Easy to build Stirling engine fan

The idea behind these plans was to make an easy to build Stirling engine, that can be built by almost anyone. It runs on only one candle, which is a bonus, although I can't honestly say it moves much air! This engine is easier to build than my last one, and should be more reliable. If there's any problems with building this, let me know, and I'll try my best to help!
I'd like to be able to magic a Stirling engine out of thin air, unfortunately, I can't. So you'll need some materials and tools, they are listed below. If you spot an omission, please post an email and let me know.

**Materials for these plans:**

- 6 - 8 Coke cans
- A small scrap of wood about 6cm x 2cm x 2cm
- A balloon
- A tuna paste lid
- A spoke from a bicycle wheel
- 1.2mm steel wire
- Epoxy
- Super glue
- A 2p coin for counterbalancing
- Sellotape
- 2 x Electrical screw blocks
- Piece of thick cardboard about 10cm square
- BBQ Skewers
- Paper
- 1.59mm (1/16") brass rod
- 2.38mm (3/32") brass tube
- Another scrap block of wood for the jig at least 75 x 75 x 20mm
- Plastic bottle lid
- Steel wire wool
- A drawing pin

**Tools :**

- Scissors
- Drill with 2mm drill bit, and 6 - 8mm HSS drill bit
- Tin Snips (you can get away without these, but they make life easier)
- Pliers (two pairs of pliers comes in very handy)
- Needle nose pliers
- Can opener
- Stanley knife
- Half round file
- Saw to cut wood, if necessary
Step 1:

This can will be the top can that holds the cranks. Remove the top with a can opener or scissors. You need to holes punched and drilled either side. To make sure that they were in line with each other, I made a paper template, you can skip doing this and just make the holes by eye, but I think it's worthwhile making the template. When you've punched the holes, drill them out with a 2mm drill bit.

Punch a hole in the can, parallel to the direction that the cranks will run in with a knife. Use this to start your cut for the viewing hole in the front of the can.
Step 2: Mark the centre of the top can, for the bushing

The bushing for the displacer shaft needs to sit in the centre of the can. I marked this using a caliper set to 33mm. Draw three arcs, they should intersect at the centre of the can. I punched a hole in the centre of the can to make sure that the drill bit didn't slip, then I drilled it out using a 2mm drill bit. The tubing for the bushing is 2.38mm, not 2, so you'll have to run the drill bit around the hole a few times to widen it.

Step 3: A jig to glue the bushing in place.

As there's nothing physically holding the bushing in place until the epoxy sets, you'll need a jig to hold it straight. The jig is just a scrap of wood with a 2mm hole drilled in it. There's a 1.59m brass rod is epoxied in this hole. Cut a piece of brass rod to about 50mm long and epoxy it in place. Whilst the epoxy is drying, keep checking that it's square to the wood with a square. Check all round with square.

When the epoxy has dried, you can add a spacer. The purposes of this spacer is to hold the brass tube in the right place on the coke can, as the bottom of the can is dome shaped. The spacer is about 9mm long and made from the end of an ink cartridge out of a biro pen.
Step 4: Cut and glue the bushing in place.

Cut a piece of the 2.38mm tubing about 10mm long. You can cut small diameter tubing by rolling the knife over it. Cutting the tube will leave tiny burrs on the inside of the tube, you need to remove these using a knife, scrape around the inside of the cut edge tube with the tip of the knife. Test that the piece of tube slides over a piece of 1.59mm rod, it should fall under its own weight.

With the tube ready, you can place it on its jig. Then place the coke can over the tube. The jig should hold it in place, so you can epoxy the tube in place. Be careful not to get epoxy on the brass rod.
Step 5: Bend the cranks

The cranks are made from a bicycle spoke. I bent the cranks using pliers. As you make them, keep checking the they running true, you can do this by laying them on a flat surface between where the two bearing points will be. A windowsill is ideal for this.

The displacer part of the cranks is bent out by about 14mm and the diaphragm part is bent out by about 4mm. These two are offset by 90°.

Step 6: The displacer cylinder

The displacer cylinder is just a coke can with a hole drilled it the side, and the top bevel cut off. The hole I drilled is around 6mm. You want to remove the top with a can opener, the cut down to just below the top bevel. Remove any burrs from the hole so they don't catch the displacer.
Step 7: A displacer

The displacer is made from steel wire wool wrapped around a length of brass rod. Cut your brass rod to 125mm long and bend a small hook on one end. This will keep the bottom cap from falling off.

Take two coke cans, mark and drill the centre of these to 2mm as you did in step 3. Cut the domes out of the bottom of the cans using tin snips. You'll need to make a depression in one of them to make space for the screw block.

To hold the two caps together, I took a screw block, removed the plastic coating and sawed it in half using a hacksaw.

Now you can roll your steel wire wool around the brass rod. Keep wrapping it until it's about 5mm smaller than the displacer can. Remove the brass rod, and cut the roll of wool down to about 40mm using scissors.

You can assemble the displacer now. First put the bottom cap on the brass rod then push the wire wool onto the rod. Put the top cap on and then secure it with the screw block. When it's finished, the displacer should be about 35mm tall. You'll probably have to make adjustments until it will fall freely in the displacer can.
Step 8: The diaphragm shelf

The diaphragm sits on a little piece of wood that’s epoxied to the side of the displacer cylinder. The wood has two holes drilled in it to transfer air from the displacer cylinder to the diaphragm.

Start by drilling a 6mm hole in the paste lid. You can position the paste lid roughly and use this to mark the depth on your drill with a piece of tape. You want the paste lid about 1cm away from the end of the wood that will be glued to the coke can. You can drill the two holes now, one in the end of the wood meeting up with another in the top of the wood, they should meet allowing air to flow through. File the edge of the wood that meets the into a curve to roughly match the curve of a coke can.

With the holes drilled, you can epoxy the paste lid to the piece of wood, make sure the holes line up. Wait for that epoxy to dry, and then epoxy the piece of wood to the side of the displacer can, again making sure that the air holes line up. You'll have to hold the wood while the epoxy dries.

It's important to use plenty of epoxy to seal the engine, as it must be air tight. Even a very small air leak will stop the engine running, so it's better to use too much epoxy rather than too little.
**Step 9**: Fit and bend the displacer rod

You can assemble the two parts of the engine now. Put the displacer in it's cylinder, and then push the top can into the displacer cylinder. Don't push the top can from the top, only push from the bottom through the viewing window. Test the displacer falls freely, it should fall under it's own weight with no obvious resistance. If it doesn't quite fall freely, you can adjust the position of the top can until it does.

With the displacer moving as it should, you can bend the end of it to a right angle, so that it can be connected to the cranks in the next step. Ignore the cranks and connecting rod in the picture, that's covered later.
**Step 10:** Make the connecting rods for the displacer and diaphragm

I made the connecting rods for the displacer and diaphragm from 1.2mm wire. The ends are wrapped around the parts they connect to, to act as bearings. They have a zig zag bend, so that the length of them can easily be adjusted by stretching or compressing the zig zag.

For the displacer connector, I bent one end around a piece of the 2.38mm tubing to connect to the cranks, and the other around a piece of 1.59mm tubing.

For the diaphragm I bent one end around a piece of the 2.38mm tubing to connect to the cranks, and the other end around a piece of 1.2mm wire.

Both of these are about 45mm long.

**Step 11:** Thread the cranks through and attach displacer

You can thread the cranks through now, as you do, thread the displacer rod connector onto the cranks. Don't worry if you widen the holes a little, we'll be adding extra bearings in the next step.

When you're happy with the cranks moving the displacer, you can bend the displacer rod over a little more like a fish hook, to prevent the connecting rod from slipping off.
**Step 12:** Steel bearing points

Because aluminium is so soft, the bearing points will wear out quite quickly (mine lasted around 30mins!). To fix this, we'll add some steel bearings.

To make these, I drilled a 2mm hole in the side a flat side tin can then I cut a square around this. Make two of these. Then thread them onto the cranks and glue them in place using super glue. The curve of the tin can should almost match the curve on the coke can.

**Step 13:** The diaphragm

The diaphragm is a balloon with a bottle cap glued to it. The bottle cap has a piece of 1.2mm steel threaded through it. I made the holes for the steel wire using a drawing pin. To keep the diaphragm connecting rod in the centre, you'll need to make two spacers by wrapping steel wire around a piece of spoke. The spacers are around 1 cm long. Thread the diaphragm connecting rod through the steel pin with a spacer either side.

Cut the neck off a balloon, and stretch the main part of the balloon over the end of a coke can. Then glue the bottle lid to the balloon using super glue.

**Step 14:** Fit the balloon onto the paste lid

The balloon is fitted over the paste lid. It should be a little bit loose. You might need to use an elastic band to hold the balloon in place. You can connect the other end of the diaphragms push rod to the cranks now. You'll need to add another screw block to the end of the cranks to stop this coming off.
**Step 15: Firebox/candle holder**

Cut a coke can down to about 45mm tall, and push another coke can into it, this is just to widen the top of the can as it'll be weak once you cut the hole for the candle.

Next cut a slot in the front of this can, about 50-60mm wide for the candle to fit in. Use your pliers to flatten the bottom of the can, so that you can fit the bottom of another can in there upside down for the candle holder.

Cut the bottom of a can right around the bottom edge. This is just to hold the candle.

**Step 16: Building a fan**

The fan is really easy to make. Essentially it's squares of paper glued onto BBQ skewers, which are epoxied to a cardboard disk.

Start by cutting a cardboard disk out about 70mm diameter, before you cut it, mark 8 sections using a protractor or similar. Cut 8 lengths of BBQ skewers at around 10cm long.

The paper is folded along it length, the folded again. Please look at the photo's, as it's hard to explain. Then it's cut along the previous fold and cut again in the middle. This should give you 8 little gift tag sized pieces of paper. These are folded over the ends of the BBQ skewers, tape the loose ends over and glue the paper to the skewers.

Tape each of the blades to the cardboard, along the 8 lines that you marked. Raise your cardboard disk up about an inch using any random object, and epoxy the blades near the centre. Raising the cardboard makes all of the blades sit at the same
**Step 17:** Attach the fan

The fan is attached on the opposite side that the diaphragm connects to. Push the fan onto the shaft and bend a hook on the crank shaft. The hook is pressed into the cap so that the crankshaft can grip it.

With the fan attached, tape on a 2p coin on the opposite side to where the displacer is connected. This is to counterbalance the displacer weight.

**Step 18:** It's finished now!

Hopefully, it'll work first time, unlike mine which needed some tweaking. You'll most likely have to adjust the diaphragm connecting rod until the engine turns smoothly. There's not much to wrong in this engine, other than too much friction, or air leaks. So if your engine doesn't work, check those things.

The next few steps are additions you can add to make the engine better, such as a fan, heat sink and "super stylish" red trim.

**Step 19:** [OPTIONAL] A heat-sink

I made a simple heat sink out of a coke can, by cutting the top and bottom off. I cut fins down the sides of the can leaving out a space for the fan. It's glued to the wooden block using super glue.