low-cost compact antennas for 20 meters

A selection of simple antennas based on plastic-pipe booms and element supports for the antenna experimenter

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All compact antennas are compromises, whether they are dipoles, verticals or beams. For low swr they must be operated over rather narrow frequency ranges, and efficiency is not as great as with a full-sized antenna. However, by using elements at least 1/8-wave long, inefficiencies may be kept to a minimum.

In the *tripole* antenna I have tried to overcome some of the disadvantages of miniature antennas by adding a third element as shown in **fig. 1.** Although this antenna looks like a ground plane at first glance, it is not; it consists of an inverted-vee dipole with a vertical element connected to one side. Performance of this arrangement has been excellent, and I have received good signal reports on both 20 and 40 meters.

The vertical support may be made from varnished bamboo or ½-inch plastic pipe. If you use plastic pipe, use plastic fittings to couple the sections of pipe together. The vertical element for the 40-meter version (originally described in *Florida Skip*) is shown in **fig. 1.** The vertical element for the 20-meter tripole consists of a 16-foot, 6-inch section of number-14 wire taped to a 17-foot bamboo (or plastic) pole; the inverted-vee elements of the 20-meter version are 16½-feet long.

The vertical element and one of the inverted-vee elements are connected to the center of the coaxial feedline; the other inverted-vee element is connected to the outer braid of the coax. To tune the antenna, use a grid-dip meter to indicate resonance. In the 40-meter tripole the windings of loading inductance L2 are expanded to increase frequency, and compressed to lower resonant frequency.

tripole beam

Two compact tripole antennas may be combined into a beam as shown in **fig. 2.** Although this particular antenna was designed for 20 meters, similar designs could be used on the other bands. The compactness is particularly useful for space-cramped amateurs who want to operate on 160, 80 and 40 meters.

In the 20-meter tripole beam, the boom is a 1-inch square aluminum pipe, 101-inches long. Each of the tripole elements are 8-feet, 8-inches long. Construction is shown in **fig. 2.** Each of the elements is center loaded with coils wound on a 5-inch section of plastic PVC pipe 3/4-inch in diameter; fill the form with 4 turns number-18 plastic-insulated wire, spaced 1/16-inch. The two 48-inch aluminum tubing elements are held together with 12-inch lengths of ½-inch PVC pipe.

Each aluminum element is pushed 2 inches over the end of the center insulator, leaving 46 inches of active element. The plastic coil form slides over the 1-inch center insulator and is connected to the aluminum elements with short pigtails. (Note that all coils are wound in the same direction.) This movable coil form is used to tune the antenna to resonance by moving it to a different

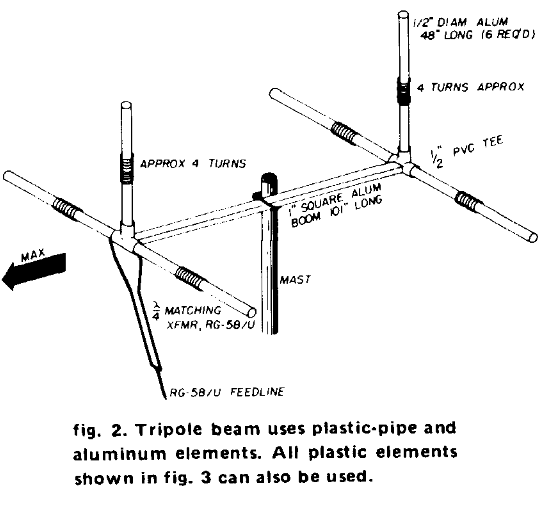


fig. 2. Tripole beam uses plastic-pipe and aluminum elements. All plastic elements shown in fig. 3 can also be used.

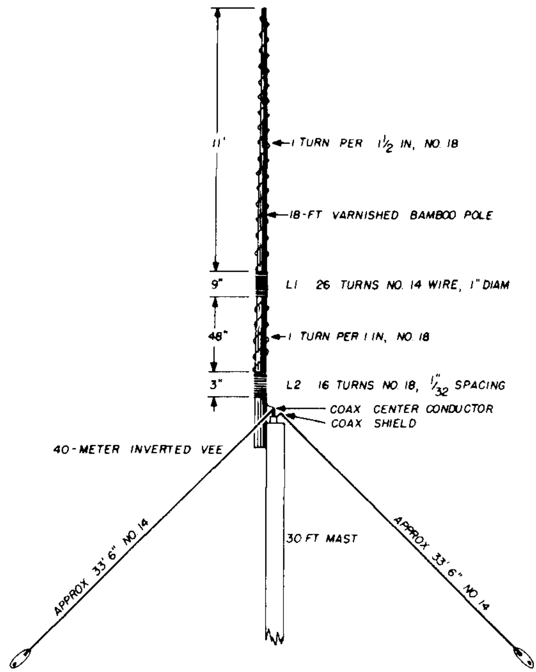


fig. 1. Tripole antenna for 40 meters. Grid-dip the vertical element to 7250 kHz. Adjust resonance with L2.

position on the center insulator.

Once each element has been resonated, the movable coil form is cemented to the center insulator. This is a rather high-Q antenna so one frequency setting will permit operation over 100 kHz of the 20-meter band for swr less than 1.5:1.

Each of the six tripole elements is held to the boom with plastic tee fittings, available at your local hardware store. When all the elements are in place on the boom, connect the base of the reflector elements together with a 4-turn coil of number-14 wire, 1½-inch in diameter, 2-inches long. The radiator is fed with a ¼-wave matching transformer made from two sections of RG-58/U; the 50-ohm coaxial line from your transmitter is connected to the bottom of the matching transformer as shown in **fig. 2.** One center conductor of the matching section is connected to one of the horizontal elements; the other center conductor is attached to the vertical element and the remaining horizontal element.

plastic-pipe tripole beam

The basic tripole system shown in **fig. 2** is easily, and less expensively, made with PVC-pipe supports and wire elements. For this simplified construction, use an long, may also be used for the boom. Each of the tripole elements is mounted on a plastic tee-fitting which is mounted to the boom. The three elements of the reflector are connected together with a

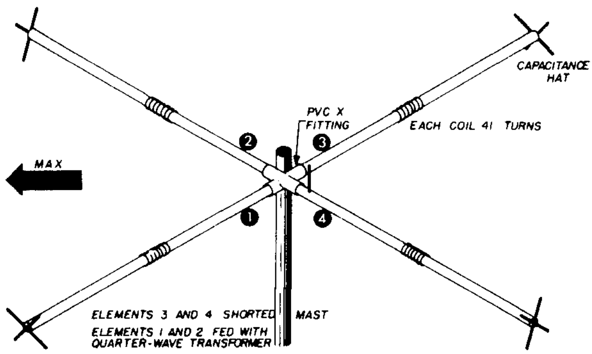


fig. 4. X-bar antenna uses four elements of the type shown in fig. 3. This antenna may be used horizontally, as here, or vertically.

8-foot, 8-inch length of plastic pipe for each element. The loading coil is wound on the outside of the tubing, and after tuning, is cemented in place. Drill a small hole in the pipe on each side of the coil, and connect the coil to 4-foot sections of wire inside the pipe as shown in **fig. 3.** Plug the ends of the pipe with wooden dowels to keep moisture out.

Each of the loading coils consists of 30 turns number-18 plastic-insulated wire on a 1-inch diameter form with a winding

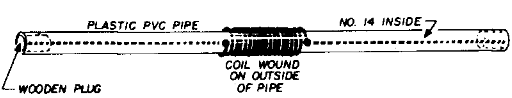


fig. 3. Plastic-pipe element consists of center loading coil and wire elements inside the pipe.

length of 7 inches. This coil, with a capacitance hat made from two 12-inch lengths of number-14 wire, provides resonance on 20 meters. Tuning range of this all-plastic antenna is on the same order as the more conventional design shown in **fig. 2.**

A section of plastic pipe, 101-inches

coil and tuned 5% lower than the radiator. The radiator is fed in the same way as shown in **fig. 2.** The tripole elements may also be mounted to the boom with plastic X fittings so the elements are symmetrically spaced 270° apart.

x-bar beam

The X-bar beam antenna is an extension of the tripole beam that uses four compact elements instead of three. Element construction is the same as that shown in **fig. 3.** The radiator and reflector each consist of four elements, attached to the 101-inch plastic boom with plastic cross fittings. The X-bar antenna is fed with a matching section as shown in **fig. 2.** Performance is slightly improved over the three-element version.

x-bar compact antenna

The X-bar compact antenna shown in **fig. 4** was developed as a result of experience with the X-bar beam. This antenna consists of four PVC pipe elements, and may be used either horizontally or vertically. I mounted one version of this antenna on a short tilt-over mast extension which could be lowered for vertical polarization, and put up (like an umbrella) for horizontal operation. Under some skip conditions I found that switching from vertical to horizontal increased signal strength. However, the swr

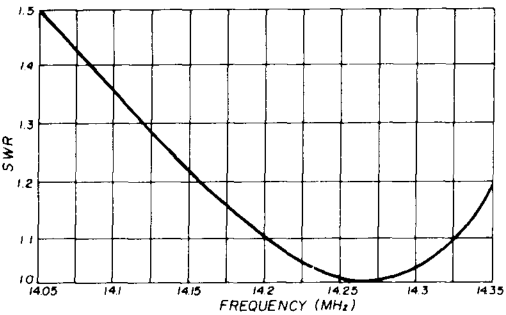


fig. 5. Swr performance of an X-bar antenna using plastic and aluminum elements.

changes from horizontal to vertical, with a slightly higher resonant frequency in the vertical position.

Each of the elements in the X-bar antenna is the same as those shown in **fig. 3.** For vertical operation the coils should be 30 turns; for horizontal operation, the coils should be 26 turns, number-18 plastic-insulated wire. With a horizontal mounting the quarter-wave matching transformer was made with 75-ohm RG-59/U; swr was nearly flat for 50-kHz each side of resonance, with an swr of 1.3:1 for a total frequency range of 150 kHz.

The X-bar antenna can also be built with the plastic and aluminum elements shown in **fig. 2.** The swr performance of the aluminum X-bar antenna with capacitance hats is shown in **fig. 5.** These measurements were made with the antenna 9-feet off the ground. For tuning it is much easier to prune the capacitance hats than to adjust the loading coils. The capacitance hats on elements 1 and 2 are 12-inches long; the element hats on elements 3 and 4 are 6-inches long.

For better swr performance two elements of the vertical X-bar antenna can be combined with full-size quarter-wave wire elements as shown in **fig. 6.** This antenna is much more directional than a dipole, and provides much broader frequency coverage. The swr is less than 1.5:1 for the entire 20-meter band. The matching transformer used with this antenna is the same as that shown in **fig. 1.**

antenna tinker kit

After building the various antennas described so far it occurred to me that these same elements could be combined in any number of ways to provide useful antennas. The elements can be built in several ways, including the aluminum and plastic-pipe version in **fig. 2** and the lower cost all-plastic-pipe version in **fig. 3.** There are several other ways of making elements, including wrapping the ends of the plastic pipe with aluminum foil and

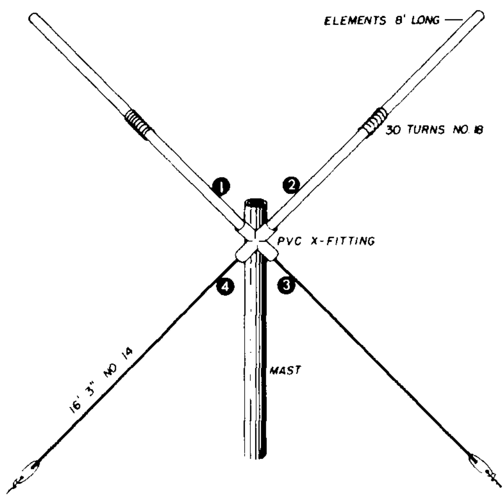


fig. 6. Improved performance is provided by two compact elements with two full-sized quarter-wave wire elements. Elements 1 and 2 connected to 1/4-wave transformer; elements 3 and 4 connected to shield.

doing away with the internal wire elements. To connect the loading coils to the aluminum foil, arrange the pigtails in the form of a sine wave and place them on top of the first layer of foil; put another layer of foil over the pigtails and tape it in place.

Another method of making elements is shown in **fig. 7.** In this element holes are drilled along the length of the plastic pipe and aluminum ground wire is woven in and out of the pipe as shown in the drawing. Each section of wire is 7-feet long. With this arrangement the loading coil is smaller; about ten turns around the ½-inch pipe is about right for 20 meters.

Although these elements are shown without capacitance hats, hats can be used. I have used the wire hats shown in **fig. 2.** as well as the loops shown in **fig. 8.** The loops in **fig. 8** are made from a 22-inch piece of number 16 wire. The antenna element is tuned by changing the length of the loop. With the capacitance loop, the center loading coil consists of 42 turns number-18 plastic-insulated wire for resonance on 20 meters.

These compact elements may be arranged in many different configurations, including horizontal and vertical dipoles, inverted vees, upside-down inverted vees, X-bars, X-bar beams, tripole beams, conventional beams, ground planes, and various phased arrangements. Because of their low cost and ease of construction, this type of element is ideal for the antenna experimenter who wants to try different types of antennas.

fig. 7. Another method of making low-cost antenna elements.

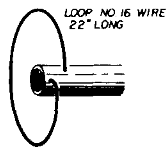


fig. 8. Capacitance hat made with a loop of wire. Resonance is adjusted by changing the length of the loop.

tuning

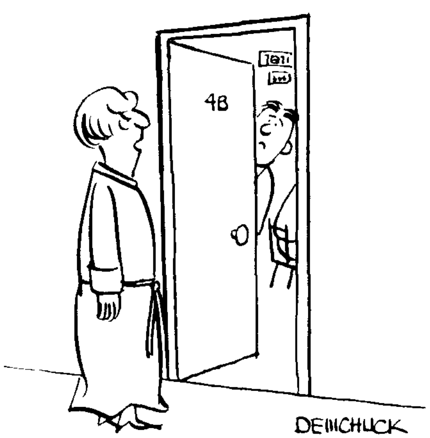
To tune each of the compact elements you need a grid-dip meter and a full-sized half-wave dipole about 5-feet off the ground. First, grid-dip and dipole and adjust it for the frequency at which you want to operate. Mark the point on the grid-dipper dial. For best accuracy use a communications receiver to check the calibration of the grid-dip meter. Use a 2-turn link to couple the grid-dip meter to the dipole.

Now connect the compact element to one side of the dipole and prune the capacitance hat (or adjust the loading coil) until the system resonates at the same frequency as the dipole did by itself. Resonate the rest of the elements one at a time with the same system.

To tune the coils you can temporarily connect a 50-pF trimmer capacitor across the loading coil of an element that has been previously resonated with the wire dipole. Without disturbing the trimmer or the grid-dip meter, connect the trimmer across the loading coils of the other elements and adjust the coils for the same resonant point on the grid dipper. This way you know the coils in all the elements have the same inductance.

For best results use white PVC pipe instead of black. The white reflects the rays of the sun and holds up much better in the weather.

ham radio



"Did a man come up here to complain about radio interference two hours ago?"