

# **Black Match**

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## Disclaimer

**By reading and carrying out the instructions for these projects, you hereby acknowledge that...**

- The procedures described on the following pages are for informational purposes only.
- If you choose to follow the instructions on the following pages, you do so *at your own risk*. Pyrotechnics and rocketry propellants, chemicals and other items are dangerous and must be handled with the utmost caution. I take **no responsibility** for personal injuries, property damage, or legal trouble caused by your (or who ever you distributed the information to) application of any of the materials presented on these pages. No warranties are expressed or implied regarding any of this information. There is no guarantee that any device will function exactly as described here.
- Also I **do not** advocate the use of this information for illegal, unsafe, disruptive, or destructive purposes. This includes building salutes, bombs, or other explosives designed to cause noise, harm, or damage.
- The possession and use of fireworks/black powder is regulated by federal, state, and local laws. The reader is solely responsible for observing his/her local laws before using fireworks or applying the information presented at this site.

## Introduction

Black match is a widely used fuse type in the hands of the amateur.

It's easy to make and fairly reliable.

This is my way of making it.

I have explored many routes along this way, making 7 or more systems to make black match. Several string types, from 1mm OD to 4mm OD have been tested and are capable of generating good black match.

My goal was: string goes in, match comes out, less work and more match in as little time as possible.

It's still the same, and I haven't completed this study yet – although I got very good results.

Black Match will also be referred as BM, shortly.

## Black match wet mix

After testing various mixes, getting fungi (mold) to grow on the mix I got to this formula, and additives - with the kind help of John and other PML members.

- Black powder – high quality ball milled BP. Nothing less is acceptable from my experience – If you put junk into your black match machine and you will get junk at the other end!
- +3% dextrine (grind with some dry BP with the dextrin using a mortar and pestle, and add to the rest of the BP batch.
- 55% v/w (i.e. 55cc of liquid per 100gr of BP) of 20% ethanol is added. The ethanol will make sure nothing "grows" on the mix and ruins the quality of the future black match. It will also prevent the formation of large nitrate crystals, which will ensure the homogeneity and proper function of the fuse (even burn rate)
- Additives suggested by John (and found to be good) -
  - 1% Boric acid (to avoid bacteria)
  - 1% Copper sulfate (to avoid fungi)The additives did not affect the BP and BM (black match) quality

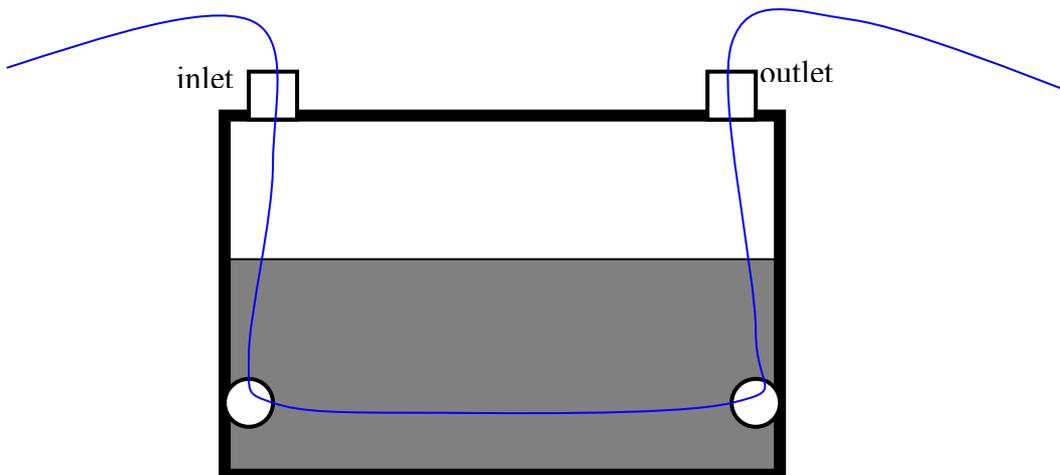
## System design

If you take a canister and run a string through it – it will locally drain the liquid (soak it up) from the BP mix and the result will be a "tunnel" of BP that allows the clean wire to run through a semi-dry BP mix.

To avoid this I have assembled my system on top of a hair clipper machine (with the blades take off for safety – they snipped my black match the first time...)

The clipper vibrates and this makes sure that no "tunnels" are formed.

The canister is actually a cream jar that has 2 inlets and 2 hooks:



Stainless steel hooks (shown as circles) force the wire to run inside the mix. Both the inlet and outlet have screw caps.

There are several caps – storage caps (sealed) close the system and do not allow air/water/ethanol vapors to come out.

The operational caps are only outlet caps – with different holes ID inside for different string types – the cap hole ID is the same as the string OD. For a very thin black match I use a 1mm string, and a 1.5mm hole is drilled in the exit cap (these are made for quickmatch); for a 2mm cotton string I use a 2.5mm exit hole in the exit cap (regular fuse for rocket ignition); and for the "Angora" brand string I'll use a 4mm exit hole to obtain a very thick black match.

Here is an image:



The lead weight makes sure that the system will not flip over if placed on the floor. The string you see is a fine knitting string (1mm OD) and is used to make my 1mm black match.

A peg is used to hold the wire if I leave the system for a while (it's messy and the peg helps).

The red cap there contains the other caps for the system. This way nothing gets lost.

### **Running the system**

I add a fresh batch of mix (usually 30gr + additives+solvents). I recommend that you mix it in a nylon bag, kneed it well, cut a corner and pour it into the container.

After 6 meters of black match a volume of 2.5cc of 20% ethanol is added and the system is mixed with a stick. This makes sure the mix doesn't get too dry.

### **Drying the BM**

Now... how to hang the black match to dry?

I use a vertical standing flat wood door, with pegs on it, and horizontal nylon wires. The wires make sure the sticky fresh BM does not cling to the wood door.

I simply hold the new black match on the top peg, pull 1.2m of black match and secure it with the lower peg, snip and repeat.

This system is time saving and space saving and allow to make and dry lot's of BM.

Here is the top section (in red script there is a note for me to refresh the black match mix with more 20% ethanol).



You can see a black nylon line below the pegs (black from all the sticky black match – no worries the new BMs won't stick to it). I spaced the nylon lines about 20cm from each other.

Well... that's it.

It's simple, fast, and can store BM mix for long times with no fear of decay.

The end caps make sure it won't dry out.

It's easy to use and user friendly, time consuming and space consuming.

Bottom line – it works for me.

### **The NEW system**

Well... after a long time I decided to make a new system.

The first change in the system is thanks to Yuv!

Instead of placing the stainless steel rings at the bottom of the cup they are now secured to the cap. I used a V shaped stainless steel wire bending the ends to form the hooks at the ends of the V arm. The V wire is attached to the cap. This makes replacing the string, or rewiring the system (if the string got loose) very easy.

This also means that I don't have to worry anymore about long term storage. After a few months, even with the caps on, the mix dries into a rock hard cement. The new system allows me to use another cap (a non punctured one ;) and keep the mix wet for a longer period.

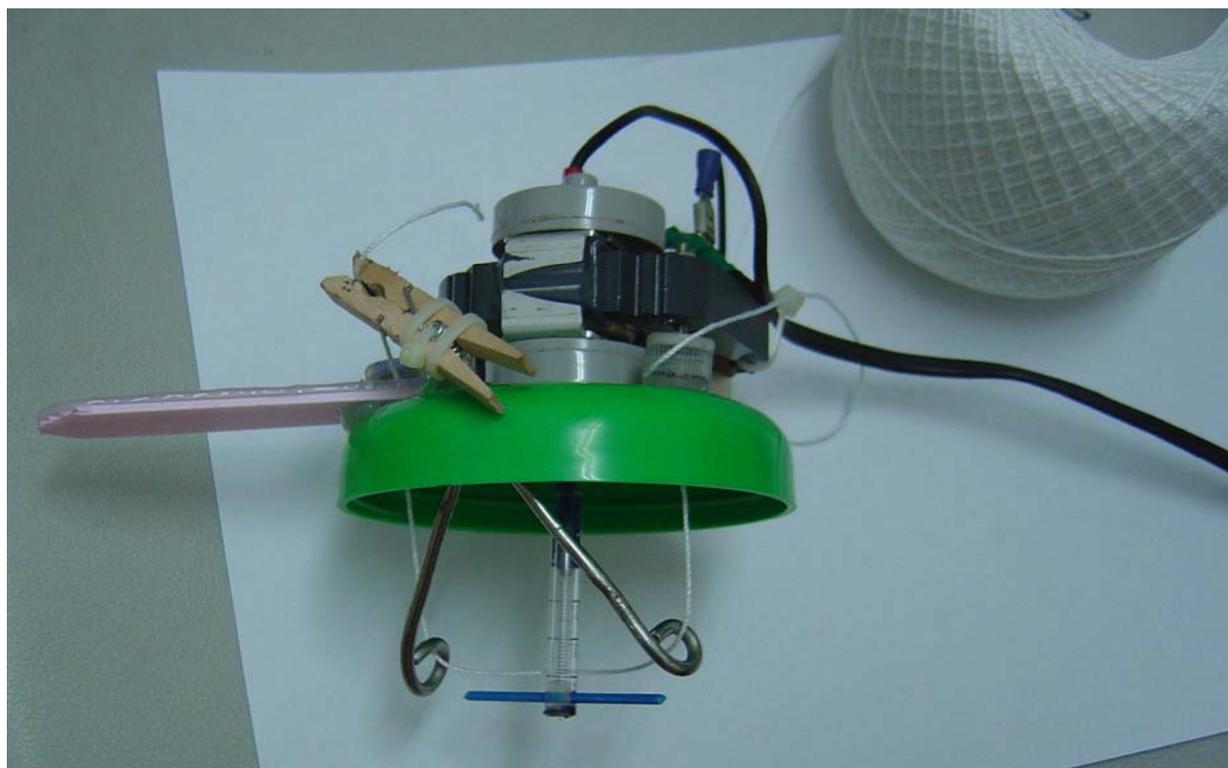
The other big change is the mixer.

From time to time, even with the hair clipper options the string doesn't get enough BP coat. The reason is that the mix is drying, and setting and doesn't adhere nicely to the string. A quick shake helps mix it better. This always happens just before you need to add the 20% ethanol. So I added a motor and converted it into a stirrer.

This will also help me shorten the handling time: Instead of taking the whole thing to the table, open the lid, add the ethanol, mix well, close and get back to making black match – I'll be able to just add the ethanol through the inlet hole (I don't use a drilled inlet cap, I just remove the storage cap).

I even added a smaller system (sorry, not in the images currently) for testing various additives. The smaller system will be hooked with a plastic tie to the main one and I'll be able to use it with only 5-10gr of BP each time.

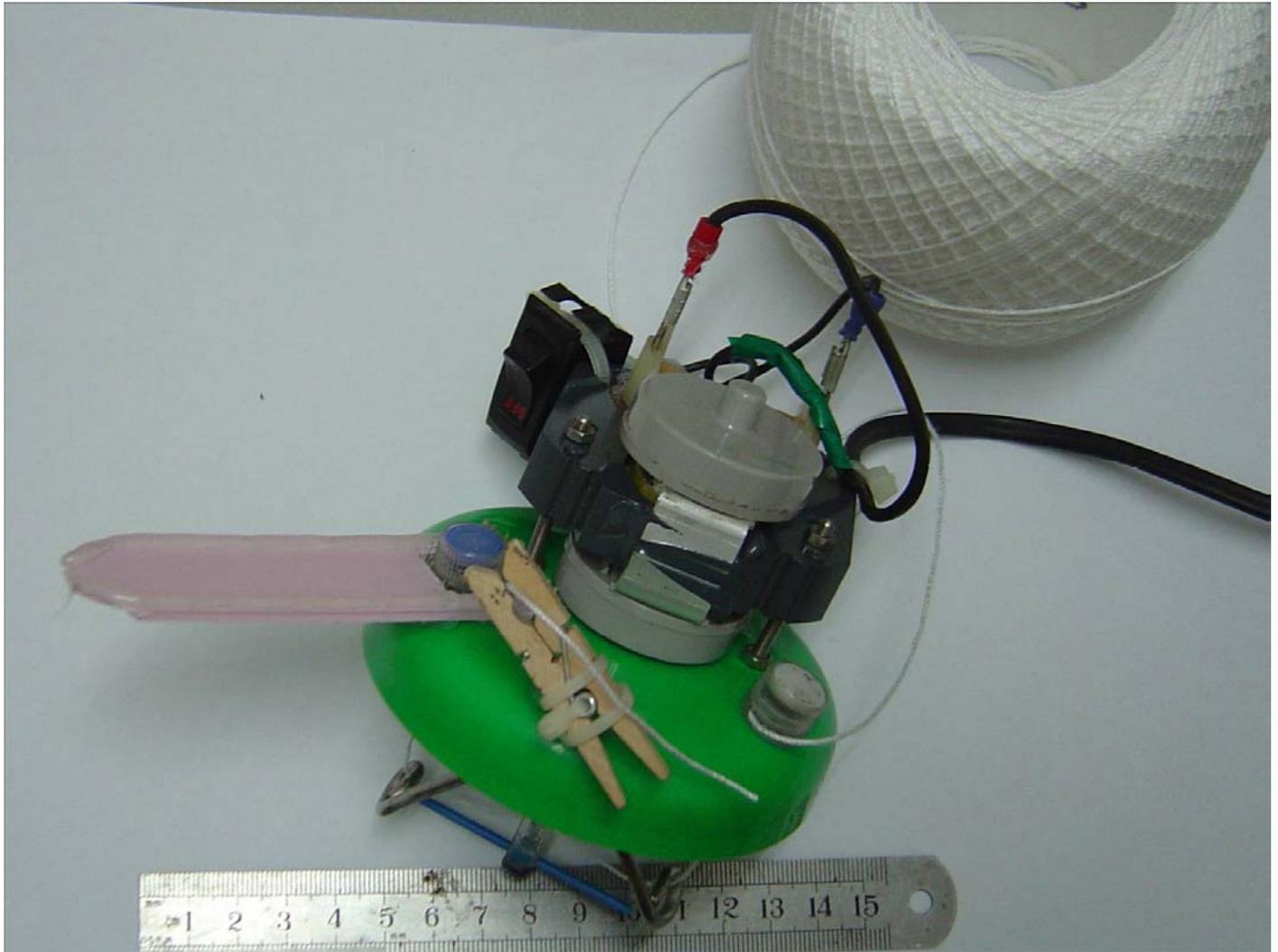
Enough typing – here are the images:



This is the cap.

It actually contains all the important parts now.

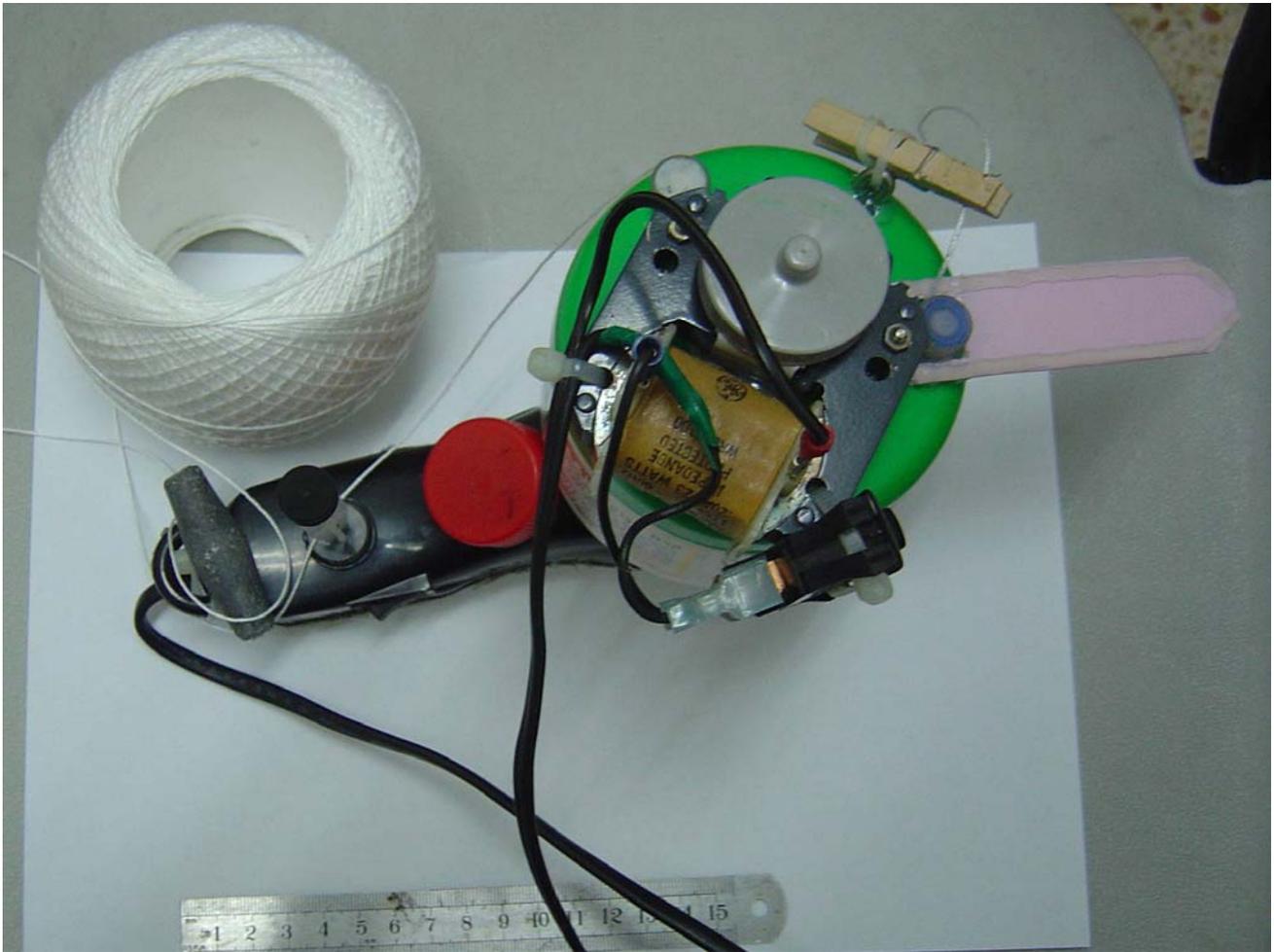
You can see the electric motor on top (110v, 60mA, 23W if you are so interested in the specs), the hooks below that run the wire through the mix (and you can see the wire too), the mixer/stirrer head (attached to the motor, of course) and the wet black match path (pink plastic sheet that guides the wet BM to the pegs).



This is the lid again, but top view:

The wire goes through the storage cap (white), runs through the stainless steel hooks, mix, and back up to the exit cap (blue storage cap, in this case). The exit caps are identical, but have exit holes of course). The peg holds the wire so it won't slip back to the mix (if I'm forced to stop during the operation). The Peg is secured to the top section of the V shaped stainless steel wire that ends with the hooks.

In the next page you can see the full system (still untested in real life):



This system has a far greater capacity. I think it may hold up to 100gr of BP. Usually 30gr of BP will give about 3 rounds of black match, which are 36meters, and still you will have some leftover BP. Although I don't plan on making tons of black match, this will enable me to make thicker black match string, with a single fill of the can. Obviously that thicker the string, the more black powder mix it consumes.

## Experimenting with Adhesives

Just before building this system I started experimenting with additives. I can give you just the initial tests results so far, and I'll have to do many more experiments (which is why I made the smaller system for tiny batches).

I have so far examined:

1. Corn flour [5% in 30% ethanol]
2. Potato starch (potato flour) [5% in 30% ethanol]
3. NC laqour [5% NC in acetone]
4. Guar Gum 3%
5. Acacia gum (aka gum Arabic)
6. Commercial ironing starch
7. SGRS – home made.

Corn flour and potato starch did well in my tubelesses and generated good and fairly reliable rockets. However, they proved to be very bad for black match. I will give them another shot at 3% and 1% to see if they can still function...

NC is great for black match.

It generates a fuse with a very even, smooth burning, even burn rate and very hot fire. One big problem with it is the acetone – the whole place reeks of acetone. It also evaporates very fast and forces the use to add more acetone every 2m or so. Sadly, it's just too annoying to work with, for me, that is.

Commercial ironing starch was also tested (the label did not include the ingredients, but stated it's all natural, and scented). I added enough of the liquid to the BP batch to make it liquid, and made a fuse. It burned well, but not through holes or in contact with anything else (place on a plate and it stops burning). It works well as an ironing starch...

As for Guar gum – good results!

3% of Guar Gum were added to the BP and mixed well.

About 50% w/v of 20% ethanol was added later to obtain a good, fairly thin paste.

It was easy to make the fuse (just like dextrin) and it dried as fast.

It burns just like dextrin and a quick match with this fuse is a fast burning, flash through quick match as you would expect and need it to be.

I also tested it using my regular masking tape test – and it works well.

Although some people said that guar gum is good for extrusions and not fuses – it still is very good for fuses.

I invented a "dampness test" to simulate what happens during the evening as everything gets moist. I placed a wad of toilet paper and sprayed some water over it. It wasn't dripping water but still very wet. Placing the fuse on the wet paper and pressing gently on it made sure it will contact water. I then ignited the fuse – and it burned well. I will tune this small test with dextrin fuses later on until I'll have a good test that will sift the good binders from the moisture sensitive ones.

The new fuse works just fine so far.

So I used it the next time I went to launch rockets.

It was great.

Instead of the 50% failure in black match burn due to the dextrin sensitivity to humidity this time we had only one fuse fail.

## **Future plans**

### **Gum Arabic.**

It was highly recommended by some members of PML.

I was able to get some from a friend.

3% of gum Arabic were added to the BP powder and mixed well.

50% of 20% ethanol were added and mixed well.

### **Gum Arabic + Guar Gum**

1.5% of each gum were added to BP.

50% of 20% ethanol were added and mixed well.

### **SGRS – home made.**

After a long discussion and lots of help from PML members I got a good concept of what I need to do.

I bought a pound of rice flour.

It was baked dry in the oven at 200c until it got brown.

At that point I stopped cooking and allowed it to cool

A small batch of SGRS was made by adding the baked flour to water and boiling.

I boiled the mix on a low flame, and stopped as soon as it boiled.

The SGRS solution was allowed to cool.

Once cool I added 1% boric acid and 1% copper sulfate according to John Collins tips. Boric acid kills bacteria and copper sulfate kills fungi very well. So these will make sure I can keep the SGRS wet, at room temp for a very long time. I have used this recipe before and it doesn't affect the burn, burn rate, burn through or any other aspect of the burning fuse. It does protect the wet BP slurry from bacteria and fungi and allows for long storage time. So does 20% ethanol, and this is why I combine all these to make a good, long lasting slurry.

Next thing is to dilute the SGRS to a 5% mix and add this to the BP powder.

A few meters of fuse were made.

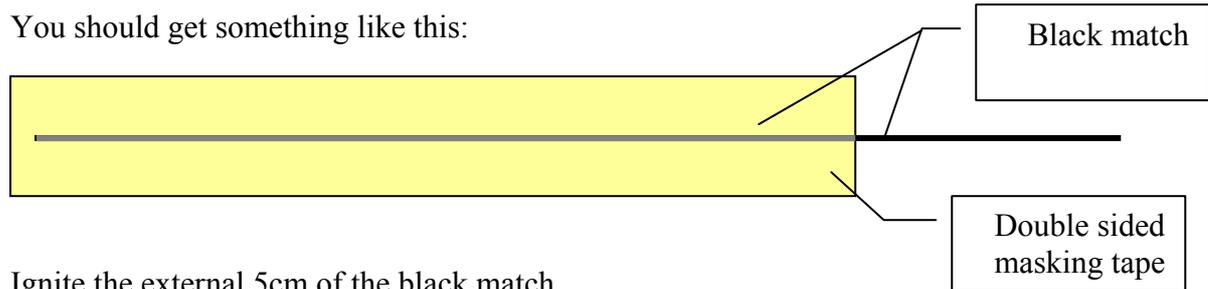
### Testing the new black match batch

The simplest way to test your new black match (to make sure it's of high quality and will go through a nozzle/hole/etc and ignite your motor/lift) is this:

Take a strip of paper based masking tape, 20cm long.

Take a 15cm long black match and place 10cm of its length on the masking tape, centered along the axis. Now fold the masking tape and make sure it's tight. No gaps between the tape and black match should exist.

You should get something like this:



Ignite the external 5cm of the black match.

The tape is now a heat sink and will draw heat from the match.

If your match burns all the way through the tape – it's good to work with.

My black match usually makes the tape fly all inside my fume hood.

So that's it for now...

Comments?

Questions?

I am fully aware to the fact that I may have missed some points as I'm so accustomed to many details that I may and probably have skipped a few...

Feel free to mail me your questions and I'll answer and update this file.

Yours,

Flint