CONSTRUCTING AN ANTENNA TUNER WITH PLUG•IN TOROIDAL CORES

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An excellent antenna tuner for shortwave receivers is the "T" type antenna tuner. It is called a "T" antenna tuner because of the shape of the circuit. The tuner consists of two variable capacitors isolated from ground and a coil connected to ground. Without special isolating sleeves or devices, the construction of this tuner usually includes placing the tuner in a non-conductive enclosure such as a plastic hobby box. If one wants to keep as much local electrical interference out of the system as possible, a shielded enclosure is more advantageous; however, how can the capacitors be isolated from ground without the special sleeve or devices mentioned before? Radio Shack sells vinyl Grommets(see parts list) which can be used for isolating the capacitors from ground in the "T" antenna tuner.

Why go to all the trouble of building a "T" antenna tuner when there are a number of models on the market that will serve the purpose? Besides having the satisfaction of building the tuner, the tuners on the market, in my opinion, do not give the results that are wanted in many instances and are usually over priced. Drastic words? I have two commercial "T" type antenna tuners setting on the shelf gathering dust because of the disappointing results that they give.

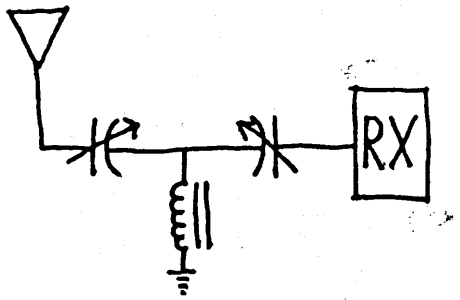

FIGURE 1

After a lot of experimenting with different types of variable capacitors and coils, I have come to the conclusion that an antenna tuner can be improved upon by selecting inductors of different properties for particular purposes. For example, an air wound coil of heavy gauge wire would probably be the best choice for high power transmissions when matching the feed line to the antenna. For high Q, shelf shielding characteristics, a toroidal core coil suggests the best choice.

A convenient "T" antenna tuner would be one with two variable capacitors and a toroidal core coil wrapped with 18 gauge wire which is taped at various points to reduce or increase inductance allowing for changing frequencies. But if a tuner of better selectivity is desired, wouldn't it be better to have a coil designed just for a particular frequency spectrum such as the sixty meter band, rather than having a coil with a large amount of inductance - eventhough it is taped at different points - possibly allowing intermodulation and spurs effect it? When designing communications receivers, engineers do not resort to taped coils in their circuits. For each location of the circuit where inductance

is required, a coil of a particular inductance is placed. For a better antenna tuner, using-plug in toroidal cores is sure to give better signal gain to the receiver because there will not be all that potential extra inductance present to cause problems.

To begin with gather the materials and components listed below:

1. Two SO-239 chassis mount sockets. UHF type.
2. Two variable capacitors 10 to 365 pF. These can be purchased from the following venders for approximately $10.95 each:

   G. C. Electronics, 400 South Wyman St., Rockford, Illinois 61101. Tele 815-968-9661. Stock No. A1-227

   Circuit Specialists, PO Box 3047, Scottsdale, Arizona 85257. Tele 800-528-1417 Stock No. A1-227

   Mouser Electronics,2401 Highway 287 North, Mansfield, Texas 76063 Tele 800-346-6873 Stock No. 524-A1-227

3. Three or more 2 conductor monaural 1\4" Phone Plugs.
4. One 2 conductor 1\4" circuit jack - open.
5. One metal (preferably aluminum) hobby box at least 3" by 5".
6. One DPDT mini-switch center-off.
7. Three or more toroidal cores T-106-2 from Amidon Associates, 12033 Otsego Street, North Hollywood, California, 91607 Tele 813-760-4429
8. Hookup wire, 20 gauge or smaller that is insulated.
9. Vinyl grommets big enough to fit the capacitor shafts. These can be purchased at Radio Shack Stock No. 64-3025
10. Litz wire Amidon Associates above.

The layout of the components on the hobby box is not critical. Usually, the capacitors are place on the right and left front of the box with the two conductor 1\4" jack located between. The two SO-239 sockets will serve as antenna and receiver inputs and should be situated on the back of the hobby box. An additional hole in the extreme upper right hand corner of the hobby box in front will hold the mini-switch.

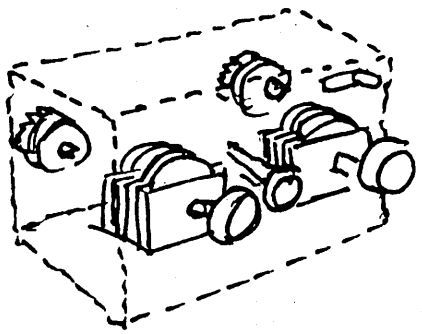

FIGURE 2

STEP ONE: Drilling holes in box.

Drilling holes in the box is usually a chore if one does not have the correct drill bits. I unfortunately do not have many drill bits so I usually drill a small hole in the box and use a reaming tool to enlarge it to the size I need. Perfectionists may feel that this is not the correct way of doing things but it gets the job done especially when ones tool box has been raided so often by a young experimenters. By using a reaming tool, it is a simple procedure to check the size of the hole as you go along thereby getting a snug fit. The circuit jack and switch should fit

snugly into the box. The capacitor's shaft hole should be just a little larger than required by the shaft size to allow for the insertion of the vinyl grommets which are required for insolation of the capacitors.

STEP TWO: Connecting sockets.

Next connect the two SO-239 sockets on the back of the cabinet. Using the reaming tool to enlarge the holes you have drilled, check for the correct size as you proceed. The sockets will be the connections for the receiver and the antenna.

STEP THREE: Connect hookup wire.

With everything installed on the hobby box it is now time to connect it all together. From both the SO-239 sockets run a piece of hookup wire to the center connections of your switch. When you are finished, you will have one piece of hookup wire from your antenna socket to one of the center connectors of the mini-switch and the second hookup wire from the receiver socket to the other connector of the mini-switch.

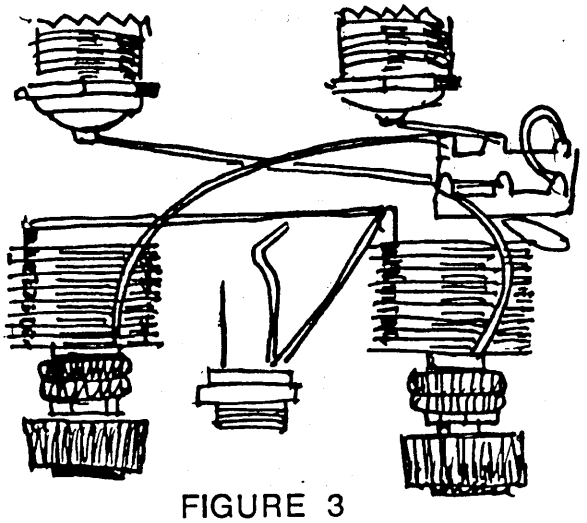

FIGURE 3

As you can see, the switch has six connections. There are two on the right hand side, two on the left hand side and two in the center. We have already taken care of the center connections, now it is time to connect the others. First take a short piece of hookup wire and connect the two right switch connectors together. This is the bypass side of the circuit. When you want to bypass your tuner, you will switch to this side of the switch, effectively bypassing the entire circuit.

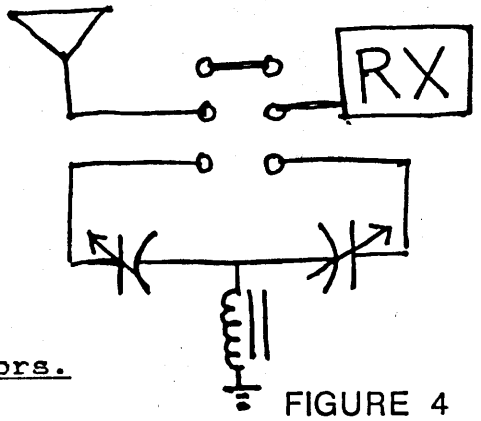

FIGURE 4

STEP FOUR: Connect Capacitors.

Next we want to connect the capacitors up to the switch. To do this we will take two more pieces of hookup wire which should be long enough to reach from the capacitors to the switch. Don't cut the wires too long! The circuit will be effected if there is too much wire. connect a piece of hookup wire to each one of the capacitors making certain that the wires are connected to the same side of each of the capacitors. The opposite can be done, just be certain that each piece of hookup wire is connected equally. Connect the other ends of the hookup wire to the remaining connection on the switch.

We must now connect the two capacitors to each other. With another piece of hookup wire, connect the capacitors together on the opposite sides that you connected to the switch.

Take another short piece of hookup wire and solder it to the wire we just used to connect the capacitors together. Take the remaining end of the wire and hookup the headphone jack with it. Connect the hookup wire to the socket on the side that is insulated from ground. Set the tuner to one side for awhile.

STEP FIVE: Constructing the coils.

Next we will discuss the construction of the coils. This is the easiest and most fun part of the entire construction project. Hopefully, you have purchased a number of T-106-2 toroidal cores from Amidon. (1) Take some of the 20 gauge hookup wire and wrap one of the cores with eighteen turns of wire. This core will work from 4.0 MHz to about 5.5 Mhz. (2) Leave about an inch and a half of hookup wire for leads on both ends of the wrapped core. (3) Remove the cover from the phone plug and insert the leads from the coil into it. (4)Then bare a sixteenth of an inch of hookup wire of the leads and insert it into the tiny connection tabs of the phone plug. One of the tabs represents the positive side of the plug and the other represents the negative side. (5) Then solder the leads from the coil onto the phone plug and screw the plastic cover of the phone plug back in place.(6) Try out your tuner by inserting the phone plug with the toroidal core coil into the jack on the front of your hobby box. Tune to the 60 meter band and try it out. If you did everything correctly, you should have an increase in your signal strength by a couple of "S" units.

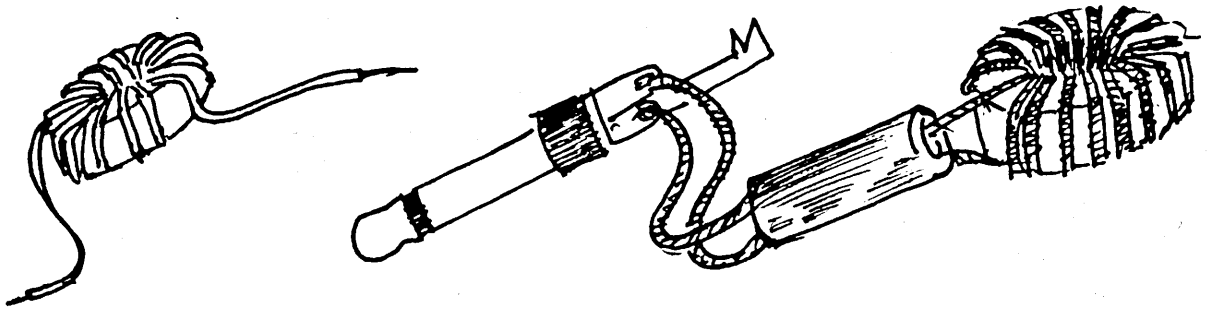

FIGURE 5

Does it work? Maybe eighteen turns of wire on the core wasn't enough or maybe it was too much. Try other bands nearby either higher of lower. If you find that the tuner works on a lower frequency, then you have wound too many turns on the core. Each receiving systems effects the core differently. Don't give up! Try to find the correct winding ratio for your system and the 60 meter band.

Iron Powder toroidal cores come in numerous sizes and are found in two basic material groups: The Carbonyl Irons and the Hydrogen Reduced
Irons.

The Carbonyl Irons are noted for their stability over a wide range of temperatures and flux levels with excellent Q factors for the 50khz to 200 MHz frequency range.

The Hydrogen Reduced Irons have somewhat lower Q values and are mainly used for EMI filters and low frequency chokes.

Toroidal cores, in general, are the most efficient of any core configuration because they are highly self-shielding. This is because the lines of flux are contained within the toroidal form. It is seldom necessary to shield or isolate a toroidal inductor to prevent feedback or cross-talk. That is why the plug in toroidal core on the tuner can be located outside of the metal hobby box and not be effected.

When ordering toroidal cores from Amidon Associates, a data sheet is accompanied with the order. This sheet contains the A values which are used to calculate the required number of turns for a given inductance value.

TURNS FORMULA

$$\text{Turns} = 100 \sqrt{\frac{\text{desired L (uh)}}{\text{A (uh/100t)}}}$$

To find inductance use the following formula:

$$\text{Inductance L} = \frac{1}{(2\pi f)^2 C}$$

This that clear? There is an easier way to find the number of turns required for the frequencies you want to tune up. Take an extra phone plug and connect two short pieces of hookup wire to the connection tabs of the phone plug. Insert these through the cover of the phone plug and then connect two alligator clips to each of the wires. Now when you have wound a toroidal core, you can connect the leads to the alligator clips and check the turns ratio by reducing the turns one at a time until you get a good reading from your receiver. You did give the toroidal core an extra number of turns didn't you?

I hope you will find this tuner to be beneficial to your antenna system. The two points to remember about this project is the unique coils made with phone plugs and the method of isolating the capacitors from the metal hobby box with grommets. I would like to get so comments either pro or con on this tuner. If this tuner leads anyone to a better method, I would like to hear from you. Good listening!

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