

El Diablo

Early Beginnings

I have a dream, a beautiful dream, a fantastic dream. I have a dream that a backpacking alcohol stove will one day boil up 250ml of cold water from a stream in less than a minute. Is this a fantastic dream? It is when you consider that the only fuel is alcohol.

I have made great progress in research (burnt fingers, scarred tabletops, and empty fire extinguishers) toward this “Holy Grail” of alcohol stoves.

First there was Turbo Tuna Surprise. She was a performer too. Boil times were already under 3 minutes and she was portable, simple, just a good, solid stove.

Next there was Don’s Dilemma, or the “SS” Simple Stove. Here was convenience, light weight, performance, fuel recoverability and really simple construction. A beauty with a 3:00 boil time which is nothing to sneeze at. It introduced me to the concept of “the virtual wick” which has played an important part in continuing development.

Then there was Spitfire. She hit the ground running at a trot and spat fire like a dragon with a hangover. Again, fast boil times were the rule at under 3 minutes. In fact, 2:40 seconds was typical.

At last there were Nasty Cat and Nasty Kitten. These are the big and little sisters with the same specs, only the Kitten holds less fuel. They seem the epitome of convenience being CAT “no pot stand required” and NON-CAT “pot stand needed” type stoves. They hit the ground running, heat up really fast, and are fuel efficient. Burn times are again excellent around the 2:30 range. Fuel efficient, lightweight, versatile, large capacity, small form factor, what more could a fellow ask for?

“LESS THAN SIXTY-SECOND BURN TIMES”

I am a spoiled brat with too many tools, too many ideas, and way too much time on my hands! I will have that “Holy Grail”. I will see my 250ml of water (a little more than a cup) boil in less than a minute! Why? Because it is there!

While I am currently exploring a few new avenues for alcohol stoves, both passive and active in operation, I have been pursuing the “El Diablo” project with vigour. It has moved ahead in leaps and bounds and the prototype is doing an admirable job, and has brought that “Holy Grail” within reach. I can not only see the light at the end of the tunnel, but I now need sunglasses for the glare of that light. I am that close!

Enough fanfare, let’s move onto the real stuff. I offer for your consideration:





*El Diablo blowing a blue streak on 95% isopropyl alcohol. "Up, up, and away."
9V on the left, 18V on the right. The fan is rated 9 ~ 24V*

El Diablo is an "active laminar airflow canted port air injection open flame design" alcohol backpacking stove. It is powered by 1 or 2 little square 9V batteries. One battery alone produces a very attractive and effective flame. Two snapped together produces the blowtorch you see before you. These batteries power a 4" computer fan mounted beneath the burner chamber within an outer containment vessel. Simply put, it's "a can in a can with a fan" hehe



I used a fruit tin, cut a hole in the bottom and inserted Twister Lite from within.

Twister Lite is held in place with a piece of coat hanger (thick one) bent into a snap ring which fits just below that little lip on the top of a cola tin. It keeps it from falling back through the hole which I inexpertly cut into the fruit tin. A close enlargement of the picture on the right bottom of page 2 shows the retainer ring. Isn't that a beautiful 18V 95% flame?



In her shining glory. El Diablo I



The fan is mounted a couple inches below the cooker bottom and just above the air intake holes. The distance from the cooker protects it from the heat and the distance above the air intake holes assures unimpeded air intake. I cut the corner tabs off the fan with a pair of diagonal cutting pliers in order to snug it up into the tin.

The holes in the bottom are made with a can opener. I spaced 8 holes evenly around the bottom ridge of the tin. It worked well enough. I have used screws to support the fan below and above, keeping it in place. It is ultra quiet because this is a quality ball bearing computer fan and quiet is its business. I attached alligator clips to the wires for easy attachment to the 9V batteries. These are those ultra-common completely easy to find little square 9V batteries that fit so many tiny radios, toys, meters and instruments, etc.

In a later version I will find a place underneath the stove to stash the batteries.



El Diablo I on 75% alcohol and 18V

Boil Time: 1:29 in my aluminium pot with a cover. Heck, I did it in a heavy steel pot with a glass lid in 1:47! This thing is hot, hot, hot! 95% alcohol.

Burn Time: 8:00 on 17ml of 95% alcohol! This means that El Diablo I is not only hot, but efficient as well!

I set the pot about 4cm from the flame. I need to figure out the ideal distance some time later. The “Magic Zone” for this flame seems to be a little different than with a passive flame. I’ll let you know.

See the next page for an update:

Okay. It seems El Diablo I likes the 9V battery best. By controlling the fan speed I have managed control of the flame and resultant temperatures generated by the flame. The 9V battery seems to get identical results in boiling water as far as boil times go, but allows for a much longer burn. I was getting burn times of around 4:00 with 18V on the fan but get times around 8~10 minutes with the single 9V batter and a slower fan speed. These times are on 17ml of 95% alcohol. Its capacity is around 50ml so burn times of 20 minutes are easily achieved ... I've done it.



I cut off the top portion of a steel Coca Cola tin and then punched it full holes with a paper punch and a lot of grunting and squeezing. Steel tins are so much tougher than aluminium!



It looks fragile. It feels delicate. It has no trouble supporting a heavy steel pot with 2L of water! I am going to make up a more "heavy duty" pot stand.

The "Pot Stand" for El Diablo I

My new pot stand should take up the entire top of the stove and rest along the outer rim of the main body of the cooker. I will feel better if the load is distributed along the outside rim and greater surface area than on the tiny center area where the Twister Lite protrudes.



"Machine Gun" Pot Support resting on top of El Diablo I

Despite the many holes and the pot support glowing red in parts, it seems to have no trouble holding a large pot with 2L of water.



She does the job but I still feel a little squeamish about the pot support.

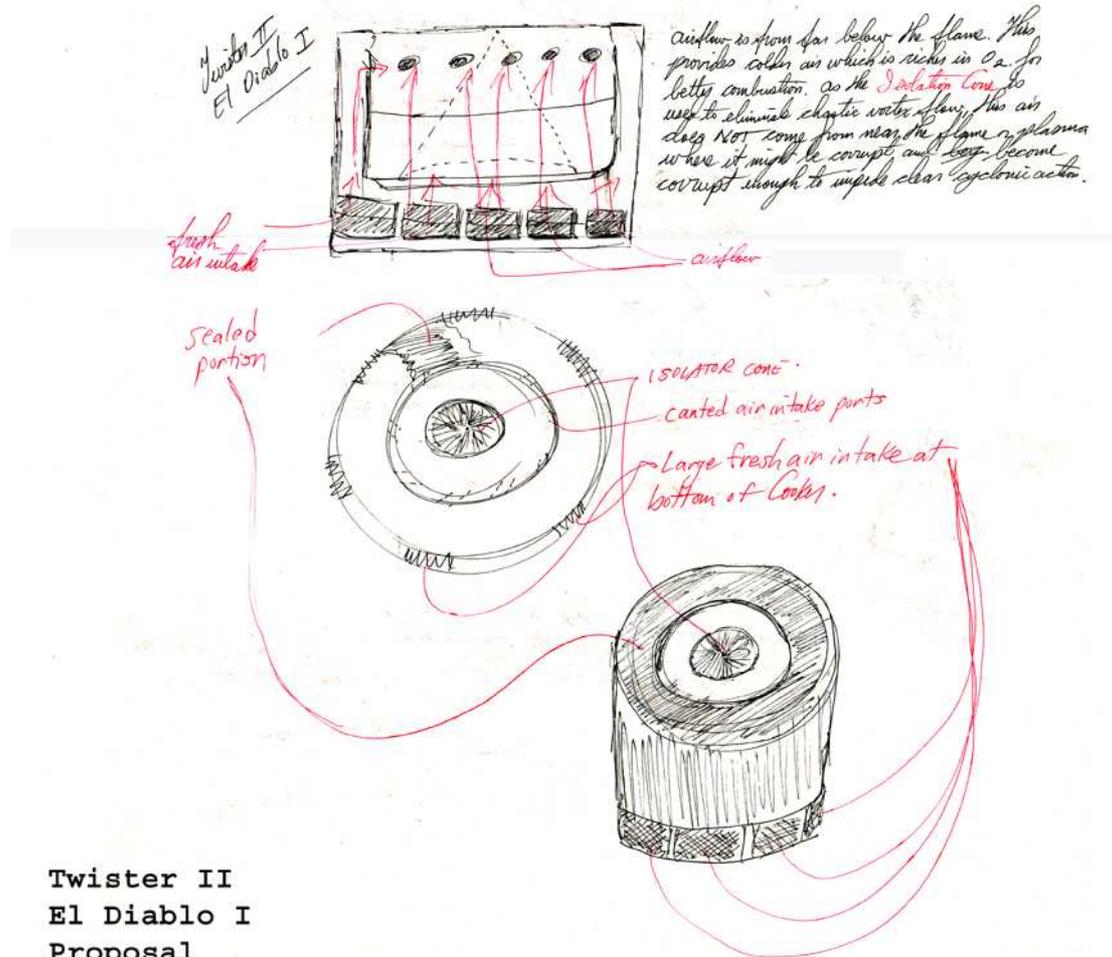
All said and done, the cook times and performance with this support are equal to “open air” cooking with a large stand set up around and above the unit. I prefer the idea of a “pot stand” approach as it offers greater convenience, simplicity, and inherent strength as it will rest on the top outer ridge of the tin which is strong, corrugated, galvanized steel.

Hello 90 Second Diablo I



Well, let's continue:

I have had an unsuccessful time increasing flame efficiency even with this “machine gun” pot holder. I took a look back just to rest my mind:



In these drawings I originally envisioned something very similar to what I have, and the concept has proven out through my prototype as shown in earlier pages of this paper. Time has come for me to work out a situation, a way in establishing consistent and maximally efficient flame-to-pot distance. **I need to find that “magic zone” where flame heat is at its hottest.**

As I pondered this, I thought it would be a good idea to give you a gander at Twister Lite, the heart of El Diablo. This is a burner which creates a cyclonic vortex all by itself even in passive mode using no forced air of any kind. It consists of the bottom and top of a steel (aluminium melts) soda tin and canted airholes. The idea here is that the air intake holes are equally canted (to similar angular degrees) and equally spaced so as to provide an anti-clockwise flow of intake air. Being in the northern hemisphere of the Earth this only seemed natural.

I used flutes inside with a very slight anti-clockwise bend to aid in directing flame plasma into this cyclonic whirl I so badly desire.

In fact, I have proven that providing this cyclonic action does indeed increase fuel efficiency while sacrificing nothing in flame temperature. It looks pretty too!



A thing of beauty is the Twister Lite in passive mode. Canted air intakes provide a cyclonic action which is aided by the flutes inside the chamber. I am not sure how much help the flutes provide but "it couldn't hurt".

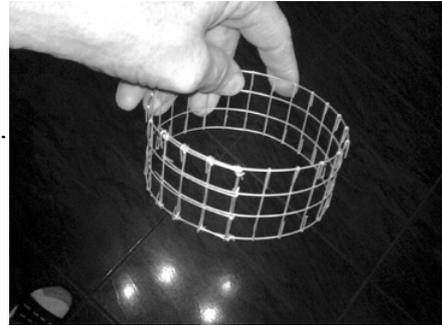
This is at the heart of El Diablo. This is where the flame is burned and raised to the proper temperature, and accelerated into its perfect cyclonic form. The stove is of steel as aluminium ones kept melting on me.



Enter the Round-pod

I ran right to the “round-pod” developed by Don Hitchcock. I needed to play around with this until I had it right.

This what I came up with at first, using 3 rows of “chicken wire” hardware cloth. I followed Don’s instructions and came up with an exquisite example.



I was later to make another only 2 rows high which serves me well, providing optimal distance and in that “magic zone” I talk about. *Somewhere, where blue meets yellow is where I want to be.*

Take a close look and you’ll see that the “round-pod” has been fitted exactly to the top of El Diablo. This actually sits barely within the raised rim of the tin providing a secure seat for the pot and a reinforced strength by utilizing the lip on El Diablo.



This picture shows 3 rows, but I use 2 instead. I also use 18V, both Batteries, for best flame at this distance with - row round-pod.





Round-pod in place with El Diablo breathing fire. Now defunct “Machine Gun” Pot Stand sits idly by in the background. No doubt pining for a hot time.

This is a good rendition of the flame quality when applied with 18V full speed fan. The top rows of the round-pod heat up and glow a soft orange colour. It worried me initially, but the round-pod seems to hold up to some rather abusive loads and doesn't groan.



El Diablo gets it on. Burn baby burn

With the “2-row round-pod I get this soft glowing only on the top row as with this “3-row” displayed in the picture at left. It doesn't seem to cause any problems (like the wire softening and the pot falling down) and has not complained or buckled even after several long firings with heavy weight of 1 ~ 2kg.



In the next pages is an updated overview, a summary, of what I have said:

El Diablo

An Updated Whitepaper for Flammable Fun
By Ian MacLeod



Well, there's been a great deal of work and development in the making of this stove. It is an alcohol stove which burns any grade of alcohol from 50% to 100% and it even likes cheap whiskey! It is a Twister Lite® fit to a wind tunnel and fitted with a Roundpod® for the finishing touch.

As alcohol stoves go there have been many disadvantages to overcome. These are disadvantages held by both commercial and DIY units. From the elaborate store bought models to the simplest "soda can" models they have faced one or more of these issues:

- Slow warm-up times, especially difficult and slow in the wind.
- Difficult to light in the wind. Even the slightest wind requires a windscreen.
- Reduced efficiency and damned slow cooking if the wind or a light rain persist.
- Not every alcohol will burn in all units. Many require 80% or higher to work well.
- Cold sensitive. If it's really cold (below 0C) they can be nearly impossible to light.
- Altitude sensitive. If you are hiking in the high mountains alcohol may not light.
- Relatively long cooking times / boiling times because alcohol is "low-energy" fuel.
- Soda can models can be very fragile and require careful packing and handling.
- A separate and often bulky pot stand is often required.
- Limited fuel capacity resulting in limited burn times, often less than 10 minutes.
- You cannot control the flame size or heat output. What you get is what you get.

That about does it. A litany of issues to overcome. Well, I did it. With the helpful input and moral support from my good friend, Don Hitchcock, I have managed to get the job done.

El Diablo I Specifications:

- 50ml fuel capacity.
- 25 minute maximum burn time in "power off" mode.
- 10 minute maximum burn time in "power on" mode.
- Instant startup, zero warm-up time.
- Super easy to light anywhere. Just toss in a match and turn on the electricity.
- Unaffected by wind, weather, altitude, cold. Hot, efficient, burns all the time.
- Strong. Made of steel and it'll take any normal use without complaint.
- Roundpod pot stand is low profile, no weight, strong, easily packed inside a cup.
- Flame can be easily controlled with 3 flame settings. "High", "Medium", "Low".

Let's take a look at this beauty and its origins:

Origins of El Diablo I

El Diablo was born a dream. My dream is the “Holy Grail” of boiling 250ml (1 cup) of cold water in under 60 seconds. El Diablo comes closest to this with a 90 second time. I call it El Diablo I because there will undoubtedly be another, faster model.

It came from the Twister

I built the Twister Lite, a stove with the intent of getting a cyclonic action to the flame in the belief that this might improve efficiency or raise flame temperatures. It increased efficiency but had no measurable effect on flame temperature. It is, however, pretty to look at.



At the heart of El Diablo is the burner unit. Twister Lite®



Canted holes in the Twister Lite give its flames a cyclonic action. The added internal flute construction helps to direct the flame plasma in a cyclonic pattern. The flutes act as directional baffles.

Twister found a home

I mounted Twister Lite in a wind tunnel. This is a fruit can cut up and modified to take Twister Lite in a mount.



Twister Lite held up by a “snap ring” made from a coat hanger.

The hole is ever so slightly too big so I used a snap ring to keep Twister Lite up in place. The ring also makes it easy to replace the burner chamber if it ever burns up. I made Twister Lite from a **steel soda can** as aluminium ones kept melting.



The tin is inverted with the bottom now the top. Twister Lite can be seen sticking his head out, supported by the snap ring. At the bottom are air inlet holes cut in with a church key can opener. The wires protruding through an airhole are for the electricity to power the electric 4” computer fan mounted inside. It works.

On the next page are clearer images of how the fan mounts. It is set two inches below the Twister Lite to avoid heat damage and allow sufficient airflow over the Twister Lite.



Computer 4" fan mounted by breaking off corner tabs and slipping it into the tin.

I have screws above and below at "4 points" to keep the fan in place at all times. It works until I figure a better way. I can use 1 or 2 nine volt batteries to control the flame. For high speed I snap one **pos** and one **neg** together so both batteries are one.





El Diablo I in place with the round-pod to go on top.



The round-pod is the genius of Don Hitchcock. I just made it smaller.

Very effective pot stand.



Round-pod in place and stove ready for use.



Both batteries and 95% alcohol. A flamethrower.

On 95% alcohol and both batteries she burns HOT! This is good for a 90 second boil time and does the job very quickly. Makes a soft turbo sound too. The fan is quiet, but the flame is not.

By using 1, both, or no batteries you can control the flame heat and power. By changing fuel from 95% to 75% for example, you can also control it.

Look below to see some differences.



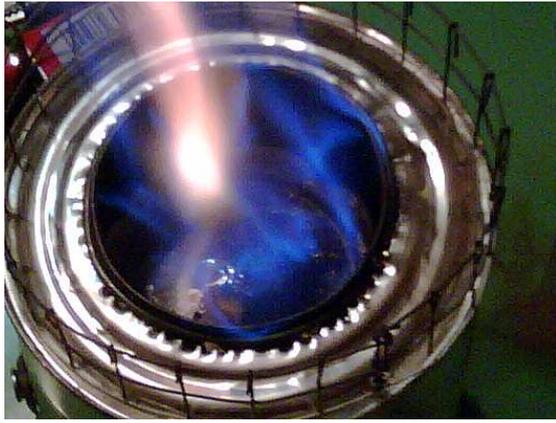
El Diablo earns her name. 75% alcohol on high speed. Menacing, hot, beautiful.

A larger pot is a good idea because a flame like this will lap all over the pot and deposits some soot. It is immune to all winds short of hurricane force. I love to see people's faces when it fires up. Warmup time is non-existent.



El Diablo at her best. 95% alcohol and both batteries. This will burn through an empty steel pot if you aren't careful. This is your configuration for 90 second boil.

Isn't that a thing of beauty? The entire unit weighs less than 300 grams. A single battery will run the fan about an hour total time which is a lot of cooking. Two batteries together about the same: an hour, maybe 50 minutes really.



The child of Twister Lite and a wind tunnel, this is the epitome of fast and cool looking cooking in an alcohol stove.

Hail El Diablo!

A collection of El Diablo snapshots. This is my finest work yet.