Specialized Top-Band DX Receiving Loop

Listen to the action on 160 meters.

by Richard Q. Marris G2BZQ

The "top-band" covers from 1.8 MHz to 2 MHz and is, therefore, the only amateur transmitting band in the MF spectrum (300 kHz to 3000 kHz).

On top-band it is not uncommon, when using a conventional antenna, to hear European stations working traffic with North America, yet all one can personally hear is a weak signal deep in the typical high ambient noise level, or no signal at all. Many therefore build a simple loop receiving antenna consisting of several turns of wire around a framework, resonated by a variable capacitor, and transformer-coupled to the receiver with a single wire turn alongside the main resonant winding. The results, though possibly better, are often disappointing, with weak signals and high ambient noise. If you add a preamplifier to boost the weak signals and it will also amplify the ambient noise pro rata.

Yet with a properly designed MF loop it is quite possible to comfortably hear, and read, previously inaudible transatlantic and other DX signals. Such a loop has to be designed to give peak performance for just the 200 kHz between 1.8 MHz and 2 MHz, resisting the temptation to take in as wide a frequency range as possible. The loop dimensions are somewhat dictated by the domestic environment.

The top-band loop antenna, properly designed, can produce good reception of transatlantic signals which otherwise cannot be identified, or heard, with the available conventional antenna.

History

The loop receiving antenna has been around since the earliest days of wireless in connection with DF (direction finding) requirements, on oceangoing vessels in those days when the ocean liner, not the airliner, reigned supreme. It is therefore useful to study old relevant textbooks covering the 1920s to 1940s, such as Terman* and *The Handbook of Technical Instruction for Wireless Telegraphists**. By far the best is the 1938 edition of *The Admiralty Handbook of Wireless Telegraphy.** This two-volume book was a standard training manual used throughout the armed services, merchantile marine colleges, and many other training establishments. The DF section, "T," has never been surpassed for locating basic information on the principles and properties of DF and loop antennas.

MF loops are divided into two distinct types: the "box" form (Figure 1) and the "pancake" form (Figure 2), which is now more commonly known as the spiral loop. They both give a theoretical "figure-eight" polar diagram of reception (Figure 3). The *Admiralty Handbook* states that in the box form "the loops are of the same dimensions, but not coplanar, and are equivalent to a single loop of 'n' times the area in a plane parallel to themselves, plus a loop at right angles of area equal to half the area of the vertical side of the box frame. Hence *zero signals will not be obtained* when the frame is exactly at right angles to the line joining it to the transmitter." This is contrary to generally held assumptions. Also, "In the pancake form the total EMF is the sum of the separate EMFs in the loops, these being proportional to the dimensions in each case. It is equivalent to one Loop whose area is the sum of the individual areas, and *gives zero signals*, when the plane is at right angles to the transmitters." More recent textbooks appear to gloss over these statements, and seldom mention the spiral loop. Too difficult to make?

Photo A. The top-band receiving loop.

The above indicates that at MF frequencies the pancake, or spiral, loop should be superior to the box loop. The loop can be any symmetrical shape, e.g. square, diamond, triangular or circular. The ideal shape appears to be circular, and is also the most difficult to construct in spiral form. In practice, a near circle can be obtained by using an octagonal framework. The size of the loop will, in practice, be influenced by the domestic operating (and storage) space available. Furthermore, textbooks and personal experiments indicate that the variable capacitor should be set at near minimum capacity, with maximum wire turns, to obtain maximum signal strength and minimum ambient noise at the target frequency (i.e. 1.8-2.0 MHz). Rotation of the loop will also reduce or eliminate adjacent interfering signals to the one being read.

Loop Description

The loop circuit shown in Figure 4 shows an 11-turn spiral loop in octagonal shape, which is very close to circular in shape, with an outside diameter of 30 inches. The turns are held apart by threading through 12-way 2-amp polythene terminal blocks, which are a convenient 5/16" apart, center to center, thus reducing the proximity effect. The loop is brought to resonance by a balanced circuit 2 gang x 500 pF per section variable capacitor (C3 + C4) with 150 pF capacitors C1 and C2 in series. These 2 gang x 500 pF variable capacitors are readily available from suppliers, on the surplus market, or salvaged from an old MW/LW domestic radio. Built-in trimmers should be removed if fitted. When C3 + C4 plates are not more than 5% enmeshed, 2 MHz is resonated. Tuning is smooth and easy with a large 3" diameter instrument knob—no slow-motion drive is required.

Coupling to the receiver's 50-ohm impedance input is via C5 (470 pF) and a short length of RG58 feedline. Originally C5 was a variable capacitor to adjust the degree of coupling. *Under*-coupling is indicated by a narrowband weak signal, and *over*-coupling by a double-hump wideband effect. The optimum coupling is just under the over-coupling

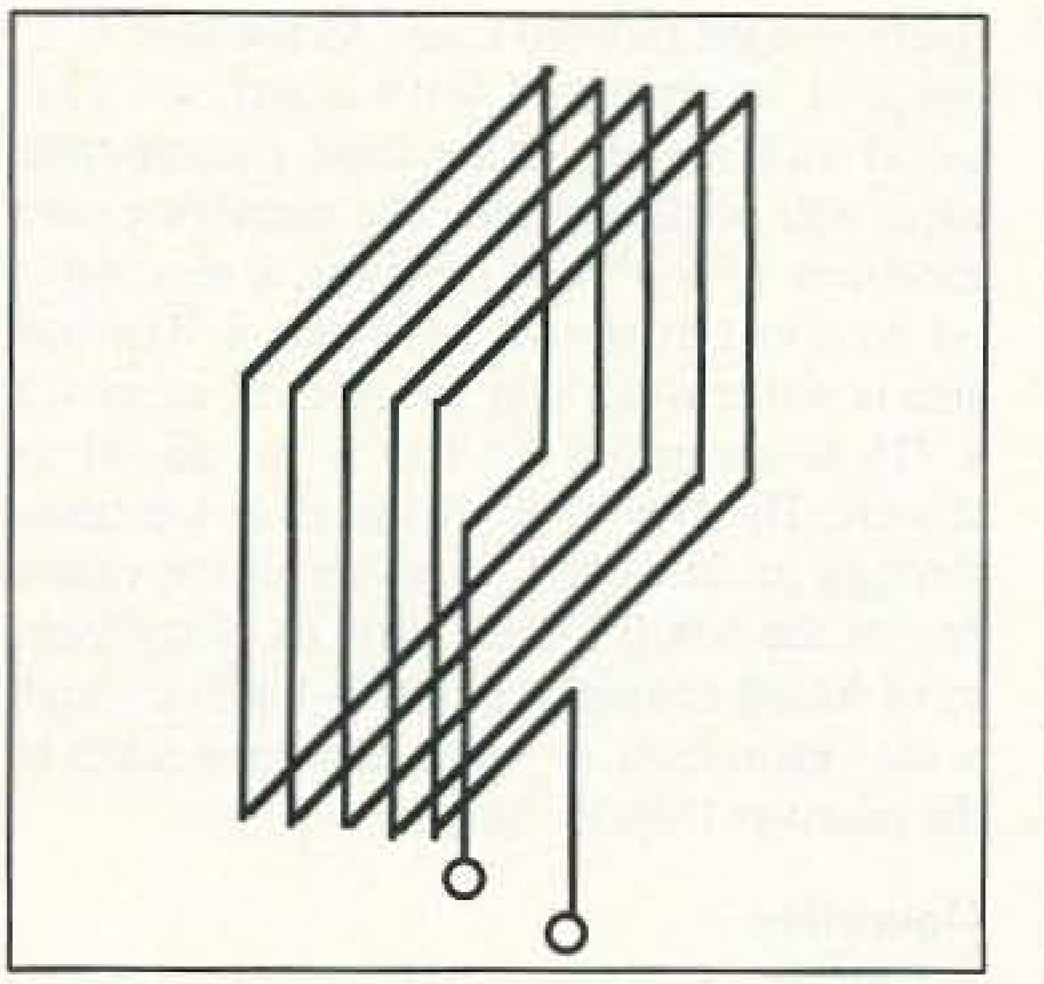

Figure 1. Box form.

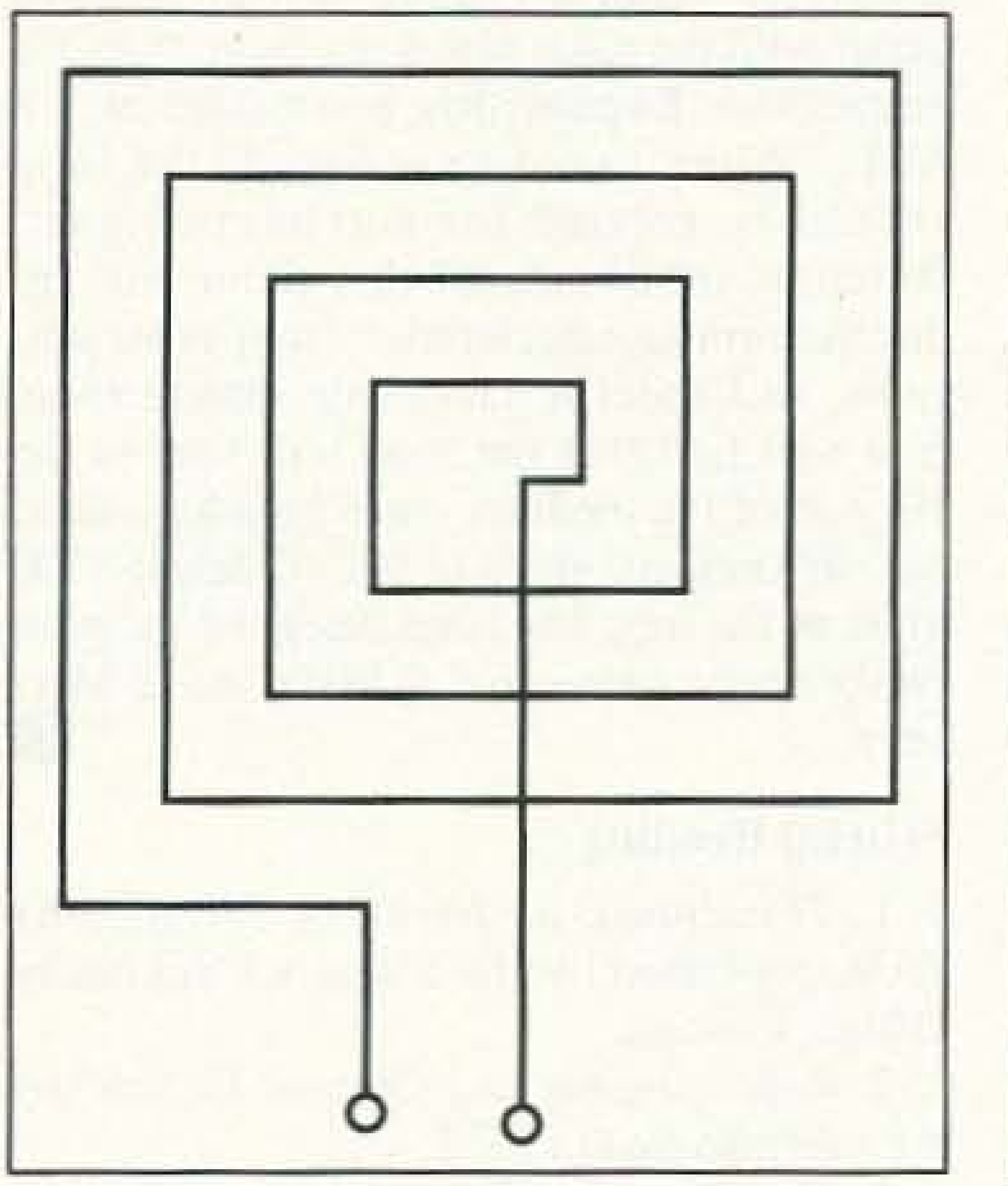

Figure 2. Pancake (or spiral) form.

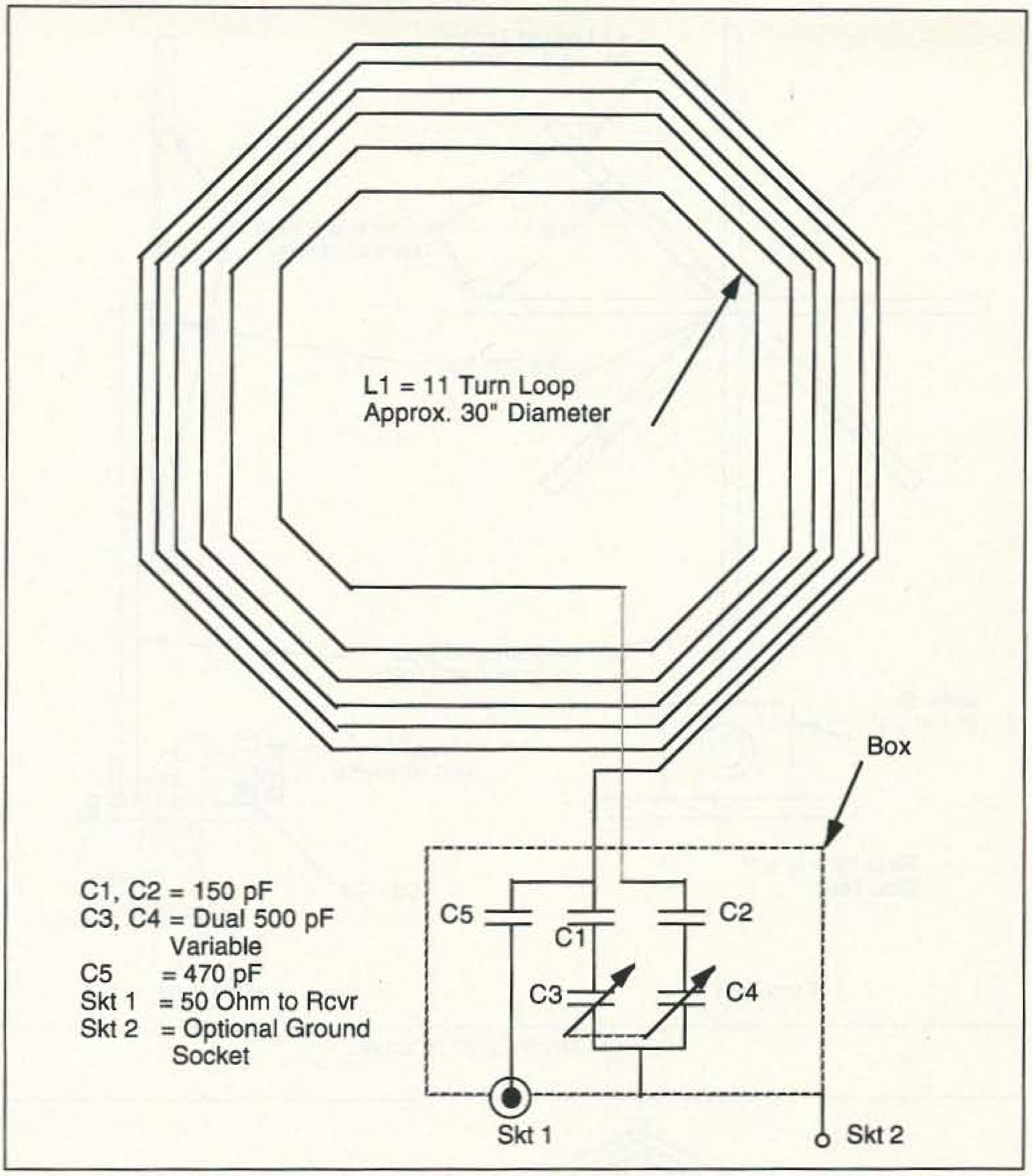

Figure 4. Topband circuit.

point where the double hump turns into a single peak. Conveniently, this worked out at 47 pt (C5). Anyone using a 300-ohm twin feedline (or other impedance) should revert to a variable C5 to arrive at the necessary capacity value. Though an optional grounding socket has been shown (Skt 2), no real advantage is apparent. Using an earth connection to a domestic water pipe increased the ambient noise, and another earth connection slightly decreased it. By far the best method appears to be making an earth connection to the receiver adjacent to the low impedance coaxial input. The whole of the tuning unit must be enclosed in a metal box.

Performance has been very gratifying in as much as transatlantic CW signals are quite clearly heard and read with a sensitive receiver, whereas they cannot be heard at all or be barely heard on a conventional wire antenna. A preamplifier has not been found to be necessary, as the whole loop is peaked over a mere 200 kHz band (1.8-2 MHz). Rotation of the loop reduces/eliminates interference from other stations, and local man-made noise.

Construction

The mechanical structure (Figure 5) consists of four lengths of good dry timber, 30" x 5/8" x 1/4", with a hole drilled in the center of each where glue is applied and the lengths secured with a bolt, a nut and washers, adjusting the limbs to 45 degrees as shown. At the end of each limb a 12-way 2-amp polythene terminal block is fitted. These blocks are used to secure the loop turns in place, approximately 5/16" apart, thus providing an 11-turn octagonal spiral winding, which is as near the ideal circular shape as possible.

The loop winding (Figure 6) consists of PVC-covered hook-up wire (7/0.2 mm with an overall outer diameter of 1.2 mm). Commence the winding at the bottom outside terminal block insert and proceed counter-clockwise, in a spiral, terminating at the inner insert. The terminal block insert grub screws should be tightened about once per turn to hold the winding rigid. Leave sufficiently long wire tails for later connection to C1 and C2.

The above eight-prong wound loop frame is bolted to one end of a 23" x 0.8" x 0.8" vertical timber support (Figure 5), the other end of which is screwed and bracketed to a 12" x 9" x 1" base. For the base, a gray inverted TV snack tray was used, which lost its original identity and provided an attrac-

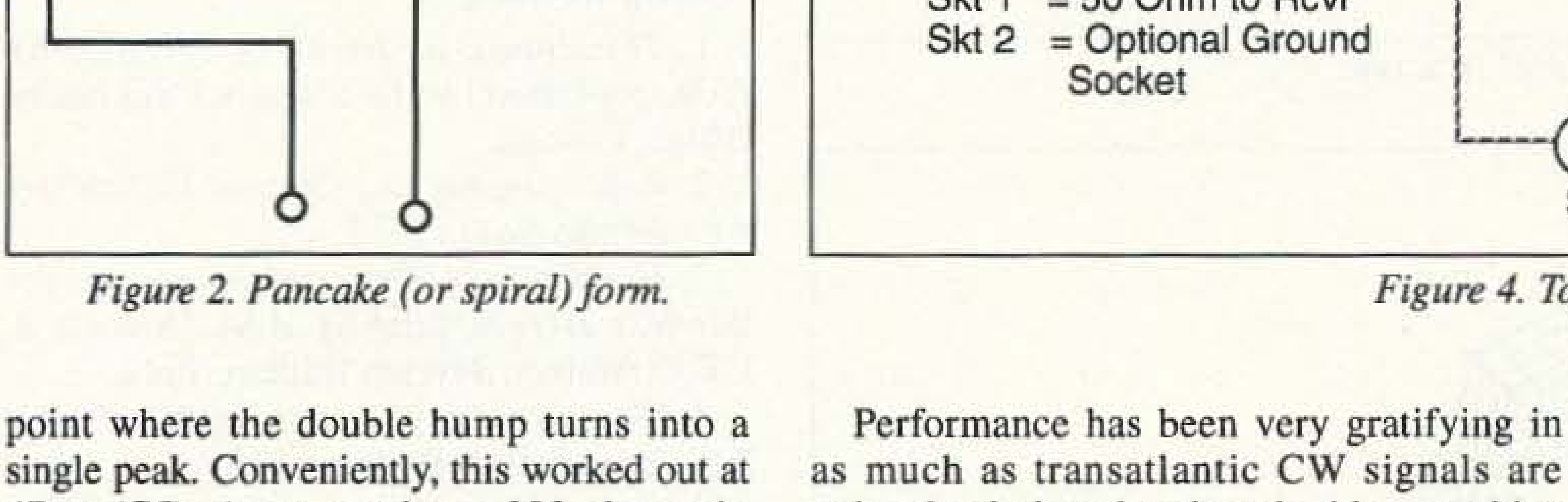

Figure 3. Typical polar diagram of reception.

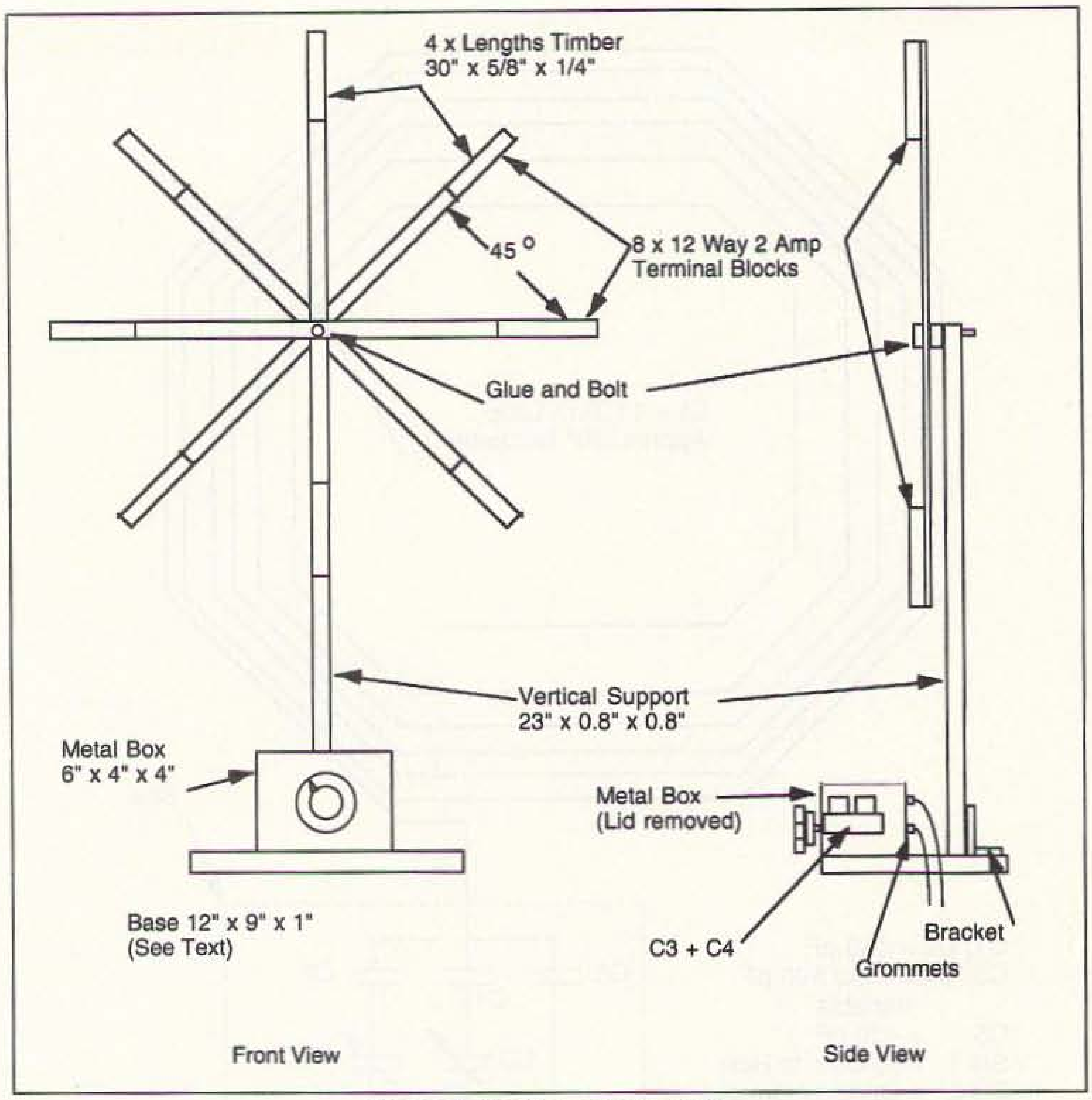

Figure 5. Mechanical structure.

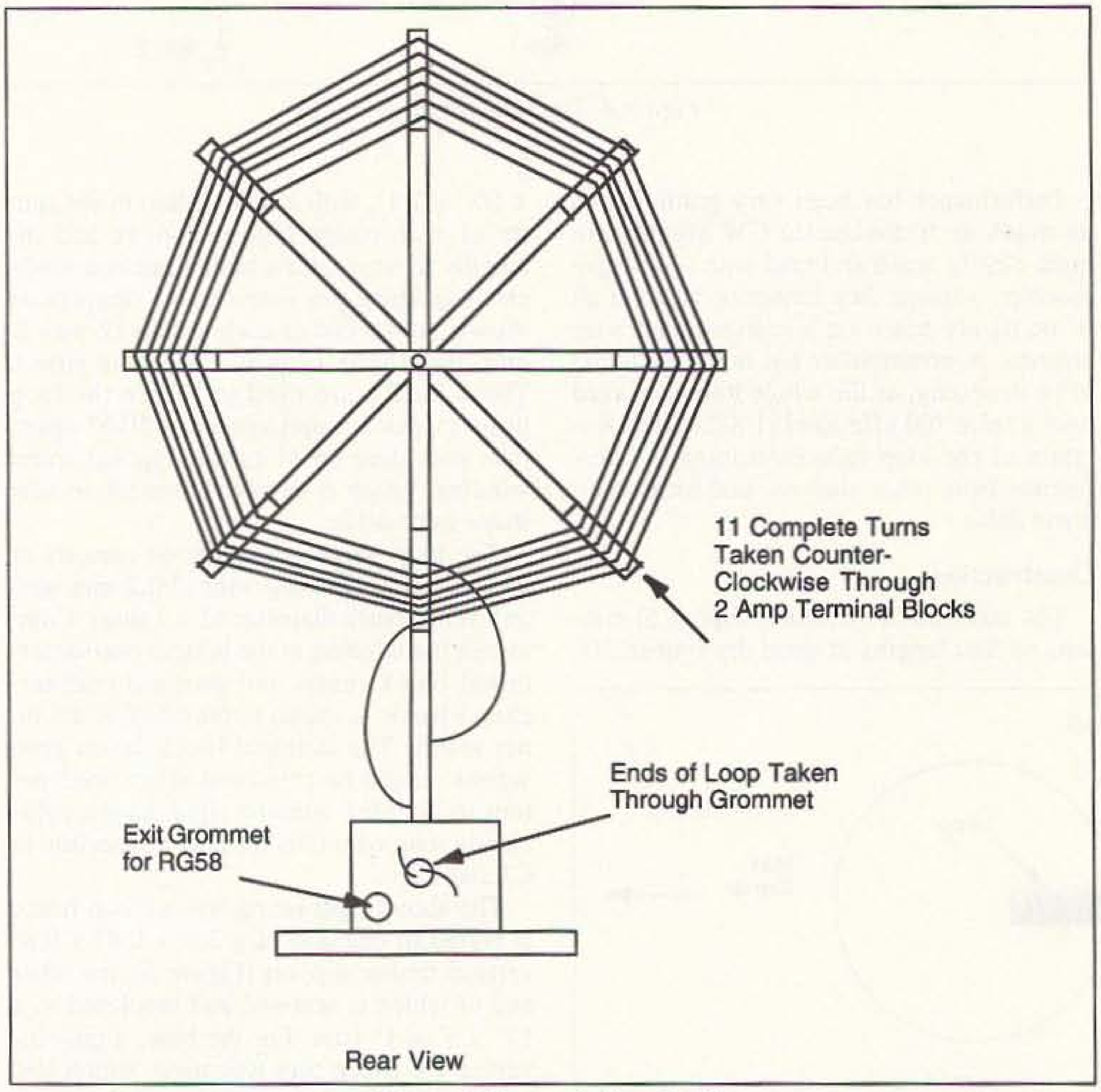

Figure 6. Loop winding detail.

tively-shaped molded base. As the base is 1" deep, it is weighted with a strip of 3/4" wood underneath. Other base construction ideas will come to mind. The metal box used measures 6" x 4" x 4", and has a removable lid mounted as shown in Figure 5. The box size is not critical. The variable capacitor C3 + C4 is mounted on the front panel as shown. The two ends of the loop are taken through an insulated grommet in the center rear of the box (Figures 5 and 6). Sixty inches of RG58 coaxial feedline is taken through a rear grommet, or via a coaxial socket to the receiver (Figure 6).

Operation

With the loop connected to the receiver, tune the latter to 2 MHz and rotate C3 + C4 to maximum signal, which should occur with the rotor plates not more than 5% enmeshed. Repeat this procedure at 1.8 MHz. When tuned to a signal, the loop should be rotated for maximum signal. Rotation either side of this point will reduce/eliminate interference from other stations, and specific manmade interference. You will find that the loop will tune to the HF end of the medium wave broadcast band but performance starts to fall off below 1700 kHz, as the loop has been designed for peak performance between 1.8 MHz and 2 MHz only.

***Useful Reading**

1. *Handbook of Wireless Telegraphy 1938*, published by His Majesty's Stationery Office, London.
2. *Radio Engineering* (Second Edition) by F.E. Terman Sc.D., 1937.
3. *Handbook of Technical Instruction for Wireless Telegraphists* by H.M. Dowsett & L.E.Q. Walker, Seventh Edition, 1942.
4. *Measurements in Radio Engineering* by F.E. Terman, First Edition 1935.
5. Others: *Antennas* by Kraus and *The ARRL Antenna Book*.

Parts List

C1,C2	150 pF silver mica capacitors
C3 + C4	2 gang x 500 pF per section robust variable capacitors
C5	470 pF silver mica capacitor
Skt 1	Coaxial feedline RG58 60" long maximum
Skt 2	Optional earth-connecting socket
Wire	PVC hook-up wire 7/0.22 mm and 1.2 mm o/d
8	2 amp polythene terminal blocks
4	Dry timber lengths 30" x 5/8" x 1/4"
1	Vertical support: dry timber 23" x 0.8" x 0.8"
1	3"-diameter instrument knob
1	Box, typically 6" x 4" x 4", with removable lid
1	Base, approximately 12" x 9" x 1"
2	Plastic grommets