On making and maintaining a wood fire

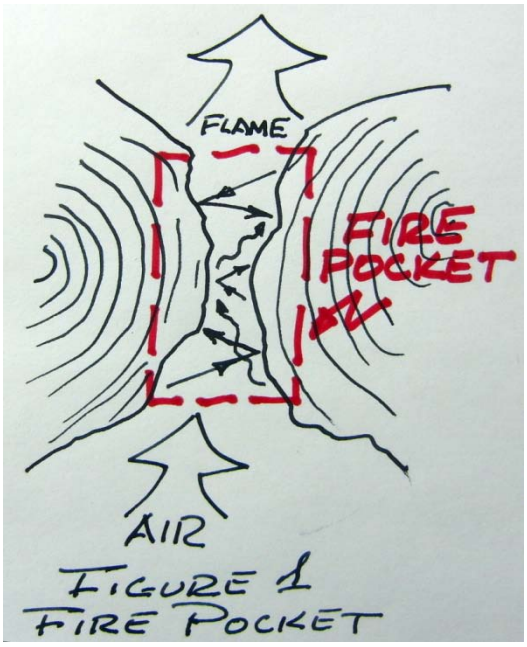
George Rebane – 4 January 2012

A well made and maintained fire in the fireplace, fire pit, or just on open ground provides the joys of accomplishment and hours of comfort. I have more than a half century under my belt of building, and more importantly, studying such fires - what makes them 'go', and why do so many people have problems with wood fires. Having been a camper since my teens and lived on acreage that provided abundant firewood for the last thirty-five years, I have accumulated my share of mistakes and fruitful experience from about 200 fires a year during that period. In this little piece I will share what I have learned and practiced.

Technically, fire is nothing but a form of rapid oxidation, the analog of rusting if you will. Fundamentally, fire needs a fuel that will oxidize (break down in a way that part of it will combine with oxygen), and a supply of oxygen to support that chemical reaction. The chemical reaction itself is usually started by an outside source of heat (we won't discuss 'spontaneous combustion'), and kept going by the ongoing heat produced from the subsequent combustion process (the chemical reaction of fuel continuing to combine with oxygen).

We should also understand the concept of kindling temperature for a fuel such as wood. A non-technical definition has kindling temperature as the lowest temperature at which a fuel can burst into flame. For wood it is about 540F. (Actually, wood burning is a complex three stage process with the first two stages involving the burning of gases stored in the wood. The secondary stage requires the maintenance of about 1100F *in the wood* to keep the gases burning, and provides the most heat release from the fire. The third stage burns the carbon in the cellulose and lignin molecules, the solid stuff, and creates charcoal in the process. This releases heat at the lowest rate and burns for the longest time. More on this later.)

The Fire Pocket. The first thing to know about starting a fire is the notion of a 'fire pocket' (Figure 1). Without a working fire pocket (FP), very few pieces of wood will burn for very long (due to something called thermal conductivity). First, a fire pocket is a space or gap between two pieces of wood that is voluminous enough to draw in sufficient air (oxygen) from below, while allowing the flame (the burning gases) to escape upward. It is critical that the gap be such that this vertical flow is kept going. The second function of a fire pocket is the self-sustaining (autonomous) feedback of heat energy between the two pieces of fuel (wood) that form the FP. At its narrowest dimension a good fire pocket (FP) gap measures about 0.5", and the FP begins to lose function rapidly when the gap gets larger than about 1.5". If required for proper spacing, inserting a wood chip or a small stone for a spacer between logs is perfectly



legal.

More needs to be said about the FP feedback process. Each contributing piece of wood in a FP emits heat energy across its gap to the opposite piece. The heat energy so transmitted is in the form of radiation (straight arrows) and convection (wiggly arrows). And therein lies the secret of a successful fire, its construction creates at least one (more is possible) functional FP such that once one of the wood pieces starts burning, its heat energy is not instantly lost to the environment, but goes to help ignite/sustain its FP neighbor across the gap. In this way you can now see the FP's virtuous feedback cycle operates, bouncing increasing levels of heat back and forth across the gap. When this feedback starts, it is surprising how quickly the fire spreads in the FP gap, and soon you have a roaring fire.

With properly constructed FPs very little or no kindling beyond a bunched up handful of newspaper is required to get a hot fire going in literally less than two minutes. In fireplaces and fire pits I never use anything besides a little newspaper, although some smaller/thinner pieces of wood will help if you're outside, the wood is damp, and/or there's a wind. More about that later.

Fire Stages. I think of a fire as a three stage process. Stage one (S1) is the interval from striking the match to when the feedback kicks off in the first FP. This is the only exciting and tenuous stage in working a fire that you should experience; it is all easy stuff after that. During this stage it is proper to cover the control of the flow through the FP's gap. With too large of a gap, the gases (air in, flame out) will tend to flow too fast. This does not allow the convection part of the feedback to work properly; you want the hot burning gases to hang around in the FP as long as possible, contributing to heating up the opposite piece of wood and helping it to burn, and, of course, also pumping up the radiation feedback across the gap.

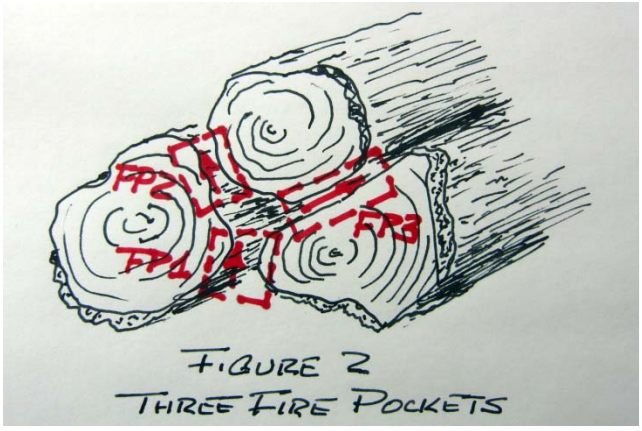


FIGURE 2
THREE FIRE POCKETS

The easiest way to do this is to put something on top of the FP to slow down the flow, but not cut it off too much. Another piece of wood will serve nicely, and in the process create two more FPs (Figure 2). However, in a pinch you can use one or more flattish rocks in a campfire situation, or special way to construct a campfire based on the FP concept that I'll describe below. You can also use tin cans laid on top of the FP to slow the flow and get the feedback started – get creative with what's available.

Stage two (S2) is from the end of S1 until an ample bed of red hot coals has formed under the flaming wood. Once this has happened, most of the wood is already at kindling temperature or above, and FP maintenance becomes secondary. But the main job of the fire tender during S2 is to make sure that at least one FP is fully functional at all times and forms the heart of the fire. This usually requires either pushing the burned/burning pieces of wood closer together, or pulling them apart sufficiently to reestablish the gap.

In Stage three (S3) you have an ample bed of coals, an established thermal mass pumping heat, and you can now throw new fuel on the fire (almost) willy nilly. The structure of the fire is no longer important. No matter how it stacks, anything you throw in there will now burn. You, of course, will start your fire with the driest and most flammable wood you have. But once you get to S3, you can start feeding in the more moist or wetter wood in your fuel pile. Always use the least dry stuff you can for S1, and start enlarging the fire with wetter wood even during S2. These stages are summarized in Figure 3.

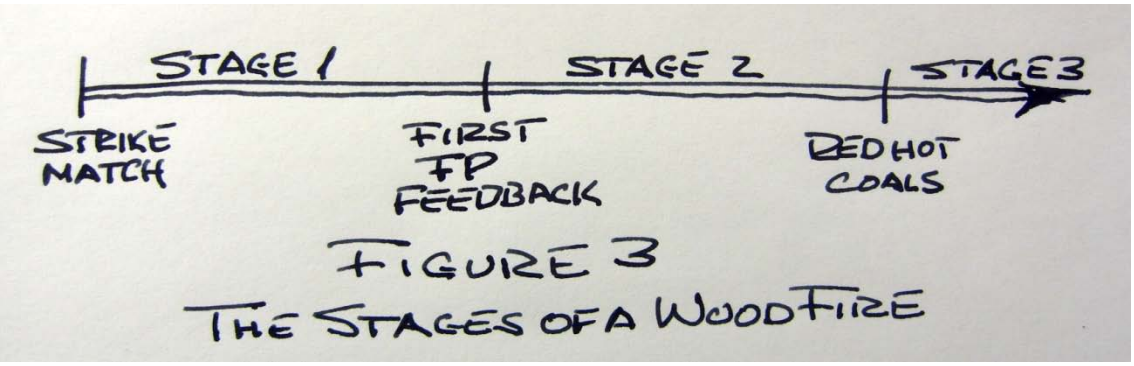


FIGURE 3
THE STAGES OF A WOODFIRE

Hint: Never discard a charred partially burned piece of wood from the previous fire. Placed between two pieces of new fuel, it forms the two best fire pockets available for your next fire since it is made up of unburned wood coated by readily ignitable charcoal.

Fireplace grates. The standard fireplace grates sold in stores are totally dysfunctional for holding wood for good long-burning fires. The reason is that their steel crossbars that hold the wood are placed way too far apart to support rapid development of the glowing base of coals that happens in S2. Any coals that form and calve off the logs fall through the grate to the floor of the fireplace which is too far down to sufficiently heat the logs burning on the grate. Their contribution (feedback) is greatly diminished or lost altogether for supporting the progress of the fire.

However, it is easy to modify a store bought grate into a first class fire platform that optimally supports a fire through all three stages. All you need is to buy a small piece of steel fencing fabric that has openings either 0.5” by 0.5” or 0.5” by 1.0”. Cut it so it slightly overlaps the dimension of the grate, place it on the grate and push it down so to conform to the contours of the grate, and wire it into place at four corners. Now you have a beautiful grate that will form a glowing base of oxygen fed coals right at the fuel level. Those coals will build a heat mass that will ignite anything that you place on them. After several years the wire webbing will wear out as its wires break and the holes become larg-

er. Just replace it with a new piece of fabric and you're good to go for another four years or so. The photo shows one of our current grates with the described modification.

Heat Mass. I mentioned 'heat mass' in the above paragraph. In a fire, a heat mass or thermal mass is a copious source of heat energy that comes from a good base of coals or vigorously burning pieces of wood. When adding new fuel, place the piece(s) on or next to active heat masses to keep the fire going strong. Sometimes you may have to move some burning fuel to expose a heat mass against which new wood can be placed.

With the notion of heat mass in mind, we can discuss the role of 'anchor fuel' in a fire. **Anchor fuel** is a large but slow burning piece of wood that is best placed at the rear of the fire nearest the back of the fireplace (or a backstop large rock in case of a campfire). It can serve as the constant heat mass that will make the fire more impervious to extended neglect and/or external shocks - logs falling apart as their support burns away, gusts of wind, inadvertent poking to ruin the fire's structure, … . In older parlance the 'yule log' was such a large piece of anchor wood that burned slowly in the rear and against which smaller pieces of wood were placed to burn away more rapidly as the hours went by.

After you watch a few tens of fires start, develop, and mature, it becomes clear that different kinds of woods have different burning characteristics. The enthusiasm with which they ignite and then burn varies. The experienced fire maker also notices that certain woods – e.g. oak – tend to have a good initial 'surface burn' which then often dies down to a smolder if it is not kept as part of a fire pocket. This has to do with the thermal conductance of the wood, or how fast the inside of the wood heats up as the outside is burning.

Thermal conductance is a function of the density of the wood and the chemical make-up of the gases it contains and releases as it heats. The thermal conductance of wood changes over its curing time. As firewood ages, it becomes less dense and loses or effervesces many of its flammable gases – in short, it loses its capacity as a heat producing fuel. Hardwoods are generally the good dense woods, and are best when cured at least nine months and not more than two or three years.

Firewood myths. Every region has its own stories of which kinds of woods burn well and which don't and which ones to definitely avoid. My own experience is with California fire woods, both southern and northern. Living in the southern California mountains we burned a lot of eucalyptus, and the various chapparal that covered most of the wild terrain. Added to that were live oaks, California and Brazilian pepper trees, Monterey pines, and Aleppo pines which liked the warmer winters there. Cured euks were of lowest density and burned most enthusiastically. Both pepper woods and the oak were the most dense and made good anchor logs. The pine woods were of medium density and burned much like the pines and firs here in northern California.

The myth in southern California was that the euks were scrap wood and not worth burning. On the contrary, euks burned well in outside fire pits (where we barbecued all kinds of meat on its coals) and in fireplaces. It was sad to see a lot of eucalyptus trees hauled away to dumps after being cut down when their work as citrus orchard windbreaks were done.

Here in northern California stories are heard from many a quarter that digger pine and madrones are no good for firewood. Madrones are supposed to burn "too hot" and no one has made it clear to me why digger pines are refused for fires. I had a chance to test both myths with diggers and madrones cut down from our property. Both trees make extraordinarily good fires. Cured madrone ignites easily and burns with a tenacious flame, it is especially good as a starting center piece when surrounded by oak and/or other woods that are not completely dry.

Digger pine firewood is refused by elder homes and other charitable residences who gladly take almost every other firewood (perhaps excepting madrone). However, my experience with cured digger has been nothing but gratifying. It's a medium to low density wood that starts well and burns well. Again, it's good for providing a rapidly developed heat mass unto which you can add wetter logs just brought in from winter weather.

Campfires. Here is a neat campfire structure that is strong and remarkably wind resistant. It may be documented elsewhere, but for myself I discovered it as a very practical, minimum fuel build for a campfire about thirty years ago. Its main structure consists of three pieces of wood laid side by side and propped up at one end by a fourth piece (Figure 4). An appropriately shaped rock or even a low berm of dirt can substitute for the fourth piece of wood. The center piece of the three is lifted at its propped up end, and then the ends of the two remaining pieces are slid together under the lifted end of the center piece to form a triangle of logs. In this manner at least two fire pockets are created between the three pieces forming the triangle with room underneath for a pile of kindling or bunched newspaper.

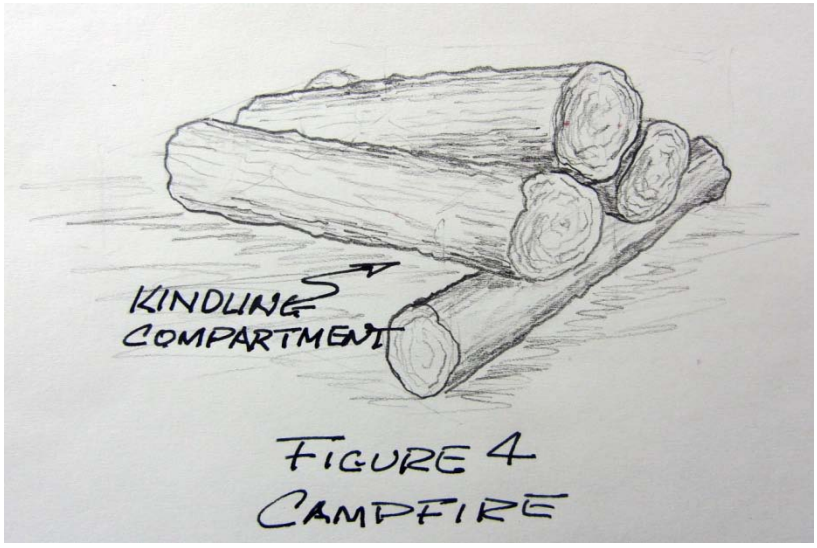


FIGURE 4
CAMPFIRE

On open ground, orient the pieces of wood in the direction of the prevailing wind/breeze. For more shelter you can build little berms on both sides of the three pieces. All the elements for a good fire, described above, are now in place. The open and sheltered 'kindling space' below the three pieces remains available during S1 to add more twigs or other fire starters until the fire is securely in S2. Note that the ground is close to the propped logs to form the platform for the developing functional coal bed during S2. More wood can always be added during S2 in a pyramidal form or just cross pieces to create more FPs, and before you know it, you are in S3, and

are ready for a good evening of secure warmth around a blazing fire you can enlarge to any desired size. If firewood is plentiful and diverse, choose your best anchor log to serve as the fourth piece onto which the three pieces are propped into their triangle configuration.

Now go try it yourself, and enjoy a nice cozy, warm fire.

