MAC'S SERVICE SHOP

DUMMY ANTENNAS FOR HAMS AND CB'ERS

By John T. Frye, W9EGV

"HEY, boss, what are you doing with that crazy paint bucket?" asked Barney as Mac came through the door of the service department carrying a shiny black gallon bucket with printing, a diagram, and a chart emblazoned in white on the side.

"Watch your tongue," Mac said; "you're speaking of my new, almost-finished Heathkit 'Cantenna,' Model HN-31, RF Load Resistor."

"Pardon *me*!" Barney replied with exaggerated contriteness, "but I thought you used a foot-long, war-surplus, noninductive resistor for a dummy load."

"I do, but I'm already overloading it with just the hundred-watt key-down output from my ham SSB exciter. I don't dare put the output of the linear amplifier, which runs about seven times that, to the resistor. It would go up in smoke. This cantenna, however, is rated at a kilowatt ICAS and will take the 700 watts continuously for fifteen minutes—plenty long enough to melt down the final tubes in a SSB transmitter. Any owner of a SSB transmitter who sits on the key for even a tenth of that time is just plain stupid."

"You really think a dummy antenna is needed, huh?"

"Do I! I believe no ham or CB operator should be issued a license unless he possesses and *uses* a dummy antenna to load up his transmitter for testing. Putting an unmodulated carrier on the air for minutes at a time or performing unidentified testing is not only illegal but it stamps the perpetrator as a 'lid of the first water,' who has a total disregard for others."

Heathkit Cantenna presents a 50-ohm resistive load to the transmitter.

Why Use a Dummy Load? "There are other sound reasons for using a nonradiating load resistor. For one thing, almost all service literature requires that the transmitter be connected to a good dummy antenna at the proper impedance when testing. Results obtained with a mismatched or reactive load are at best meaningless and, at worst, quite likely to cause damage. Moreover, with a good dummy antenna you can establish a reference standard of performance. As soon as I finish the Cantenna, I plan to feed it with the exciter barefoot and then through the linear amplifier at a selected logged frequency on each band. In each case, I'll tune for maximum output and then log grid current, plate current, tank and load capacitor settings and relative voltage reading as indicated by the Cantenna's monitor circuit, which I'll discuss later. If I question performance at some future date, I can compare new readings with those I logged to see if anything has changed. If it has, I'll have some very helpful clues as to where the trouble lies."

"What makes a good dummy antenna?"

"First, it should present an accurate, unchanging, purely resistive load—usually 50 ohms—to the transmitter under a wide range of frequencies and power outputs. The load resistor should be shielded to prevent radiation, and capable of absorbing the maximum output of the transmitter at 100% duty cycle for a reasonable length of time. AM and full-power tune-up represent 100% duty cycle; CW, 50%; SSB, 33%. The dummy antenna should connect to the transmitter through coaxial cable and a coaxial antenna switch so the transmitter can be switched quickly from the antenna to the dummy load, and vice versa. Finally, it's helpful if the dummy antenna incorporates some method of indicating at least relative r-f input. Ideally, it will indicate actual wattage being absorbed and dissipated by the resistor."

"Those requirements eliminate a lot of things," Barney observed. "For instance, a 100-watt incandescent bulb can take a full 100 watts of r-f indefinitely and translate it into radiated light and heat, but its resistance changes from 10 ohms when cold to about 144 ohms at its normal operating temperature. You can imagine what happens to the resistance when you're pumping an SSB signal into the filament. Carbon resistors are very limited in the power they can absorb without damage. Wirewound resistors have inductance. But hey, how about giving me a peek at that grandaddy kilowatt resistor inside the bucket? I don't think I ever saw anything bigger than a couple of hundred watts wirebound."

Smiling, Mac pried up the bucket lid with a screwdriver and set it upside down on the bench. Barney saw a 5" × 11½" aluminum tube fastened vertically to the bottom of the lid with two brackets that held the top of the tube about 1½" (3.8 cm) below the bottom of the lid. Inside the tube was a 5" (2.7 cm) film-type resistor on a hollow ceramic form ¾" (1.9 cm) in diameter. Silver-plated copper contact straps were bolted around the silvered ends of this resistor, which was centered in the bottom of the tube by four triple-nutted brass bolts. The bolts also made firm contact with the bottom strap. The top strap clamped the open ends of a U-shaped silver-plated bracket against the silvered contact surface. The center of this bracket was connected to a porcelain feed-through insulator that went through the lid into a metal box on the top.

"You mean to tell me that little resistor can dissipate a kilowatt?" Barney asked in disbelief.

"It can and will when I fill this bucket with non-conducting, high-temperature transformer oil. Much of the heat of the resistor will be transferred to the oil circulating around and through the resistor, effectively increasing the dissipation capacity at least a hundred fold."

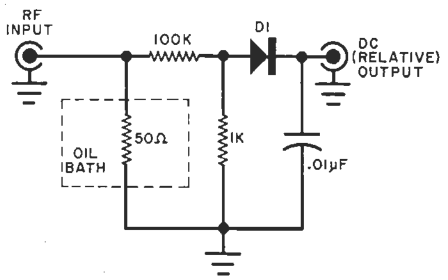
"Why is the resistor inside the metal tube?"

"Two reasons: first, the diameter of the tube is proportioned to the diameter of the resistor so the combination submerged in oil has a surge impedance equal to that of a 50-ohm coax line. What we then have is a continuation of the coaxial cable with the resistor serving as the center conductor of the last five inches of the cable. Incidentally, if this were a solid bar instead of a film type resistor, the r-f resistance would increase with frequency because the current would concentrate on the surface. That's why film resistors are used almost exclusively in dummy loads.

"The second reason for the resistor-in-a-tube combination is that it forms a 'thermal siphon' in the oil. Oil heated by the resistor expands, rises, and flows out the top of the tube. This pulls cool oil from the bottom of the bucket into the bottom of the tube. Heated oil rising to the surface spreads out radially and contacts the air-cooled walls of the bucket, where it gives up some of its heat and sinks to the bottom. All this creates a "closed-loop fountain" in the oil that aids in cooling the resistor."

"What's in that little box on the lid?"

"It carries the fitting for attaching the coax cable from the transmitter and also houses the components of the relative voltage monitoring circuit shown on this diagram on the side of

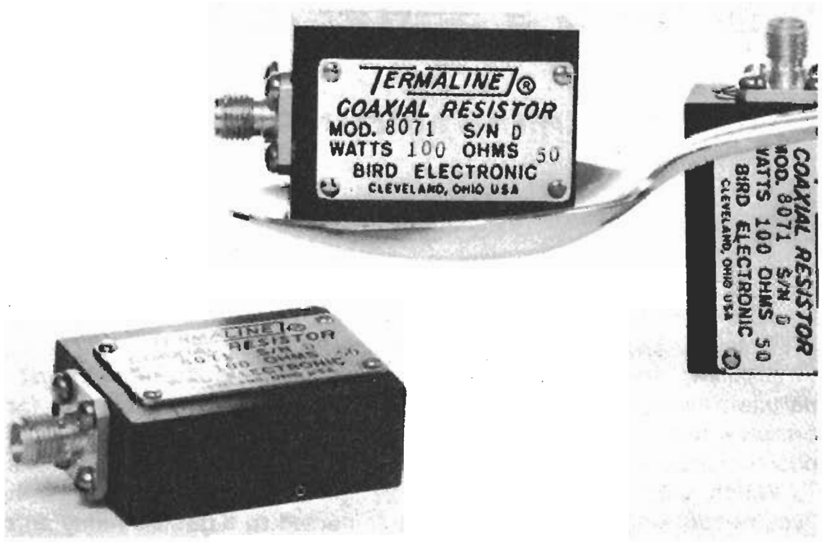


Power is dissipated by resistor in oil bath, while other components form a dc sampling circuit.

the bucket. A voltage divider across the r-f load resistor feeds a small fraction of the r-f voltage to a germanium diode for rectification. The 0.01-µF capacitor smooths the rectified signal which can then be measured with a VTVM or other high-impedence meter connected to the phono jack on the end of the box. Any change in r-f across the load resistor is reflected as a change in dc output. This permits a transmitter to be tuned for maximum output."

Output Wattage. "Can't you calculate transmitter output wattage from the meter reading?"

"No, because the resistive voltage divider is frequency sensitive. The reading goes up with frequency. This occurs because the carbon composition resistors in the divider tend to exhibit stray reactance. A capacitive divider, on the other hand, remains purely capacitive for a wide frequency range, and most Bird Termaline® wattmeters are designed with capacitive dividers."



Bird's small dummy load can handle up to 100 watts from dc to 2 GHz, when heat-sinked to equipment panel.

"How did the birds get into this conversation?"

"The Bird Electronic Corporation of Cleveland is a leading manufacturer of coaxial load resistors, r-f absorption and directional wattmeters. Their dummy antennas, called Termaline Coaxial Load Resistors, come in sizes all the way from 2 watts to 50 kilowatts. These are precision, laboratory-grade instruments and are priced accordingly. While the low-cost Cantenna—which I consider adequate for most ham and CB use—is claimed to have a VSWR of less than 1.5 up to 300 MHz and less than 2.0 up to 400 MHz, a comparable air-cooled, liquid-dielectric Bird unit rated at 1 kW *continuous duty,* has a VSWR of 1.1 up to 1 GHz and only 1.25 up to 2.5 GHz."

"How does Bird do it?"

"They start with a special high-precision film resistor that will maintain its 50-ohm value through all rated temperatures and frequencies. Instead of being a cylinder, the resistor shell tapers in a logarithmic fashion from the full diameter of the line at the top to only the diameter of the resistor at the bottom, where the two meet. A wave traveling down the line sees 50 ohms at the top of the resistor, 25 ohms at the center, and 0 ohms at the bottom. To insure a frequency-independent termination, the shell must be matched to the resistor at any point along its length. The shell is filled with a heat-conducting dielectric and is equipped with external heat-radiating fins. By combining a form of r-f voltmeter calibrated directly in watts with a coaxial load resistor, Bird forms their series of Termaline R-F Absorption Wattmeters.

"Bird makes load resistors that are dry-air cooled, air cooled with a liquid dielectric, cooled with forced air, and water cooled. Their absorption wattmeters operate from 2 to 500 MHz. They have Thruline® directional wattmeters that will read forward and reflected power at any point in a feed line.

"Now let me tell you how you can measure transmitter output with a Cantenna or similar dummy load. Connect the vertical deflection plates of a scope (already calibrated in peak-to-peak volts per inch deflection) across the line feeding the dummy load. Once you know the sine-wave p-p volts across the dummy load, convert this to rms volts by multiplying by 0.3535. Square this, and divide by 50 ohms to get the power in watts. For example, my exciter gives me 200 volts p-p, or 70.7 volts rms. The square of this is 4998—let's call it 5,000—and 5,000 divided by 50 is 100 watts. It's no coincidence this is the rated output of the exciter."

"I've just reached a conclusion," Barney announced with a sigh; "there's nohing dumb about dummy antennas!" ◈

FLAG-POLE HAM ANTENNA

Vertical helix disguised as a flag pole produces good results

BY ROLAND J. McMAHAN

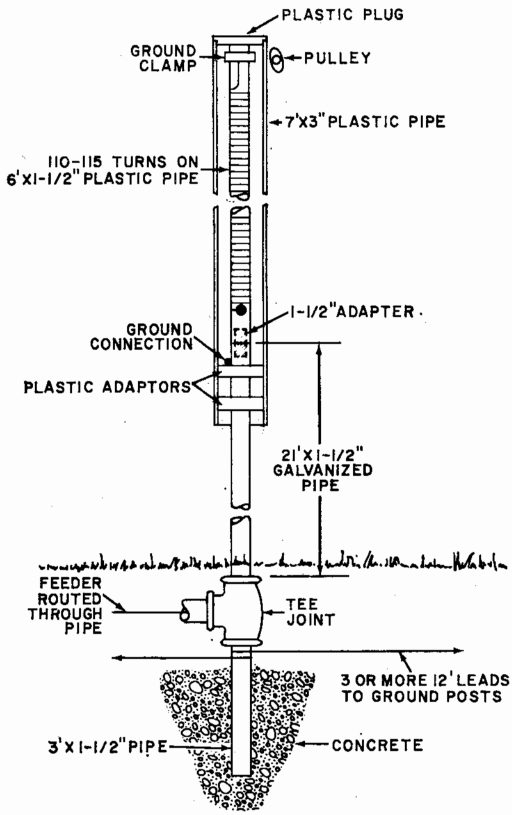
WHEN we moved to our new house, my usually gentle and permissive wife issued an unusual ultimatum: "Please do not put up a spider web of antennas around our new home." For a moment, my world reeled; 40 years of spider webs—uh, amateur radio—had taught me that a good antenna is the first requirement of a good station.

I ruminated for a while, rejecting the idea of an antenna camouflaged to look like a lightning rod in a location where lightning rods are a rarity. A flag pole? We're patriotic enough to have had one at our last location, so I was sure my wife wouldn't object. Now, I became obsessed with the idea of designing a flagpole antenna.

Trial and Error. The various handbooks cover vertical antennas very well—except for the helix, which is probably the easiest to build, consisting of a half-wave length of wire wound on a form. Convinced that this was the design I needed, I wound 70 ft. of #12 insulated stranded wire on a 6-ft. length of 1½-in. inner diameter rigid plastic pipe. The turns stayed in place; so, I drilled a hole at each end of the pipe and passed the wires through them to secure the coil.

The turns stayed in place well without cement—at least until the antenna-ground system was resonating on the 40-meter band, at which time about 20 turns suddenly dropped a foot and completely demolished my work up to that time. Too late, I realized that I should have taped the turns at about 12-in. intervals.

I checked the resonant frequency of the antenna-ground system with a dip meter and verified the frequency with my calibrated receiver. (The depth of the dip gives an indication of the Q of the system. The resonant frequency will change by 0.2-0.4 MHz when the antenna is raised to its perch atop a flag pole; it did with mine.)



My first effort, running the antenna to a loop around my dip oscillator coil and then to the ground I intended to use, gave a high-Q dip at about 6 MHz. Removing turns of wire sometimes raised and at other times seemed to lower the resonant frequency. Adding a ground-type clamp as a top-loading capacitance connected to the antenna at the top seemed to make the antenna behave better.

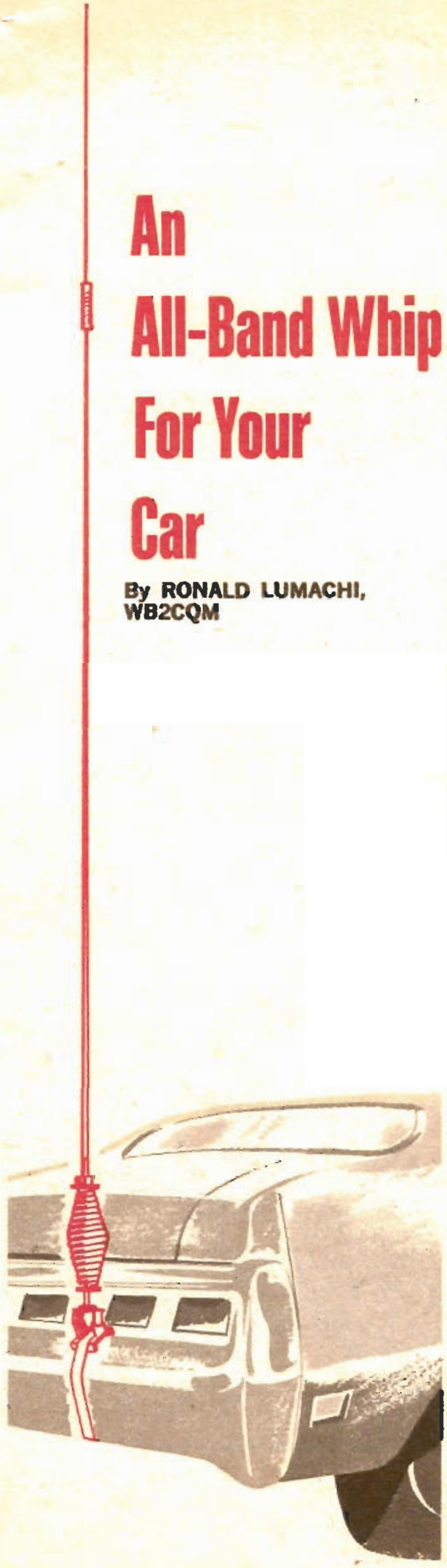
I removed turns until the wire on the form was only 60 ft. A high-Q dip appeared at 6.4 MHz—still far too low. I decided to try the antenna indoors and far off resonance because I wasn't sure yet how much difference raising the antenna would make. So, with the antenna and ground connected to my transceiver, I had to increase the loading adjustment and got the plate current to increase from 100 mA to 200 mA. The point of maximum field strength and minimum plate current occurred at the same plate tank tuning setting—an indication of low SWR.

With the antenna sitting on a table and leaning against a wall, I received an S7 from Seattle, some 300 miles away. On transmit, power to the antenna system was about 80 watts. I removed a few more turns until the oscillator indicated a dip at 7.1 MHz (this was later verified). Now minimum loading caused a broad tuning, flat plate current of slightly more than 200 mA. I tuned for maximum field strength indication and received some S8 reports.

Finalizing the Design. Now I decided to try out my antenna outside, feeding it with a 50- or 75-ohm line. Fitting a plastic adaptor into the lower end of the plastic pipe form, I screwed the antenna into an iron coupling on a 3-ft. iron pipe and planted the pipe in the ground. One lead of a length of flat ac power cord ran to the antenna, and the other I clamped to the pipe and to a wire about 30 ft. long which terminated in a pipe in the ground.

Now the frequency was 7.4 MHz; too high. However, I tried the system out and received an S7 from a ham aboard a ship some 1000 miles away. Adding some turns and mounting the antenna on a 21-ft. length of galvanized iron pipe, with the feed line running down the center of the pipe, I raised the antenna and leaned the pipe against the roof of the house to minimize capacitance problems. The antenna checked out 0.2 MHz higher than it was when on the ground.

That antenna went up and came down so many times that our neighbors must have thought I was signaling with my flag pole. Eventually, I got the antenna to resonate at 7.1 MHz. Readings of S9 became common, and I got an S6 from one of the Japanese Islands on 40 meters. Using the third harmonic and with no changes to the antenna, I logged an S9 from Germany—no mean feat in Idaho. ◈



An All-Band Whip For Your Car

By RONALD LUMACHI, WB2CQM

OUTFITTING a car for mobile operation is generally an expensive matter. The transmitter, receiver, power supplies, mounts, suppression kits and wiring add up to a substantial cash outlay. The antenna system is another item that can easily add $70 to $80 to the cost. But for $15 you can make an all-band mobile whip that will work as well as any commercially-made antenna. That's a big saving and it will make mobile operation a lot more enjoyable.

Our antenna is basically a center-loaded whip that radiates equally well in all directions. By inserting a coil (or spacer) between the upper and lower sections of the whip, and fine tuning the telescoping upper element by changing its length, the antenna will resonate in the Citizens Band and the 10, 15, 20, 40 and 80-meter amateur bands. The antenna's impedance is 46-54 ohms (depending on frequency); consequently, it will match the output network of almost every transmitter (250 watts or less) using RG58/U coax.

Construction

The basic antenna you start off with is a 102-in. Lafayette CB bumper-mount antenna which comes with a stainless-steel mounting strap. The antenna is inexpensive, however, it is well constructed and will last a long time. Cut off a section exactly 24 in. from the top of the whip; this section may be discarded. The dia. of the whip at this point is exactly 0.138 in. which is the outside dia. of a No. 6 screw. Thread the end of the whip (Fig. 3) using a 6-32 die. One end of the wood-dowel coil support will be screwed on the whip at this point. The telescoping upper element goes in the other end of the support.

The Coils

Coils could be handwound, however, the preformed coils specified are easy to work with. File or sandpaper three flat surfaces on each dowel in order to accommodate the plastic supports on the coil. When filing the flats on the hardwood dowels (Fig. 2), be certain that the coils fit snugly on the dowel; the flats will prevent coil movement. Because of the design, there is no strain on the coil.

Cut the wood coil-support dowels to the lengths shown in the Table. Drill ¼-in.-dia. holes approximately 1 in. deep in each end of the dowels.

Coat the dowels with several layers of varnish to prevent weathering. File or grind round one end of the hexagonal spacers (internally threaded for a 6-32 screw) and solder

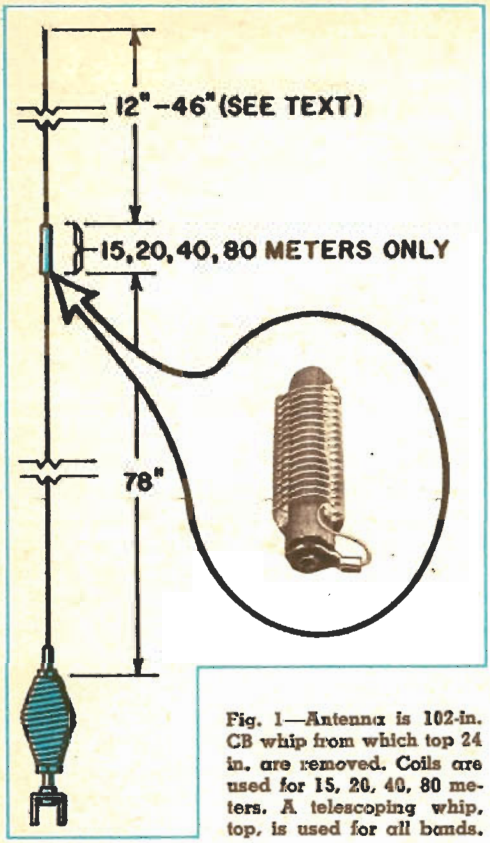


Fig. 1—Antenna is 102-in. CB whip from which top 24 in. are removed. Coils are used for 15, 20, 40, 80 meters. A telescoping whip, top, is used for all bands.

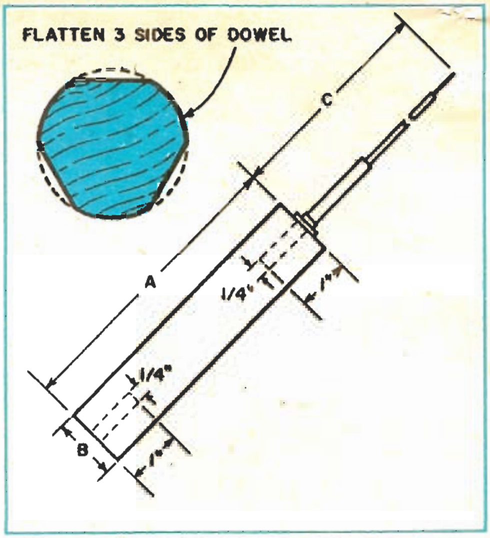


Fig. 2—Wood forms on which the loading coils are mounted; the lengths are different for each band. Refer to table below for the lengths and diameters.

Band	Dimensions (in.)			Air Dux coil
	A	B	C	No. and turns
10 m	spacer	spacer	12	none
CB	spacer	spacer	16	none
15 m	3	3/4	15	604T, 7½
20 m	3	1	29	816T, 32
40 m	3	1	42	832T, 56
80 m	7½	1	46	832T, 96

An All-Band Whip For Your Car

a ¼-in. lug on the end of the spacer as shown in Fig. 5. Force fit the lug spacer in one end of the wooden dowel as shown in Fig. 6. Refer to the Table and cut each coil form to length. Mark each coil for reference.

Slip the coil on the dowel support and fit the remaining spacer/lug in the other end. Solder the ends of the coil to the lugs. Either end of the coil may now be screwed on the threaded end of the whip.

The upper radiating portion of the antenna is a telescoping whip antenna that is used for fine tuning within the limits set by the coil. The whip antenna comes supplied with a 6-32 adaptor (Fig. 6, center) that allows it to be coupled securely to the whip and spacer.

Attach the stainless-steel bumper mount; the mount is universal and will fit any bumper. Connect the braid from a length of RG58/U coax to the mount and attach the center conductor to the antenna below the

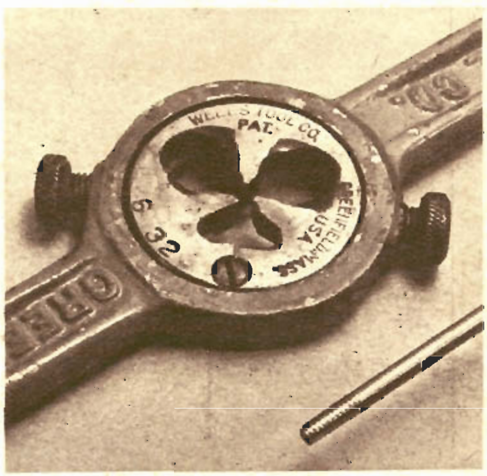


Fig. 3—The dia. of CB whip 24 in. from top is 0.138 in.—the dia. of 6-32 screw. Thread whip end using 6-32 die which is shown above in stock.

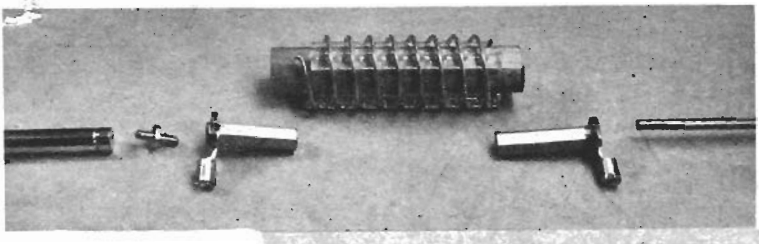


Fig. 5—15-meter coil. At far left is telescoping whip. Objects near coil are hex spacers on which are soldered lugs for the coil wires.

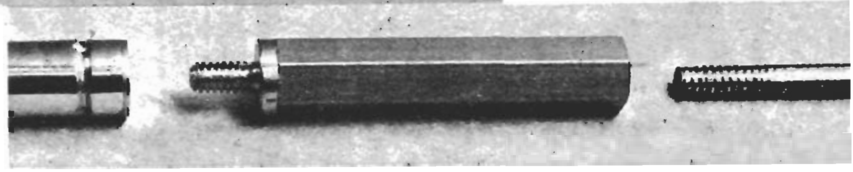


Fig. 4—At right is spacer used (instead of coils) for 10 meters and CB. Telescoping upper section is at left and top of whip antenna is at far right.

heavy spring as shown in Fig. 7. Threaded bolts are conveniently located for both connections. Attach the whip section of the CB antenna on the bumper mount.

Select a coil and install in between the lower whip and upper telescoping antenna. Adjust the telescoping whip to the dimension shown in the Table. Adjustment of the upper section will fine-tune the antenna for the frequency you're going to operate on. Strive for maximum power output with a minimum SWR. For optimum results, always readjust the upper section when changing bands.

The coils may be wrapped with plastic tape for an added degree of protection. Operation on CB and 10 meters does not require a coil. Substitute a brass spacer (Fig. 4) for the coil and adjust the telescoping portion to the length shown in the Table.

PARTS LIST

Antenna, telescoping, 46½ in. (Burstein-Applebee, 3199 Mercier St., Kansas City, Mo. 64111. Stock No. 10A3035, $1.95 plus postage)
Antenna, bumper mount CB (Lafayette 42 F 01596WX)
Coils: Air Dux Nos. 604T, 816T, 832T (Jeff-Tronics, 4252 Pearl Rd., Cleveland, Ohio 44109. 93¢, $1.13, respectively, plus postage)
Die stock (BA 37A3214. $1.34)
Die, 6-32 (BA 37A3223. 80¢)
Dowel, wood; 3 ft. x ¾-in. dia.
Dowel, wood; 3 ft. x 1-in. dia.
Spacer, brass hex; 1 in. x 6-32 (BA 12A1390. 10/$1.23)

Fig. 6—4-40/6-32 adaptor is used to attach the telescoping whip at left to hex spacer in dowel coil support. The coil has not been installed yet.

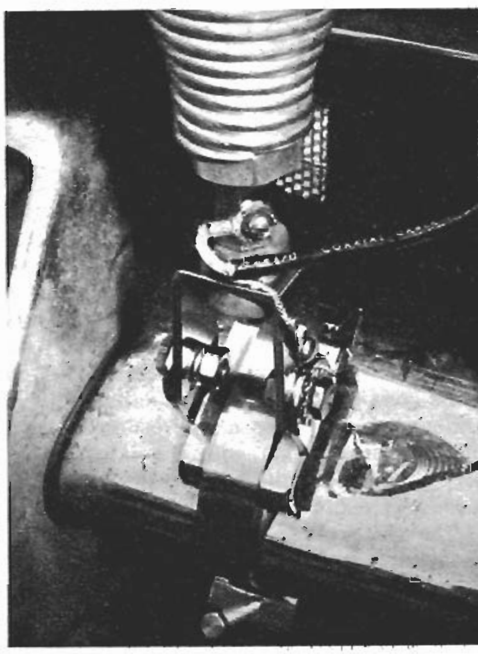


Fig. 7—Installed bumper mount. Coax's center conductor is attached below heavy spring. Braid is grounded to car at solder lug on bracket.

Pinchpenny Skyhook for 6 and 2

By RONALD LUMACHI, WB2CQM

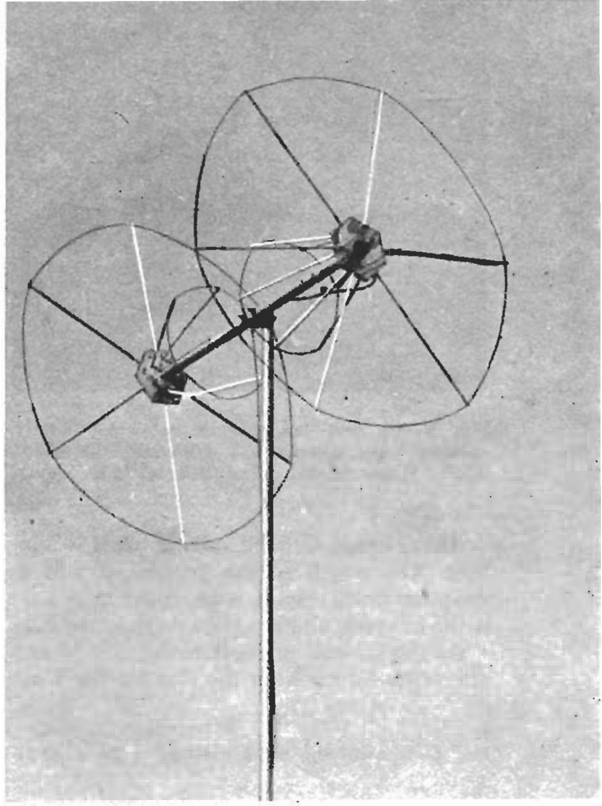


Fig. 1—Antenna in operating position. Round elements are for 6 meters; conical elements are for 2 meters. Tape coax to boom and mast and attach mast to center of the boom with a U clamp.

SOME hefty wire, a few dowels and a bit of aluminum tubing can be turned into an exceptionally lightweight and efficient antenna for operation on the 6- and 2-meter ham bands. With no trouble you can bring the project in under $3. Our bill for materials came to exactly $2.35, but we're semi-professionals at the game of pinching pennies.

Our Pinchpenny rig makes a quite-satisfactory permanent installation at home but also has special features as an antenna for the road. The light weight is one. Another is small size. Lastly, it solves the problem of nondirectivity, the affliction that besets halos, which long have been popular for travel. A halo can't compete in directivity with a good beam, which is the type of performance offered by our 6/2-meter antenna.

In many respects, our rig closely resembles a cubical quad and, like a two-element quad, has performance approximately equal to that of a three-element beam. In addition, it offers a lower angle of radiation than does a beam.

A quad owes its good performance to the fact that it has a large peripheral area which intercepts a relatively large portion of signal. Our circular design improves on this point with an even-larger periphery and more signal pickup (and radiation on transmit).

We compute our Pinchpenny's peripheral area to be about 20 per cent greater than that of a comparable quad. So one can figure on performance figures roughly 20 per cent on the light side.

Summing up our bit of sales talk, we'll say that our little rig will perform alongside any three- or even four-element yagi.

Construction. Our skyhook is two separate antennas mounted on a common boom, each antenna being fed from a common feed point. A standard aluminum TV mast cut to 3 ft. makes a good boom because it is lightweight, strong and readily available. The circular radiator and director elements, made from No. 14 copper wire, are held in place by ¼-in.-dia. wooden dowels. The dowels are mounted on six-sided hubs made from two pieces of ½-in.-thick exterior-grade plywood, cut to the dimensions shown in Fig. 5 and glued and nailed together. The dowel holes must be drilled in the center of each side of the hub.

The dowel holes for the 6-meter portion of the antenna are drilled perpendicular to the edges of the hubs. To provide the proper angle for the dowels for the 2-meter antenna, the holes for the dowels must be drilled at an angle of 20°. To drill the holes accurately, make a triangular jig as shown in Fig. 2; the holes should be ½ in. deep.

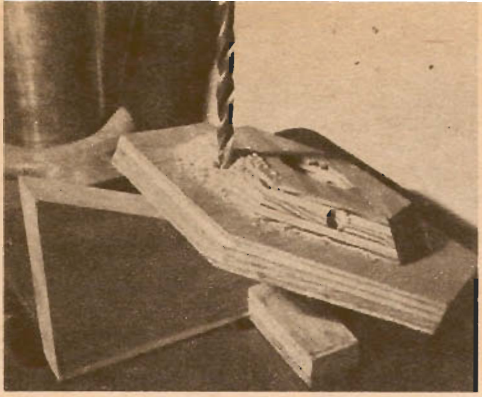


Fig. 2—To drill the angled holes for the 2-meter-antenna dowels, use a wedge with a 20° angle. Holes should be drilled to ½-in. depth.

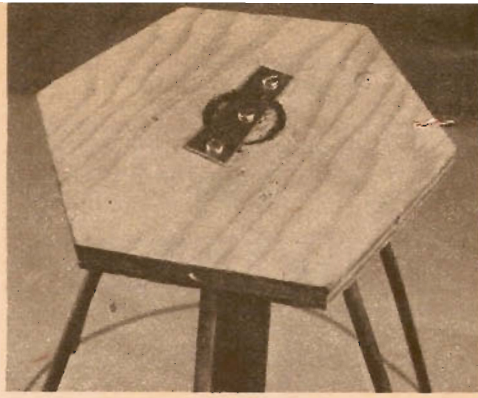


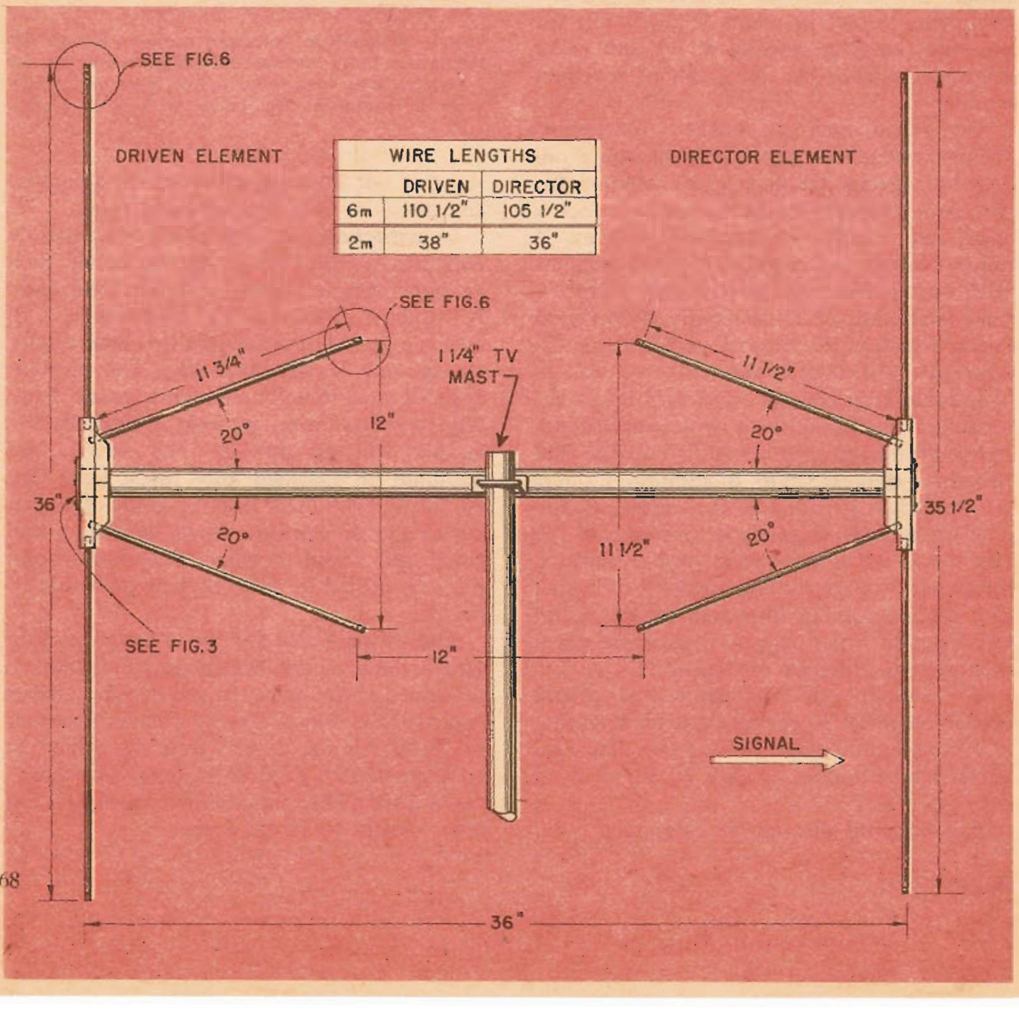
Fig. 3—Back of hub. Force fit short lengths of 1⅛-in.-dia. dowels in each end of boom. Attach hubs firmly to boom with 3-in.-long pieces of metal.

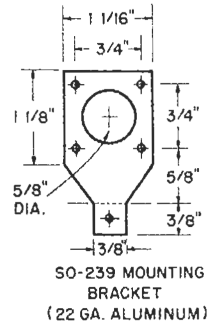
The 6-meter-element dowels are 15½ in. long. The length of the 2-meter dowels in the diagram in Fig. 4 is from the wire hole to the hub; add another ½ in. to go in the hub.

At the far end of each dowel drill ⅛-in.-dia. holes ½ in. from the end for the wire. The six dowels for each element form and support the wire and keep it rigid. The dowels may be glued if you don't plan to disassemble the antenna.

Before measuring and installing the No. 14 wire, put one end in a vise and stretch the

Fig. 4—Dimensions. Boom may be a TV mast or of wood. Driven and director wire lengths are critical.





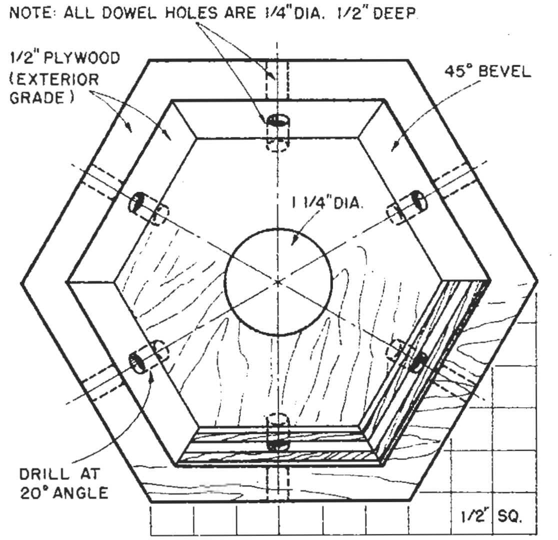


Fig. 5—Diagram above is of bracket used to support SO-239 connector shown in Fig. 7. Diagram at right is of hub (make two). Outer holes are for dowels for 6-meter element. Holes drilled at 20-degree angle are for the 2-meter element.

Pinchpenny Skyhook

wire by pulling it. This takes out all the small bends and kinks and will help in forming a circle.

Solder the two ends of the 6- and 2-meter director wires to form a closed loop. On one dowel of each driven element (for 6 and the 2 meters) drill a second hole then tape on a length of RG58/U coax.

Orient the 6-meter dowels so they are in a vertical plane with the feed-point dowel at the highest or side position. Solder the center conductor of the coax to one end of the antenna wire and the braid to the other as shown in Fig. 6. To keep the wires in place while soldering, form a right-angle bend in the coax after passing it through the dowel.

Install an SO-239 connector on a small homebrew racket (Fig. 5). Twist the center conductors of the coax together and solder to the center post of the connector. Install a solder lug on the shell of the connector and solder the braids to it as shown in Fig. 7.

The antenna may be rotated manually or with a rotator. The wind load is light and almost any rotator will be suitable. The antenna is sufficiently broadband on both bands to make tuning unnecessary. And switching is unnecessary even though both elements are tied together.

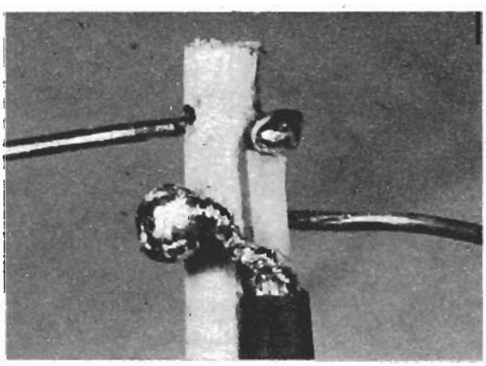


Fig. 6—On one dowel (far end) of 6- and 2-meter elements, drill two holes ½-in. apart. Solder coax to each end of antenna wire as shown.

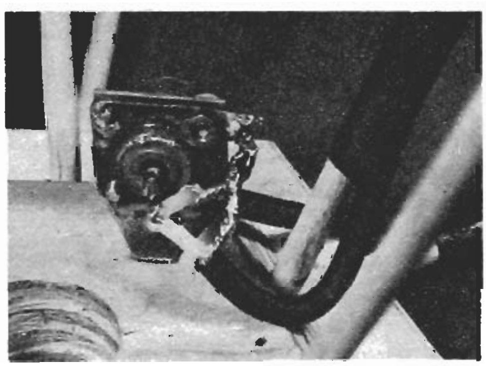
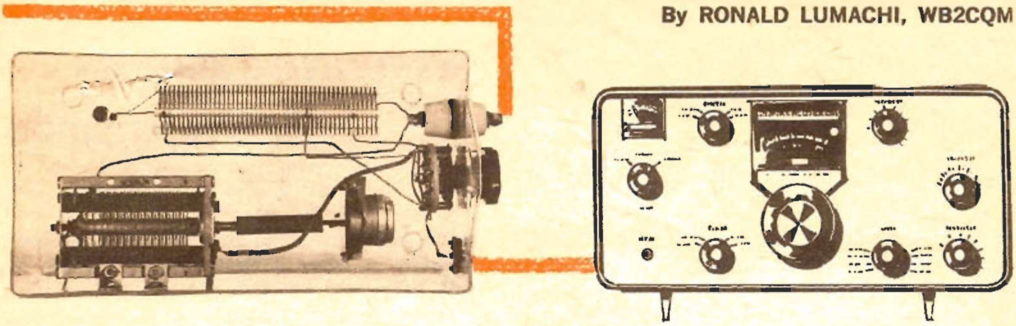


Fig. 7—Photo shows SO-239 coax connector mounted on hub of driven element. Solder coax from both 6- and 2-meter elements to the connector.

By RONALD LUMACHI, WB2CQM



Remotely-Tuned SWL Antenna

TAKE it from experienced hams or short-wave listeners—the only way to pull in those weak DX stations is with an antenna that's tuned as sharp as a razor. The finest receiver in the world might just as well be a $40 bomb if it has a poor antenna connected to it. A second-rate skyhook will degrade the performance of a receiver to the point where only the strongest signals will squeak through.

Unfortunately, you don't collect a great many QSL cards by confirming contacts with only the most powerful stations. To QSL those weak, hard-to-hear stations, you need an antenna that can be tuned to a particular frequency.

Such an antenna is our remotely-tuned SWL (and ham) antenna. You tune it two ways: First, you switch-tune it to a broad band of frequencies in which you want to operate. Then you fine-tune it to a particular frequency in that band by pressing a push-button switch near your receiver. This energizes a 1-rpm motor which turns a variable capacitor in the tuner. While you hold the button you will see your S-meter rise as the antenna is tuned to the frequency the receiver is tuned to.

The antenna is basically a long-wire inverted-L (a variation of a Marconi antenna) as shown in Fig. 1. Total antenna length is 50 ft. At the bottom of the verticle element there's a parallel-connected inductor and variable capacitor between the feed line and the element. The inductor electrically lengthens the wire. The motor-driven capacitor tunes the antenna precisely.

Since the elements of the antenna are hori-

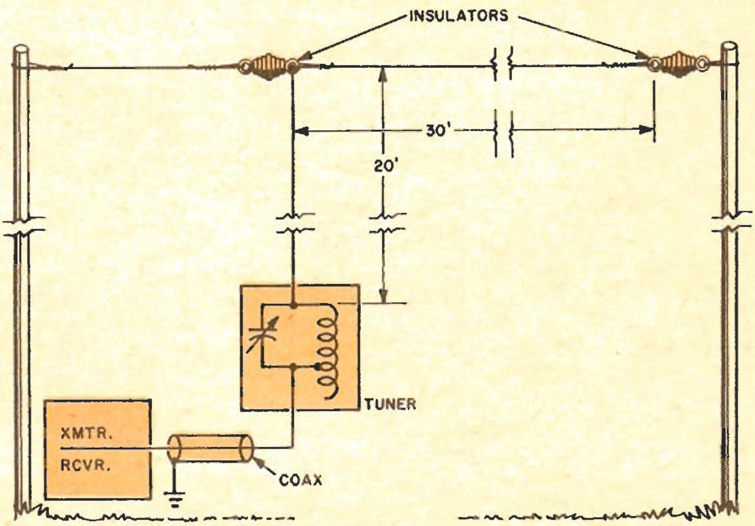


Fig. 1—Schematic shows a typical installation. Vertical element could be attached to the peak of your house's roof. Tuner should be connected to bottom of vertical element. RG58/U coax from receiver or transmitter should be grounded at transmitter or receiver.

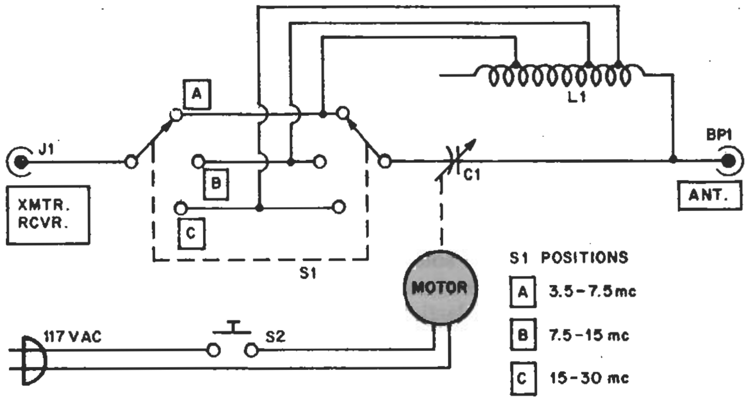


Fig. 2—Schematic of tuner. Left section of S1 selects tap on coil L1 for particular band of frequencies you operate on. Right section of S1 connects variable capacitor C1 in parallel with selected section of L1. S2 activates motor which turns capacitor.

zontal and vertical, the antenna has good horizontal and vertical pickup characteristics. This is especially important for shortwave listening since radio waves of either vertical or horizontal polarization may be intercepted by the antenna. Although a signal may be transmitted with a vertical polarization, ionospheric reflection and refraction may alter the original polarization. It is an advantage, therefore, to incorporate both types of polarization in one design.

You can make small changes in the lengths of the vertical and horizontal elements to suit the space you have available providing the overall 50-ft. length is not changed. The coil/capacitor combination will let you tune from 3.5 to 30 mc (10 through 80 meters) in three bands. Take a look at the schematic in Fig. 2. When S1 is in position *A* the antenna in broadly tuned to 3.5 to 7.5 mc. Position *B* covers 7.5 to 15 mc. In positi *C* you're set up for 15 to 30 mc. Since the antenna exhibits identical electrical characteristics whether receiving or transmitting, it may be used with equal success in either mode. For transmitting power less than 150 watts (input power) you can use a phone jack at the input end. For input power up to 1 kw, substitute a SO-239 connector for J1. No other changes are necessary.

Construction

Our tuner (see Figs. 5 and 6) is built in a 12 x 7 x 4-in. plastic food-storage box. Such boxes are available in houseware stores and are inexpensive. Mount the coil, rotary switch, motor and capacitor as shown in our model. The motor is mounted on a homemade right-angle aluminum bracket. Cut the coil to a length of 6 in. and then unwind one turn at each end. Mount one end on the porcelain feed-thru insulator and the other on the porcelain stand-off insulator. The vari-

PARTS LIST

- *BP1—Porcelain feed-thru insulator (55¢, 12A262)
- *C1—12-250 μμf variable capacitor (Hammarlund MC250M. $3.70, 12A1924)
- *J1—Phono jack (7¢, 12A1088)
- L1—Air-core inductor. 1¼-in. dia., eight turns-per-inch, 10-in. long (Air-Dux 1008T, World Radio, 3415 W. Bway., Council Bluffs, Iowa 51501. Stock No. 20A086, $2.80 plus postage)
- MOTOR—Synchronous motor, 1 rpm (Allied 41 A 5800 C, specify 1 rpm)
- *S1—three-pole, three-position ceramic rotary switch (49¢, 18A531)
- S2—SPST push-button switch
- Misc.—*Porcelain stand-off insulator (36¢, 12A249), No. 14 solid wire, plastic box

Note: parts listed with (*) are available from Burstein-Applebee Co., 3199 Mercier St., Kansas City, Mo. 64111. Price (add postage) and stock No. are enclosed in parenthesis.

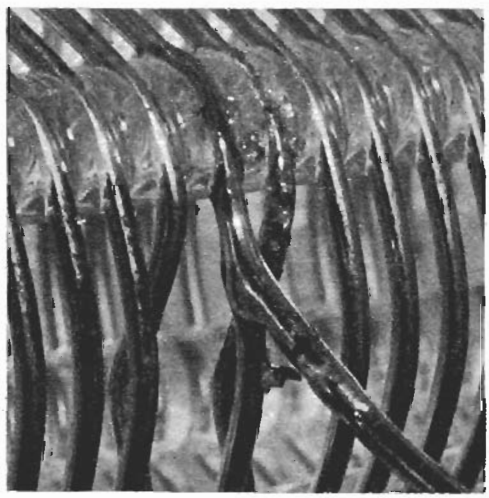


Fig. 3—Photo shows how wire is soldered to tap point on coil. To prevent short to adjacent turns, push in wires on each side of turn to be tapped.

Remotely-Tuned SWL Antenna

able capacitor may be mounted on the side or bottom of the plastic box. The holes for the switch, input jack, feed-thru insulator and screw holes should be made by melting through the plastic with a soldering iron. A drill will crack the plastic unless you are very careful and back up the plastic with a piece of wood.

When installing band-selector switch S1, orient it so that one pole is close to input connector J1. Make all connections with No. 14 wire. Solid wire is easy to work with and will handle the high power if the tuner is used with a transmitter.

It is important that the synchronous motor be insulated from the variable capacitor. To connect the shafts, make a coupling with a short length of a wood dowel or a plastic rod. Drill a hole in each end of the coupling to accommodate the shaft dia. of the capacitor and the motor.

The coils taps should be made at the following points:

3.5-7 mc—1 turn from the ungrounded end
7.5-15 mc—15 turns from the antenna end
15-30 mc—5 turns from antenna end

A low-loss ceramic switch should be used for S1. It must be a two-pole, three-position heavy-duty type capable of handling at least moderate power if the system is to be used with a transmitter. For receiving, any type rotary switch can be used. One pole selects the coil tap. The other pole connects the capacitor in parallel with the selected section

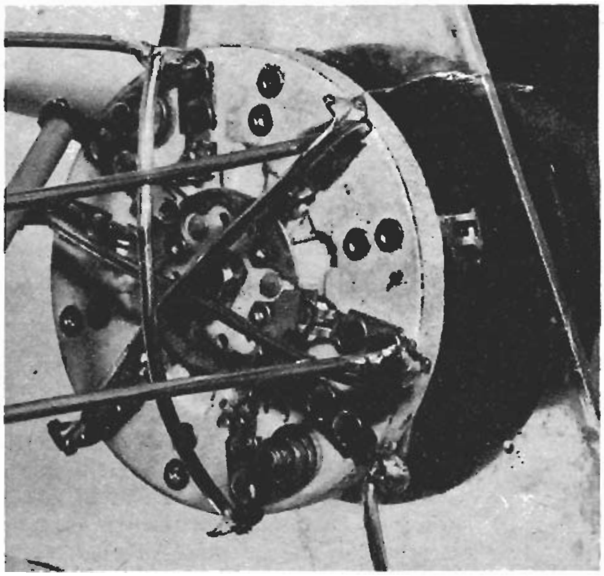


Fig. 4—S1 wiring. One wiper lug has wire coming to it from bottom of photo. Insulated wire is connected to other wiper in the upper left corner.

of the coil being used. Be sure the wires don't touch or even come too close to each other (especially if the tuner is to be used with a high-power transmitter).

Installation

After erecting the antenna as shown in Fig. 1, connect the bottom of the vertical element to feed-thru connector BP1 and connect your receiver (or transmitter) with RG58/U coax to J1. Depending on your

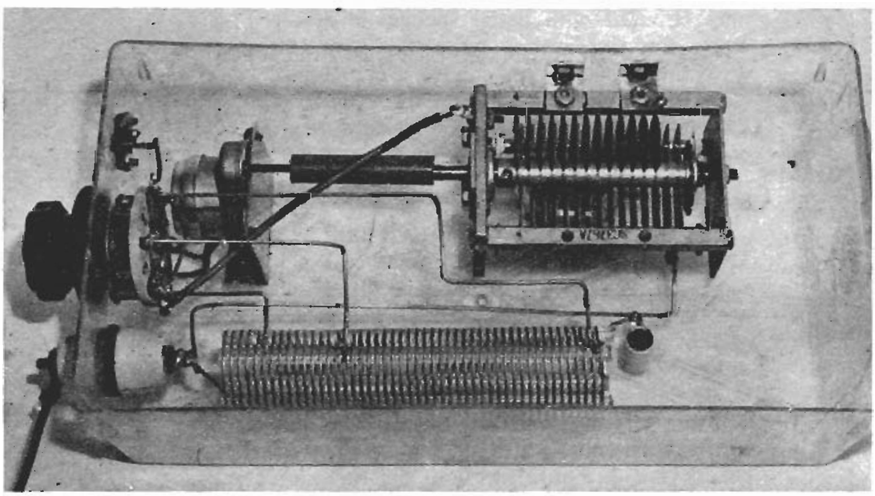


Fig. 5—Tuner can be built in smaller box if available. Note wood coupling used to connect motor's shaft to variable capacitor's shaft. If you substitute capacitor for one we specify in Parts List be sure rotor can turn 360°.

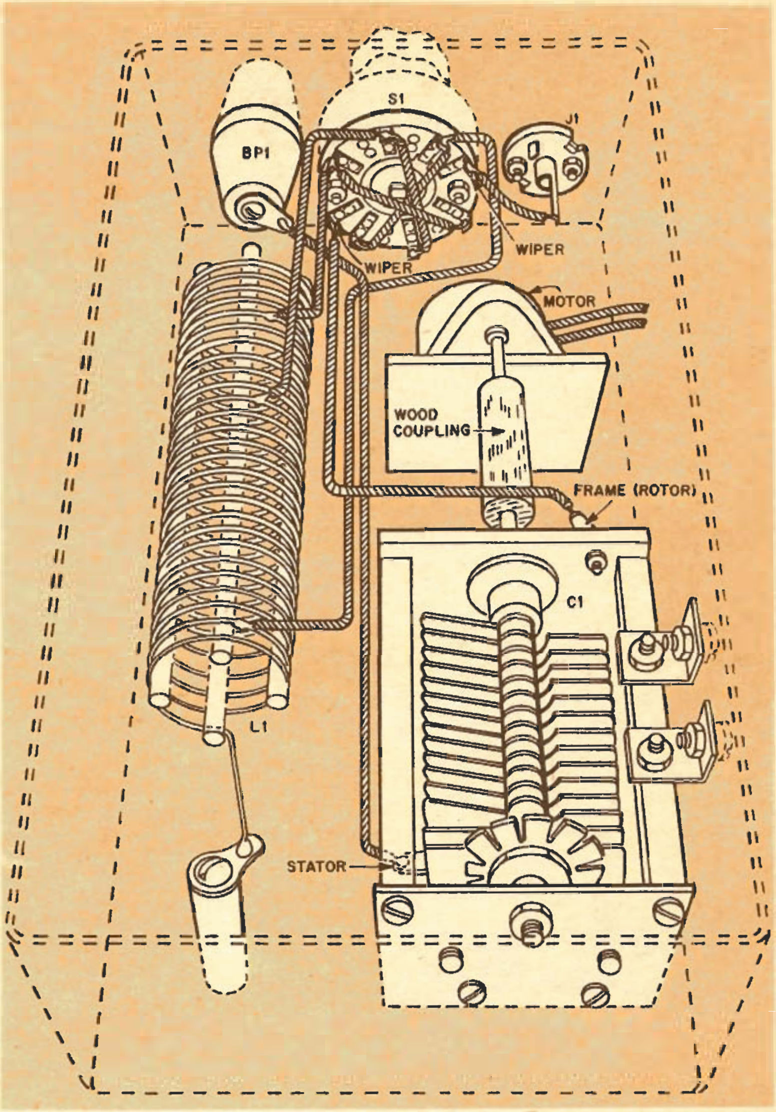


Fig. 6—Rear end of L1 is supported on porcelain stand-off insulator; connection is not made to this end. Capacitor we specify for C1 looks different from type used in author's model, but this will present no problem. It can be mounted on side of box, as shown, or on bottom. Put tape over heads of its mounting screws. If tuner is to be used with transmitters whose input power is greater than 150 watts, substitute an SO-239 coax connector for Jack J1.

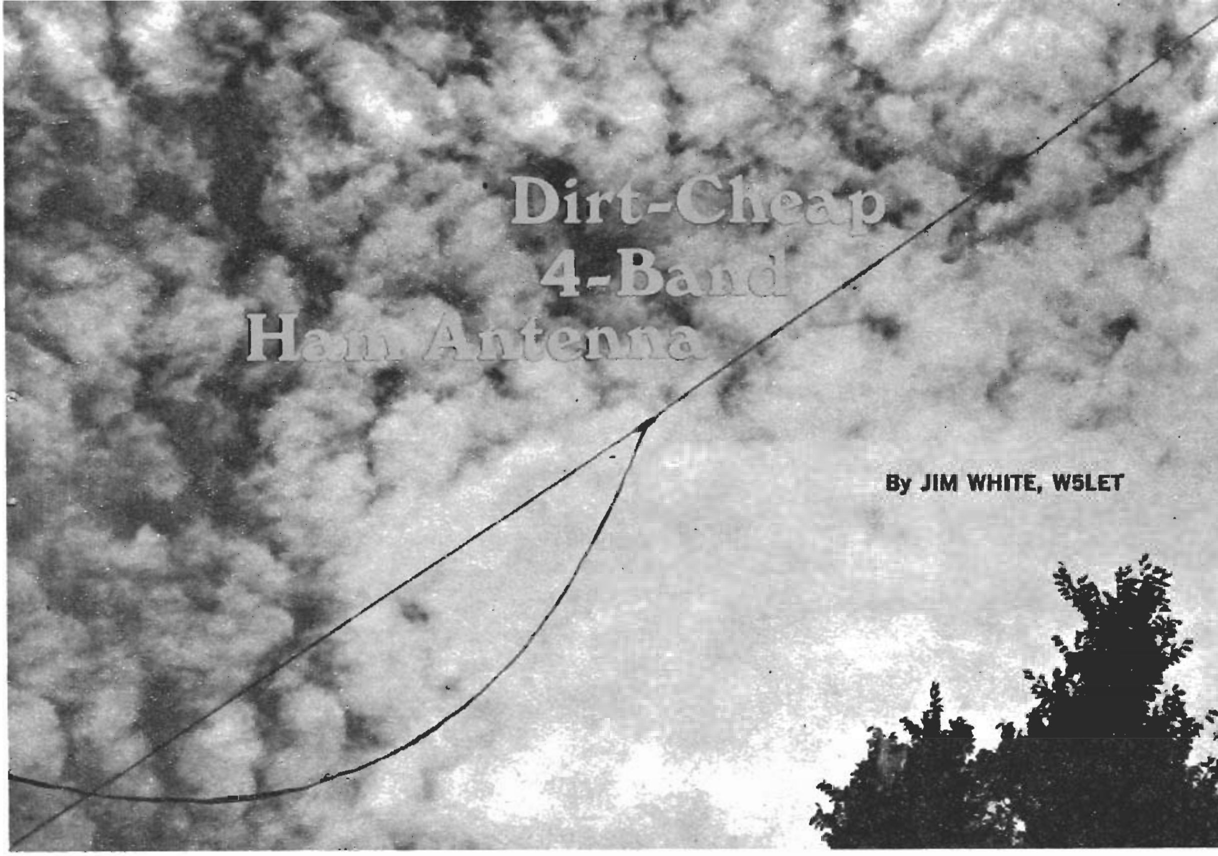
shack's location the tuner may be installed close to the receiver (providing the tuner is at the bottom of the vertical element) or a good distance from it. One safety precaution: put tape over the heads of screws used to mount the variable capacitor to prevent accidentally grounding it to something nearby.

Run a length of lamp wire from the motor to your operating position. The control circuit for the motor consists of a series hookup of a push-button switch, the motor and 117 VAC, as shown in the schematic. Instead of just plugging into an AC outlet, we suggest you use a 1:1 isolation transformer between the outlet and the motor circuit.

Operation

First, select the band in which you want to operate with switch S1. Then tune your receiver and peak the antenna by pressing the push-button switch. Observe your S-meter. You'll know at a glance when the antenna is tuned because the meter will peak. Frequency changes are easy to make. Simply retune the receiver to another portion of the band within the range previously selected by S1, hit the push-button switch and watch the S-meter peak again. When you want to operate another band, just flip S1.

Dirt-Cheap 4-Band Ham Antenna



By JIM WHITE, W5LET

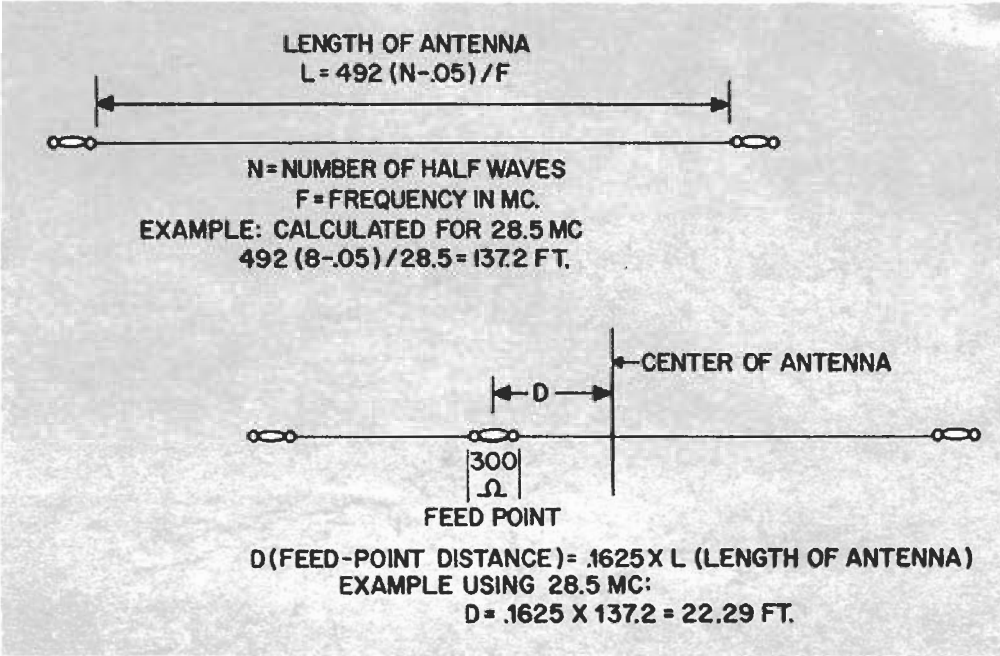
A LOT of hams have had bad cases of antenna-itis and don't know it. That obsessive state of mind compels them to want to rig up *one* more antenna to see whether it will perform just a shade better than the last one. This disease is not too bothersome to the lucky ham with plenty of room for antennas but to the one-antenna man it can be frustrating.

We have an answer to the multiple-antenna problem. It is a four-band antenna that works—and well, too. Known also as a Windom or off-center-fed antenna, it takes about the same space as a half-wave 80-meter dipole, but has the advantage of working on not only 80- but 40-, 20- and 10-meters as well. It won't break even a piggy bank to put it up. A few dollars for 140 ft. of copper wire and TV twin lead, and a couple of hours of work and it's yours.

How it Works

In order to understand the operation of this antenna a review of a few basic fundamentals is necessary. If a half-wave dipole is erected in the clear, the radiation resistance at the center will be about 70 ohms. Such a dipole can be fed with a 70-ohm transmission line for a good match. Now if the feed point is moved away from the center toward either end the radiation resistance increases. At the ends this will be in the vicinity of 4,000 ohms.

It is apparent that at some point between the center and either end there is a point where the radiation resistance will be 300 ohms. This point will provide a good match for 300-ohm transmission line.



4-Band Ham Antenna

Diagram at top shows how to calculate length of antenna that's eight half-wavelengths long on 10 meters (four half-wavelengths long on 20, two half-wavelengths long on 40 and one half-wavelength long on 80). Sketch below shows how to find distance of feedpoint from center of antenna.

But what happens if the aforementioned 80-meter halfwave dipole is used on 40 meters? On 40 meters it is no longer a half-wave but a full-wave antenna. The radiation resistance is no longer 70 ohms at the center, but is near 4,000 ohms. The radiation resistance at the ends is also about 4,000 ohms.

As the feed-point is moved either way from the center of the full-wave antenna two points will be hit (on either side) where the radiation resistance will be 300 ohms. One of these points coincides with the 300-ohm point for 80-meters. By using this point you will have a good match for both bands.

What happens when an 80-meter half-wave dipole is used on 20 meters? On 20 meters it is two full-wavelengths (four half-wavelengths) long and the number of 300-ohm points either side of center increases from two to four. Again, one of these 300-ohm points coincides with the point used for feeding the antenna on 80 and 40 meters.

What happens when you use an 80-meter antenna on 10 meters? Here the antenna will be four full-wavelengths (eight half-wavelengths) long. By feeding the antenna at the same point, you can have four-band operation from one 80-meter dipole.

Because 15 meters is not harmonically related to the four bands discussed, the antenna will not operate satisfactorily on this band.

Building the Antenna

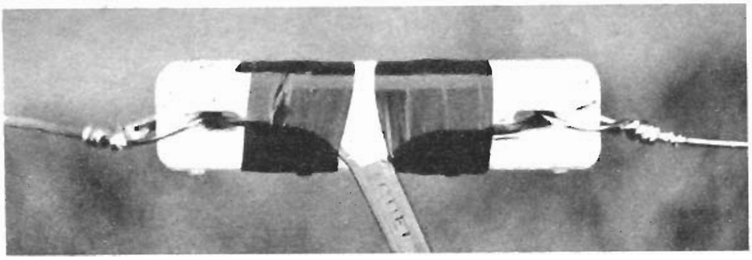
Setting up the antenna is as simple as cutting a piece of wire and soldering a few leads together. That's about all there is to it, except for a slight climb to get the antenna as high as you possibly can. But first you must determine the correct length of the antenna.

All calculations are based on an operating frequency in the 10-meter band. Reason for this is that the length of the antenna is more critical at a high frequency. If you do not plan to operate on 10 meters, then calculate the length by using an operating frequency on the next lower frequency band—20 meters.

The antenna length is determined with the formula.

$$L = \frac{492\ (N-0.05)}{F}$$

In this formula for the length of a long-



At the feedpoint use a good sturdy insulator. Twist the antenna wires a few times and apply solder. Feedline is heavy-duty 300-ohm twinlead which is soldered to the antenna wires. Apply lots of tape to hold twinlead.

MATERIALS

Antenna wire, 140 ft. No. 12 or No. 14 Copperweld (Allied 11 C 1358 or 11 C 1360)

Porcelain antenna insulators (Allied 47 C 6051 or 47 C 6052)

300-ohm TV twin lead.

wire antenna, L is the length of the antenna in ft., N is the number of half wave-lengths on the antenna and F is the frequency in mc.

The formula gives you the length of an 80-meter antenna that is one half-wavelength long on 80-meters, two half-wavelengths long on 40 meters, four half-wavelengths long on 20 meters and eight half-wavelengths long on 10 meters.

Let's go through a calculation using a frequency of 28.5 mc. The length, L, would be

$$L = \frac{492\ (8-0.05)}{28.5} = 137 \text{ ft. } 2 \text{ in.}$$

After the wire is cut to the proper length locate the exact center. Using the dimensions of the preceding example this would be 68.6 ft. If this were a regular 80-meter dipole you would cut it here, insert an insulator and feed it with 70-ohm transmission line. But ours is not fed at the center; it is fed off-center.

The feed-point is located by multiplying the total length of the dipole by 0.1625 and measuring off this distance from the center. Going back to our example we find this to be 22.29 ft.

With the feed point determined, cut the wire and insert an insulator. The insulator can be almost any type that will support the strain imposed upon it. Two other insulators are required—one at each end.

The 300-ohm line can be any good-quality TV lead-in. If you plan to run high power it is best to use the heavy-duty type. Tie the line to the insulator without spreading the leads too much. Wrapping the leads to the insulator with tape will help keep them close and also help keep some of the strain off the line.

No antenna can be any better than the way it is erected. This is true mechanically as well as electrically. Erect the antenna high and in the clear. Use only enough line to reach your operating position. You will be looking for trouble if you have excess twin-lead coiled up in the corner.

Using The Antenna

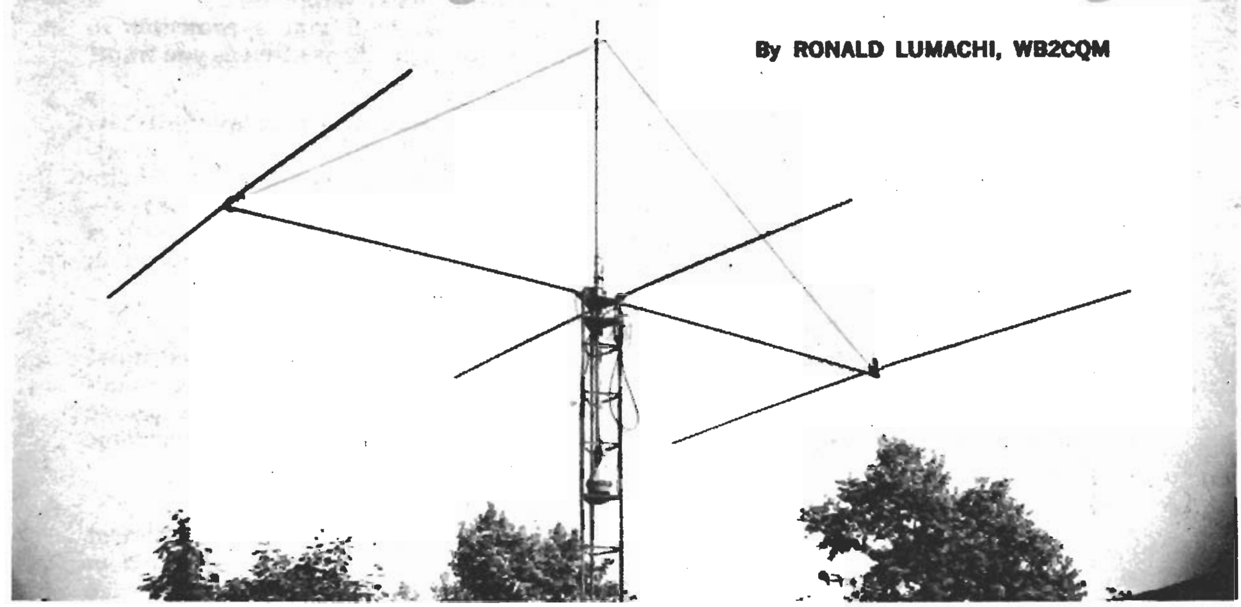
If your transmitter uses link coupling from the final tank coil to the antenna you can connect the antenna to this link. If it doesn't load up properly you may have to increase the number of turns on the link.

If your rig has an unbalanced output circuit, such as pi-net, you probably will have to use an antenna tuner or balun coils. Such an arrangement is desirable because not only will it provide a match from the balanced to the unbalanced line, it will match the 300-ohm antenna impedance to 75 ohms.

The antenna works well, but being a multiband design there are a few things you should remember. One of these is its directional pattern. On 80 meters it will perform as any other half-wave antenna in that it will be directional broadside; the pattern will resemble a figure eight. As you move up in frequency the pattern will approach the plane of the antenna. On 80 meters the angle of radiation will be 90° and on 10 meters it will be around 30°. With this in mind it is important that you give some thought to the direction you intend to work on each band and erect the antenna accordingly.

At the author's QTH, the antenna is approximately 40 ft. above the ground. With the transmitter running less than 50 watts input, several DX stations have been worked on 20 and 10. On 80 and 40 meters both the east and west coasts have been worked regularly from northeast Louisiana.

A Ham Yagi With Total Tuning



By RONALD LUMACHI, WB2CQM

SAY you live in the New York area and want to beam Europe and Africa for an elusive DX station. If QRM is bad you can get real up-tight. But when you start getting knifed in the back by Mid-Western and West Coast stations that are also aimed east, you can quickly lose your cool.

No need to go off the air or start working South America. The way to pull in the weak ones is with our Ham Yagi with Total Tuning. The rig is a three-element antenna with a gain of 7 to 8db. Sound pretty conventional so far? It isn't. Big thing about it is its total tunability. Mounted on its rear (reflector) element is a tuning device that tunes the antenna for a high front-to-back ratio. This means rock-bottom signal pickup from the rear.

For example, an antenna on the East Coast beamed east will be able to reduce Central-

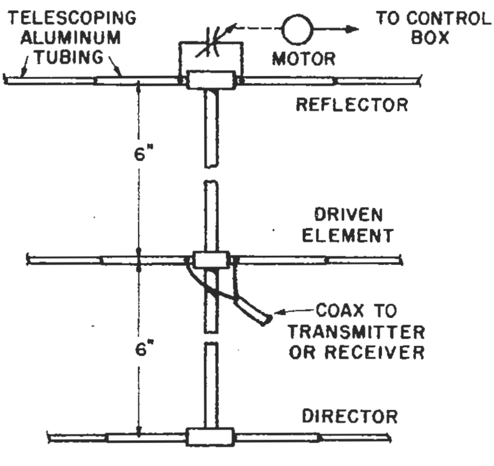
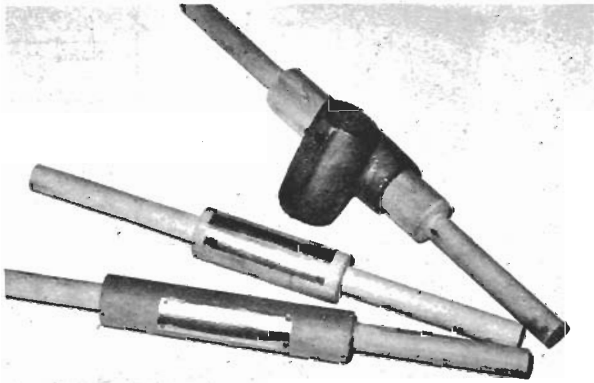


Fig. 1—Antenna (left) consists of three dipole antennas parasitically coupled (no direct connection between elements). Tuned reflector rejects signals from rear. Elements (below) are supported on boom by Nu-Rail aluminum crosses that are attached to supports by set screws (metal strips prevent set screws from burrowing in wood). Standard 1¼-in. dia. electrical conduit is ideal for the boom.



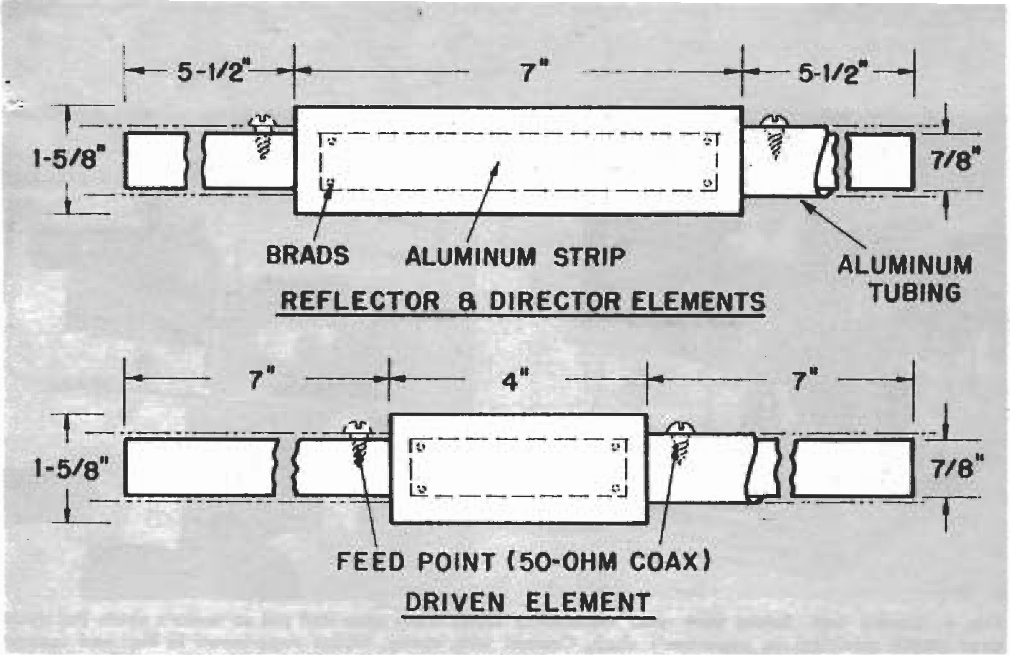


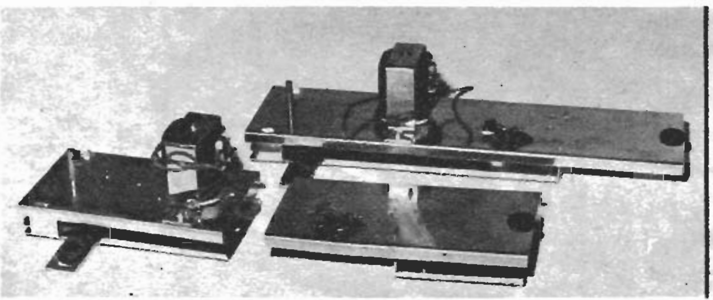
Fig. 2—Make center-element supports from 1⅝-in.-dia. wood pole. You'll need 5 ft. for three supports.

and Western-State QRM by at least 30-40-db. Therefore, a W6 station in California with as S-9 signal will be reduced to about S-3.

A similar tuning device can also be installed on the director element to further improve tuning If you install a tuner (same construction as the reflector's tuner) on the director, you must reduce the director's length by five per cent. We include dimensions in a table for operation on 20, 15 and 10 meters as well as the Citizens Band. Since the antenna exhibits reciprocal characteristics, it can also be used for transmitting.

Construction. For multi-band operation, you have two choices. You can make the elements with 1-in. and ⅞-in. tubing that will telescope. Or you can build the antenna for operation on 20 meters (greatest dimensions) and put knife switches on the elements (Fig. 8). The switches will disconnect outer ends of the elements to shorten them for operation on the higher-frequency bands.

Take a look at a diagram of the antenna in Fig. 1 to get an idea of what it's all about. The reflector, driven element and director are made of aluminum tubing and joined at the center with the wood supports shown in Figs. 1 and 2. The supports are made from a 1⅝-in.-dia. wood pole. The aluminum tubing is forced on the ends and held with wood



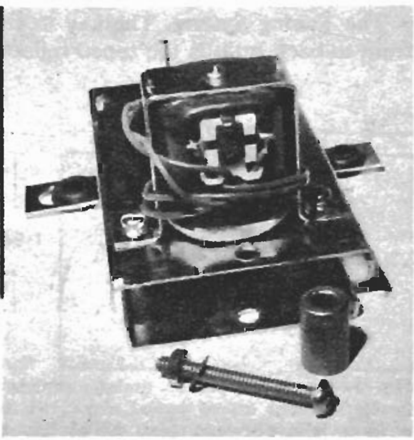


Fig. 3—Motor/gear-train assembly (rear, top photo) requires modification. Cut wire then saw frame in two about 1-in. to right of motor. Discard right side (lower right). Install ⅝-in. spacer (right photo) to provide support. Secure spacer with screw. Put nut on motor side of frame.

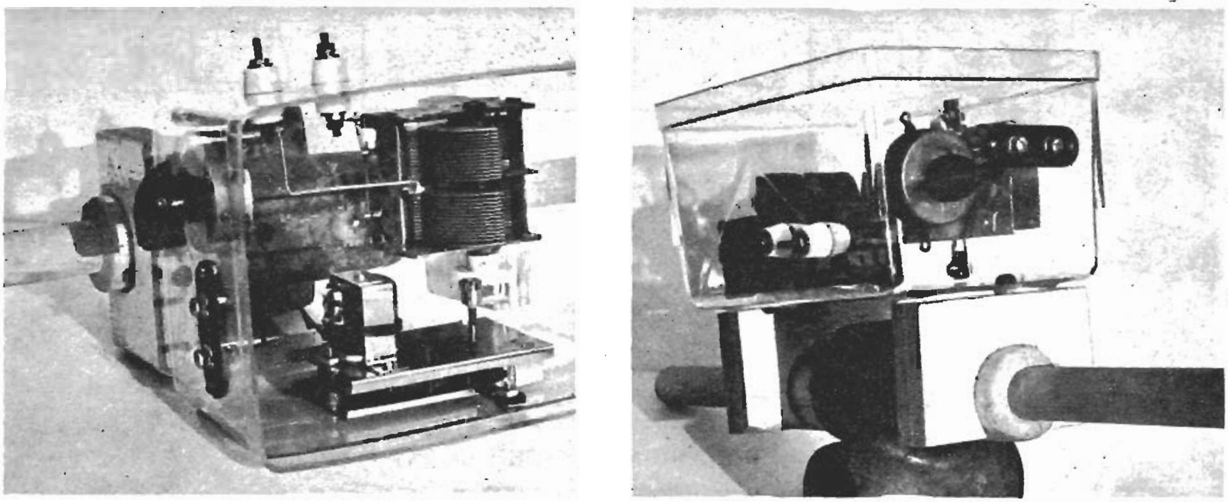


Fig. 4—Tuning unit. Select from gear assortment small brass gear and put on motor's shaft. Put nylon gear (check meshing) on capacitor's shaft. Cement with epoxy. Mount components in box and connect as in Fig. 7. Connect capacitor's stators then connect frame to one lead-in bushing, stators to other.

screws. The wood supports are attached to the boom with Nu-Rail aluminum crosses as shown on the top support in Fig. 1. The aluminum strips on the supports prevents the screws in the crosses from burrowing into the wood.

If you use knife switches, force a 12-in. length of wood dowel into the element ends as shown in Fig. 8. Leave a 2-in. space between the aluminum tubing and mount an SPST knife switch on the wood between the elements. The arm of the switch should be connected to the outer section of the element. Be sure to include the length of the switch arm (about 1½ in.) when calculating the overall dimensions.

The Tuning System. The key to the high front-to-back ratio is the tuned reflector element. A two-section (connected in parallel) variable capacitor, found in every AC/DC table radio, is series-installed between each of the halves of the reflector element as shown at the extreme right of the schematic in Fig. 7. The element is electrically lengthened as more capacitance is introduced into the circuit. The DC drive motor operates on 1.5-3 VDC. The motor is reversed by changing the battery polarity with switch S1.

The lengths of each half of an element must be identical in order to resonate at the proper frequency. Therefore, it is important that the wire from the rotor and stator plates of capacitor C1 to the feed-thru insulator and

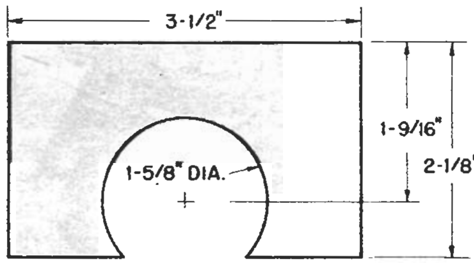


Fig. 5—To mount plastic tuning-unit box on reflector element above cross, make two supports of ½ or ¾-in. plywood using this sketch as guide.

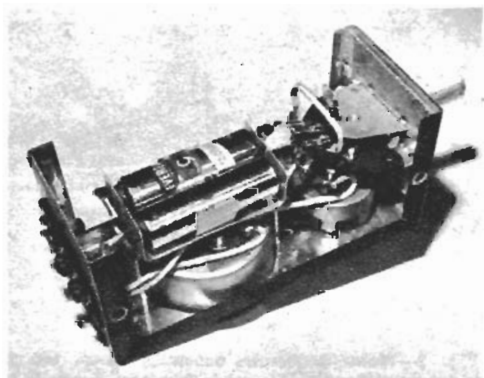


Fig. 6—Control box houses lever switch, speed-control pot (under switch) meter and battery holder. Terminal strip is on left end of the box.

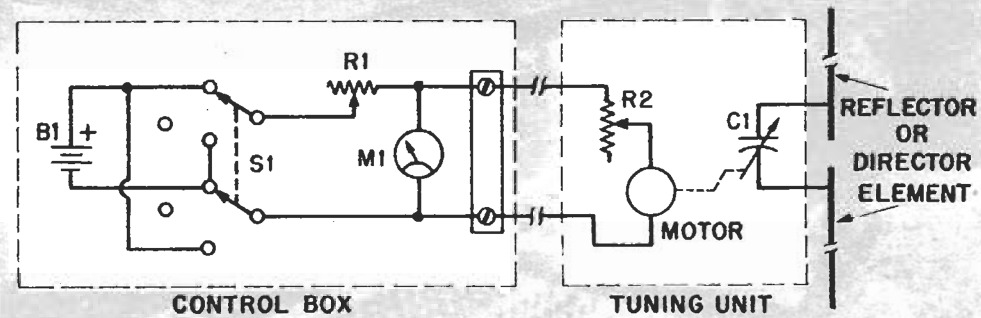


Fig. 7—Control-circuit schematic. S1 reverses polarity of voltage to capacitor drive motor to change its rotation. Connect units with lamp wire. Voltage on M1 drops when capacior stops turning.

TOTAL ELEMENT LENGTHS				
Band	Freq. (mc)	Director	Driven	Reflector
20 m	14-14.35	31′ 9″	33′ 6″	34′
15 m	21-21.45	21′ 6″	22′ 5″	23′ 2″
CB	26.965-27.255	16′ 10″	17′ 3″	17′ 9″
10 m	28-29.7	15′ 9″	16′ 10″	17′ 1″

finally to the elements (see Fig. 4) must be exactly the same length. For example, if one feed-thru insulator is closer to one element, add extra wire in order to equal the wire length to the other element. Make the measurement from the capacitor and include the wire length in the plastic box.

The control-box components are mounted on the main section of a 5 x 2¼ x 2¼ in. aluminum Minibox as shown in Fig. 6. Lever switch S1 is wired so that it will reverse the polarity of the voltage to the motor. Switch S1 has a center-off position. Mount the 20-ohm pot on top of the box and install the battery holder on the back of the meter.

Final Construction and Tuning. Before installing the tuner on the reflector, connect the wire from the control box to the tuner. Reduce R1's resistance to a minimum and adjust R2 so the motor will start each time the lever switch is moved. If too much resistance is used, the motor will not turn. Speed control R1 sets the speed of capacitor rotation. Once in motion, the speed of the motor can be reduced. Practice with the unit for a while to become familiar with its operating characteristics.

The meter serves a dual function. It monitors the voltage to the motor and indicates

[*Continued on page* 101]

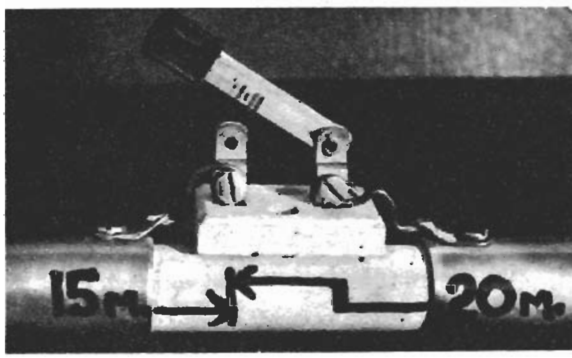


Fig. 8—Knife switches along elements make antenna multi-band. Include length of switch in element measurements to maintain the overall dimensions.

PARTS LIST

B1—1½ V penlite cells (two reqd.)
C1—Two section superhet variable capacitor (Allied 43 A 3529 or equiv.)
M1—DC voltmeter, 3-0-3 V (Allied 52 A 7631)
R1, R2—20 ohm, 3-watt wirewound potentiometer, Allied 46 A 3835)
S1—Two pole, three-position, non-shorting lever-action switch (Centralab 1455, Allied 56 A 4027)

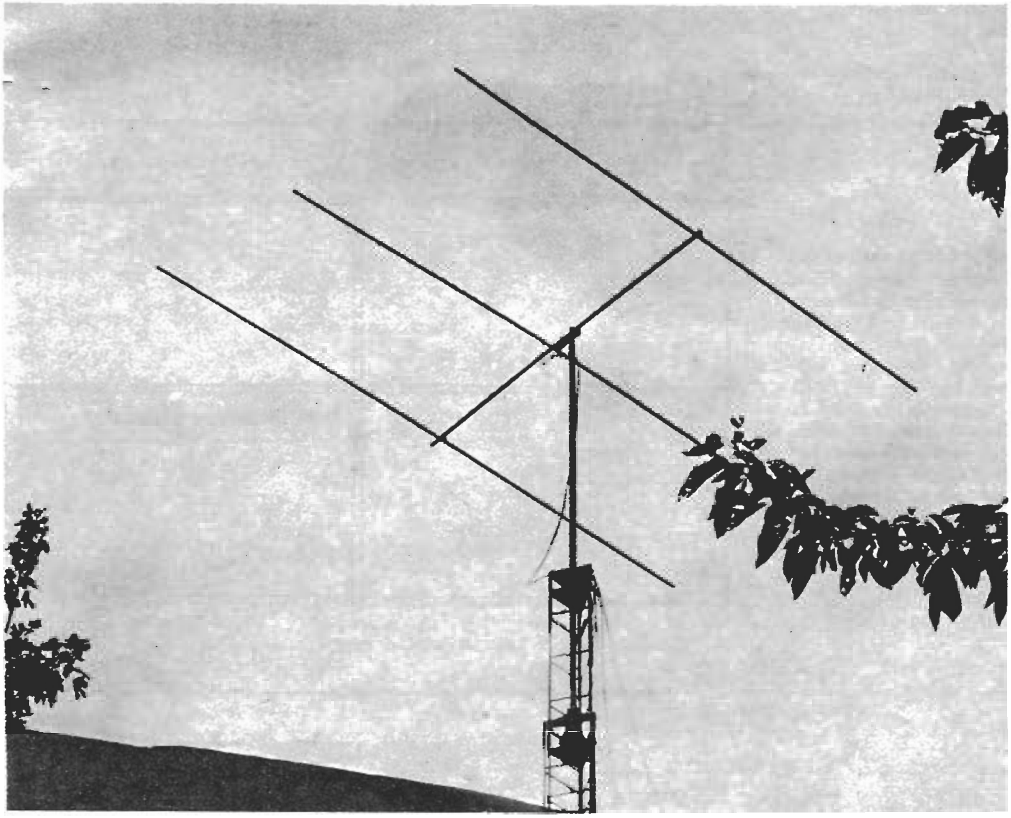
Miscellaneous

Aluminum conduit: 1¼-in. o.d. x 12-ft. long
Battery holder (two AA cells)
DC motor with gear train (Edmund Scientific Co., 100 Edscorp Bldg., Barrington, N.J. 08007. Catalog No. 60,700. $1 postpaid)
Gear assortment (Edmund Scientific Catalog No. 60,352. $1.50 postpaid)
Knife switch, SPST (Allied 56 A 4884)
Lead-in bushing (Allied 47 A 6223)
Nu-Rail crosses: No. 10, 1¼ x 1¼ in., three reqd. (Hollaender Mfg. Co., 3841 Spring Grove Ave., Cincinnati, Ohio 45223. $2.68 ea. plus postage for 3 lbs.)
Plastic box (approx. 5 x 7 x 8 in.)
Two-screw terminal strips (two reqd.)
Wood dowel, ¾-in. dia. x 12 ft.
Wood pole, 1⅝-in dia. x 5 ft.
Aluminum tubing, 1 in. and ⅞-in. dia.
Aluminum Minibox, 5 x 2¼ x 2¼ in.

Continued from page 93

each extreme of the capacitor's rotation. At such points watch for the voltage to drop about ½ V. Release the lever and change direction by moving S1 to the other side.

Final antenna tuning is simple. After installing the antenna on your roof, turn it 180° away from a steady signal source. Tune in a steady, unmodulated carrier from a local radio operator 3-5 miles away. Using S1 to turn the capacitor's drive motor, watch your receiver's S-meter drop for a minimum indication. There is only one point where the antenna will null the incoming signal.



$10 Beam Antenna for 10 Meters

By RONALD LUMACHI WB2CQM

AFTER several years in the doldrums, 10 meters now is buzzing with activity. One sure way to get in on the action is to use a skyhook which is tuned to the center of things and has some gain to boot.

A dipole, the mainstay of antennas because of its simplicity and low cost, might be the first antenna you'd think of stringing up. However, it has only a moderate amount of directivity and has no gain (it is the reference on which the gain of other antennas is based). A two- or three-element array excited by a dipole and rotated is a better choice.

Such an antenna is our three-element 10-meter beam (Yagi). Costing about $10, its gain is 5 to 6db and spurious-signal rejection at sides and rear is about 30db and 35db, respectively.

The Driven Dipole. Our beam consists of driven-dipole, reflector and director elements. The key to success of any antenna system is the means by which RF is transferred from the transmitter (and transmission line) to the antenna (and free space) with a minimum of loss. The matching technique used in our array results in the transfer of almost all of the power.

Construction. Prepare an 8-ft. 5½-in. length of RG8/U coax (if your input power is less than 400 watts, you can use RG58/U coax) in the following manner: At the center (4 ft. 2¾ in.) carefully cut through the outer jacket with a sharp knife. Make additional cuts in the jacket 3½ in. each side of the center. Be careful making these cuts because the braided shield must not be cut. Peel away the jacket to expose the shield.

At the center of the coax, carefully cut through the shield with a scissors. Be sure you don't cut the dielectric. Unbraid the shield from the center toward the sides, twist the shield and tin it. Cut off about 1 in. of each length of shield and install solder lugs on each end as shown in Fig. 2.

At each end of the coax, remove ½ in. of the jacket, peel back the shield and cut off about ¼ in. of the dielectric. Do not cut the inner conductor short.

Twist the shield around the center con-

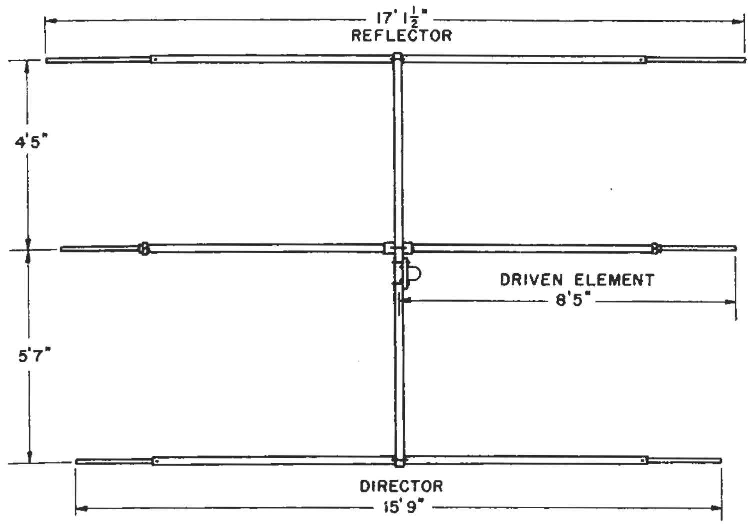


Fig. 1—Dimensions of 10-meter beam. Main section of reflector, driven element and director are 12-ft. lengths of 1¼-in. o.d. aluminum tubing. Lengths of ⅞-in. o.d. tubing are fitted in ends to extend elements to lengths indicated. Reflector and director are one piece. Driven element is two pieces joined with wood support as shown in Fig. 3.

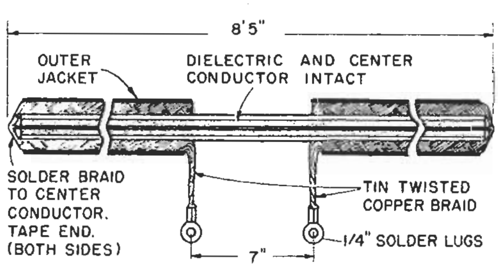
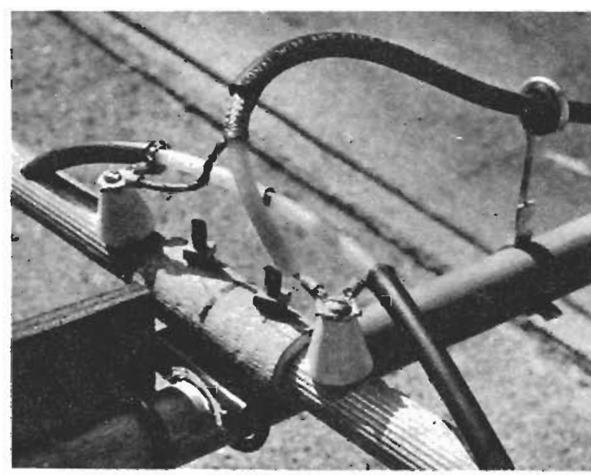


Fig. 2—Remove 7-in. of outer jacket from center of 8-ft. 5½-in. length of coax. Cut braid at center, twist, tin and attach solder lugs. Don't cut into dielectric. At each end solder braid to center conductor then cover ends with tape. Take prepared wire and slip it into elliptical holes in driven element as shown at right. Signal is inductively coupled from the coax to the tubing.



$10 Beam Antenna

ductor and apply a generous amount of solder to insure a good electrical connection. Tape the ends carefully so no wire is exposed. Set the coax aside; it will be installed later.

The three antenna elements are each made from 12-ft. lengths of 1-in.-dia. aluminum tubing which are extended to the dimensions in Fig. 1 with short telescoped lengths of ⅞-in.-dia. tubing. Make the measurements between the elements from the center of the tubing to insure both electrical and mechanical balance. The dimensions will resonate the

MATERIALS

1—10-ft. TV mast; 1¼-in. o.d., 18-gauge steel
*3—12-ft. lengths 1-in. o.d. aluminum tubing, 0,058-in. wall thickness
*1½—12-ft. lengths ⅞-in. o.d. aluminum tubing, 0.058-in. wall thickness
9-ft. length RG8/U or RG58/U coax (see text)
7—mast clamps (Lafayette 18 T 0195)
2—solder lugs
4½ x 9 x ½-in. thick exterior-grade plywood
12—No. 6 x ⅜-in. self-tapping screws
12-in. length 1¼-in. wood dowel
2—1-in.-high cone insulators (Lafayette 33 T 3213 or equiv.)
2—No. 6 x 1¼-in. screws, nuts, lockwashers
2—1¼-in.-dia. stainless-steel hose clamps
*Available for $2 per 12-ft. length (freight charges collect) from Gotham Antenna, 1805 Purdy Ave., Miami Beach, Fla. 33139

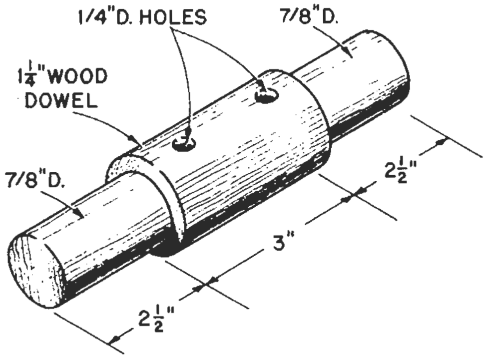


Fig. 3—Driven-element insulator is made from an 8-in. length of 1¼-in.-dia. wood dowel. Machine screws hold each element on ⅞-in. dia. ends.

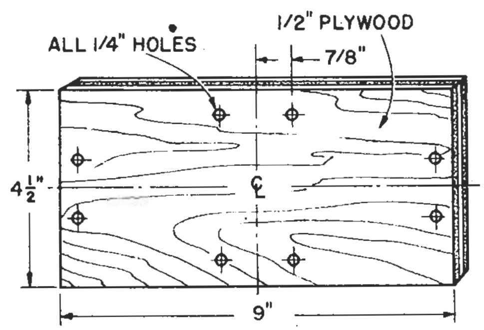


Fig. 4—The boom/mast mount is made from a 4½ x 9 x ½-in. thick piece of exterior-grade plywood. Boom is attached on one side, mast on the other.

antenna around 28.6 mc, depending on your installation.

When installing the end pieces, insert about 4 to 5 in. of ⅞-in. tubing in the 1-in. tubing for added strength. On the director and reflector elements drill a small hole through both sections and secure the extensions with stainless-steel self-tapping screws.

At each end of the 12-ft. driven element, cut several 1½-in. lengthwise slits. Place hose clamps over the ends (Fig. 5, center), adjust to the dimensions in Fig. 2 and tighten the clamps. Seven-eighths of an in. each side of the center of the driven element, reflector and director elements, drill a ¼-in. hole for the U-shaped mast clamp. The reflector and director elements are attached to the boom using the clamp arrangement shown in Fig. 5 (right).

Cut the driven element exactly in half. To insulate the two halves of the driven element from the mast, it is necessary to make a combination insulator and support. If a lathe is available, turn down the ends of an 8-in.-long x 1¼-in. dia. wood dowel to the dimensions in Fig. 4. Drill ¼-in. holes in the wood support for the mast clamp.

Six in. from the inside ends of the driven elements, drill a ⅜-in. hole through *one* wall of the tubing. Elongate the opening along the tubing length by manipulating the drill to accept the coax as shown in the photo in Fig. 2. File smooth the edges of the holes. Drill No. 6 holes through the tubing and dowel and mount the two porcelain insulators as shown in Fig. 2.

A standard 10-ft. steel TV mast is ideal for the boom and is readily available. The mast/boom support is made from a 4½ x 9 x ½-in. thick piece of exterior-grade plywood as shown in Fig. 4. Spray the wood with a paint or preservative to prevent weathering.

Assemble the beam on the ground being careful that all elements are parallel. Tighten

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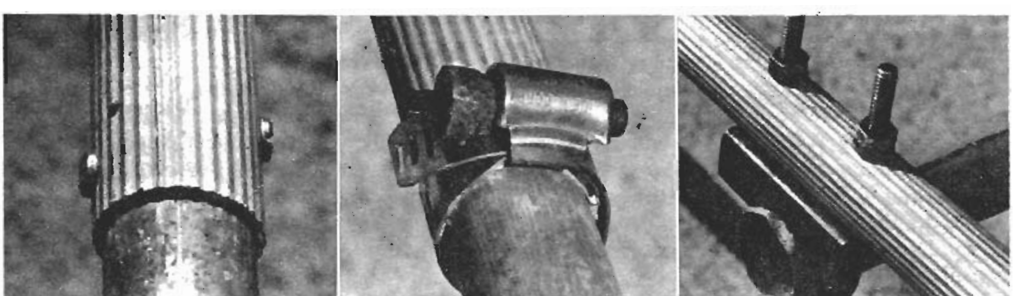


Fig. 5—Use self-tapping screws (left) to attach extensions to director and reflector elements. Hose clamps (center) permit driven element's ends to be adjusted easily. Reflector's and director's boom clamp (right).

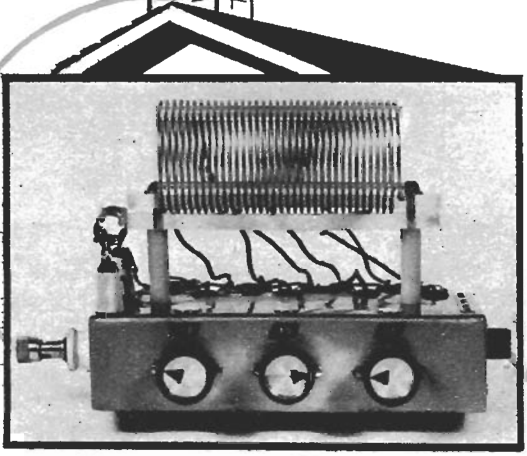
$10 Beam Antenna For 10 Meters

Continued from page 97

all the mast clamps securely using lock-washers, and be sure the mount is perpendicular to the plane of the array.

To reduce the surface area exposed to the wind, plug the open ends of each element with a cork. (This will also prevent water from accumulating in the driven element.) Slip the previously-prepared length of coax into the driven element as shown in Fig. 2. Connect the feed line to the porcelain insulators. To insure maximum efficiency, place the antenna at least 8 to 10 ft. above the ground.

By R. C. ALEXANDER
W6IEL



Remote Tuner for Vertical Antennas

YOU wake up with a start. That old intuition, from years of digging DX out from under 15 layers of QRM, tells you skip is rolling in. You fire up the receiver and there it is—the DXpedition to the Tsooris Islands. The chance of a lifetime and you're going to blow it because the antenna is tuned to 15 meters and you're listening on 20.

Of course you could run out in that driving rain through a field of mud to tune the antenna to 20 but why do it the hard way? If you're one of the many hams using the standard 23-ft. vertical antenna just connect our remote tuner to the base and you can change bands from the shack in a matter of seconds—no longer than it takes to throw a switch.

As the name implies, the remote tuner is a remote-controlled vertical-antenna tuner covering 80 through 10 meters. Basically it's a tapped inductor of 35 turns, 2 in. dia. (8 turns per in.) with the appropriate taps selected by relays controlled from the shack.

The shack's control unit is simply a low-voltage power transformer and a rotary switch that energizes a particular relay. Each relay selects not only the band tap but also connects the Z-match (impedance) for each band in use. Since the Z-match is adjustable, it is calibrated at the time of installation to insure the minimum SWR.

Construction. The tuner section to be installed at the base of the antenna is built on any chassis large enough to hold the coil, four relays and tuning capacitors C1, C2 and C3. Coil L2 is needed only if the antenna is shorter than 23 ft. It provides a match on the 10- and 40-meter bands. (L2 is a 5/8-in.-dia. coil (10 turns per in.) It will be pruned later on if necessary.

Small clips should be used at the ends of the connecting wires from the relays to make tuning as easy as possible. After the correct taps on L1 are established the clips can be removed and the wires soldered permanently to the coil. We show both techniques in the pictorial; five taps are shown soldered and two are shown with the cut-and-try clips.

To insure proper operation, follow the photographs and pictorial as closely as possible. Mount the relays on one side of the chassis and the tuning capacitors on the opposite side. The input coax connector (SO2) is on one end of the chassis near RY1 while the output, a porcelain insulator (BP1), is on the other end of the chassis near RY4.

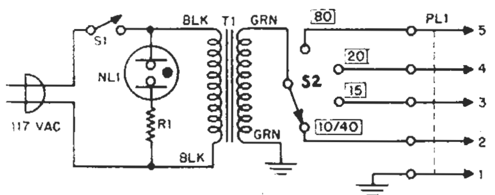
Coil L1 should be mounted approximately 2 in. off the chassis, using steatite or porcelain insulators. Similarly, L2, if used, should be mounted on small standoff insulators.

The connections between the relay terminals and L1 should be made with at least No. 16 *stranded* wire. Do not use solid wire because vibration at the bends could cause the wire to break.

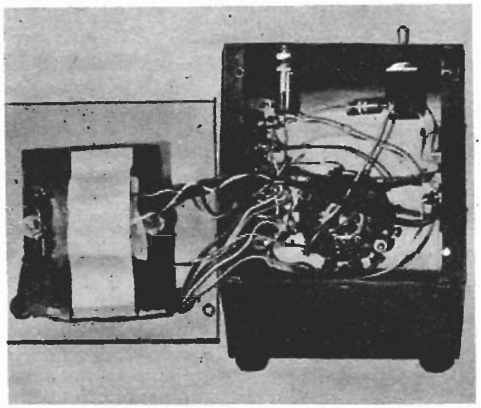
The completed antenna tuning assembly should be mounted at the base of the antenna in a watertight cabinet. A large Minibox or electrical box with covers sealed with silicon adhesive such as GE RTV or Silastic, makes a perfect watertight installation. But don't seal the box until the adjustments to L1 have been made.

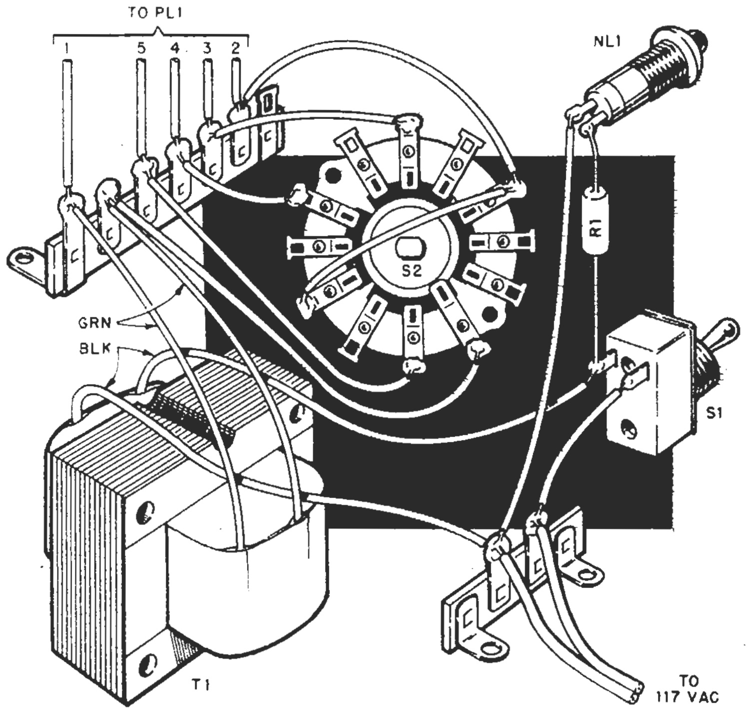
An attractive control unit can be built in a sloping-panel meter case as shown. Cover the meter cutout (if the cabinet has one) with a sheet of aluminum and mount a single-pole five-position rotary switch on the aluminum plate. Mount power switch S1 and power indicator lamp NL1 on the top of the cabinet. Cut an aluminum plate to fit the back of the cabinet and mount transformer T1 on the plate.

T1's output must match the relays. If the



Control section, which is located in shack, contains standard filament transformer whose output is fed by S2 to one of the four relays in the antenna unit.



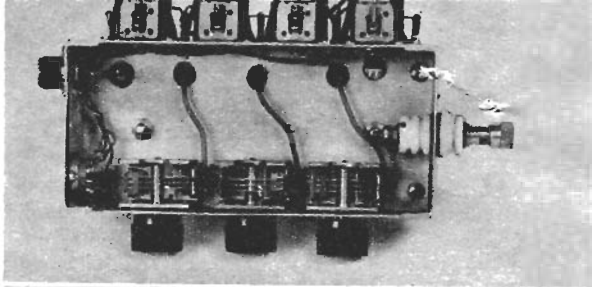


Control-section parts are installed in a 4-in.-wide sloping-panel cabinet (above). Transformer is mounted on rear cover panel and neon light and power switch are mounted on top. Layout isn't critical so you can use a larger box to avoid crowding. For convenience, we used every other contact of the 12-position rotary selector switch.

Remote Tuner

relays are 6.3 V, T1 must have a 6.3-V secondary. If the relays are rated at 12.6 V, T1 must have a 12.6-V secondary. Make certain T1's secondary current is sufficient for the relay because T1 will always be on when the tuner is in use. For example, if the relays require 1 A, T1's output must be rated for a minumum of 1 A. Since only one relay is in use at any given time, T1 need be rated for but a single relay.

The control section can be connected to the antenna section with a section of five-conductor TV antenna-rotator cable.



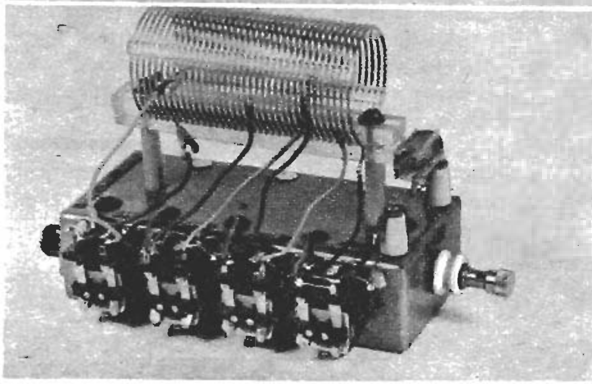
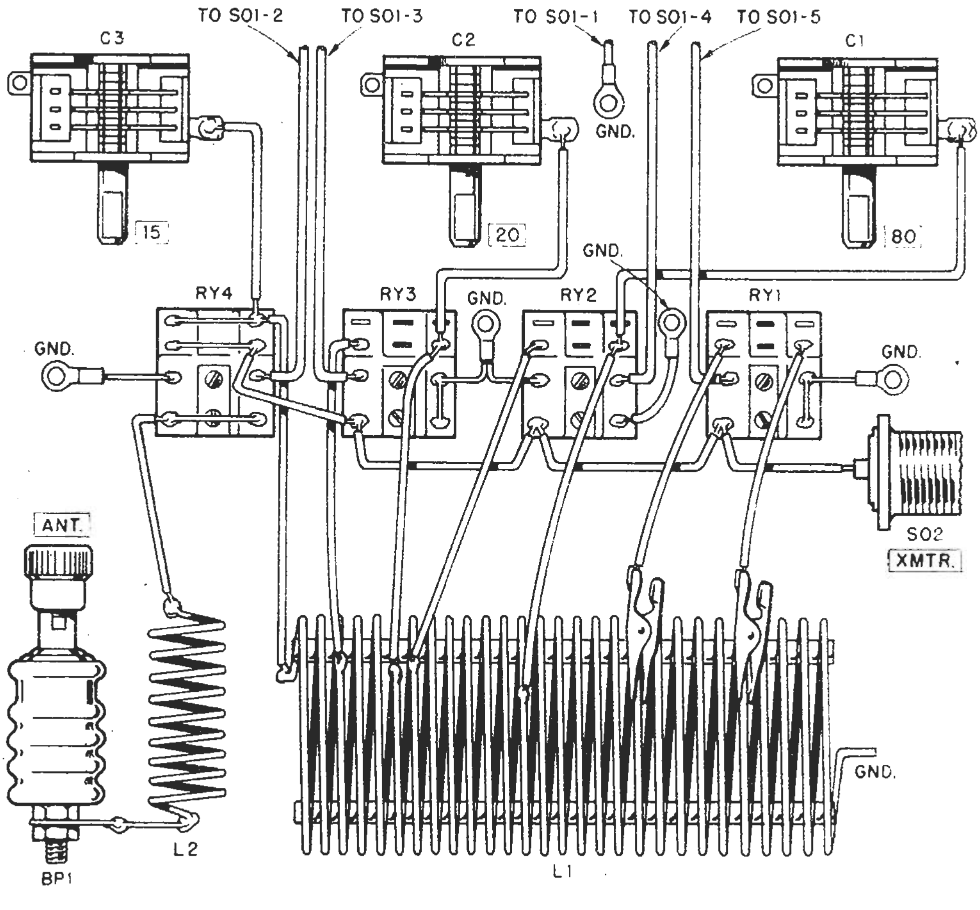
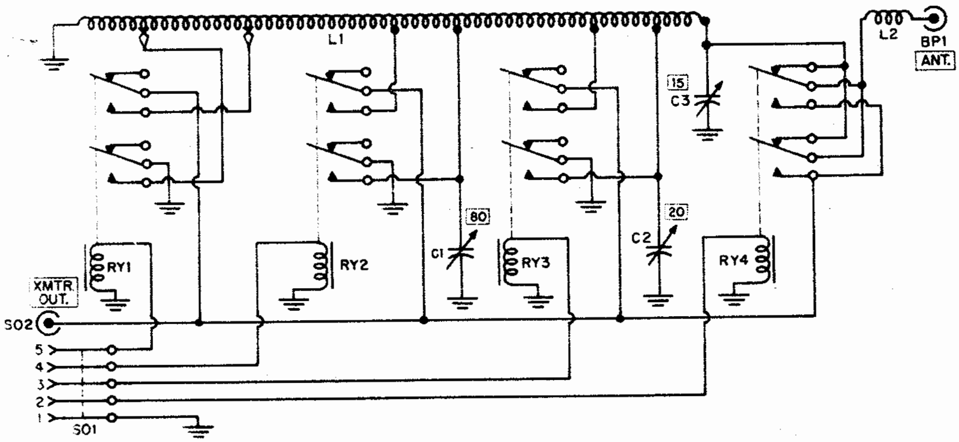


Photo at top is of underside of antenna section. Input coax connector is at left; output is binding post at right. Note in photo at right how coil is held between strips of Lucite which are supported by 2-in.-high porcelain standoff insulators.

Use photos for parts placement and pictorial for connections. Parts marked gnd. go to chassis ground.





Contacts of energized relay short out turns to left and connect appropriate tap on coil to antenna line.

PARTS LIST

BP1—five-way binding post
C1,C2,C3—5.7-75 µµf variable capacitor (E. F. Johnson 167-4, Allied 43 B 3780 or equiv.)
L1—Air-Dux coil: 2-in. dia., 8 turns per in., No. 14 wire. (Illumitronics No. 1608T, World Radio Labs., 3415 W. Bway., Council Bluffs, Iowa 51501. Stock No. 20D101. $2.70 plus postage)
L2—Air-Dux coil: ⅝-in. dia., 10 turns per in., No. 18 wire (Illumitronics No. 510T. World Radio Labs. No. 20D069. 69¢ plus postage)
NL1—NE-2 neon lamp and holder
PL1—five-prong plug
R1—100,000 ohm, ½ watt, 10% resistor
RY1,RY2,RY3,RY4—DPDT relay 6 VAC coil (Potter & Brumfield KA11AY, Allied 41 B 5159)
S1—SPST toggle switch
S2—1-pole, 12-position non-shorting rotary switch (Mallory 32112J, Allied 56 B 4351)
SO1—five-prong socket
SO2—SO-239 coax connector
T1—Filament transformer; secondary: 6.3 V @ 0.6 A (Allied 54 B 1416 or equiv.)
Misc.—2 x 5 x 7-in. aluminum chassis, 4-in. wide sloping-panel cabinet, Micro-gator clips (Allied 47 B 5178), five-conductor cable

Tune-up. Connect the antenna and ground system to the antenna section and start tune-up on the 10/40 meter band. Turn switch S2 and check that the relays close in the proper order. Set S2 so the 10/40 relay is closed, fire up the transmitter and check the system's SWR.

If the SWR is high, disconnect the coax transmission line at the antenna and, using a GDO (grid-dip oscillator), zero in on 40 meters by adjusting coil L2. (Use more than ten turns and remove them one at a time.) Then connect the coax and check SWR again. If necessary, tune L2 for minimum SWR. Next, tune-up on 15 meters. Try moving the tap on L1 until you get lowest SWR and the best plate-loading setting. Similarly, adjust for minimum SWR on 20 and 80 meters.

When adjusting L1's taps, always adjust the associated capacitor so that minimum SWR coincides with proper transmitter loading. Under certain conditions if the capacitor adjustment isn't made you can obtain a low SWR but insufficient transmitter loading.

Keep in mind that the tune-up should be done carefully because subsequent adjustment on a higher band will require readjustment on the lower bands.

For example, assume you have completed the entire tune-up and then find you are not getting quite enough transmitter loading on 10 meters. If you readjust L2 for 10-meter operation you must go through the entire tune-up for 80, 20 and 15 meters. Remember, any adjustments made for 15, 20 and 10/40 meters means retuning L1 for the lower-frequency bands.

After you are satisfied you have a good tune-up, install and seal the relay unit's cover. A good watertight seal is obtained by applying a heavy strip of RTV adhesive around the area of the cover flange. Place the cover in position and press it down firmly so the RTV squeezes out around the edges. Then install the cover's retaining screws.

If you feel you will have to get at the relay unit you can prevent the cover's screws from rusting by covering them with a small drop of RTV. When you want to remove the screws simply peel away the rubber RTV from the screw slots.

When installing the connecting cable, take care to avoid having it rub against a metal surface such as the edges of rain gutters and downspouts. —◆—

INDOOR 20-METER HAM ANTENNA

BY ROLAND J. MCMAHAN

Author pulls in overseas contacts easily with 6-ft. home-brew antenna

AMATEUR RADIO contacts from the west of North America to Europe are not unusual on 15 and 20 meters. But when they are made using a 6-ft (1.83-m) long coil of wire sitting on a desk as an antenna, that's something new and different. With just such an antenna, this author was able to contact Northern Ireland, France, and Costa Rica in a few short minutes —which is a little out of the ordinary.

Such an indoor ham antenna will be of great value to apartment dwellers and travellers who do not have the space in which to erect a more elaborate antenna. Add to this the fact that the antenna has a minimum of TVI and a high signal-to-noise ratio. It can be fabricated at a minimum of cost.

How to Make the Antenna. To fabricate the indoor antenna, wind 22 turns of #14 stranded wire around the outside of a 2-in. (5.08-cm) inner-diameter plastic pipe. (You can get the pipe at most hardware stores.) The pipe should be 6 ft (1.83 m) long. The preferred type of pipe to buy has holes through it and is used in septic-tank drain-line applications. You can use the holes to tie or hold the ends of the coil.

Other than winding the 22 turns of wire, there are two rules that must be observed when making the antenna: (1) The top turn must form a closed loop and be soldered to assure good electrical conductivity and mechanical strength. (2) When connected to the ground or counterpoise system, the antenna must resonate on the 20-meter band.

The second rule is the only difficult part of the fabrication process because not all ground systems are the same. In this step, you will have to use a dip oscillator to find the resonant frequency.

If you try to use this 20-meter antenna on 15 meters as well, you will find that the response is too sharp for this. However, you can tap the coil five turns up from the bottom to obtain 15-meter operation. Slide the first five turns together so that they are closely wound before completing the 20-meter antenna. The remaining turns can be randomly wound, some as much as 8 or 10 in. (20.3 or 25.4 cm) apart.

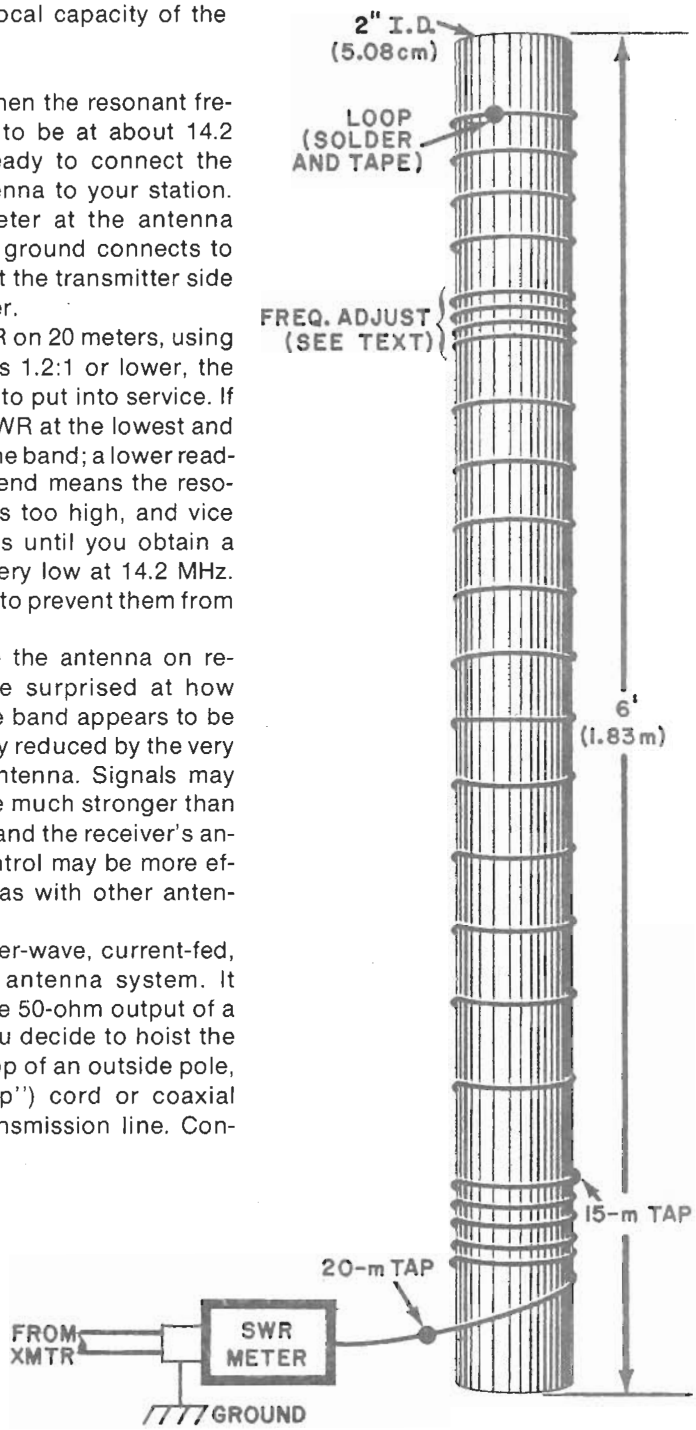
To adjust the antenna to 20 meters, you might try sliding the top four turns close together, about 10 in. (25.4 cm) from the top. Sliding the turns down lowers the resonant frequency, as does close winding. Your own adjustments will depend on your ground system and the local capacity of the ground.

Final Steps. When the resonant frequency appears to be at about 14.2 MHz, you are ready to connect the ground and antenna to your station. Use an SWR meter at the antenna connection. The ground connects to the coax fitting at the transmitter side of the SWR meter.

Check the SWR on 20 meters, using low power. If it is 1.2:1 or lower, the antenna is ready to put into service. If not, check the SWR at the lowest and highest ends of the band; a lower reading on the high end means the resonant frequency is too high, and vice versa. Slide turns until you obtain a reading that is very low at 14.2 MHz. Tape some turns to prevent them from slipping.

When you use the antenna on receive, do not be surprised at how much quieter the band appears to be as static is greatly reduced by the very high Q of the antenna. Signals may also appear to be much stronger than you are used to, and the receiver's antenna tuning control may be more effective than it was with other antennas.

This is a quarter-wave, current-fed, low-impedance antenna system. It works best on the 50-ohm output of a transmitter. If you decide to hoist the antenna to the top of an outside pole, use ac line ("zip") cord or coaxial cable as the transmission line. Connect the ground side of the transmission line to the metal pole, and use some ground radials, making each radial long enough to total 17 ft. (5.17m) when added to the length of the pole. Resonance is all-important; so, work with the antenna until it is properly resonant. ◈



Here's an idea on how to operate in restricted areas using a mobile whip antenna.

Amateur Radio Operation From Apartments And Motels

BY HARRY K. BOURNE*, ZL1OI

An increasing number of radio amateurs live in apartment buildings, town houses or in multiple housing units where there are restrictions on the erection of antennas, and where the location seems to offer little opportunity for amateur radio operation.

The writer has operated successfully from several apartment buildings in Washington D.C. and elsewhere in the United States. For some years he operated as G2AH/W4 from an apartment on the twelfth floor of a high rise building at a height of 120 feet above the ground, where no form of outdoor antenna was allowed by the management. Each apartment unit, as in so many blocks of this type, opened onto a small balcony, approximately 16 feet long and 6 feet wide, surrounded on three sides by an iron grille railing. The reinforced concrete floor and roof of the balcony, formed the roof and floor respectively of the balconies of the neighboring apartment units below and above. The antenna was mounted on the balcony, which was in effect a partly screened box with a slot approximately six feet high, open on three sides and screened on the fourth side by the steel frame structure of the building, a situation which would appear to be extremely poor for amateur radio operations.

The writer operated successfully from this location using a Hustler[1] mobile whip antenna mounted on the balcony railing, inclined at an angle of 35 degrees to the horizontal. The antenna was normally located inside the balcony space where it was not visible from outside the building, but it could also be swung outboard over the edge of the railing in the clear to reduce the screening effect. The antenna was mounted on a lightweight TV antenna rotator so that it could be moved into either position from the operating desk. The arrangement is shown in fig. 1.

Operation on the bands from 80 to 10 meters was provided by selecting the appropriate resonator for the antenna for each band. The antenna was fed with 52 ohm coaxial cable, with the outer shield connected to the steel railing which acted effectively as a ground plane on the 10 to 40 meter bands providing a low value of s.w.r. On the 80

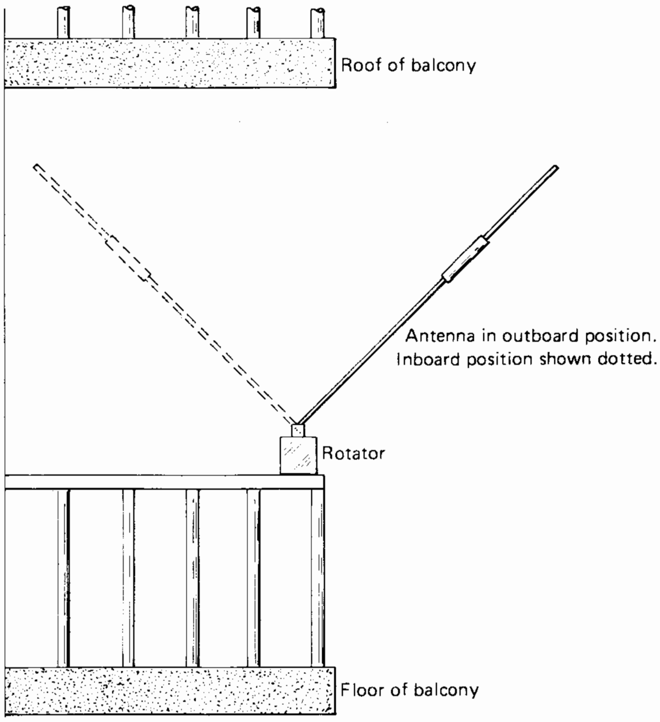


Fig. 1—The arrangement of the antenna and rotator on a balcony railing. If the balcony is made of metal, it acts as a ground plane for the higher frequencies.

*54 Whitehaven Road, Glendowie, Auckland, 5, New Zealand.

[1]The Hustler is a mobile whip with changeable resonators for each band. The resonators are available in two power ratings, 400 w.p.e.p. or 2kw p.e.p. It is manufactured by New-Tronics, 15800 Commerce Park Drive, Brookpark, Ohio 44142. The antenna is available at many distributors.

meter band the railing did not serve efficiently as a ground plane and for this band a single insulated counterpoise wire, 66 feet long, connected to the shield of the coaxial feeder at the antenna end, laid on the floor of the apartment, enabled an acceptably low value of s.w.r. to be obtained.

During the hours of daylight, the antenna was used inside the balcony. In spite of the screening effect, results on the 10, 15 and 20 meter bands were surprisingly good and many DX contacts were made on c.w. and s.s.b. using a Drake TR4 transceiver. On the 40 meter band, results were satisfactory in directions through the "slot" towards the northeast and the north including Canada, through the Midwest and Central States to the Pacific Northwest. In other directions, the signals were attenuated by the steel frame of the building and results were less favorable although communication could be maintained with all parts of the U.S.A. On 80 meters, the effect of the screening was more apparent and in this case the antenna was always used in the outboard position. This was not a serious handicap as most operation on this band was conducted after dark when the antenna could not be seen even though it was outside the railing.

On the 10 meter band the screening effect was less noticeable than on the lower bands and excellent results were obtained with the antenna in the inboard position, and the difference in results from the two positions was less marked.

Owing to the fact that the tip of the antenna was only about 12 inches from the roof the balcony, a small change of resonant frequency occurred between the inboard and outboard positions, and for the best efficiency it was necessary to reset the length of the resonator when changing from one position to the other. A compromise setting of the length of the resonator was used normally but for extended periods of operation in one position or the other, the length was set to give minimum s.w.r.

With the antenna swung outboard after dark, or in the early morning hours when it was unlikely to be seen, good results were obtained with world wide DX on 15, 20 and 40 meters, including regular contacts over a long period with VK, ZL and European countries. The good results were no doubt attributable to the considerable height of the antenna above ground, over 120 feet. The antenna was also used in the outboard position for occasional daytime contacts, and was swung inboard again immediately at the conclusion of the contact, or even between "overs." At such a height above the ground, and with exposures in the open for only brief periods separated by comparatively long intervals, the antenna was never noticed by anyone during a period of over three years.

The writer used the same type of antenna in another location in a second floor apartment only some 15 feet above the ground. In this case a wooden railing surrounded the balcony and the ground plane consisted of wire netting laid under a rug on the floor of the balcony. This gave good results on 10, 15 and 20 meters, but for operation on the 40 and 80 meter bands, better results were obtained by using two single wire counterpoises 33 and 66 feet long respectively, one along each side of the room, concealed under the carpet. In this case again, in spite of the low height of the antenna above ground, good DX results were obtained on the 10 to 40 meter bands.

The Loaded Dipole

In this location another antenna requiring no ground plane proved to be effective. This used two Hustler mobile whips mounted on a strip of insulating material to form a loaded dipole. This very compact dipole was mounted on a short wooden rod on the balcony railing and was oriented to take advantage of the directional characteristics of the dipole. After dark, the antenna was pushed outside the balcony into the clear.

The writer operated as G2AH/W4 in the Washington D.C. area for many years using antennas described above and enjoyed thousands of contacts throughout the U.S.A. and with many countries overseas.

Operation In New Zealand

The writer has also put the mobile whip antenna to good use in New Zealand where mobile and portable operation are very popular. Many of the motels in this country have iron roofs which may be used to provide a ground plane. Good results have been obtained on 40 meters with the mobile whip clamped to the edge of the roof gutter, with the shield of the coaxial feeder connected to the gutter and or the iron roof. The dipole using the two mobile whips described above mounted on a short wooden pole supporting it above a car has also been used satisfactorily and has generally given better results than those obtained from the vertical whip.

TVI

It is very important to avoid causing t.v.i. when operating in an apartment building or a motel where the t.v. receivers of neighbors may be only a few feet away, otherwise the activities of the amateur will be severely curtailed. By using a low pass filter and adjusting the antenna for minimum s.w.r., the writer has not experienced any difficulties with t.v.i. over many years of operating from apartments.

Advantages of the type of antennas described are that they may be erected inconspicuously in a wide variety of conditions, are self-contained, take little space, require no tuning unit and may be fed with 52 ohm coaxial cable. They enable the amateur to operate in conditions which may appear at first to be completely unsuitable for amateur radio. ■