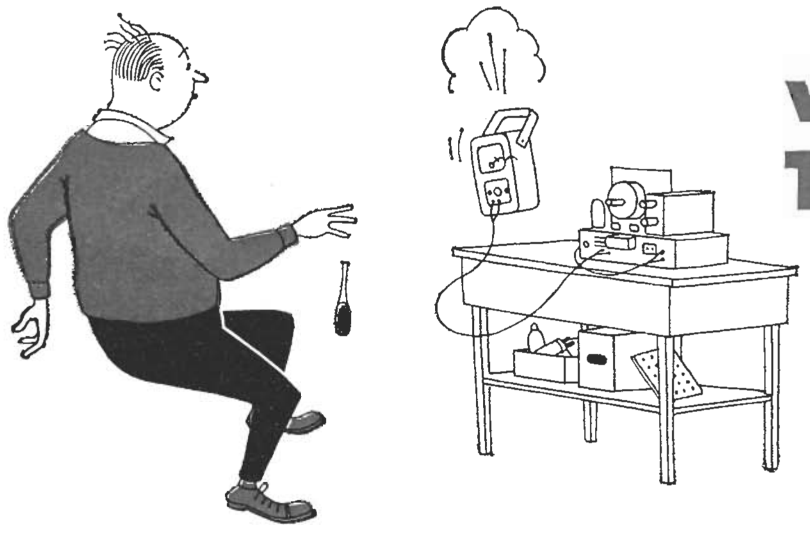

# watch out for TRANSIENTS

## They can put a sudden end to meters and rectifiers

By E. H. LEFTWICH*

FOR MANY YEARS, I WENT MERRILY about my work checking circuit voltages with a vom or vtvm. In every case, I connected one meter lead to ground or chassis and checked through the circuits, holding the other meter lead (insulated prod) in my hand. All went well.

Recently, I checked the high-voltage secondary of a 1,000-volt power transformer for no-load output. Because I was somewhat afraid of holding one lead in my hand, I connected both leads of my vtvm to the transformer secondary terminals, and set the meter range switch to 1,400-volt position (ac).

So, I plugged the transformer primary into the ac line—and jumped back! Lights in the shop went dim—like a dead short circuit—the meter needle flipped over and hit the post, and I heard a "sizzling" noise in the meter—all this in the fraction of a second it took to jerk the plug out of the ac line socket. I pulled the meter chassis out of the case and found that the range switch had arced across the 1,400-volt ac contacts, burning them off. The "burnout-proof" meter movement was fortunately not damaged.

Next, because I was "hard-headed" and unbelieving, I connected my vom the same way—to the high-voltage secondary terminals. I set the range switch for the 5,000-volt ac scale. I plugged in the transformer primary to the ac line as before—and as before, I jumped back. Again, the shop lights dimmed, fire flashed and smoke rose from the vom case. I snatched the plug from the ac line socket again. I removed the vom from its case and inspected the damage. The meter needle had struck the post so hard that it was bent over in the shape of a sawtooth wave. Coil turns on the lower meter-movement spring were welded together, and the range switch contacts in the 5,000-volt ac circuit were burned off. In addition, a resistor in the circuit had exploded and burned to a fine white powder!

I was now in a sorry position. Both my meters had blown and there was work to be done in the shop. I ordered replacement parts for the meters, but could not afford to wait for them to arrive. So, I bought a new, top quality vom and reasoned that later I could "work off" the repaired meters (at a ridiculously low price) to some associates.

Now, I was smart. I didn't know why the meters had blown—but I had learned the hard way. I wasn't taking any chances with the *new* meter! So, I dragged out a transformer with a rated secondary voltage of only 400. (Here, again, the instruction manual furnished with the new meter read CAUTION—ALWAYS CONNECT THE METER LEADS *FIRST* BEFORE TURNING ON THE POWER.) For this test, I again connected the test leads to the 400-volt secondary terminals of the transformer, and set the meter range switch to the 1,600-volt position (ac). "Surely," I reasoned, "there will be no trouble this time—with only 400 volts in the circuit." I was wrong! When I plugged the transformer primary into the ac line socket, the shop lights dimmed *slightly* (about the same as though a 1,000-watt electric heater had been connected) and the meter needle flopped gently against the post. Instantly, I pulled the plug out of the ac line socket, and this time the meter was not damaged.

Here, I had a transformer secondary rated at only 400 volts, yet the meter needle had pinned the post on the 1,600-volt scale. How was this possible? "Okay," you might say, "what about the peak voltage?" But, this would not explain the phenomenon because $1.77 \times 400 = 708$ peak volts, and this would not pin the meter needle to the post on the 1,600-volt scale. Conferences with a number of friends resulted in various theories, none of which appeared logical: "surge voltage"; "defective or incorrectly rated transformers"; "magnetic-field current buildup"; "*impossible*—could not happen; if meter range is 5,000-volts ac, then meter should take 1,000 volts ac without blowing."

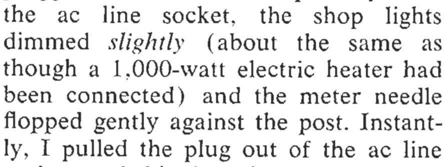


*Fig. 1—Simplified circuit represents the input primary of an unloaded transformer.*

Finally, with the assistance of an electronics design specialist I know, and reference to a comprehensive book on transformers† the phenomenon was explained. Briefly, a transformer, when not loaded, constitutes what is essentially a resonant-tuned circuit (Fig. 1).

Analysis of transient effects at an input of only 100 volts indicated a voltage as high as 22,600 volts rms at the secondary terminals of a transformer! Because of this, you must safeguard your test instruments. The following two rules will protect you and your test gear:

1. *Do not connect meter leads to a transformer before power is turned on unless the secondary is shunted by a reasonable load (5,000 to 50,000 ohms).*
2. *If you want to check the actual ac output of an unloaded transformer secondary, turn on the primary power FIRST, use the high-voltage test probe in one hand and put your free hand in your pocket.* (When primary power is turned on before the test leads are connected, no meter damage will result, assuming that the proper meter scale is used.)

These two simple rules apply principally to ac voltages, except for instantaneous make-and-break circuits where a battery is used. In ac power

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*Advanced design, Ryan Electronics, Ryan Aeronautical Co.

† Lee, Reuben, *Electronic Transformers and Circuits*, Wiley, 1947.