

# The Discriminator

*A directional receiving antenna for hams and SWLs.*

by Richard Q. Marris G2BZQ

The Discriminator is a ferrite loop high performance experimental directional receiving antenna, designed for use between 1600 kHz and 4000 kHz. This frequency range covers the 80 and 160 meter amateur bands, marine beacon and communication bands, some aircraft activities and, of course, a large number of broadcast stations worldwide. It should be of interest to both the TXing and SWLing amateur.

The circuit is pictured in Figure 1. The design will produce a perfect figure-eight polar diagram with acute nulling at 90 and 270 degrees (Figure 2A). In addition, with

the aid of an optional sensing rod antenna, the polar diagram can be changed to a cardioid configuration, as shown in Figure 2B.

Mounted on a turntable, the Discriminator will eliminate QRM and QRN, and also, with some practice, will, if required, give direction-finding facilities.

The Figure 1 circuit shows a balanced ferrite rod loop L1 tuned by C1A and C1B, coupled to the receiver's 50 ohm input via L2. The nickel zinc ferrite rod is unusually 15" long and 1/2" in diameter. This long rod substantially in-

creases the RF signal voltage. The winding width of L1 is about one ninth of the total rod length, so very acute nulling is achieved, to a far greater extent than would be expected with a single 7-1/2" or shorter ferrite rod. For those not requiring sensing facilities, the ferrite loop L1, C1A, C1B, and L2 can be used as an efficient entity (see the right side of the assembly profile in Figure 3).

To produce an optional cardioid polar *Continued on page 18*

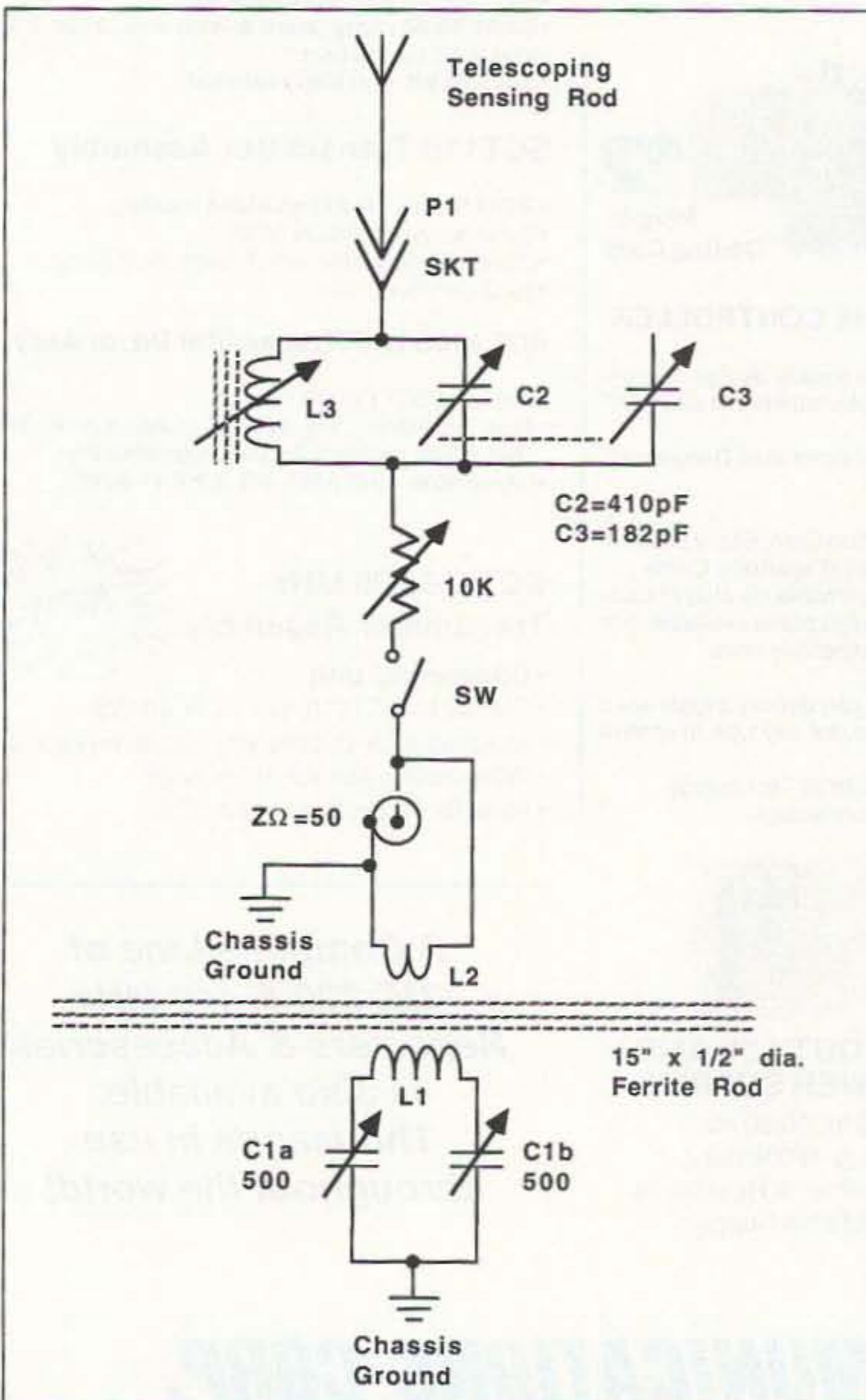


Figure 1. Circuit.

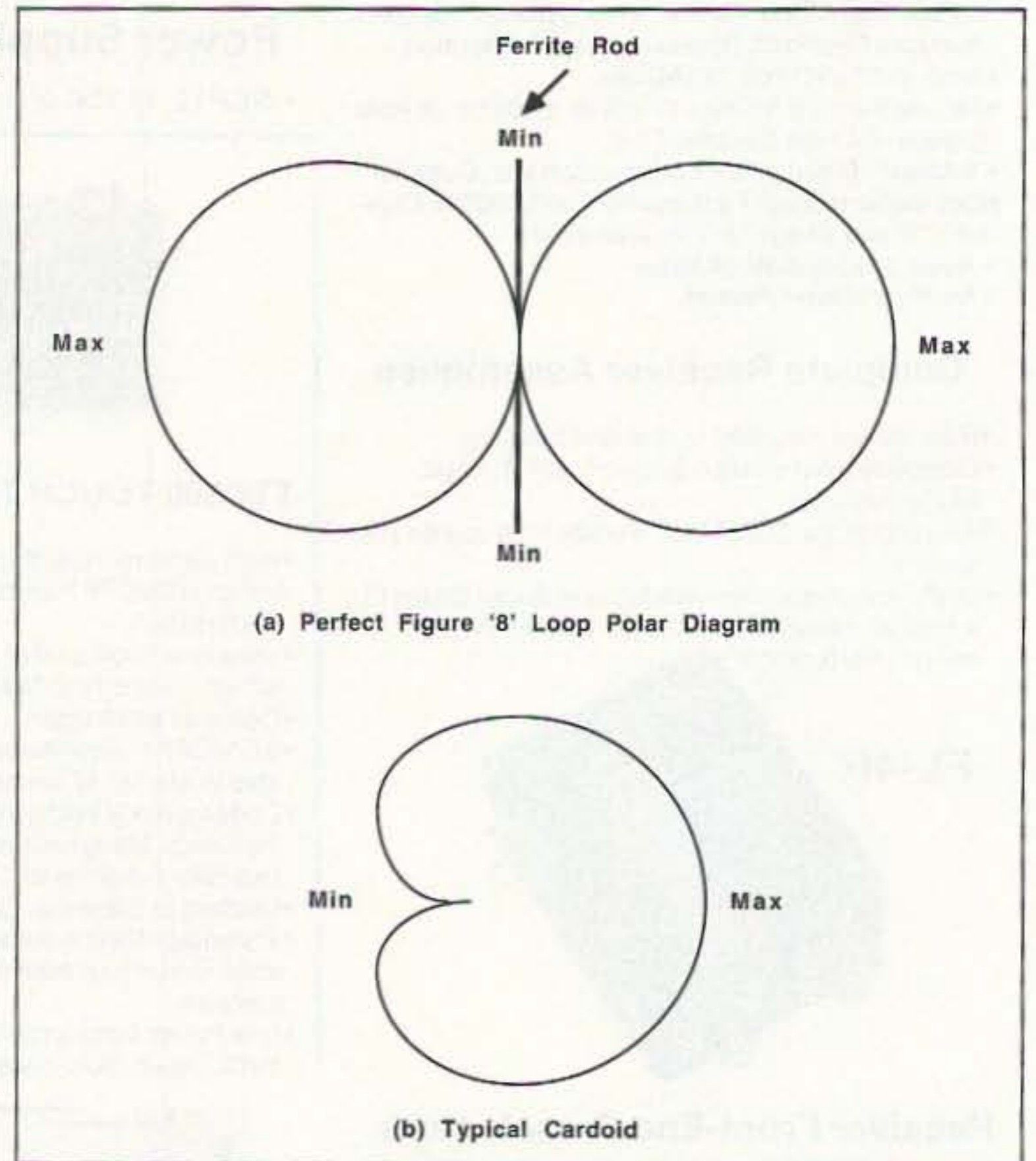


Figure 2. Polar diagrams.

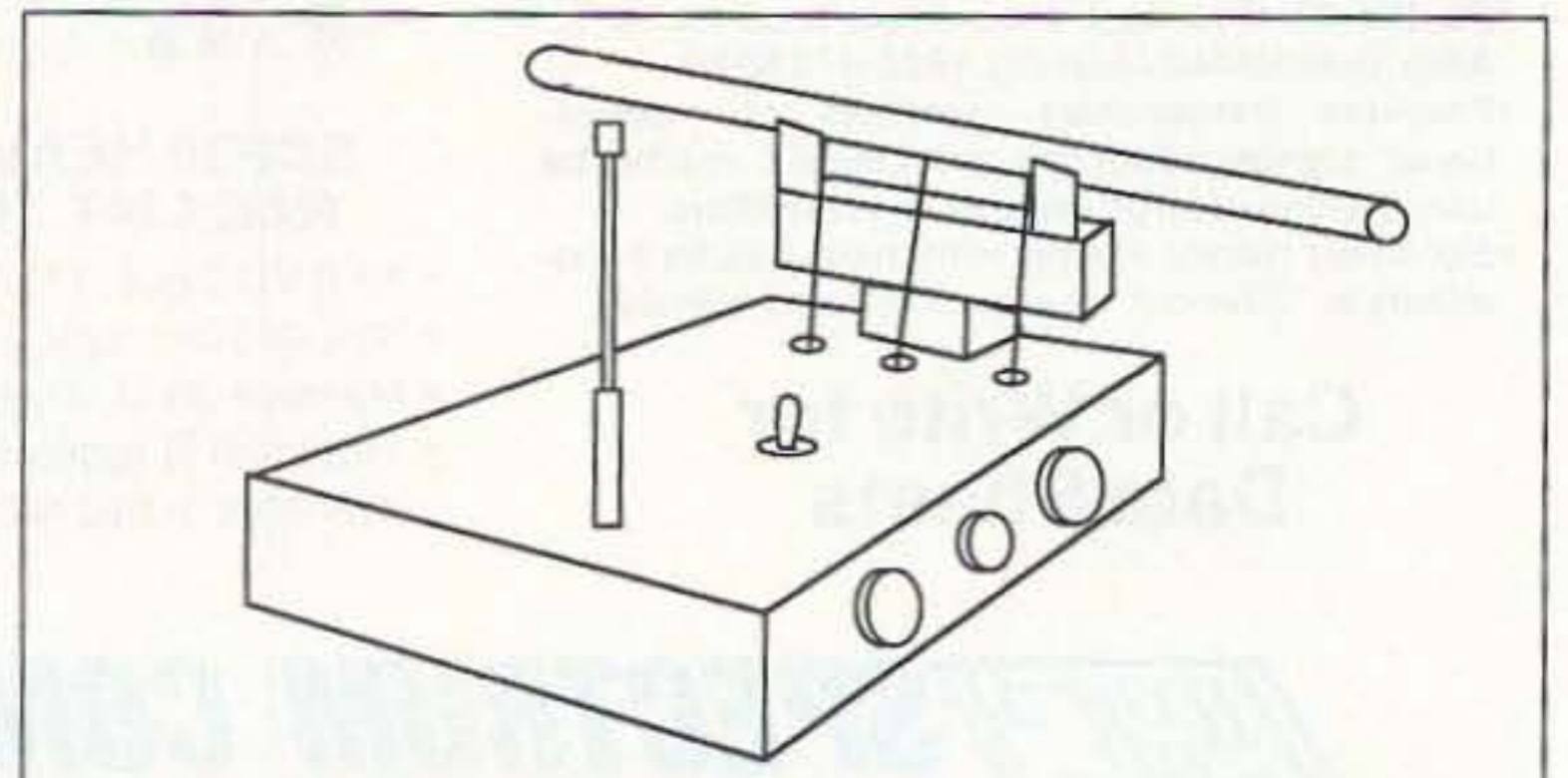


Figure 3. Profile.



diagram (Figure 2B), the sensing circuit consists of a short vertical sensing rod resonated to a quarter wave by  $L3/C2$ , with a 10 kilohm variable phasing control resistor  $R$ . The switch  $SW$  enables this sensing circuit to be switched in/out when required (described later in this article).

The original very experimental proving model was assembled on a sheet of circuit board, with the sensing rod stuck out on a wood boom arm. Two things became immediately apparent: A 15" horizontal ferrite rod was very vulnerable to damage and would require protection; and the vertical sensing rod, on its horizontal boom together with a 15" rod, produced a most ungainly and unwieldy contraption. The problem was solved with chassis construction: a robustly protected ferrite rod assembly, and a plug-in telescopic sensing antenna rod.

### Construction

The whole final assembly was built on an aluminum chassis size 8" wide x 2-1/2" deep x 2-1/2" high. The profile (Figure 3) and layout (Figure 4) shows the horizontal 15" ferrite rod on the right, with the control knob of resonating capacitor  $C1A$  and  $B$  to the righthand front. The vertical sensing rod plugs into extreme left with the resonating capacitor ( $C2$ ) knob in front. The phasing resistor knob is in the center front, with switch  $SW$  above on the chassis. A very essential dimension is the 6-1/4" distance between the sensing rod and ferrite rod. If the cardioid sensing facilities are not required, then the chassis width could be reduced to 3" or so. If necessary, there is room for a wideband RF amplifier under the chassis, which has a removable bottom plate.

The chassis underside (Figure 4) is self-explanatory.  $C1A+B$  is a conventional 500 + 500 pF U-frame variable capacitor, mounted on the chassis front.  $C2 + C3$  is a similar 410 pF + 180 pF variable mounted on an insulating bracket, with insulated control shaft. Variable resistor  $R$  is direct on the chassis front.

$L2$  consists of 30 close-wound turns of 22 gauge enamel copper wire wound on the end of a 1-1/2" x 1/2" diameter paxolin tube, and fitted with flex ends. The 3/8" diameter ferrite rod was cut to 1-1/2" from a length of salvaged rod from an old radio.

The step-by-step fabrication of the ferrite rod  $L1$  and  $L2$  assembly is shown in Figures 6 and 7. Two 7-1/2" long x 1/2" diameter nickel zinc ferrite rods, type R61-050-750, are adhered end to end (see Figure 6A). The rods' ends are cleaned with fine glass paper, and adhered together with a cyanoacrylate adhesive (e.g. Superglue). It sets within a few seconds. Next, wind one turn of 4"-wide self-adhesive label at the rod center (see Figure 6B).  $L2$  is close-wound using 36 turns of 0.9mm o.d. PVC-covered 10/0.1mm connection wire (see Figure 6C), with the ends held in position 4" apart by 1"-wide masking tape. Over this wind two turns of 1"-wide masking tape at the center of  $L1$ , over which wind four turns of PVC

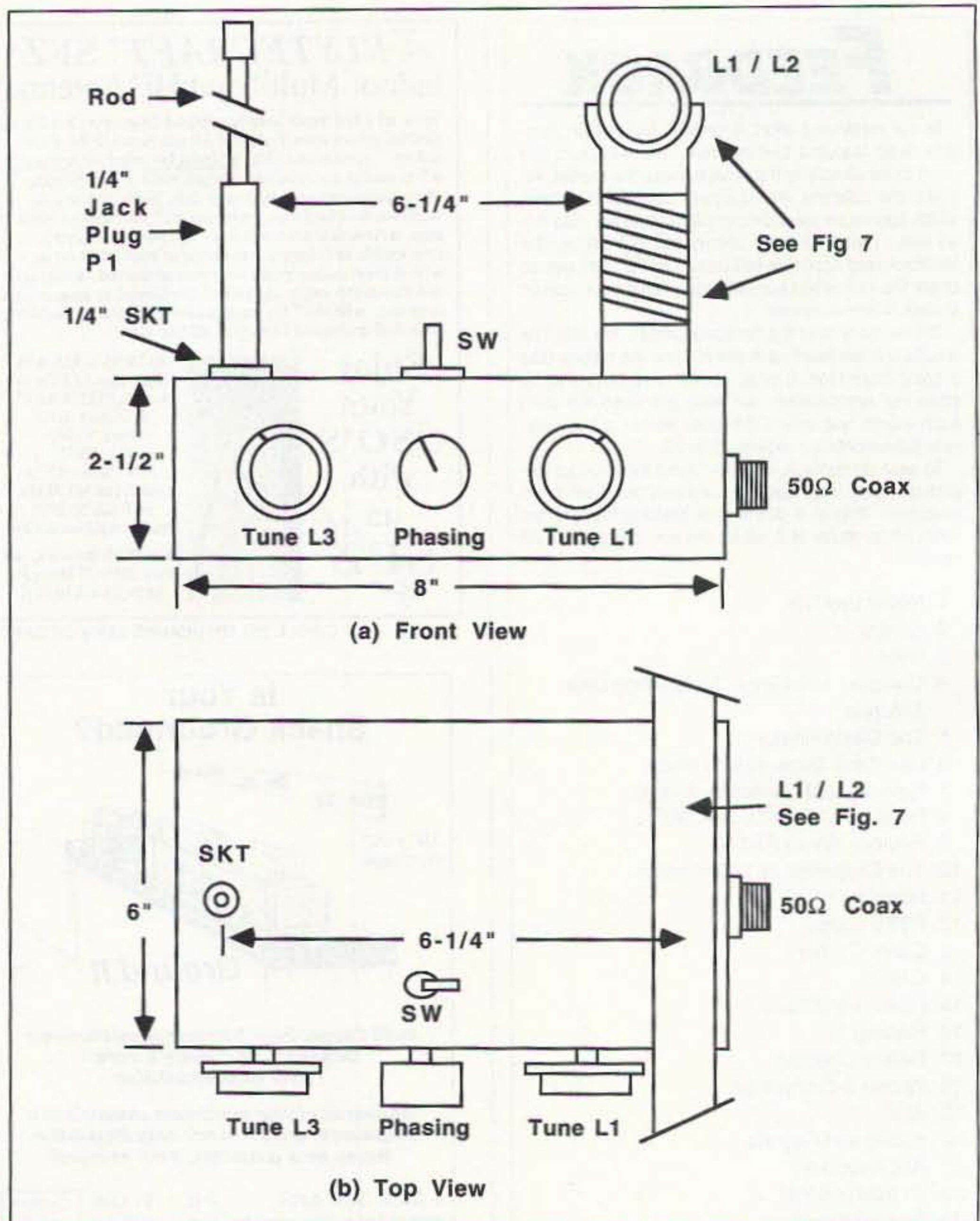


Figure 4. Layout.

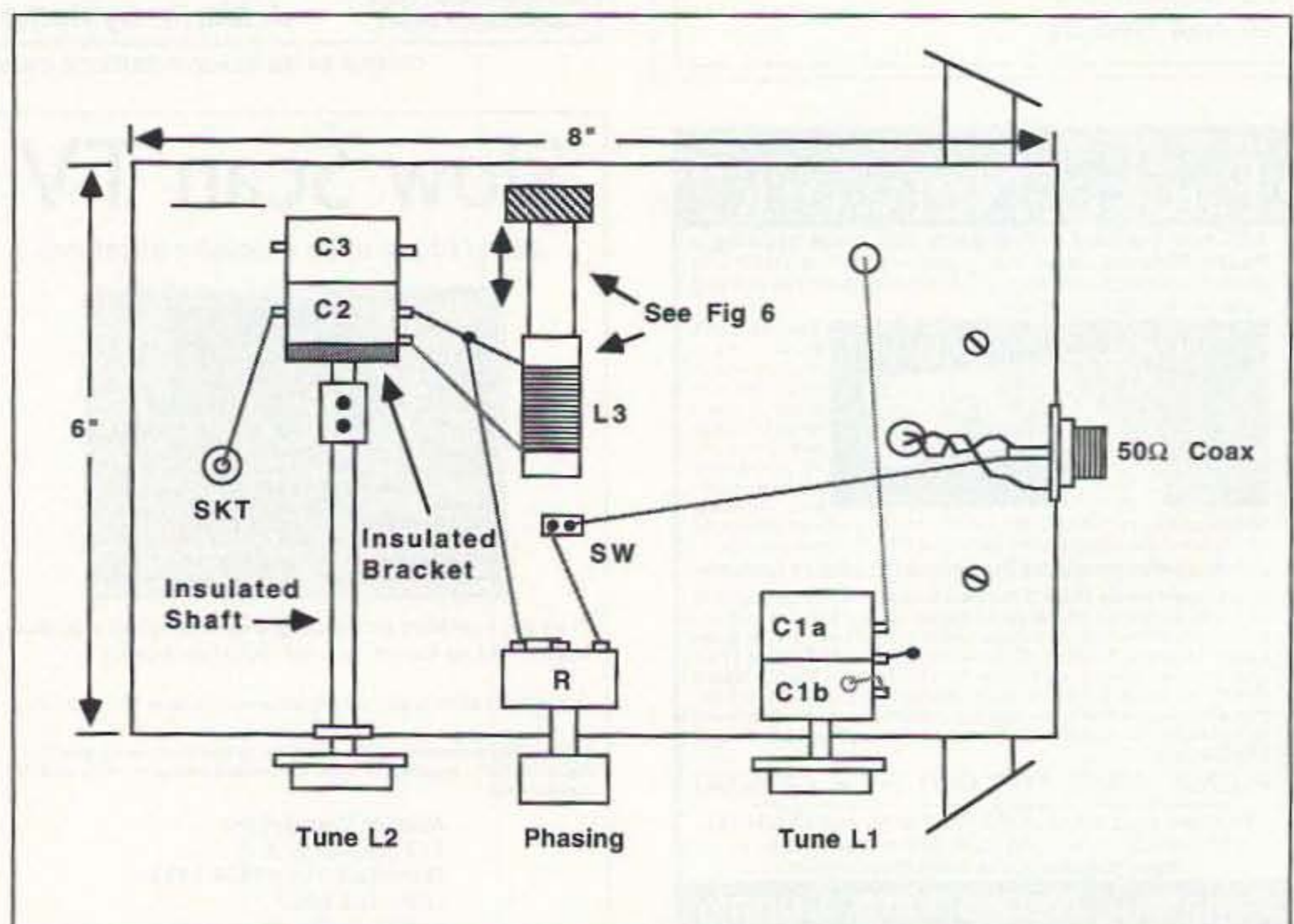


Figure 5. Underview.



hookup wire, with the ends twisted lightly together, as shown in Figure 6D.

The above assembly is protected and mounted, as shown in Figure 7A, in a 16" length of 7/8" o.d. PVC pipe used in plumbing, mounted and held in place on a robust "T"-shape wood frame and held to the main chassis with wood screws. Three 1/4" diameter wire exit holes are drilled in the tubing, one at the center and the others 4" apart as shown in Figure 7C. The rod/winding assembly is inserted into the tubing and the coil wire ends pulled through the 1/4" holes. The rod ends are supported by coils of 2"-wide thin coiled card, inserted into the ends of the tube around the rod ends. The "T" support, shown in Figure 7B, is made of dry timber, varnished, with two plastic tubing wall clips screwed on either end (shown in Figure 7B).

The plug-in sensing antenna rod is a standard 20" telescopic whip. The end is soldered to a 1/4" plastic-sleeved jack plug center connection. A corresponding jack socket is fitted to the main chassis (see Figures 4A and Figure 5). The distance from this socket to the center of the ferrite rod assembly was calculated by experiment and is 6-1/4" (see Figures 4B and 4A).

The whole underchassis assembly and wiring is shown in Figure 5.

### Setting Up

The unit should be connected to the receiver input with not more than 36" of RG58 coaxial feedline. Set-up procedure is as follows.

(1) Ferrite Rod/L1/L2 Assembly: With the sensing rod removed and the switch OFF, set the receiver to a signal around 2000 kHz and rotate C1A and B to resonance. Rotate the unit for maximum signal—see the polar diagram in Figure 2A. Rotate the unit to check the acute nulling. Repeat this operation at 1600 and 4000 kHz. and spot frequencies in between. The prototype covers from 4100 kHz to below 1600 kHz. This part of the unit can, as previously mentioned, form a self-contained, highly efficient ferrite rod antenna on a reduced 3" wide chassis, producing the polar diagram shown in Figure 2A.

(2) Sensing Rod Circuit: Plug in the telescopic whip, put the switch to OFF and rotate C2 to near minimum capacity. Tune the ferrite loop to a signal at 4000 kHz with C1A+B; put switch SW to ON and, with the phasing resistor at around midposition, slide L3 along the short ferrite rod (see Figure 6) until resonance is found, then seal L3 to the

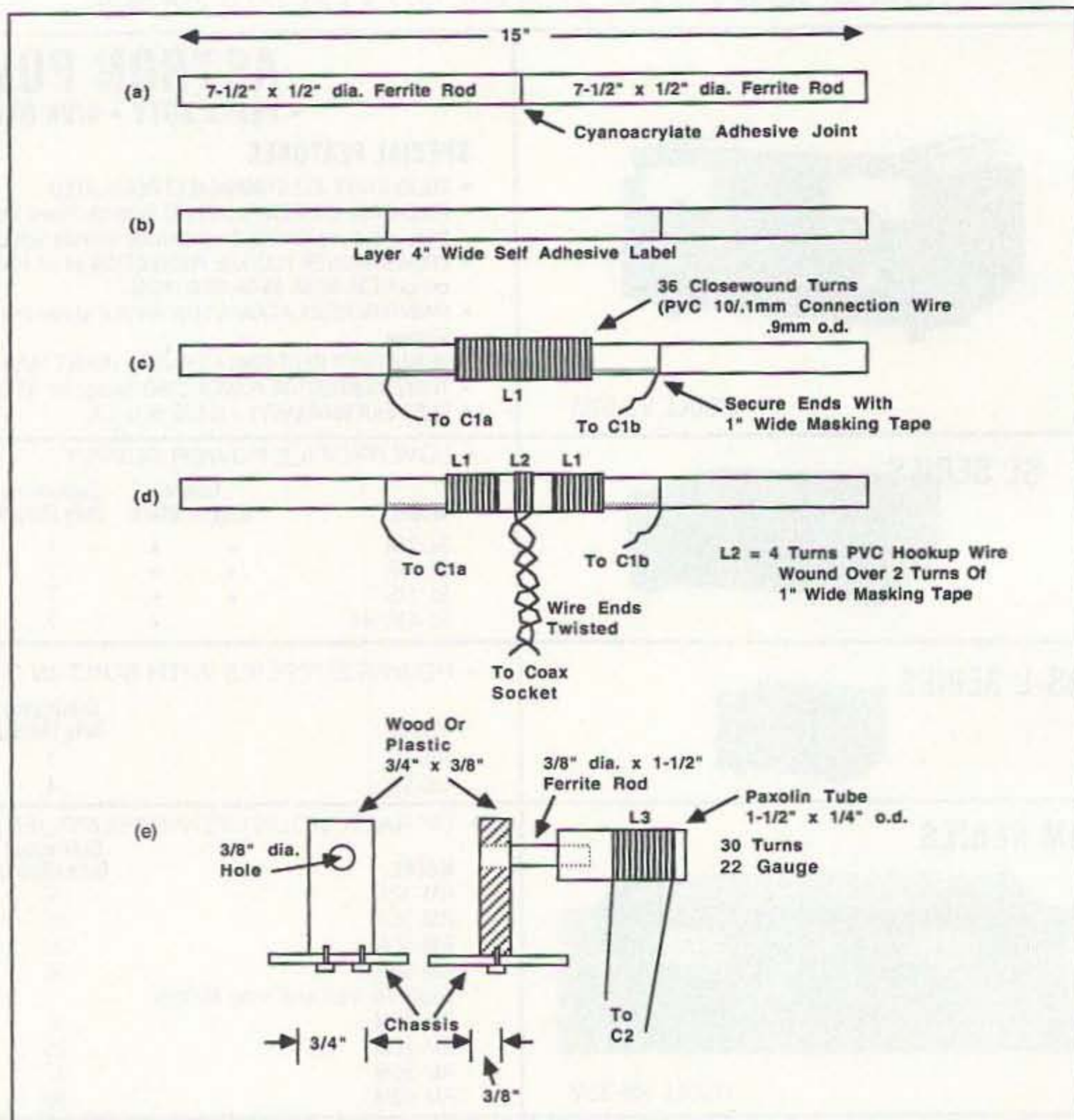


Figure 6A, B, C, D: Ferrite L1 and L2 assembly; E: coil assembly.

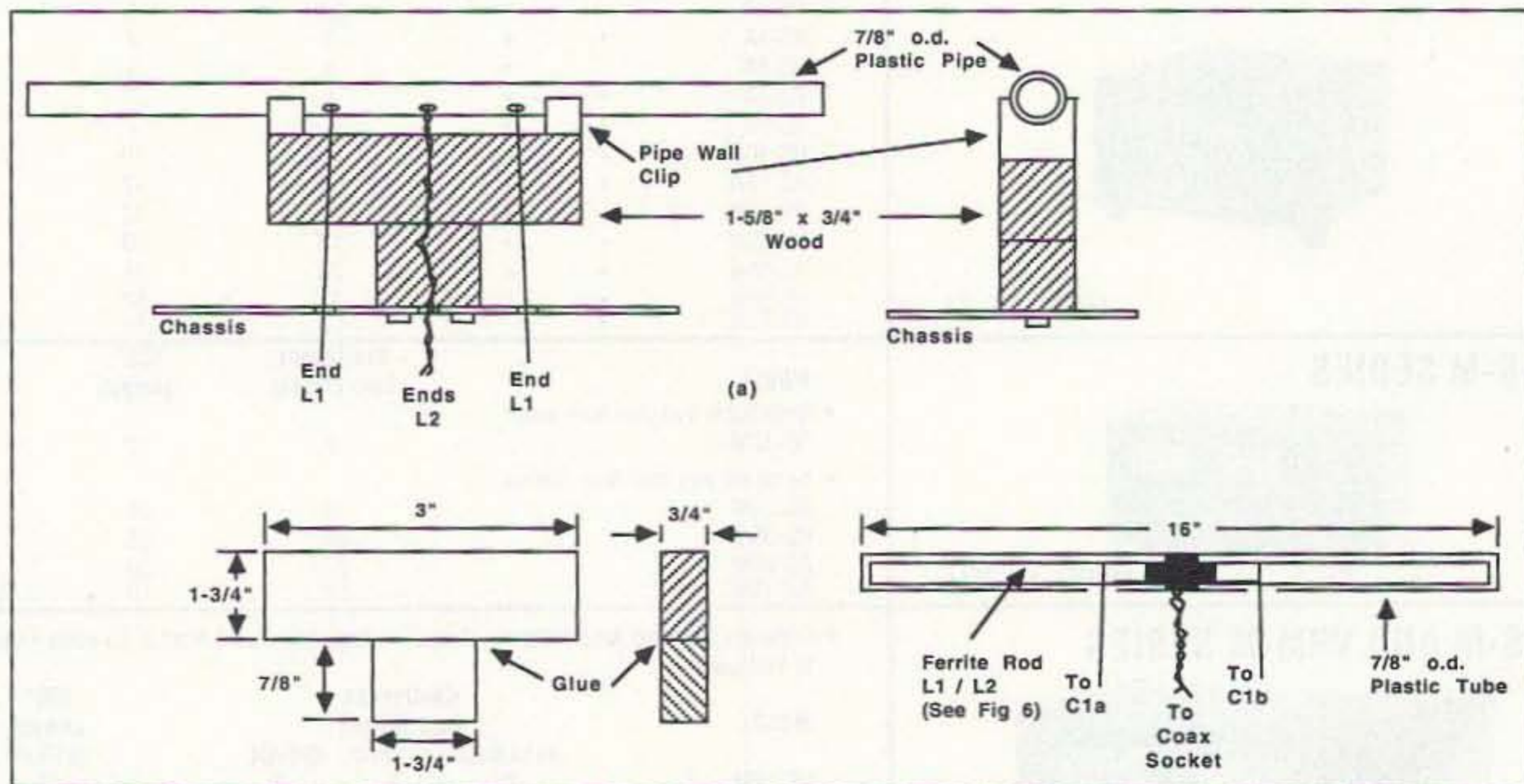


Figure 7. Ferrite rod coil and support assembly.

rod with hot candle wax. The sensing rod circuit should now operate between 4000 and 1600 kHz. It can be extended down frequency by connecting C3 in parallel with C2.

### Operation

In operation with the ferrite loop used with the sensing circuit in the OFF position,

tune C1A + B to the required frequency. Maximum signal is *broadside to the ferrite loop*, and minimum signal is on the rod ends. The nulling is extremely sharp and eliminates most QRM and QRN. The chassis bottom plate must be fitted for full screening. With a high RF gain receiver a preamplifier has not been necessary but, if required, a wideband RF amplifier circuit



board can be fitted underchassis.

With sharp nulling and a figure-eight polar diagram, it is possible that a station on the 180 degree reciprocal bearing could interfere with the wanted station. If this occurs, the sensing switch can be switched on to change the polar diagram to the cardioid pattern (Figure 2B), with a large single forward lobe, and the null now at the back. With C2L3 tuned to resonance and the telescopic whip 17" long, the phasing resistor should be adjusted so that signals from

the sensing rod and ferrite are equal in amplitude. In practice, the cardioid null is not as pronounced as that shown in Figure 2A, but the forward lobe is larger. So, in practice, with a flick of the switch it is possible to change from one polar diagram to the other.

Introduction of the sensing rod also enables the user to find the directional bearing of a station, assuming a simple turntable is placed under the unit. It will also indicate the bearing of persistent QRN. 73

### Parts List

Qty.	Description
2	Ferrite rods, 7-1/2" long x 1/2" diameter; type R61-050-750 (Available from Amidon Associates Inc., 2216 East Gladwick Street, Dominique Hills CA 90220 USA
1	2-gang 500 + 500 pF variable capacitor with knob
1	2-gang 410 + 182 pF variable capacitor or single-gang 400 pF (such as 500 pF with series capacitor) insulated coupler shaft and knob
1	10k ohm carbon track variable resistor with knob
1	1-1/2"-long x 3/8"-diameter ferrite rod (cut some BC receiver-type rod)
1	1-1/2" x 1/4" o.d. paxolin or plastic tubing
1	Aluminum chassis with bottom plate, 8" x 6" x 2-1/2"
1	20"-long telescopic antenna whip
1	1/4" (6 mm) mono jack plug with plastic (not metal) sleeve
1	1/4" mono jack socket
1	Mini ON/OFF toggle switch
1	Chassis mounting coaxial socket plus 36" maximum RG58 feedline with suitable plugs
1	16" length of 7/8" o.d. UPVC plumbing piping with two standoff wall clips
Wood	1-3/4" x 3/4", one piece 6" long and one piece 7/8" long
	1-3/4" x 3/4" x 3/8" hardwood
Wire	22 gauge enamel copper wire for L3
	PVC 10/0.1mm connection wire 0.9mm overall o.d. for L1
Sundries	1"-wide masking tape; cyanoacrylate adhesive (Superglue or similar); nuts, bolts, washers and roundhead brass wood screws

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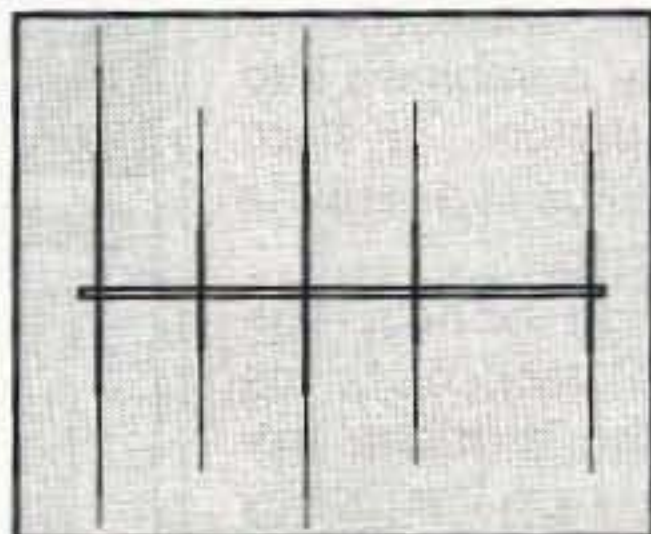
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