Part IIa, the „Λ-8 stove”

1 Introduction

This is how the Λ-8 stove was developed. Read it if you care to understand how the stove works. It will show you how to adjust the design to your needs. If you simply want to build, go toPart IIb.

“Why the hassle, just take a cat food can, punch a few holes in it, and there is your alcohol stove!” OK, why not. Skip all the rest. But, if you are concerned about fuel-efficiency, read on.

1.1 A long way to go.

The father of all alcohol stoves: the trangia stove. In any case it is a first reference point - for better (simple, reliable) and for worse (heavy, real army-surplus style, leaking if not burnt dry).

left: The Trangia stove, right: a "penny-stove" with Trangia adapter and pre-heating bowl

The Trangia is a “fish-eye” stove design. It has an “open bowl” in the middle. There, alcohol evaporates, the fumes mix with air and burn if lit. The Λ-8 stove is a special fish-eye design, too.

The original penny stove is another reference point. I like the jet design. Jets make the fumes exit faster. This gives a better mix of the fuel fumes with air. A good mix will give you a good burn with no or little soot.
During my experiments, I was puzzled by the penny stove quitting when being used in a Trangia windshield and pot stand. I then discovered that these worked as a giant heat sink. Insulating the stove from contact with the wind-shield solved this part of the problem. The rest, fussy operation with a penny to lose and extra fuel to light up the pre-heater in a cramped area remained.

So, after many different penny stoves built, they all went to the aluminum-recycling…

getting rid of dozens of more or less fiddly, more or less functioning stoves…

Another fish-eye design goes as “the only camping stove you will ever need”. Fumbling with a few of these was a real eye-opener. They taught me the concept of “wicking” the fuel up. Two sheets of foil touching each other will do the job nicely.

#1: "The only camping stove you will ever need"..., #2 open bowl designs

These #1 stoves tend to burn very hot, suitable for cooking 2 liters or more water at a time. They also tend to get a bit sooty. They run so hot, they evaporate too much alcohol. You simply do not get enough fresh air under the pot to burn it all.

Then, the jet-less open-bowl designs #2: You can reduce the burn-rate by choosing their dimensions. If you make the hole in the middle smaller, they burn less hot. But: you will have to adapt the height! If the hole is too small and too high up, the stove can not be lit at all. Also, the jet-less designs have a tendency to produce more soot than the jet-designs.

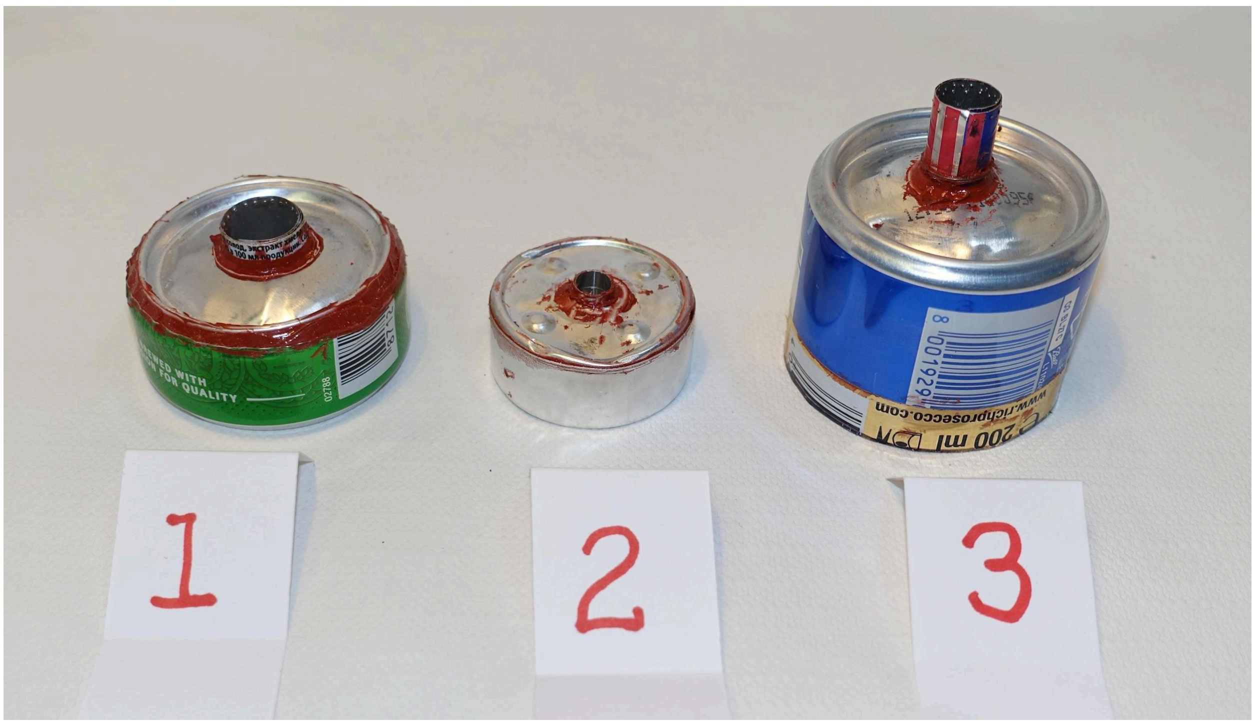
One very good open-bowl design is the Trail Design 10-12 stove. For my taste, it burns a bit too hot. It is a challenge to build a stove which equals or even beats the 10-12 as far as fuel-efficiency goes. I "boiled" my 10-12 against the Lambda stoves and would not get more than a 10% advantage over the 10-12. So do not expect wonders...

Going back to jet designs: The designs sometimes referred to as “rift” stoves taught me the concept of heat-feed back:

“rift”-stoves with different heat-feedbacks stove #1 has the jet-holes about 20mm below the top rim. It burns incredibly hot and violently. It almost melts the top of the stove itself!

stove #2 has the jet-holes about 12mm from the top. It burns a bit less violently,
stove #3 finally has the jets about 5mm from the top and behaves quite nicely.

The solution seems to lie there: reduce the feed-back of heat into the fuel tank. So you should rise the flame of your stove up and away from the alcohol.



First designs to wick the alcohol away from the fuel tank

The first designs to reduce the heat feed-back suffered from spluttering operation, which is not too good for an even, non-soot burn. Also, it was not easy to get them to run "dry". Further, they now were too weak. They would give you just a decent simmer.

To solve these issues, the "wick" was changed from a cylinder into the typical Lambda-cone. So the bottom of the "wick" would rest in the bottom groove of the can. This is where last drops of fuel remain towards the end of a burn. The “wick” gets them up to the flame. The top diameter of this “wick” will be adjusted according to the desired power output.

#1 is the very first Λ-stove. "Sealing" was sort-of achieved with some crinkled aluminum foil.

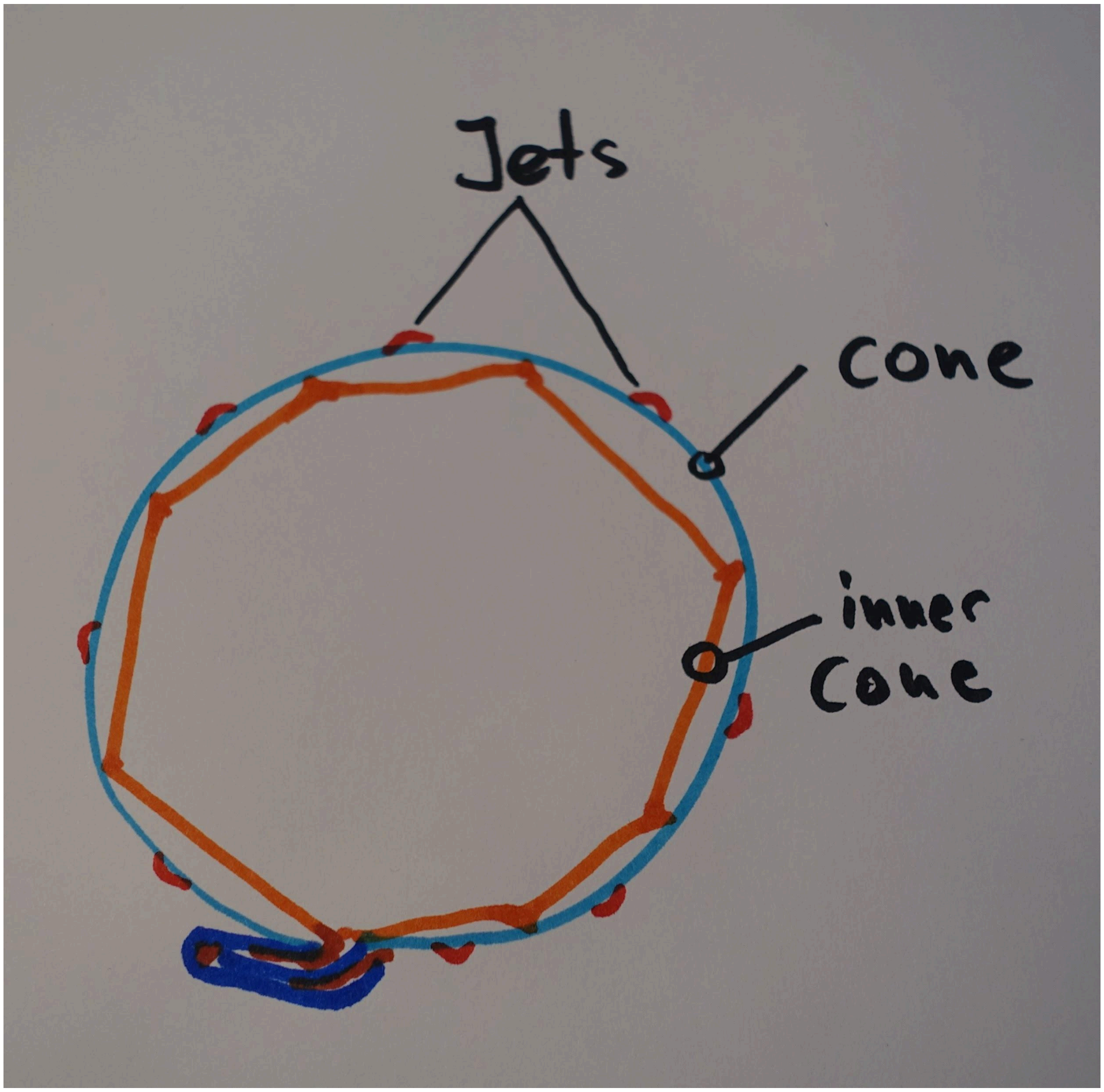
The first few Lambda-Stoves

#2 already is really sealed with oven-grade silicone. The spluttering persisted until I made room for the alcohol fumes to accumulate before exiting through the jet-nozzles. So this stove now sports small bulges around the jet-nozzles. The heat-feed back was a bit too low. It gave me a rather weak burn.

#3 is more or less identical with #2, but with a little more heat-feed back by moving the jet-nozzles down on the cone.

As the bulges were very touchy to make without damaging the aluminum foil, I finally came to change the inner cone to a partially hexagonal or octaconal shape. So it forms nice big pockets under the jet-nozzles for the alcohol fumes to pile up and seek their way out of the stove via the jet nozzles.

#4 is pretty much the final design with a cross-section of the cone like this:

- 

Cross-section of the Lambda-cone

Now at last I had a pretty consistent burn, no more spluttering. From then on, I started to "streamline" the design. Here is the result you can build yourself:

The final Lambda stove design

#1 were the Λ-6 stove designs we took along in the Sierra Nevada in Summer 2015 and successfully did all our 2-person cooking on. They are made from 500ml beer cans, but as we rarely ever would burn more than 20ml of alcohol in one go, I decided to continue with the smaller 250ml cans, thus saving another 5gr per stove (or one third of the stove weight...)

The final Lambda stoves, Λ-8 stoves on the right

#2 shows some of the Λ-8 stoves with the larger opening in the cone, with different heat-feed-backs.

#3 shows the Λ-8 stoves with the small opening in the cone, my current favorite. The left one has a little more heat feed-back for colder weather, the right one is the "fair weather" variant. You can see the jets in the fair weather variant (right one) are farther up the cone than the jets of the colder weather variant (left one).

1.2 What do I want / need finally?

Playing around with all these stoves finally got me to define my personal aim for a stove. It should of course be lightweight, **fuel** efficient and easy to operate. When I need a stove most, I am usually hungry, tired, cold and not up to the peak of my abilities any longer. Therefore, my field kitchen must be simple to operate. This seems to be a common concern among hikers and backpackers. I hope my construction article will thus be useful for the lightweight backpacking community.

Many designs available on the net claim to be super efficient. Efficiency can be defined from different points of view:

• Either you want a time-efficient stove, one that boils your water in no time. It will burn a lot of fuel in a short time interval. The designs on the net I came across usually claim to boil your half liter in three to four minutes on 30ml of alcohol (double the amount I use), if they give you a figure at all.

• Or you want a fuel-efficient stove that boils your water with the least amount of fuel practical. For me, the latter approach is more appealing. When I am going out lightweight, I am not ready to carry extra fuel just to boil my water in four instead of twelve minutes. When I set up the stove immediately after stopping for a meal, I am not ready for hot water in 3 minutes, I will have to unpack my food and set up the freezer bag in its cozy, cut it open and maybe peel an orange for dessert, search for soup, tea or coffee and therefore do not need to have my water boil before 10 minutes. Plus, if I was going for a fast and hot burning stove, I would need a sturdier windshield and pot stand - all at weight penalties. I soon found most designs on the net to be far too hot for solo or 2-person use. They may be okay for three to four people, when you are carrying a large 3liter pot and a suitable stand and windshield. So the primary quest was to design a stove that would burn less violently and thus suit my needs of typically cooking half a liter of water in about 10 minutes.

The final design yields itself to a certain range of “power”, according to your preferences. It is not an adjustable stove though, you will have to make different stoves for different outputs, but at 10 to 15g per stove, you may carry more than one as well…

Construction concept

I did not want the design to depend on a special brand of aluminum can or bottle. Just about any standard can between 200 and 650ml can be used. Amazingly enough, they all seem to have one common feature: The diameter of the bottom groove is 48mm on all the cans I got hold of. Seems to be an industry standard for beverage cans. The patterns provided rely upon this feature of the cans. The wall thickness usually is 0.15mm, but this is not critical.

1.3 From Trangia to the Λ-8 stove

Actually, almost any “design” works. As alcohol evaporates way down below zero degrees, you can just pour alcohol anywhere and light it up. However, you may soon find

your pot getting some nasty black soot (real lamp black) that comes off like dust and blackens everything. In this case, the carbon part of the alcohol has not all been burnt to CO_2, as desired. You may also burn a ridiculous lot of alcohol to boil an equally ridiculous amount of water. And you may damage or even melt your aluminum windshield instead of just boiling your water.
Many designs ("penny-stove") rely on getting all the alcohol inside the stove to boil. Such designs tend to be overly sensitive to the environment: If it is a bit on the cold side, they just quit, if it's warm, they will go out of control. Other designs use a wick to get the alcohol up and evaporate. These designs may work under all conditions, but they tend to be on the weak side. Plus you can not run them really dry, they will keep leaking. Should the fuel reservoir once get hot enough to have the alcohol evaporate directly, they also tend to go berserk.

The first point which I want to make: It is important to control the burn-rate of your stove. This rate depends - even with the final Λ-8 stove design - on the environment of your stove. If you are out in summer and temperatures are high, your stove will burn more violently . If it is cold, and you want a hot meal in a snow camp, your summer stove will burn at half the rate as in summer or even quit! The windshield arrangement also is crucial, as it is responsible for the "micro-climate" your stove is working in. If I test any of the Λ-8 stoves on the top of my workbench, just on a piece of fireclay, at nice ambient temperatures, it will for example burn 1.0ml of alcohol per minute. If I put this stove into the snow, without any insulation, it will probably quit after a few minutes. If I put the stove on dry ground, on top of a reflecting piece of aluminum foil, inside a nice windshield cone and with a pot of water on it, the very same stove will burn about 150% hotter, meaning the burning rate goes up to 1.5ml per minute. This is why you will have to find out how hot a stove you want to build for your needs, and this is also why I think a good design should be adaptable to the intended use, e.g. summer or shoulder-season (or even winter…).

Second, it is equally important to control the mixture of air versus alcohol-vapor. If there is too much alcohol-vapor and too little air, you will get only a partial combustion, which means a sooty pot. This also means bad efficiency.

So the design goals finally were easy to define. The Λ-8 stove has
- to handle as easy as a Trangia stove
- to be lightweight
- to be made from trash (old beverage cans)

- to be made with simple tools, no machining shop required
- to be very fuel-efficient, with boil-times of around 10 minutes allowed for 500ml of water
- to have a certain range of power to be chosen at the beginning of the building process
- to burn all the fuel put into the stove at the beginning of the cooking process (no ever moist and leaky wicks)
- to work together with the Trail Designs cones, e.g. with pots 78mm (3in) above the ground. This is a personal preference, as I have two of their cones and really like them.

To meet these construction goals, I applied some construction principles derived from many (many, many) evenings tinkering with lots of different stove-designs.

1) A jet-design has the advantage of making a good mixture of the alcohol vapor with air, resulting in a clean burn. The jets however should come on instantly and not need excessive priming.

2) The feed-back of heat into the body of the stove has to be kept under control, in order to keep the stove from running too hot and "going berserk".

3) The stove has to strive for a "hot spot" in the very center of your pot. This makes the longest possible way for the hot combustion gases along the bottom of the pot and up the sides until they escape. Some designs (all designs that "abuse" the stove as a pot stand) violate this principle and thus sacrifice fuel-efficiency.

The resulting construction principle is simple:

1) "wick" the alcohol, which finally will rest in the bottom groove of the can, up and away from the rest of the fuel. This is done with a double-walled cone going down into the bottom groove and up over the top of the fuel reservoir. The double wall will act as a wick, due to the capillary action induced by the two walls (partially) touching each other.

2) Make the top of the cone as narrow as practical. The narrowest cone would have a top diameter of about 5mm, to accept the tubing of the snuffle flask for easy filling. The narrower the cone, the smaller the hot spot in the center of your pot.

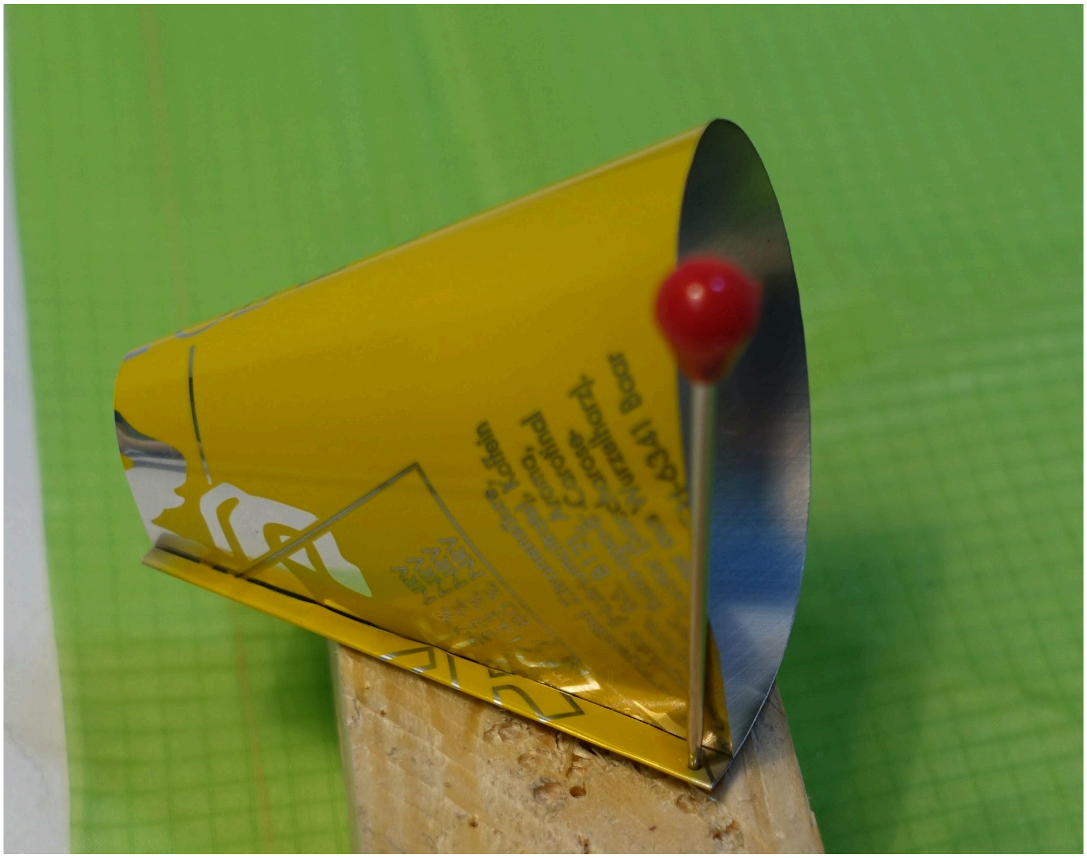
3) Keep the rest of the stove small and low, to have the flames and heat well above your fuel supply. You will typically burn some 15 -20ml of alcohol in one go, so this is easy to achieve, you do not need a large fuel supply in the stove. As these little stoves weigh around 10 (from 250ml cans) to 15 grs (from 350 to 650ml cans), they will also cool in a minute and can be refilled again for the next boil.

Cooking lunch for one on the GTA, Monte Erisetta near Dolceacqua, Italy, on February 10, 2016. Robens Ti 800 bowl, Λ-8 stove, and, of course, a snuffle-flask...

Understanding all this or not, get at it:

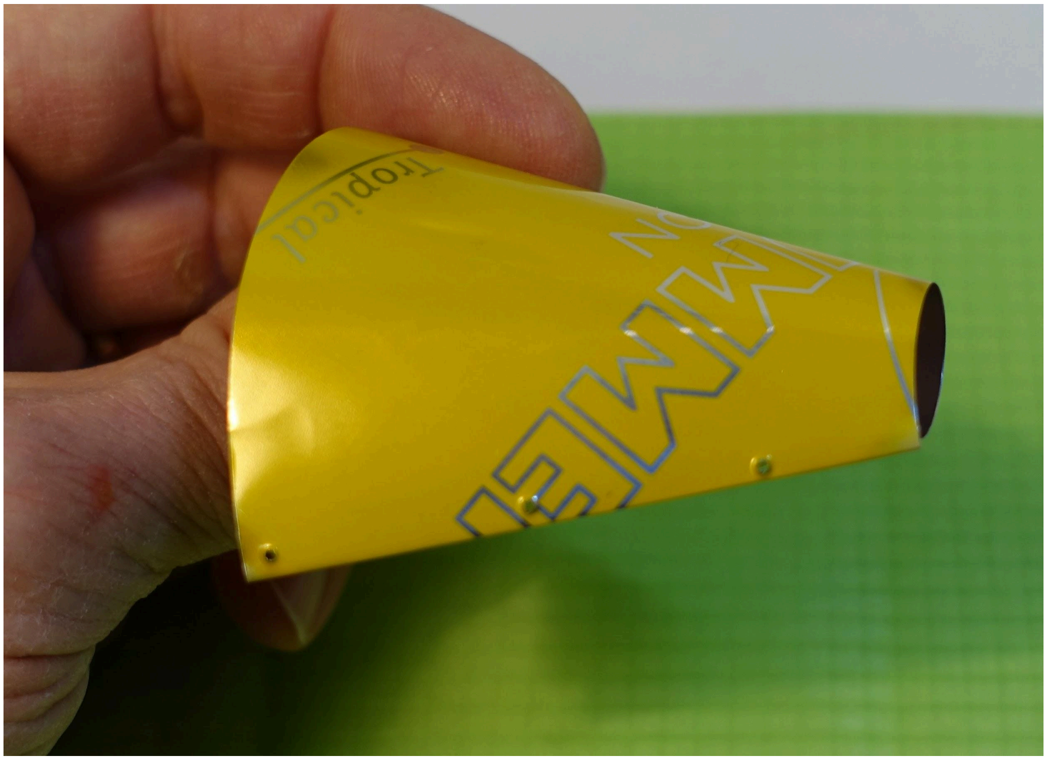
1.4 Two important building techniques, or "core concepts".
Successfully building a Λ-8 stove relies on two core concepts: (1) keeping the aluminum soft and (2) riveting the thin beverage can foil.
1.4.1 The first and most important of these core concepts is to capitalize on the properties of aluminum: If bent or scratched, the thin aluminum foil used on beverage

cans almost instantly becomes hard and brittle and will break along the scar or bend. Very nice if you really want to cut the aluminum along this line.
If you want to work bends and curves into your aluminum, this feature can be a real killer: instead of a bend, you will get a cut - very undesirable, as you will have to throw the piece of material you are working on away and start again.
So, whenever you want to make a bend, you will have to keep your aluminum soft at all times. Should there be the slightest fraction anywhere on our stove, it will leak and not be serviceable. Fortunately, aluminum will soften over and over again if heated with a lighter or a candle. I found normal butane cigarette lighters to be very convenient, as they are not hot enough to melt the aluminum. Keep off micro torches, they will melt your flimsy cans in no time! Even an alcohol flame can be too hot. Just stick with a lighter that will barely burn the lacquer off the can if you heat the same spot for an extended period of time. Heating with such a lighter will re-soften the aluminum and allow you to do all the amazing bends and shapes you will need for your Λ-8 stove without even impairing the lacquer. You can even integrate the lacquered design of the can in your stove. For example, the text on the stove in the introductive video to part I says “nonalcoholic”, as it was derived from a can of nonalcoholic beer. I kind of liked this on an alcohol-stove!
1.4.2 The second core concept is “self-riveting”. A simple way to join sheet metal plates always is riveting. The concept here is simple and lightweight: Just overlap the aluminum parts to be joined and carefully punch a few holes through all overlapping layers.



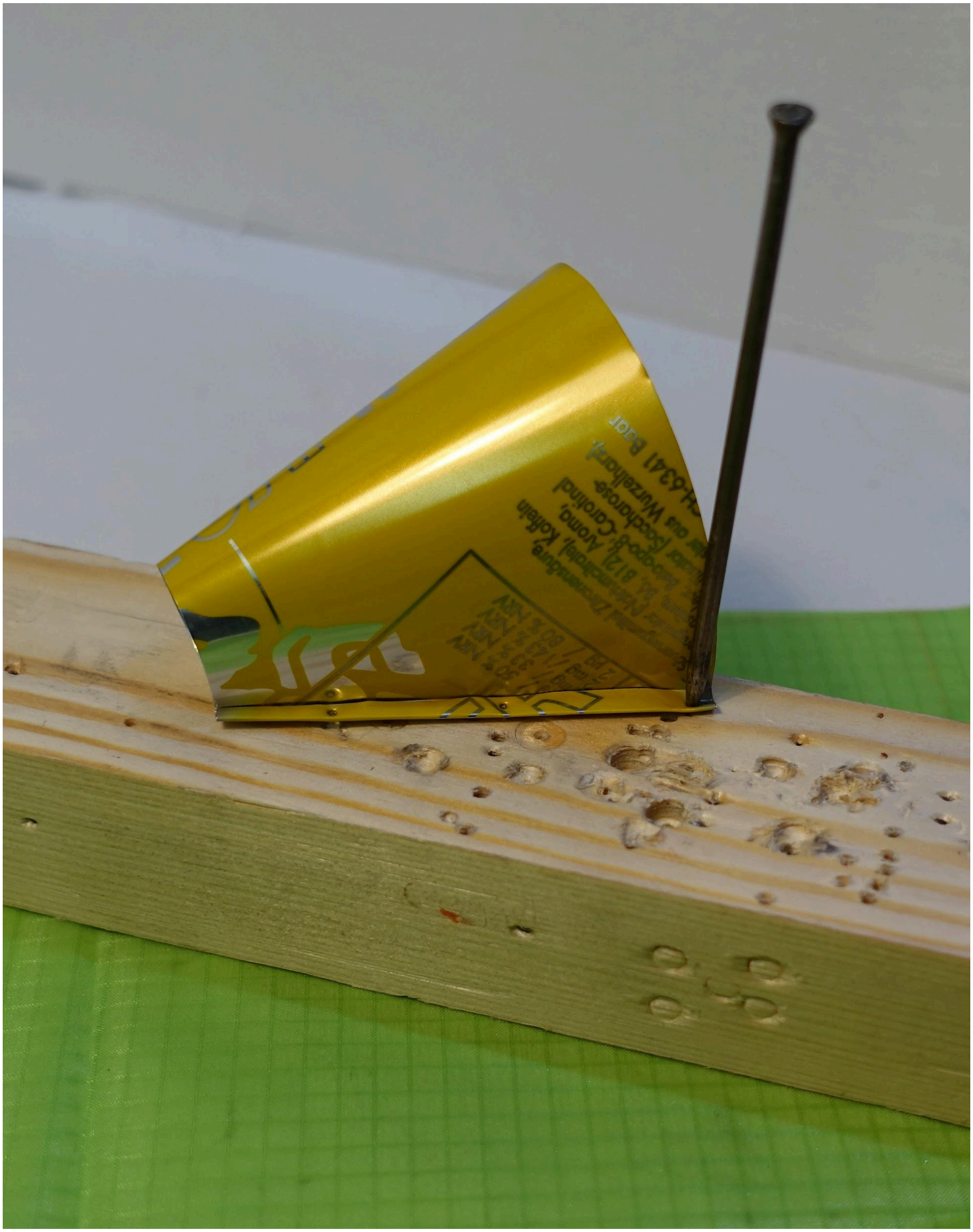
Riveting a cone: start with a sturdy pin

First, go with a sturdy pin. Make sure the pin and the ragged "teeth" of the aluminum exit into a hole drilled into the soft wood block. If there is no hole, you will not get the "teeth" needed for the rivets.



"frist round", ready to soften the rivets

The reverse side should look like this - some tiny teeth (to be grown further...) protruding above the surface of the aluminum foil.
Now heat the area around the holes with your butane lighter to soften the aluminum. It has become hard and brittle by punching the pin through.



riveting, second round

Now go at it again with a larger pin or a round awl, over a slightly larger hole in your soft wood block, until the bent up and ragged rim of the top layer sheet protrudes well below the bottom layer.

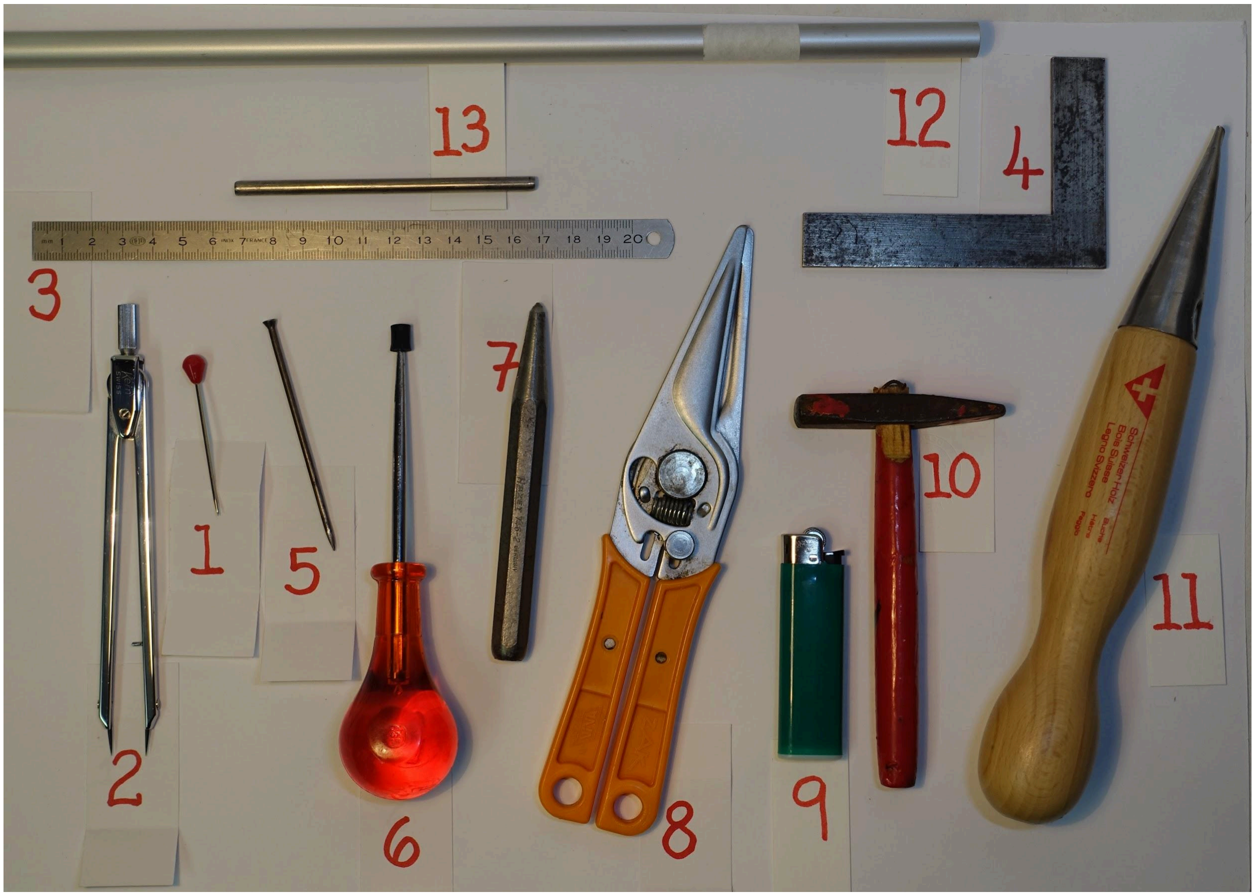
Now heat (soften) again. Flip the cone over and bend the “teeth” of both layers down to the now top, former bottom layer. On small rivets, I like to do this job with a center punch. Its 120° head centers nicely in the hole of the rivet and pressing it down gently bends the “teeth” as required.

When done, give each rivet a few punches with a **small** hammer or a pinch with some pliers. There you are with riveted sheets.

The construction of the core element of the Λ-8 stove, the cone, depends on your riveting. Practice with a few scrap pieces, then give it a try with a few cones, don’t expect to be successful on your first try. If you do not want to get too drunk, take pop cans instead of beer, or take a stroll through the “party zones” in your place. You will probably end up with enough raw material for a couple of stoves.

2. Construction
2.1 Tools required

not shown:
- a circular cutter as described in part I
- x-acto type knife
- small clothes pin (typically 0.5mm diameter)
- 2 clamps (woodworking tools, see pics in construction part)
- 1 piece of stripwood, about 30mm x 40mm x 300mm
- 1 piece of rubber derived from an old bike tube
- 1 x-acto type blade
- various thickness card stock
- various thickness scrap pieces of plywood



Tools used for cone construction

(1) sturdy pin (1.5 mm diameter)
(2) dividers
(3) ruler, preferably a steel ruler with a thickness of around 0.4mm. A normal ruler will do, if you have a straight strip of sheet metal of about 0.4mm thickness
(4) straight edge (don't abuse your ruler…!)
(5) spring steel nail (not mandatory but handy in lieu of the awl, for riveting)
(6) awl
(7) center punch
(8) sturdy scissors
(9) butane lighter
(10) small hammer (this is what I mean with small!)
(11) dibble from the gardening section of your department store
(12) 12mm dia aluminum tubing, hardwood dowel or similar
(13) 6mm dia steel rod, hardwood dowel or similar

2.2 Materials required

some pop- or beer cans, size is not crucial, but the bottom-groove must have a diameter of 48mm to fit the pattern provided. I was working with 200 to 250ml cans, so the measurements for the height of the "cup" and the "lid" are given for these cans. They would have to be adapted for the 500 to 650ml cans. The measurements of the cone only depend on the diameter of the bottom groove of the beverage cans.

Oven-silicone or some other heat-resistant sealant (JB-weld may work too. I am happy with the 300°C version of the coltogum-brand silicone sealant). The design does not depend on the bonding capabilities of your sealant, but on the sealing. Watch out for a sealant rather than for a glue.

2.3 Give it a go:

2.3.1 First clean your beverage can, any residues of beer (malt) or pop (sugar) are not welcome. Then set your circular cutter at 17mm for the 18mm top opening cone, or to 14mm for the 6mm top opening cone. Punch it into the middle of the top (yes, the top!) of your can, and scar the circle. The middle is easy to find, as the opening tabs are riveted onto the middle of the can. Just punch the center of the tab's rivet.

scoring the top of your can

push the opening out with a sturdy knife or a screwdriver

The scar has hardened your aluminum top to the verge of breaking. Jjust pop it out with your knife (or a screwdriver). It feels almost like opening a can.

2.3.2 Now you will have to cut the top and the bottom off your can. The top will make the lid of your stove, the bottom the cup.

The setup for cutting the can

For this purpose, I stack a short length of wood of a little more than the desired height of the lid (30mm here) with the rubber and the x-acto type blade and clamp it to the workbench. Watch for the x-acto type blade protruding at about 31mm in this setup.

scoring the lid-section at 30mm

To cut the top/lid, I use just a piece of cardboard to geht the distance between the “cutting floor”, e.g. the cardboard, and the protruding tip of the blade to 30mm.

To cut the bottom / cup, replace the cardboard with some 6mm plywood to get the 25mm height of the “cup”. Turn the can around and score the bottom.
Be sure to score the can on both ends. Do not yet really cut it or break the lid or the cup off your can! It is not easy to score a can once you have removed one end of it.

With **both ends scored**, punch the blade in one of the scars and brake the can’s body from the end. Repeat for the other end.

starting to break an end off your can

continuing to break off an end

When done, you have the lid and the cup, plus some waste from the body. Soften the rims of both the lid and the cup with your lighter to prevent them from ragging during further processing.

softening the rims

softening continued

2.3.3 Now prepare the cup for assembly by indenting the rim as shown on the picture. I like to divide the circumference by 12, but anywhere from 10 to 14 will work. The idea is to reduce the diameter of the rim so the lid will fit over it. To define “clean” indents, I first push the rim inwards with a small metal straight edge.

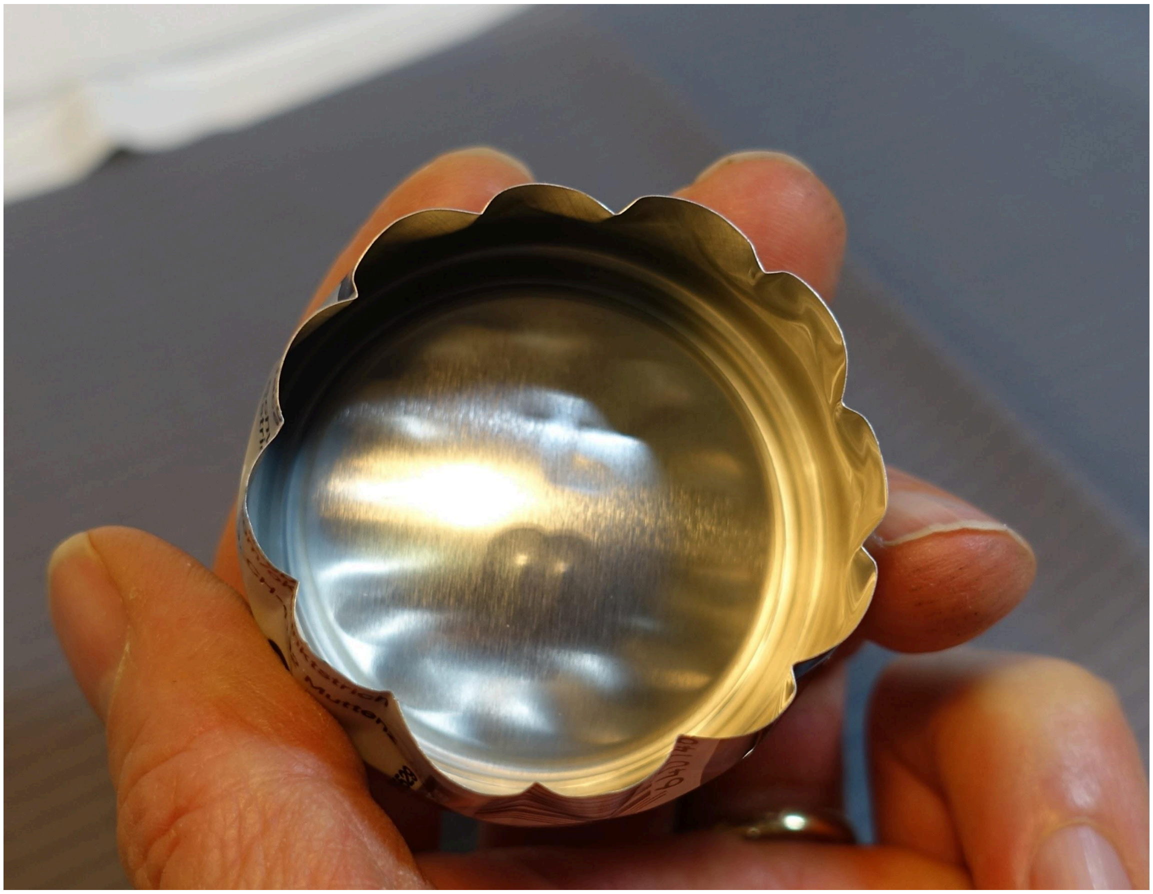
marking the cup for evenly spaced indentation

making the first indentation with the straight edge

how the cup looks after the first round of indenting

Then I deepen the creases it by hand, just pressing the thumbnails into the indentations.

second round: deepening the indentations



the cup ready for (later!) assembly

Lightly grease the lower portion of the cup with some vaseline or a good machine grease. This is to make sure the lid will go down over the cup with ease. Make sure to keep this cup away from the rest of your work. You want to have the surfaces completely clean and de-greased for your sealant to work.

2.3.4 Now it is time to get at the cone. You will need the aluminum foil derived from one single pop or beer can. The left-overs from the 250ml beverage can you derived the lid and the cup from are too small to make one of the two cones. I provide two patterns, one with a bigger top opening (about 18mm), one with a small top opening (about 6mm). The one with the larger top opening is easier to make, the other one is probably a bit more efficient (no comparative tests done so far though...). Take the larger top opening for your first try, and, when successful, go for the small one.

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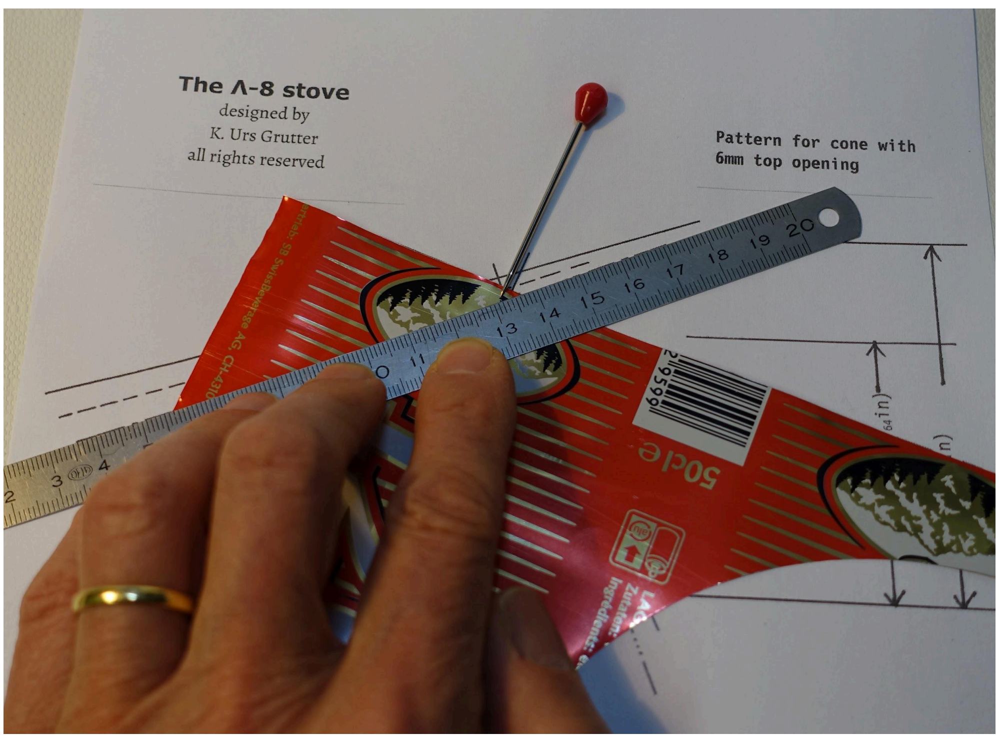
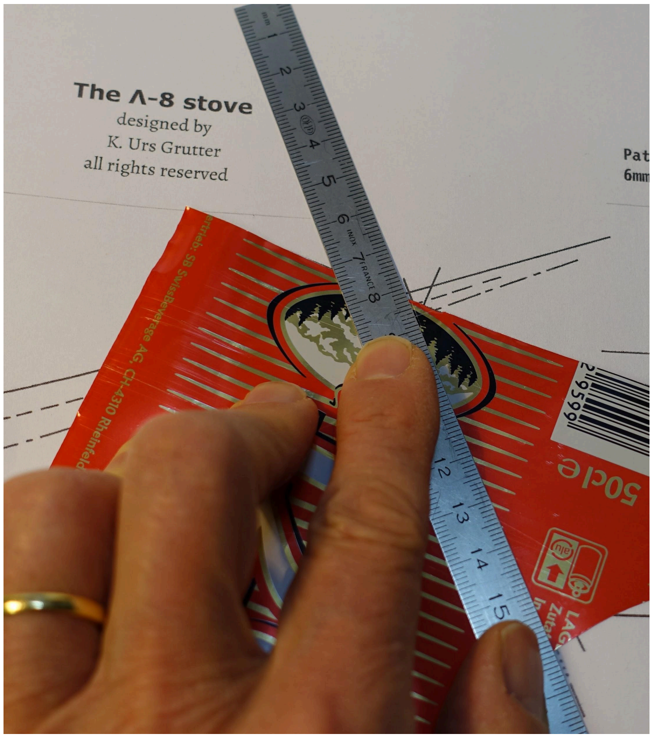
Print the patterns making sure the distance between the center point and the outer (bottom) circular line measures exactly 91mm for the 18mm top opening cone or 66mm for the 6mm top opening cone respectively. You will probably have to do some scaling up or down to get a proper pattern. This is inevitable, if you do not want to draw your own pattern starting from the vertical section of your cone.

Study the patterns closely. The lines are drawn in the very same style on both patterns, so refer to the cone18.pdf pattern for the meaning of the lines of the cone06.pdf pattern and vice versa. In the cone06.pdf pattern, I gave you the horizontal lines, which mean, from top down: Bottom of pot (78mm), top of cone (55mm), top of stove- lid (on both patterns, 28mm, the rim of the lid protrudes about 3 to 4mm up over this line), ground (0mm).

Note the “end line” designates the theoretical end of the cone, but you have to add an allowance for riveting. Therefore, you will add a strip to the theoretical end of the cone. This strip is 4mm at the bottom and 3mm at the top (cone06.pdf: 5mm at bottom, 3mm at top). On one end of the cone, you will have to add two riveting allowances. Therefore, the lines where you will have to cut the aluminum do **not** go through the center point! Put the foil on the pattern, aligning the right cut line with an edge of your aluminum foil and decide where the center of the circles should be. Take foil from the pattern and lightly punch a hole for the center. Your sturdy pin comes in handy, but go easy, you want the hole to be just large enough to reliably keep your compass or your divider. I prefer the divider. If you punch too hard, the hole will be too large and the sleek dividers pin will slop around and you will not be able to do a precise scar for scoring and eventually cutting the aluminum foil .



determining the center point on the cone material

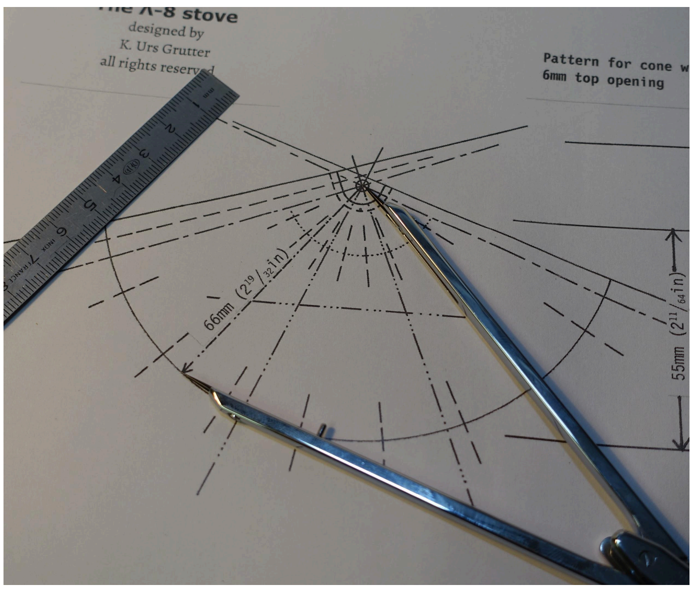


second step in determining the center point

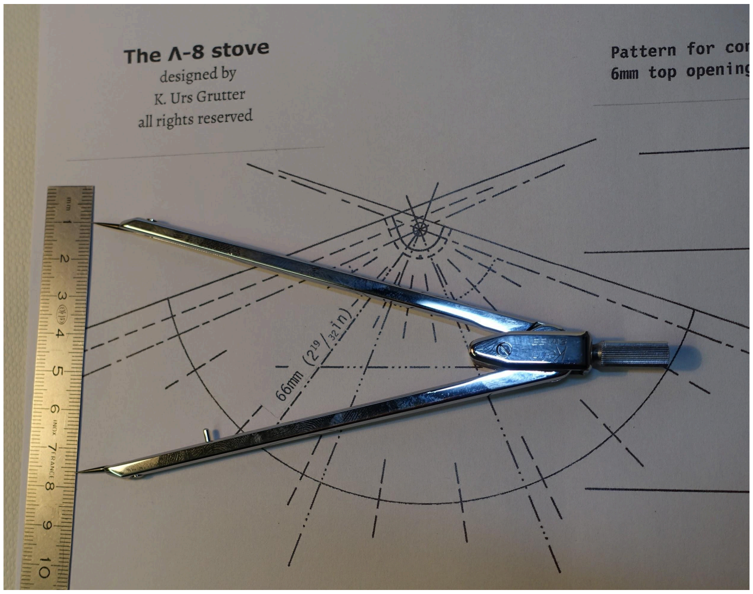
and now lightly punch a small hole to keep the tip of your divider

If you do not want to buy a divider, make one yourself by stacking two strips of hardwood of about 200mm length with a screw on one end, so you can adjust the opening, and insert a pin in each end. Cut the head of the pin off and sharpen the pin. There you are with your DIY divider.

Now score the 91mm (or 66mm) line onto your aluminum with the divider, it takes about 10 times, always in the same sense (probably mostly counter-clockwise for right handed people). Go easy, you do not want to break the sleek tips of your divider!



setting the divider according to the pattern



double check for the proper measurements: 91mm for the larger top diameter cone, 66mm for the small top diameter cone

lower rim of the cone scored, ready for breaking the aluminum

Scored like this, you can break the foil along the scored line. If you only have a compass, you will have to cut the foil along the line with some heavy scissors. Do not take your wife’s dressmaker’s scissors, you will ruin them forever.

breaking the cone piece off the rest of the can

cone material, bottom rim and right end as per pattern; top and left end pending

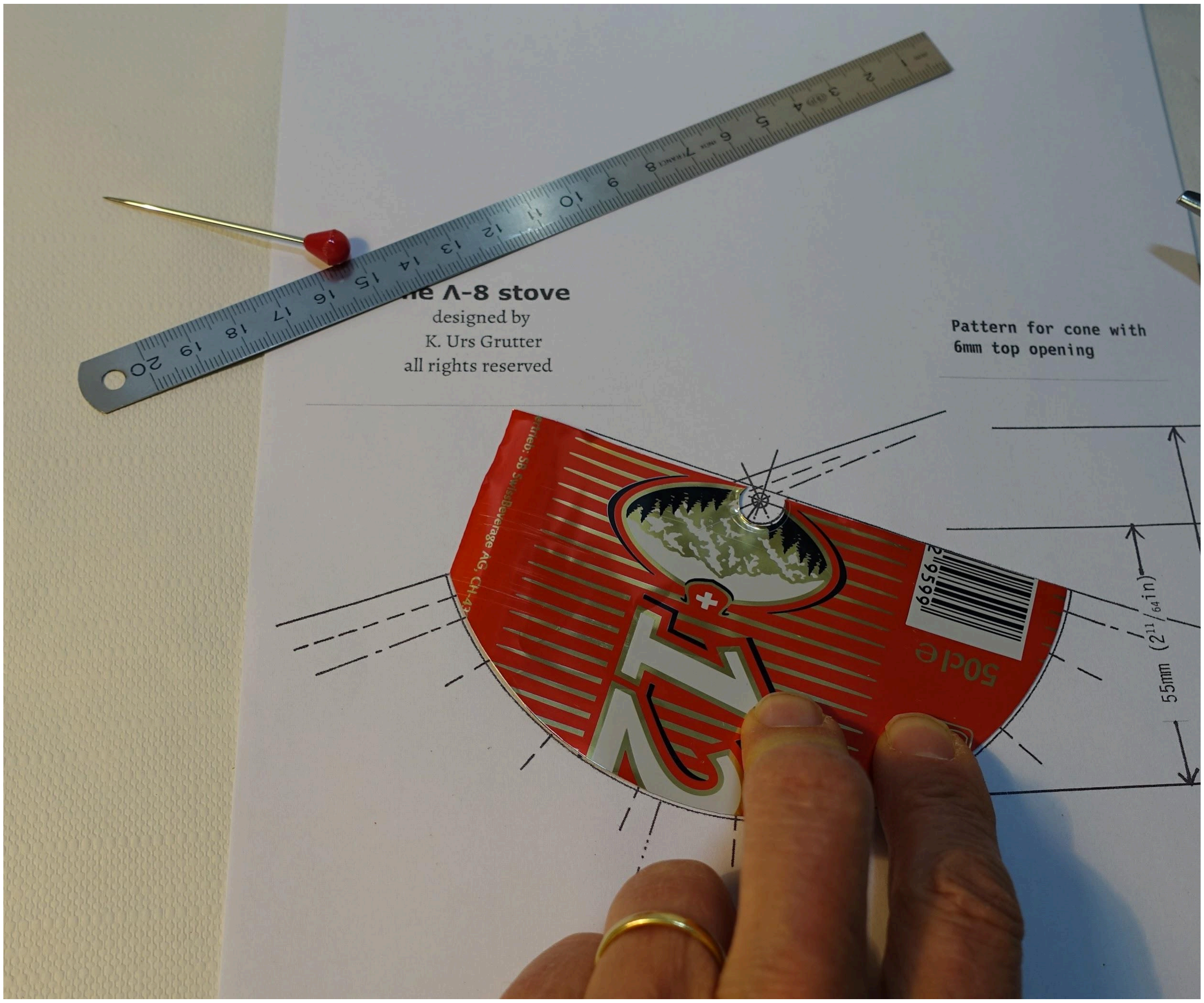
I like to keep the colored side of the can on the outside of the finished stove. For further work, flip the cone piece over and work on the inside of the former can and future stove. Now mark the height of the jets very lightly, do not scar the aluminum there, you only want a mark, not a cut! For the cone18.pdf, a good start for your jets is 8mm from the top rim (or 10mm from the top cut line), for the cone06.pdf, take 12mm (or 14mm respectively). For a hotter burn, move the jets farther down, for a weaker burn, move them up towards the top of the cone. Then mark the upper end of the cone. Only mark, no scoring! The upper end of the cone is the line along which you will have to fold back a 2mm sealing rim. So now mark and score the additional cut-line 2mm above the top end of the cone:

marks on the cone material, from left: location of the jets, top of the cone, cut line (2mm above the top of the cone)

Then score the “cut line” about 2mm above the top edge of the cone. You will later have to fold this allowance inside the cone to seal its top.

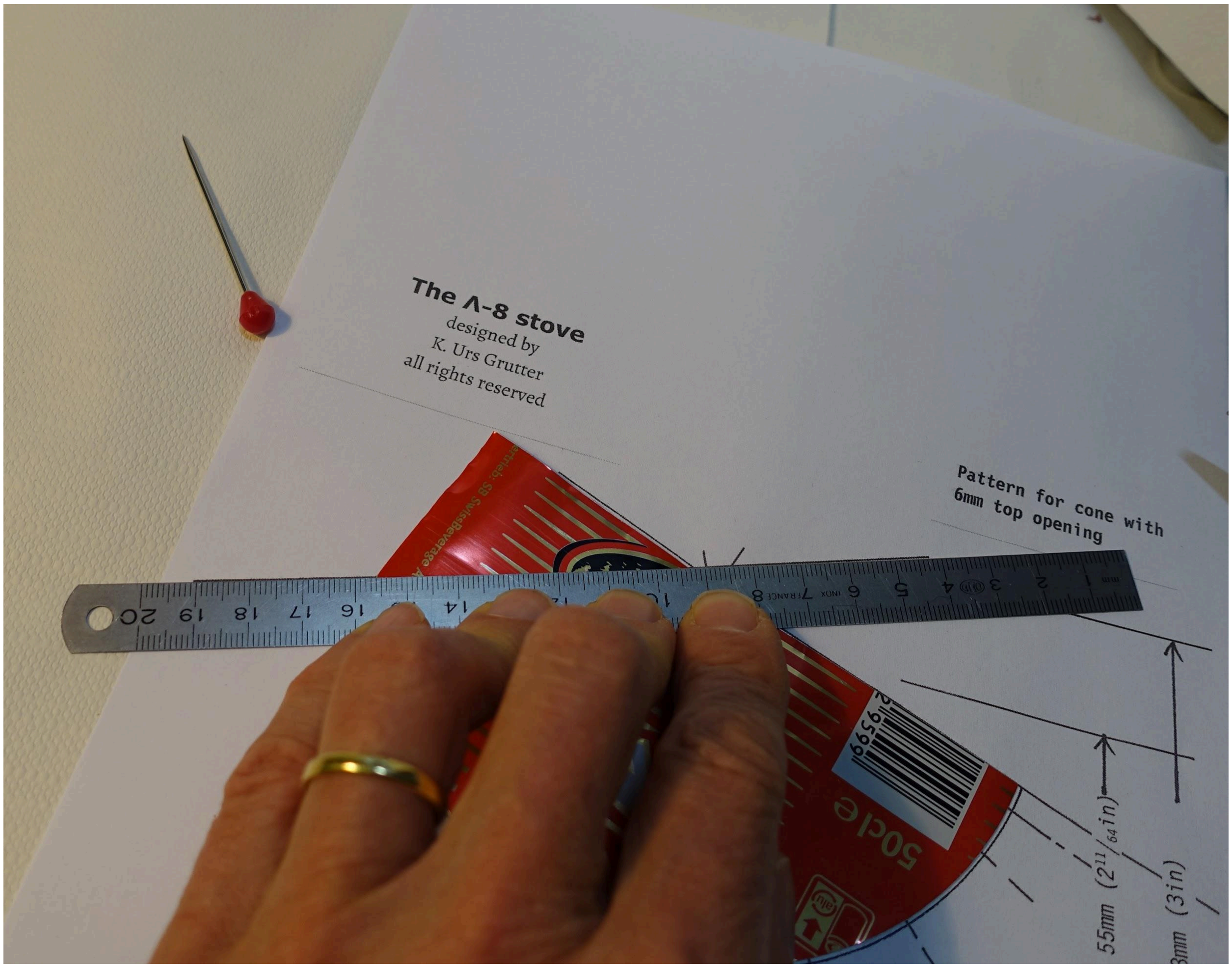
Building the cone with 18mm diameter on top, you will score the top cut line with your divider the same way you did on the bottom line. Building the cone with 6mm diameter on top, you have to cut this small circle with a suitable hollow punch (10mm diameter).

cutting the top of the cone with a hollow punch



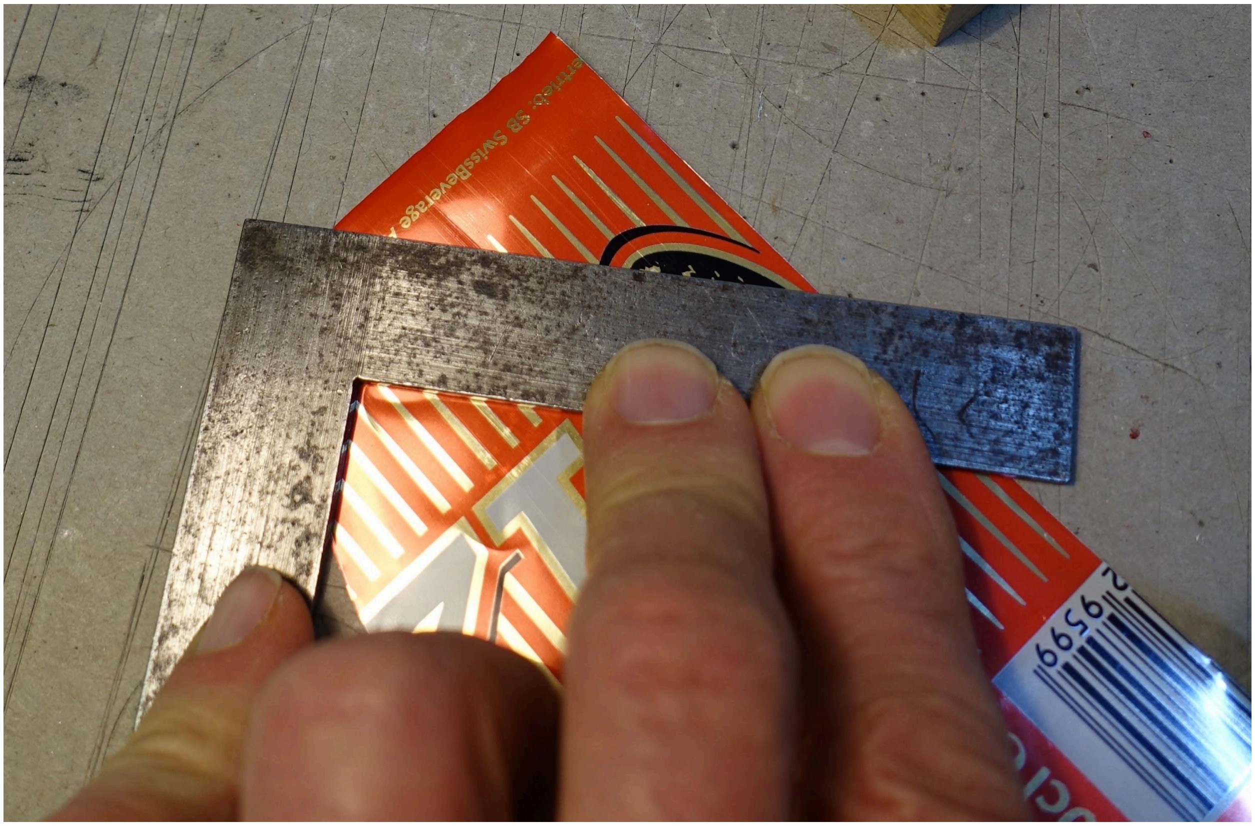
aligning the aluminum on top of the pattern

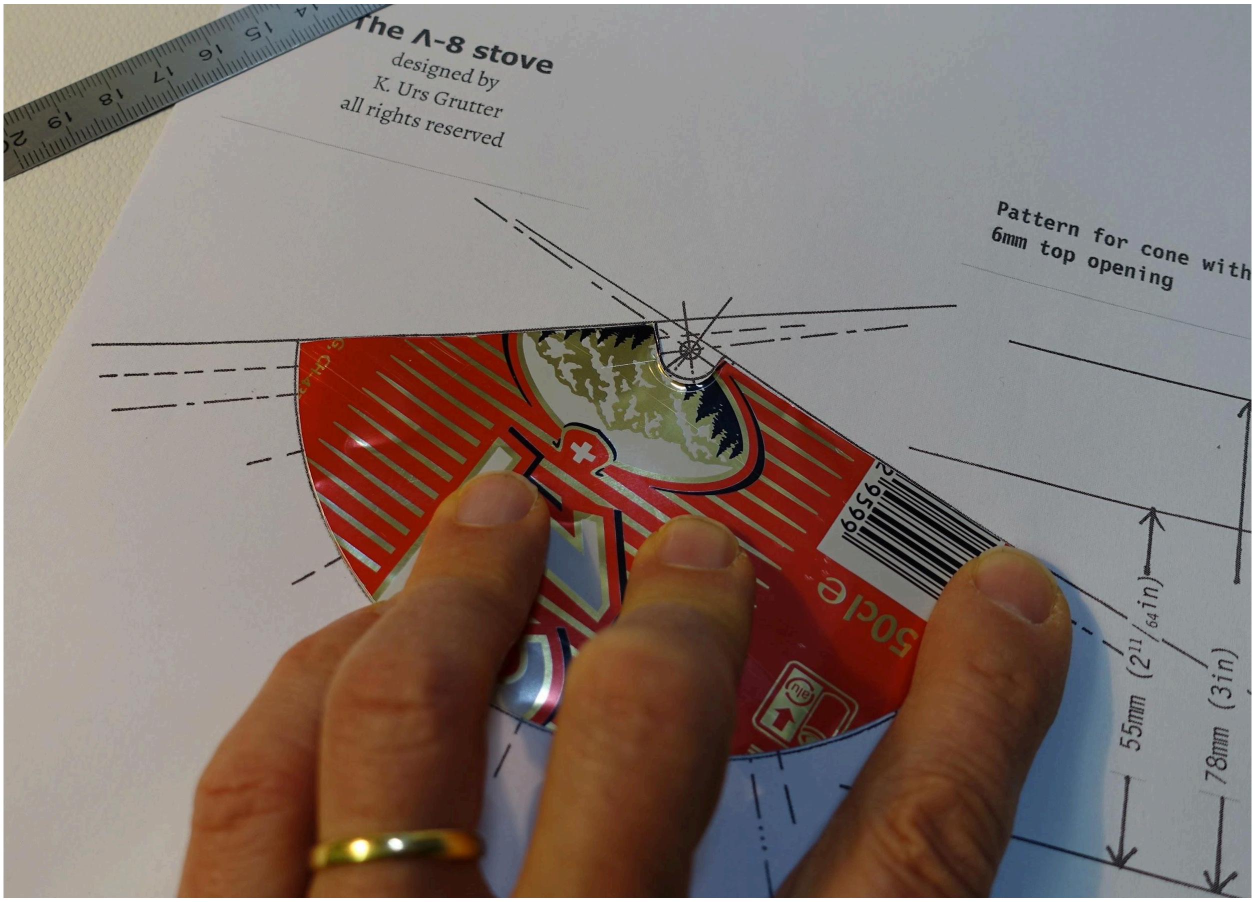
Now lay your aluminum on top of the pattern and lightly mark the missing straight cut line. Remember: you aligned the aluminum with the right straight cut line on the pattern at the very beginning of the cutting process. Find the extensions of the cut line, put your steel ruler on them and mark.



marking according to the pattern - the cut lines are drawn long enough so your piece of aluminum foil will not cover all of them

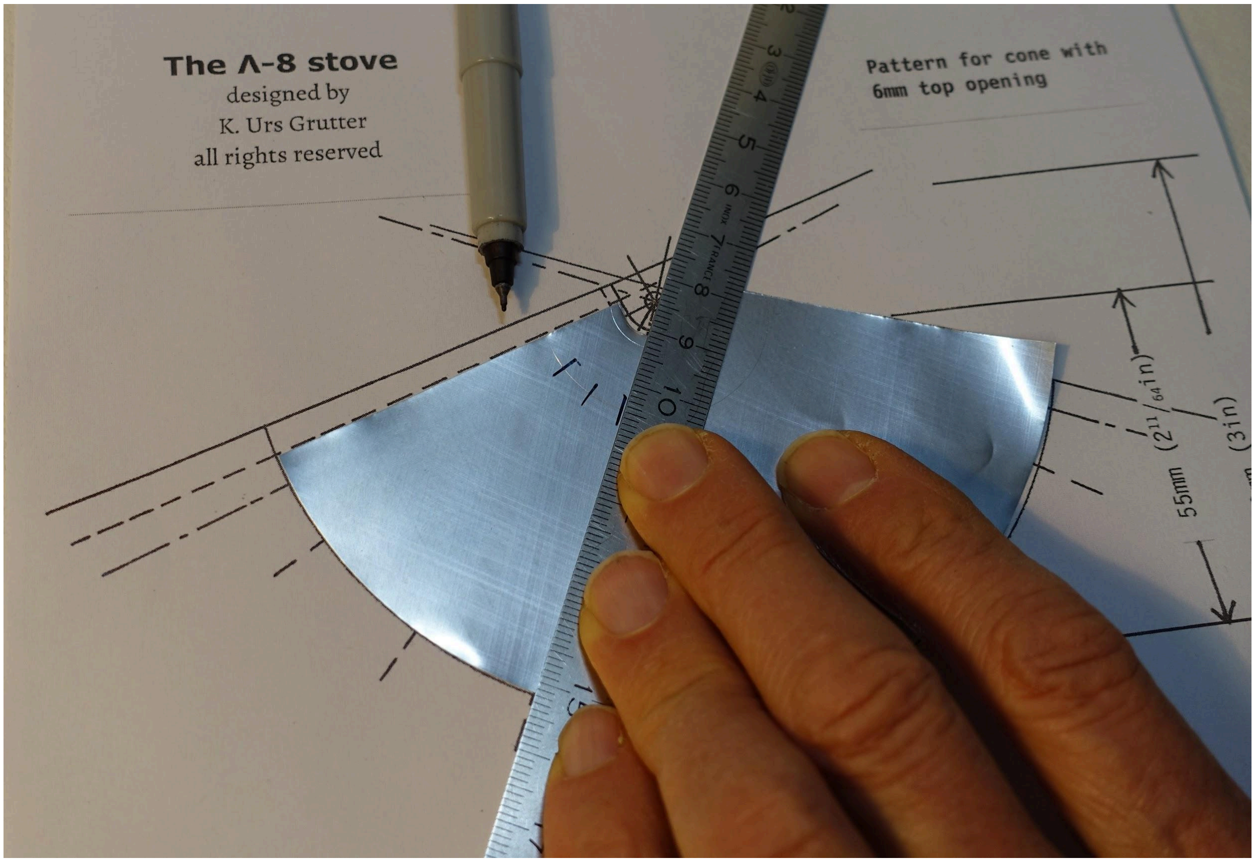
Take the aluminum foil off the pattern, put it on your cutting board and score until the aluminum breaks.


scoring on the cutting board with the straight edge



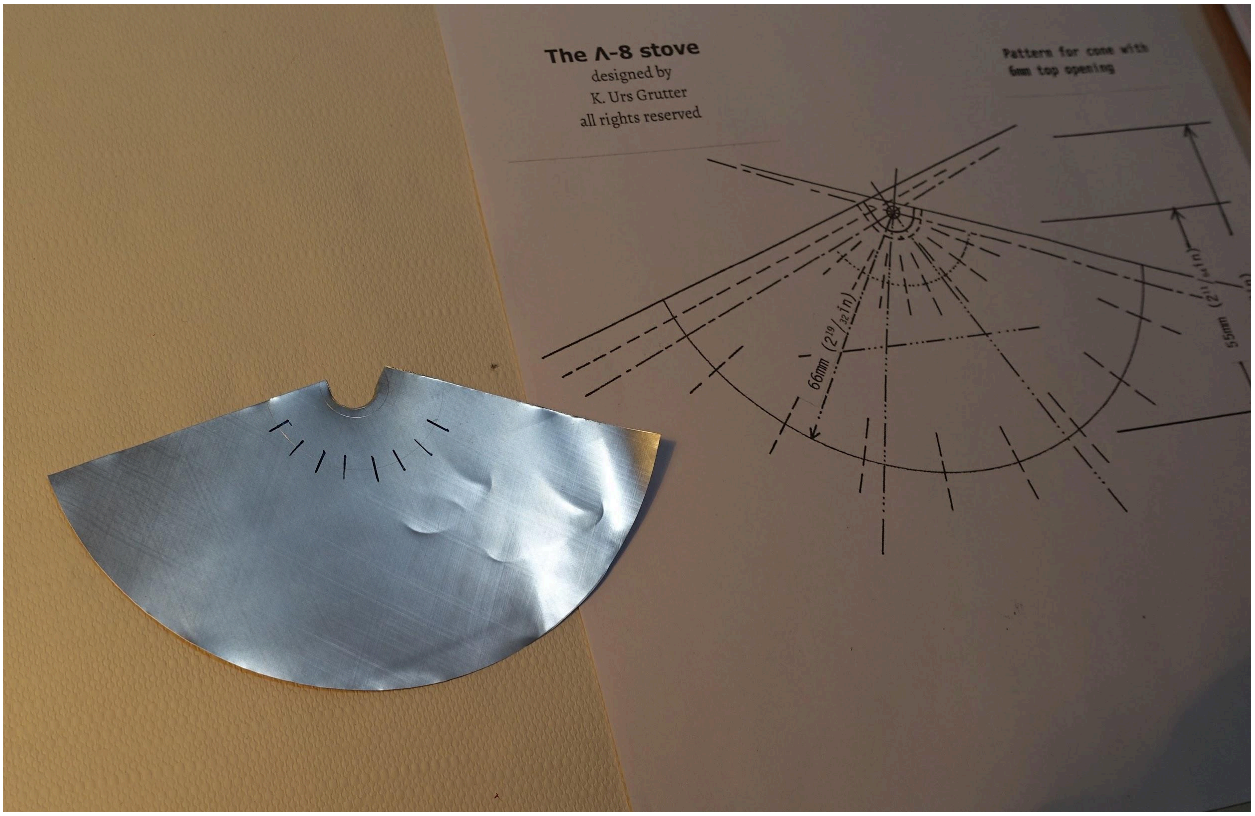
check precision of your cone piece

Now soften all the edges of your aluminum piece thoroughly with your lighter. The scoring has hardened the aluminum. It will be brittle and break unless softened thoroughly.



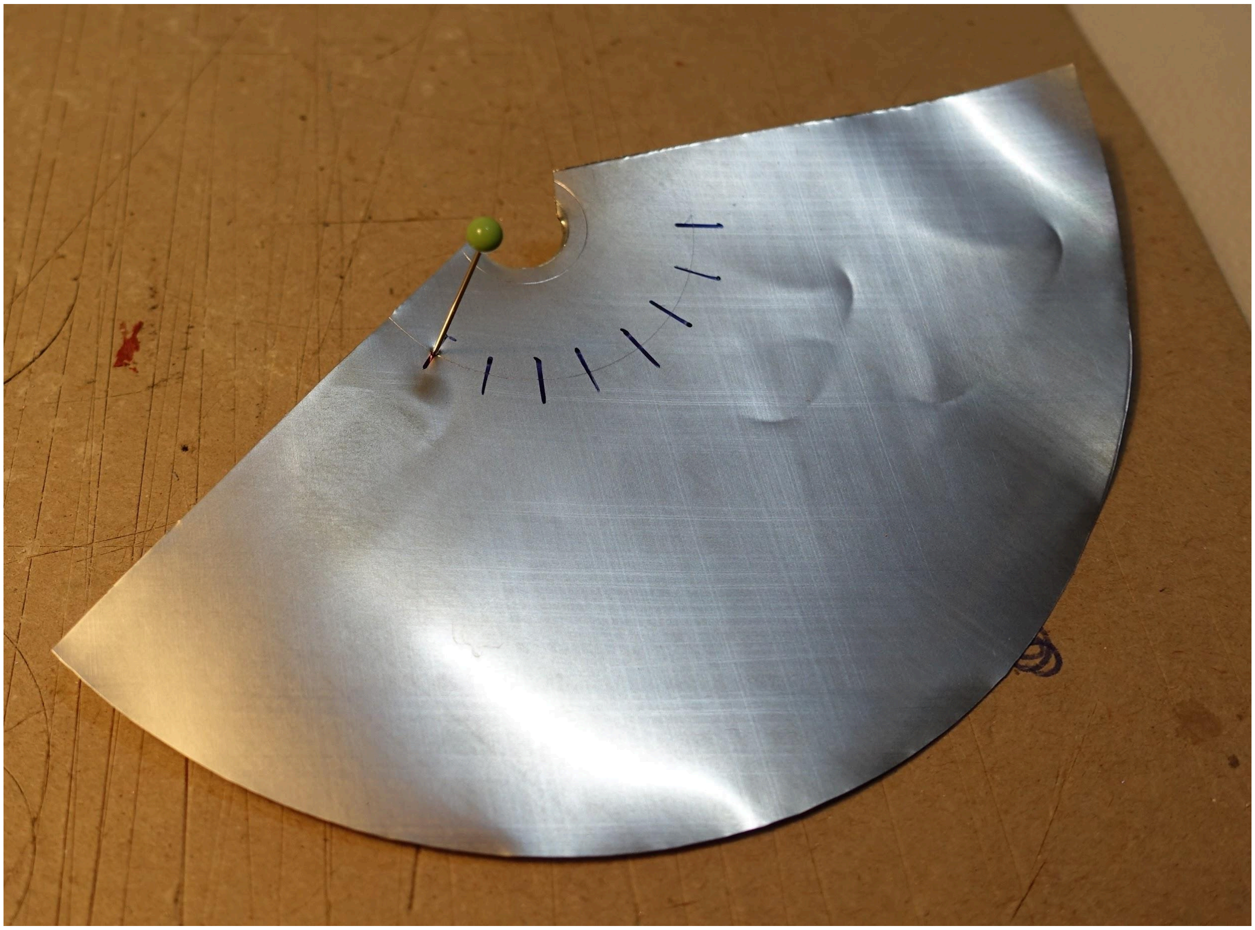
marking the position of the jet nozzles

Now mark the position of the 8 jets according to the pattern.

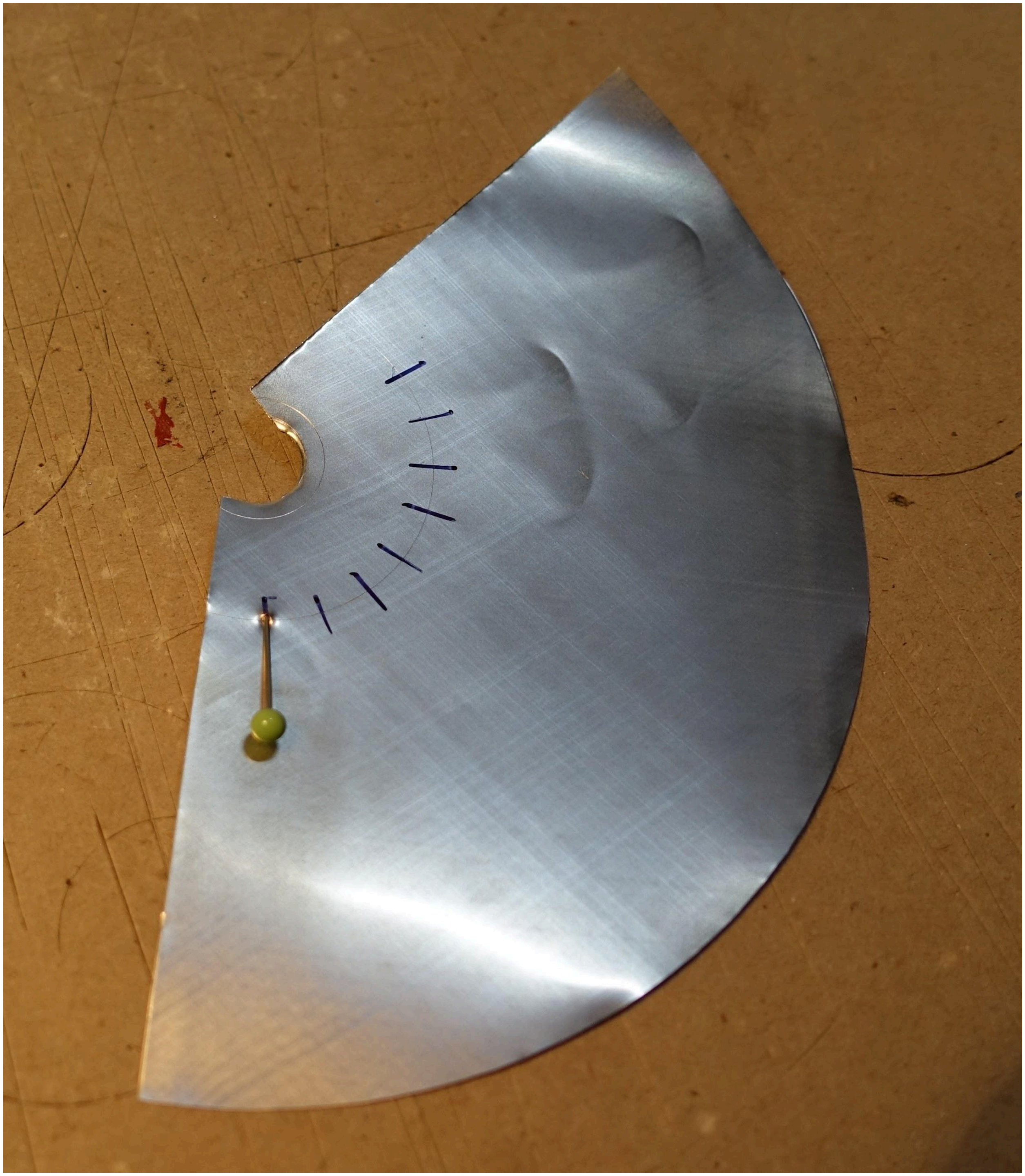


position of jets marked, ready for punching

Then soften the aluminum at the position of each hole.


punching the jet holes

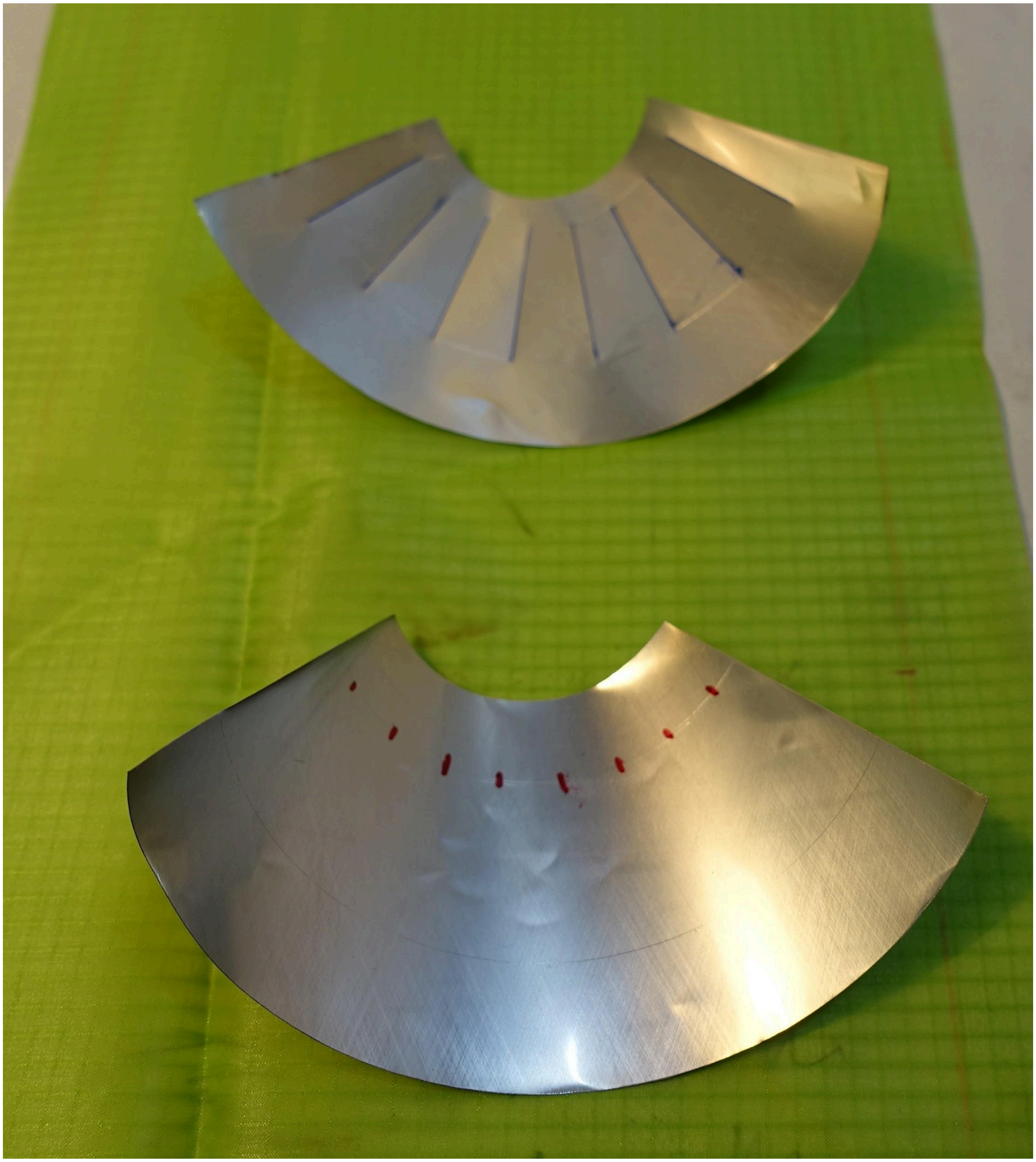
Punch the jets with the small (0.5mm) pin, from the inside of the cone towards the outside...



directing the jet nozzles upwards

...and bend the head of the pin down towards the bottom of the cone. This gives you a nice little nozzle pointing out and up. Be careful, go easy! You want 0.5mm nozzles and not some ragged slits in your cone!

the jets should look like this



top: inner cone, bottom: outer cone

Now make a second cone. This will be the inner cone. You therefore have to cut the top along the dashed "fold line". The upper rim of the outer cone will be folded down and over the inner cone to seal the cone and avoid pressure loss on the jets. With a ball pen, score the inner cone at the dashed lines provided in the pattern. If handled with care, the ball point will just crease the aluminum and avoid any cuts or breaks. These scores

make the inner cone more or less octagonal, providing the "pockets" where alcohol vapor builds up.
Now you have to bend the riveting allowances to get the cone piece ready for riveting. Put the cone piece on your pattern. Make sure everything is aligned perfectly. Slip your steel ruler or a straight piece of steel sheet under the riveting allowance on the left, put your straight edge on top and over the fold line on the pattern.

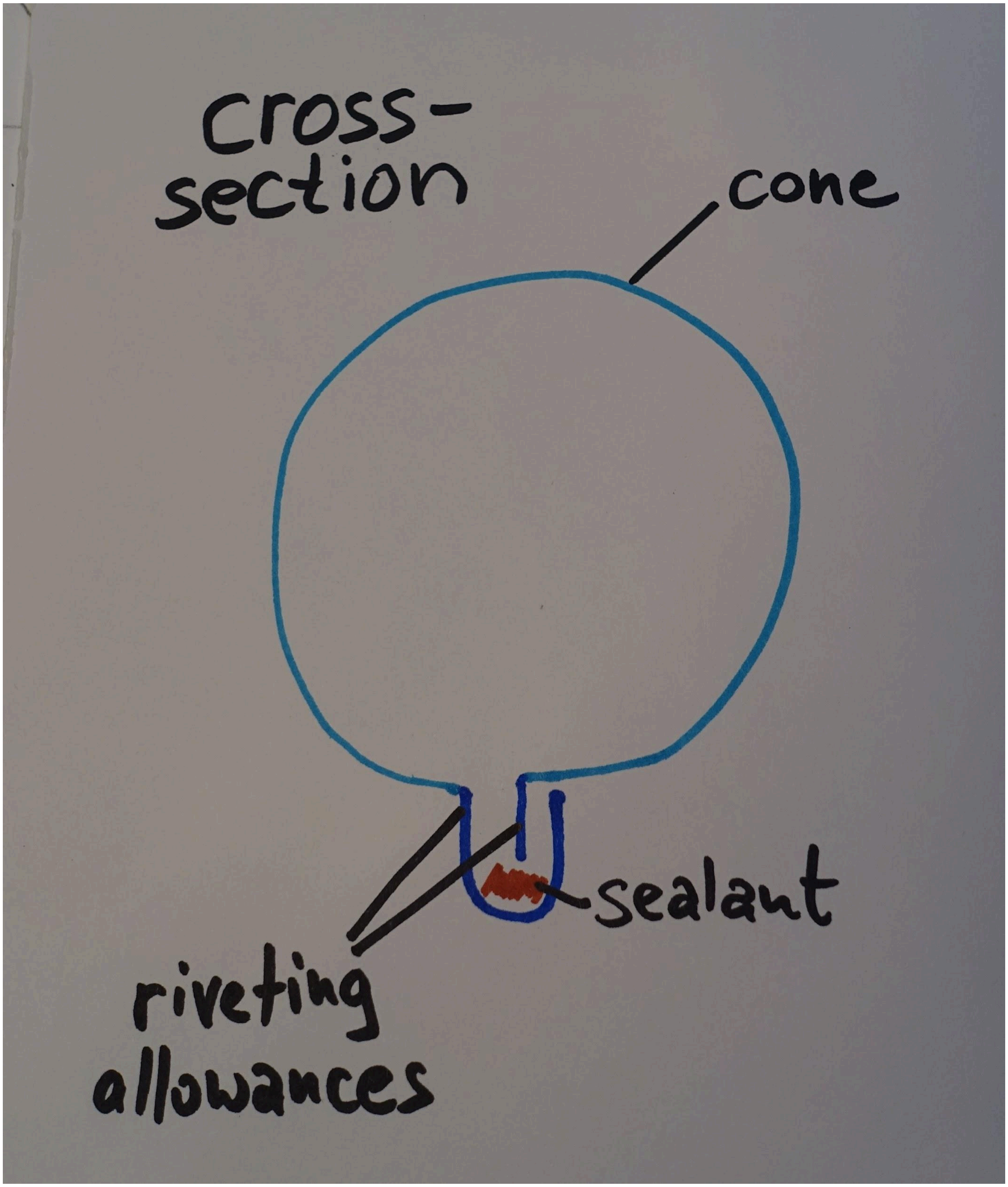
how to start a clean bend

Now fold the steel ruler up against the metal straight edge. This makes a nice, even 90° upwards bend of the riveting allowance.

riveting allowance bent up

Result of the bending process

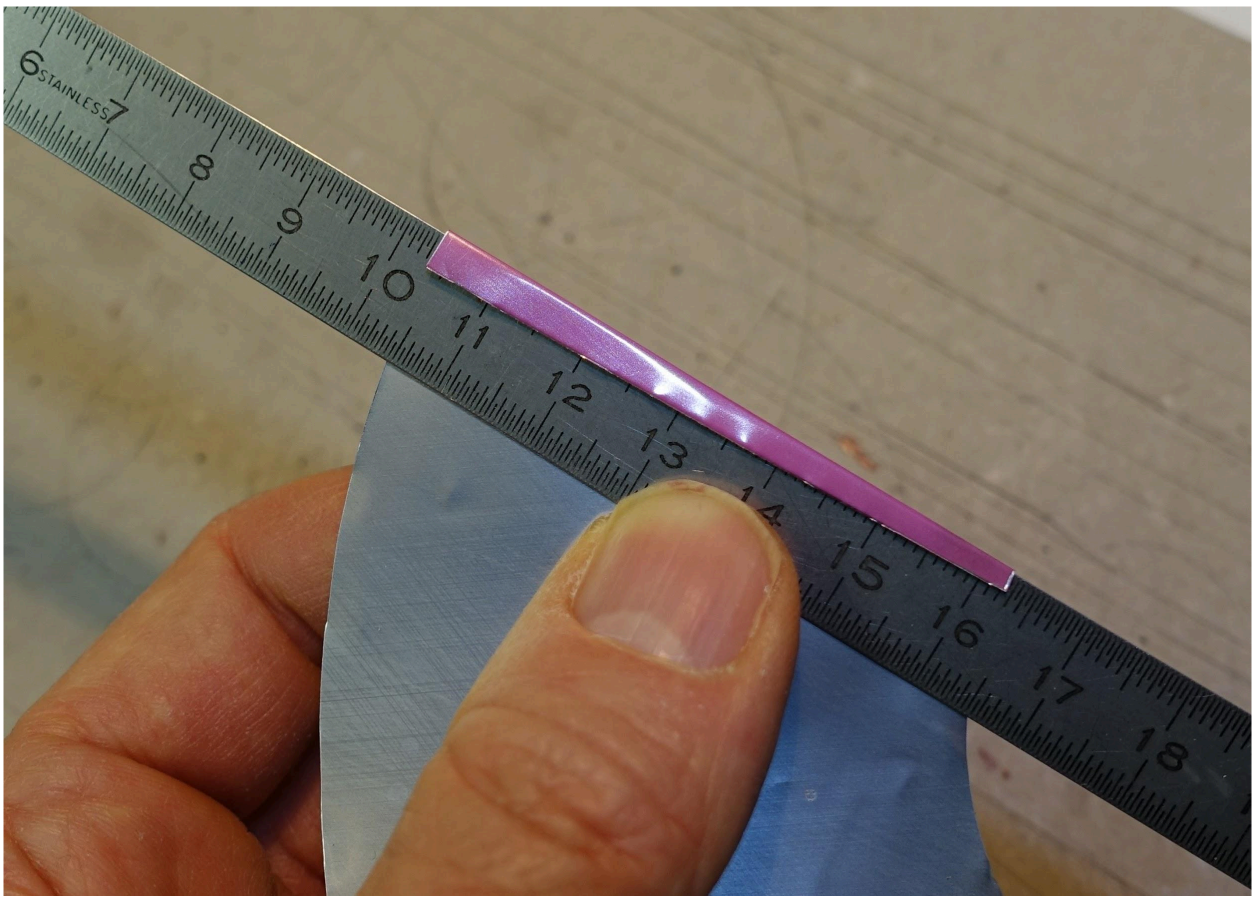
Note: The cone theoretically ends at the “cone end” lines. To rivet the cone, you need some additional material, actually three times the riveting allowance of 5mm at the bottom and 3mm at the top of the cone. The cross-section of the cone with riveting allowances looks about like this:



principle of riveting the outer cone

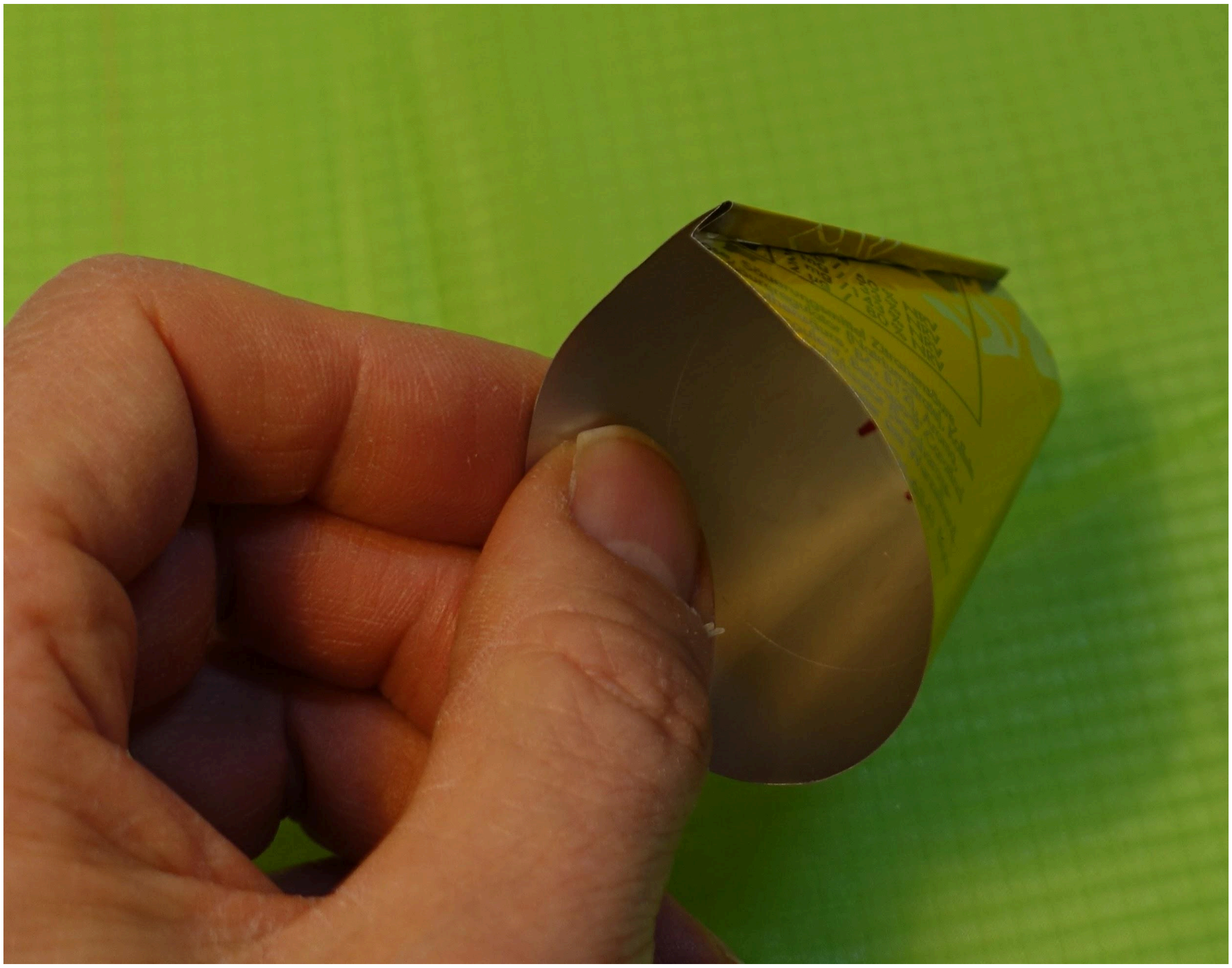
Remember to thoroughly soften all the edges of your cone before attempting to do any bends!

By now, you bent the riveting allowance on one side 90° towards the outside of the cone. On the other end (with double riveting allowance), one allowance is to be bent 180° towards the inside. To this end, flip your cone piece over and put it on the pattern again. You will work the bend on the same side of the pattern, but on the other side of the cone piece, as you flipped it over. Do a 90° bend, then soften your aluminum foil again, and fold it completely down over your metal ruler or your strip of 0.4mm sheet metal. Having the ruler or similar material inside the bend is vital: There has to be space to slide in the riveting allowance of the other side of the cone, and you have to avoid a crease and break of your cone piece at all costs.



doing the 180° bend on the other end of the cone

Now smear some oven silicone (or JB-Weld or other sealant, it should not set before about 10 minutes you need for riveting etc.) into the groove of the 180° bend, join the cone by slipping the 90° bend into the 180° bend and rivet.


cone ready for riveting. Do not forget the sealant!

Refer to 1.3 for proper riveting! Soften your aluminum frequently to prevent it from breaking. Especially the small “teeth” of foil forced up in the riveting process tend to break off easily and thus compromising the riveting process, if not softened after each go.

rivets large enough after two "gos"

Now carefully bend the ragged teeth of all the layers flat against the riveting allowance

finishing the rivets

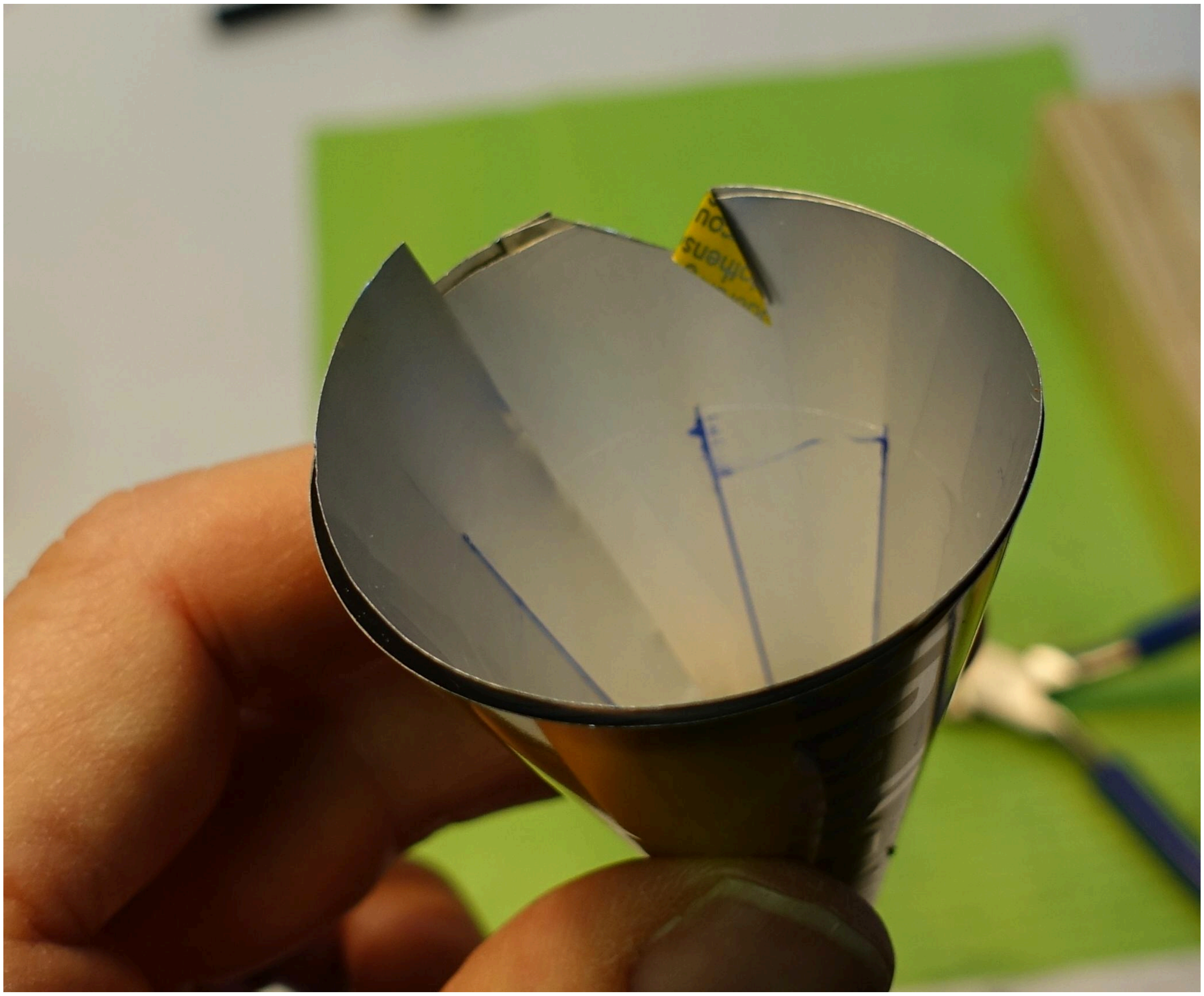
After riveting, soften the 90°bend thoroughly and then bend the riveting allowance flat against the cone, with the ragged rivets pointing outside. Check for a smooth inside of the cone and remove (wipe only, no thinners, they might compromise the properties of your sealant!) all excess silicone on the inside of your cone. Set the cone aside for 24hrs to let the sealant set.

bending the inner cone to shape

Now you should bend the inner cone roughly to shape. The dibble is a good tool for this task. The inner cone will not be riveted, just overlapped. So you may want to keep it a little larger than the outer cone and push it into the outer cone. Due to its elasticity, the inner cone will nicely press against the outer cone. This is important for the wicking action induced by the two metal sheets touching.

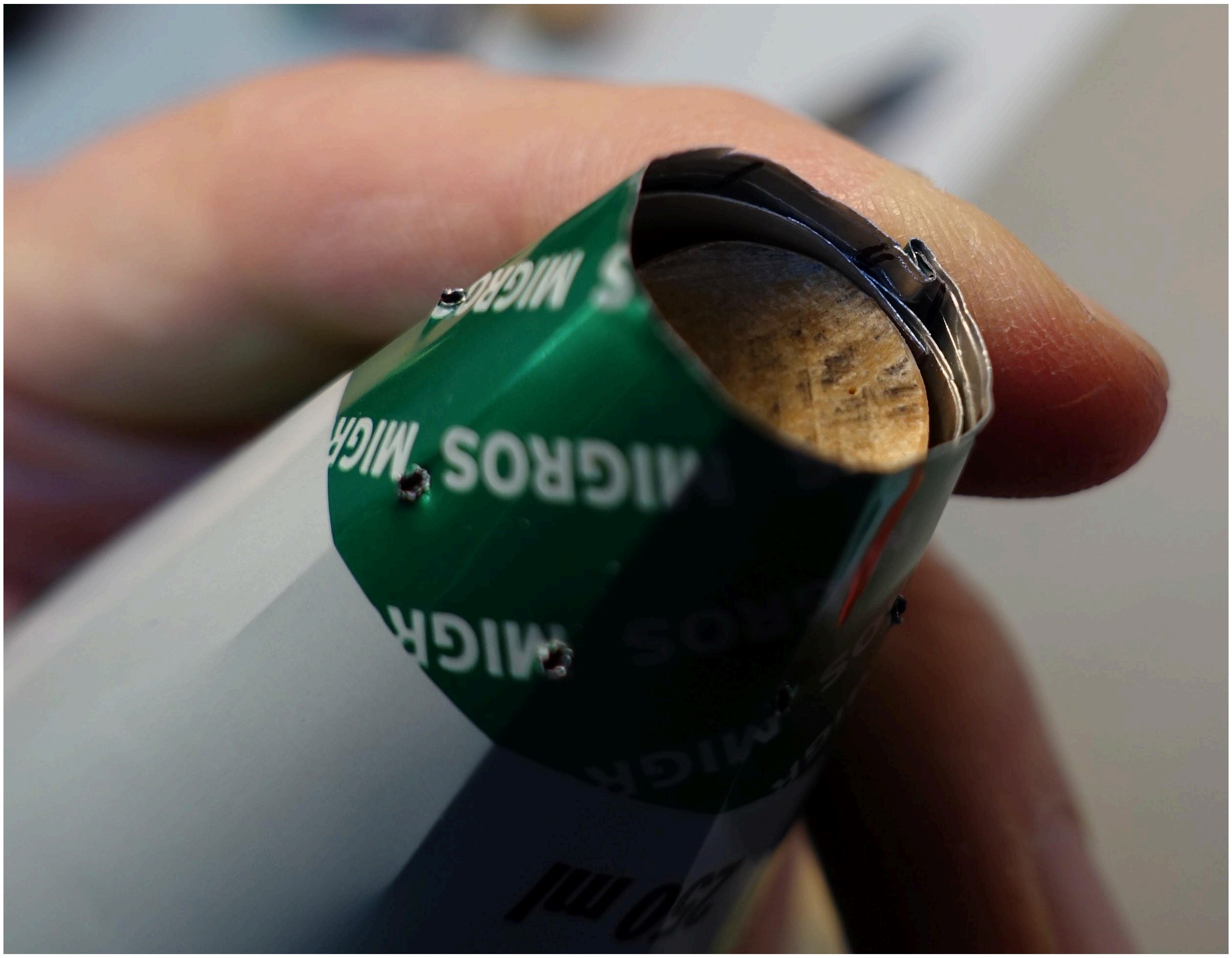
Insert the inner cone into the outer. Align the top of the inner cone with the fold line on the top of the outer cone. Work on one end of the inner cone first. When aligned properly, cut a small slit in the lower rim of the cone and bend the resulting "tooth" of both layers of your cone towards the inside of the cone assembly.

Mounting the cone assembly: cut through both cones



how to make the cone assembly

Align the inner cone so the scored ball pen lines are placed between the jets. This will provide the necessary "pockets" for the alcohol vapor. With one end of the inner cone secured, work your way around (here clockwise) and mount the inner cone with two to three more cuts through both cones. Looking into the top opening of your cone, the inner cone should now align more or less with the fold line on the outer cone.

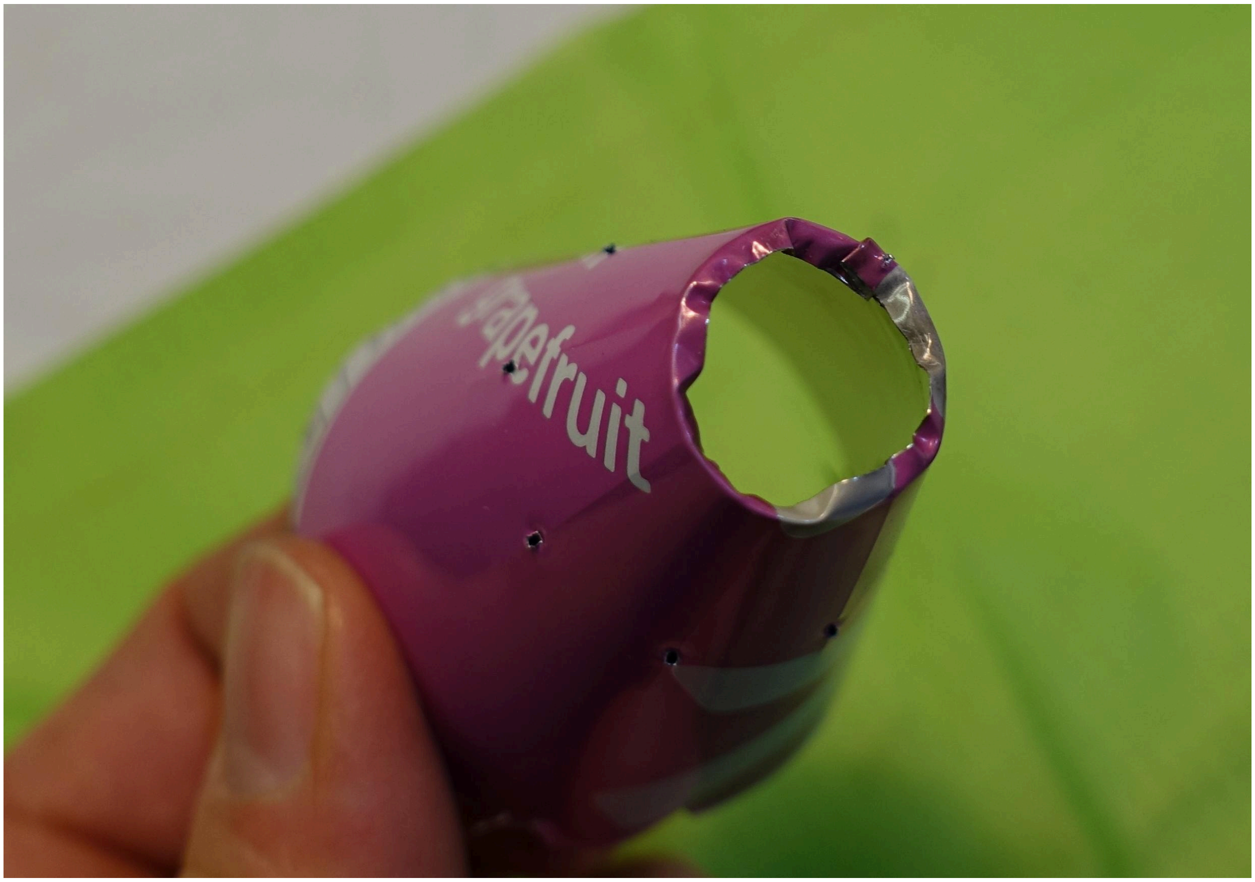


inner cone aligned properly, dowel inserted to fold line

Insert your dowel or aluminum tubing, align with the fold line and bend the folding allowance towards the inside of your cone. Start with the bulky riveted part. Make only a small indentation, then immediately heat the bent part with your butane lighter before continuing.

bend - and heat/soften again!

Now go on, do more bends, one at a time, and soften/heat after every little indentation. This is important in order to avoid breaks in the top rim.



bending process at the top of the cone assembly

From here, continue with the dibble. Remember to soften your aluminum frequently!

continuing with the dibble

For finishing, go from the bottom, but careful! Rather you want to have the bent part intact but not completely flush with the inner cone as opposed to induce cracks and rips in the folding allowance!

finishing the top of the cone assembly

The finished product should look like this. Mind you: This was not my first cone!

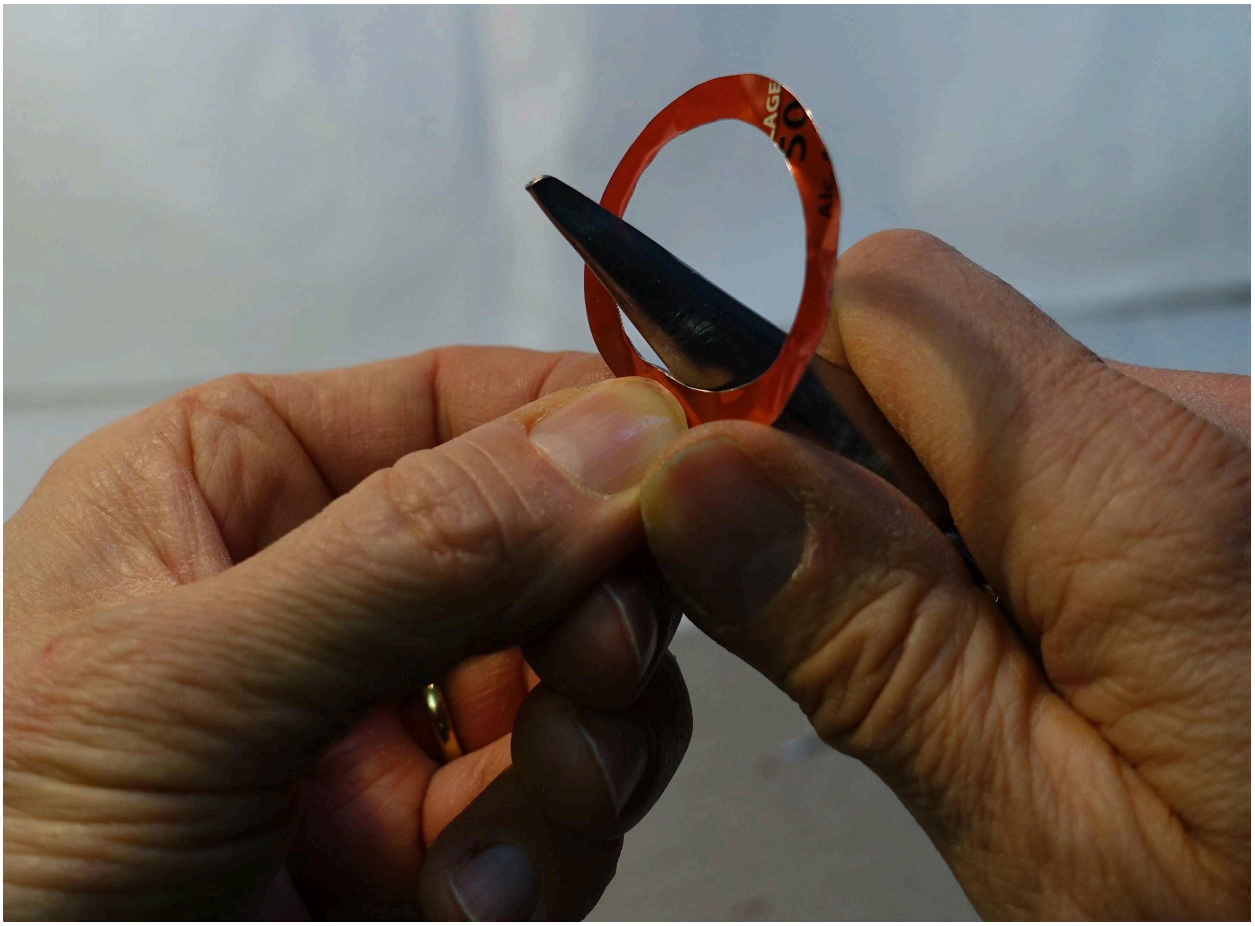
the finished top of the cone assembly

You can now put the cone aside. For the final assembly, you need a sealing ring to cover the hole in the top of the lid left from removing the opening tab of the beverage can.

2.3.5 With your divider, score and cut a disk to fit the inside of your lid.

start your sealing ring with a disk to fit into the top of the stove

Then score and break/cut the opening for your cone assembly into the disk. For the 18mm top opening cone, you will have to cut a 32mm circle, for the 6mm top opening cone, you will have to cut a 28mm circle to provide a suitable sealing ring. When cut, soften the ring with your butane lighter, then bend the inner rim of the sealing ring upwards with your dibble. This will give you a wider area for the sealant to adhere to your cone assembly and the sealing ring. Go around as many times as required to get the perfect fit according to the pictures (it usually takes me two "rounds"). Soften your ring frequently. If you keep the aluminum really soft, it is a joy to work this bend.

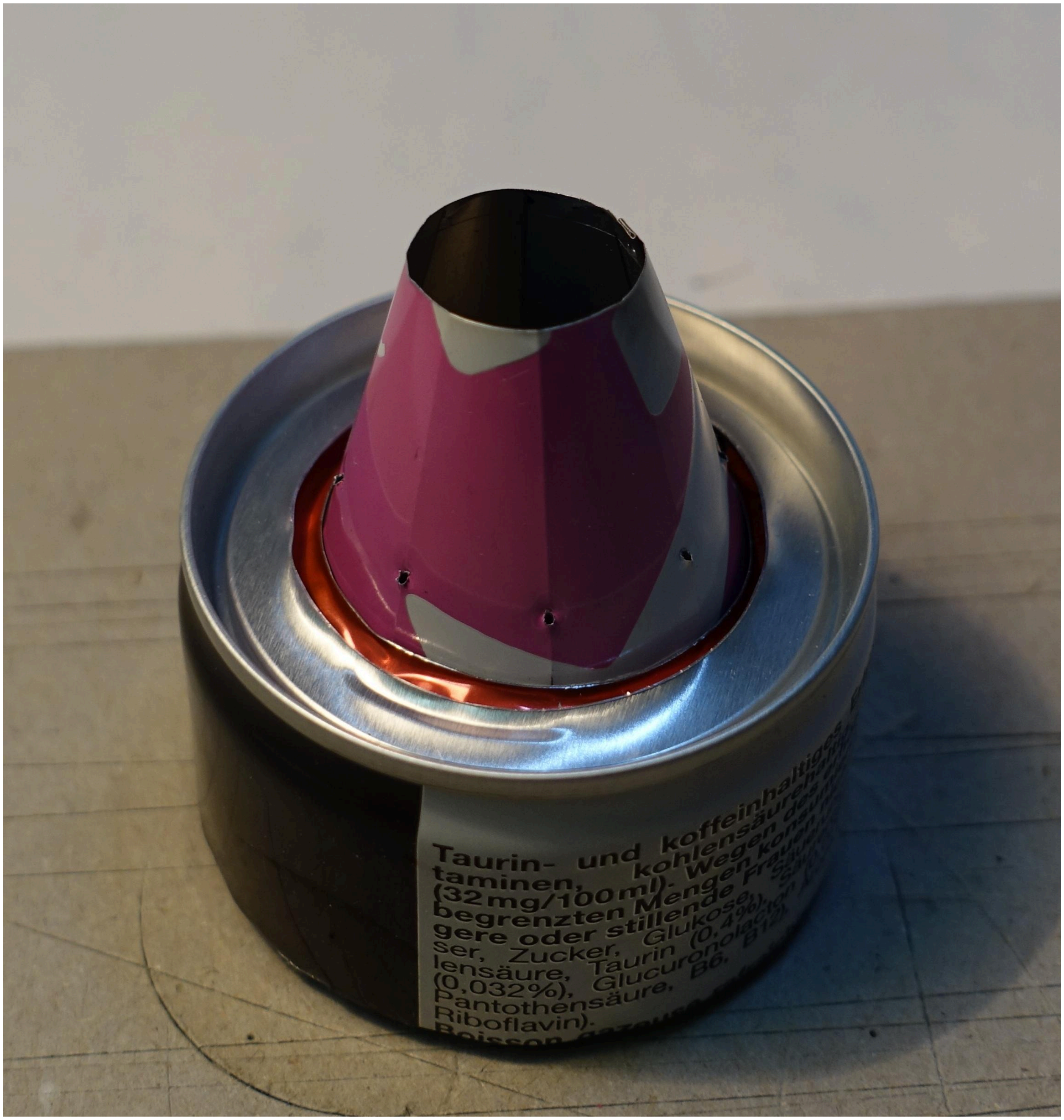


forming the sealing ring

When you think your ring looks ok, set your cone assembly on the table and slip the sealing ring in place. It should look like this:

sealing ring ready for test fit (note this is a cone for a very hot burning stove as the nozzles were placed 20mm from the top - a real winter stove!)

This picture also shows how much "bend" you can work into the aluminum without breaking it, if you keep it soft all times. Then put the lid over the assembly and check whether the lower rim of the lid just goes down to your working surface. If not, check why. If the sealing ring sits too high on the cone, give it another "round". If the hole in the lid seems to be too small, give it the same treatment as you gave the sealing ring. Remember to soften your lid, too!



successful test fit

Now it's a good idea to soften your sealing ring once more. If you keep it really soft for the final assembling process, it will be forced into an optimal shape without breaking.

Then clean all surfaces (cone, sealing ring, lid) thoroughly with alcohol. You want them to be clean and absolutely grease-less to have the sealant work properly.

Then take your cup and put the cone assembly in. Careful, the outside of your cup should be greased for the final assembly process. You do not want this grease to be transferred anywhere the sealant has to adhere to!

cup and cone ready for final assembly

Put it on your working surface, ready to slip the lid over. Now prepare the lid. You have to stick the sealing ring to the lid with some sealant. So apply sealant to the upper rim of your lid as shown in the picture:

lid ready for final assembly, generously furnished with sealant

Now insert your sealing ring, and also furnish the inner rim of the sealing ring with some sealant, to make the seal between the cone and the sealing ring. Then slip the lid over the cone, carefully inserting the creased upper rim of your cup into the lid. Then slowly slide the lid all the way down over the cup. Make sure to keep your lid horizontal and not force it down on one side. If it gets tough, you may put a piece of wood on the rim of your lid and tap it lightly with a small hammer or another piece of wood, working round and round, until the lower rim of the lid is all the way down on your working surface.

Congratulations, your are done! Your Λ-8 stove is all finished. It should look like the stoves in the introduction, at the end of section 1.1 above. Set your stove aside until the sealant has hardened - this will be 48hrs for the coltogum-brand silicone, or whatever time your sealant requires.

3. Operation

3.1 Refer to the introductory video to part I for operation. It is really simple. But: always use common sense! Liquid combustibles are inherently dangerous. A little negligence, sometimes resulting from wearing out routines, can lead to a desaster! I must admit I almost set my workshop ablast two times during the past three years just because I was not cautious enough. Fortunately, I am not all too easily scared and managed to smother the fires with a large rag I always have at hand. Mind you: if a stove runs havoc, it will not only be the stove that burns, but it will spit burning fuel all over the place and you will have to quickly quench many little flames. Also, after an incident like this, a decent fire-watch has to be kept. You never know what happens in the next hour or so, after a stove has spouted burning fuel all over your workshop.
Don't let this discourage you. If possible, stay outside with your stove experiments, but do not start wildfires…

3.2 Testing and correcting little flaws
If the stove does not deliver a nice and continuous burn, the inner cone is probably touching the outer all around and your attempt to get it octagonal was not overly successful. As this spluttering action impairs a steady and efficient combustion, something should be done about it: You can try to separate the inner cone from the outer by carefully inserting a pin into the nozzles, one at a time, and try to force the

inner cone a bit towards the inside, the outer to the outside. Go easy, you do not want to puncture one of the cones! I keep a pin with a rounded pinpoint handy for this task: I did grind the point down and then rounded it off, to minimize the danger to lacerate one of the cones during the process. You also should take care not to widen the nozzle or to slit the cone at the nozzle. If this does not help, you will have to make another stove, this time trying to get the inner cone somewhat more octagonal. You can extend the ball pen creases from top to bottom of the inner cone if needed.

Small leaks on the cone: I once was on trail with a stove sealed with some high-temperature epoxy. Apparently, the temperatures were a bit too elevated for the sealant, and the stove developed two leaks around the seal between the cone and the lid. As this meant more heat feed-back and eventually too hot a burn and a sooty pot, I made up some clay from traildust and a drop of water and sealed the holes with it. These improvised seals are still there. They survived about a dozen or more cookings so far. As these seals may become brittle and fall apart during hiking, I finally covered them up with silicone the next time I did some sealing.

4. Final remarks
I think the snuffle-flask is the number one item to make your alcohol-cooking easy and enjoyable on the trail, no matter what make alcohol stove you use. The Λ-8 stove then has the potential to substantially reduce your fuel consumption in relation to the water boiled. Another story is the windshield - pot assembly. Maybe the editors are going to have me telling you about this too, if you give them enough likes for the snuffle-flask and the Λ-8 stove articles…

The stove works nicely in cold environments too. No need to carry heavier equipment when you have to melt snow for your water. Just carry some more fuel and allot some more time for your cooking:


Good trail kitchen: sunny, no draft, snow compacted.

Materials: poplar ply disc, reflecting sheet of aluminum foil, a Λ-8 stove (of course), mini-bic lighter, a combined windshield/pot holder, a modified trangia 1l pot, a foil lid, and a kneeling pad.

Fill stove with 25cc of alcohol, light your stove and get clean snow into your pot. Refill with snow until you have your half liter of water and wait for the boil:


LANER
e-Weißbier

Nice rolling boil at Lombachalp near Interlaken, at 1600m (about 5200ft).
With this setup, we used 75cc of alcohol to get 1.5l boiling water from snow. Ambient temperature was around freezing.

Same field kitchen near Schwalmflue, on 1850m (6070ft). Again, 75cc alcohol used to get 1.5l boiling water from snow!

Same field kitchen, with some alpine flair, again near Schwalmflue, 1930m (6300ft)

Happy trails!