankshaft. make sure they both swing freely on the crankshaft. If they don't, use a 1/16" (1.5 mm) drill bit to enlarge the holes slightly.



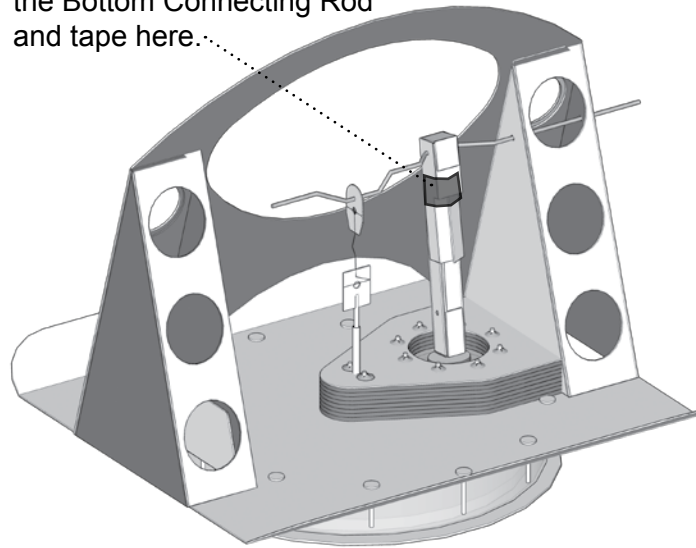
Do the same procedure with the CA glue on each of the holes in the column. Insert the Crankshaft through the holes in the column.

Make sure the displacer is moving freely. Now with the displacer and the Crankshaft Tie in the down position, take the thread attached to the Displacer Rod Tie and thread it through the hole in the Crankshaft Tie and wrap it in the slots in the sides of the Tie.

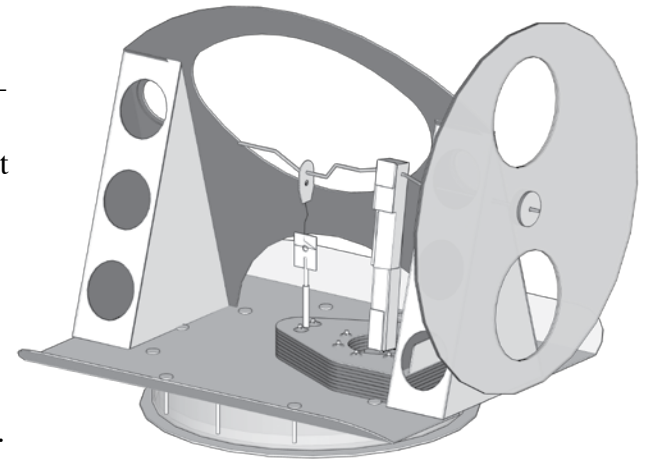


Place the Bottom Connecting Rod inside the Top Connecting Rod flaps and close the flaps, tightly trapping the bottom connecting rod inside. Secure the flaps with a piece of tape.

Fold these flaps in around the Bottom Connecting Rod and tape here.



Take the flywheel assembly and slide it onto the end of the crankshaft leaving some space. Use a small amount of superglue to attach them. Try to keep the flywheel parallel to the end of the engine so it does not rub against the column.



8) Testing, Running and Troubleshooting

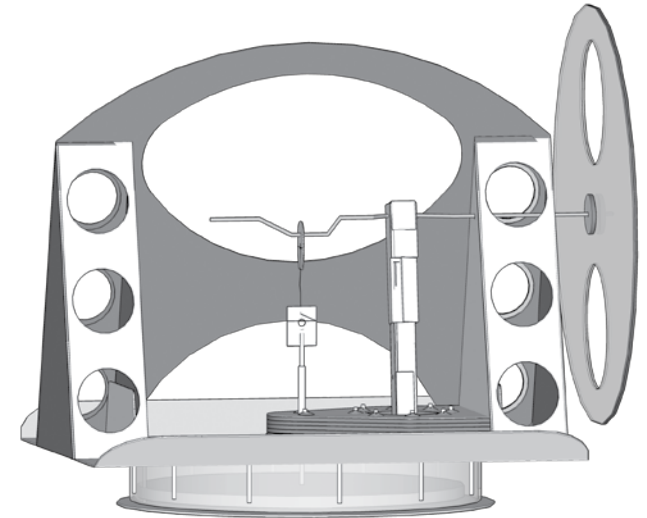
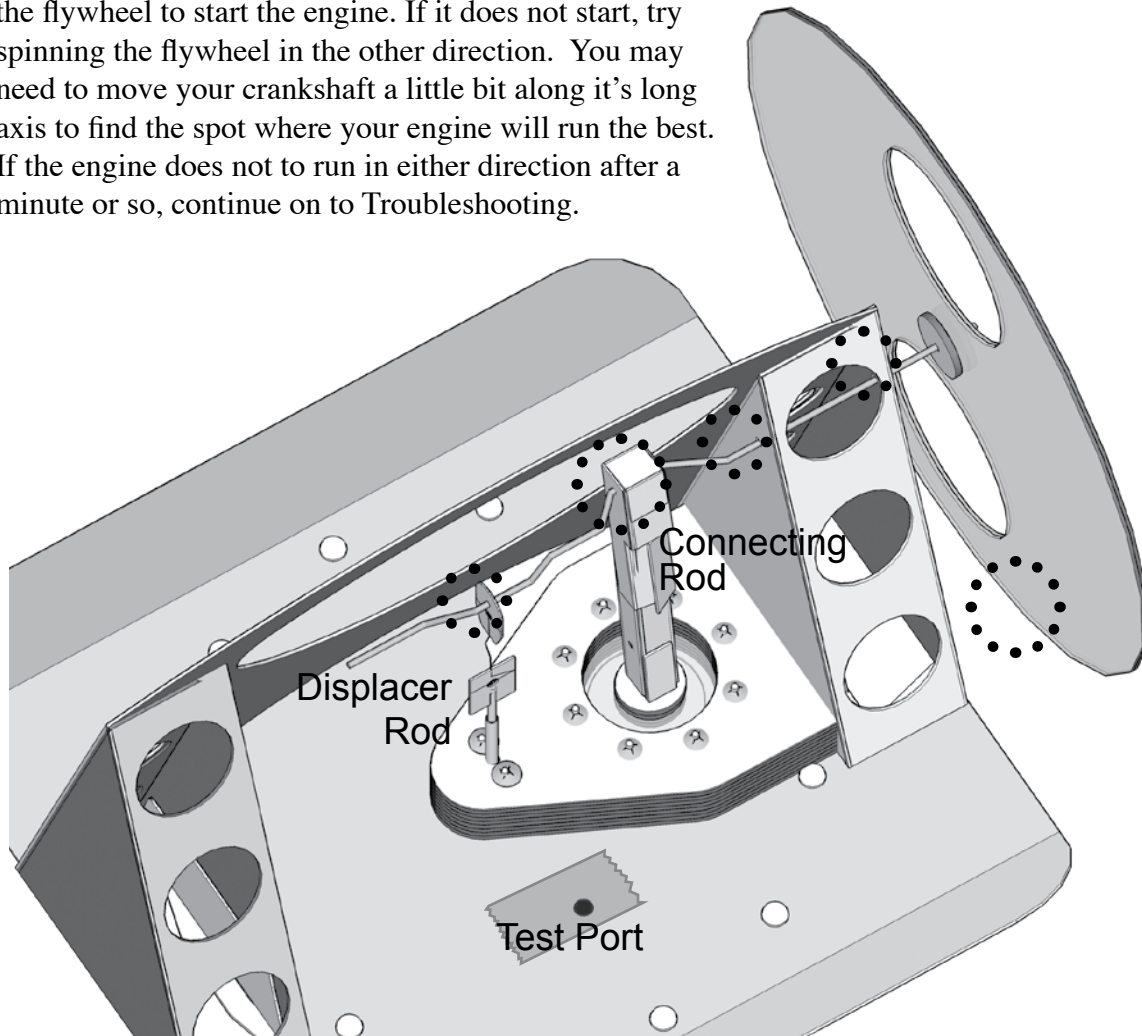
Now that your engine is assembled, there are a few tests to do to make sure it is ready to run. Spin the flywheel to check it spins freely. If not go to Troubleshooting.

Running the Engine

On the top plate between the Displacer Rod and the cylinder aligning rivets there is the Test Port. When the Test Port is open the engine has no compression, so it should turn without resistance.

To run the engine the Test Port needs to be covered with a piece of tape.

Boil a mug of water and center the engine on top of the mug. After 20 seconds try spinning the flywheel to start the engine. If it does not start, try spinning the flywheel in the other direction. You may need to move your crankshaft a little bit along it's long axis to find the spot where your engine will run the best. If the engine does not run in either direction after a minute or so, continue on to Troubleshooting.



Troubleshooting

The 2 big enemies of Stirling engines are friction and air leaks.

Look carefully at the areas that are circled in the dotted lines to the left to see if you can see anything that is binding or rubbing while slowly turning the flywheel. Make sure the Displacer does not bind at the top or the bottom of it's travel. The idea is to center the displacer in the middle of it's possible travel. You don't want it to hit the top or the bottom of the cylinder. You can tweak the position of the displacer by adjusting the length of the thread.

You may also need to adjust the length of your Connecting Rod. If it is too long or short it could be trying to stretch the Diaphragm too far on one end of the stroke, which would cause friction. To adjust the Connecting Rod loosen the tape and open the flaps on the Upper Connecting Rod before you lengthen or shorten it.

Even a small amount of friction can make a big difference.

Go to the StirlingEngine.com website for more info on adjusting and modifying your engine.