Fire by Friction

Rather than creating a spark into tinder, fire by friction causes the fuel to heat up until it reaches the combustion temperature and ignites. This is around 800 degrees fahrenheit. Moisture is the biggest obstacle to overcome when attempting to create fire by rubbing wood. Start with extremely dry wood and keep it dry to ensure success. In areas of higher humidity, more effort is required.

Following are some of the more common methods of creating fire by friction in order of increasing complexity. All of these methods create a coal of smoldering wood dust which is then transferred to waiting tinder to be coaxed into flame. They also employ one piece of hard wood and another slightly softer wood which wears away. Neither of these woods should be too soft nor too hard. Excessive resin in the wood will also cause failure since it will cause the wood to become polished and smooth.

These are simple introductions to each method. Individual success depends on strength, practice, materials used, and troubleshooting. These methods require a lot of effort and consistency. Some woods to consider using:

- Cedar
- Willow and Redwood
- Yucca and Oak

Fire Plow

- Form a plow board of softer wood that is flat and a couple inches across and 2 feet long.
- Form a plow stick that is hardwood and has a sharpened tip.
- Cut or rub a depression about 6 or 8 inches long in the plow board. This is the trough in which you will scrape the plow stick.
- Hold the plow board firm as shown or kneel on it or sit on it if it is a longer board. The idea is to keep the board steady.
- Point the plow stick into the plow board at about a 60 degree angle and push it forward with downward pressure.
- Release the downward pressure and pull the plow stick back to the start of the trough.
- Push and pull the plow stick quickly, creating wood dust at the far end of the trough. It is important to end each stroke at the same spot so dust can accumulate there.
- Eventually, the wood dust will combust and can be pushed into waiting tinder.

Fire Saw

- a softer wood stick is cracked along its length (but not completely split) and a small peg or pebble is placed in the end to hold the two halves apart about 1/4 inch. You may want to tightly wrap the end which you do not want to split before cracking.
- Tinder is stuffed in the crack.
- A sharp edged harder wood stick is sawn back and forth across the crack, perpendicular to it.
- Sawdust is worn away and drops into the tinder, eventually heating enough to develop a coal.
- Dried bamboo stalks are also used for fire saws with a notch cut across half a stock and the ember falls through the cut onto tinder.
Hand Drill

A smooth, straight shaft of wood is spun between the palms of the hands, forcing the tip of it into the hearth wood, generating an ember.

- Choose a straight stalk or stick of a harder wood for your drill. It should be about 18 to 24 inches long, 1/4 to 1/2 inch wide, with very few side branches, preferably none.
- Smooth the drill of all bumps, knobs, and roughness so it will not rip up your palms.
- Create a hearth board about 1/4 to 1/2 inch thick and 1 inch wide. Split a piece of softer wood to form a fairly flat surface.
- Cut a small depression in the top of the hearth board about 1/8 inch in from a side. This is where you will seat the drill.
- Hold the hearth board firm with a knee and position the drill in the depression.
- Spin the drill between your palms to wear out the depression and see that the drill seats well.
- Carve a notch half way in to the center of the depression from the edge. As you spin the drill, the wood dust collects in this notch so place a piece of bark under this area to catch it.
- Spin the drill, repositioning your hands at the top when they work their way to the bottom.
- Over time, the wood dust will accumulate and ignite with smoke and finally a small ember. Transfer it to tinder.

Bow Drill

bow drill is the most common primitive fire making method demonstrated at shows and classes.

- The fire board is a flat piece of softer wood with a depression and notch like the hand drill.
- The drill is a smooth, straight stick of harder wood. The top end should be pointed and smooth. The drilling end should be rounded.
- The bow has a cord tied between the two ends and wrapped once around the drill.
- The socket holds the drill in place and provides downward pressure. It should have an indentation into which the drill end seats smoothly. Lubricate it with resin or oil from your skin.
- While pressing down on the socket, move the bow back and forth, causing the drill to burn into the fire board.
- Collect the ember and start your fire.

Fire Pistons

The fire piston is a unique method of creating fire, using nothing but compressed air to ignite tinder.

A plunger is quickly pushed into an air-tight tube, compressing the air, raising the temperature, and igniting a bit of charcloth or other tinder set in the tip of the plunger.

The key requirements for a fire piston to operate correctly is a straight, smooth bore and a plunger that seals the chamber air-tight.

Fire pistons are commercially available with an emphasis on the artistic rather than the function. You can create your own from scratch or purchase a kit to assemble and carve.
Fire by Friction

The Theory

Fire by friction. This is most people's idea of the pinnacle of outdoor skills - the idea being if you can light a fire with nothing more than a few sticks then you can probably survive anywhere. Being able to light a fire without a lighter or matches will certainly impress your friends - and with good reason. There are probably only a handful of people in Britain who can pull it off while in the US you'd share the skill with maybe a few hundred people. No wonder it's a skill that impresses!

Before we get any further, let me clarify that here I mean fire by wood-wood friction - technically, striking a match or a ferro rod and striker is fire by friction too!

OK, so how does it work? Well, the trick is to rub two sticks together in such a way that you generate both wood dust and heat. Both of these elements are vital. The heat is what turns the wood dust into a glowing ember. The wood dust takes quite a bit of heat before it forms a ember - at least 430°C. Anything that gets in the way of either the heat or the formation of wood dust will put a halt to the whole thing and all your hard work will be in vain.

There are a number of factors that can get in-between you and your fire by friction. Some of them are obvious. Wet wood is a no no straight from the start. But some of the other negative factors aren't as obvious. If the wood contains volatile substances like resin or tar, this can evaporate and prevent proper heating. Another factor is using wood that is too soft which disintegrates as opposed to forming dust. What this means that before you begin to try to achieve fire by friction you first need to start off with the right wood. Here is a list of the best UK/European woods to use with bow drills:

<table>
<thead>
<tr>
<th>Alder</th>
<th>Birch</th>
<th>Clematis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elder</td>
<td>Elm</td>
<td>Hazel</td>
</tr>
<tr>
<td>Horse Chestnut</td>
<td>Ivy</td>
<td>Lime</td>
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<tr>
<td>Oak</td>
<td>Pine</td>
<td>Poplar</td>
</tr>
<tr>
<td>Sycamore</td>
<td>Willow</td>
<td></td>
</tr>
</tbody>
</table>

Ivy and alder are considered to be best, but no matter which wood you choose or have available, you need to ensure that it is both dry and not rotten (rotten wood won't make the right kind of dust).

Identifying the right wood to use isn't as easy as it sounds. A good place to begin is by practicing your tree identification skills (one good reason to get good at tree recognition!), but that's just the beginning. Naming a tree is one thing, naming dead wood is harder. Standing dead wood is easier but can still sometime present some difficulties. Finding dry wood is
another challenge. This is easier in summer than it is in winter - but remember that you are more likely to "need" a fire in winter. You might be able to dry out damp wood by placing it out in the sun or next to a fire (!!!) but again this could be tricky in a life-threatening situation. However, it's better to practice skills before you need them for real and to begin with you want everything to be on your side so you can get a feel for the process and maximize your chances for success.

**Take it easy!**

When you are first learning bow drill fire-making, you need to make sure that the environmental conditions you will be dealing with and your bow drill set are as close to perfect as possible to give you the best possible chance of forming an ember. If you start off with less-than-perfect conditions you are making things hard on yourself and chances are you'll give up too soon.

You can make things easier on yourself in a variety of ways:

- **Use the easiest woods**
- **Practice using the set in a warm/dry sheltered location (indoors if you can - but remember to move away any flammables and to disconnect the fire alarm as there could be a little bit of smoke!)**

Once you have a good section of wood (the more, the better), split it in half with an axe (or knife) to let it dry. A branch the diameter of your fist and a about 60 centimeters long (24 inches) is a good size to work with. You want to have plenty of spare wood around to experiment with.

Once you've split the wood, let it dry for about a week (in the sun if possible). Once the drying process is finishes, you can make your set bow-drill.

**Part of a bow drill set**

There are five parts to the bow-drill set:

1. The bow
2. The string
3. The spindle/drill
4. The board
5. The handhold

These parts go together like this. The drill spins against the board on one end and is held vertically by the handhold at the other end. The drill is spun by the bow and string.

Let's take a look at the parts in detail:

**The board**

Take the your split branch and then cut it (with a saw if you have one, or whittle it of just snap it) into a foot long length. Then take an axe or a knife and baton (a short, sturdy branch for
walloping the back of the knife blade) combo, split the branch evenly down the middle. Keep splitting until you get a flat board that is about 2.5 centimeters (1 inch) thick (about the thickness of your thumb). Whittle it down to remove any bits that stick out so you end up with a flat board (the shape of the board isn't important). The board should ideally be about 7.5 centimeters (3 inches) wide.

The spindle

Take a piece of wood about 20 centimeters (12 inches). This wood needs to be straight-grained and you need to whittle it into a straight dowel of about 2 centimeters (slightly less than 1 inch) in diameter straight dowel. Whittle the last 2.5 centimeters (1 inch) of each end into sharp points. The fatter the spindle, the less wear and tear it puts on the string. However, the trade-off is that the fatter the spindle, the longer the bow you will need in order to get the same amount of rotations per bow stroke. Put simply, this works in pretty much the same way as the gears on a bike.

The handhold

For the handhold take the other half-split branch and cut off a section about 10 - 12 centimeters (about 4 - 5 inches) long. Whittle this down carefully to remove any rough spots and also to give you a comfortable surface to hold. On the flat side of this, precisely in the middle of the wood (mark this from all four sides), gouge a hole with the point of your knife. Make this hole approximately 1 - 1.5 centimeters (about 0.5 inch) deep. Shape the sides of the hole so they slope at 45 degree angle so you form a nice cone-shaped depression in the wood.

The string

The string can be pretty much whatever you have to hand - leather laces, cotton, paracord, nylon rope - anything you have at hand. Some say that you should avoid synthetics because they can melt but if synthetic rope is all you have available it will do - just take care that it doesn't get too hot and start melting.

The bow

Find a piece of a green (live) branch that is about the thickness of your index finger and which is straight or slightly curved. The piece needs to be about the length of your arm from elbow to fingertip. The bow should be flexible but not flimsy. As a guide, it should not bend more than about 5 centimeters (2 inches) from straight when flexed using little strength. If it bends too easily or snaps, find a slightly thicker branch or use a denser wood. If it hardly bends at all then you can carefully whittle off a little wood on the inside of the curve. Make sure it bends evenly to avoid weak spots.

Basically:

If the bow doesn't bend, the string will slip frequently and soon break.
If the bow is too flexible the string will also slip and you won't be able to apply the force required.
Split the first 5 centimeters (2 inches) of each end of the bow using your knife. This is the reason why you need a green branch - a dry branch won't split right. Make sure the split is even and doesn’t run off to the side or the other. The orientation of the split is very important if the wood you have chosen for the bow has a curve. When the bow is set on a flat surface, you should make the splits so that they are parallel to that surface. Now take two short lengths of cordage and tie them around halfway up the splits. This prevents the splits from getting bigger.

Tie one end of the bowstring into a knot. Place this end into the split in the bow so the knot is on the side of the bow that is curving away from itself (the convex side). Make sure that the string is held tightly by the split by moving the short piece of cord up the split toward the bowstring. What this does is tighten the split. Then take the other end of the bowstring and repeat on the other side. The amount of slack in the string that you have is something that must be adjusted using trial and error when you fit the spindle you made. Initially the string should be a bit loose, otherwise you won’t be able to load the spindle.

**Using the bow drill**

If you are right-handed, it is best if you hold the bow with this hand. Place the board flat on the ground making sure it is stable. Now take the spindle and place the point of it onto the board so that you make a mark. This point should be about the width of the spindle from the edge of the board. This point should also be at one end of the board so that you have room to place your foot on the board. With your knife, gouge a shallow hole similar to the one in the handhold. Now, put your left foot on the board (if you are right-handed) so the inside ball of your foot is next to the shallow gouge you made. Your right knee should be on the ground and you should be sitting on your right foot. Your right leg should be parallel to the board.

Load the spindle by wrapping the string around the spindle so that the spindle is outside of the bow. This may mean that you have to adjust the string. Ideally the spindle should feel like it’s going to pop out. The tighter the string becomes, the better, (but don’t make it so tight that it breaks the bow!).

Holding the loaded spindle and bow in your right hand, place the bottom point of the spindle into the hole in the board and place the handhold at the other end and apply a bit of pressure to keep the spindle from popping out. Now here is a test to see if you loaded the bow in the right way - let go of the bow. The bow should be pointing itself up towards you. If it is pointing down, reload the spindle so the top is now the bottom and vice versa. Repeat until the handhold starts to smoke. Keep going until the hole in the handhold is the same diameter as the drill. It should now also match the curve of the drill point exactly.

**Running in**

You can now begin the “burn-in” process. This is to form the handhold hole. All you have to do is begin stroking the bow back and forth slowly. Keep the pressure on the handhold fairly high. Eventually, after some effort, you should see a small amount a smoke coming from one or both ends of the spindle. This is your cue to gather up a little bit of speed until both ends are smoking. It is important that you get the handhold end to smoke at this point. If it won't, reload the spindle so the top is now the bottom and vice versa. Repeat until the handhold starts to smoke. Keep going until the hole in the handhold is the same diameter as the drill. It should now also match the curve of the drill point exactly.
Now you must lubricate the handhold end (it is vitally important that you keep track of which end is up and which is down!). The lubrication is added because what you new need to do is reduce the friction at the handhold end. Unload the spindle and clean off the top into the hole in the handhold of any dust. Push the drill into the handhold as hard as you can and slowly rotate the drill. Remove it and blow off any dust once again. Now you can lubricate the handhold end - rub this end into your hair, or along the sides of your nose to transfer the oils found on your skin onto the wood. Another thing you could do is add some earwax (I know, it's gross but now you see that it does have some uses!).

Repeat the process until you remove as much of the friction from the handhold end as possible.

Notching the board

Now we come to an important but often overlooked part of the bow drill - the notching of the board.

You notch the board by taking your knife and scribing a 45 degree angle in the top of the board that starts from the center of the hole. The two lines will go to the nearest edge of the board. Now cut out the wood in between these lines so that you have removed a section of the burned-in hole (about a sixth to an eighth). This cut needs to go all the way to the bottom of the board so that you can removed a wedge of wood from one side of the board which points towards the middle of the drill hole.

Making embers

Place something under the board where the notch is to catch the embers. Birch bark is ideal for this. Now get into the position described earlier and start drilling. Make sure to put the lubricated end of the drill in the handhold - getting this wrong will mess up the whole works!

Now you want to begin making "powder". Drill slowly and carefully, applying firm pressure until the bottom end of the spindle begins smoking. Keep the smoke down to a minimum.

How the powder looks will tell you how things are going - you are aiming for powder that is dark brown/black in color that is has a fuzzy consistency.

If the powder is light brown in color and dusty, then you are going too slow and not applying enough pressure.

If the color of the powder is too light but the consistency is right, you're going too slow.

If the color is right but the consistency is that of little rolls of fiber, you might be going too fast or not pressing down hard enough on the handhold.

If the color is right but the powder takes on a crusty look, you are either going too fast, pressing down too hard or both.
You should begin to see powder building up in the notch. Keep the bowing slow and easy until the notch is almost filled. Once it is filled it is time to ease off on the pressure and begin drilling very fast. This is the how you heat up the power and turn it into an ember. Now things should begin to smoke quite a bit (this might be the point at which you regret doing this indoors!!!). If you don't get enough smoke, apply some more pressure until it does. Keep going until you have loads of smoke and then stop drilling and carefully remove the drill from the notch. If smoke continues coming from the powder pile you probably have created an ember! Gently blow on the ember until it glows red.

The final step!

Now all that is left to do is carefully transfer the ember to your tinder (it's a good idea to have this ready in advance!) and get your file going!

The Firepiston: Ancient Firemaking Machine

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I was but a young lad when my father, who'd always taken a keen interest in primitive technology, first told me of the firepiston. He had seen it in a documentary about stone-age natives from jungle islands somewhere in the Pacific. What he described sounded amazing - a tube of wood that could instantly create a hot coal with just a quick push of a plunger-and it had been used for ages.

I tried for many years to find out more about this device. I talked with universities, searched libraries, contacted The National Geographic Society, and even the Smithsonian without success. Finally a query posed to George Hedgepeth of Great Lakes Primitives provided a splendid lead which in turn led to a number of good sources of information on this topic.

In this article I will attempt to bring all of the information from these sources together with the hope that it will be a convenient reference for those who wish to pursue this subject further. We will look at the history of firepiston technology and explore sources that describe how to build or buy one of your own. In addition, addresses for further video or print information will be provided.

How does it work?

Air gets very hot when it is compressed under high pressure. A classic example would be the heat that is created when one uses a bicycle pump. But when the air is compressed in a firepiston it is done so quickly and efficiently that it can reach a temperature in excess of 800 degrees Fahrenheit. This is hot enough to ignite the tinder that is placed in the end of the piston which has been hollowed out to accept it.
Ancient examples of the tube itself are of hardwood, bamboo, or even horn. It is closed on one end, very smooth inside and accurately bored. Equal care is taken in the creation of the associated piston. A "gasket" of wound thread, fiber, or sometimes leather insures a proper seal for successfully creating the compression. This gasket is "greased" to help with the seal and to allow free travel of the piston. Those pacific natives I told you about earlier believed that the firepiston wouldn't work unless it was greased with dog fat. The natives of the Philippines say to use the grease of a wild pig from the jungle. But if you don't have time for a wild pig hunt, or the money to liposuction Fido, shortening has been shown to work. You might also want to try a combination of bacon fat mixed with a little candle wax, which is what outdoorsman John Rowlands used on his firepiston.

An article by Richard Jamison in a 1994 issue of Woodsmoke contains a nice description of how to operate a firepiston:

"...the cylinder is held firmly in the fist of the left hand: a small piece of tinder...is placed in a cavity on the point of the piston, which is just entered into the mouth of the bore; with a sudden stroke of the right hand the piston is forced up the bore, from which it rebounds slightly back with the elasticity of the compressed air, and on being plucked out, which it must be instantly, the tinder is found to be lighted."

As you can probably see, this ancient firemaking machine is utilizing the Diesel principle.

History

By 1865 European explorers had reached the jungles of Indonesia where they found firepiston use well established and widespread. Areas of distribution included Burma, the Malay Peninsula, French Indo-China and Borneo. From some of these areas it made its way to the East Island Archipelagos and the Philippines.

One thing I'd often pondered was the discovery by essentially stone-age people of a technology with such meticulous conditions for successful operation. I finally decided that it could have been an accidental discovery somehow connected to blow gun manufacture. The Woodsmoke article came to the same conclusion adding that perhaps during the process of boring or gauging them, there may have been compression of air that ignited material in the bore or perhaps on the rod. Reference was also made to the fact that oriental blow guns often occur in the same areas where the firepiston is found. In addition, speculation was made that perhaps when making blow guns of bamboo they would use a rod to pop out the nodes between the sections and that the discovery was accidentally made during this operation. In any event, the discovery was made. The distribution of firepistons was so widespread by the time of those first European explorers that it indicates knowledge of the necessary technology.
for ages. It continues to be used in some areas right up to the present as witnessed by U.S. Navy survival instructor Mel DeWeese.

In the 1970's, Mr. DeWeese and some others landed in a remote jungle village of the Philippines in a helicopter. The natives were quite interested in this event and all came out to see what was going on. They were dressed "in loin cloths and carrying bows and arrows." But despite this primitive aspect one of their number casually pulled out a firepiston and used it to light a cigarette. Mr. DeWeese was instantly intrigued and set about trying to find something the native might want to trade for it. Communication was hindered by the fact that neither could understand the others language. Finally, after much gesturing, the deal was cinched to the satisfaction of both parties when the native agreed to give it to him for a Zippo lighter and (here's the part I like) two pieces of Hubba Bubba bubble gum. What's important about Mel DeWeessees acquisition is that it has been studied and seen in action by many people and has provided a working pattern for those struggling to make a functional copy. Also it's a testament to the durability of the device. After all these years and countless "lights" it still works.

Europe

Often times in history the same discoveries or inventions are made independently of one another. The firepiston is an example of this. Both the Asian and the European discoveries were accidental, although by different means. The European version was discovered in the early 1800's in connection with the manufacture of air guns in France. It was noticed that when they were discharged in the dark the air guns gave off a light. Later tinder was ignited using the heat generated by charging the airgun. It didn't take too long before the discovery was used to make brass firepistons to show off the effect which in turn led to domestic use as fire starters. In England the effect was used to make what has been termed a "fire syringe." It was slightly different however as the air was compressed through a small aperture to heat things up. But the regular firepiston was also well known.

What killed the firepiston in England and Europe? It would seem that just as it was ready to take the market by a storm, the invention of the wooden kitchen match stole its thunder and relegated it to attics and museums.

Primitive re-enactors and firepistons

During a conversation with Bob Perkins of BPS Engineering, we discussed the plausibility of primitive re-enactors employing firepistons for demonstration and general use at rendevoux. The point was made that in 1807 a patent was given for a firepiston in England. Also, as previously discussed, its use was well known in England and Europe. Magazine articles of the early 1800's also described how to
make them. It is not far fetched to think that immigrants from Europe, or someone who had visited there, could have brought the technology or the device to America. It seems to me that those re-enacting the period of the early 1800's should be able to use firepistons since the technology was available to the people of that time. Whether one used the brass models or those of wood or bone would have to be researched so as to insure that they would be in keeping with the era.

Making the Firepiston

One thing I have to mention right from the start is that almost every source I contacted or read described how much care is necessary in making a working firepiston. Also, it is said that there's some technique to working it. John Rowlands warns that "it takes patience and practice and not to be disappointed if your first firepiston doesn't work." Other sources also speak of the need for practice. On the other hand there are those who say that if care is taken in the manufacture, and easily ignited tinder is used, it shouldn't be a problem. With that said, lets look at a couple of sources that tell how to make firepistons.

The John Rowlands Firepiston

The book Cache Lake Country by John J. Rowlands (1947) was the first place I found written reference to firepistons after hearing of them from my father. He had a copy of the book but I later found a copy for myself through a used book service. This book is a tremendous store of woodcraft and outdoor knowledge written by a man who spent a lifetime in the unspoiled beauty of the Canadian wilderness.

John made the tube for his firepiston out of a short piece of quarter-inch brass pipe. He said the secret of making it was to have a small, smooth bore with one end closed. Then there must be what he calls "packing" on one end of the piston. This must mean what we've been referring to as the "gasket." He hollowed out the end of the plunger to a depth of no more than one-eighth of an inch and that's where the tinder was inserted. His plunger was made out of a large nail with the end cut off square. He then put a groove around the circumference of the nail as close to the end as possible which served as a place for winding on the thread for the gasket. He made sure the body of the nail was very smooth and then he greased the gasket with the bacon fat and candle wax mixture we discussed earlier. A wooden handle was fastened to the other end of the piston for a grip. I suppose one could either solder the end in the tube or make a threaded plug for it, taking care to adhere to the dimensions specified in the drawing.

John indicated that the speed and force of the thrust had a lot to do with making it work right. He suggested putting the end against a tree or wall and then giving the handle a quick shove. He used charred cotton rag or finely shredded bark and stressed that they must be absolutely dry.
A Traditional Firepiston

Here's a drawing for a traditional wooden firepiston. The cylinder is 4" to 6" long and 3/4" to 1" in diameter. Make the inside diameter around 1/2". Follow the drawing for making the piston. The walls of the bore must be perfectly straight and polished smooth.