

Your typical first gun

Getting Started

Before doing anything, it's in your best interest to read my [safety precautions](#) that you ought to take when working with this device. When you set out to building this gun you may think you're being sneaky. You may think you can go to the store and buy these components and nobody will know what it is. You may think you can go to various stores and get away with it. The truth is, unless you live in a large city that doesn't know about this stuff yet, you can expect to hear SOMEONE yell potato gun behind you in line at the checkout. Take my word for it.

I specify PVC piping although you may want to use ABS piping. It is argued which is better. I have a section discussing the [pros and cons of ABS vs PVC](#) farther ahead.

(*)Note: I selectively lifted the following 'Materials' and 'Assembly' sections from the 'Backyard Ballistics' 'hairspray powered spud gun'. For the remainder of this page, I will assume you're following the specifications laid out by this section, with the exception: I used a 4" dia. combustion chamber, as opposed to the 3" dia. one recommended here. A link to the 'Backyard Ballistics' page is provided at the end of the previous document under the links section.

Chamber Volume Calculation

This is a relatively simple calculation to figure out how on earth your going to make your chamber 1 1/2 x's the volume of the barrel. Don't ask me why this is the case. All I know is that is the best barrel chamber ratio for a combustion gun out there. The text in blue is an example.

(1) Determine which Pipe sizes your going to use for your chamber and barrel. (e.g. 1 1/2 in. barrel : 3" chamber.)

(2) Determine the volume of your barrel (e.g. lets say that you want your barrel to be 36" long. So that's $\cdot \Pi r^2 \cdot 63.570 \xi 41.3(2 \times 36 = 63.585 \text{ in.}^3)$)

(3) Now multiply that by 1.5 (and you get 95.3775 in.^3)

(4) Find the area of the base of your chamber - $\cdot \Pi r^2$ (3.14 x 1.5 x 1.5 and you get 7.0875 in.^2)

(5) Now you set the equation ($63.3775 \text{ in.}^3 = 7.0875 \text{ in.}^2 \times X$)

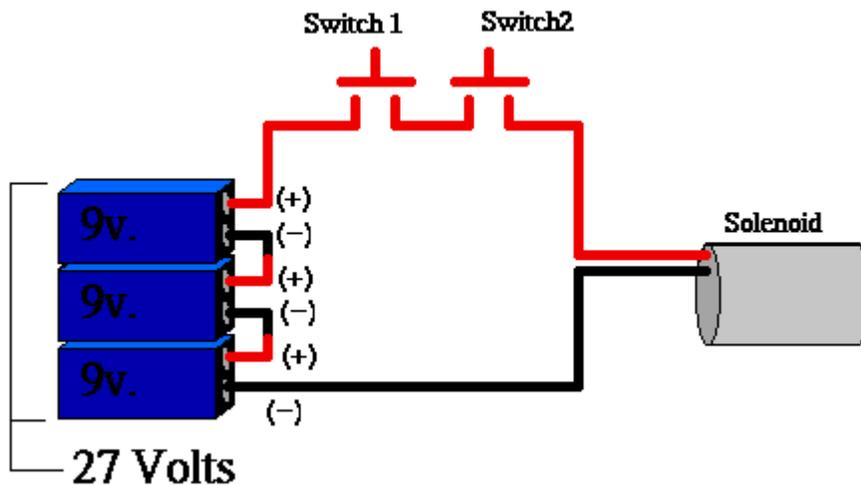
Then you simply solve for X by dividing both sides of the equation by the # next to X and if you did it right you end up with the length of your chamber (13.5 in.)

So that's a 36in barrel of 1 1/2 in. PVC and 13.5 in. chamber of 3" PVC. This is the optimum barrel-chamber ratio for your combustion gun.



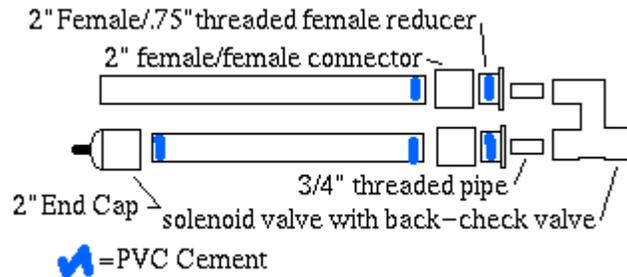
Air Cannon Electrical System

The electrical system in the air cannons I built centers around the solenoid for the sprinkler valve. Most sprinkler valve solenoids require 24 volts to open. I found the most convenient way to supply this was to link 3 9 volt batteries in series, to provide 27 volts, more than enough to open the valve.



Above is a schematic of the electrical system I used. I've colored the wires red and black out of convention. The solenoid actually has white wires as it does not matter which direction the current flows through it. You'll notice I used two push buttons (switch one and switch2). That was to allow one to act as a safety. The user must press both switches at the same time to get the air cannon to fire. As an additional safety measure, I always remove one of the batteries while loading, handling the air cannon off the game field.

Air Cannon Fittings



Not much to say here, the picture pretty much shows what I did. The barrel I used is 30" in length, with a 26" air chamber. Note it is important to let the PVC cement fully cure. A number of people have told me stories about how they eagerly tried their aircannons too soon, blowing out the air chambers. Pesco's first air cannon did not have the barrel glued into its connector, and consequently self destructed while firing for the 4th or 5th time!

Ignitor Info

The ignition is the single most important part of a combustion cannon and requires the most thought. There are several methods of ignition. (1) flint lantern igniter (2) BBQ igniter (3) piezoelectric lighter (4) high voltage stun gun. I'll have pictures up at a later date.

(1) **Flint Igniter**-This is the most common form of spudgun ignition. It is installed directly into the cleanout plug of the spudgun. A small spark is created by sharply twisting a brass shaft which is connected to a small metal wheel. Also a tube containing flint is attached adjacent to the steel wheel. When the steel wheel turns, it brushes against the flint creating a small spark which is just enough to create the ignition.

Pros

- +It works nearly every time.
- +Is easy to install
- +Require no risk of high voltage electrocution
- +Has no contacts to interfere with



Cons

- Flint eventually runs out
 - The flint has to periodically be exchanged
 - It can get gummed fairly quickly if you don't clean it
-

(2)**BBQ Igniter**- This is the second most common form of ignition used. It uses to contacts which have a high voltage running through them enough so to make a spark jump to form ignition.

Pros

- +Works nearly every time
- +Is easy to mount
- +Is easy to activate

Cons

- Requires a small chamber to work in
 - Is cumbersome when seen mounted
 - Is quite expensive
 - Uses metal contacts
-

(3) **Piezoelectric Lighter**-This is a very good method which works 90% of the time. This switch is very small and compact (about the size of a penny). It also uses the spark jumping method.

Pros

- +Very compact
- +Has a larger spark
- +Can use variable contact wired in series

Cons

- Practically none.



The last method is a very dangerous method that is used by the maintainers of the SpudRock page. This method should only be used by very experienced experts! You should be able to come by it through most major search engines (Google, Hotbot, Altavista ect...)

Air Cannon Pipe

The pipe I used for both the air chamber and the barrel on my air cannon was thick wall (schedule 40) 2" PVC pipe. I don't remember if the thinwall pipe had the necessary pressure rating, but it didn't look rugged enough to handle the rigors of a paintball field. Pesco also made an air cannon with a 1.5" diameter barrel. I have found the 2" to be small enough to carry easily, yet large enough to handle a good size group of paint pellets.

PVC PIPE SPECS

Nominal Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nominal Wt./Ft.	Max. W.P. PSI**
1/8	.405	.261	.068	.045	810
1/4	.540	.354	.088	.081	780
3/8	.675	.483	.091	.109	620
1/2	.840	.608	.109	.161	600
3/4	1.050	.810	.113	.214	480
1	1.315	1.033	.133	.315	450
1-1/4	1.660	1.364	.140	.426	370
1 -1/2	1.900	1.592	.145	.509	330
2	2.375	2.049	.154	.682	280
2-1/2	2.875	2.445	.203	1.076	300
3	3.500	3.042	.216	1.409	260
3-1/2	4.000	3.520	.226	1.697	240
4	4.500	3.998	.237	2.006	220
5	5.563	5.017	.258	2.726	190
6	6.625	6.031	.280	3.535	180
8	8.625	7.943	.322	5.305	160
10	10.750	9.976	.365	7.532	140
12	12.750	11.890	.406	9.949	130
14	14.000	13.072	.437	11.810	130
16	16.000	14.940	.500	15.416	130
18	18.000	16.809	.562	20.112	130
20	20.000	18.743	.593	23.624	120
24	24.000	22.544	.687	32.873	120

Nominal Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nominal Wt./Ft.	Max. W.P. PSI**
1/8	.405	.203	.095	.058	1230
1/4	.540	.288	.119	.100	1130
3/8	.675	.407	.126	.138	920
1/2	.840	.528	.147	.202	850
3/4	1.050	.724	.154	.273	690
1	1.315	.935	.179	.402	630
1-1/4	1.660	1.256	.191	.554	520
1 -1/2	1.900	1.476	.200	.673	470
2	2.375	1.913	.218	.932	400
2-1/2	2.875	2.289	.276	1.419	420
3	3.500	2.864	.300	1.903	370
3-1/2	4.000	3.326	.318	2.322	350
4	4.500	3.786	.337	2.782	320
5	5.563	4.767	.375	3.867	290
6	6.625	5.709	.432	5.313	280
8	8.625	7.565	.500	8.058	250
10	10.750	9.492	.593	11.956	230
12	12.750	11.294	.687	16.437	230
14	14.000	12.410	.750	19.790	220
16	16.000	14.214	.843	25.430	220
18	18.000	16.014	.937	31.830	220
20	20.000	17.814	1.031	40.091	220
24	24.000	21.418	1.218	56.882	210

Propellants

Hairspray	Depending on what type you use, most hairsprays are pretty standard and gum up your cannon pretty easily. I recommend that you use the White Rain brand
Propane	Propane works great and doesn't gum up your cannon.
Butane	Pretty much the same as propane
Carburetor/Lighter Fluid	Packs some the most powerful punches yet is harder to dispense
Denatured Alcohol	Hard to get to light. Very Powerful
Acetylene	Very Dangerous yet the strongest stuff out there. I don't

	suggest that you use it unless you are willing to take your life into your own hands for acetylene has the power to shrapnelize your chamber completely if the projectile is stuffed in too tight
Bug Sprays	Most bug sprays work well but be careful which ones release toxic vapors.
Static Guards	Same as Bug Sprays
Aerosol Right Guard	Works great and smells great

Air Cannon Fill Valve

The fill valve I used was an automobile tire valve stem. It had its own nut and washers, so it was simply a matter of drilling an appropriate sized hole in the reservoir end cap and installing the fill valve before gluing on the end cap on to the reservoir pipe.

I'd like to talk for a minute about power sources and such. This seems kind of obvious to me, but there are a lot of people out there who just don't get it.

The schedule 40 PVC pipe is rated to 280 psi. Most sprinkler valves are rated to around 110 or 120 psi.

I commonly get asked by people how to hook up a CO2 tank to this. CO2 tanks have pressures as high as 1200psi. Do the math people! 1200psi in a system rated for 110 psi means PVC shrapnel tearing the skin from your bones in a rather ugly explosion!

The simplest and safest method for charging an air cannon is to use a bicycle pump that has a pressure gauge. It takes a minute or so to charge it up. The air cannon's air chamber is good for one shot. For paintball use, I treat the air cannon like a one shot device. I carry it around to somewhere near a flag station, wait, use it, then leave it 'till after the game. It's most practical that way.

Another charging method is to use an air compressor with a pressure gauge. A friend of mine had one that ran off the cigarette lighter connection in his car. It re-charged the air cannon quickly and easily between games in the parking lot.

The **only** way CO2 can be used is with a regulated gas supply. This means using a regulator on the CO2 supply to bring the output pressure down to 100psi, **and** using a safety valve to blow out in case the regulator fails and overpressures the air chamber. **NEVER, and I mean NEVER** hook CO2 directly into the system. I have gotten e-mail from people asking if they could just install a valve, and open it "real quick" so that just

enough gas got through to reach 100 psi. The problem with that is that the tiniest pinhole leak, or failure to totally shut the valve, means that the pressure in the air chamber will slowly continue to rise until it is enough to burst, and cause serious injury or death. I have heard an unconfirmed report from a reliable source about someone losing an arm from a system like this.

High pressure compressed air (SCUBA tanks etc.): The same thing as CO2. Regulation and safety valves are essential. Don't even think about messing with this stuff if unless you are very experienced working with and designing systems for high pressure compressed and cryogenic gasses.

Over all, if you are just building an air cannon as a fun toy, or for paintball, stick with the bike pump. It's cheap, safe, easy, and convenient (I've run regulated CO2, and it's added weight and impracticality).

Air Cannon Valve



The heart of the air cannon I built was the valve. I used a solenoid operated sprinkler valve. Since it is a diaphragm valve it opens almost instantly when triggered. This is important as if it opened slowly (like a hand valve) it would let the air out slowly and not provide enough propellant force to the paintballs out of the barrel at a decent velocity. The valve I chose was rated up to 125 psi, but I always used just 100 psi, it did the trick, and I saw no need to go any higher. Another option I chose was a back check valve. This isn't really necessary, but since it hangs open normally, it makes muzzle loading easier. The real reason I chose the model with a back check valve was it meant I didn't have to mess with other adaptors and elbows, the valve outlet was pointing 180 degrees from the inlet, and spaced just right for an air cannon! You may notice the silver metal box in the above picture. I put that over the solenoid to protect it from getting banged around, which would strip out its threads.

Construction

Materials

- 1 10 foot piece of 2 inch diameter schedule 40 ABS pipe
- 1 10 foot piece of 3 inch diameter schedule 40 ABS pipe
- 1 3 inch to 2 inch reducing bushing
- 1 3 inch coupling
- 1 3 inch threaded (one side) coupling
- 1 3 inch threaded end-cap
- 1 can ABS solvent-weld pipe glue. NEVER USE PVC GLUE on ABS!!!
- 1 Coleman sparker - these are easily found in any sporting goods store that has a decent camping section. They are normally made for putting inside a Coleman lantern or stove so you don't need matches.

Assembly

Step 1 - Cut the combustion chamber to size. Cut off a 14 inch section of the 3 inch diameter pipe. You don't need the rest of the 10 foot length, so save it for future bazookas, or make one with a couple of buddies splitting the cost.

Step 2 - glue the 3 inch to 2 inch bushing into one side of the 3 inch coupling, glue the other side of the coupling to one end of the 14 inch combustion chamber. Make sure the joints are clean first and be liberal with the glue.

Step 3 - glue the threaded coupling to the other end of the combustion chamber (using the slip-joint side, obviously) make sure the glue doesn't run into the threads.

Step 4 - Cut the "barrel" to size. Cut off a 36 inch (3 foot) length of the 2 inch pipe. Glue this into the other end of the bushing you've glued to the combustion chamber. You should now have the complete gun, but it's not ready for firing just yet.

Step 5 - Using a file, taper the "muzzle" for the last half an inch on the outside. This will serve to cut the potato as it's rammed in.

Step 6 - You'll need to mount the sparker inside the end cap. If you got the Coleman one, it is threaded and has two nuts with it. There is also an angled piece of metal meant to hold the ignitor inside a lantern. Take the knurled knob off the end of the shaft. Be

careful - there's an extra flint inside the knob. Unscrew the nut and discard the angled bit of metal. Drill a hole dead center in the ABS end cap of a diameter to take the shaft of the ignitor. Mount the ignitor inside the end cap, put the nut on the outside of the shaft and tighten until the ignitor is held in place. The shaft will slide back and forth, but won't come out. Put the end knob back on and tighten the lock screw.

Step 7 - Make sure the glue has "cured". I left mine overnight before firing.

Step 8 - make a ram rod. I used surplus 1/2 inch PVC pipe, 4 feet in length. A broom handle, etc. will do. Measure and make a mark about 2 feet 8 inches down the ram rod.

Your First Shot

So, your gun is all assembled and you're ready to fire it for the first time. **Good!** You'll need to decide what propellant you will be using. If you're unfamiliar with the common ones, I have a section on [propellants](#) you may wish to read.

Your first shot isn't always a successful one. A handful of things can prevent the gun from firing. If it doesn't fire, read ahead to my [troubleshooting segment](#).

Firing the gun is simple enough. Because you beveled the tip of the barrel, your potato is going to be cut to the perfect size as you press it down. When you're pressing the potato into the barrel, take your time. Keep it lined up so it's not at an awkward angle (which would give you a poor seal). Use the ramrod to slide your spud as far down as you can.

Note: Some people drive a nail through the bottom of the barrel. This lets them push the potato as far as they can without it dropping out the other end of the barrel.

Note: The tip of your barrel will get dulled regularly from cutting so many spuds. Don't forget to sand it down to a nice point frequently.

Spud in place, the next step is to fill the combustion chamber with your propellant of choice. Every propellant has a different fuel/air ratio, and it varies even more depending on the size of your gun. My suggestion: start low. Use only a little of whatever you've got, because you won't need much. If it doesn't fire, then put a **little** more in next time and slowly work your way up. As soon as it will fire, keep slowly increasing the amount of propellant and notice how the power of the shot increases. At a certain point, you will notice the power of the shots begin to **decrease** as you add more propellant. The point where you stop gaining power from shots is the optimum fuel/air mixture. Stick with that for the best shots!

Note: When you fire the gun, byproduct gasses (and liquids) may be formed by combusting your propellant, in the same way a car emits exhaust. In between shots, you should blow through your gun to flush those useless gasses out.

*Note: I prefer to fill my combustion chamber with propellant **first** and then ram the potato. This compresses the gas in the chamber, increasing its volatility and the power of the shot.*

Troubleshooting

Having a little trouble? Don't worry, it happens to everyone. Fortunately, there are only a few reasons why your gun should ever not fire reliably. And here they are:

Too little propellant

Ok, so it sounds too simple, but it can be the case. Not enough propellant in your chamber and it just won't fire.

Too *much* propellant

This is the more likely of the two cases. You don't need so much propellant that you could level a small city. If you keep trying to fire and it's not shooting, try less propellant. This happens to me constantly.

Poor seal

Poor seal? Yes, the potato (or other projectile) needs to fit very **snugly** in your barrel. Hold the gun up and look through it. If you can see light at the other end of your barrel, it won't work. For a shot to be successful, pressure will have to build up rapidly in your chamber. It will never build up at all if the gas can just slide by the potato.

Extreme temperature

This isn't so much a case of too much heat, rather too much cold. Gas will lose its heat extremely fast. This makes cold-weather shots difficult if not impossible. My propane will not reliably combust under 50°F. To fire in colder weather, keep your propellant as warm as possible, but *not hot!*. You won't be happy if your propellant starts to combust in its container. Just keep it warm, and it should still be able to fire in the cold.

Dirty/wet ignitor

Electric ignitors will tend to gunk a little at their contacts. You need to keep the two contacts as clean as possible on your electric for it to spark. A flint sparker won't work when it's wet, but is impervious to gunk. If you get your sparker wet, use a lighter to dry it off.

Too much exhaust

When you combust your propellant, other uncombustable gasses (and liquids) will be formed as byproducts. Every few shots, you should blow air through the gun to flush these gasses out. Just like in your car, if the exhaust isn't pushed out of the engine it will kill the performance.

It just won't work

There are days, few and far between, when the universe aligns itself against you and the gun simply isn't going to fire. This seems to happen whenever you're showing the gun to friends who've never seen it and expect to see spuds flying thousands of yards. My recommendation for this one: give up and try later.