Safety Power Breaker For The Test Bench

Avoid a shocking experience.

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When setting up a test and service bench, safety often gets short shrift. Most of our equipment, both test and working, operates from potentially lethal 117-VAC. To coin a cliche, "familiarity breeds contempt." Even neglecting the hazard to life or limb, the only way to limit further damage to equipment in a memorable minority of failures is to remove all power from the circuit RIGHT NOW. Yet, many service benches are cat's cradles of power and signal connections with a maze of switches and controls—certainly not conducive to fast, effective emergency action when something unpleasant starts.

The Big Three

The most important attack on this problem is forethought. As in defensive driving, you must tinker defensively. Observe the following three rules:

1) Set up hypothetical danger situations and come up with responses to them ahead of time. "What do I really need to do fast if something happens?"

2) Know who plugs into what in a specific test setup, and how both AC and DC are fed to the various units involved.

3) Know the location of the "most definitive" OFF switch; how to reach it; and, ensure a clear path to it. Check this often, particularly when working with new, partially defective, or questionable equipment.

The Added Edge

This thinking is more valuable than any hardware, but there is a hardware device to help—a safety-wired 117-VAC relay or "contactor" whose coil is powered from its load side with several normally-closed (NC) "panic" switches in series (see figure). With this configuration, opening any one (or more) of the panic switches, even just momentarily, will turn off the current solidly, and you have to intentionally reset the system to restore power. (Of course, this will not disable such sources as batteries or big capacitors on the bench...)

To get the benefit from this device, be sure that it is the sole power source for all equipment on the bench, especially for any dubious units you are working on. You don't want it to serve any room lighting. All you need is to have something exciting happening with, perhaps, a small fire starting, and then find yourself in total darkness!

The panic switches can be any normally closed types, either momentary or sustained (I prefer momentary so I don't have to check them to reset), rated for 117 VAC at the coil current. Suitable examples are some nice big red-button industrial ones that sometimes show up on old equipment in junk yards.

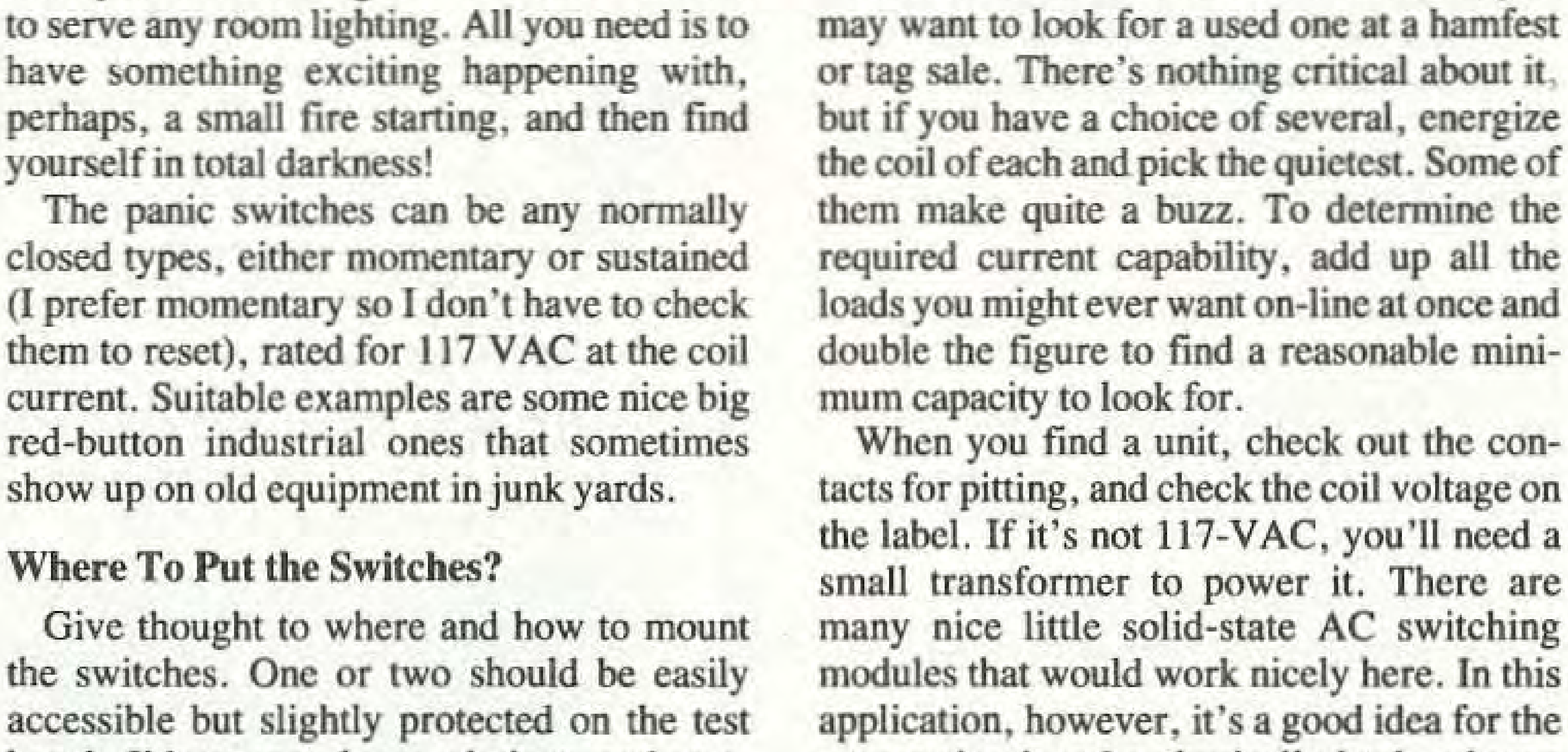
Where To Put the Switches?

Give thought to where and how to mount the switches. One or two should be easily accessible but slightly protected on the test bench. I'd put one—large, obvious, and completely unprotected—just inside each door to the room. It's also possible to have a switch on a hinged pipe "kick bar" along the length of the bench. Don't forget to explain the system to family, co-workers, or technical guests, so they can activate it if they witness a problem while you have your hands full of probes. The reset switch, on the other hand, can be in an obscure place, perhaps on the relay box, and well protected.

Because of the cost of new contactors, you may want to look for a used one at a hamfest or tag sale. There's nothing critical about it, but if you have a choice of several, energize the coil of each and pick the quietest. Some of them make quite a buzz. To determine the required current capability, add up all the loads you might ever want on-line at once and double the figure to find a reasonable minimum capacity to look for.

When you find a unit, check out the contacts for pitting, and check the coil voltage on the label. If it's not 117-VAC, you'll need a small transformer to power it. There are many nice little solid-state AC switching modules that would work nicely here. In this application, however, it's a good idea for the power circuit to be physically broken by an air gap.

Both for safety and to conform with the National Electrical Code, mount the relay in a sturdy metal box (called a "NEMA" box), available from your local electrical supply outlet. The input power can be taken from



The safety-wired 117-VAC relay or "contactor." Opening any one (or more) of the panic switches, even just momentarily, turns off the current.

any unswitched 117-VAC outlet (or hardwired) and goes only to the the relay input contacts and the reset switch. Connections from the relay output contacts fan out to the protected outlet boxes and other equipment, as well as back to power the relay coil.

In doing this wiring, preserve the color code (black and white) through the relay contacts. In other words, when the relay is closed, make sure that the black wire going in connects to the black wire (and not the white) coming out. The ground wire (either bare copper or green insulation and connecting to the round ground pin on the power plugs) is never opened by the relay. It connects solidly to the relay box as well as to the ground connections to the outlet boxes.

There are several other enhancements you can provide for your power distribution system. The cheapest and simplest would be three GE Metal Oxide Varistors, MOVs, that will peak-limit damaging high-voltage transient spikes on your household power line. The next enhancement would be line filtering—reducing some of the high-frequency (but lower voltage) garbage on the line.

Another safety enhancement would be a ground fault interrupter (GFI) that would disconnect the power if it found current returning through the green or bare ground wire. The last enhancement is to fuse- or circuit breaker-protect, according to the dictates of your conscience. Fuse and breaker protecting is another whole subject, but there's a small tip I'd like to insert here: Most of the breakers available from local electrical suppliers are thermal with large ampacities, intended to prevent fire in the household wiring. Electronic and surplus sources are apt to have magnetic breakers (faster acting) in smaller ampacities. I devote an individual fuse or breaker to each major piece of equipment that normally resides on my test bench.

Unless I don't want the unexpected shutdown of a piece of equipment, I'll fuse- or breaker-protect it at about 110% of its current rating, rather than the more customary 150 to 200%. That way, in the event of a problem in the protected equipment, the fuse or breaker will pop as a warning before the smoke starts, and there may be less secondary damage.

The "self-fed" contactor scheme outlined here has one additional benefit: Most modern electric power distribution systems (electric companies) use "reclosers." These are sophisticated circuit breakers that, on experiencing an overload and opening, automatically "try again" several times, reapplying power to see if the fault might have cleared. The problem with this for us is that the repeated switching of the electricity off and on can be stressful to many kinds of electro-mechanical devices. With the self-fed contactor, your equipment will not be subjected to the retry switching; it will go off on the first failure, and stay off until you reset the contactor.

Safety may not be an interesting or exciting topic as ham radio endeavors go, but along with increasing our ranks by selling ham radio to new converts, it pays to protect the hams we already have. 73