Resurrecting the Beverage Antenna

—try this 55-year-old, low-noise, lowband antenna

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One can derive considerable satisfaction from the friendly, leisurely-paced contacts often found on the 160 meter band, contacts which sometimes may be set up simply by erecting an inverted L or dipole antenna and using it both to transmit and to receive. More than likely, though, sooner or later the 160 meter operator begins searching for methods of reducing the level of man-made and atmospheric noise predominant on 1.8 MHz. The simplest solution is to place near the operating position a receiving loop antenna, which may be rotated to "null out" noise sources or interference from nearby stations while the outside antenna continues to be used for transmitting.

The loop will solve many receiving problems, and may well be the only such antenna used to satisfy the needs of the user. On the other hand, a good loop may whet the appetite for an even better receiving system. On 160 or 80 meters, the answer is likely to be a Beverage antenna, named after its primary developer, H. H. Beverage W2BML. Beverage wrote a now classic paper on the wave, or Beverage, antenna which appeared in the November, 1922, issue of *QST*. Even after more than five decades, his article remains the gospel of Beverage theory and practice. If low-noise receiving antennas interest you, locating a copy of the article is a must.

This article will dwell not upon the theory, however, but rather on the practical construction of Beverage and Beverage-type antennas for low noise reception on 160 and 80 meters.

Like most topics in amateur radio, there are as many opinions on how to construct an effective Beverage antenna as there are those offering them.

The substance of this article is drawn from more than two years of collecting articles and opinions and using this type of antenna. Although we are going to describe an antenna that requires a fairly large amount of real estate if constructed in true Beverage form, a satisfactory Beverage-type antenna can be built on a small lot and still provide low noise reception and a degree of directivity.

Admittedly, there are other ways to construct a Beverage antenna than those given in this article, but the ones here are likely to be the easiest and most foolproof.

What Is A Beverage?

In the most simplistic terms, a wave or Beverage antenna is a single straight length of wire at least one wavelength long viewed as a feedline, with one side the wire and the other side Earth.

Just as with a feedline, there is an impedance between the wire and the Earth. This impedance stays reasonably constant along the length of the antenna and with frequency. The antenna may therefore be used over a wide frequency range; a Beverage designed for the 1.8 MHz band will perform

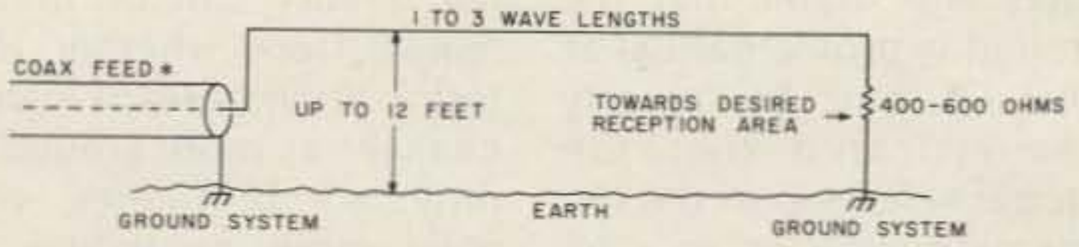


*Fig. 1. Basic Beverage antenna. Value given for termination resistance is approximate for normally conducting soil. Adjust as described in text. Preamplifier may be inserted at feedpoint. This is a terminated unidirectional Beverage with maximum response to signals arriving from the terminated end of the antenna. Signal voltage increases as radio wave sweeps the length of the antenna from right to left. Signals arriving from the left and traveling to the right are dissipated in the terminating resistor. See text for description of ground system. *See text for details of feedpoint matching.*

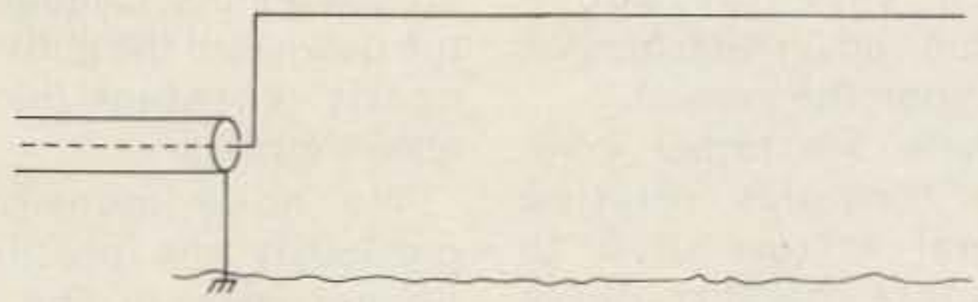


Fig. 2. This Beverage is similar to Fig. 1, but is not terminated. Signal response is nearly equal off either end, but slightly favors the non-fed end. Short, Beverage-type antennas are similarly constructed; see text.

well at 3.5 MHz.

For the Beverage antenna to be directional, and obtain maximum gain off the end of the antenna opposite the feedpoint, the Beverage must be terminated to ground through an impedance equal to that between the wire and Earth. In other words, the non-fed end is grounded through a carbon resistor. If you wish to receive off both ends of the antenna, omit the termination and let the far end float. There are ways to use a single Beverage for reception in either direction through a more-or-less complicated phasing system. This is beyond the scope of this article. For this information, the reader is directed to the June, 1977, *QST* article by Barry Boothe W9UCW, entitled, "Weak-Signal Reception On 160—Some Antenna Notes." The article is excellent and well worth reading.

A Beverage antenna receives the most response from signals arriving off the end(s) of the wire, not from broadside. The intensity of the signal builds as it travels along the length of the wire, reaching the maximum for a given length at the end(s). A Beverage erected in an east/west direction receives maximum signal energy from these directions.

In our east/west example, maximum signal energy arriving from the east is dissipated in a load, in this case the receiver, while signals arriving from the west are mostly dissipated on the east end through another load, a terminating resistor. The closer the termination resistor is in value to the impedance of the antenna, the more complete the dissipation of the west-arriving signal and the better the front-to-back rejection. See Fig. 1.

This is true in a terminated Beverage. A similar antenna left with the non-fed end floating (not terminated) will reflect signals back down the wire from the floating end to be dissipated in the receiver. In this case, much of the directivity of the antenna, if that is what is desired in addition to low noise, is destroyed, although signal intensity arriving broadside will still be reduced. See Fig. 2.

Some directivity of Beverage-type antennas will be noted with lengths as short as one half of a wave, but directivity becomes much more pronounced in true Beverages one wave or more long.

Logically, one might expect that the longer the Beverage, the better. This is not true. For reasons that will not be discussed here (see the original article by Beverage), it is possible to make the antenna too long. A Beverage of one to three wavelengths long is ideal; in the case of 160 meters, this is 550 to 1600 feet. A length of 800 to 1000 feet will give good performance on both 160 and 80 meters.

Short Beverage-Type Antennas

Thus far we have dealt with Beverages of some physical length. Available real estate and other considerations may preempt such construction.

A true Beverage is physically long, as explained, but don't rule out some Beverage advantages in short Beverage-type antennas. Although you will not achieve the gain and directivity of a true Beverage, you can still have the Beverage characteristic of low man-made and atmospheric noise pickup by constructing an antenna as short as 100 feet using the methods given in this article. See Figs. 1 and 2.

I have obtained good results from Beverage-type antennas as short as 100 feet laid upon the ground. Laying the wire upon the ground has the effect of decreasing its velocity factor—and therefore reducing the physical length for a given electrical wavelength.

As an example, in winter I have used a Beverage-type antenna 250 feet long laid upon the ground in an east/west direction. The antenna is terminated to ground on the eastern end through a 50-Ohm resistor. The antenna exhibits low noise and some directional pattern. From north central Texas, the pattern covers about 90 degrees, 45 degrees on either side of its axis. W4s and Caribbean stations within the pattern are typically 10 to 12 dB stronger than 8s, 9s, or Øs located more-or-less broadside to the antenna, referenced to a receiving loop. Stations to the west and northwest are very poor copy on the Beverage-type antenna.

The antenna does not have the directivity or gain of a similar antenna 1200 feet in length, but the shortwire is better than a loop and much, much better on noise rejection than my quarter-wave transmitting antennas.

There is no reason why similar antennas cannot be tried on city lots, laid upon the ground or suspended 6 feet or so in the air.

I should add that I am of the opinion that anyone who takes seriously his ability to hear well on 160 or 80 meters cannot possibly have too many receiving antennas ready to select at the flip of a switch. At the moment, I have available no fewer than 7 separate receiving antennas, including 3 loops and 4 Beverage or Beverage-type antennas, and none of them shows behavior identical to another's!

Height Above Ground

One of the interesting characteristics of the Beverage antenna is that it does not have to be lo-

cated very far above ground and, in fact, may be laid upon the ground.

There are rather complex formulas relating several factors used to compute height above ground. In practice, however, a height high enough to permit passage of persons, animals, and vehicles below the antenna is a good choice. A height of 6 to 12 feet over "normally" conducting soil is an excellent choice. The impedance of the antenna changes very little between 6 and 12 feet. Greater heights will introduce unwanted noise pickup. See Table 1 for the antenna impedances for various heights above ground and wire sizes.

Regarding the wire itself, most any size may be used as long as it will support its own weight. The wire may be uninsulated if erected above ground, or insulated if laid upon the ground.

The wire may be supported in any number of ways, but if metallic supports are used, the wire should be insulated from them. Examples of supports are metal or wood fence posts, 1" x 1" wood stakes, convenient trees, and the like. The wire should be run at a nearly constant height above ground and in a straight line not varying more than 10 degrees. If the antenna crosses a gully, it should be run down into the gully at a nearly constant height above ground.

We have mentioned previously the possibility of actually laying the Beverage upon the ground. This has been tried by me and many others with excellent success, but it should be done in untraveled areas, for obvious reasons.

I live in an area of the country which is said to have excellent soil conductivity. There are those Beverage experimenters who say that in such areas it may well be an advantage to lay the Beverage wire upon the ground. I can neither prove nor disprove this. I have used Beverages both on the ground and up to six feet above ground without noticing any performance changes.

If the Beverage is laid upon the ground, obviously you will use insulated wire. If you choose to terminate the antenna, I would suggest doing so directly to ground or through a 50-Ohm resistor.

Providing Termination Ground

Undoubtedly the most difficult and uncertain construction aspect of an unidirectional terminated Beverage antenna is the ground itself.

While some Beverage users will argue that the ground is problematical at best, it can be clearly demonstrated that the proper selection of the terminating resistor in conjunction with the ground does have a definite effect upon the directional characteristics and the rejection of unwanted signals from the rear of the Beverage.

Even though the Beverage antenna may perform best when erected over poorly conducting soil, this same soil also accounts for more difficulty in grounding the terminated end. But unless you can ground your Beverage through a single stake in salt water or a marsh, it remains worthwhile regardless of soil conductivity to establish the best possible ground connection.

A single ground stake may be sufficient under the above mentioned conditions, but seldom will such conditions exist. So how is a low resistance ground established?

The answer is to put in contact with the soil the most practical amount of metal possible. Probably the minimum ground acceptable is a system of three copper ground rods as long as possible driven into the soil, spaced a minimum of two feet apart and bonded together. The bonding may be done with automobile battery grounding straps or with the shield removed from a discarded length of RG-8 or similar cable. Do not rely upon the clamps provided with the ground rods. Solder or braze all connections, first making sure the rods and strap material are free of grease, paint, or whatever. The same applies before driving the ground rods into the soil. A torch will be necessary to provide enough heat for proper bonding.

An indication of grounding quality can be determined from whether the termination resistor value changes as more ground is provided. If it does, you need more grounding or metal in contact with the soil. At some point you obviously reach a practical limit, but you should try to achieve the least possible change in the termination impedance. Proper determination of the correct resistor value is made by observing the strength of a signal arriving from the rear (fed end) of the antenna and selecting a resistor value which provides the deepest null or rejection of that signal. An AM broadcast station is a good signal source for this adjustment. Here is an application where a carbon potentiometer is useful for the termination resistor (as opposed to fixed-value carbon resistors).

What we are attempting to establish is the lowest possible resistance to Earth. Three ground rods provide 1/3 the resistance to ground as a single rod, and therefore a three times better ground connection.

In extremely poor soil conductivity areas, an elaborate ground system will be useful. Such a system was described by Roger Hoestenbach W5EGS in his December, 1976, *QST* article entitled, "Improving Earth-Ground Characteristics." This article is recommended reading.

A technique similar to that described by Hoestenbach would be to bury an old auto radiator obtained at low cost from a junkyard. A grounding strap should be bonded to the radiator, and the radiator filled with a heavily-concentrated brine solution. The brine solution is made by dissolving as much rock salt as possible in the quantity of water required to fill the radiator. The rock salt used in water

Height of Wire	4′	8′	12′
Wire Size #	Ohms Impedance		
10	460	493	520
12	474	507	534
14	488	521	548
16	502	535	562
18	516	549	576
20	530	563	590
22	544	577	604
24	558	591	618

Table 1. Impedance of Beverage antenna as a function of wire size and height of wire above ground. These values will vary some minor amount due to local soil conditions. You can also expect variations from day to day and season to season. The proper terminating resistance can be determined as given in the text, or an adequately close value for most locations can be selected from this chart.

softeners is an inexpensive source.

A similar brine solution may be poured on the soil around the ground rod system, but remember that the brine solution will kill all plant life for some area as it leaches into the soil. The condition will exist for several years. Repeat the brine solution application as needed, probably once every 30 to 90 days.

Wire mesh or screen also may be buried a few inches in the ground, equipped with a suitable bonding strap.

Another method of providing a low-resistance ground is through the use of a radial system extending away from the Beverage. Do not run the radial wires back towards the Beverage. The radials should be made of uninsulated wire, with the ends staked to ground through metal stakes as long as you wish. A larger number of short radials is better than a lesser number of long radials. Sixteen radials about 55 feet long, fanned about 11 degrees apart and distributed over the 180 degrees off the end of the Beverage, would be ideal. If this is impractical, use as many radials as possible (even though they may be but a few feet long each) fanned over the 180 degrees. Treating the soil with the brine solution may also be useful.

Providing a low-resistance ground may be carried to whatever extreme the builder wishes, but the point is to provide the best possible ground circumstances permit.

Similar grounding techniques must be used at the fed end of the Beverage where the shield of the coaxial cable is bonded to the ground system. This will prevent random signal pickup on the coaxial feedline, pickup which will destroy the entire Beverage antenna system by upsetting the directional characteristics.

This ground system business may seem like a lot of trouble and work, but the effort expended may be the difference between a mediocre receiving antenna system and one that will provide many enjoyable hours and the ability to hear the weak ones your competition does not. And whether you choose a terminated unidirectional Beverage or a bidirectional one (with no termination), be sure to provide a ground system for the coaxial cable at the fed end, even though it may be as unelaborate as one or more ground rods.

Feeding the Beverage

Ideally, the Beverage, like any antenna, should have its feedpoint matched to the feed or transmission line. Physically, it is unlikely that you will be able to bring the fed end of the Beverage directly to your receiver, especially without varying the axis of the wire less than 10 degrees. Even if you can, some type of a matching device should be used to lower the 400- to 600-Ohm antenna impedance to that of a typical communications receiver.

In most all cases, the Beverage is, or should be, isolated from the home or other antennas. This dictates the use of a feed or transmission line.

My suggestion is the use of RG-58 or RG-59 uncontaminating coaxial cable, double-shielded if available. Double-shielded RG-59 is available from cable television supply houses or CATV companies, and is commonly known as drop cable. The better the shielding, the better will be the rejection of unwanted signals picked up on the feedline. Beware of the RG-58 being sold in many CB stores and some ham outlets. I have seen some that would be doing well if it had 45 percent shielding.

Elsewhere in this article is a brief discussion on whether a preamplifier is necessary. If you choose to use one, then the input circuit will need to be designed for the high impedance feedpoint of the Beverage and the output made to match the coaxial cable impedance.

For the purposes of this section, let us assume that you are not going to use a preamplifier and therefore need to match the antenna directly to the feedline.

This may be accomplished in many ways: the common L-type network, a toroid autotransformer with a tapped selection of high impedance points, a common autotransformer made of coil stock,* or a 4:1 balun of the type used on the antenna input of a television set.

I am a believer in cutting the coaxial feedline to some multiple of an electrical half wavelength determined by the velocity factor of the coax, .66 for solid dielectric or .81 for foam. Free space half wave at 1.8 MHz is approximately 273 feet. A .66 velocity factor is 180 feet, or 221 feet with .81 velocity. Therefore, the feedline would be 180, 360, etc., or 221, 442, etc., feet long respectively.

Be certain to ground the coaxial cable shield at the feedpoint. Either bury the coax a few inches in the ground or lay it upon the ground—do not suspend in the air. These measures are taken to prevent stray pickup on the feedline.

Preamplifiers

It may be desirable to employ a preamplifier with the Beverage antenna, particularly in instances where long runs of coaxial cable feedline are necessary. Admittedly, signal losses per

*Though this is rather bulky, try about 3 inches of B&W coil stock #3062 with the low impedance tap up 3 or 4 turns from the ground and the high impedance tap 15 to 30 turns up—you'll have to experiment.

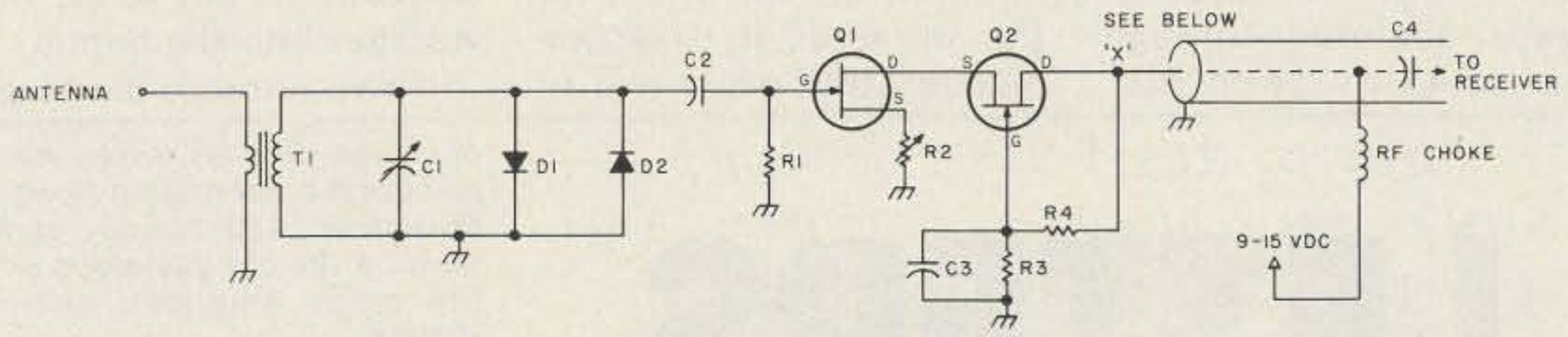


Fig. 3. 160 meter preamplifier suitable for Beverage use. T1: Amidon toroid, FT-82-61 or FT-114-61, primary (to antenna) of 2 turns #18 enamel, secondary of 25 turns #18 enamel. C1: miniature 365 pF air variable. D1-2: 1N914 or similar diodes. C2: 100-500 SM. R1: 220k. R2: 0-200 Ohms; adjust for preamplifier gain. R3: 6.8k. R4: 27k. C3: .01. Q1-2: MPF-102. Preamplifier may be powered at point "X" with a self-contained battery, 9-15 V dc, or by duplexing through the coaxial cable feedline, in which case the power may be inserted at the station end of the coaxial cable through an rf choke. C4 is a .001 blocking capacitor. If preamplifier is used at the feedpoint of the antenna, make certain of waterproofing. Preamplifier must be grounded to Earth, and may be built in a small minibox with short, point-to-point wiring. The entire assembly could be placed in a small plastic refrigerator box for weather protection.

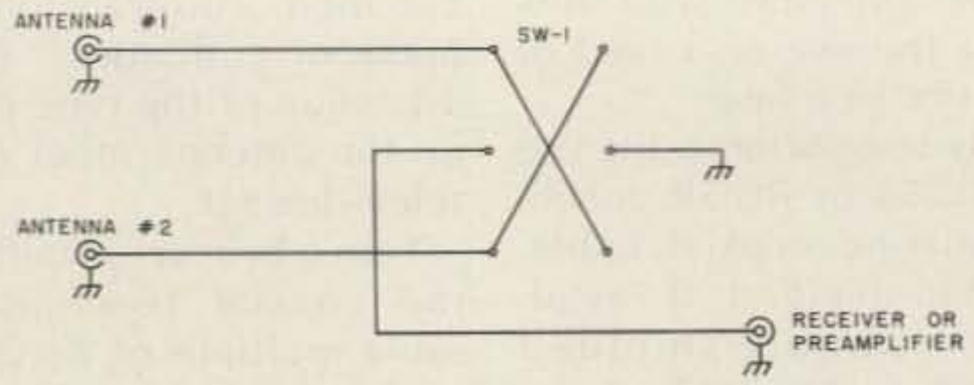


Fig. 4. Manual switch for grounding one of two antennas not in use to prevent reradiation; see text. SW-1 is a non-shorting double-throw double-pole toggle built inside a small minibox. Use leads as short as possible. Make certain all grounds are good. If used at the feedpoint, bond minibox to ground system. If used at the receiver, bond it to receiver chassis. Do not rely upon coaxial cable shield for ground.

hundred feet of coax are low at these frequencies. Whether a preamplifier is necessary is left to the user.

If one is deemed necessary, a simple circuit is described by Doug DeMaw W1FB, in his April, 1977, *QST* article, "Build This 'Quickie' Preamp." In this preamplifier, as in all others, I would suggest the use of back-to-back diodes such as 1N914s at the input to prevent rf and similar damage to the preamplifier.

Back-to-back diodes are included in the schematic of another suitable preamplifier within this article. Credit for this circuit apparently belongs to K1PBW. See Fig. 3.

If the preamplifier is used at the antenna, the most logical place, the device may be supplied power duplexed through the coaxial feedline, through a buried control cable that may also carry voltages for antenna selection relays, or from a battery contained within the preamplifier case.

Reradiation and Inter-Antenna Coupling

One undesirable characteristic of the Beverage antenna is its ability to reradiate large amounts of signal energy to nearby antennas, and to couple into them and cause variations of antenna pattern and other unwanted characteristics.

It is recommended that a Beverage antenna be physically removed from any other antenna by a minimum of half of a wavelength; more is desirable. This may not be possible due to space limitations, but whatever the situation, it is recommended that when two or more receiving antennas are used, some method of grounding the unused antenna be provided. A schematic of a suitable manual switch included in this article can be used, or a method of automatic grounding with electrically-controlled coaxial switches or relays can be devised. See Fig. 4.

Government-sponsored tests on Beverage antennas reveal that they may be crossed within a few feet of each other, provided they do so at angles of 60 degrees or more. Beverage antennas run parallel to one another, utility lines, wire fences, or the like should be separated by at least one wavelength.

Lightning and Static Discharge Protection

Beverage antennas are susceptible to collecting damaging voltages in the presence of certain weather conditions such as electrical, snow, and dust storms. Attention to the protection of receivers and preamplifiers is necessary. The ultimate protection is to disconnect the coaxial cable feedline at the antenna, or, if a preamplifier is used, to disconnect the antenna prior to the preamplifier's input stage. Various configurations are obvious, and are recommended to be at the antenna so as to not route the voltages into the home.

If two or more Beverage antennas with separate feedlines are being used and you insist on bringing the feedlines into the house, a Barker and Williamson model 376 coaxial switch, properly installed, is suggested. The switch could be installed at the entrance to the building.

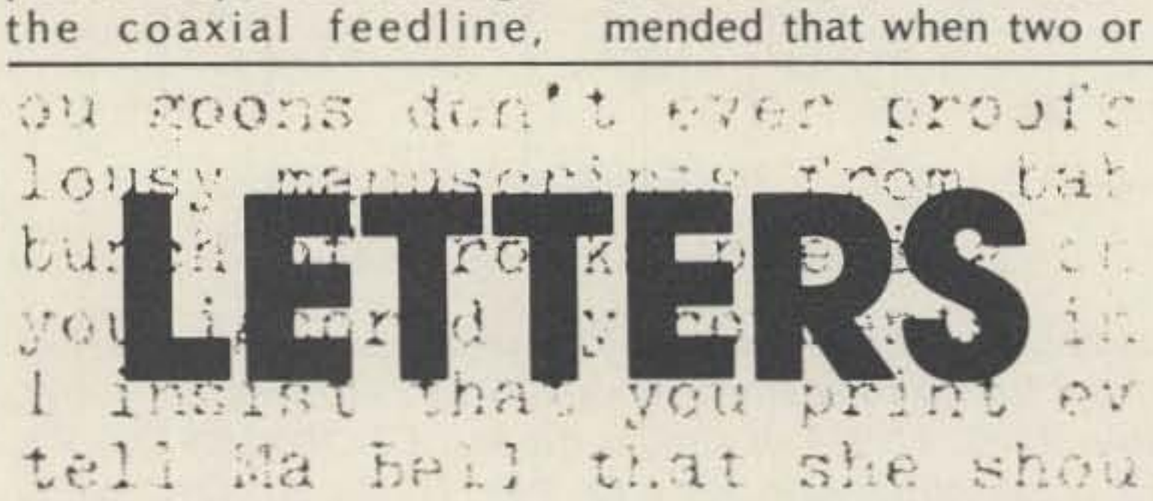
If you are using a terminated Beverage, it is wise to inspect the termination resistor following any severe weather, as often the resistor will be damaged.

Play it safe: Disconnect the Beverage when a storm approaches and any time you will be away from home.

Conclusion

The Beverage is not a cure-all or all-purpose antenna. It is a directional antenna and should therefore be carefully aimed in the desired direction of reception. With a length of one to three wavelengths, the horizontal pattern will be approximately 45 to 30 degrees, centered on its axis. It is also primarily a DX antenna, not intended for general all-around use.

For serious DXing on 160 or 80 meters, several Beverages will be required if all compass points are to be covered. However, several Beverages and a good receiving loop will enable you to explore to the fullest the two lowest high-frequency bands. ■



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200-Watt medium power ops come through a couple of times a week. The 20-Watt stations are readable maybe once or twice a month, and then they are usually smothered by European QRM.

Of course, I also use a gas guzzler now. I used a very economical Datsun until I got fed up with the 55 mph speed limit. Now, as long as I can't enjoy driving any more, I go in a big van and work while someone else (Sherry) drives me. I just don't enjoy driving along at 55 mph in a 120 mph car, so we burn up the old gas along with the other American cars.—Wayne.

SELLING MORE MAGAZINES

Although I have been licensed for only a relatively short period, I feel that the time has come to vent some steam and offer some suggestions and comments aimed at improving our way of life.

I follow with interest and sometimes frustration what seems to be a never-ending battle between Wayne Green and the ARRL. Yes, probably most of the buyers of *73* are ARRL members. Any worthy organization such as the ARRL will solicit and accept suggestions aimed to improve its performance, but it seems to me that Wayne's constant downgrading of the League is aimed toward selling more magazines instead of helping amateur radio. Let us all offer our full support to the League by offering suggestions and improvements. If the elected officers fail to do their job, let's

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