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The QRM Killer

— antenna alternative for 40

Like many people, I have a special problem. While I dearly love amateur radio, my actual operating time is quite limited. Having a busy young family with varied interests, I find that it is usually quite late in the evening by the time things settle down. My job demands that I rise no later than 6:00 am during the workweek, so any hamming I do usually occurs somewhere between 9:30 and 11:00 pm. (I should add that this is further complicated by the fact that I have come to enjoy 40-meter phone operation. Have you ever tried to work the General portion of 40 phone late in the evening?)

The following is a list of common problems I'm sure that many of you can identify with:

- Only 75 kHz is available (7.225-7.300 MHz) in the General portion of the 40-meter band, and it appears that the entire ham population in America wants to operate there in the late evening.
- Foreign broadcast stations mysteriously appear (seemingly out of nowhere) all evening long, usually right after I think I've found a spot clear enough to get a CQ through. These stations also have the temerity to use AM, which is all but uncopyable on most SSB transceivers—so I often don't even know who they are. Generally, however, they tend to wait until I have engaged some unfortunate in a QSO before they fire up on frequency.
- High ambient rf noise level seems to intensify as the evening proceeds. For example, it might be an S6 level at the start and then various QRM levels may combine to bring this to an S9 within a few hours or so. I should add that I am basically vertically polarized, so this may act to compound the problem somewhat.
- QRM is compounded by those who can't hear me (or anyone else) on the frequency because they, too, have trouble hearing much of anything in the evening.
- I've tried more power, such as provided by a linear, and it solves nothing. The problem is in reception.
- I haven't the desire or space to erect wire beams that are switchable in all directions. Besides, I would never be able to get them high enough to realize their full potential. (Even a fraction of a wavelength at 40 meters is big!)

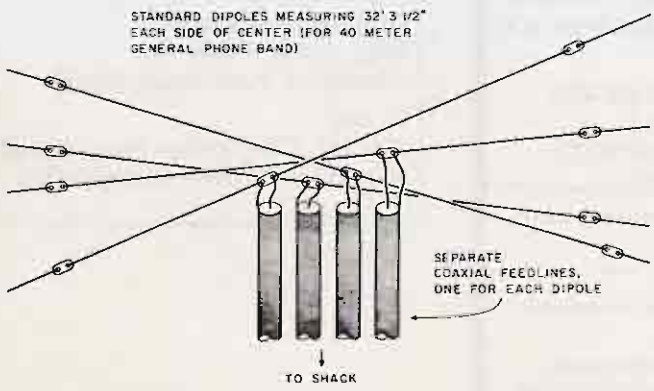


Fig. 1. The basic principle for the QRM Killer evolved from this simple matrixing of crossed dipoles.

A few points may be worth mentioning here because they are probably not unique to my situation: First, the high QRM level is hard to combat—period. Second, the Q5 QSO problem cannot be solved with a linear. Third, and most important, it is necessary to appreciate the fact that the yagi beam (or something comparable) will not solve the problem either. Why? Well, on 40 meters in the evening, we are not exactly facing a traditional type of problem. As a result, simplistic solutions won't work. To illustrate:

- A few weeks ago, using split-frequency operation, I worked two Italian stations in succession on 40-meter phone. One gave me an S9, the other an S7. I copied both Q5 because they were in the clear. The message was gratifying for someone like me who normally has trouble holding a Q5 QSO with either American coast. QRM is clearly the problem. I certainly don't need more power or a beam in order to be heard or to hear anyone else, if I have a clear frequency.
- If I switch from a vertical to a horizontal antenna on receive, sometimes a complete transformation results

—depending upon where the station is that I'm listening to. He could go from Q2-3 to Q5 because of an improved signal-to-noise ratio.

Short Antennas

Much has been written lately about short antennas for the low bands. However, you must build entirely new antennas and the tuning can be difficult. Top hats are also most peculiar-looking. I cannot, somehow, picture my XYL seated under a top-hat umbrella (as depicted in a recent article on short antennas). In addition, I am convinced that I need antenna help primarily for receive.

Why go through an elaborate antenna investment just to solve what is basically a receive problem? What can short antennas accomplish on receive? Well, judging by the latest Sony and Panasonic double- and triple-conversion, battery-powered, allband portable receivers—plenty. (I copied the Italian station mentioned earlier on a Sony that my XYL got me for Christmas. But get this: I received them on the Sony's built-in one-foot telescoping antenna while underground in my basement ham shack. Their signals were every bit as good as they were on my transceiver, which was hooked to a outdoor ham-band antenna.)

Clearly, receivers (including transceivers) have more gain than they need on the low frequencies, so antenna gain itself is not necessary. This is not the case on VHF or on 10 meters, where beams do perform a needed service.

What this does tell us, however, is that short antennas—perhaps those that can be rotated—could be a practical consideration on 40 meters. You might not want to transmit on them, but they certainly might improve the receive situation in the evening.

Here are a few practical considerations:

- While helically-wound elements can "shorten" antenna size on 40, they may not be necessary if we're not planning to load up with rf.
- Element spacing, necessary to achieve directivity and front-to-back ratio, cannot be shortened. So, what good are one-foot elements if we must space them 15 feet apart?
- If a short vertical antenna is constructed, what's the advantage? We still have a vertical, with no directivity, no front-to-back ratio, and no signal-to-noise improvement—probably a degradation.

But, what about a short dipole? The more I thought about this, the more possibilities came to mind.

The Progression

Like tens of thousands of amateurs today, I use a multi-band commercial vertical. Mine is a roof-mounted Hy-Gain 14AVQ-WB which has the minimum number of radials required (2 for each band) per the manufacturer's recommendations. Operationally, it actually performs as a ground plane when elevated in this manner.

On 40 meters, the radiating element is about one-eighth of a wavelength; the radials, however, are a full quarter of a wavelength.

I have experienced exceptionally good luck with this very simple antenna system. After much study, I feel there are two reasons for this:

1) The antenna height is almost exactly one quarter of a wavelength on 40 meters.

2) All radials are elevated above the roof.

With these points in mind, let's go back and see if such a system can solve our basic problem.

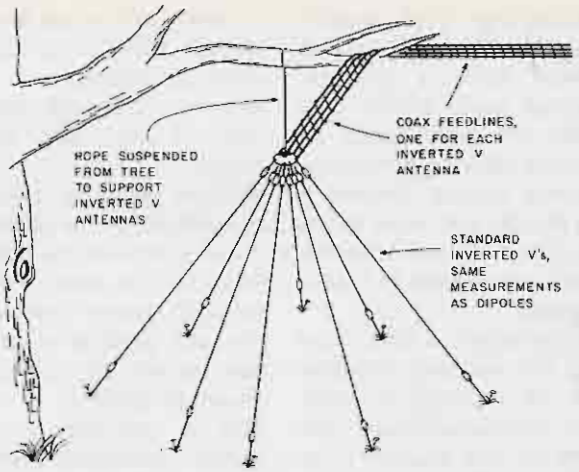


Fig. 2. More appropriate for most hams—at least those who use 40 meters—might be this crossed system of inverted vees. (Notice how this resembles most rooftop vertical radial systems.)

If a dipole, even a short receive dipole (as contrasted with the vertical), could possibly solve the 40-meter QRM problem, a switchable dipole array might also afford the directivity necessary to null out unwanted signals (see Fig. 1).

This idea has its drawbacks, however. First, it would mean that I must install another antenna system in the trees. Second, it would take up a lot of space, especially if I were to go full size with the elements, although that might not be necessary.

A variation of this, though, would be the same principle used in an inverted-vee fashion (see Fig. 2). This might be somewhat easier to erect, but could run the risk—depending upon apex angles—of functioning as a vertically-polarized array. Either system holds potential, especially in short-element configurations.

What about interaction between the dipoles? What would happen if we could select one dipole and ground all unused dipoles? This concept of grounding unused elements is an interesting one and, as far as I know, has not yet been fully explored. It holds some fascinating potential in the areas of pattern changes, broadbanding effects, and general quieting.

Take another look at Fig. 2. What does it resemble? Right—the radial system of a roof-mounted vertical.

Notice how easily we have progressed to the central idea: Why not work up a system that will selectively activate a portion of a radial system, converting it to dipole operation while leaving the remaining radials functioning as is, and feed this dipole through a separate coaxial line for receive? It wouldn't have to work exactly like that, but the central idea seems to be well worth exploring.

Results

Let me disgress a moment and summarize what has happened since this idea first struck. At first I looked far and wide to find someone who had tried it, to no avail. Second, I reviewed every antenna article I could find published over the last 20 years and could find nothing on this approach. So, I resigned myself to having to actually construct something and give it a try.

I have conducted a series of tests on the air, and the results are extremely en-

couraging and worth reporting. In my ham shack I now have a remote-control unit which will select any given radial on the roof, remove it from the antenna circuit, convert it to a dipole, and allow me to use it as a receive antenna. Here's a summary of how it operates:

- Surprisingly, I find I can load the selected radial/dipole on transmit as well. Only one radial/dipole presents an swr change from the basic 1:1 of the vertical, and that one only presents 1.24:1.
- The basic unit *does* solve the receive problem that has plagued me for years now. I can pull any signal out of the noise/QRM by "rotating" the system until I hit the optimum antenna.
- No receive preamplifier is necessary, even though several radials are cut for other frequencies.
- So far, I have not lost one QSO! I can copy everything!
- Noise level is reduced considerably. For example, if one examines the ratio of noise level to overall signal strength when comparing the old vertical with the new system, the results are shown in Table 1.
- It is possible to null foreign broadcast QRM. In all cases, I've been able to lift the desired station above the foreign broadcast QRM level.
- In 40% of the cases, my own signal report goes up one to two S-units when I transmit over the radial/dipole, in contrast to the vertical. This difference diminishes with distance, of course, as the vertical continues to excel over DX hauls.
- If I call CQ and several stations reply, I now find myself eager and able to select the weakest signal respondent for the QSO. I'm finding a whole new world of DX and QRP people out there who were probably there all along —but I simply couldn't hear them.

Now, I don't want to mislead anyone into thinking that this system eliminates all 40-meter evening-hour difficulties. It does not. It does, however, solve more problems in this area than anything else I've ever seen.

So far, everyone I've spoken with has requested (over the air) a detailed explanation of the system and how it works. I've found that this is not the best way to disseminate the information. It takes too much time and reaches too few people. This article will, hopefully, inform a large enough audience and spark other experiments in this direction. Most conversations, once I've explained the system, usually end with the other station saying, "How simple. I wonder why no one has done it before?" I have the same question myself!

Call	Vertical Q factor	Percent of noise	New Q factor	New Percent of noise
WB8CHJ	Q4	60%	Q5	20%
KA3AVP	Q4	50%	Q5	15%
K2ZTL	Q3	70%	Q5	20%
K3VK	Q2-3	60-75%	Q5	25%
W9UPV	Q4-5	40-50%	Q5	10%
K9HW/0	Q1	98%	Q5	20%

Table 1.

Other Benefits

Aside from performance, there are several other benefits to be derived from this configuration:

1) No "new" antenna(s) must be constructed.

2) The switching unit is not ugly and, thus, no new neighborhood eyesore is created.

3) It is incredibly easy to construct.

4) It can be expanded easily, so that additional radials/dipoles can be added if desired.

5) It is quite inexpensive to put together as all parts are readily available from either a junk box, hamfest flea markets, ham parts dealers, or your local Radio Shack or Olson Radio outlet.

6) It will work almost as well on other bands as on 40 meters.

I honestly feel you'll enjoy building something that, until now, has not been done and is not yet commercially available. This means you'll be able to configure the design for your own particular requirements and be able to completely baffle others who will be wondering how you are suddenly able to do so much better.

How It Works

While this may not be the most effective example of the principle, the unit I constructed functions quite simply.

Each radial on the vertical is disconnected from the antenna, and an insulator is inserted as close to the original tie point as possible.

Next, a short jumper wire is affixed to the radial, which then is connected to a relay at the antenna. The relay, unless activated, grounds the radial back to the antenna. In this fashion, the vertical performs as usual unless a relay is turned on.

Two radials, opposite each other, tie to a single

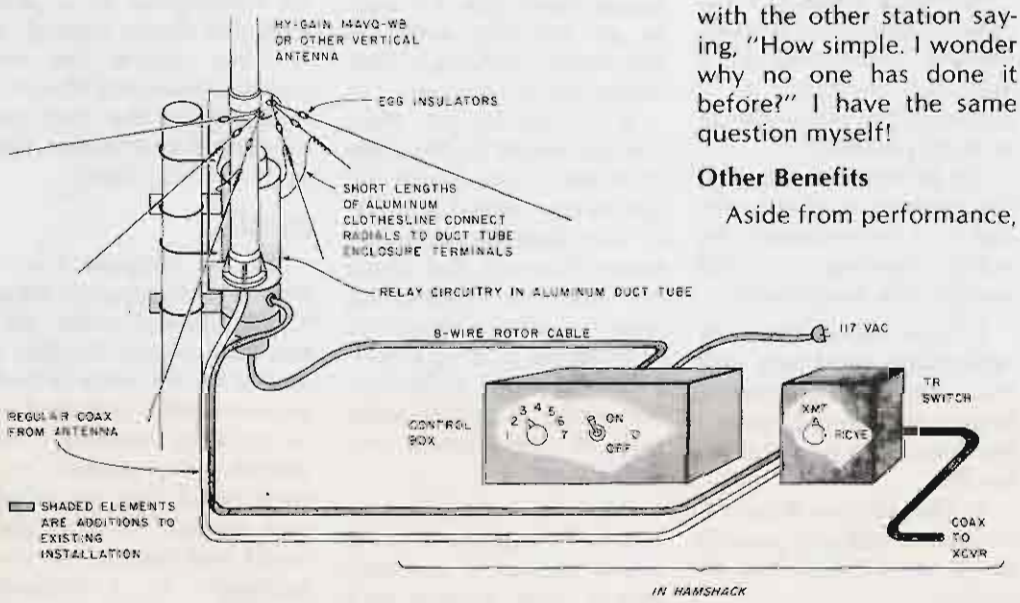


Fig. 3. Overall view (not drawn to scale) of the QRM Killer system, composed of the existing rooftop vertical, the adapter box attached to the antenna, a new feedline and length of rotor cable, and the control box at the ham shack. In operation, the radials/dipoles are steered remotely from the shack. Relays in the adapter unit on the roof select any given radial pair, disconnect them from the overall antenna, and re-configure them into an active-dipole antenna.

relay (I used a 3PDT type). When the relay is turned on, both radials are removed from the vertical antenna ground circuit and connected, instead, to a separate (new) coaxial line feeding down to the shack. One of the two radials is connected through the relay to the shield of the coax, the opposite radial to the center conductor. The effect realized is a sloping dipole, with the angle depending solely on your own particular rooftop.

I find that fascinating effects can be realized by the interaction which results from the fact that the existing design leaves all deactivated radials still functioning as radials. Similarly, by selectively removing the activated radial pair from the system when using the vertical in its normal state, interesting things happen to the otherwise normal omnidirectional vertical pattern. It is entirely possible, I'm finding, to actually improve transmit effectiveness by eliminating a particular radial pair, depending on where the other station is located.

How does this thing work? I'm not completely sure myself. From an equipment standpoint, my system uses a standard 8-wire rotor cable to interconnect the antenna-mounted relay bank with the remote-control switcher in the basement ham shack. There, a single-pole rotary switch fires a transformer-reduced (to 6 V ac) current to the desired rooftop relay. When the transformer unit is switched off, the entire system shuts down and the vertical system operates as usual.

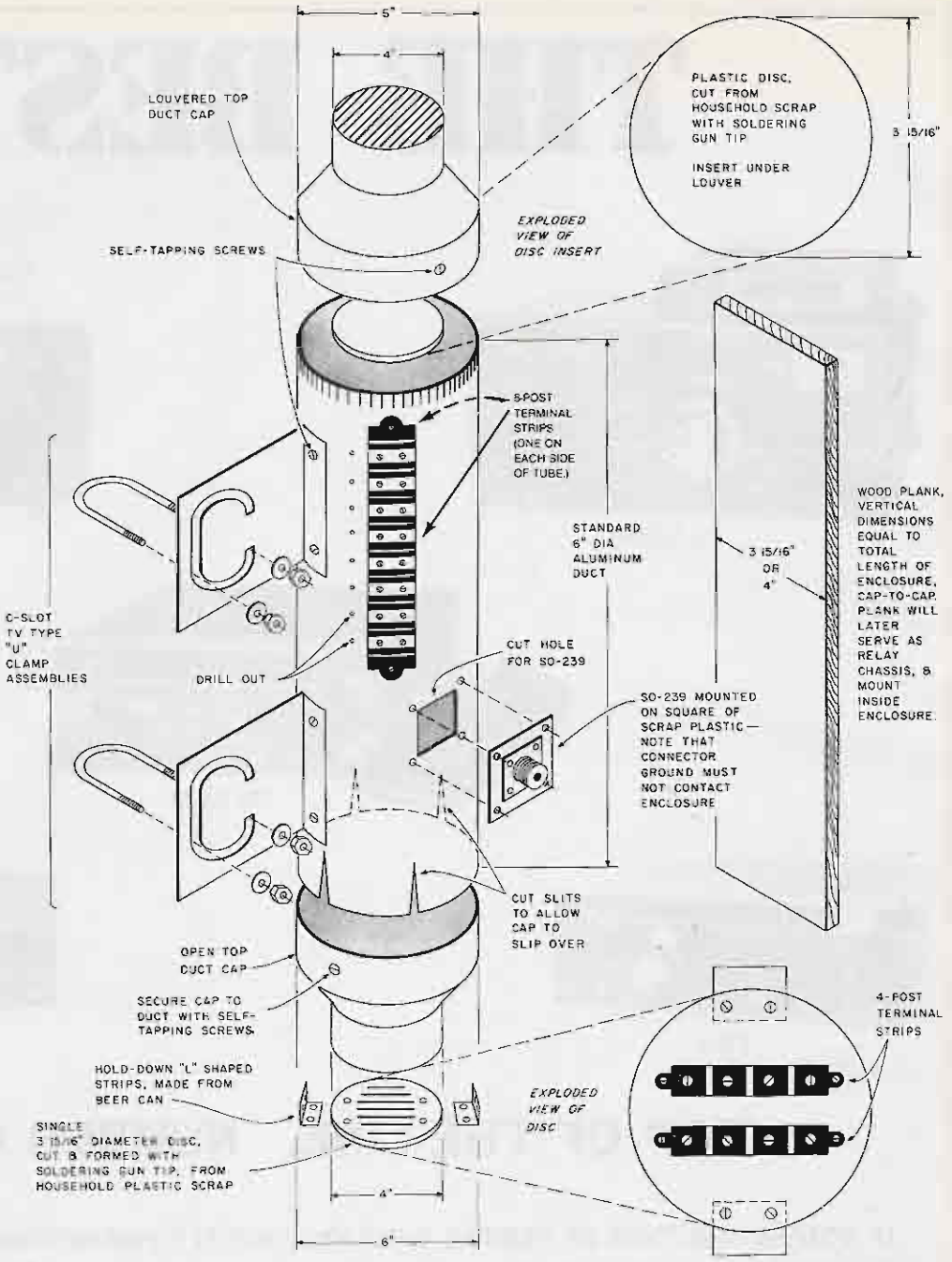


Fig. 4. Detail of the rooftop enclosure, fashioned from standard small-diameter aluminum duct work, available at any hardware store.

Construction: The Enclosure

While I can now think of a multitude of other and perhaps better ways to operate this system, let me first discuss exactly what I constructed. If you wish to follow the approach I used, at least you can be assured that it won't cost you very much for parts. (Later, we'll discuss practical variations, including one that I have added to my own unit.)

I suggest that the first item you obtain should be the enclosure. (I failed to do this myself and ended up doing some rewiring that otherwise would not have been necessary.)

For the primary rooftop enclosure, I wanted something that could be readily mounted at the antenna itself and as close to the radials as possible in order to eliminate long leads that might otherwise alter resonant frequencies. I wanted it to be made of aluminum, easily weatherproofed, easy to get inside of if necessary, and capable of circuit expansion later, if so desired.

My only other consideration was that it should be vertical, to complement the existing 14 AVQ-WB antenna from a visual standpoint. The perfect solution for this was found just around the corner at the neighborhood hardware store—heat ducting.

What I obtained was just the ticket and ended up only costing about two dollars:

1) A standard 6" diameter aluminum duct tube, about two feet long.

2) A reducing vent cap to fit the top of the tube,

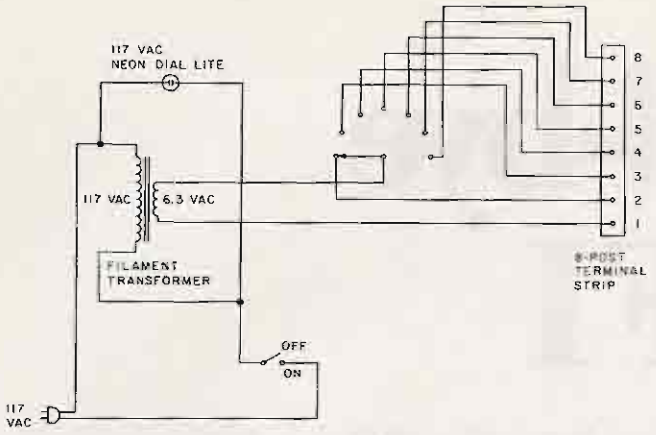


Fig. 5. Schematic of the control box used to activate and steer the system.

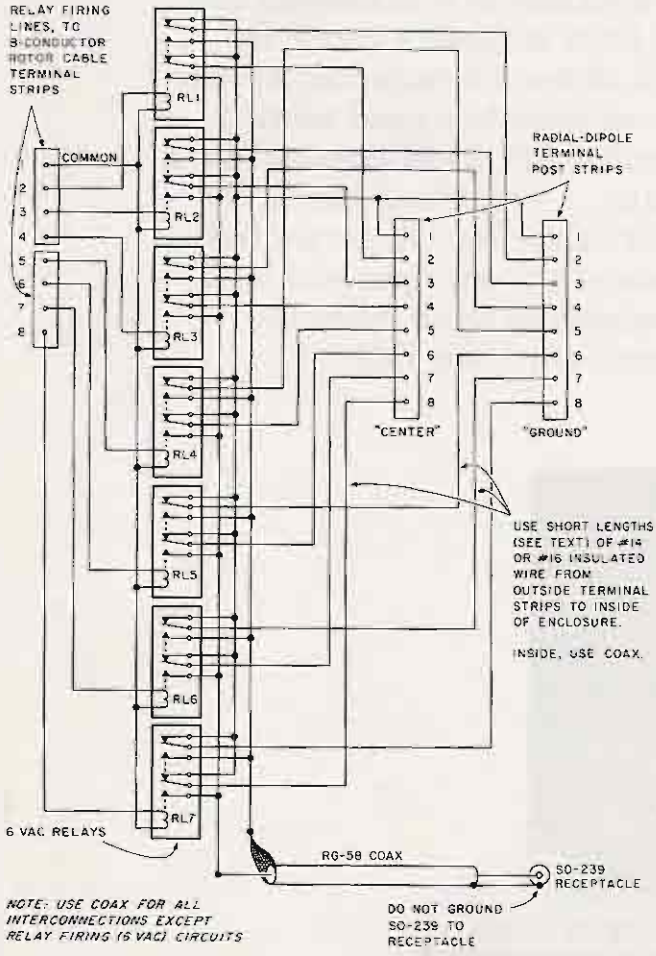


Fig. 6. Schematic of the relay-switching circuit, heart of the QRM Killer. This circuit is mounted on a wood strip and inserted into the duct-tube enclosure at the antenna.

which looks like a round, 4" louvered lid. This vent cap slips over the 6" diameter tube with a 1½" to 2" lip.

3) An open-ended reducing cap, much like the louvered one, which also can be made to fit over the duct tube. (See Fig. 4 for more detail on this enclosure.)

As with any piece of ducting, one end is ridged to be able to slip into another identically-diametered piece of duct work. To cap off both ends as I did, however, you'll need to slot the bottom end of the duct with a pair of metal cutters in order to permit the open-ended cap to slip over the end.

The temporarily-mounted caps should then be drilled through to permit two self-tapping screws on either side of each cap to serve as fasteners.

Next, find some plastic scrap around the house. I used a split clear-plastic shoebox.

With a heated soldering-gun element, "cut" two disks to fit inside the 4" diameter caps. The top disk is simple. The bottom disk should be formed the same, except that it should have two rectangular holes to allow for installation of two screw-type outboard terminal strips used later to connect to the rotor cable. I bought 4-post terminal strips at the local Radio Shack. Drill holes to install the terminal strips in the bottom disk, affixing them with small nuts and bolts.

To connect the radials to the system, you'll find it useful to use two 8-terminal strips mounted vertically near the top or upper center of the enclosure on opposite sides of the duct tube. These should be positioned at right angles, away from the U-clamp assemblies. More on this shortly.

Drill a hole through the enclosure duct next to each terminal-strip connection, for a total of 8 holes per strip. You'll ultimately feed insulated wires through these holes which will terminate at the RG-58/U coax used to connect to internal relays.

At this point, the enclosure is almost complete, save for the coax connector and a means of mounting.

First, drill out a hole in the tube's lower section and install an SO-239 connector.

The mounting method really had me perplexed until I stumbled onto the solution while at Radio Shack. They make an unusual U-bolt hardware assembly that is circularly slotted. This means that the U-bolts, which come with the assembly, can be turned in one direction for clamping even though the duct tube runs in another. Perfect! (See Fig. 4 again for some idea of what these things look like.)

Gads! I almost forgot to tell you how I affixed the bottom plastic (with terminal strips) to the end cap! Get out the tin snips and prepare to operate on a beer can. Cut yourself a 1" × 3" strip for each side of the disk. Connect them by bolt and nut to the disk and use self-tapping screws to connect them to the aluminum cap.

It is also important that the enclosure be conductive, for two reasons:

1) Primary electrical ground to the vertical antenna will be accomplished through the U-clamp to the grounded vertical masting below the radiating element of the 14AVQ-WB.

2) The entire enclosure functions as a very effective shield for the circuitry inside, enabling radial resonance to be maintained on the antenna itself. This shielding enclosure also helps to minimize stray-lead pickup of signals.

All I know is that it works well the way it is, although the more ingenious among you may easily devise another means of electrically grounding and shielding in a simpler way.

The Control Box

This part is so simple that I will go over it rather quickly. I happened to have an available panel box that I'd used before for a different antenna-switching system.

The key elements are:

- A 6.3-volt filament transformer (chosen because I didn't want to ever run the risk of electrocuting myself).

- A piece of 117-V ac line cord.
- A single-pole rotary switch with at least 8 available positions.

If you wish to add a few refinements (as I did), you'll need a miniature 117-V ac toggle switch and a panel-mounted neon lamp.

The circuit that I used for the control box is shown in Fig. 5. I also installed an 8-post terminal strip on the rear of my control box for easy interconnection to the rotor cable. For the common lead, I used the black rotor wire.

Relay Switching Circuit

For my own system, this was the really fun part. I enjoyed wiring and testing the relay system which does the actual conversion of radials into operating dipoles. Here's what I used:

1) Seven 6-volt ac 3PDT enclosed relays. You actually need only two of the three operating circuits, but these relays came cheap for me.

2) Two more 4-post terminal strips.

3) Two more beer cans (to make clamps to hold the relays in place).

4) Some RG-58/U coax.

5) Some hookup wire.

6) A plank of wood, as long as the enclosure, yet narrow enough to fit snugly inside the 4" diameter enclosure caps. This wood becomes your chassis.

You could probably eliminate the beer cans if you obtain relays which could be fastened down or socketed. Mine could not be, so I had to empty the beer cans and fabricate some hold-down strips from them.

For the circuit, refer to Fig. 6. This is much simpler than the original version, which was designed before I realized the advantage of using the conducting enclosure—which eliminated a lot of ground wiring.

However simple, it works very well. For clarity, the schematic (Fig. 6) shows the radials as dipoles. In reality, though, remember that they are opposite radial pairs—the same ones now on the vertical.

The only change you must make later is to install egg insulators at the antenna to force the radials to go through your relay-switching circuit in order to function normally.

If you are a typical BTV or 14AVQ owner, you've noted by this time that I've several more relays going here than you have radial pairs (four are normal, one each for 10, 15, 20, and 40 meters). This allows for further expansion of the rooftop system, which we will discuss later. However, you could simply use four relays and do just fine.

There is nothing particularly tricky about this circuit, except its objective—which you may want to change somewhat to suit your own needs. Personally, my desire is to have all radials functioning as radials at all times, except when I select a pair by activating the corresponding relay.

In the circuit shown, the selected pair of radials is removed from the antenna circuit completely and connected in dipole fashion to a second feedline going down to the ham shack. This "receive" dipole can then be switched into the primary transceiver antenna feed whenever desired. Another option, of course, would be to use the transceiver relay to automatically kick in an antenna changeover relay on receive that would be connected to the new relay system. However, at the moment, I enjoy the manual select operation because it permits me instant comparison with the vertical system.

In wiring the relay circuits, I found myself making errors. Initially, I used insulated wire throughout. However, because I had to rewire anyway (because of the errors), it seemed like a good time to switch over to RG-58 coax for all the active rf circuits. In retrospect, it is probably a good idea to do this at the outset to minimize the length of "free" wire, carrying either primary or ground-circuit rf. If I hadn't done this, I probably would have had to shorten the antenna radials to return them all to resonance.

Mechanically, I mounted each relay about one relay-length from each other on the long strip of wood mentioned earlier. This was more than ample, and there was plenty of room both in-between and alongside to run the wires and coax (see Fig. 7).

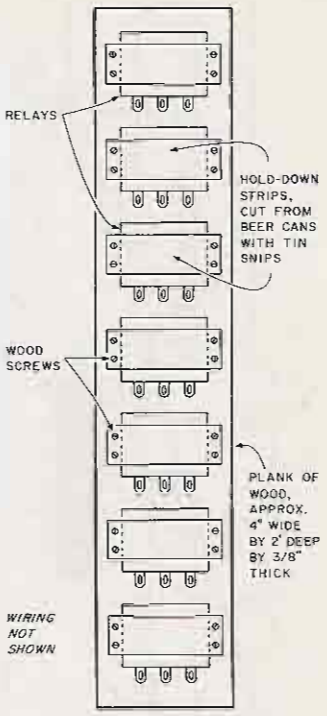


Fig. 7. General mechanical layout of the relay-switching circuit.

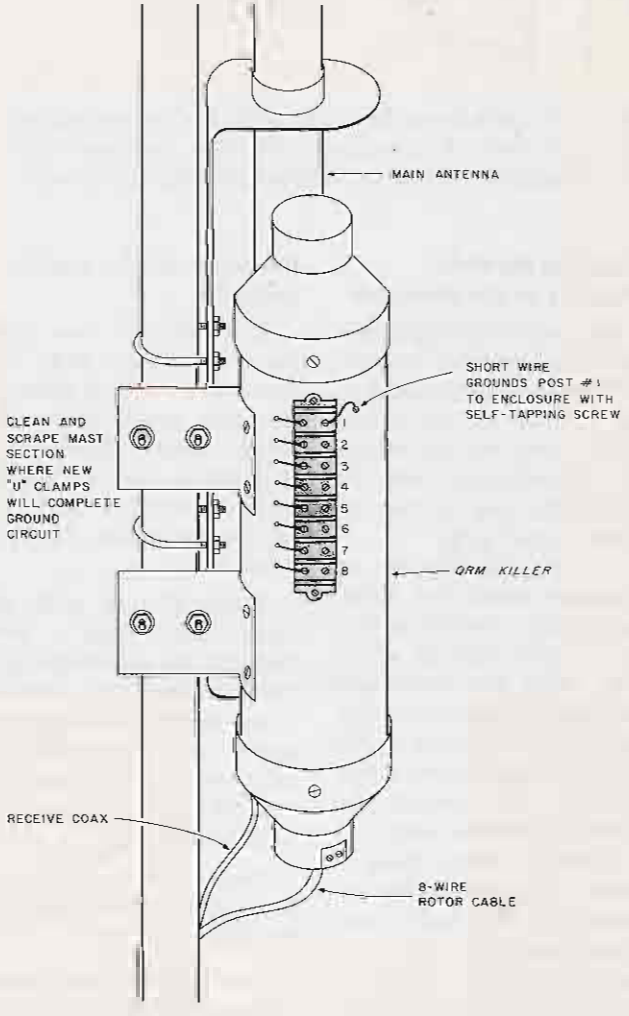


Fig. 8. Pictorial shows how the enclosure is mounted to the rooftop antenna, after assembly is complete and tested.

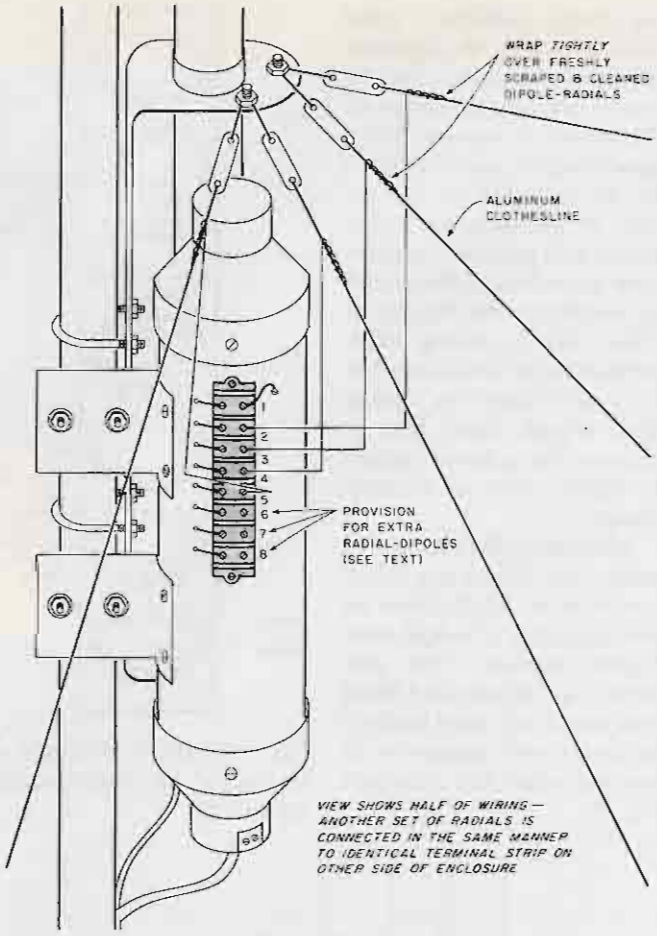


Fig. 9. This view shows how the radials are connected to the enclosure unit. A simulated wire-wrap technique using short lengths of aluminum clothesline does quite well.

Mounting the Relay Assembly in the Enclosure

Before attempting to put the relay assembly and the rooftop enclosure together, you'll want to do a few more things to the enclosure. Specifically, add the interconnecting wiring as follows (see Fig. 8):

1) Cut 14 lengths of stranded insulated wire, each about a foot long. This can be #14, #16, or whatever. Strip the ends and pass them through all the 8-post terminal holes on the side of the enclosure except the top two—terminal one at the top of each strip.

2) Make certain there is some play between the diameter of the holes you drilled and the size of the wire; too tight a condition might lead to an inadvertent stripping of the insulation and a shorting-out of the leads to the enclosure ground.

3) Next cut two short pieces, strip the ends, and terminate each of these to the top screw-down terminal posts. Remember that there are two 8-post terminal strips on each side of the enclosure. To summarize:

Terminal one gets the short lead. Drill a hole through the enclosure near terminal post one on each strip, insert a self-tapping screw, and terminate the other end of the short terminal #1 lead to ground in this manner.

Terminate terminals 2 through 8 on each strip to the long 1' wires.

The total of 14 wires now passing through to the inside of the enclosure will later be terminated to coax from the relay circuits.

4) Next, take the long coax feedline that goes into the relay circuit (the receive line) and connect it to the SO-239 receptacle connection points on the inside of the enclosure. Allow enough feedline so that you'll be able to slip in the entire relay strip later. There will be ample room inside the enclosure to house any extra coax length that may be necessary here.

Now the relay firing wires must be connected to the terminal strips on the underside cap of the enclosure. Again, leave ample room for maneuvering later on. These should, of course, be connected in sequence to correspond with the control-box switching system.

You are now ready to insert the relay strip and its associated wiring into the enclosure. You'll want to slip it through from the bottom.

Once this has been accomplished, pull all the coax ends from the relays through the top of the enclosure. Do the same with the insulated terminal-strip wires. Match them carefully, strip the coax, and connect them, using as short a length of the insulated wire as you can and still be able to move the relay strip in and out of the enclosure.

For simplicity's sake, I use one of the outside vertical 8-post terminal strips as "center" and the other as "ground" and I mark them that way on the outside of the enclosure. This greatly eases coax wiring at this stage.

Each terminal-strip-wire number (corresponding to a given post point) is either soldered to a coax center or to a coax-shield ground. In this manner, for example, the "center" terminal strip post-2 wire goes to relay one's coax center conductor. The shield from that relay goes to the "ground" terminal strip post-2 wire. This sequence is repeated until all posts are so terminated.

At this point, before everything is permanently capped off and bolted shut, it is a good idea to check performance. If you have done everything correctly, you should be able to interconnect the control box to the enclosure assembly, connect a piece of interconnecting coax from the SO-239 connector to your transceiver, and give it a whirl on receive.

All this can be done in the shack. To check out the switching, listen for a sequential relay clacking as you rotate the control-box switch through its various positions. So far so good?

Next, connect a couple of wires to the antenna lead coming from your rooftop antenna. Connect the ground side to the "ground" terminal strip, terminal 2, and the center conductor to the "center" terminal strip, terminal 2. Activate the control box and switch to the first relay. At this point it should be quite obvious to your receiver that this thing is working. In this position, you should have normal reception, with next to nothing on all the other positions.

Repeat this test on terminals 3 through 8 until you are satisfied that each works as it should. You may hear some signals very weakly on the posts not connected to your antenna, but most of this pickup comes from exposed wiring. This will all but disappear after you connect the assembly to your antenna.

If everything is okay, you have a little more work to do at this point:

1) Position the relay strip inside the enclosure, center it vertically, and stuff all the wiring inside.

2) Now, insert the plastic disk into the top ventilating cap (to keep the rain out), center the wood strip, and

slide the cap over the relay wood strip and then on down over the duct work. Now, using self-tapping screws, secure the top cap to the main enclosure.

3) Follow pretty much the same procedure for the bottom cap assembly. Make certain the wood inserts into the smaller diameter of the cap.

4) Once the bottom cap is secured, drill and use woodscrews through the sides of the enclosure into the edges of the wood at one or two places. This will relieve the duty of the caps (which should be for positioning and centering only) and give more support to the wooden relay strip.

When you are all through, the entire unit should be able to be jarred without rattling. As a safety precaution at this point, repeat the testing procedure conducted earlier, running the circuit through posts 2 through 8 to verify that everything is still okay.

Rooftop Installation

Before the unit is installed, you'll want to electrically disconnect all the radials from the antenna itself.

Depending on how many radials you're using, you'll need a number of egg insulators. Cut the radials a few inches out from where they are terminated to the antenna. You'll need this extra lead length (I left 6-8 inches) to secure the egg insulator at the antenna. Do this all around the antenna.

If your radials also serve as guys, you'll want to reconnect the radial ends to the insulators as you go—to prevent your antenna from crashing down on the rooftop. In some cases, you may have to readjust the end lengths so that they will free enough extra radial lead at the insulator to wrap around sufficiently to ensure a secure termination (see Fig. 9).

Important: If you have followed these instructions fairly well, the radial lengths, even though they are now shortened a mite because of the new insulators, will still resonate well at the operating frequencies for which they are intended after installation is complete. This is because of the internal wiring from the two 8-post terminal strips to the coax. The rest of the needed length will be accomplished later.

Once the radials have been insulated off and resecured, it is time to mount the unit. As indicated earlier, it mounts vertically, but note that the U-clamp assembly mount causes a mechanical standoff condition to exist, so that the duct tube parallels the antenna mast about two inches away.

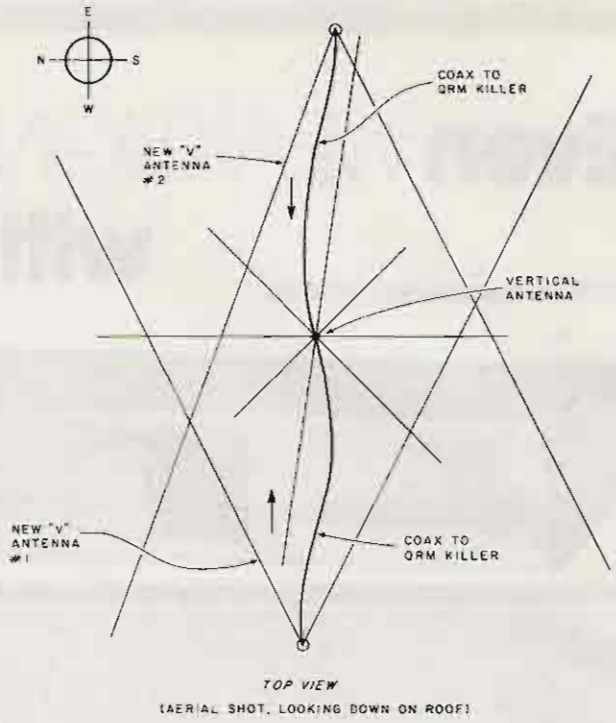
The two U-clamps are all that is required to connect the unit to the antenna mast. Position the unit as high as possible under the antenna, so that the terminal strips will be immediately underneath the radials. This will allow your connections to the radials to be reasonably short.

Now, for connection of the radials to the unit. I found that aluminum clothesline is perfect for this job (see Fig. 9). I removed the screw from post 2 of the terminal strip, bent the end of a short length of clothesline around it, and then screwed it back down into the terminal post.

The free end of the clothesline is now *tightly* wrapped around a *cleaned* section of radial. If you use a couple of pairs of pliers when doing this, you'll have a neat, wire-wrap effect. Now find the opposite radial and connect that to terminal post 2 of the opposite terminal strip. Do this in rotation all the way around the antenna until all radials are connected.

Once this is done, your installation is complete. All you need do now is install a length of RG-58/U (or RG-8/U, or whatever) to the SO-239 on the enclosure and wire up your rotor cable correctly to the bottom of the unit. You may want to tape these connections or otherwise seal them from the weather.

Return now to the shack and give her a try! Your swr should be the same as it was originally, before the new system was installed.



TOP VIEW
(AERIAL SHOT, LOOKING DOWN ON ROOF)

Fig. 10. This view shows the rooftop system with two vees added by the author. While these are east and west of each other at my QTH, the vee configuration not only fits the roof but also concentrates the beam in the desired direction.

Modifications

As was noted, I provided for more relays than I had original radials.

How I took advantage of this is shown in Fig. 10. I set up two new vee antennas on the roof, each firing in an opposite direction, although both are basically capturing east-west signals because of the layout of my particular roof.

For these vees to be optimum, they need to be elevated from the roof somewhat. TV-type standoff insulators are ideal for this purpose.

To feed these vees, I use RG-58/U and terminate it to the unit at the 8-post terminal strips.

Other modifications are possible which might markedly improve the ease with which this system operates. One would be a system which would use the transceiver relay to automatically trigger a T-R relay. Another possibility would be to add a circuit at both the box and the relay strip to switch in the primary coax at the antenna, thus eliminating all need for a separate receive feedline to the ham shack. I would guess that many of you may elect to go this route. If you would like to do this, simply wire up one of the relays provided to permit this to happen and see that it remains activated no matter which of the other relays is selected for receive.

Another modification that some may wish to experiment with would be to change the basic wiring

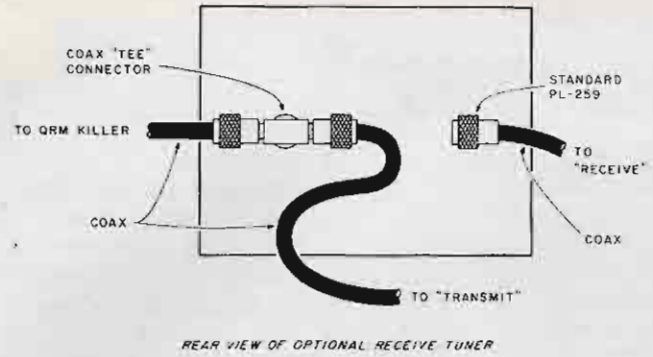


Fig. 11. This shows how the optional receive tuner is wired into the circuit to allow for automated transceive. When configured in this manner, the tuner optimizes selected radial/dipole performance at receive frequency, but does not directly couple transmit rf. This allows you to use common receiver-type junk-box components for the tuner instead of having to worry about the power-handling capacities of individual components.

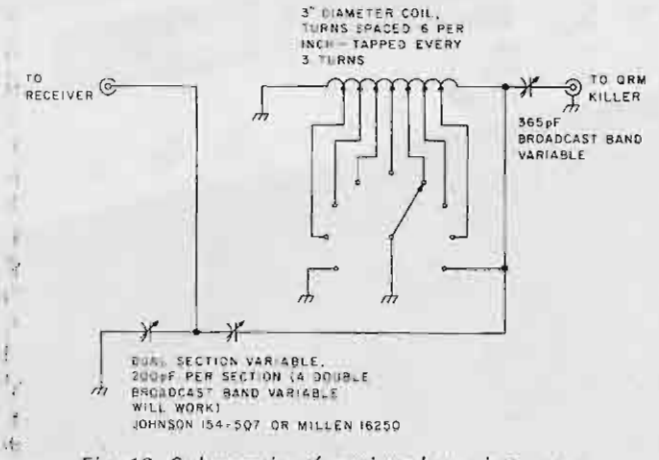


Fig. 12. Schematic of optional receive tuner.

principle I have applied—that is, that all radials not used as dipoles remain in the circuit as operating radials. It may be interesting to some to remove (electrically) the radials immediately adjacent to each of the opposite activated radials (now one dipole) so that the dipole would not be "looking" at closely adjacent grounded elements. I chose not to go this route because I didn't want to remove more radials than I was using on receive.

However, if an antenna T-R system is automated, then it would be entirely possible to extend this experimentation considerably. As it is right now, the removal of a single radial/dipole does not hinder normal antenna operation at all. In fact, as indicated earlier, it is interesting to see what it does do to the antenna pattern. At no time does an swr problem present itself.

A Receive Tuner for Purists

I fully realize that there are many among you who won't want to see a sudden drop in antenna gain occur when switching over to the new system. Actually, if Q factor on receive (clarity) is the main objective, it should hardly matter. But it is certainly true that the 10-meter radial/dipole pair, for example, will not produce the gain that the normal vertical antenna will.

So, for those who would like to freely switch, or rotate, their system with no significant change in antenna gain, I would suggest construction of a simple receive tuner. Figs. 11 and 12 show how I did it. The reason that Fig. 11 is included is to show that it is possible to use a low-power tuner in the circuit all the time and still be able to transmit. The T-connector is the secret.

The tuner is constructed of handy junk-box components, similar to any tuner you have ever seen in articles or handbooks. In my case, the tuner is quite broadbanded at 40 meters and peaks all the radials/dipoles equally.

Your receive S-meter will be your guide here. With the tuner in the circuit at the ham shack, you can simply tune for maximum signal strength over the various radials/dipoles until the signal levels equal what you are getting on the regular main vertical antenna. Once this has been set, you can pretty much forget it.

Now you have a system that will be truly amazing to demonstrate to your ham friends. It is particularly intriguing because the QRM can be tuned out, yet the basic gain of the system remains the same.

Transmitting

I have had extraordinarily good luck in also being able to transmit over this system. As discussed earlier, there are certain times when a selected radial pair will out-perform the ground-plane effect of the basic vertical antenna—substantially.

I should, however, describe my station. This is because I normally do have a 3-kW tuner in the circuit at all times. The rig consists of a Kenwood TS-520 into a Heathkit SB-220 linear, which, incidentally, I don't find myself using as much as I used to.

On transmit, it is necessary to readjust the tuner on some radials/dipoles, depending on which are selected. However, this adjustment is very small. And, if I didn't have the separate receive tuner in the circuit, this adjustment might not be necessary at all. The adjustment is required because the receive tuner, when feeding in the way it does to the transceiver, produces a different impedance from that which the main tuner is accustomed to seeing. So, when transmitting over a radial/dipole, I will either peak the main tuner (hardly ever) or the receive tuner (more often than not). Depending upon just how you have your particular system interconnected and switched, you might find the reverse to be true for you.

But transmitting over this system can be fun and even startling for others whom you talk to during a demonstration. The reason is simple: When you use this arrangement on receive, no one but you appreciates how well it works. When you get into an on-the-air demonstration of the system's rotational qualities, however, it will produce a dramatic effect at the other end if you are transmitting on it.

I find it fun. However, it is exasperating to try to explain this thing over the air to someone who is not basically an antenna buff. For example, to begin with, it is necessary for the other guy in the QSO to be able to realize that a rooftop vertical is not a "vertical" at all, but functions, instead, as a ground plane. Surprisingly, very few people think of their antennas that way. (If you want to test this out yourself, listen to people describe their Hy-Gain 14AVQs on the air. I have yet to find one who refers to a 14AVQ as a ground-plane type.)

Measuring Results

If you are at all like me, you like to try to work out

some system for measuring results. Well, I'm still in the process of doing that with this array:

- First, I check for improved receive Q-factor. My system (shown in Table 1) is a simple listing of existing Q-factor and existing noise level expressed as a percentage. I "rotate" my system, find the optimum position, and record the findings. Once a pattern has been established, you should be able to find the "right" radial/dipole fast.
- Next, I check the antenna pattern. This is a bit more difficult because there are several patterns to deal with here. However, a simple method is to begin with the "nulling" out of identified foreign broadcast signals.

As for me, I'm still working on the pattern situation and don't know if I'll ever really get it all figured out. The most intriguing situation, at least to me, is the primary-antenna pattern change which sometimes occurs as a particular radial/dipole is removed from the circuit. Often, it produces startling results to just listen on the main vertical antenna and then rotate through the radials/dipoles.

Conclusions

While this design undoubtedly will be refined and improved upon by many over the years ahead, I have formed a few preliminary conclusions based on my own results to date:

1) It works better on 40 meters than on just about any other band. On 20, it is gangbusters on receive, but does not perform as well on transmit as would a rotatable yagi or quad.

2) It proves (through active use of radial elements not cut for 40) that short antennas are very effective on receive, with nothing needed (as far as loading coils, etc.) to make them work well.

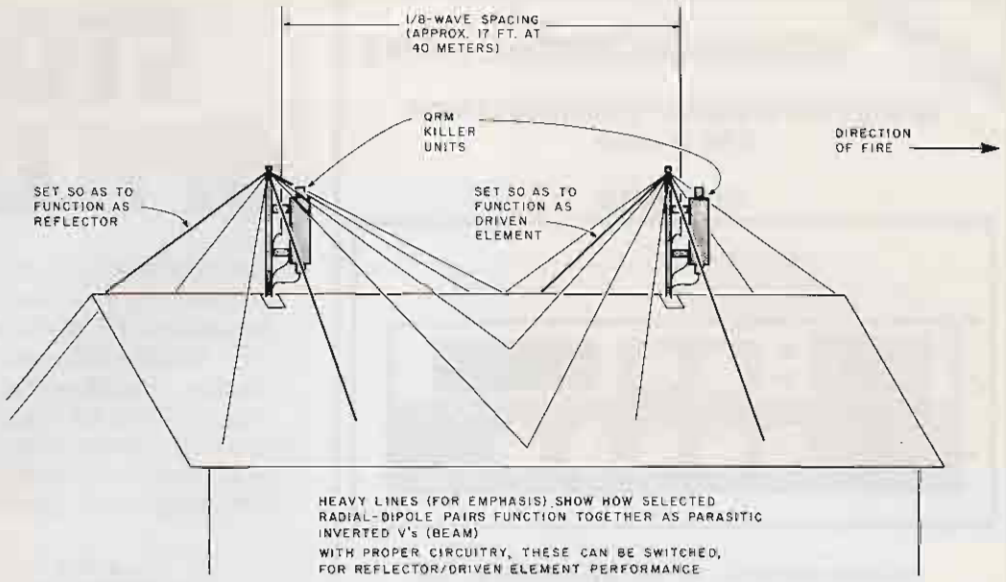


Fig. 13. Layout of a double QRM Killer array, showing how parasitic coupling could be achieved, if desired, for added 2-element directivity. See text for details.

3) The system should work well for anyone now using a roof-mounted vertical (ground-plane) antenna.

4) Signal-to-noise ratio is dramatically improved, particularly if the noise is QRM-generated.

5) A degree of directivity is achieved, directivity which can be beamed in a particular direction by rotating the system remotely.

One Final Thought

Though I have not yet tried this, it seems entirely possible that parasitic element performance—and, hence, even greater directivity—could readily be obtained by adding another vertical array.

I plan to do this in the near future. What I will install is another Hy-Gain 14AVQ essentially for phasing purposes.

However, for simplicity's sake, one could forego phasing and simply place the two arrays about 15 feet apart for 40 meters (if this is the desired band for this effort).

A second array could be wired into the same control box so that, as radial/dipole "A" is activated from antenna #1, the same thing happens at antenna #2. That is, the corresponding radial/dipole "A" on antenna #2 is also activated by removing it from antenna ground and putting it into a parasitic relationship with that on antenna #1. The next logical step would be to work up a system for lengthening either of the two radials/dipoles on command from the ham shack. Doing so would enable you to realize pattern reversibility, as one radial/dipole functions as the driven element while the other functions as a reflector. This would make for a most interesting study. And the very least that could happen (which would be nothing) would still leave you with an omnidirectional overall system gain of 3 dB, as the two verticals are driven together (less fading would be noticeable, also).

If one were to add phasing to the system, spacing at 40 meters should probably be about 17 feet between the two antennas (1/8 wavelength) (Fig. 13). If you went out to the full 40-meter ¼-wave spacing (34 feet), you might be too far out to realize any desired parasitic interaction. However, with a correct phasing system and corresponding delay-line switch box at the ham shack, you should be able to pick up 10 dB or so when flipping between endfire and broadside positions. Then, when firing up the paralleled systems discussed in this article, considerable additional directivity and front-to-back ratio might be achieved through the reversal of the driven element and reflector and relay-controlled "rotation" of the radial/dipole element. (This assumes that the phasing system would also be flipped into the activated radial/dipole circuit as well.)

If everything worked out, you could easily end up with the same effect (and maybe better) that you would realize with a full-size rotatable 2-element 40-meter beam. Plus, you'd have the advantage of being able to switch polarization to take advantage of DX.

Well, regardless of what you end up doing with this thing, I'll continue tinkering and will report results of other designs as they evolve. Meantime, if you are troubled with 40-meter QRM and are thinking of giving it all up for 2 meters, do give this system a try. You'll be pleasantly surprised. ■