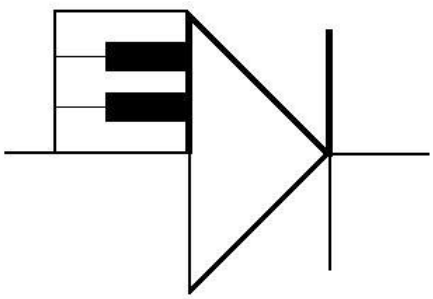


ELECTRONOTES

WEBNOTE 22 1/6/2015

ENWN-22

SAFETY FIRST (OR AT LEAST EVENTUALLY)

DON'T OVERLOAD YOUR ELECTRICAL OUTLETS!

My high-school music teacher looked up sheepishly from his task of plugging in a daisy-chain of music stand lights. These were all low wattage lights used to illuminate the music on the stands for the musicians in the "Dance Band" which otherwise performed in relatively low light levels. [He was setting all this up himself. It was years later that I learned (teaching labs) that this was really easier than trying to get the students to do it!] "I am probably overloading the outlet," he apologized. This was not a surprising conjecture – it was just wrong. At that time TV stations had fascinating PSA's virtually shouting "Don't Overload Your Electrical Outlets" showing a double outlet with two cube taps with a total of 6 plugs. I assured him that while he had a lot of lights (probably 20) in the chain it all amounted to just a few hundred watts. I think he kind of understood that intuitively already.

[I read somewhere that students tend to have a general high affection for their music teachers and their art teachers. This was certainly true in my experience in high school and college. I had a lot of good instructors, but my high school band director and my college music professor in a "liberal elective" were right at the top of my list of people who I gained from immensely.]

So a lot of plugs is not necessarily a hazard except as the wires themselves in their profusion could fray, or just trip someone. It's about amps or watts. It would seem that you should be able to plug any one appliance (a lamp, a vacuum cleaner, a computer, or an electric heater) into any outlet if you don't use cube-taps and/or multiple output extension cords. But clearly you could overload any particular "circuit". Of course you can blow a fuse or pop a circuit breaker. Most outlets as installed in wall boxes come in

units of 2 or 4 sockets. But of course, “behind the wall” there might be several or many possible sockets. These circuits, for which there is usually a dedicated “circuit breaker” in the service box, are rated at 15 amps at 120 volts in the US. That’s nominally 1800 watts. You can pop the breaker by just two appliances that normally would be fine separately. Most often this occurs in the kitchen – perhaps a microwave and a rice-cooker on the same circuit. It happens, and if it is annoying enough, we run an additional line from an additional breaker.

It is a bit amusing to see how people misunderstand the physics of everyday life. There is a totally uninformed notion among a few people that “all plugs are equal”. Thus we find people extolling the virtue of electric automobiles as though recharging the vehicle is equivalent to leaving a lamp on. It’s like the person who gives a bad review to a computer printer because the “ink cartridges only lasted a month”! And people who have purchased an electric heater and complain either that it did not heat their whole house and/or that their electric bill went way up. All readers of the notes here cringe at these sort of postings.

So here is something I find interesting. Can you get into any difficulty if you just have one high wattage appliance plugged into a branch circuit? Like an electric heater. I have several scattered about to turn on, to take out chills, as occasions warrants. They are labeled at 1500 watts, and that seems about right. I could make a 1500 watt heater by hooking up about 15 100 watt incandescent bulbs in parallel, and the blast of heat from them would be about what I get from the electric heaters. The current should be 1500/120 = 12.5 amps, so the breaker should not pop by the heater alone, and it doesn’t. The interesting thing is what I sometimes find when I unplug the heater to move it - - - the plug is sometimes warm. Not really hot – but warm. Clearly there must be some resistance in the contacts.

How much resistance? I don’t know if I could measure it – perhaps if I could get a millivolt reading across the contacts. But we can estimate it. I can compare the heat of the plug with the heat of a night-light bulb, and I happen to know how warm this is because we sometimes use such a “heater” when incubating a batch of yogurt. I would guess the plug heat is half that of the 4 watt bulb, so 2 watts. Since we know the current is about 12.5 amps, $R=2/(12.5^2) = 0.0128$ ohms (and the IR drop across the contact resistance would be 12.5*0.0128 or 160 millivolts). Roughly the resistance I get from about 5 feet of a perfectly connected 14 gauge copper wire. We don’t notice the heat distributed over 5 feet. Ballpark numbers at best. Understood, but everything else equal, I would just as soon the plug didn’t get warm at all. But it’s not a surprise when associated with an electric heater or a vacuum cleaner (a plug widely abused).

So I was surprised when my hand brushed against a warm plug as I reached to turn off a light switch. In fact, I was not that aware that the plug was even there. It was part

of the wiring of one of my workbenches. It plugged in the bench which had extensive power strips (a Cornell discard – great benches). I plugged it in perhaps 15 years ago, and never gave it another thought. It was warm, of course, because I had plugged in a heater into the power strip.

But I wondered what would happen if I cut out all the loads and just "exercised" the plug by inserting and removing it a dozen times or so. I was guessing that it might scrape off any oxide layers, going back to near zero ohms. I did this, and in fact, the plug remained cool thereafter. Perhaps it does take a long period of time to develop the resistive layer. Like a penny? Makes sense. The lesson, exercise the plugs from time to time.

One could preemptively polish off the tarnish. It is clear how sand-paper or an emery board can do this job – for a plug. What about the socket? Well I have not tried either the plug or the socket indoors. Just exercising the two together seems adequate.

Outdoors is another matter. We are never surprised when an outdoor circuit and/or extension cord in poor repair (is there any other kind!) causes problems. And GFI's do their thing - as they should! But garage-stored equipment is subject to moisture and grime. (I have even had a mud-wasp use the ground hole of a socket as a place to hatch an egg.) What works just dandy for restoring the socket end is the afore-mentioned double-sided emery board. You cut it half width lengthwise and scrub the slots (yes you do unplug them first).

PYROLYSIS

Electricity is a hazard that can result in electrical shock or fire. We know of both as being dangers and (like the PSA on overloading) we are warned from early age. Who warns us about "Pyrolysis"? If you have never heard of it – welcome to the proverbial club.

Here is where I heard about it – in an email:

"Pyrolysis is the process by which the ignition temperature of wood changes. When wood (framing, studs, etc.) is kept 2" away from the pipe, heat has a chance to dissipate and causes no issues. When some of that air is removed and wood is put much closer to the heat....it will eventually go through some unfortunate changes. These changes are known as pyrolysis and can eventually cause the temperature at which wood will catch fire to become lower and lower. So, instead of needing 600F or more for wood to ignite, long term exposure to heat can lower that temperature to 250F or less!"

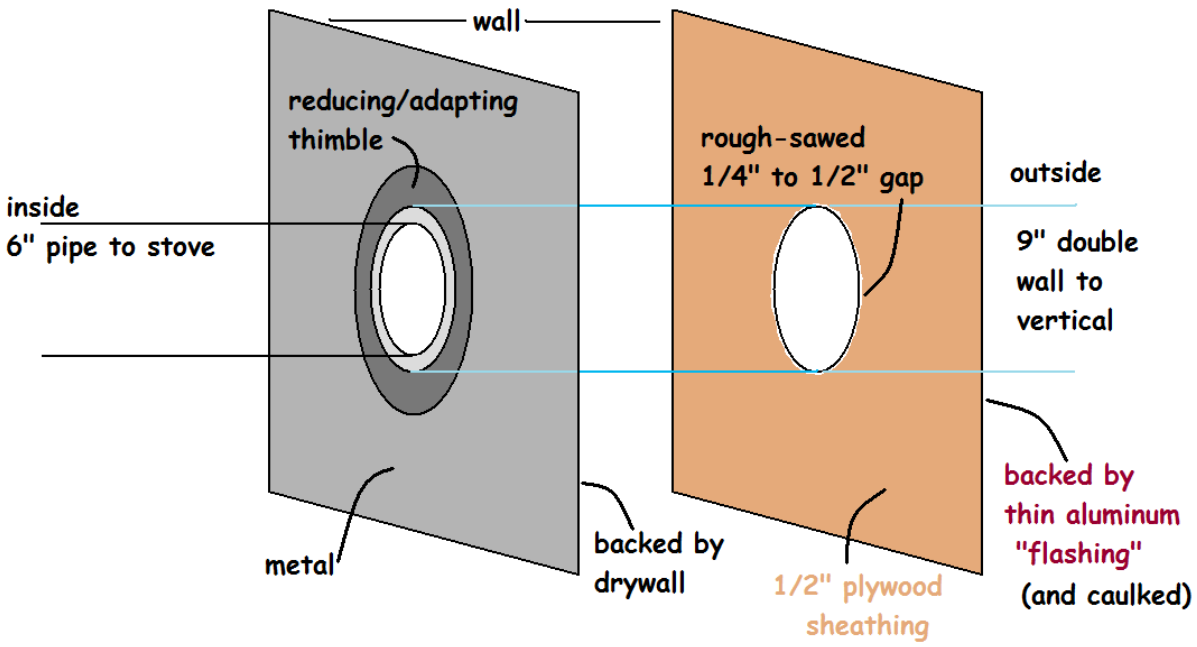
If this description does not make your hair stand on end – it should. I got this email several years back, and can just barely tolerate seeing it again. It came from a lady who

is apparently an engineer for a manufacturer of layered metal chimneys, and was admirably and authoritatively offered. It was in response to a detailed technical description I had sent the company, and this perhaps prompted the detailed response, or perhaps this is just an outstanding company already (maker of Metalbestos).

Now, perhaps obviously, this response had a disquieting prologue. We had a little fire. Note that the difference between a little fire and a big one is largely a matter of time. Thinking about this after the fact, I recognize that there are three important things about a small fire. (1) It should be extinguished quickly and definitively and to the extent that these two adverbs apply, the second point is (2) that you did not need to call the fire department (we had likely dialed at least the 9-1 of 9-1-1) or caused a similar commotion. Now, (1) and (2) being true, the third important thing (3) is that it was NOT your fault and you have someone to get really mad at.

In our case, this was a wood-stove chimney installed 15 years prior when our house was built. The builder/installer disappeared shortly thereafter. This was installed improperly and I can't think of a proper word to describe this improper installation. "Careless" almost applies in the sense of not-caring, but not really in a sense of being merely insouciant. "Criminal" gets more to the essence. Keep in mind that no wood was supposed to be closer than 2" from the pipe.

The figure below shows a not-to-scale sketch of how the chimney pipe was installed with a horizontal section going through the wall to the vertical section outside. The wall had already been constructed. The components were a 6" single wall stovepipe from the



woodstove to the “thimble” (an adapter/reducer) and a section of 9” double-wall pipe running outside to the 90° cleanout/vertical adapter. The inside wall was standard drywall and the outside wall was 1/2” plywood sheathing (generally covered with vinyl siding). Not shown are 2x6 studs and some wooden strips to which the “thimble was attached with screws through the drywall. This wood was well back more than 2”.

Now you would expect a second thimble (or the second section of the assembly) to have been configured about the outside plywood wall. Apparently the installer did not have the second metal thimble. Instead he cut about a 10” hole through the existing plywood. Effectively, he made a “flange” out of plywood! To the extent that the 9” pipe was not exactly centered, the gap between the outside pipe wall and the plywood was less than 1/2”. So much for the fundamental errors of not using the correct metal flanging, and of getting wood too close.

So inside, it all looked proper. Outside the pipe sticking through the hole in the plywood sheathing just would not do! What the installer did was to take some aluminum “flashing” metal (very thin aluminum sheeting – you can tear it by hand once you get started – you can figure out how I know this) and cut a nice round hole slightly bigger than 9” in it. This he fit over the 9” pipe, covering up the rough plywood hole, and caulked the seam. Then typical vinyl siding edges were fit to about an 18” square. Looked like a metal plate. Let’s be the most charitable and assume that the installer was interested in a weather-tight cover. In any event, he in effect “covered up” his failure to get the right parts. This was just one of the workers the builder had hired by the way. I don’t know if he had ever done a chimney installation before.

So, all went well for many years. But I envision the plywood with its ignition point dropping from 600°F to 250°F as years went by. How hot is 250°F? Well my coffee cup comes out of the microwave at 212°F. Too hot to touch. Did the outside wall of the double pipe ever get to 250°F? I would touch it from time to time, and it was sometimes too hot to touch for very long. But the inside stove and inside pipe was much hotter – that’s kind of the point of a wood heater.

We don’t know when the fire started. The fire in the stove was not especially hot when it happened (when we discovered it). I strongly suspect it had been slowly smoldering from the day before (or longer) – the wall was very tight.

Lessons: (1) You can’t make a metal flange from plywood and cover it with thin metal. (2) Pyrolysis. (3) Don’t trust your installer.

Things were reassembled. There is no longer plywood sheathing on the outside of the wall. Instead it is a 4’x8’x1/2” sheet of cement board. The pipe goes through a hole in this board, and is covered outside with a metal flange. Inside the wall, the pipe sees no wood at all, unless it can see through a double layer of cement board. Exceptionally safe.

So is all well? Nope. We are not healed “psychologically”. Even though it’s been over two years, we can’t be comfortable with that woodstove running! We are much more cautious and refrained, and the stove is less useful. Even though the chimney is better than new, fixed from head to toe, it betrayed us once, in the manner of a “ticking time bomb”. Philosophically, we don’t really need additional reminders that we are surrounded by (in fact, we ourselves are!) ticking time bombs.

Cheers!