The Improved Resonant Feedline Dipole

A compact, low impedance, end-fed HF antenna that needs no tuner!

by James E. Taylor W2OZH

The end-fed RASER antenna described in *73 Amateur Radio* (September 1992, pp. 8-14) utilized the RFD (Resonant Feedline Dipole) approach. This concept has drawn an enthusiastic response from hams throughout the country. It achieves an end-fed dipole, or a RASER, for any band desired *using a coaxial feedline and without a tuner*. It has been praised by many who have site restrictions which preclude the use of the customary dangling center feedline. A unique feature of these antennas is the use of the T-choke—eg.: a 13-turn coil of coax which is suspended at the input end of the radiator. If, however, you find such a coil cumbersome the present article offers help!

The RFD Concept

As mentioned in the previous articles, an obvious approach to the electrical isolation of the input end of the dipole might involve the use of a current balun. However, calculation showed that this direct approach would not provide sufficient impedance. At that time I chose to use the somewhat more bulky T-choke method of isolation. Nevertheless, the idea of making a more compact choke was rekindled when I found an article in my files by Joe Reisert W1JR (*Ham Radio*, September 1978, pp. 12-15). That article described "a new type of balun" which featured a high permeability toroidal core wound with coaxial cable using opposed windings for reduction of external field, as shown in Figure 1. Based upon that idea, I made a few comparative impedance calculations, which were encouraging. Experiments then led to a simple practical design in which the T-choke is replaced by a compact box.

I will describe the final design of the RFD antenna for the 80 meter band in some detail, and tabulate the results of the calculations in the "Calculations" sidebar. Also included is a tabulation of the calculated number of turns and lengths of the dipole halves for the other popular HF amateur bands.

The Design

In the previous design of the RFD the self-resonant T-choke served two related functions: It gave the high impedance required to isolate the end of the dipole, and it provided the reactance which tuned the system to resonance, thereby enabling an excellent impedance match to the feedline. In the Improved RFD design these functions are achieved by adding a fixed resonating capacitor in parallel with a winding of coax on a toroidal core, as in Figure 1. First, calculation shows that if we use the Type T-200-2 powdered iron core commonly used for baluns in this frequency range the inductance would be an order of magnitude lower than that for the T-choke. Even two such coils in series, tuned to resonance using a 264 pF capacitance, is lower by a factor of five. In spite of this I temporarily wound two 13-1/2-turn coils on these cores for preliminary experiments. The results confirmed the feasibility of the approach but the measured common mode current on the feedline was too high. (The MFJ H-field Antenna Probe is convenient for comparing these currents). However, during this test an important fact was determined—*in order to get the desired 1:1 SWR it was necessary to place a current balun in the line ahead of the tuned coils*. For this I used a 20-turn bifilar coil on a T-200-2 core. This current balun provides impedance balance relative to RF ground.

Further review of the Amidon data sheets indicated that we must consider ferrite material, which provides higher permeability, in order to get the higher inductance desired. However, this comes at the expense of some reduction in temperature stability. The FT-240-61 core was chosen for our desired power levels and frequency range. This core has an initial permeability of 125, and with a core o.d. of 2.4 inches it should handle a kilowatt of power without excessive heating. The calculation of inductance of a 12-turn coil on such a core gave a value of 25 microhenries—much greater than that of the powdered iron cores and even greater than that of the RFD T-choke. Since the loss resistance is roughly a factor of five less than that for the original RFD, the calculated prognosis for the Improved RFD is very promising! (See the Coil Tester comments at the end of this article.)

Construction and Adjustment

For the final coil I wound 6 + 6 turns of RG-8(M), field-opposed, on an Amidon Type FT-240-61 toroidal core (see Figure 1). This coil was mounted in a 6" x 3-3/16" x 1-7/8" plastic box along with the current balun referred to above and the two coax sockets, as indicated in Figure 2. For the

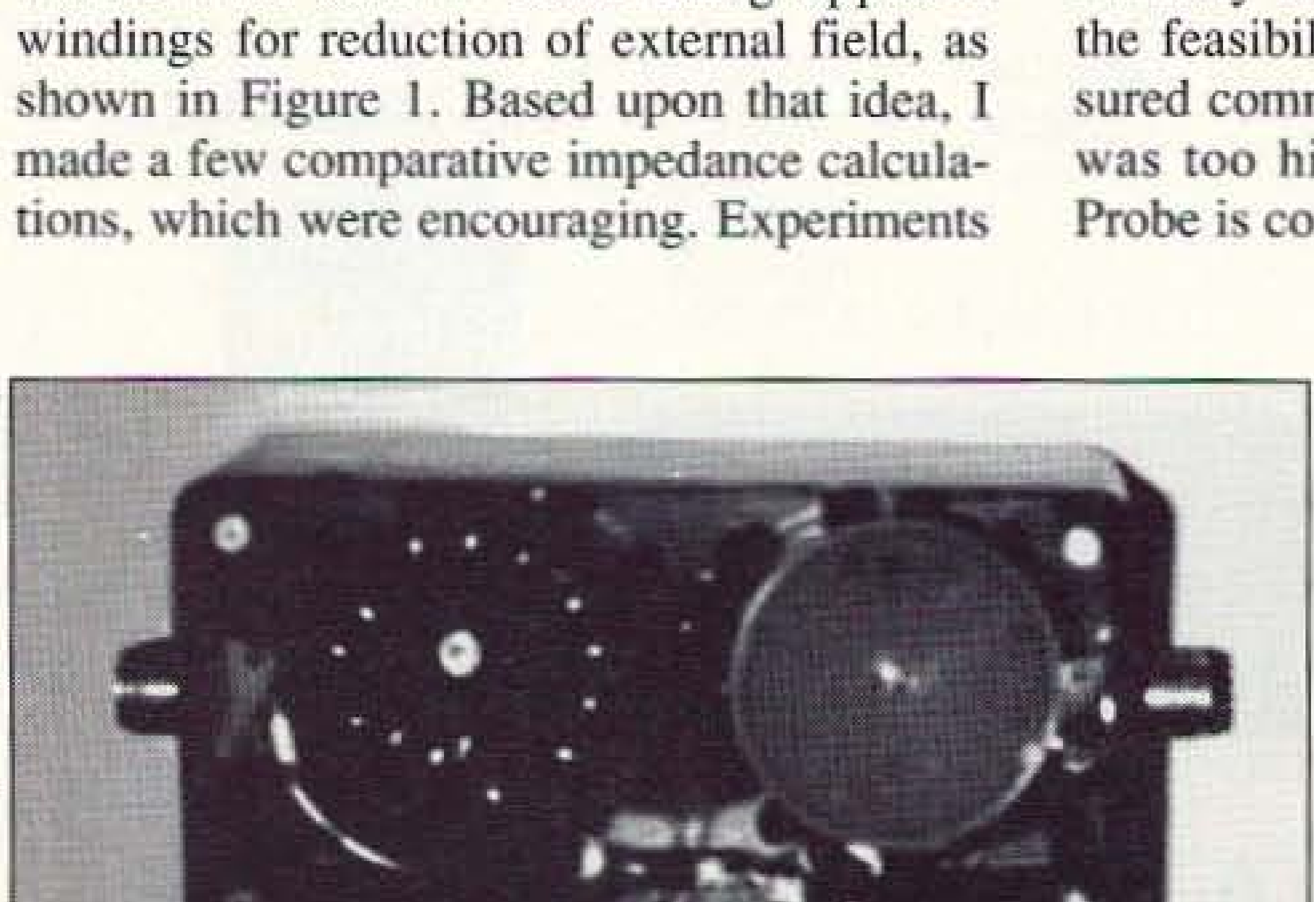

Photo A. An early version of the "box."

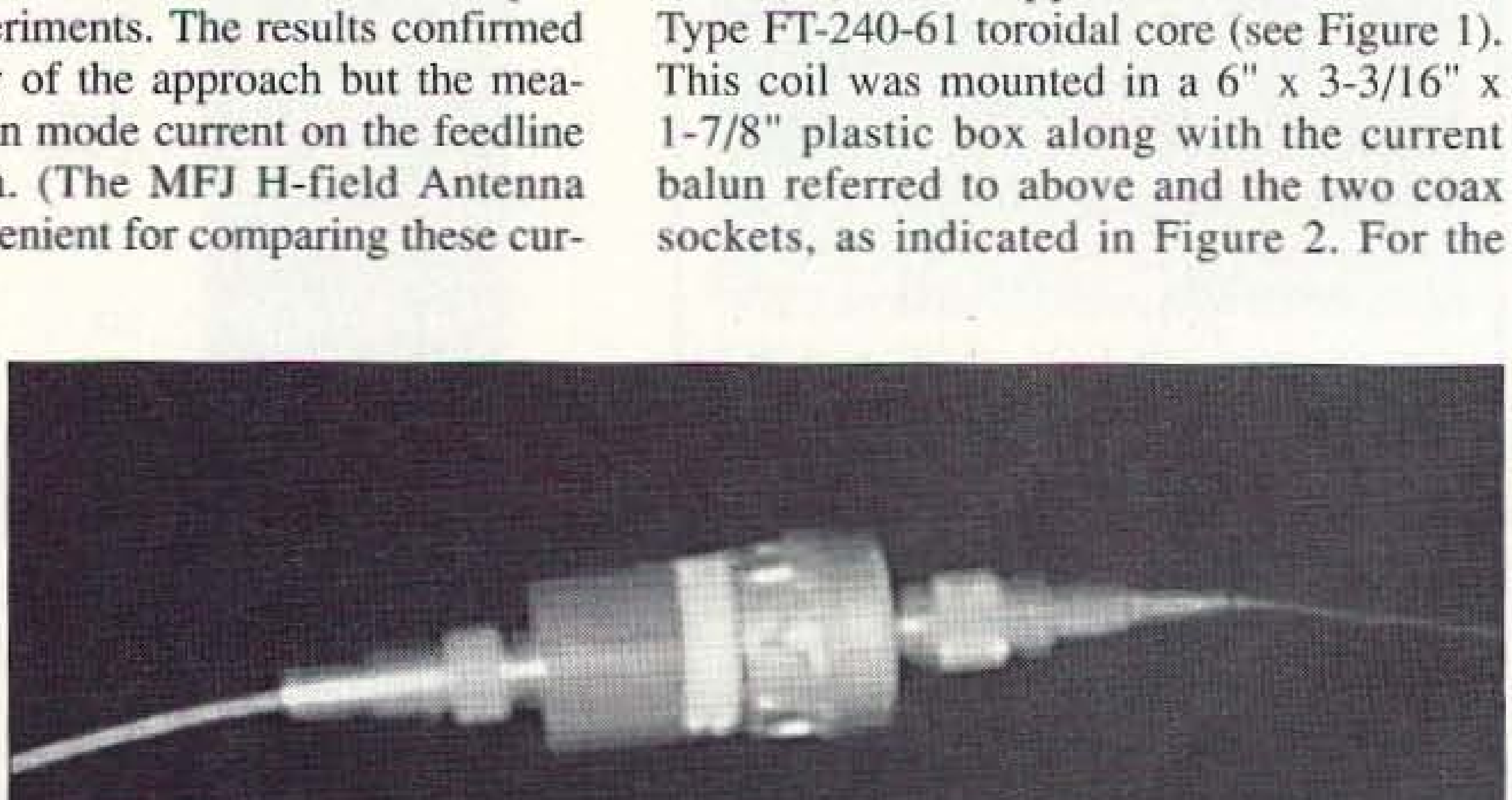

Photo B. A plastic pill bottle does the trick.

simple bifilar current balun I wound 20 turns of sheathed bell wire on the T-200-2 core, shown schematically in Figure 3. The general packaging is shown in Photo A, which is of an early model. Figure 4 shows the schematic diagram of the circuit. The simplicity of the circuit is apparent—other than wire and coaxial cable fittings, there are only five parts!

I have found that a plastic pill bottle (the popular amber-colored cylindrical one with the locking cap) makes a very useful center insulator for this type of dipole. I mounted SO-239 sockets on the bottom and the top of the box. Connections are as indicated in Figure 5. Photo B shows this compact, rugged assembly. The unit can withstand a surprising amount of tension and the parts are conveniently disconnected, when desired. Figure 6 shows the complete antenna.

The only adjustment required was the choice of the tuning capacitance connected across the coil of coax on the ferrite core. I made a preliminary adjustment by using an air variable across the coil on the bench, and using the coil tester described at the end of this article. I then made the final adjustment with the antenna in place and with the plastic box lowered to stepladder height, using an SWR bridge to indicate 1:1 SWR. These adjustments agreed to within about 10%. The air variable was then replaced with fixed silver micas and the box was raised to normal height. (Since the voltage across this capacitor is high I placed two equal capacitors in series.) For my installation 50 picofarads (2 x 100 pF in series) brought the resonance within 15 kHz of the desired frequency of 3.953 kHz.

Photo C. The radiator, suspended by two 40-foot-high masts. The box is at the lefthand mast and the center insulator is near the righthand mast.

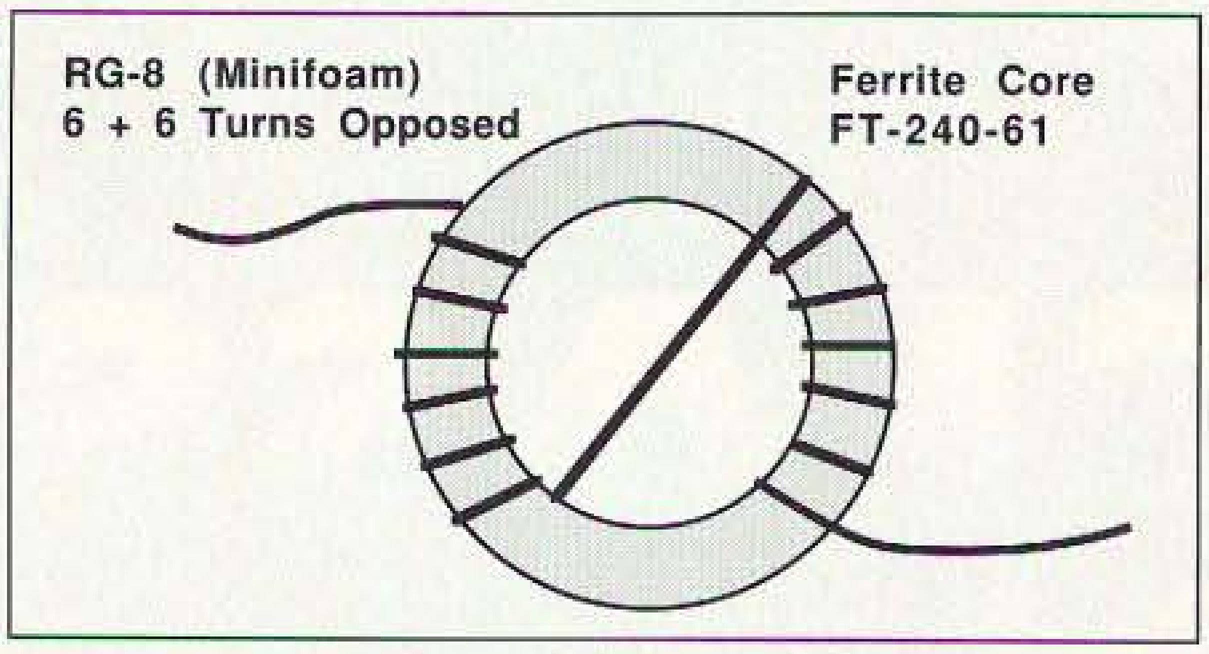

Figure 1. The Improved RFD Antenna's coil.

Results

The adjustment and operation of the Improved RFD Antenna on 80 meters was straightforward and satisfactory in all respects. The radiator was suspended between the two 40-foot-high masts which support the two RASER gain dipoles at W2OZH. This can be seen in Photo C, where the box is at the lefthand mast and the center insulator is near the righthand mast. The "terminator" half of the dipole slopes downward off of the photo to the right. (The segmented sections sloping out of the photo from the righthand mast are not part of this antenna system.)

It was interesting to observe the action of the tuning capacitor in limiting the shield radiation and matching the radiator to the feedline. The shield current was indicated by the MFJ H-field probe and the match was measured by an SWR bridge while turning the air variable capacitor. At resonance the shield current showed a sharp null. Also, the SWR was a flat 1:1 at a point slightly off

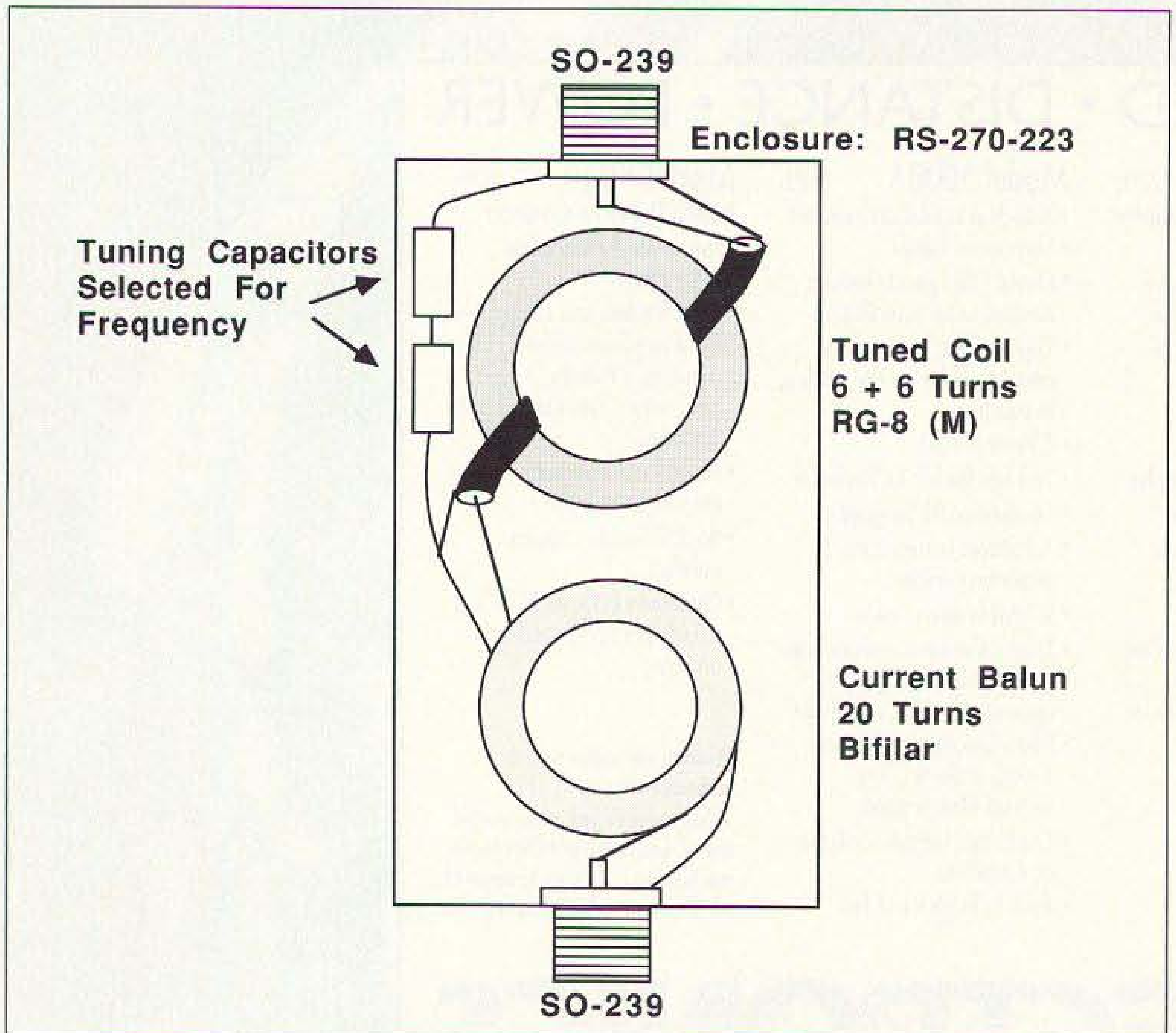

Figure 2. Connect the transceiver to the bottom of the box.

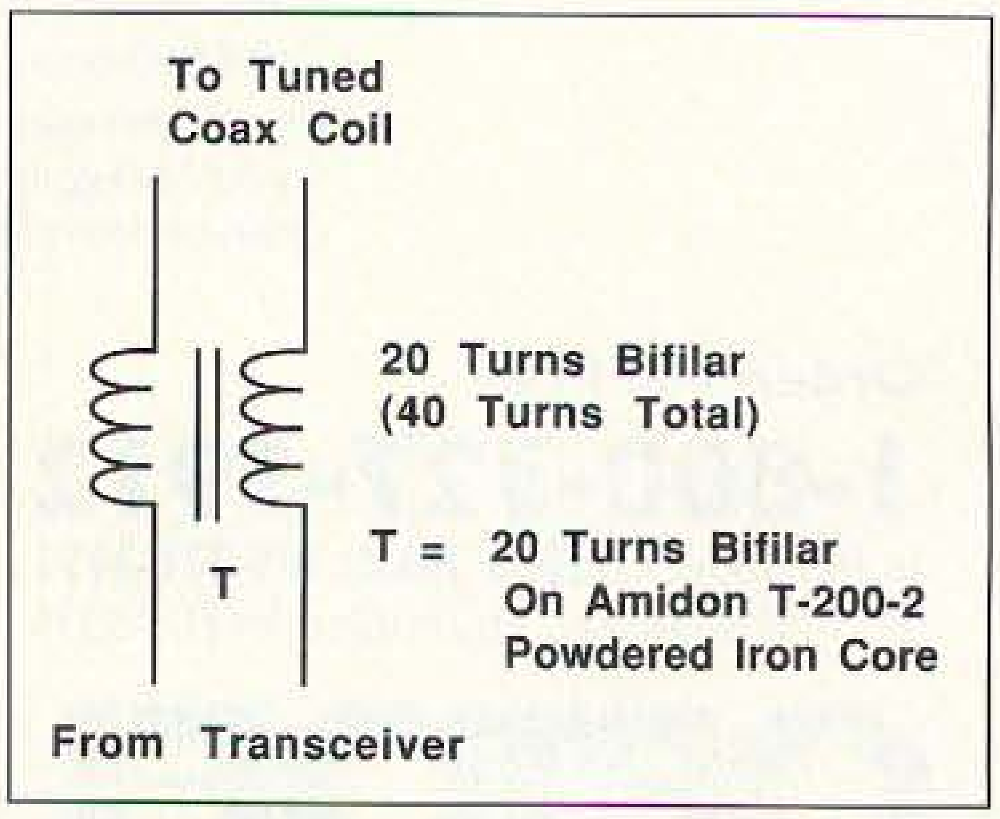

Figure 3. Schematic for the current balun.

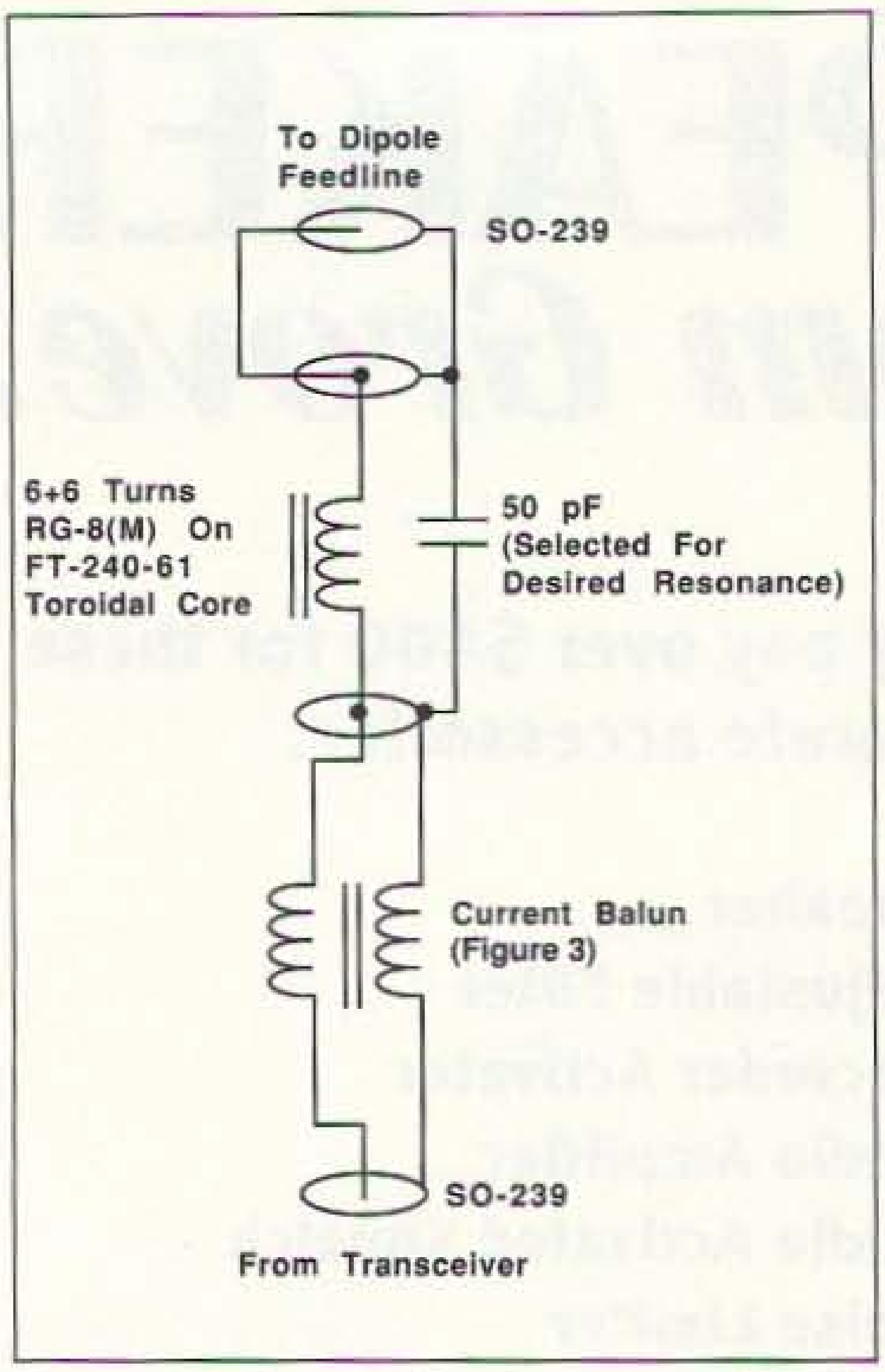

Figure 4. Schematic for the Improved RFD's box.

Specifications for Other Bands

Band	Freq.	Turns	Dipole Half Length
160m	1.9	17	123'2"
80m	3.954	12	59'2"
40m	7.263	9	32'3"
20m	14.29	7	16'5"
17m	18.14	6	12'11"
15m	21.38	5	10'11"
10m	28.65	4	8'2"

resonance, as expected. Noise bridge measurements confirmed this resonant frequency and indicated an input of 52 ohms. The measured bandwidth of the system was 170 kHz between the "SWR = 1.2" points, which is very acceptable. The common mode shield current was appreciably less than for a standard well-balanced center-fed dipole. Stations worked reported no difference in signal strengths between these dipole antennas.

Conclusion

The Improved RFD Antenna is an end-fed dipole using coaxial cable without a tuner. It achieves the same advantages as the original RFD system, while replacing the T-choke coil with a compact box. It also provides a more convenient method of adjustment to resonance.

I wish to acknowledge the patience of the number of hams who gave signal strength comparisons which confirmed the viability of the design.

Coil Tester

Michael Covington (*73 Magazine*, Sept. 1990, pp. 48-51) described a simple coil tester which gives a direct measurement of the resonant frequency of a parallel-tuned coil. This tester, together with my Alfa digital multimeter (which measures frequency up to 20 MHz) gave a direct preliminary measurement of this antenna's tuned-coil frequency.

Core Kit

The two toroidal cores for the Improved RFD are available as a kit from Amidon at a reduced price of $12 by referring to this article.

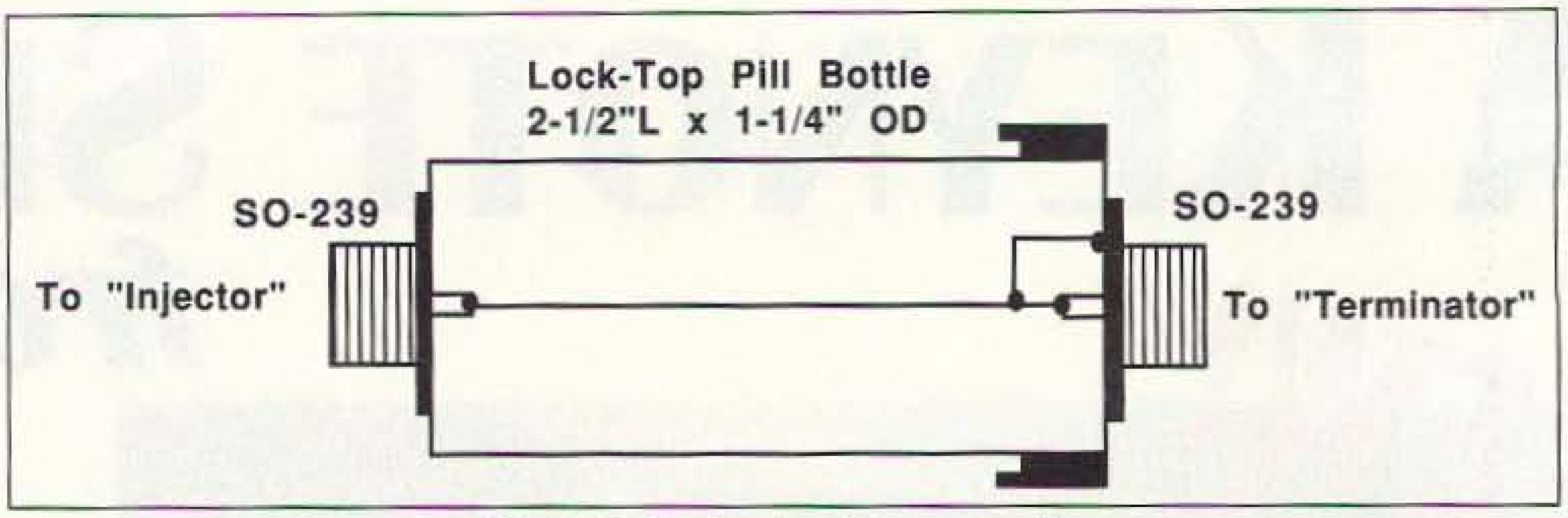

Figure 5. Center insulator assembly.

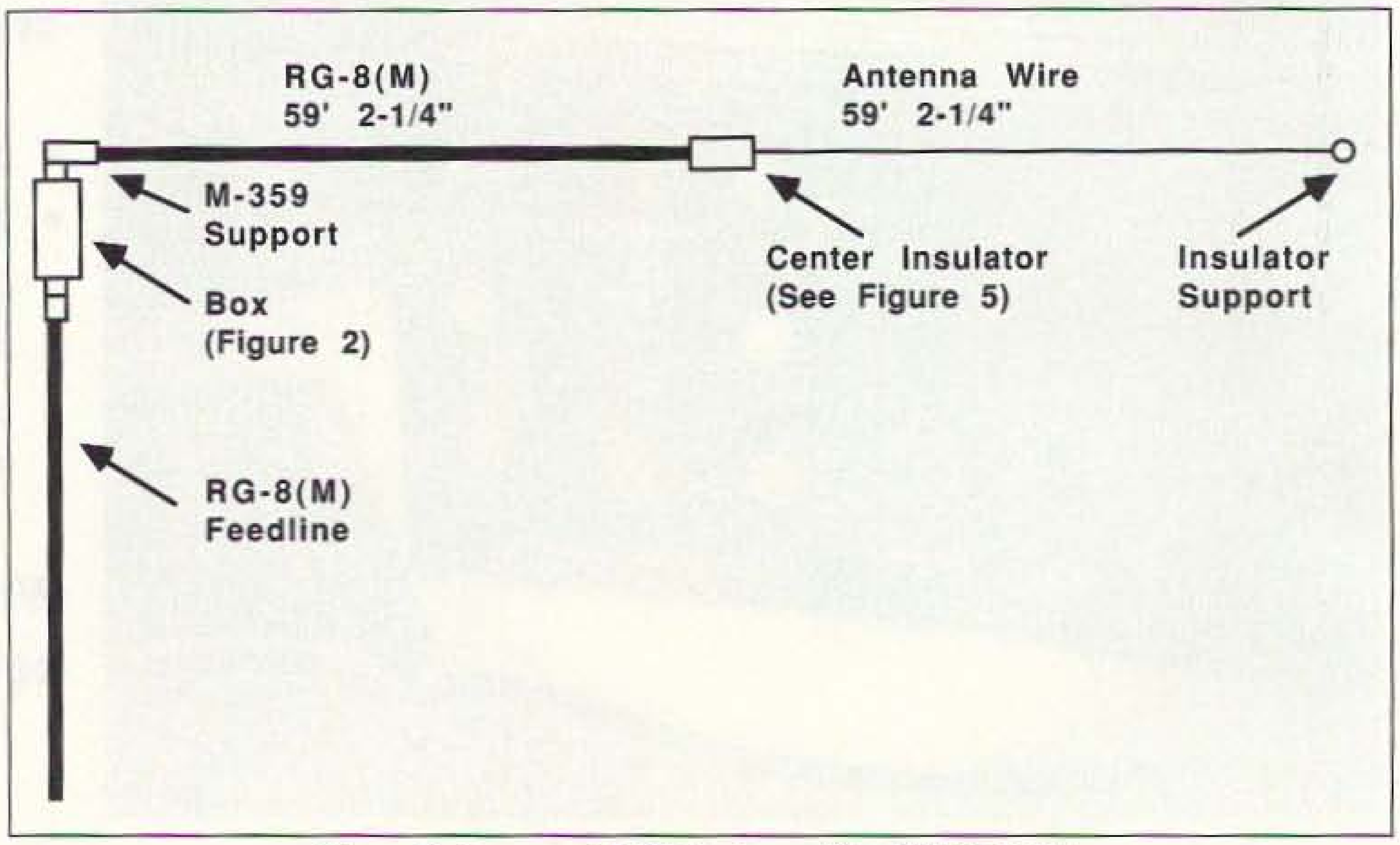

Figure 6. Improved RFD Antenna (for 3.9535 MHz).

Parts List

Description	Part Number	Optional Supplier
1 ferrite core	FT 240-61	Amidon Associates
1 powdered iron core	T-200-2	Amidon Associates
1 enclosure box	270-223	Radio Shack
1 plastic pill box	1-1/4" o.d., 2-1/2" H	Any pharmacy
Silver mica caps	Assorted (100/$5)	Fertik's, 5400 Ella St., Phila. 19120
Antenna wire	#14 stranded	Radio Shack
4 coax sockets	SO-239	Radio Shack
5 coax plugs	PL-259	Radio Shack
5 coax reducers	UG-176	Radio Shack
1 right angle conn.	M-359	Radio Shack
Coaxial cable	RG-8 (Minifoam)	Radio Shack
Twin bell wire	(Sheathed)	Any home supplier

Calculations

Item	Equation	Value
13 Turn T-Choke:	$L = a \times n^2 \times J =$	20 µH
	$Z_{i\,(OLD)} =$	$25 \times 10^4/R_{1\,(OLD)}$
2 x 13.5 Turn T200-2: (i.e. IRFD1)	$L = 10^{-4} \times N^2 \times A_L \times 2 =$	4.3 µH
	$Z_{i\,(RFD1)} = L/C \times R_1 =$	$2.4 \times 10^4/R_{1\,(IRFD1)}$
6+6 Turn FR-240-61: (i.e. IRFD2)	$L = 10^{-6} \times N^2 \times A_L =$	25 µH
	$Z_{i(IRFD2)} = L/C \times R_1 =$	$64 \times 10^4/R_{1\,(IRFD2)}$
Z Comparison:	$Z_{i(RFD1)}/Z_{i(RFD2)} =$	0.25
	$Z_{i(IRFD2)}/Z_{i(RFD1)} =$	12.5