RE's Service Clinic

The VRT saturated transformer

A problem that became a solution

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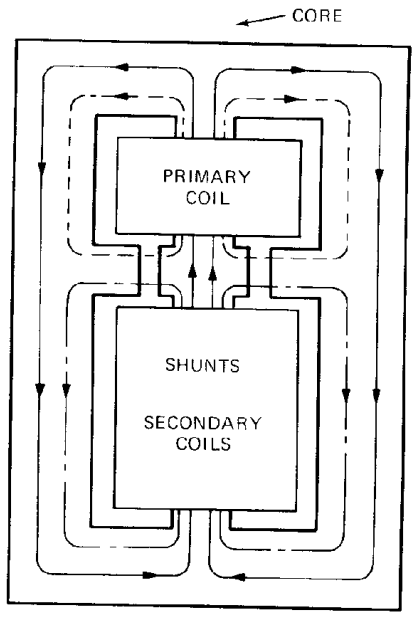
ALL KINDS OF INITIALS ARE FLOATING around today. One that will be important to us is VRT. Not VTR that's Video Tape Recorder; not crt that's Cathode Ray Tube. This one, VRT, means Voltage-Regulating Transformer. Zenith came out with it a couple years ago, and it is reported that their entire line from 17 inches on up will use it this year. Many other manufacturers are beginning to use it as well.

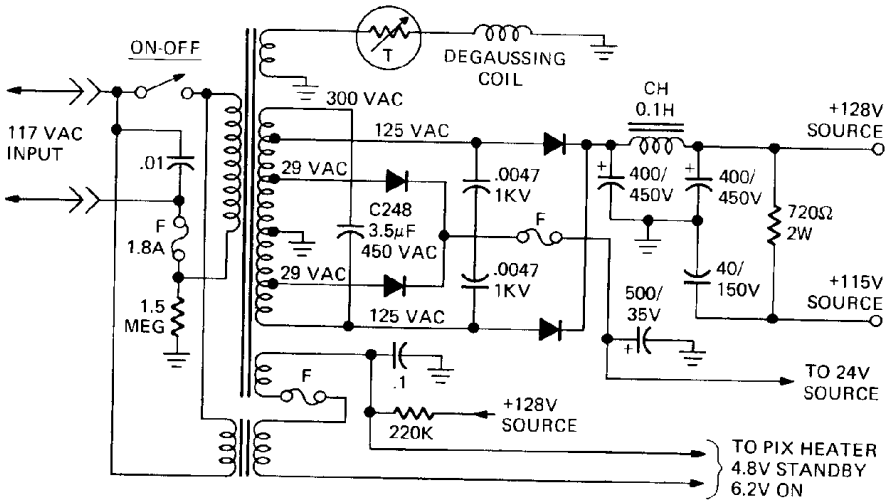
With the big swing to solid-state TV, added to the possibility of brownouts and severe line voltage fluctuations, tight and reliable voltage regulation became more important than ever. Transistors are well-known for their dislike of transients, too. Transistor voltage regulators have been extensively used in the past. However, these regulate only a few of the output voltages. The VRT regulates *all* secondary voltages, even the picture-tube heater. This should add to its life.

How it works

The operating principle of the VRT power supply is simple. The secondary of the transformer is tuned with series capacitor C248 in the diagram of the power supply used in Zenith's 25DC56 chassis. This is tuned to 60 Hz. The secondary is loosely coupled to the primary. In fact they're wound as separate windings on the core instead of the old method of overwinding the secondaries over the primary.



MAGNETIC COUPLING of the voltage regulating transformer is shown. The primary and secondary are wound on separate legs of the core.



ZENITH'S 25DC56 POWER SUPPLY using the voltage regulating transformer. Capacitor C248 tunes the secondary.

Now comes the kicker. With the secondary resonant, the voltage increases to the point where the transformer core *saturates*. With the core saturated, very little voltage increase is possible. You won't find much about this in the reference literature. I went through what is supposed to be *the* book on transformers, and all I found was about 25 pages of discussion dealing with ways of *preventing* core-saturation! So, what was a problem has now helped to find a solution.

This thing gives results that are amazing, to men used to dealing with "standard" power transformers. Normally,

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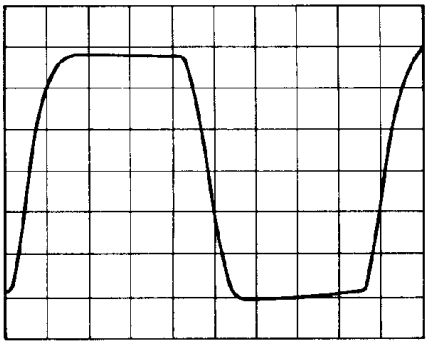
secondary voltage rises and falls in direct proportion to the applied primary voltage. The VRT can operate over a tremendous range of primary voltage. In actual tests, the secondary voltages stayed practically constant over a range from 70 to 145 volts ac on the primary.

Besides this, there's a fringe benefit. For example, if a 30-volt transient appears in the primary for a duration of *two seconds*, it will show up in the secondary as a spike of less than 15 volts, for only 100 *milliseconds*. This is due to the characteristics of the saturated core; when the spike hits, the core is delivering all of the energy it can, and any more just doesn't get through; it's clipped off.

This action can be likened to a pair of back-to-back Zener diodes. The peaks are clipped off, holding the peak values down. This brings us to one of the important differences between these and conventional transformers.



OUTPUT VOLTAGE WAVEFORM for the voltage regulating transformer.

For the most important one, we cannot read the secondary ac voltage *accurately* with our old peak-reading ac voltmeters. Despite the fact that they are calibrated in rms values, they read peak voltages. They're calibrated on a pure sinewave. The VRT's output voltage is almost a square wave. (If you want to make up a correction chart for the voltages you actually read on these, OK.) But there is an easier way. Just read the dc voltage outputs. If they're normal, fine. If they're not check for the stock power supply troubles; shorted diodes, open electrolytic capacitors, etc. Of course a scope with a calibrated vertical amplifier *will* show you the waveform and its exact peak-to-peak voltage, and you can get the voltage you need from that.

The loose coupling of the primary and secondary, together with the saturated core, help hold down high currents due to a short. The current will rise to only about twice the normal value, and the circuit-breaker will trip. The transformer won't be damaged.

The VRT will run slightly hotter than the old transformers. This is caused by the core-saturation. It should not smoke, of course. Just a little too hot to hold your hand on. The original versions (made by Zenith for themselves) used round copper wire. They're planning new versions using flat aluminum ribbon wind-

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ings. This will not only reduce the weight of the transformer but keep it cooler. The inner windings, always the hottest spot, will run cooler.

The first VRT's were used in Zenith chassis such as the 25DC56. A small auxiliary power transformer was connected with its primary in series with the VRT primary; it served merely to keep the picture tube heater warm. The on-off switch shorted the primary of the I-O transformer, and applied full voltage to the VRT. Later versions won't use this instant-on arrangement.

There are a few unusual faults possible here, of course. For one, if the switch is off but you still hear a loud buzz from the speaker, the primary of the instant-on transformer could be shorted. The VRT will be energized, and dc voltages present, but the picture tube won't light.

Another "unlikely but possible" problem is, if *all* of the dc voltages, and the picture-tube heater voltage are about 20% low. Check the resonating capacitor in the VRT secondary. It could be open. This is a special 3.5-μF unit, oil-filled. It must be replaced with an exact duplicate or the VRT won't work as it should.

If you want to be sure that the set you're working on does have a VRT, check for the presence of the reasonating capacitor in the secondary. In the Zenith version, at least, if there isn't one, then it's not a VRT. **R-E**