The WEETENNA

An Electrically Shortened Multi-Band Dipole To Fit Whatever Space Is Available

No, this is not your basic leprechaun antenna only seen on St. Patrick's Day. It is, however, small enough that the little guy himself might use it at his own QTH.

BY GEORGE MURPHY*, VE3ERP

Every amateur is always looking for the "Magic Antenna"—one that works all bands, occupies no space, and costs nothing. In spite of past wild claims to the contrary by many self-acclaimed Antenna Know-It-Alls (including me), there is no such thing. The WEETENNA, however, comes close.

The WEETENNA concept is shown in fig. 1. Simple, right? WRONG! The idea is simple, but unless you or a friend has access to a computer, carrying it out can be extremely intimidating due to the dreadful mathematics that are involved. The WEETENNA is based on the principle of the off-center loaded dipole, with lumped-constant loading.[1] If that very full mouthful does not nauseate you, a look at the design equations will. *(We decided not to publish the equations here for fear they might scare you off—ed.)*

How then can one design a WEETENNA without equations? Simple. With the aid of a computer and free software called HAMCALC, a collection of more than 80 programs dealing with amateur radio.[2]

HAMCALC will design a WEETENNA as fast as you can input the required data, which consists of only the center frequency of the portion of each band you want to work and your choice of the overall length of the proposed dipole antenna array. If you decide to wind your own coils with insulated wire, you will also be asked to wind a short length of the insulated wire you want to use around a ruler so as to determine the close-wound turns-per-inch for that particular wire.

The program is in two parts. The first part calculates the inductance required for a selected size of antenna wire at a given frequency (see fig. 8[A]), and the second part designs a coil of that inductance using the same size wire (see fig. 8[B]). There is no reason why you can't run the two parts of the program independently if you want to use different wire sizes for the coils and the antenna itself. As we shall see later, the physical design of the WEETENNA makes it possible to use relatively small wire for everything.
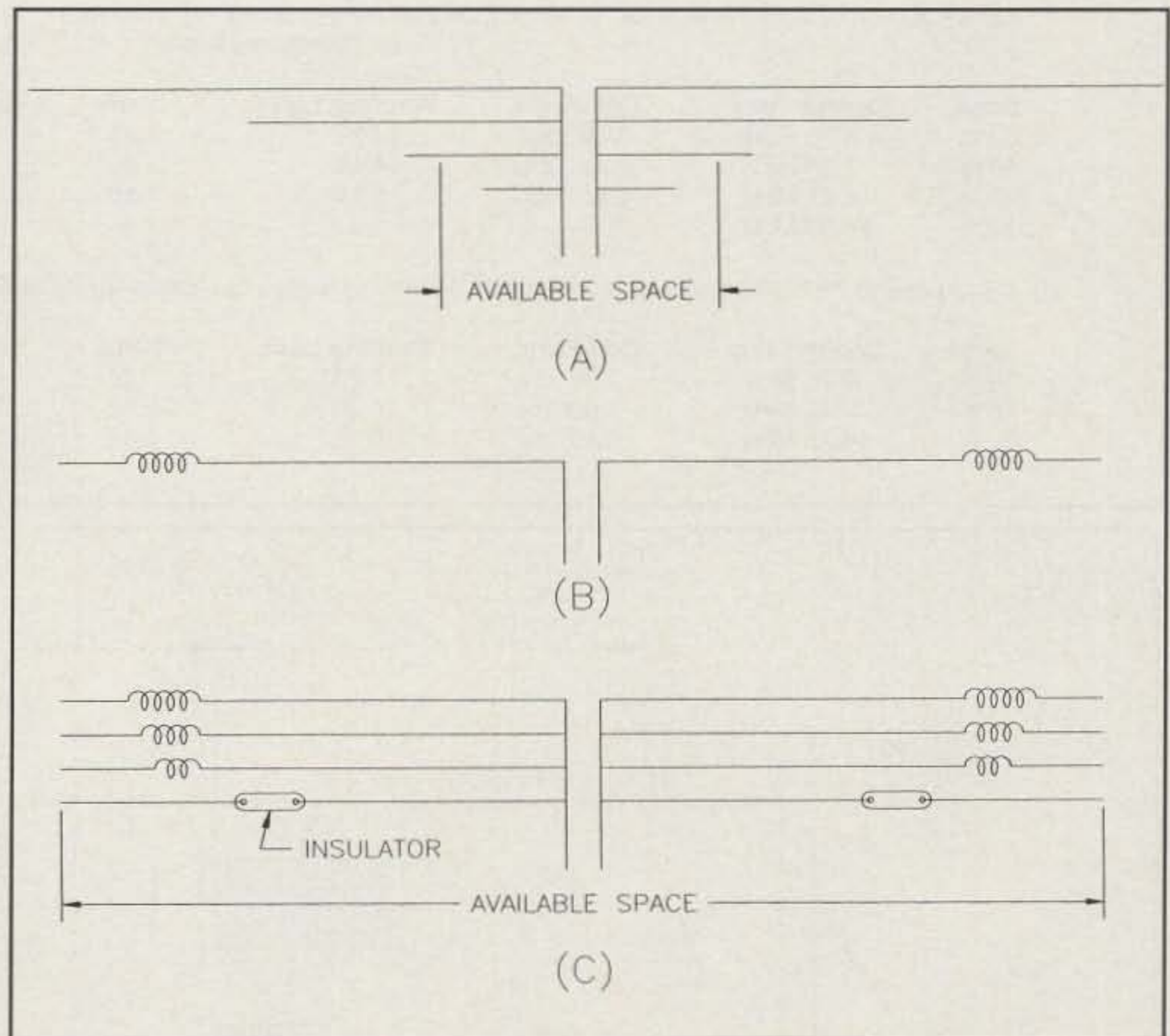
*77 McKenzie St., Orillia, ON L3V 6A6, Canada

Fig. 1– (A) TWAP (Time Worn And Proven) Multi-Band dipole—*several dipoles mounted one above the other originating from a common feed point fed by a single transmission line. Usually the space required exceeds the space available. (B) TWAP electrically shortened lumped-constant loaded dipole fed with 50 ohm coaxial cable (see text). Old Timers who lived in apartments often used this configuration by mounting two horizontally opposed TWAP center-loaded mobile whips bottom to bottom on a windowsill or balcony railing. (C) TWAP antennas (A) and (B) combined. Voilà! The WEETENNA!*

A 31 ft. WEETENNA For 80, 40, 20, and 10 meters

As an example, let's suppose you have space for a 31 ft. dipole, a roll of #18 insulated wire that close-winds at 9 turns-per-inch, and you want to center your operations on 3.750, 7.150, 14.250, and 28.600 MHz. HAMCALC comes up with the dimensions shown in fig. 2, letting you know that a 28.6 MHz dipole is only 16 ft. 4.1 in. long and no loading coils are necessary (see fig. 9 for details). When building your WEETENNA, you might want to add about 5% to the length of each leg that has no coil to allow for pruning later.
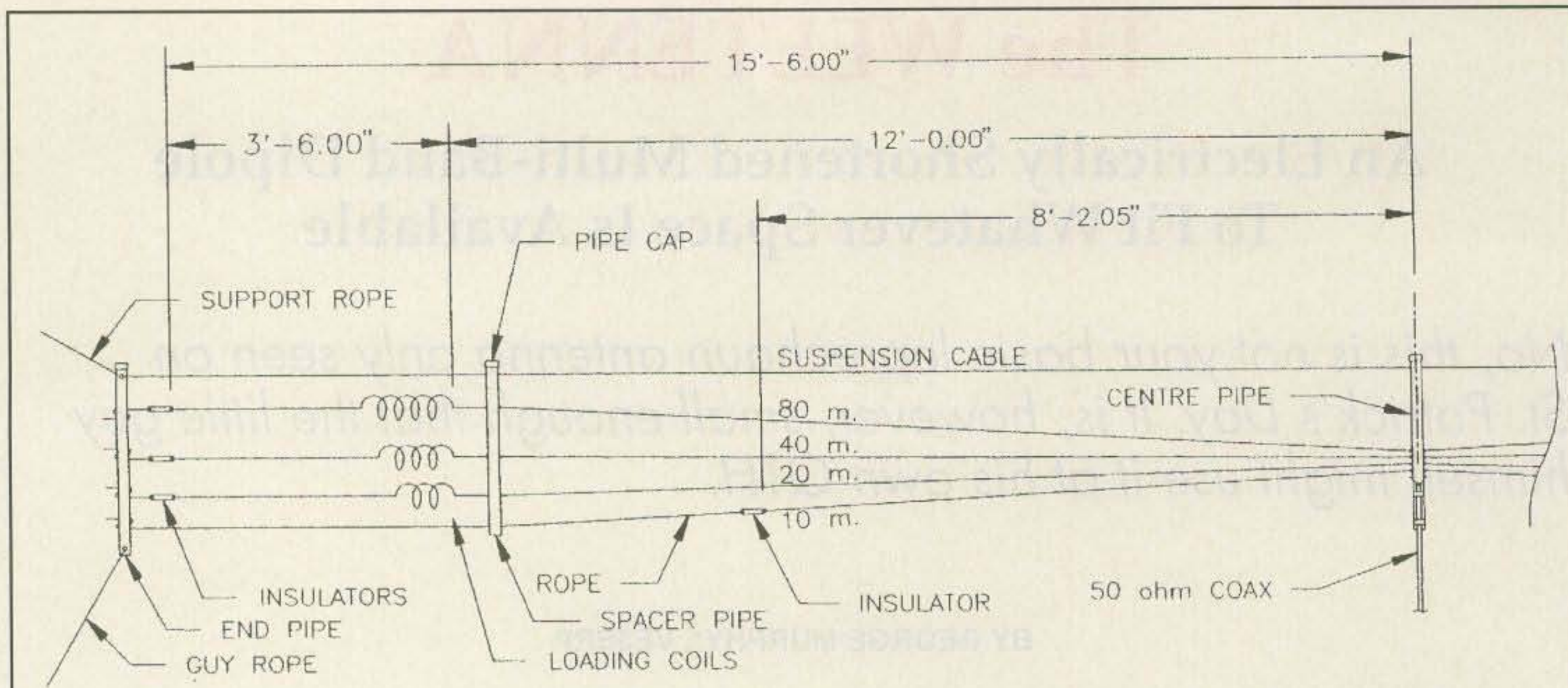
Fig. 2– A 31 foot WEETENNA for 80, 40, 20, and 10 meters using #18 insulated wire (see text). Close-wound loading coils for this example are:

Band	Center Freq.	Coil Form	Winding Lgth.	Turns	Inductance
80 m	3.75 MHz	4.50" dia.	7.89"	71	269 μH
40 m	7.15 MHz	2.88" dia.	4.78"	43	68 μH
20 m	14.25 MHz	1.66" dia.	1.11"	10	4.1 μH
10 m	28.60 MHz	—	—	—	—

If you were to make the same antenna of #24 enameled wire, which close-winds at 45 TPI, the coils would be as follows:

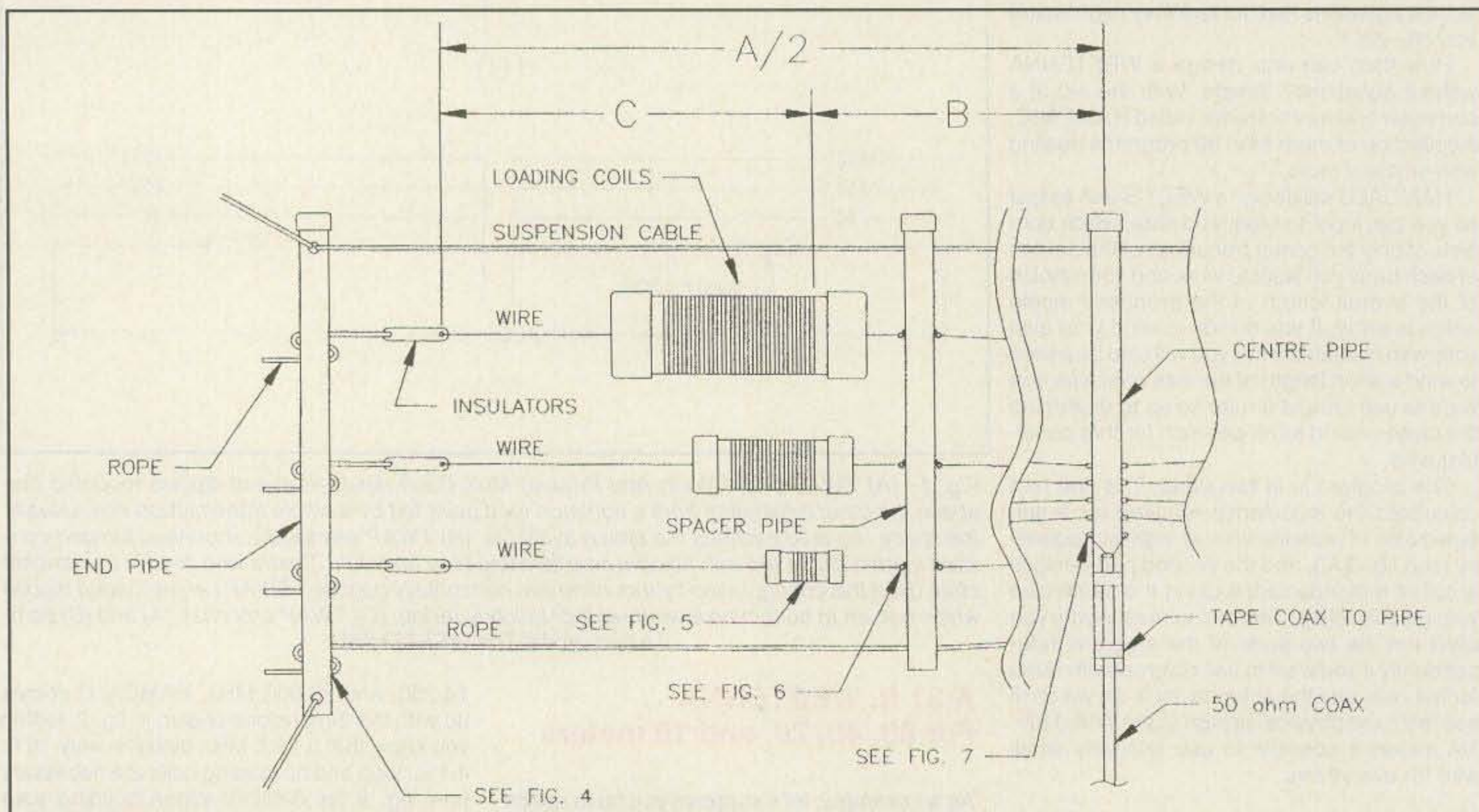| Band	Center Freq.	Coil Form	Winding Lgth.	Turns	Inductance
80 m	3.75 MHz	1.66" dia.	2.64"	119	295 μH
40 m	7.15 MHz	1.66" dia.	0.93"	42	74 μH
20 m	14.25 MHz	0.66" dia.	0.36"	16	4.5 μH

Fig. 3– Construction details for a typical WEETENNA. The suspension cable can either be polypropylene (nonstretching) rope or steel wire clothesline. Dimensions B and C are calculated by HAMCALC (see text).
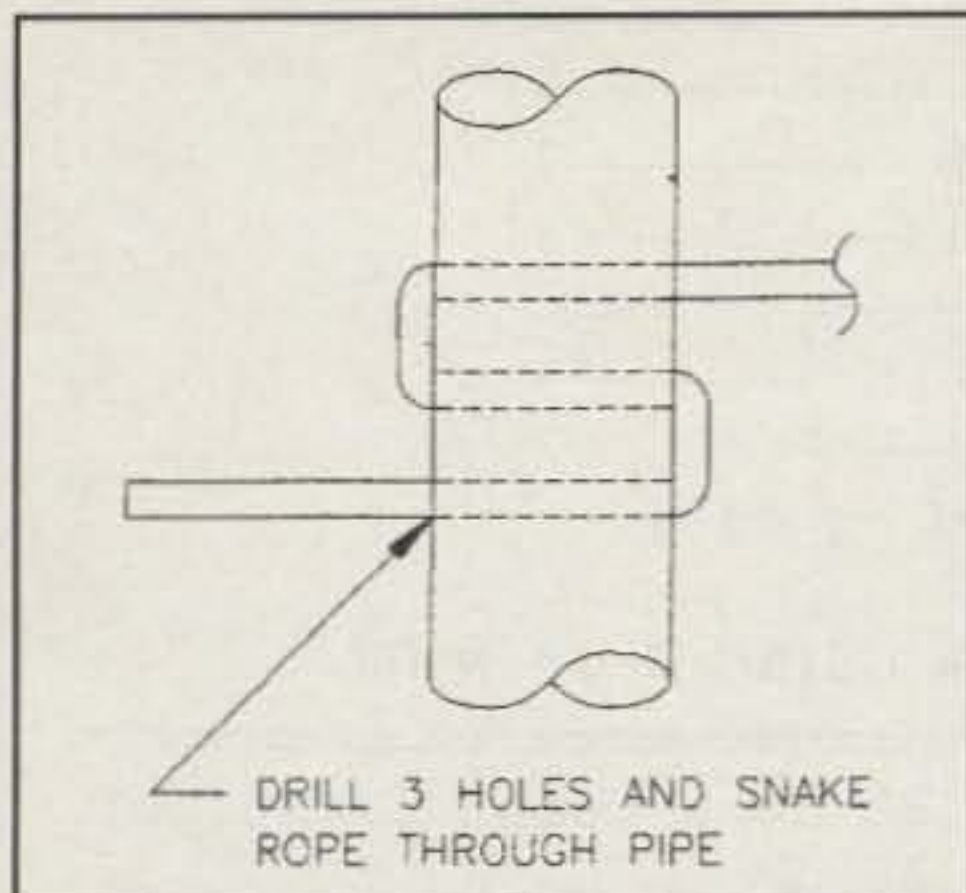
Fig. 4– Rope ends. The "snake" system of securing ropes makes adjustment easy. If you are worried about the ropes slipping (they probably won't), you can fill all the holes with silicone caulking.
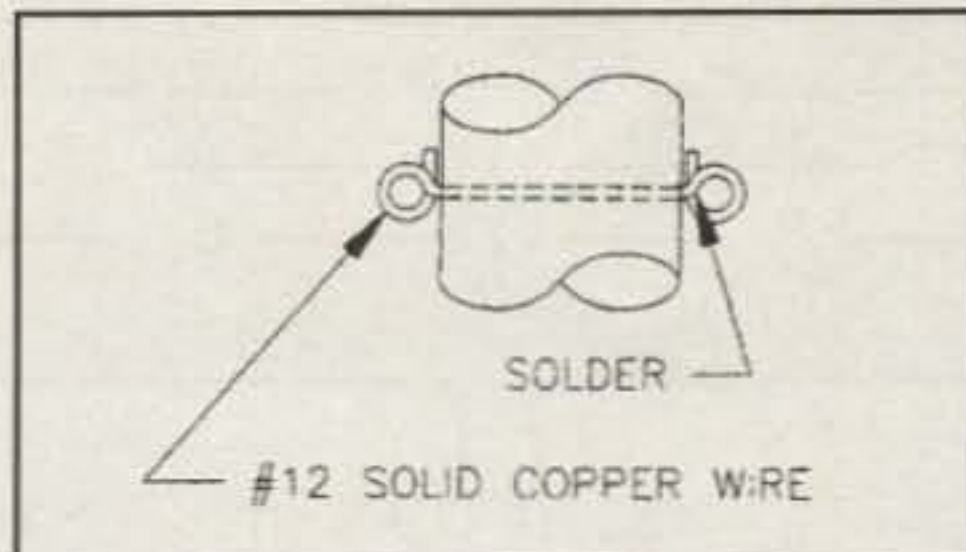
DRILL 3 HOLES AND SNAKE ROPE THROUGH PIPE

SOLDER
#12 SOLID COPPER WIRE

Fig. 6– Spacer pipe. Form loops around a 1/4 inch drill and solder junctions where wire crosses itself.

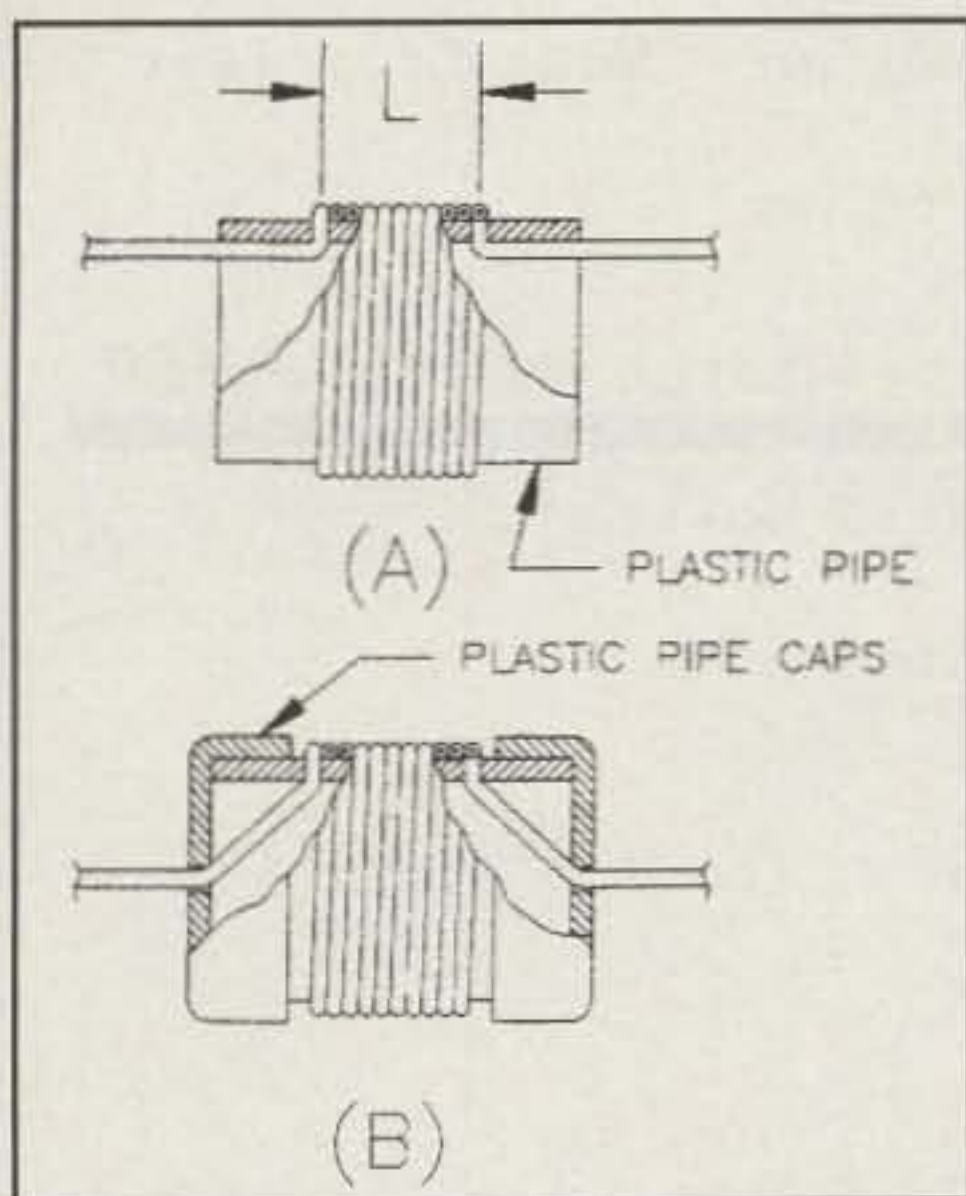(A) PLASTIC PIPE
PLASTIC PIPE CAPS
(B)

Fig. 5– (A) Coil forms. Drill holes in form spaced L apart where L equals length of winding. This will assure proper close-wound spacing of the turns. (B) For a professional touch install plastic pipe caps after final testing and pruning. Capless, large-diameter coils suspended below the wire as in (A) may whip around on windy days.
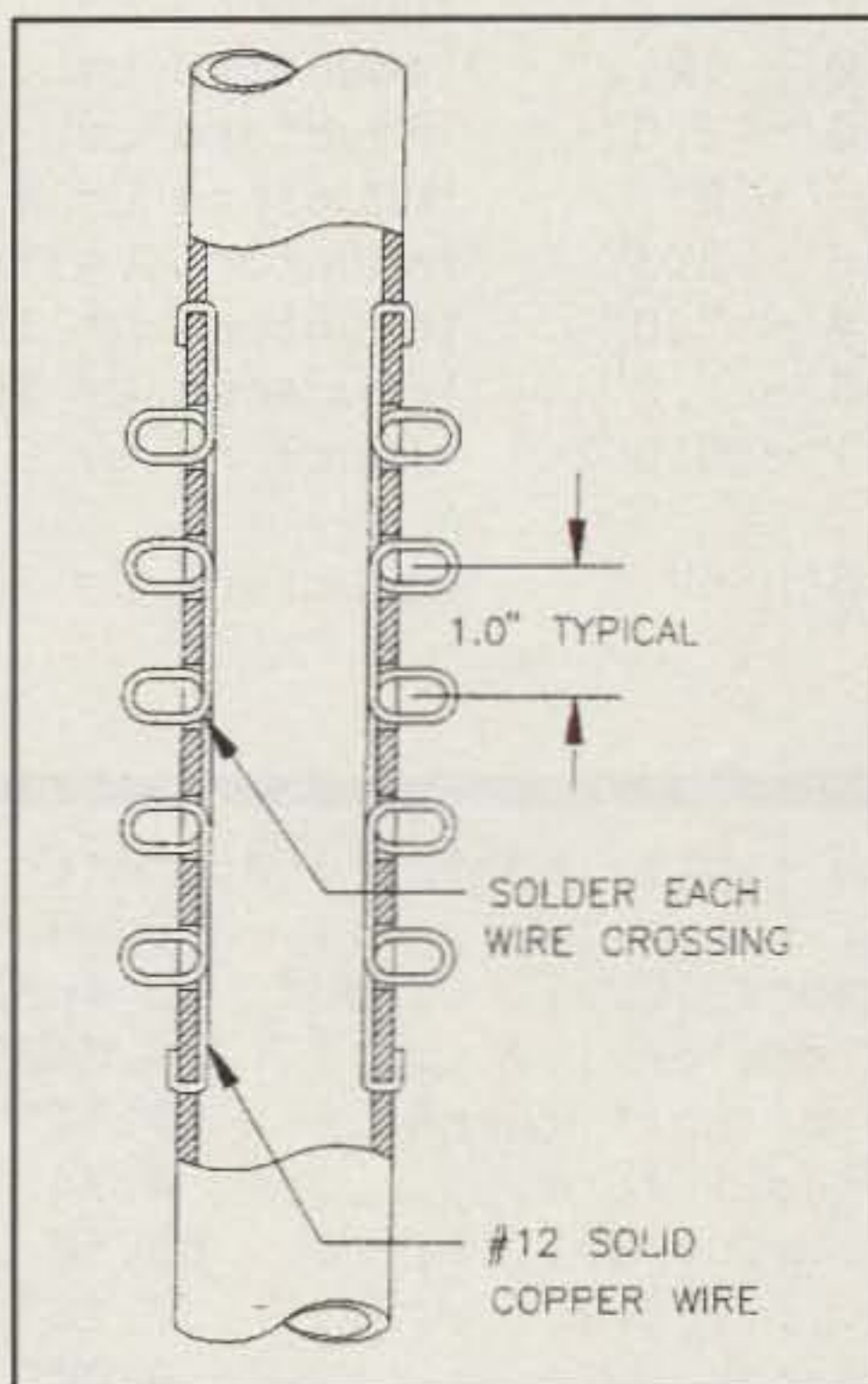

1.0" TYPICAL
SOLDER EACH WIRE CROSSING
#12 SOLID COPPER WIRE

Fig. 7– Center pipe. Drill 5/16 inch holes through pipe for wire loops. Form loops around a 3/8 inch drill, solder junctions where wire crosses itself, and then squeeze loops to about 3/16 inch inside dimension. Use #8 screws and washers to secure the antenna wires during testing and pruning. At final assembly stage solder wires to loops and seal all holes with silicone caulking.

Construction Details

The general arrangement of a WEETENNA is shown in figs. 2 and 3. It is hung from a suspension rope that takes most of the weight and tension off the antenna itself. This allows you to use small-gauge soft copper wire if you want.

Details are shown in figs. 3 through 7. You may, of course, use any construction method you want, but using cheap[3] and readily available plastic plumbing pipe for coil forms and spacers makes things simple. You can even make your own insulators out of small-diameter plastic pipe if your junk box does not yield any fancy ones. As with any antenna, seal the end of the coaxial feedline so that moisture cannot penetrate the cable, the exposed braid, or the insulation of the exposed center conductor. In other words, plaster the lot liberally with goop.[4]

When constructing the loading coils, leave a short pigtail on one end to connect to the spacer pipe and a long pigtail not less than dimension "C" long (see fig. 3) to terminate at the end insulator. If you install pipe caps (see fig. 5), secure them with goop, not plastic-pipe cement which will weld them in place forever, thus preventing future fiddling due to the average amateur's propensity for never getting it right the first time. Serious 30-Year Veteran Extra Class Antenna Know-It-Alls such as myself refer to fiddling with antenna boo-boos as "pruning."

Testing and Pruning

Testing and pruning of any antenna can be a frustrating experience, but not so with a WEE-

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《————————————————— 31' - 0" —————————————————》|
   《————————— 15' - 6" ————————》|《————————— 15' - 6" ————————》
   《—— C ——》|《———————— B ————————》|《———————— B ————————》|《—— C ——》|
         ┌─────┐                                    ┌─────┐
─────────│  L  │────────────┐        ┌──────────────│  L  │──────────
         └─────┘            │        │              └─────┘
      loading coil      50 Ω COAX          loading coil
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TYPICAL 3.75 MHz (80.0 m.) SHORT DIPOLE ANTENNA USING # 18 WIRE

< 1 >	B= 1'- 6.6"	C= 13'- 11.4"	Inductors L= 64.95 µH	Least Efficient
< 2 >	B= 3'- 1.1"	C= 12'- 4.7"	Inductors L= 73.05 µH	
< 3 >	B= 4'- 7.8"	C= 10'- 10.2"	Inductors L= 83.58 µH	
< 4 >	B= 6'- 2.3"	C= 9'- 3.6"	Inductors L= 97.78 µH	
< 5 >	B= 7'- 9"	C= 7'- 9"	Inductors L= 117.87 µH	
< 6 >	B= 9'- 3.6"	C= 6'- 2.3"	Inductors L= 148.28 µH	
< 7 >	B= 10'- 10.1"	C= 4'- 7.8"	Inductors L= 199.36 µH	
< 8 >	B= 12'- 4.7"	C= 3'- 1.2"	Inductors L= 302.16 µH	
< 9 >	B= 13'- 11.4"	C= 1'- 6.5"	Inductors L= 612.01 µH	Most Efficient
< 0 >	B= 12'- 0"	C= 3'- 6"	Inductors L= 266.86 µH	

COIL DESIGNER   by George Murphy VE3ERP

DESIGN SPECIFICATIONS for a 1.5:1 length-to-diameter ratio coil:
        Inductance............................. 266.86 µH
        Solid copper wire gauge..........AWG# 18 insulated
                      wire diameter........... 0.0403"
        Approximate spacing of coil turns.... 0.111"
        Outside diameter of coil form........ 4.741 in.   (coil ø 4.852")
        Number of turns....................... 65.50
        Length of coil........................ 7.28"
        Number of turns per inch.............. 9.00
        Length-to-Diameter ratio.............. 1.50:1

ALTERNATE DESIGN FOR 71 FULL TURNS ON A 4.5"ø COIL FORM:
        Inductance............................. 266.86 µH
        Solid copper wire gauge..........AWG# 18 insulated
                      wire diameter........... 0.0403"
        Approximate spacing of coil turns.... 0.112"
        Outside diameter of coil form........ 4.500" (coil ø 4.611")
        Number of turns....................... 71.00
        Length of coil........................ 7.97"
        Number of turns per inch.............. 8.91
        Length-to-Diameter ratio.............. 1.73:1
        Approx. length of wire in coil....... 85.71 feet

Fig. 8– Computer screen display of the 3.75 MHz antenna design parameters for the WEETENNA shown in fig. 2 (see text).

TENNA. Fire it up and locate the frequency on each band where minimum SWR occurs. These frequencies are what HAMCALC refers to as the "Prune" frequencies. Due to your antenna site and installation conditions[5] these probably will be somewhat off your design frequencies. Run the program in the Prune mode and enter the Prune freque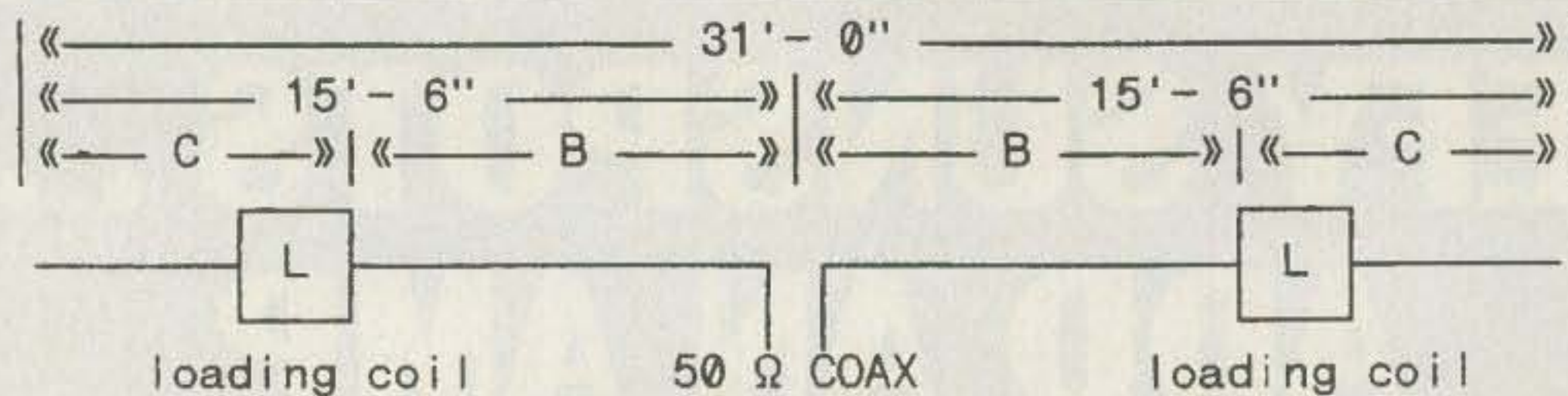ncies. HAMCALC will tell you how many turns to add or delete from each coil (the overall length of the antenna does not change). You probably will be able to do this easily by drilling new holes for the wire in the coil form as shown in fig. 5(A). If for some reason this is not possible, it is no big deal to make another coil. Don't forget to fill the old holes with goop.

If any of your WEETENNA dipoles do not have loading coils, you are on your own, and you will have to prune the length of wire just as Old Timers had to do in the years BC (Before Computers).

The HAMCALC Program

HAMCALC is extremely user friendly. It has to be. I used to write very complex programs

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«————————————— 31' - 0" ——————————————»
«————— 15' - 6" —————»|«————— 15' - 6" —————»
|«— C —»|«——— B ———»|«——— B ———»|«— C —»|
        ┌───┐                      ┌───┐
────────┤ L ├──────────    ─────────┤ L ├────────
        └───┘          │  │         └───┘
    loading coil      50 Ω COAX     loading coil
```

Available space is ample for a full size half-wave 28.6 MHz Dipole, which is
16' - 4.1" long

Fig. 9– Computer screen display when you try to design a WEETENNA for a space that doesn't need one!

SHORT INDUCTIVE LOADED DIPOLE for Restricted Space   by George Murphy VE3ERP

This antenna is a dipole with lumped-constant loading. At modest
heights (10-30 metres) it will work well if its physical length is
longer than 0.2 x wavelength. This threshold length is displayed
early in the program. Shorter lengths will be less efficient.

The antenna can be fed directly with 50Ω coaxial line. The design
is based on the concept of inductive loading, widely used in centre
loaded mobile whip antennas.

For maximum efficiency the antenna should be as long as possible,
consistent with available space. The loading coils should be as far
from the centre feed point as possible, bearing in mind that the
farther the coils are from the feed point the larger they become.

The program calculates 9 different combinations of inductor size
and location. You can specify an additional location if you wish.

For maximum efficiency select the combination using the largest
inductor that is practical for your application. When you select
one of the options your screen will display a list of commercial
coils of the inductance required.

For an acceptable Q choose a coil whose length does not exceed
twice its diameter, or you can design your own coil by selecting
option <2> from the main menu.

Make printouts of each screen display as you are designing your
antenna for later use when testing and pruning.

Pruning is accomplished by adjusting the number of turns on the
loading coils. All you have to do is determine the frequency where
the SWR is lowest. Run the program again, using the original data,
except you re-design the antenna for the PRUNE frequency, which the
program provided when you selected the PRUNE option from the menu.

What the PRUNE option does is shift the design centre frequency
from where it ended up to where you wanted it in the first place.

Fig. 10– Computer screen display of program preface.

which impressed computer hackers, but were of no use to me because I couldn't figure out how to run them.

Keep your printer on-line when you run HAMCALC. One of HAMCALC's handy features is a message bar that appears at the bottom of every screen display, giving you the option of moving along with the program or making a hard-copy printout of the screen display before moving along with the program.

Except for a few numbers that you are asked to enter, most of the program is menu-driven by single keystrokes in response to multiple-choice questions.

To start things off, select the "Short Dipole for Restricted Space" option from the HAMCALC main menu. You will get a multiple-choice sub-menu that gives you three options: run the program, design a coil, or quit. (If all you want to do is design a coil, select the design-a-coil option. You will be asked to enter the inductance and the turns-per-inch, and the program will design the coil.)

To design a WEETENNA select the "Run" option. This presents you with a brief description of what you are about to design (see fig. 10). You then are asked if you want the dimensions in metric or old-time feet and inches.[6] This is followed by a request to type in your choice of frequencies and antenna length.[7] Next, from

a displayed table of wire sizes you are asked to select one. When you do, you will see a screen display similar to fig. 8(A), except item <0> is not there yet. Instead, you are asked if you want to add your own choice of "B" and "C" dimensions. If you answer "yes," you have to type in the "B" dimension you want. You then get a display that looks more like fig. 8(A).[8]

Make a hard-copy printout of the screen display for later reference when testing and pruning the antenna. The next step is to select your choice of WEETENNA by pressing one of the numbers in < > in fig. 8(A). The screen displays a list of B&W commercial coils for the selected antenna, just in case you don't want to wind your own.[9] When you exit this display, the program returns to its start-up menu.

Select the Coil Design menu option. You will be asked to wind a length of the antenna wire you selected around a ruler and enter the number of turns that can be close-wound in one inch. The top half of the screen will then display the design parameters of the coil (the top half of fig. 8[B]). The bottom half of the screen displays a list of commonly available plastic pipe sizes and the request to enter the size coil form you want to use. You can, of course, use any coil form you want[10], but plastic pipe is cheap and plentiful.[11] When you enter a diameter, the bottom half of the screen display changes to something like the bottom half of fig. 8(B), except the number of turns probably will not be an even number. You will be asked if you want to even up the number of turns, and if you do, then enter the nearest whole number to the number of turns shown. The display will change to show a coil of the same specifications, but with an even number of turns (fig. 8(B)).

Make a hardcopy printout of the screen display, and then exit to return to the startup menu, which now has an added option to prune the antenna. If you want to prune your WEETENNA, you must first run the program from the beginning, entering the same data that appears in the printouts (figs. 8[A] and 8[B]) that you saved when originally designing the antenna. This lets HAMCALC know what it is you want to prune. When you have entered all this data and the program returns to the startup menu, you select the "Prune" option from the menu, which asks you to enter the frequency at which each dipole exhibits the lowest SWR. A new inductance for each coil is calculated and displayed on the screen. You are then taken through the coil design procedure again, at the end of which you compare the original and new normalized coil designs to find out by how many turns you need to prune the coil.

That's all there is to it.

Conclusion

If you are a relative newcomer to amateur radio, you should learn the acronym that was the "Knot In The Knickers" to all of us Old Timers—HDYKIWWIYDTI (How Do You Know It Won't Work If You Don't Try It?). If you think you have no space for a multi-band dipole antenna, you probably are wrong. All you need is a firm belief in HDYKIWWIYDTI and a couple of supports between which to hang a WEETENNA.[12]

Footnotes

1. Hall, Jerry, K1TD, "Off-Center-Loaded Di-

pole Antennas," *ARRL Antenna Anthology* publication No. 36, p. 107. Also the *ARRL Antenna Book*, publication No. 15, 14th edition, pp. 10–5.

2. You will need HAMCALC version 8.8 or later. For a *free* copy of HAMCALC version 9.4 on a 3¹/₂ inch 1.44 Mb diskette, send a check or money order for $5.00 (US) to cover cost of disk, mailer, postage, and handling to the author, George Murphy, VE3ERP, 77 McKenzie St., Orillia, ON L3V 6A6, Canada.

3. "Cheap" is my favorite operative buzzword.

4. My choice of goop is usually general-purpose silicone sealant, because it can be removed without too much trouble if you do something wrong, which I usually do.

5. Antenna designers are always careful to point out that if their design doesn't work, it is probably due to *your* site conditions. This coverup is known as "Antennagate."

6. For the example antenna discussed in this article I chose feet and inches because we are dealing with coils, and turns-per-inch seems to be a universally accepted standard for coils. If

anyone knows what the equivalent metric standard is for turns-per-inch, I would appreciate your letting me know.

7. Courses in typing are available at your local community college or trade school.

8. For the example WEETENNA discussed in this article I typed in "12" because that is the length of the longest feet-and-inches tape measure I could find in the shack.

9. This program originally was intended to feature commercial coils, but for most WEETENNAS there was no coil available to suit the design. When there was one available it was usually one of the large, expensive ones. Being your basic Cheapnik, I rewrote the program for home-brew coils rather than spend a buck.

10. You can also design coils using the HAMCALC program "L/C Network Tuned Circuits."

11. Plentiful is okay, but *cheap* really gets my attention.

12. Such as: (a) the inside end walls of your attic; (b) the existing supports for your clothesline (you will have to buy a clothes dryer); or (c) two very tall, retired professional basketball players. ∎