Cheap and Simple Steam Engine

by **liam2317** on June 14, 2010

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Intro: Cheap and Simple Steam Engine

Recently I saw a video of a remote controlled boat powered by a miniature steam engine and was instantly hooked on the idea. After doing a bit of research I found miniature steam engines cost hundreds of dollars or require some very advanced skills and tools to build. Yet looking at the actual mechanism which allows them to run they are really quite simple so I decided to try and make one on the cheap.

First off I should state that this steam engine is only a steam engine. This instructable does not include instructions on how to build a boiler to produce steam. Instead I run the steam engine on compressed air. If you don't have a compressor a bicycle pump works well too, it's just a lot more work for you. ;)

I should also note that even if you did build a boiler this engine probably wouldn't work well because many of it's major components are wood. In the presence of steam the wood would swell and warp causing problems. A simple solution to this problem would be to replace the wood parts with aluminum ones.

The point of this project was really to see how cheaply and easily a steam engine could be built. I built this engine in one day and for under $10 in materials so I think it's safe to call it a success.

I am a very visual teacher so be sure to read the 'Image Notes' (hover your mouse over the yellow boxes on the images), it will likely make my instructions clearer.

SEE MOVIE Below

step 1: Materials, Tools and Plans

Most of the materials and tools for this project you will likely already have around the house. The only things I had to buy were the brass tubing, tubing cutter, and some wire.

Materials:

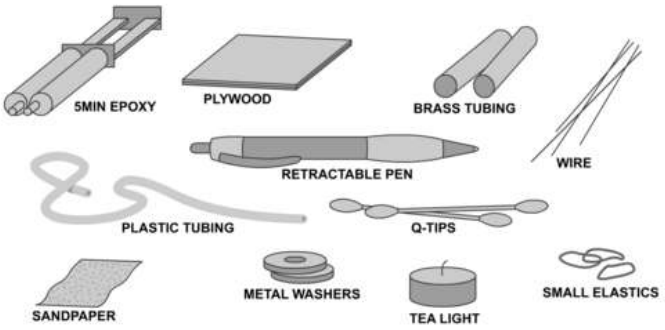
• 3/16" Plywood (aprox: 12x8cm)
• Retractable Pen (optional)
• Brass Tubing: (find some at your local RC hobby shop)
  13/32" for the piston and 7/16" x 0.014" for the cylinder
• "Tea Light" candle
• Heavy washers with a diameter less than that of the tea light
• 5 Minute Epoxy Glue
• Plastic Tubing (to connect your compressed air supply)
• HomeDepot sprinkler marker flags or piano wire (~18AWG)
• Floral stem wire or piano wire (~24AWG)
• Q-Tips with plastic tube (not paper)
• Small elastic bands
• Plastic Wrap

Tools:

• Drill (or better yet; a drill press) and bits
• Tubing Cutter ($5)
• Pliers and Wire Cutter
• Empty Tin Can
• Razor Knife
• Sandpaper
• Vice (optional)

Plans:

Attached are two PDF files. "Parts Only With Measurement" includes a layout of all the parts you will need to cut out of wood as well as the lengths for the wire and brass tubing parts. "Parts Only No Measurements" is exactly the same but without any measurements printed on the page; good for cutting out and gluing to your wood as a guide.



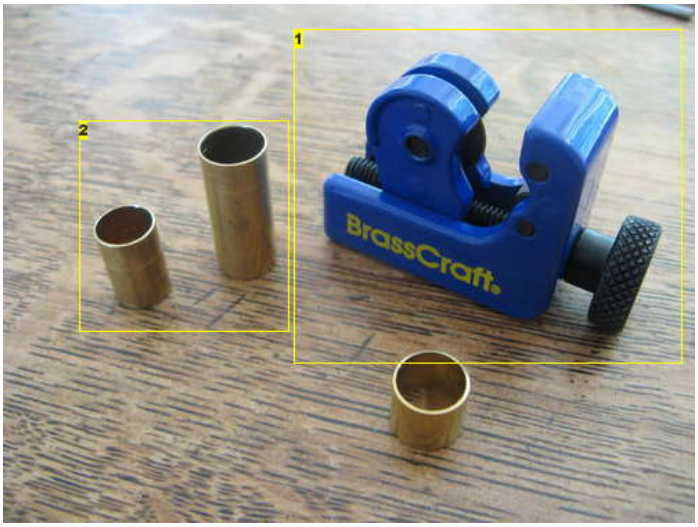


Image Notes
1. Tubing Cutter - $5 at Harbor Freight
2. Brass Tubing

Image Notes
1. 3 or 5 Minute Epoxy from the dollar store
2. Small Elastic Bands

Image Notes
1. 3/16" Plywood from Wal-Mart Craft Department

File Downloads

Parts Only With Measurements.pdf ((612x792) 102 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Parts Only With Measurements.pdf']

Parts Only No Measurements.pdf ((612x792) 67 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Parts Only No Measurements.pdf']

step 2: Cut the Piston and the Cylinder

Cut the cylinder and piston from two pieces of brass tubing. They do not have to be exactly the same diameters as I used but the smaller one should fit very snugly inside the larger one and still be able to slide freely. Your local hobby shop should have the correct sizes of brass tubing.

The cylinder should be 25.5mm long, and the piston 14.5mm.

Using a Tubing Cutter:
To use a tubing cutter align your cut with the cutters blade and tighten the knob, not too tight though as not to squish the tube. Slowly rotate the tube inside the device tightening the knob every few turns until the blade cuts through the tube. It may take a few practice runs, I ended up squishing the tube too much several times.

Scrape out the inside lip of the cylinder with a razor blade to ensure no burs are left to scrape up your piston.

If you don't have a tubing cutter you can buy one from Harbor Freight for $5 .

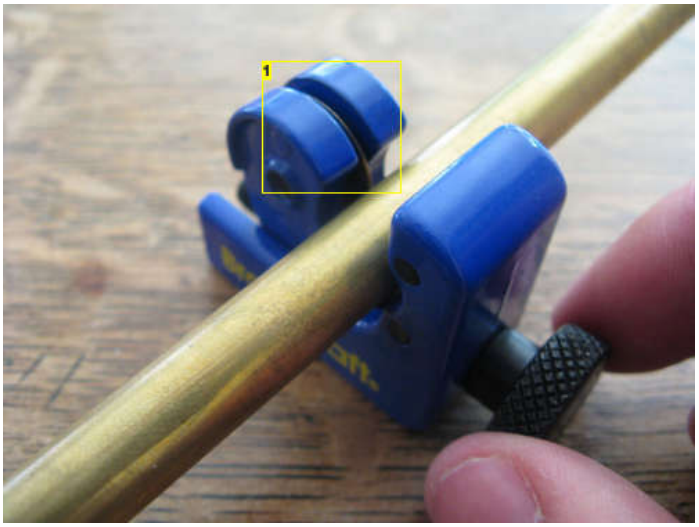


Image Notes
1. Align blade with where you want to cut.

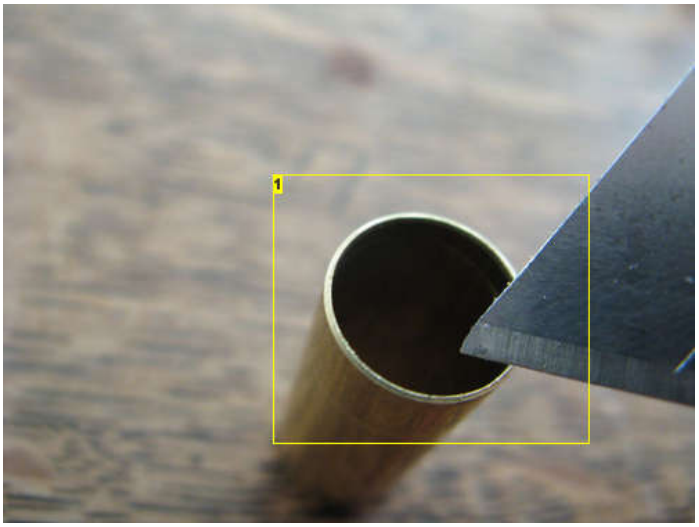


Image Notes
1. Remove any burs on the inside of the cylinder with a razor blade.

step 3: The Piston

First cut the wire (24AWG) for the piston rod (I used a thin piece of floral wire but any stiff wire will do), then make a 90 ° bend 3mm from one end.

Now take some sandpaper and scuff up the inside of the piston.

Next take a small piece of plastic wrap and cover one end of the piston tube, secure it with an elastic.

Mix some epoxy and fill the inside of the piston tube with it. Be very careful not to get any on the outside of the piston, also try to keep the tube pressed to the table so no epoxy will get out under the edges of the plastic wrap.

Now insert the piston rod (bent end first) straight into the epoxy.

To ensure that the piston rod stays at 90° you may want to push it through a piece of ~0.7mm foam first and glue that in along with the piston rod (see Images).

Image Notes
1. Scuff up the INSIDE of the piston with sand paper to make the epoxy stick better.

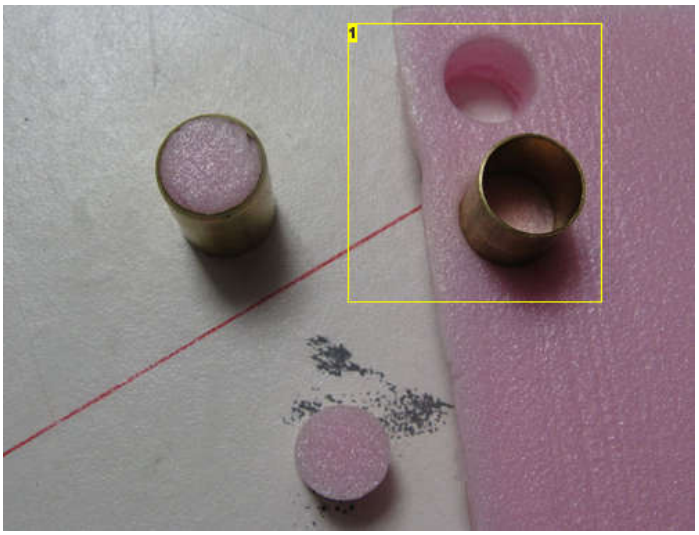


Image Notes
1. Punch out a circle of foam to stick the piston rod through to keep it centered in the epoxy. (Optional)

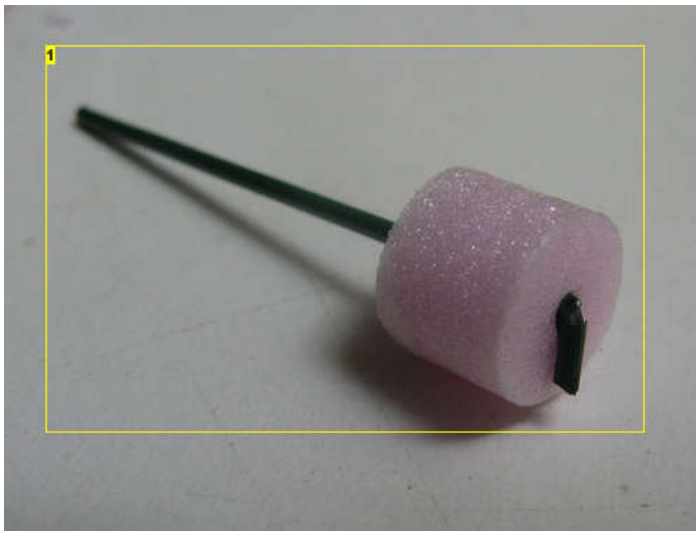


Image Notes
1. Foam will keep the piston rod centered in the piston while gluing. (optional)

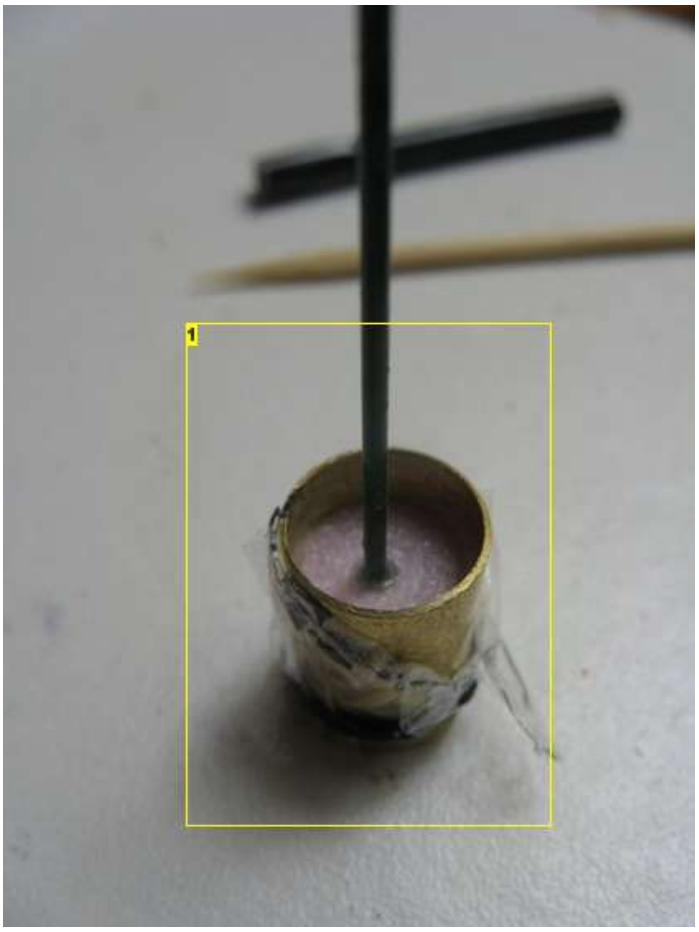


Image Notes
1. Put some epoxy in the piston, then the piston rod and optional foam leaving some space on top to fill with more epoxy.

Image Notes
1. All Finished!

step 4: The Flywheel

Start by cutting the crankshaft wire. It should be a 45mm long piece of ~18 AWG wire. I used the wire from one of those little red flags you see stuck in lawns to mark the sprinkler system. If you can't find one Home Depot sells them. This size of wire is excellent because it fits perfectly inside of the plastic tube that Q-Tips are made of.

To make the flywheel I popped the wax out of a tea light (candle), inserted the crankshaft wire through a few pieces of wood to keep it from pulling out of the wax and glued them to the crankshaft, then I added some metal washers (to add weight). Next I put all this back into the tea light and poured its melted wax back in to hold it all in place. Hopefully the images below will better explain this process.

To melt the wax I put it in the bottom of a tin can which I had bent a bit of a spout into to make it easier to pour. Then put the can in a pot of boiling water on the stove until the wax melted.

Be sure to lay down a few layers of news paper before trying to pour molten wax, I also wouldn't recommend doing this over carpet. Epoxy could also easily be substituted for the wax, I just didn't have enough epoxy to do it.

If I were to do it again I would drill a hole through the bottom of the tea light and run the crankshaft wire all the way through so that the motor could be easily connected to another device in order to power it. If you do this you should probably make the crankshaft wire a cm or so longer.

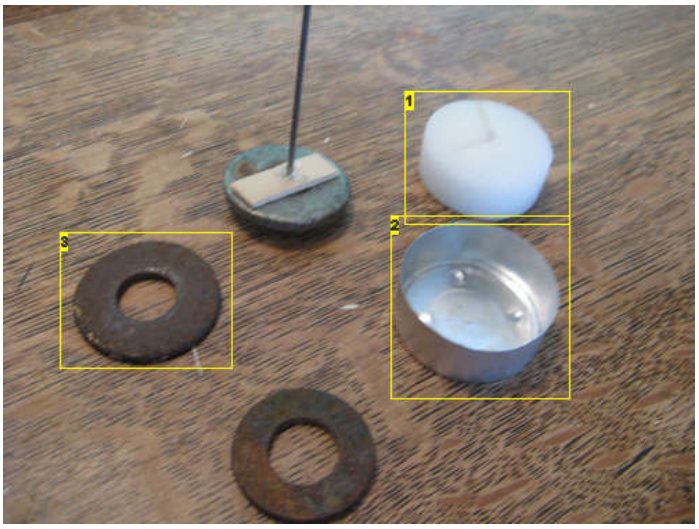


Image Notes
1. Wax removed from tea light.
2. Metal base of tea light.
3. Washers.

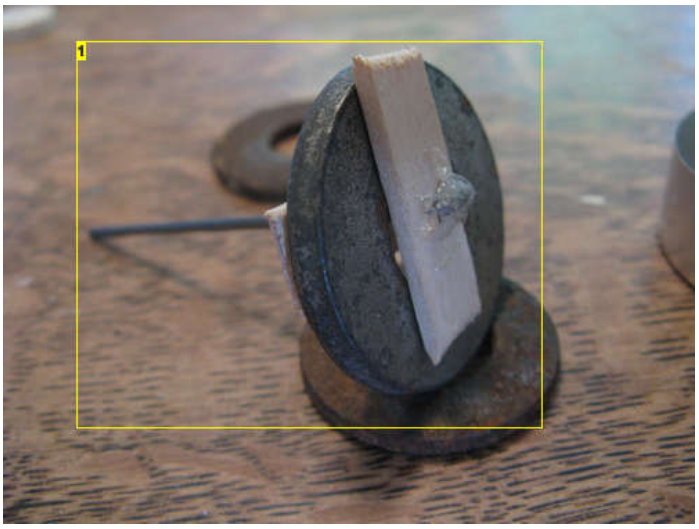


Image Notes
1. Crankshaft wire with wood glued to it on either side of a washer to prevent it from pulling out of the wax.

Image Notes
1. Getting ready to pour the wax.

Image Notes
1. Bend a spout into your tin can to make it easier to pour.

Image Notes
1. Melt wax in a can in a pot of hot water on the stove.

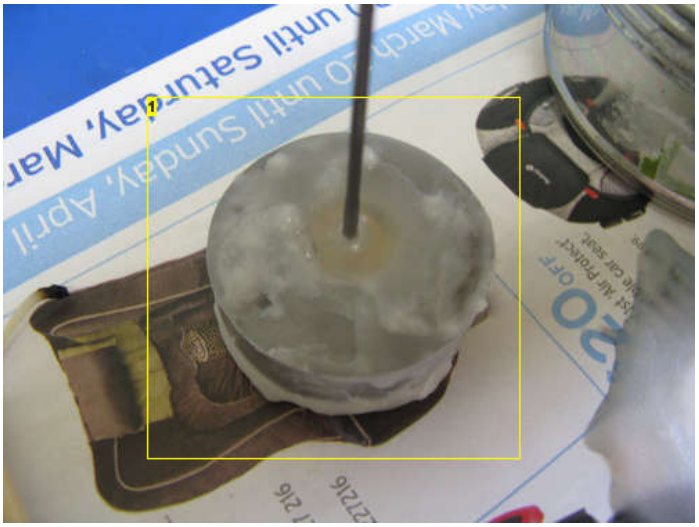


Image Notes
1. Pour the wax into the flywheel. Don't forget to put down some newspaper, this is messy stuff.

Image Notes
1. All done!

step 5: Make the Wood Parts

The wood parts are to be made from 3/16" plywood. I bought mine from the craft department in Wal-Mart; $3 for a six pack of 7x3" sheets. You could also use aluminum, brass, Teflon, plastic or Plexiglas instead of wood. Just make sure whatever you use it has a nice smooth finish in-between the moving parts. You will find the plans for the wood parts back on the Materials Page.

3/16" plywood is easily cut, even with a razor knife. Cut both sides and go over it with the blade several times until the wood cuts. Sand the edges smooth. To cut the round crankshaft part start with an octagon shaped piece and sand the edges to a circle.

Body:
Now start by gluing the part Body 2 to Body 1. Drill the top two holes with a 3/32" drill bit. Drill the central hole the same size as the wire you used for the Cylinder Pivot Wire. Finally Drill the bottom hole the same size as the plastic tube from your Q-Tip.

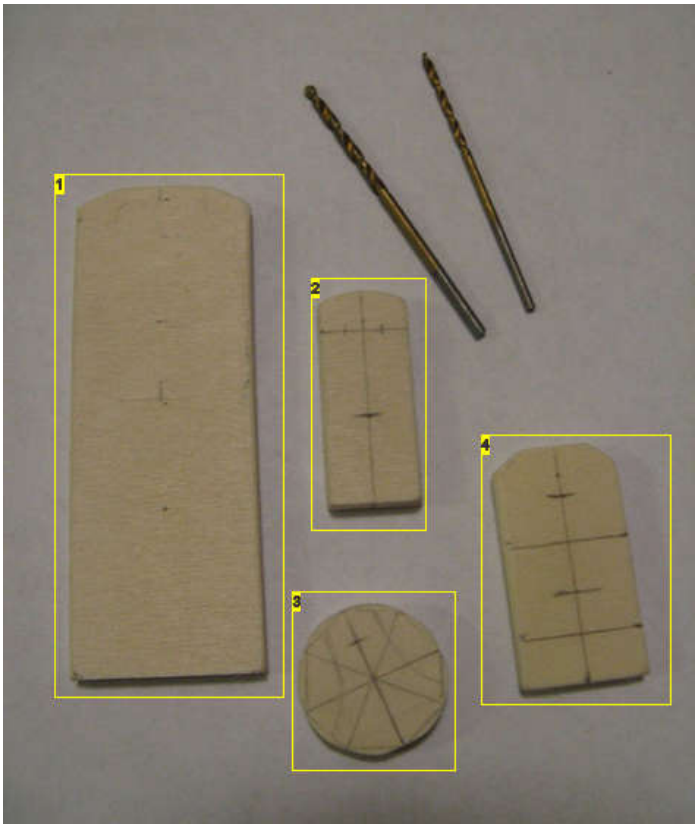


Image Notes
1. Part: Body 1
2. Part: Body 2
3. Part: Crank Shaft
4. Part: Cylinder Back

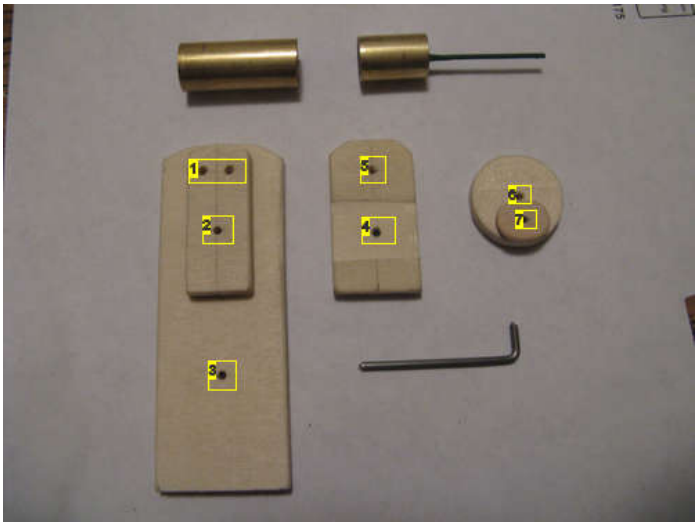


Image Notes
1. 3/32"
2. same size as the wire you used for the Cylinder Pivot Wire
3. same size as the plastic tube from your Q-Tip
4. same size as the wire you used for the Cylinder Pivot Wire
5. 3/32"
6. Same size as Crankshaft Wire
7. Same size as Piston Rod Wire

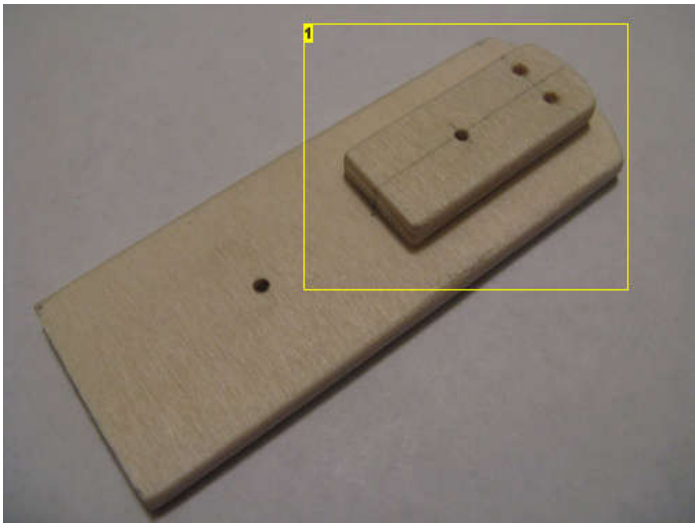


Image Notes
1. Glue Body 1 to Body 2

step 6: Cylinder Block

Cylinder Back:
To build the cylinder block start by taking the wooden part "Cylinder Back" and sanding down the center gray area of it by about 1mm. This will make a smaller contact area between it and the body, thus reducing friction.
Now drill out the center hole in this part the same size as the wire you will be using for the "Cylinder Pivot" wire. Now drill out the top hole with a 3/32" bit.
Cut the wire for the "Cylinder Pivot" part and make a 90° bend 5mm from one end. Now, on the opposite side from where you sanded down 1mm on the "Cylinder Back" part you must cut a 5mm long grove from the middle hole towards the top hole, just deep enough for the 5mm of wire to rest in when it has been inserted through the wood. This is the side you will be gluing the cylinder to.

Cylinder Head:
Start by drilling out the 12mm hole in the cylinder head before you cut out the square around it, unless you have a drill press such a large hole will be hard to align with a small piece of wood. This also helps it from splitting on you. Now cut out the 2.5mm deep grove in the other Cylinder Head part.

Cylinder Block :
The next step is to glue the two cylinder head parts, the brass cylinder tube, and the cylinder back parts together. You may want to press some foam into the end of the cylinder tube to prevent any epoxy from dripping into it before gluing.
Epoxy the cylinder head to the cylinder then both of those to the 'cylinder back' so that they are centered horizontally and the bottom of the cylinder is aligned with the bottom of the cylinder back. The 2mm deep grove you cut in the second cylinder head piece must also line up with the top hole in the 'cylinder back'.

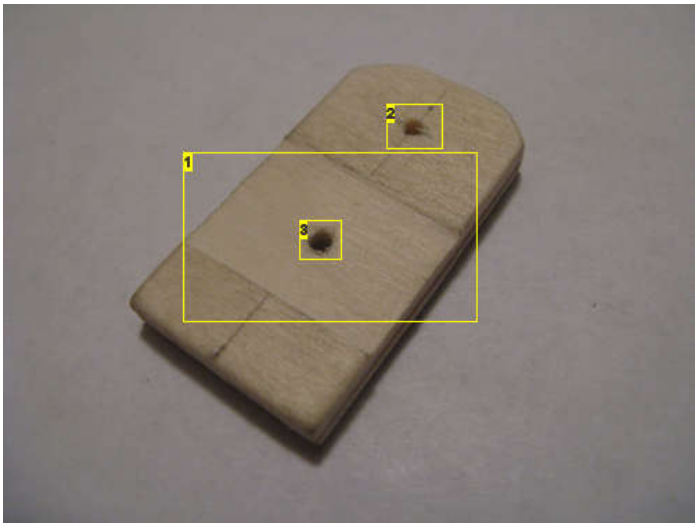


Image Notes
1. Sand down center of 'Cylinder Back' about 1mm.
2. 3/32"
3. same size as the wire you will be using for the "Cylinder Pivot" wire

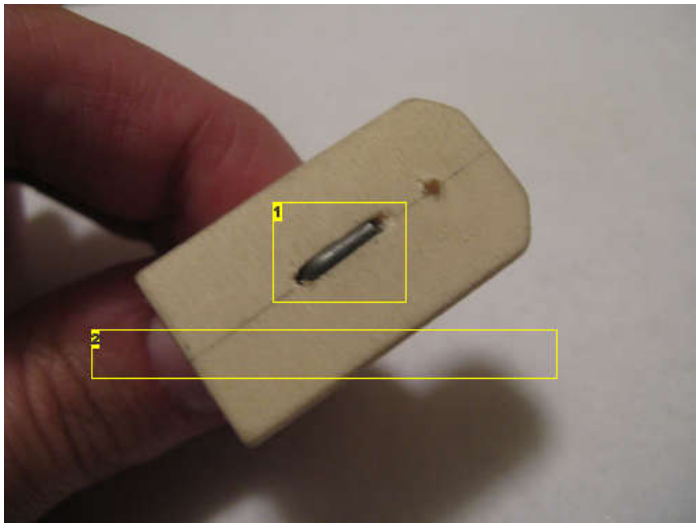


Image Notes
1. Cut a small grove in the face of 'Cylinder Back' for the bent end of 'Cylinder Pivot' wire to sit in.
2. You will be gluing the cylinder to this side.

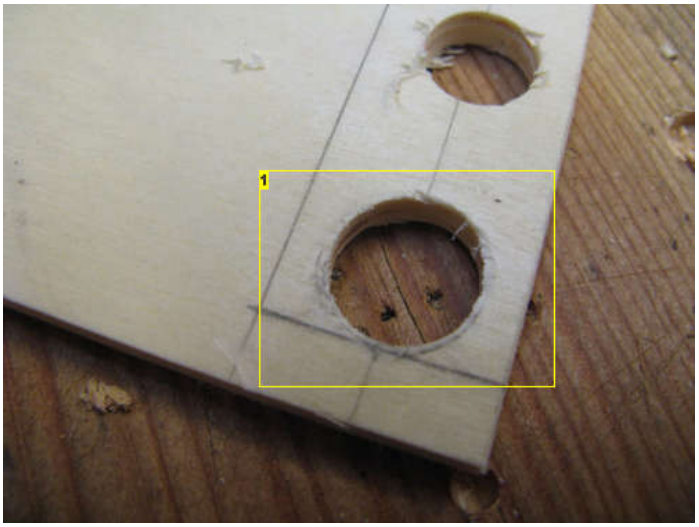


Image Notes
1. Drill out the hole for the cylinder before cutting the part out from your piece of wood. This makes it much easier to drill without cracking it.

Image Notes
1. Cut a 2.5mm deep grove into this piece.

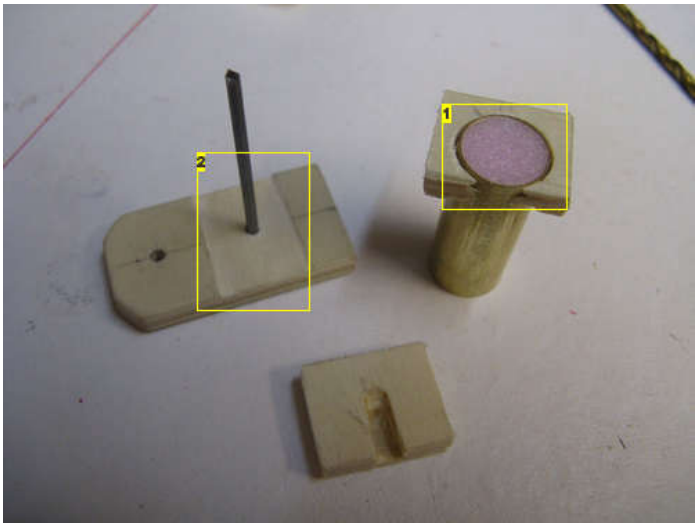


Image Notes
1. You may want to press some foam into the cylinder to prevent any glue from getting in there while it's setting up. (remove the foam after the glue has set)
2. Cylinder Pivot wire protrudes from the side that has been sanded down 1mm.

Image Notes
1. Cylinder block finished!

step 7: Crankshaft

I added a small circle of wood around the outer hole in the wooden crankshaft part. This gives the piston rod a little more clearance and prevents it from creating more friction rubbing on the crankshaft. See the Image below.
Next drill the outer hole in the wooden crankshaft part the same size as your piston rod wire, then drill the central hole in that part the same size as the wire used for your crankshaft.

Now epoxy the part "Brace" to the flywheel side of the body just under the hole for the crankshaft, I also added a small brace to the piston side of the Body.
Now epoxy a Q-Tip tube into the hole though the body and to the top of the brace. You can now insert the crankshaft through the body, add a few washers made of free spinning Q-Tip tube between the flywheel and the body. Add more Q-Tip washers on the piston side to provide proper spacing so the face of the wooden crankshaft part will be under the center of this piston. This also helps prevent the wooden crankshaft part from accidentally getting glued to the body.
Finally trim off any excess length of crankshaft wire as it will collide with the piston rod if it sticks out at all from the face of the wooden crankshaft part. Now glue the wooden crankshaft part to the metal crankshaft wire (the other end of which is secured in the flywheel), fixing it in place.

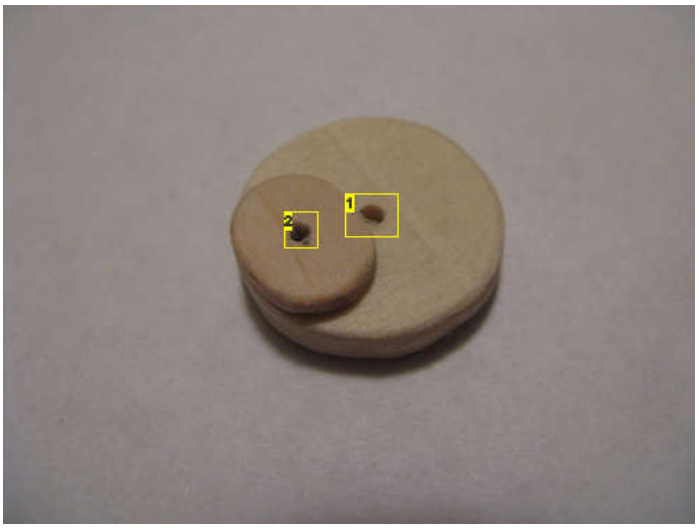


Image Notes
1. Same size as the wire used for the crankshaft.
2. Same size as the wire used for the piston rod.

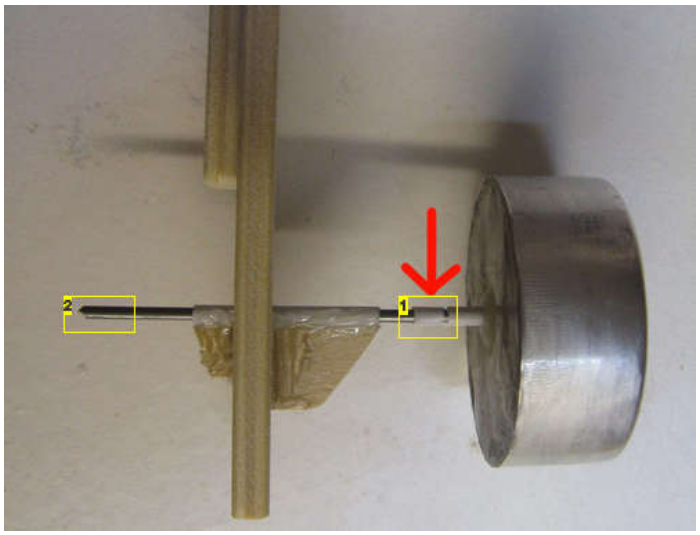


Image Notes
1. "Washer" made from Q-Tip Tube.
2. Going to have to do some trimming here!

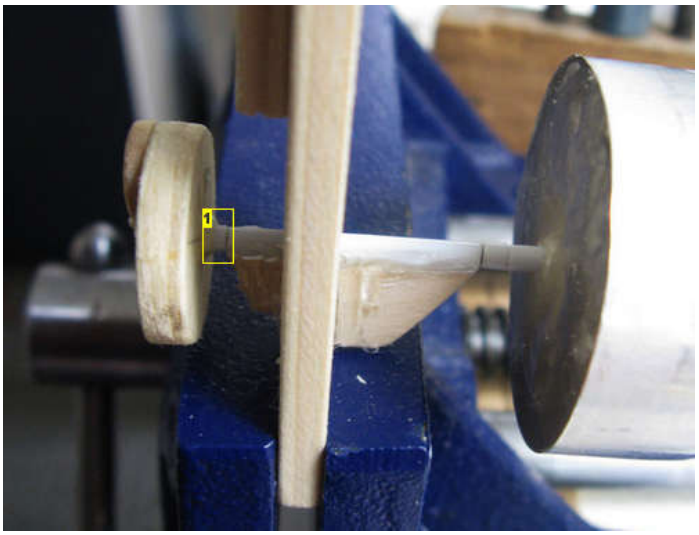


Image Notes
1. Q-Tip tube spacer added to keep glue from the wooden crankshaft part from attaching it to the body. Also serves to align the face of the wooden crankshaft part with the piston rod.

step 8: Finishing Up

Piston:
First make a 90° bend in the piston rod 20.5mm from where it enters the end of the piston. Now insert the piston into the cylinder, then simultaneously push the cylinder pivot rod and the cylinder rod through the body and the crankshaft respectively. You will likely have to turn the crankshaft to make the hole for the cylinder align with the bend in the cylinder rod.

Now you just need a way to hold the cylinder tight up against the body. I used a spring from a retractable pen held in place with a screw on "prop-saver" from a model airplane. I also found just putting an elastic band around the piston and body worked quite well... if not better than the spring, this option is also much easier to remove than if you glued a cap on the cylinder pivot rod. An elastic or two should really be all you need here.

Air Supply:
Lastly you need to connect one of the top two holes on the flywheel side of the body to a compressed air tank or pump. To do this I just glued some plastic tubing to the body; just do whatever works best for you. This motor works quite well for me on ~15psi. Turn on the air and give the flywheel a quick flick and the motor should start, if not try flicking it in the other direction. If you line it up just right the motor will even start without you flicking it. Switching which hole the air goes into will reverse the direction of the engine's rotation.

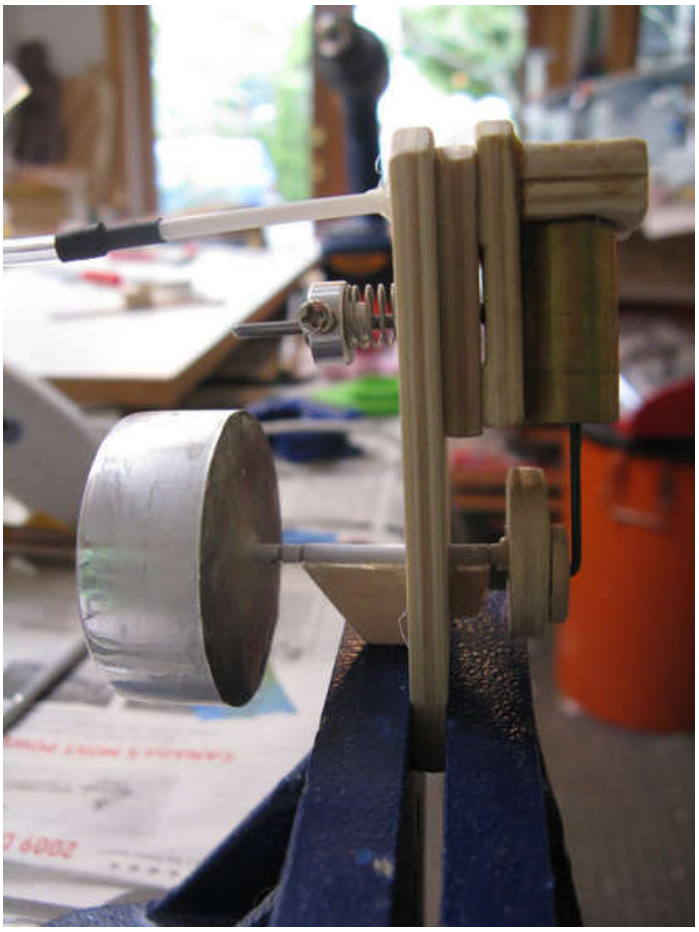
Troubleshooting:
If your motor does not run first make sure everything spins fairly easily when turned by hand. If it doesn't try figure out what is stopping it. Next make sure that you did not accidentally get glue in any of the holes that supply air to the motor. Lastly try running the motor on higher PSI. Other than that there isn't much more I can suggest. You can try posting any questions in the comments, I'll see what I can do but I'm no expert on the subject.

Final Thoughts:
Over all I am very pleased with how this little motor came out. It runs very smoothly, looks good and was really easy and cheap to build. Some possible improvement

include; the use of bearings to reduce friction, waxing the wood where it rubs together, or replacing/coating the wood with a layer of Teflon which would greatly reduce friction and help with the air seal. You might also try making the air input/output holes a little bigger and upping the PSI for more speed.

If you have any comments, questions, or suggestions please don't hesitate to put them in the comments. I'll do my best to respond to them.

I hope you enjoyed my instructable and I wish you a successful build.



Related Instructables

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Build a Coke Can Stirling Engine by reukpower

A Stirling Engine Project by marshon

R/C Steam Turbine Tank by crabfu

Build a Better Stirling Engine by marshon

Coke Can Stirling engine (video) by reukpower

Comments

5 comments **Add Comment**

nieks says: Jun 15, 2010. 8:41 AM **REPLY**

I agree with Phil B. Also: You probably used some sort of steam engin plans, which you adapted for this purpose. Could you tell us the source of the plans you based this on.

Phil B says: Jun 15, 2010. 6:27 AM **REPLY**

I am unclear on how you open a valve or passageway to let air into the cylinder and then close it, as well as how you open a valve to exhaust the air at the bottom of the power stroke and then close it. It seems any engine would need to do these things.

Tombini says: Jun 15, 2010. 4:02 AM **REPLY**

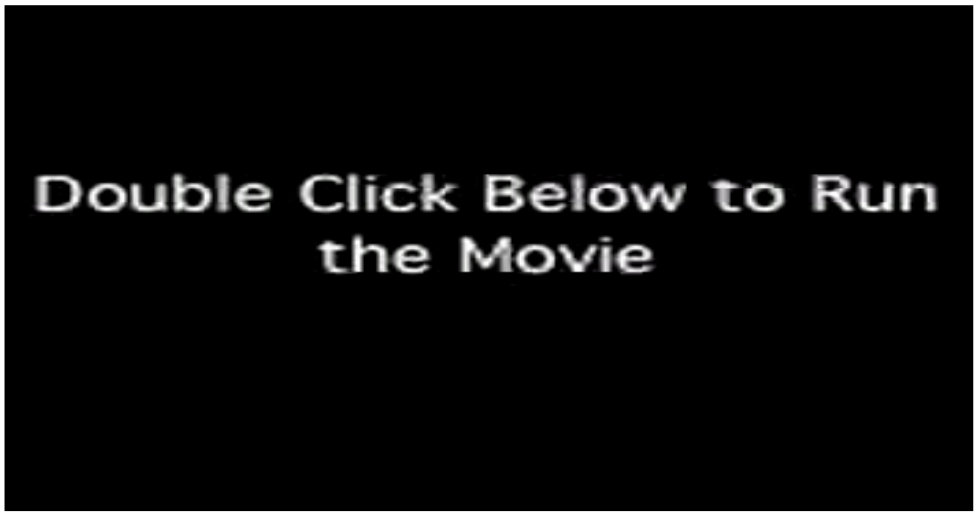
I recently made a compressed air engine as part of a engineering course at school, got it running around 6000 RPM at 600Kpa. It was a bit more work since it was a full design process and made out of stainless steel, brass and other bits. I could upload some of the 80 pages of write up here if you would like :P

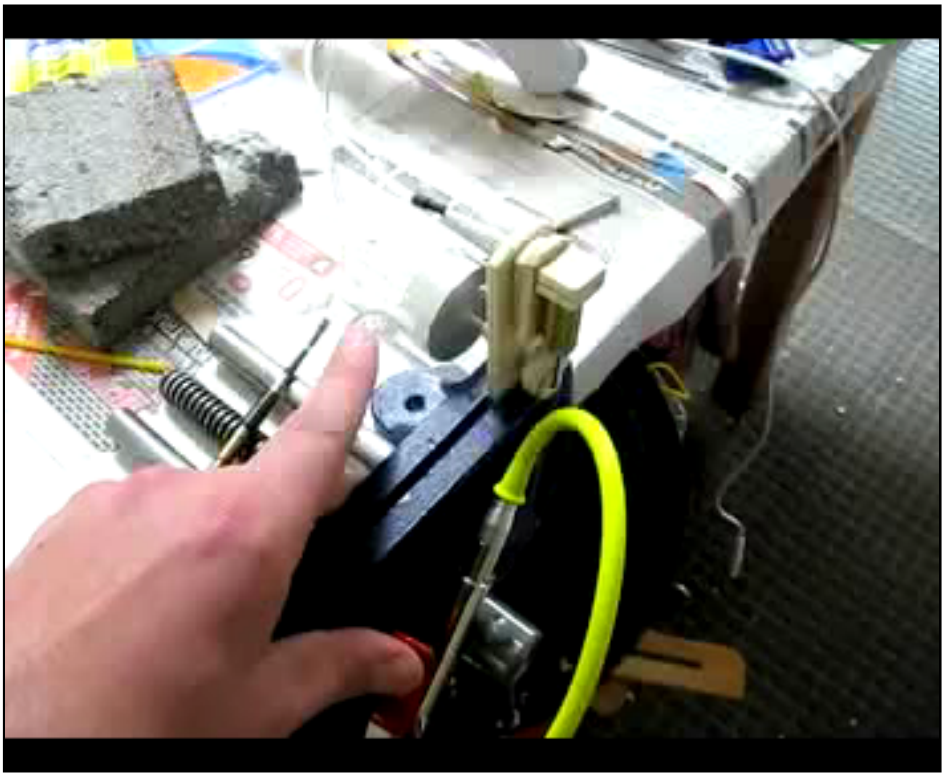
Nerdz says: Jun 14, 2010. 9:54 PM **REPLY**

It would be cool to see how much power (electrical power) if you used a Stepper motor (or some other motor) in place of the flywheel to act as a generator. Very interesting Technology :)

jam BD says: Jun 14, 2010. 9:33 PM **REPLY**

It's kind of cute =)

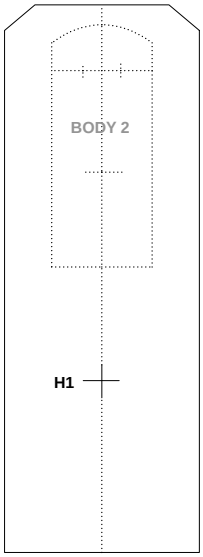




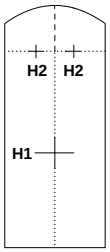
DIY "Steam" Engine

3/16" PLYWOOD PARTS WITHOUT MEASUREMENTS

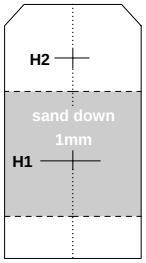
BODY 1



BODY 2

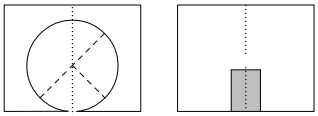


CYLINDER BACK



BRACE

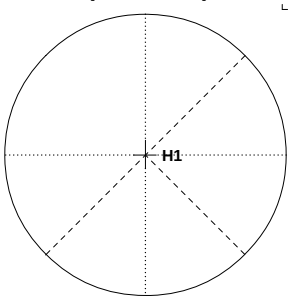
CYLINDER HEAD



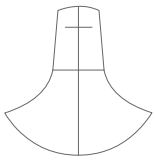
HOLE SIZES:

- **H1: Same as size of Crankshaft or Cylinder Pivot wire.**
- **H2: Drill with 3/32" drill bit.**
- **H3: Same as size of Piston Rod wire.**

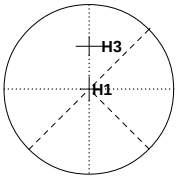
FLYWHEEL (not wood)



Alternative Crankshaft



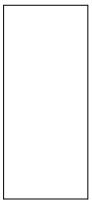
CRANKSHAFT



METAL PARTS WITH MEASUREMENTS

BRASS TUBING

CYLINDER



OUTER DIAMETER 7/16" (11.11mm) WALL 0.014" (0.356mm)

PISTON

OUTER DIAMETER 13/32" (10.39mm)

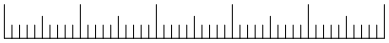
PISTON ROD 24AWG

BEND 90° AT LINES

CRANKSHAFT 18AWG

CYLINDER PIVOT 18AWG

BEND 90° AT LINES



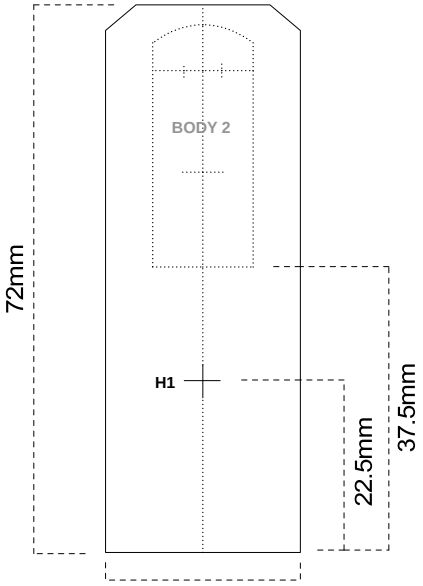
5cm

DIY "STEAM" ENGINE V1.4

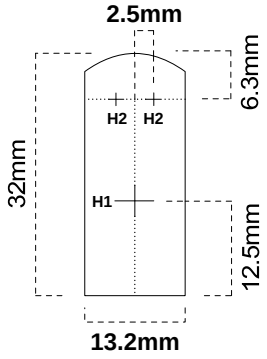
DIY "Steam" Engine

3/16" PLYWOOD PARTS WITH MEASUREMENTS

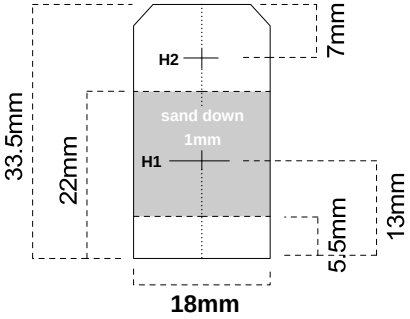
BODY 1



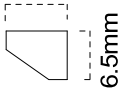
BODY 2



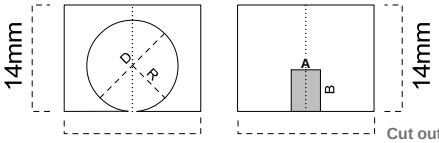
CYLINDER BACK



BRACE



CYLINDER HEAD



18mm
D: 12mm
R: 6mm

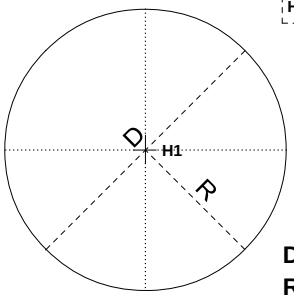
18mm
A: 4mm
B: 5.5mm

Cut out grey area 2.5mm deep.

HOLE SIZES:

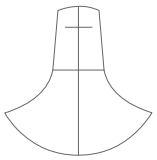
H1: Same as size of Crankshaft or Cylinder Pivot wire.
H2: Drill with 3/32" drill bit.
H3: Same as size of Piston Rod wire.

FLYWHEEL (not wood)

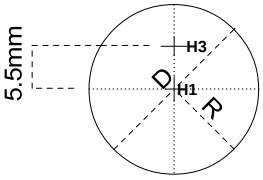


D: 37mm
R: 18.5mm

Alternative Crankshaft



CRANKSHAFT

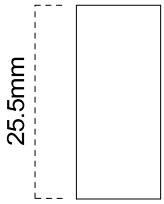


D: 22.5mm
R: 11mm

METAL PARTS WITH MEASUREMENTS

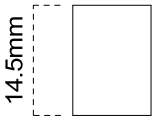
BRASS TUBING

CYLINDER



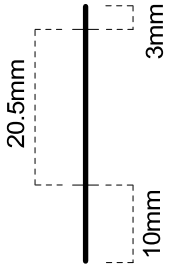
OUTER DIAMETER 7/16" (11.11mm) WALL 0.014" (0.356mm)

PISTON



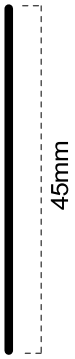
OUTER DIAMETER 13/32" (10.39mm)

PISTON ROD 24AWG

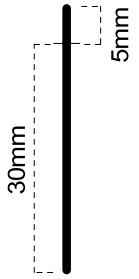


T: 33.5mm
BEND 90° AT LINES

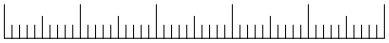
CRANKSHAFT 18AWG



CYLINDER PIVOT 18AWG



T: 35mm
BEND 90° AT LINES



5cm

DIY "STEAM" ENGINE V1.4