THE ION PROPELLED LIFTER

- Next Efforts Involve Amplifying The Ion Flow Like The Air Force Did With The Orbs6

by: **Steven Dufresne**

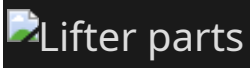
Comments

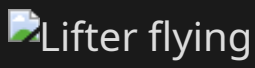
Like many people, going through university followed an intense career building period was a dry spell in terms of making things. Of course things settled down and I finally broke that dry spell to work on what I called “non-conventional propulsion”.
I wanted to stay away from the term “anti-gravity” because I was enough of a science nut to know that such a thing was dubious. But I also suspected that there might be science principles yet to be discovered. I was willing to give it

a try anyway, and did for a few years. It was also my introduction to the world of high voltage... DC. Everything came out null though, meaning that any effects could be accounted for by some form of ionization or Coulomb force. At no time did I get anything to actually fly, though there was a lot of spinning things on rotors or weight changes on scales and balances due to ion propulsion.

So when a video appeared in 2001 from a small company called Transdimensional Technologies of a triangle shaped, aluminum foil and wire thing called a lifter that actually propelled itself off the table, I immediately had to make one. I'd had

enough background by then to be confident that it was flying using ion propulsion. And in fact, given my background I was able to put an enhancement in my first version that others came up with only later.


Lifter parts


Lifter flying

For those who’ve never seen a lifter, it’s extremely simple. Think of it as a very leaky capacitor. One electrode is an aluminum foil skirt, in the shape of a triangle. Spaced apart from that around an inch or so away, usually

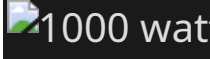
using 1/6″ balsa wood sticks, is a very thin bare wire (think 30AWG) also shaped as a triangle. High voltage is applied between the foil skirt and the wire. The result is that a downward jet of air is created around and through the middle of the triangle and the lifter flies up off the table. But that is just the barest explanation of how it works. We must go deeper!

The Unsteady Lightweight

For a lifter to succeed it has to be extremely lightweight. There’s no chance of carrying the power supply along. A typical lifter with 4″ (100mm) sides weighs in at just 0.07 ounces (2 grams).

If you've ever seen one lift off while the voltage is gradually turned up you'll have noticed that its flight path is highly erratic until the voltage is sufficiently high that it appears to hover. The truth is, the flight still is erratic, or would be, if it weren't for three threads tied to the legs, tethering each corner down. Typically the propulsion produced by the three sides of the triangle is not even and so to get it stable, all three sides have to be propelling enough to lift their respective sides. That means that the strongest side is propelling more than it needs to and the weakest side is propelling just as much as it needs to. The threads holding it down make it

look stable at that point.
It wasn’t long after the first lifter was flying that variations were also being made: multiple triangles connected together, spirals instead of triangles, even foil tubes in place of the straight sided skirts.
I recall one from Asia (I seem to remember it was in Japan but am not sure) that was room sized and flew in a large garage or warehouse. The documented record for payload is a 98 gram hexagonal shaped lifter lifting a 102 gram payload using 40kV from a specially made 1000 watt power supply. This isn’t the answer to how to fly like Iron Man.

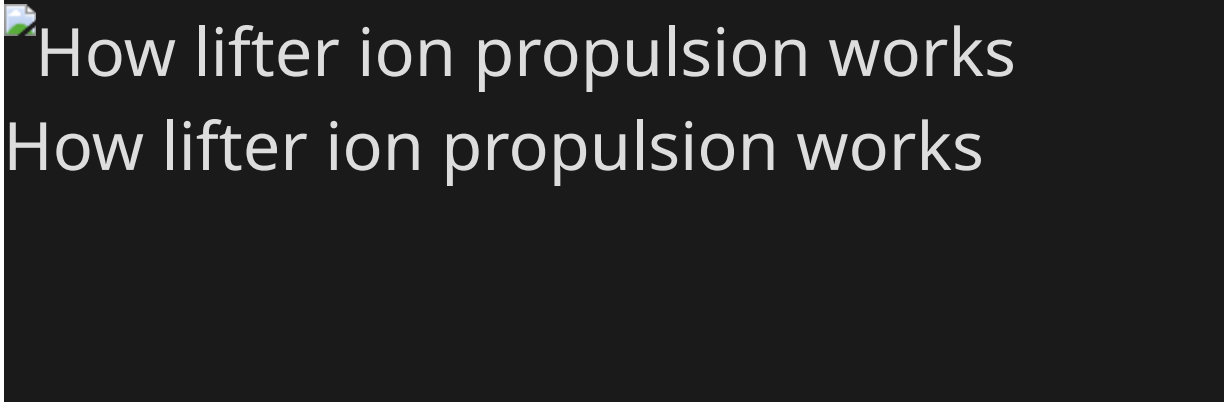

1000 watt high voltage power supply


100gsetup_blazelal

HOW IT WORKS

The lifter flies using ion propulsion. The key is that one electrode acts as a sharp point and the other acts as a smooth edge. The thin wire is the sharp point. Mine is usually positive. Any sharp point at sufficiently high voltage in air ionizes the air around it. That’s due to the strong electric field there. The foil skirt is the smooth edge and is at the opposite polarity, negative and connected to ground in my case.

Having a large surface area, the electric field there is weaker and so there’s less ionization. The enhancement I made in my first version was to make the edge of the foil closest to the wire be rounded, resulting in an even weaker electric field. When I tried following the plans of others without the rounding, it was more difficult to get it to lift off. Having an asymmetric electric field as created by sharp and smooth electrodes is essential to this form of ion propulsion.


How lifter ion propulsion works
How lifter ion propulsion works

The positive ions are attracted to the negative skirt. Some get to the skirt and are neutralized, and some collide along the way with neutral air molecules and impart momentum to them. The neutral molecules then continue in a generally downward direction. The resulting downward flowing jet is made up of these neutral molecules, though I've found some evidence that a few positive ions also make it past the skirt. The momentum is passed from the ions to the lifter through the electric field during the collisions. Think of the electric field as arms and hands that are physically a part of the lifter and the ions as balls. A ion colliding with a neutral atom

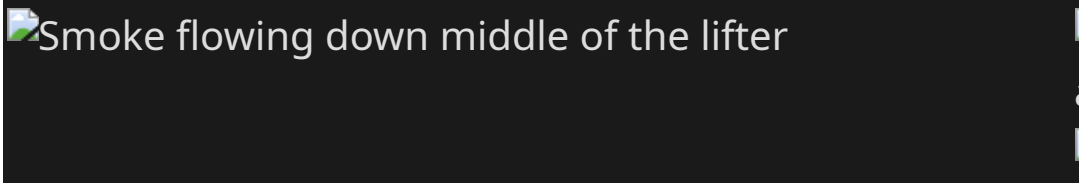
is analogous to the ball in your hand smacking into another ball. When the balls smacking together it pushes your hand in the opposite direction. The same happens to create ion propulsion.

Electrons also play a part but with the wire being positive in my example they play more of a part in creating the positive ions than in transferring momentum.

SMOKE AND VACUUM TESTS

Smoke tests show the large mass of air rapidly moving downward through and around the middle of the triangle. I’ve tested this using smoke from an incense stick. Not only did that clearly show the moving air mass, but as you

can see in the last photo, I captured a glowing piece of the incense break off and be rapidly carried away in the moving air mass.



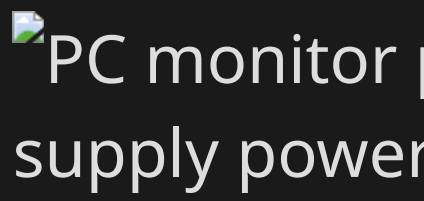
While there have been a mix of results in vacuum chambers with lifters and sharp object/smooth object arrangements, any resulting movement is always tiny compared to

a flying lifter. Sometimes the experiment is a device suspended along a torsion wire with a small twist produced in the wire. A larger twist is achieved by turning the power supply on and off in time to the movement, but the resulting larger twist is simply the result of resonance, the same as happens when you apply force to a swing at just the right point in its arc to make it swing higher yet.

TIPS AND TRICKS

A lot of people who try to fly a lifter fail because their power source isn't powerful enough. The original video by Transdimensional Technologies showed a Van de Graaff generator with a dome of approximately 14". I

tried with my own 14″ dome VDG and judging by the bluish ionization it came up woefully short, even for a 2″ lifter. To make a 0.07 ounces (2 grams) lifter fly requires 25kV and somewhere above 250 microamps (the analog meter I was willing to sacrifice topped out at 250 microamps.) I've read of a 0.18 ounce (5 gram) lifter requiring 37kV and 1.7 milliamps. For that you're talking about a wall powered Cockcroft-Walton voltage


PC monitor power supply powering lifter

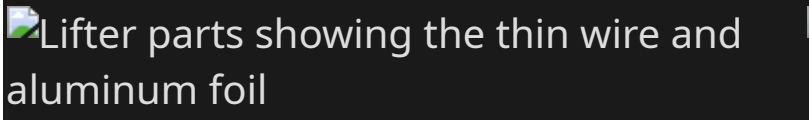
PC monitor power supply powering lifter

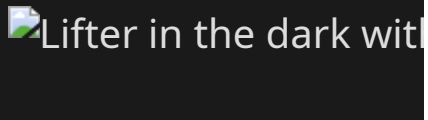
multiplier power supply. An old CRT PC monitor has that and is easily adapted to fly lifters. Some sparks can contain enough current to cause damage to some power supplies, especially PC monitor power supplies. To protect against that use around 240 kiloohms of at least 2 watt rated resistance in series with the input to the lifter. I usually put it on the ground side since that doesn't have as many issues with leakage.

Note that I once tried flying a lifter from a dusty floor and it didn't work. I suspect that the dust was getting positively charged by positive ions getting past the skirt. That would result in the positively charged floor attracting the negative skirt down. So

stay away from dusty surfaces.
But the best tip for getting a lifter to fly is to do it in total darkness — while taking all safety precautions. In darkness the corona that is the ionization is visible as a bluish glow. This way you can tell which sides of the triangle are contributing to the lift. Often you'll find it's just one side. After turning on the lights and turning off and discharging the power supply and the lifter, try moving the wires on the other sides closer to the foil skirt, or the ionizing one further away. If you get sparks then you've moved the wires too close. Sparks are the enemy of ion propulsion since they are a

shorting out of the electric field that produces the ions.


Lifter parts showing the thin wire and aluminum foil


Lifter in the dark with

And that’s a brain dump from my experience with lifters. Have you done any ion propulsion in any form? Perhaps you’ve done the much simpler spinning needle form in school? We’d love to hear about your experiences. Let us know in the comments below.

Posted in classic hacks, Engineering, FeaturedTagged Cockcroft-Walton, corona, high voltage, ion, ion propulsion, ion wind, ionizing, lifter, smoke, vacuum, voltage multiplier

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THOUGHTS ON “EXPANDING HORIZONS WITH THE ION PROPELLED LIFTER”

Michael Eversole says:
May 29, 2017 at 11:39 am

I did build the simple triangle lifter and used the back of a computer screen to power it. Still looking for a viable power to weight design and power source, I am playing with the idea of alternative materials, both in higher lifting characteristics, such as silver coated magnesium or graphene corona wire and reduced surface wire mesh collector tube. Several HV Multiplier in 5,000 volt 0.3ma. Last is a viable power source with a power to weight ratio that is not off the shelf yet. Graphene Super Capacitors is the only way. What I do not have is the design. Is it stacked or spared out? Small or large? What is the surface area calculation to lift a 1000 lbs? I suspect it will be a tubular frame of carbon fiber made in the bicycle industry or perhaps a panel system like those from http://www.ayrescom.com . Mounting of the lifter will need to be on a simple hydraulic or electric 3D gimbals for thrust vectoring. Now lets imagine a four seater, like a Tesla S Model with no wheels, but rather the undercarriage or over carriage of lifters. Lets get to work!

Reply Report comment

Steven Dufresne says:
May 30, 2017 at 5:51 am

I once did some calcs comparing the energy required for the approx. 2 gram triangular lifter in the video to hover and the energy in a supercapacitor and the supercapacitor had the needed energy for a few seconds at least. However, that didn't take into account the losses in stepping up the voltage, or the weight of anything onboard except the lifter.

26,000V x 0.000275A for hover = 7.15W = 7.15J/s

Using.https://www.sparkfun.com/products/746 Thi s one is 10F/2.5V
supercapacitor energy = 1/2CV^2 = 31.25J

Note, the 0.000275A is low but it was the highest my analog ammeter could go for the range. The needle went off scale.

Certainly going with a thinner wire than the usual 30 gauge will reduce the power required to make the lifter fly

This lifter holds the record for how much mass it could lift, 100 grams, and the lifter weighed 98 grams:
http://blazelabs.com/l-c-hexspiral.asp
http://blazelabs.com/e-exp14.asp

Reply Report comment

yup says:
July 13, 2016 at 7:45 am

Wonder what would happen after hitting the degauss button…

Reply Report comment

Max Dobmann says:
July 13, 2016 at 7:55 am

The degauss normally runs directly off of the mains supply and is current-limited by a PTC thrmistor that provides an initial surge of current that fades-away quickly. Unless you're operating your outlet on the border of overload there should be no interaction of the circuits…

Reply Report comment

NewCommentor1283 says:
July 14, 2016 at 8:39 pm

"no interaction of the circuits"

well normally there is no interaction, but the wires used in this expierement are very lightweight and would be "shaken" by the degauss coil, im thinking the craft would loose control, fall, maybe short out, and maybe even fold up into a ball? well something anyway…

Reply Report comment

Timothy Gray says:
July 13, 2016 at 8:11 am

nothing really. Degauss is a coil of wire ran around the face of the unit and is simply 110V sent in that coil. it does nothing at all to the high voltage from the flyback.

Reply Report comment

Mike Szczys says:
July 13, 2016 at 8:25 am

Wonder no more, Adam already exposed the secret world of the degauss button.

Reply Report comment

wesfaler says:
July 13, 2016 at 7:52 am

Ah, this brings back memories. Ran a small club at college for building Lifters. Was even the entertainment for a kid's birthday party, showing the kids how to build Lifters. 10 kids + high voltage, sure why not! Used those skills and now have a patent on a plasma thruster for CubeSats. I cannot stress enough the importance of hands on learning! And the occasional clown nose.

Reply Report comment

forthprgrmr says:
July 13, 2016 at 8:16 am

Reminds me of the August 1964 article in Popular Mechanics.
Starts out with the line: “It was downright spooky.”

Reply Report comment

RichardS says:
July 13, 2016 at 8:17 am

Nice article Steven! Nicely written and informative.

Reply Report comment

PWalsh says:
July 13, 2016 at 8:26 am

I’ve often wondered whether there is some science to be discovered in these things.

For instance, I would guess that most of the ions generated by the wire hit the rolled-over top of the foil. If you had two wires a short distance apart, then the electrons will approach the foil at a slight angle, and perhaps miss the top fold completely.

Would that make a more efficient lifter?

Then is it possible to make a “stacked” version of the foil leaves to get more thrust?

It seems like there should be an application for these things, but I don’t know what that would be.

Reply

Report comment

Steven Dufresne says:
July 13, 2016 at 9:05 am

The ion thrusters used in space do use meshes where a lifter has the foil. In that case positive ions are accelerated through the meshes and there's care take in the meshes to make sure a certain percentage get through. But once the positive ions have exited the back of the engine, they may still be attracted back to the engine. To counter that they have a negative charge sprayer outside the engine that sprays negative charge at the departing positive ions to neutralize them. Once neutralized there's not backward attraction and they keep
going. http://dawn.jpl.nasa.gov/DawnClassrooms/2_ion_prop/inter_syn/2_sr_trip.pdf
As for stacked lifters, a few have experimented with stacked ones but off-hand I don't recall any rigorous comparisons. The how-it-works paper I link to above (here's the full one you get if you click
through http://rspa.royalsocietypublishing.org/content/469/2154/20120623.full, done in October 2012) includes experiments with a dual-stage thruster.

Reply

Report comment

ludwig says:
July 13, 2016 at 8:41 pm

I was thinking about the kelvin water dropper https://en.wikipedia.org/wiki/Kelvin_water_dropperand its variations with a pump. Consider one of the variations with a pump, but replace the

pump with a passive tube, and apply HV instead of having a spark gap. Could larger (compared to ions but still tiny) charged water droplets be more efficient? It's probably a bad idea...

I was thinking in 2 senses:
1) analogous to the classic thrusters: the propellant is still the air, but the working fluid to transfer momentum to atmospheric air propellant would be the mist of larger in cross section water droplets (instead of single ions). The thruster should be designed to collect the droplets back while still efficiently allowing air to pass on...
2) analogous to rockets: in this case the heavier water droplets are the propellant, and will be consumed (!) a positive and negative jet of water could be aimed to combine so as to neutralize and keep charge balance.

But again, probably makes no sense and only serves to increase weight...

Reply Report comment

CRJEEA says:
July 13, 2016 at 8:46 am

These things are good fun. Not so easy to get things smooth and [really] light. Not to mention the power requirements. Still if you're bored and don't have much to spare in your junk box they are reasonably fun. I do enjoy the smell of ozone. [plasma burns and tingly fingers, not so much]

On a slight side note; wooden kitchen skewers split down their length straight enough to produce very thin, light and reasonably strong strips.

Reply Report comment

randybob says:
July 13, 2016 at 11:37 am

Alexander Seversky (designer of the P-47 Thunderbolt) demostrated this is 1965. Check out:https://www.youtube.com/watch?v=GijJmIz1G7U

Reply Report comment

William Shaw says:
July 13, 2016 at 11:55 am

We are actually doing something similar with the propulsion system for a CubeSat our team is designing to compete in the NASA CubeQuest challenge. Our thrusters were recently tested in one of the vacuum chambers at Georgia Tech (http://miles-space.com/news/weekly-round-table-6-will-suck-electric-spacecraft-propulsion-vacuum-chamber-testing/) and showed pretty impressive results using Xenon gas to create the plasma. We're currently crowdfunding further development on the propulsion system to enable us to move forward in the Cube Quest challenge (http://kickstarter.miles-space.com).

Reply Report comment

notarealemail says:
July 13, 2016 at 11:56 am

Blimp.
[https://youtube.com/watch?v=Cn_RQanyGOI]

Reply Report comment

Boz says:
July 13, 2016 at 1:07 pm

Thanks for the link, Interesting video because they managed to get the HV power supply on-board, something you could never do with a classic lifter like the one in the article.

Reply Report comment

Ipcalit says:
July 13, 2016 at 12:34 pm

How about a funnel-like design where a couple “lifters” are placed sideways to accelerate the air into a spiraling motion before exiting something like a nozzle. One could start with just 3-4 sets of wire + foil placed inside a cone with both ends open to test. If results are promising, then a denser setup with 6-12 sets could be powered in sequence to accelerate the ions even more. Same power requirements but the output velocity should be much greater.

Reply Report comment

wesfaler says:

July 13, 2016 at 1:20 pm

Tried a funnel (aka 1/2 a 2-liter bottle) and got more lift than expected. I think the faster moving air on the inside made lower pressure and it acted like a wing of sorts: fast/low-pressure on “top”, normal/high-pressure on “bottom”. Tried adding a wire to the front of a styrofoam RC plane wing, and measured lift with a fan for air flow. 18% greater lift with the wire. That’s called a plasma
actuator. https://en.wikipedia.org/wiki/Plasma_actuator

Reply Report comment

Ipcalit says:
July 13, 2016 at 12:51 pm

How about a funnel-like design where a couple “lifters” are placed sideways to accelerate the air into a spiraling motion before exiting something like a nozzle, similar with the centrifugal designs of the bag-less vacuum cleaners. One could start with just 3-4 sets of wire + foil placed inside a cone with both ends open to test. If results are promising, then a denser setup with 6-12 sets could be powered in sequence to accelerate the ions even more. Same power requirements but the output velocity for the air should be much greater.

Reply Report comment

Ipcalit says:
July 13, 2016 at 2:30 pm

Sorry about the double post. HAD shows me no feedback when posting.
Regarding the plasma actuator, there are multiple ways to accelerate ions: (1) centrifugal, where the electrodes go parallel with the axis of the cone and power is applied in sequence to pairs of electrodes, (2) multistage coaxial where the electrodes are perpendicular to the axis of the cone in a similar model with the Dyson air multipler fan to get more air to move. Which of these did you try?

Reply Report comment

wesfaler says:
July 13, 2016 at 2:36 pm

Just the most basic: wire ring inside the cone and foil near the exit nozzle. So, option 2, just really simple.

Reply Report comment

darkflame says:
July 13, 2016 at 3:31 pm

I wonder if anyone has tried computer simulations to “evolve” a design of a lifter. It seems like its all known physics enough to be simulated?

Reply Report comment

Ipcalit says:
July 13, 2016 at 4:14 pm

It is all known physics, just that according to the article above (http://rspa.royalsocietypublishing.org/content/469/2154/20120623.full) we should be looking into increasing thrust to power ratio through engineering a better system. The authors claim “F/Pth is in the range 1.23–3.24 N kW−1 with a mean of 2.22 N kW−1” or “2.46 N kW−1” for a jet engine. In comparison, they claim “F/P degrades with increasing thrust (and so increasing voltage) consistent with equation (2.6). For example, for d=21 cm, F/P peaks at 110 N kW−1 (or averaging 68 N kW−1 for all power levels below 1 W), and reduces to 16 N kW−1 at 0.35 N of thrust, compared with values of approximately 2 N kW−1 for current aircraft engines (or approx. 4 N kW−1 if the core thermal efficiency is factored out). This does not imply that EHD thrusters are practical, but it does point to their potential for relatively high efficiency where efficiency is defined as thrust per unit power”.

So, it would be interesting to see some calculations for a switched radial/centrifugal design that would be mechanically much simpler than say a VASIMIR plasma engine and suitable for small satellites (e.g. cubesats) carrying a tiny amount of fuel. To counter any rotational issues, one could have a pair of funnels side by side or in a concentric design. Probably much better chance of success than the other EmDrive attempt posted here: https://hackaday.io/project/10166-flying-an-emdrive