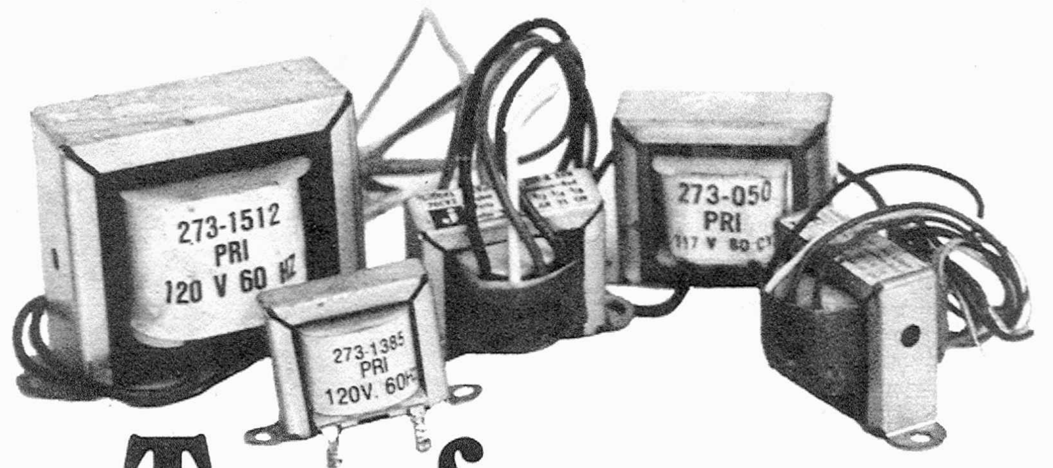
You Can Custom Build



Transformers

Save money on hard-to-find units with this easy method

by John E. Portune, WB6ZCT

TRANSFORMERS called for in electronic projects are often the most difficult components to find. The effort to locate anything but common, low-voltage types is enough to discourage many would-be constructors.

Fortunately, there is an answer—rewind your own. You may have never considered rewinding a transformer, but it's a lot easier than you might imagine and a real money saver. Small 6-, 12-, and 24-volt transformers available at most electronics outlets can easily become a complete range of custom audio and power supply transformers.

Radio Shack stores, for example, offer a selection of small low-voltage transformers the author has found extremely suitable. Other brands are equally good provided they are not held together by varnish and brown paper. It is almost impossible to successfully unwind this type and it is usually wise to avoid surplus and older transformers for this reason.

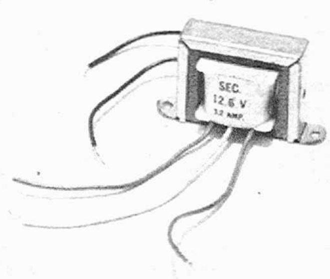


Fig. 1. Typical filament transformer has current and voltage ratings printed on side providing data needed to calculate wire size and turns ratio modifications for constructing a transformer with different voltage, impedance or power rating.

Taking Your Transformer Apart. First, remove the core clamp. Bend-over tabs hold it at the bottom. Next, disassemble the core. The laminations, which are stuck together with varnish, can be separated with a knife blade. The outer laminations are securing laminations and should be the first pushed out through the coil bobbin (See Figs. 2 & 3). The remaining laminations are then easy to remove.

It is wise, as you disassemble the core, to take a few notes. Putting the core back together can be a little like a puzzle if you don't pay attention during disassembly (see Fig. 2).

Unwinding the Bobbin. The windings on Radio Shack transformers are held on with tape. The first layer is an outside covering printed with transformer data. Unwind it carefully and stick it, along with all other tape pieces, to a clean surface for reuse. Under the next layer or two you'll find the bent-over connections of the external wire leads to the actual transformer windings. (Fig. 3). Bend them up to allow you to remove the tape and expose the windings. Then, unsolder the external leads and lay them aside.

The outside (secondary) winding is wound with only a few feet of relatively heavy wire. Unwind it in a straight line on the floor, avoiding tangles. For the primary (if you are removing it), it is better to unwind the wire onto a spool. It is finer wire, and there is more of it. Be sure to count the number of turns on each coil as you unwind it. This is critical data for modification.

Reassembly is a matter of reversing the process, including the necessary changes in the number of turns and wire size. Here are some tips in making the modifications.

Adding A Center Tap. The simplest modification is the addition of a center tap. You can solder a new lead at the half-way point in the winding, but it is better to double (bifilar) wind the center-tapped coil.

Simply cut the wire into two equal-length pieces and rewind them both together onto the bobbin to form the new center-tapped winding. Connect the ends as shown in Figs. 4 and 5. This provides a more accurate and balanced center tap.

Changing the Voltage. For power supply use, changing the transformer's voltage may be desired. Suppose, for example, you need a transformer with

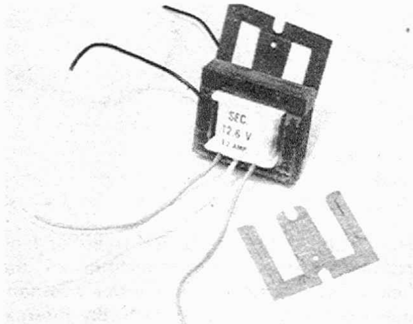


Fig. 2. After loosening the bent-over tabs of the core clamp and removing it the laminations are separated with a knife blade and pushed out through the core's bobbin.

twice the original output voltage. Basic transformer theory tells us that twice the voltage requires twice the number of turns. But to make the new secondary fit in the same space as the one it replaces, smaller wire must be used. If you own an accurate caliper or micrometer to measure the wire diameter, a standard wire table will tell you which smaller wire size to use. In practice, however, the author has been entirely successful with visual estimates at the wire rack at the local radio store.

In the transformer shown in Fig. 1, the 117 volt primary winding needed to be replaced with a 6.3 volt winding. Since 6.3 volts is exactly half the existing secondary voltage, the new primary was wound with half the number of turns of the secondary, using wire about 50% larger in diameter, or slightly more than twice the cross-sectional area. Following this technique of using the existing wire sizes and number of turns on the unmodified transformer as a guide, it is simple to create new windings of exactly the voltage required for a specific project. Remember, the voltage ratio is equal to the turns ratio.

Audio Transformers. Except for extreme high-fidelity applications, small filament-type transformers work well in audio applications. Normally, however, audio transformers are rated by impedance rather than voltage and current. But Ohm's law tells us that:

impedance = voltage ÷ current

Therefore, the illustrated 12.6 volt, 1.2 amp transformer has a secondary impedance of 10 ohms (12.6 V ÷ 1.2 A). This would be quite suitable for a loudspeaker output, for example.

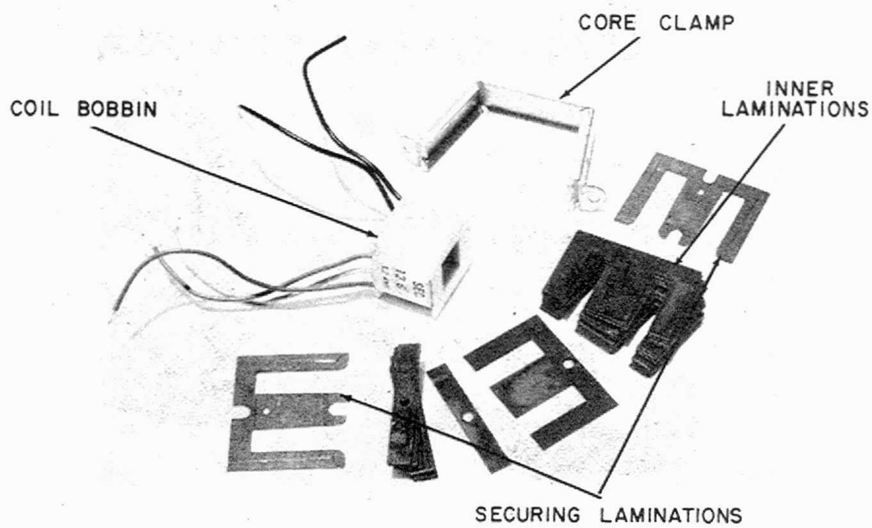


Fig. 3. Transformer is completely disassembled here. The coil assembly has been removed and is ready to be rewound. Be sure to make a diagram of the relative position of the laminations so they can be fitted back together again. Failure to do so will result in having extra pieces left over!

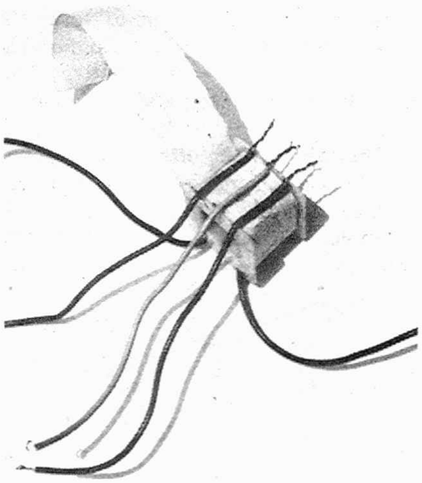


Fig. 4. Coil bobbin with first layers of tape removed shows the connections of the heavy wires which run to other components outside the transformer to the internal transformer windings. Caution: Some of the windings are made of very fine wire. Be very careful in handling this wire not to break it.

To find the primary impedance, we use the formula:

$$Zp = \frac{Vp}{Vs} \times Zs$$

where Zp is the primary impedance, Vp and Vs stand for primary and secondary voltages, and Zs is the impedance of the secondary winding.

Stated in another way, the impedance ratio of a transformer is equal to the square of the voltage ratio.

$$\frac{Zp}{Zs} = \left(\frac{Ep}{Es}\right)^2$$

Our example transformer has a turns ratio of about 9 to 1 (117V to 12.6V). Therefore, it has an impedance ratio of 81 to 1. Multiplying the 10 ohms secondary impedance by 81, we find that our primary has an impedance of about 810 ohms. Then by rewinding, using these relationships, we could create any desired set of impedances.

Physical Size. The final consideration in selecting a transformer for modification is its physical size. This is determined almost entirely by the power (watts) it must handle. In audio service this is usually known directly from the application. For power supplies, the power can be found by multiplying the supply voltage by the current it supplies.

For maximum efficiency, it is best to select a transformer only slightly larger than required. A core that is too small will result in damage to the windings or too little voltage. Too large a core will waste power. There are formulas for determining the core size, but it is far easier to multiply the voltage and the current printed on the transformer secondary. The manufacturer has provided a core that will handle this power correctly, so it's a good indicator of the core's wattage capacity. Pick one slightly larger than required, especially for audio applications.

Much more can be said about transformer modification. But to the electronic constructor willing to undertake the simple job of rewinding, the otherwise limited number of easy-to-obtain low voltage transformers becomes a whole range of custom-designed power supply and audio transformers for specialized applications. And the cost savings will be substantial. Wind on! ■

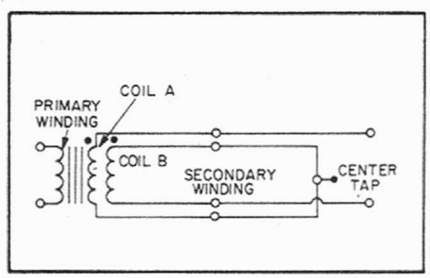


Fig. 5. This diagram shows how a bifilar winding of the secondary coil provides exactly even lengths of wire for the center-tap connection, yielding exact balance of the two secondary halves. Coil A and coil B are wound together starting and stopping at the same place.