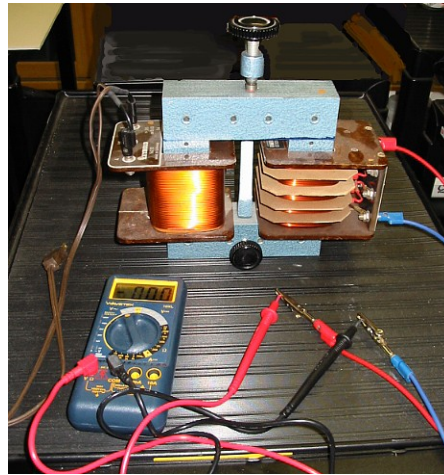


## The Transformer



**The Transformer**

**Purpose:** Demonstrates the transformation of electrical potential via mutual inductance.

With an AC voltmeter, one can directly demonstrate the concepts involved in this ubiquitous device.

If all of the flux generated by the primary coil (of  $N_p$  turns) is captured by the secondary ( $N_s$  turns), the induced voltage across the secondary coil is

$$V_s = (N_s / N_p) V_p.$$

This transformer is essentially ideal:  $N_p = 250$  and  $N_s = 46$ , and I measured  $V_p = 122.0$  V (rms) so you would expect  $V_s = 22.45$  V. The measured value was 22.5 V! By removing the top crossbar, to make it less than ideal, the secondary voltage drops to 5.8 V.

The secondary coil is also tapped at various points, so that one can show how to extract different voltages by splitting the secondary up into 'subcoils.'

Watch out for the exposed house current at the primary connection. You can use a Variac to supply a lower input voltage. With the Variac, you can also use the secondary as input, making a step-up transformer. This is probably not so safe using the 120 V input.

**Note:** It is also tempting to talk about current transformation: Since energy is conserved, the textbooks tell us that, when the secondary circuit is loaded,  $V_p I_p = V_s I_s$  so that

$$I_p = (N_s/N_p)I_s,$$

and a smaller current flows in the primary than in the secondary.

However, this is not so easy to show because of the quiescence current flowing in the primary at all times, even when the secondary is open. In the ideal case the primary is purely inductive so that current and voltage are  $90^\circ$  out phase — and no power is used. (In the real world this is not true, and we all waste a lot of energy heating all those little transformers that are always plugged in.) I measured 0.9 A flowing with the secondary open.

**Extra Equipment:** AC voltmeter and some connectors.

**Location:** Shelf F3