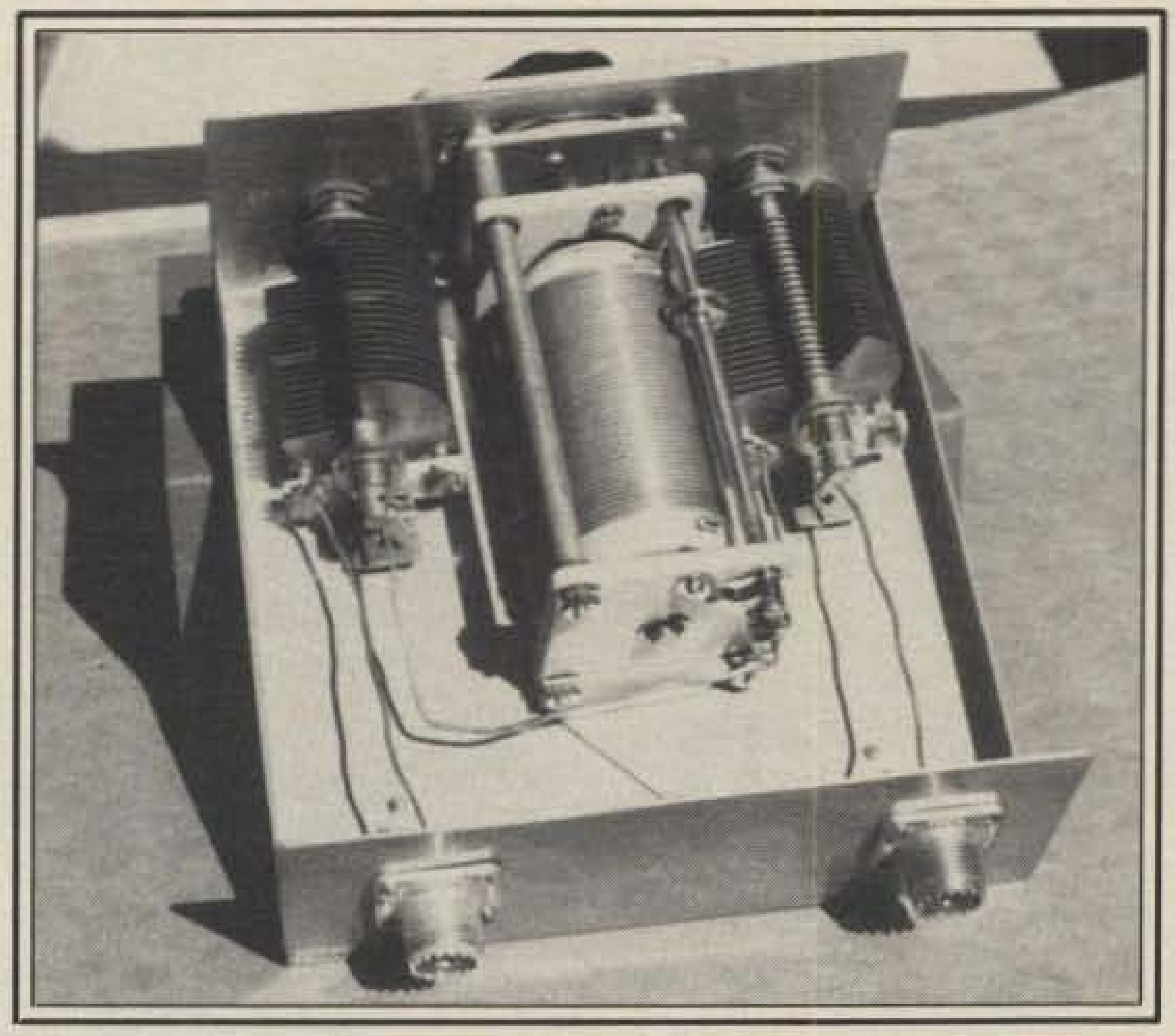
W1ICP offers us some straight talk on antennas and the use of a Transmatch.

To Use Or Not To Use A Transmatch

One More Discussion of a Popular Subject

BY LEW MCCOY*, W1ICP



Here is a junk-box Transmatch. Refer to fig. 1(B). C1 is 150 pF, as is C2. Any value from 150 pF to 350 pF can be used. The roller inductor is about 25 uH and was picked up at a fleamarket. Any inductance value over 15 uH will work for 80 through 10 meters. The capacitors have receiver-type spacing and will handle about 200 watts when the Transmatch is perfectly matched. For this reason, be sure to use low power when tuning up, and by low, I mean just a few watts. Not shown is a toroid balun that provides balanced output. Details for making such a balun can be found in antenna chapters of any recent handbooks.

Certainly one of the most frequently asked questions I get at lectures and in the mail concerns the use or non-use of Transmatches. And I might add that these same questions have been asked for the last 20 years—at least! The reason for the questions is certainly understandable. Antennas, feedlines, and coupling antenna systems to the transmitter is a complex subject—one not thoroughly understood by many amateurs. So let's see if we can clear the air a little more.

What Is A Transmatch?

In the early days of amateur radio any device used to couple an antenna system to a transmitter was called an "antenna tuner," and many amateurs still use this term. Back in 1961 in July *QST* I wrote an article describing "The 50-Ohmer Transmatch." In that article the word "Transmatch" was used for the first time, and here is what was said: "A generic name coined by the editors to apply to any type of matching network inserted between a transmitter and a transmission line. There has been an obvious need for such a word, since 'antenna coupler' is inadequate both technically and psychologically." So if any modern-day amateur is interested in why the term *Transmatch* is used, it stems from that 1961 article by this author.

Stated as simply as possible, a Transmatch is a combination of coils and capacitors that make up an adjustable RF transformer. The function of a good Transmatch is to take the unknown load of the antenna **system** (note I say "system") and convert that load to a usable one for the transmitter. In addition, when an antenna or antenna system is nonresonant, there is always reactance present, and a good Transmatch should be capable of tuning out such reactances. Briefly, then, a Transmatch is simply a circuit consisting of coils and capacitors best described as an RF transformer and reactance "tuner-outer."

Modern-Day Problems

After WW II several things happened to change amateur radio forever. First, coaxial feedline became cheap enough so that any amateur could afford it. Coaxial lines were preferred, because it was easier to run coaxial line rather than the more commonly used open-wire feeders. Using coax meant working with 50 or 70 ohm loads, which happened to be the characteristic impedance of coax. Second, television came along and gave us TVI to contend with, and that led to completely shielded transmitters. This, in turn, led to the use of pi-network tank circuits, because such circuits offered simplified bandswitching. Because of the use of coaxial lines, amateurs started thinking in terms of multiband 50 ohm impedance antennas. Gradually, antenna manufacturers started to work towards antennas that would be 50 ohms impedance no matter on what frequency they were used. (I might say that outside

*Technical Editor, CQ, 200 Idaho St., Silver City, NM 88061

of a dummy-load antenna, such a condition really only exists in ham heaven!) The result of all these changes was that transmitter manufacturers started eliminating all adjustable final-stage transmitter components. (They were more expensive than fixed-value components.) They designed their equipment to work into 50 ohm loads. When solid-state came along, this only emphasized the problem, so now if one doesn't have a 50 ohm load, the transceiver will actually shut itself down!

For those of you who entered amateur radio in the last 20 years or so, the 50 ohm antenna is now a way of life. Believe it or not, the transmitters before 10 or 15 years ago had built-in Transmatches! As an example, the old Johnson Ranger transmitter had a tank circuit that would actually match any antenna load used, no matter what the SWR or impedance happened to be. So all a Transmatch really is, is the adjustable tank circuit those manufacturers took away from us years ago. How about that!

What Kind of Transmatch To Use?

I am putting the cart before the horse in this article in telling you what kind of Transmatch to use before actually telling you if you need one, hi! However, there are certain circuits I prefer, and I'll tell you why. Historically, as far as present-

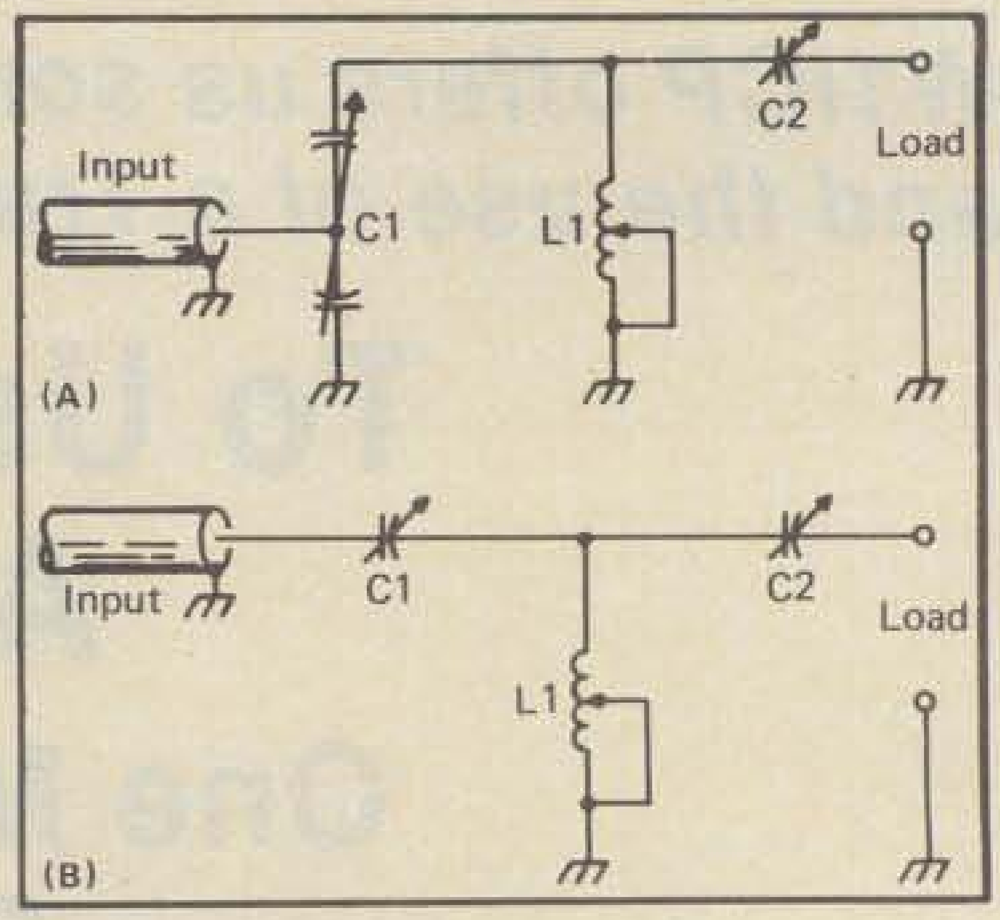


Fig. 1– Circuit diagram of Transmatches. (A) is the basic Ultimate circuit and (B) is the Walt Maxwell version. L1 can be a tapped coil, but does not provide the flexibility of a rotor inductor. If you use a tapped coil and find you cannot get a perfect match, you might try adding a short length, 5 to 10 feet or so, of feedline. This will change the overall impedance and may put you in a matching range of the tapped coil.

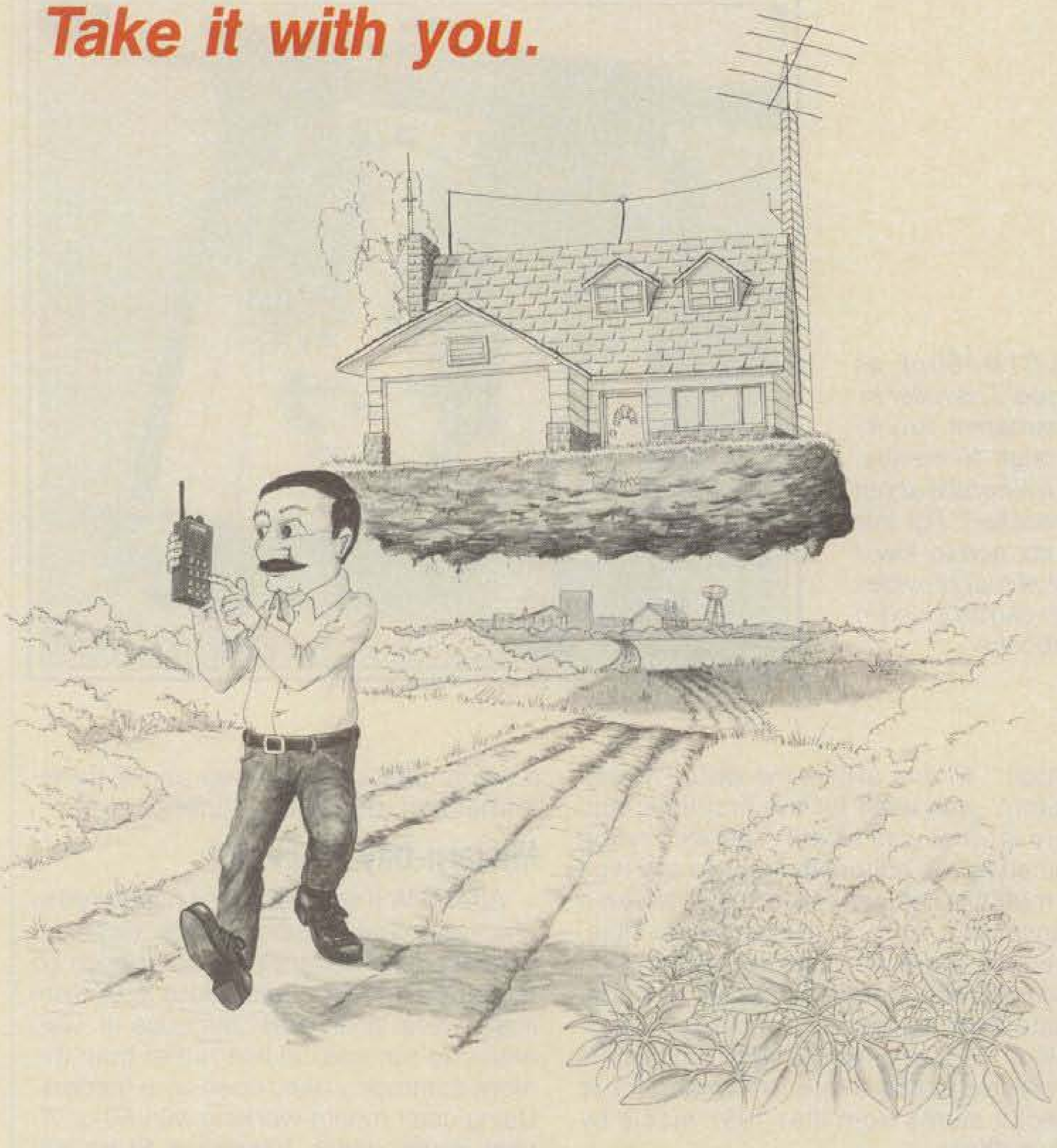
day circuits for Transmatches are concerned, they all are derived from the "50-Ohmer Transmatch" mentioned above. I described another circuit in July 1970 *QST* called "The Ultimate Transmatch," which was very popular, because with that circuit it was possible to match any load of any impedance or reactance. Fig. 1(A) is that basic circuit. A few years after the original article appeared, Walt Maxwell, W2DU, correctly pointed out that a dual capacitor was not needed at C1, and he suggested the circuit shown in fig. 1(B). A few years back an argument erupted over the Ultimate and W2DU circuits in that neither was purported to be good for harmonic suppression, second or third harmonics, that is. To be very honest, I considered the argument ridiculous for a very simple reason. The FCC had long ago passed a rule that *all* transmitters must have 40 dB harmonic attenuation of all harmonics in the final amplifier stage (that amplifier stage attached to the antenna system). That is the case today, so harmonic attenuation arguments as far as Transmatches are concerned are ridiculous.

Getting back to the choice of circuits, Maxwell's simple T-circuit is just about as good as one can use. I would prefer a variable inductor for L1 because there are many antenna system loads that can be extremely critical to match. A switched, tapped coil can create some matching problems with such loads simply because the inductance range is fixed. In order to match any impedance, the inductance should be continuously variable.

The Meat—Transmatch or Not?

For those readers who have become tired reading up to this point, I can make it short. If you wish to always have a 50 ohm

Take it with you.



ShackMaster™ puts your home station in the palm of your hand. Whether portable, mobile, around the yard or around town you'll be linked through your handheld to your high performance equipment at home. Even call home from any Touch-Tone phone and operate.

Scan the bands, change modes, select antennas, turn gear on and off – all from your Touch-Tone keypad. Check into nets, work skeds, ragchew and DX without being tied down to the shack.

Exchange electronic mailbox messages with your family – like "I'll be late", or "All is OK". Or talk with your family directly through *ShackPatch*™, with you in remote control of your home station. Report traffic accidents or disabled motorists through your home phone while mobile or portable with *PersonalPatch*™

All the power of your home station (and more) really can follow you anywhere . . . to find out more about ShackMaster™ just write, send us your QSL, or call and talk with us at 408-749-8330.

acc advanced computer controls, inc. 10816 Northridge Square • Cupertino, CA 95014 (408) 749-8330

CIRCLE 152 ON READER SERVICE CARD

The TITAN final amplifier may be your final amplifier!

Model 425 TITAN
Linear Power Amplifier

We have been accused of "over designing" the TITAN. And certainly, by cutting corners, it could be built at lower cost. But we think, in the long run, it will be an investment in reliability, flexibility, and the pure enjoyment of a *permanent addition* to your station — long after the price is forgotten.

Every component is chosen to work well below its rating. The power transformer is our own, using a Hypersil® tape wound core, generously designed for excellent regulation. Capacitors and inductors are also made in-house for close quality control.

The TITAN uses two 3CX800 tubes that will loaf along at 1,500 watts output. And, as they require lower plate voltage than older tubes, insulation breakdown is less likely.

We think we have included present and future needs. Things such as full break-in and operation on 160 meters and all authorized bands. A separate power supply makes station layout easy for most convenient operating. And if you use AMTOR, SSTV or RTTY, there is no problem with continuous operation.

The TITAN could easily be your final FINAL AMPLIFIER.

$100 CASH BACK
WITH PURCHASE OF A
TITAN BEGINNING
NOVEMBER 1.

See your dealer or write

TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862

*Commercial version available

CIRCLE 51 ON READER SERVICE CARD

load for your transceiver and have maximum transfer of power, plus keep your transceiver running cool, then use a Transmatch. For those of you who wish to continue, I have more to say. In fact, I could write five articles on just subject!

Let's first talk a little about losses. Any circuit will have some losses, so adding a Transmatch to your antenna system will introduce some losses. I have made many tests using Transmatches, so I can give you some figures. A well-constructed Transmatch—one using good electrical connections and good components—doesn't introduce any great losses. The *T* configuration with a roller or variable inductor can introduce as much as 7% loss. In other words, 100 watts out of the rig, you could lose as much as 7 watts in the Transmatch. However, and there are several "howevers," that 7% loss only takes place under a very badly mismatched load, with standing-wave ratios on the order of 15 or 20 to 1 and a high value of reactance! The minimum loss through a Transmatch is on the order of only 3%. My method of checking was putting identical wattmeters on both sides of the Transmatch, input and output, and then measuring the differences into a wide variety of mismatched loads. One of those "howevers" we mustn't overlook is what we gain, not what we lose. I have no way of giving exact figures, but you would actually pick up power from your rig simply because its load would be exactly for what it was designed. The rig would run cooler—no doubt about that.

Still another advantage is that a Transmatch is certain to improve reception. Your receiver will always be looking at a resonant antenna system and will profit accordingly. In addition, the Transmatch will provide a certain amount of selectivity.

Resonant Antennas—Eh?

There is another important consideration that should be brought in at this point: a discussion about resonant antennas. For some reason that is obscure to me, many amateurs insist that a resonant antenna is much better than a nonresonant one. Let's first define a resonant antenna as simply as possible (and without offending any antenna experts). A resonant antenna is one where only ohmic and radiation resistance exists in the feed point—no reactance is present. Keep in mind that you cannot get power through a reactance; you must cancel out the reactance. It is probably best to use an example. Let's say your favorite frequency is 3600 kHz, so you cut a dipole using the formula 468 divided by 3.6 to get a resonant antenna. Look at that! The SWR is 1.1. to 1 and you have a full 100 watts going out! So comes the day and you decide to operate phone up on 3900 kHz. The question then arises, what about the resonant 3600 kHz dipole? It isn't resonant anymore. Even worse, when you used the antenna on 3600, the SWR was just about 1 to 1, but up here on 3900 it looks like 8 to 1! And added to that, the rig won't load at all! Gosh, I guess you need another resonant antenna for 3900. Hogwash!

Let's suppose we attach the transmitter end of the 50 ohm feedline cable, RG-8/U, to a Transmatch and the rig to it. We next adjust the Transmatch so we have a 1 to 1 SWR on the piece of coax between the Transmatch and the rig, which indicates the transmitter is seeing a 50 ohm load. What we have done is taken the complex load that appears at the Transmatch end of the 50 ohm line and done some interesting things. However, it is at this point that many amateurs have a hard time understanding what is happening. Keep in mind, if you will, that the actual impedance of the load at this end of the coaxial line is not 50 ohms, the impedance of the line. Rather, it could be a much higher or lower value and have lots of reactance present. And, going back to the beginning of this article, we are now looking at what I like to call the "antenna system," and that is what we are going to tune. By adjusting the coil and the capacitors in our Transmatch, we tune out the reactance present in the load and also step up or down the necessary transformation required for the transmitter to "see" a 50 ohm load. Also bear in mind that the antenna system load has not changed, nor will it.

We load up our transmitter so that we have 100 watts output, just as we had with our 3600 kHz resonant dipole. So where is the 100 watts going to go? It is true that coaxial line has some losses as the SWR increases. We do have an SWR of 7 or 8 to 1 up here on 3900, so we may lose a few watts on the way. However, for all practical purposes we now have just about 100 watts in our "nonresonant" antenna. Actually, it isn't really nonresonant anymore. At least the antenna *system* isn't nonresonant. Don't forget that we tuned out the reactance by using the Transmatch, so all we have left is radiation and ohmic resistance.

Some things do change with our antenna, but certainly not its efficiency. A resonant half-wavelength dipole has the characteristic figure-eight radiation pattern. As an antenna gets longer or shorter other lobes are developed, and if the antenna is longer than a half-wavelength, it actually exhibits gain in some directions. Remember, resonant antennas are strictly a state of mind. In the real world we want resonant antenna *systems*.

Matched Antennas and Transmatches

The real crux of the article is whether to use a Transmatch with a matched antenna—one that has a low SWR. In my

Measure Up With Coaxial Dynamics Model 81000A RF Directional Wattmeter

Model 81000A is a thoroughly engineered, portable, insertion type wattmeter designed to measure both FWD/RFL C. W. power in Coaxial transmission lines.
81000A is comprised of a built-in line section, direct reading 3-scale meter protected by a shock-proof housing. Quick-match connectors, plus a complete selection of plug-in elements, gives the FRONT RUNNER reliability, durability, flexibility and adaptability with a two year warranty.
Contact us for your nearest authorized Coaxial Dynamics representative or distributor in our world-wide sales network.

COAXIAL DYNAMICS, INC.

15210 Industrial Parkway
Cleveland, Ohio 44135
216-267-2233
1-800-COAXIAL
Telex: 98-0630

Service and Dependability. . .A Part of Every Product

CIRCLE 161 ON READER SERVICE CARD

own case I have a seven-band beam, and while on some frequencies the SWR is 1 to 1 or close to that, it goes well over to 2 to 1 on others. Therefore, I keep a Transmatch in the line at all times. It means making a few extra adjustments each time I switch bands, but those adjustments are easy and fast. However, most important to me, my equipment is always working into the design load.

If you find that your equipment loads easily and you don't have antenna problems when QSYing, then you probably don't need a Transmatch. However, if any of your antennas show an SWR of much more than 1.5 to 1, then I would recommend using a Transmatch. I have already discussed the 3% power loss in a Transmatch, but as I also said, I find that insignificant given the other advantages.

For years I tried to convince the amateur fraternity to use what I thought (and still think) is the best multiband antenna system. This is an antenna that has no traps or resistors and uses a practically lossless transmission line. But it does require the use of a Transmatch. Now that we have all the new bands, we need an antenna system for the average amateur who cannot afford numerous towers and beams. So here goes at reviving that outstanding system.

A Really Good Multiband Antenna

The formula for making the antenna is quite simple. You first find out how you plan to support the antenna and what is the maximum possible length of wire you can use. It may be that the antenna must be an inverted-V type with a single high support at the center and the ends as high as possible off the ground. If you have two widely separated supports, such as trees, then the antenna can be horizontal (horizontal is nearly always better than vertical or an inverted V). In any case, the antenna is made long enough to reach between the two farthest supports. If that happens to be 100 feet overall, fine! If it is 200 feet, even better. (Always make the antenna as long as possible.) Next cut a wire that long.

What Kind of Wire?

A frequent question is, "What kind of wire can I use for a wire antenna?" Almost any kind of wire that is copper or copper-clad steel that is strong enough to support itself is usable. Nearly any electrical supply house has single wire, No. 12 or 14 copper wire. Farm supply houses usually have electric fence wire, which is customarily No. 18 copper-clad steel.

Getting back to our antenna, find the center of the wire and cut it again. You now have two wires to make a dipole. Note I didn't say half-wavelength dipole because it would be only chance if it were. Because we are going to use this antenna on a multitude of frequencies and bands, it would be expected that the

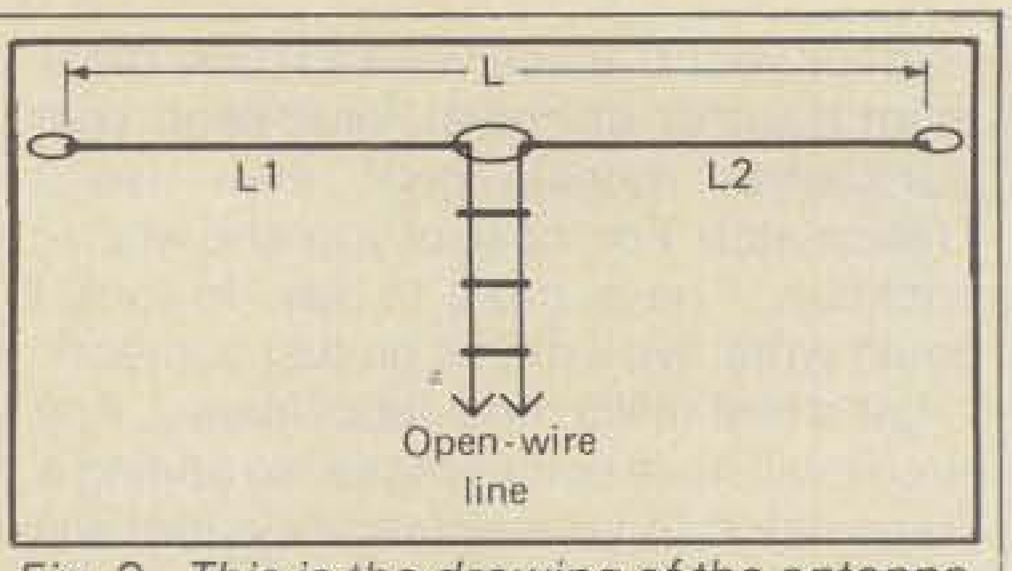


Fig. 2– This is the drawing of the antenna described in the text. The length L can be any convenient length, but one should try to make it at least one-quarter wavelength long on the lowest operating band. L1 and L2 should be equal lengths. Also, the antenna can be mounted as an inverted V. If you like slopers, this same antenna can be installed as a sloper.

SWR will be quite high in some instances. For this reason we will need a relatively low-loss feedline—certainly not coax. If you don't care to make your own line, then you can use a good grade of 300 ohm TV-type twinlead. Even better is a heavy-duty-type twinlead that has sections cut out and approximates open-wire feeders. It is easy to make your own feeders by using two wires separated 2 or more inches. The insulators between wires can be made from almost any poly or phenolic material. One-half inch plastic plumbing pipe can be cut and drilled to make insulators. (Hair curlers of plastic

A1015—6 Meter Amplifier
10 Watts In—150 Watts Out
All Mode Operation with Rx Preamp
Remote Keying

B23A—2 Meter H/T Amplifier
2 Watts In-30 Watts Out
All Mode Operation with Rx Preamp
compact Size (3½" × 2" × 7")

B108—2 Meter Dual Purpose Amplifier
10 Watts In—80 Watts Out
2 Watts In—30 Watts Out
All Mode Operations with Rx Preamp

B215—2 Meter H/T Amplfier
2 Watts In—150 Watts Out
Designed for H/T use
All Mode Operation with Rx Preamp

B1016—2 Meter Dual Purpose Amplifier
10 Watts In—160 Watts Out
2 Watts In—60 Watts Out
All Mode Operation with Rx Preamp

B3016—2 Meter Amplifier
30 Watts In—160 Watts Out
Operates with 2 to 50 Watts Input
All Mode Operation with Rx Preamp

C22A—1¼ Meter H/T Amplifier
2 Watts In—18 Watts Out
Compact Size (3½" × 2" × 7")
All Mode Operation with Rx Preamp

C106—1¼ Meter Dual Purpose Amplifier
10 Watts In—60 Watts Out
2 Watts In—23 Watts Out
All Mode Operation with Rx Preamp

C211—1¼ Meter Amplifier
2 Watts In—110 Watts Out
High Power H/T Amplifier
All Mode Operation with Rx Preamp

C1012—1¼ Meter Dual Purpose Amplifier
10 Watts In—120 Watts Out
2 Watts In—40 Watts Out
All Mode Operation with Rx Preamp

C3012—1¼ Meter Amplifier
30 Watts In—120 Watts Out
2 Watts In—40 Watts Out
All Mode Operation with Rx Preamp

D24—430-450 MHz Amplifier
2 Watts In—40 Watts Out
All Mode Operation FM,SSB,CW,ATV
Optional "N" Type Connectors

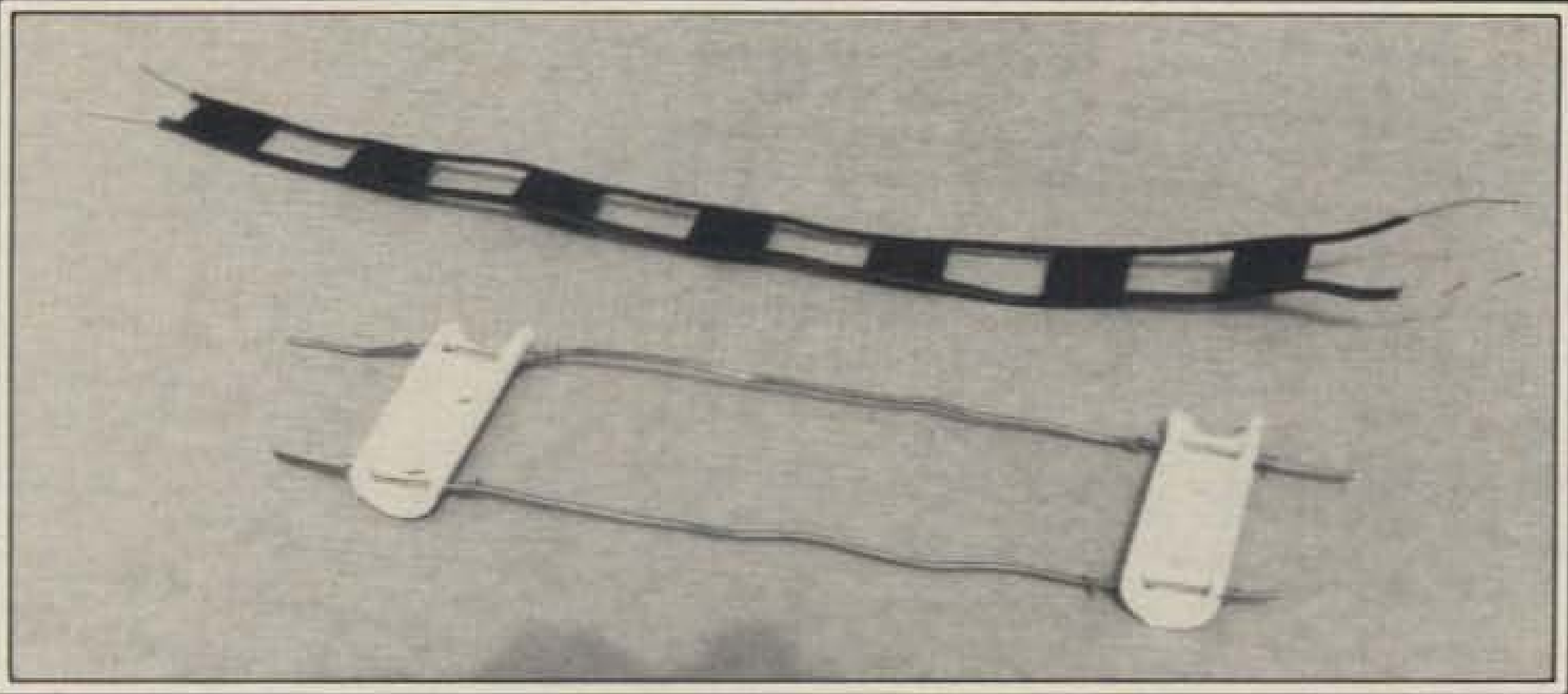
D1010—430-450 MHz Dual Purpose Amplifier
10 Watts In—100 Watts Out
2 Watts In—45 Watts Out
All Mode Operation FM,SSB,CW,ATV
Optional "N" Type Connectors

D3010—430-450 MHz Amplifier
30 Watts In—100 Watts Out
All Mode Operation FM,SSB,CW,ATV
2 to 35 Watts Input

BACKED BY THE INDUSTRY'S ONLY 5 YEAR WARRANTY
See the complete line of Mirage RF Amplifiers, Peak Reading Watt/SWR Meters and accessories at your local dealer or contact:

MIRAGE
P.O. Box 1000
Morgan Hill, CA 95037
(408)779-7363

CIRCLE 29 ON READER SERVICE CARD



Below is a short section of line that is made using plastic water pipe insulators. I made these from a piece of tubing 3 inches long that was sawed in half, providing two insulators. Holes are drilled in the ends of the insulators and the wire for the feeders and then fed through the holes. The other holes are put in to eliminate any moisture accumulation. The wire spacing is not critical; any spacing up to 6 inches is suitable. One 10 foot length of PVC tubing should provide more than enough spacers. Above is the heavy-duty "open-wire" type twinlead. This line will handle the amateur legal limits, but it is more lossy than the homemade line at the left.

are suitable.) Even wooden dowel rod can be cut and drilled, but in this case it might be wise to dip the wooden spreaders in hot paraffin.

Make the line long enough to reach from the center of the antenna to your shack. Many amateurs insist that the length of the feedline must be a half-wavelength or multiples of same. The only time that such lengths are of any importance is if we are going to attempt to measure the feedpoint impedance of the antenna. To be brief, make the feedline long enough to reach the shack; that is what is important. Do try to bring the feeders away from the antenna at right angles. This is done to avoid feeder coupling to the antenna itself, causing parallel standing waves and feeder radiation. However, this isn't as important as some amateurs think when using open-wire line. Such coupled power is radiated, not lost.

Some amateurs balk at bringing open-wire feeders through the wall or windows. An easy out here is to mount the end of the feeders near a shack window, and at that point attach a length of the commercial twinlead to come into the Transmatch. There may be an impedance mismatch between the values of open-wire line and twinlead, but both lines are balanced, so again this isn't important.

Connect the end of the feeders to the station Transmatch using the balanced configuration output of the Transmatch. Use as low a power as possible to get an SWR indication on your matching indicator. Be sure to keep notes of the different settings of the Transmatch that provide a match. Go through the various bands and note all settings. This will probably take a few hours, but when you are finished, you will be able to quickly change bands and frequencies. Assuming you are using one of the Transmatch circuits described earlier, I can guarantee that you will obtain a 1 to 1 match on all bands.

What you now have is just about the best multiband antenna system you can find. In my case, I have about 170 feet, center fed, with the heavy-duty twin-lead type feeders. I keep a coax switch in the feedlines, and I am sometimes surprised to find that the wire antenna will provide better signals than the beam! This is, of course, because of the gain on certain lobes from the wire antenna plus a better angle of radiation for a given signal. Remember that you now have a tuned resonant system—not necessarily a resonant antenna.

I don't like to downgrade other multiband antennas. However, there has been much written lately about the off-center-fed Windom and the G5RV. Before making remarks about these antennas let me make something clear. Many years ago I came up with what is known as McCoy's Law. Simply stated, McCoy's Law says, "If the damned thing works, leave it alone!" In any case, I have some comments about these and other multiband antenna systems that I don't think anyone will argue about.

Generally speaking, trap multiband antennas always will suffer when compared to the multiband dipole described above. So will multiband verticals. The off-center-fed Windom will suffer from feedline radiation. This isn't really bad, but the antenna is inherently unbalanced. Also, to cover 80 meters you will need a Transmatch anyway. From all I have read and heard about the G5RV antenna, plus testing several, a Transmatch is needed to keep the SWR within reason. If so, it becomes slightly ridiculous to attempt to hold to fixed antenna and feedline lengths.

No antenna expert will argue about the efficiency of a decent-size dipole with open-wire feeders. And as to decent size, a good rule of thumb is to try to make the antenna at least one-quarter wavelength long on its lowest operating frequency—in other words, at least 60 feet long if your lowest band is 80 meters, but the longer the better. The antenna will work with shorter lengths, but no where near as well. It is just an unbeatable antenna for 80 through 10 (it will also work on 160), and the beauty of it is that the antenna and feeders are cheap.

So that's the scoop. I hope you've read this far. If so, you'll know a little bit more about Transmatches and good multiband antennas. There is a lot more to say, but by now you must be bored, right? CQ

The completed Transmatch is mounted in a small utility box.