The Heli-Hat Antenna

An 18-inch wonder for 10–17 meters.

by J. Frank Brumbaugh KB4ZGC

What is compact, portable, and efficient? Covers 17 through 10 meters? Is omnidirectional, with low angle radiation? Reduces QRM, QRN, and harmonics? Has one-knob tuning for low SWR?

More and more hams find themselves living in subdivisions, apartments, and condominiums where deed and building restrictions make normal antenna installations impossible. Hams in mobile home parks, and those ranging the country in motor homes, have few options for useful antennas other than loaded vertical whips—mobile antennas. These are useful for the higher HF bands, but commercial versions are very expensive. What they need is an antenna with the above features.

Although I now have a 40 meter dipole for HF use, there have been many times during my 40-plus years as a rag-chewer when I lived in locations where even a whip antenna on a balcony was frowned upon. I experimented with many different antenna configurations. Some worked quite well. Others were duds. The more-or-less standard dipoles and quarter-wave wires, even bent to fit the available indoor space, generally gave satisfactory results when properly tuned. However, even small gauge wires strung around a small apartment were sometimes noticed and questioned by landlords, requiring elaborate explanations—lies—which seldom were believed. What was needed was a compact, effective HF antenna that could be easily hidden in a closet or attic when "official" visitors were expected.

Such an antenna should be of a size that could easily be transported in an automobile and rapidly set up in a motel room, or even put on top of the car for fixed mobile operation on Field Day. The Heli-Hat Antenna was my solution to this problem. It has all the features I opened this article with!

Originally designed before WARC to operate on 10 and 15 meters, it has been used since then on 17 and 12 meters, and results have been most satisfactory. This antenna may well be of interest to other hams with similar antenna problems, or as a "quick and dirty" Field Day antenna.

Heli-Hat Antenna

The antenna, illustrated schematically in Figure 1, covers the 17, 15, 12 and 10 meter bands. It includes one-knob tuning so SWR can be reduced well below 1.5:1—usually 1.1:1 or 1.2:1, making it compatible with modern solid-state transceivers. It is compact, fitting into a space approximately 18 inches high and 18 inches in diameter. With the top hat removed it takes up about as much space as two loaves of bread staked end-to-end.

Table. Taps vs. Frequency

Band, Meters	Tap	SWR
17	7	1.1:1
15	7	1.2:1
12	6	1.2:1
10	6	1.1:1

Note: Tap points measured from bottom of helix. The 10-meter tap is for 28.4 MHz and may vary at higher frequencies. Taps for other bands are for centers of bands.

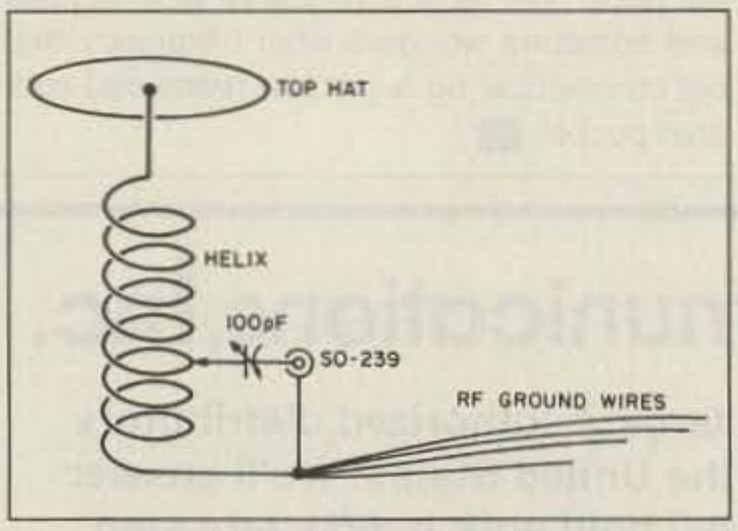

Figure 1. Heli-Hat antenna schematic diagram.

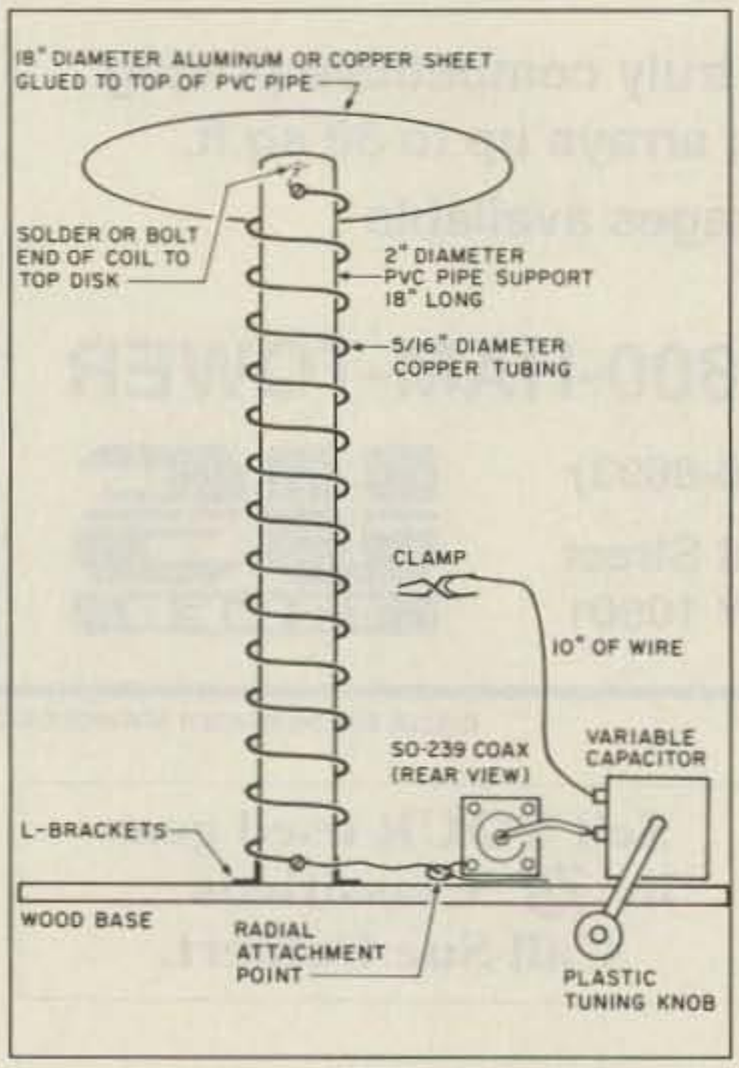

Figure 2. Construction details of the Heli-Hat.

Basically, the antenna is a tuned, top-loaded helix. A portion of the base of the helix, tuned by a 100 pF variable capacitor, resonates at the operating frequency and simultaneously presents a nonreactive 50 ohm load to the transmitter or transceiver. The upper portion of the helix is tuned by the effective capacitance of the top hat at the operating frequency. The entire antenna structure radiates.

This is a high-Q antenna, so it exhibits a relatively narrow bandwidth. This requires slight adjustment of the tuning if a large frequency excursion is made, especially on the 15 and 10 meter bands. A major advantage of such a high-Q antenna is that it rejects any harmonic energy which may be present on transmit, and on receive it reduces the level of signals near the operating frequency in a manner similar to the way a peaked filter functions. Not only will this antenna reduce QRM, it also reduces QRN to a great extent because of its narrow bandwidth.

The base of the helix must be grounded for RF. In most indoor installations this can be best accomplished by attaching open-ended quarter-wavelength wires to the ground connection, a solder lug on one of the screws holding the RF connector to the antenna base. Ground wires can be stretched out while operating, and rolled up and stowed with the antenna when not in use.

For operation on all four HF bands, the four wires should be cut to 13 feet 7 inches; 11 feet 7 inches; 9 feet 10 inches; and 8 feet 6 inches, respectively, for the 17, 15, 12 and 10 meter bands. Four separate insulated wires can be used; or two pairs of 2-conductor speaker wire, or even a length of 4-wire telephone cable such as that used indoors. Each wire should be cut to the length specified, and one end of all wires connected to the ground lug on the SO-239 RF connector on the antenna.

Continued on page 35

Continued from page 32

WARNING: *When transmitting, the entire antenna structure as well as the open ends of the ground wires will exhibit high RF voltages which can produce burns if touched. Be certain your installation is protected from being touched by children or pets.*

Finding The Parts

New copper tubing is rather expensive, but the length required should not break any ham's budget. Scrap tubing, copper or aluminum, is often available for little or nothing at businesses involved in manufacturing and installation of refrigeration and heating/air-conditioning systems. The tubing I used was obtained from an air-conditioning installer for $2.00. It is also often possible to locate a sufficient length of cable TV hard-line—spool ends containing as much as 80 or 90 feet are usually discarded—and if you explain your intended use to one of the technicians, you probably can get as much as you need free of charge. Although copper tubing is best, aluminum can be used in constructing the Heli-Hat antenna.

The 100 pF variable capacitor I used has 0.03-inch plate spacing, which is OK for up to 100 watts. For 500 watts a plate spacing of 0.05 inches is recommended, and up to 0.1-inch spacing for maximum legal power. My capacitor came from the lowest depths of my junk box. It is odd, with trapezoidal-shaped stator plates, removed long ago from some esoteric military "boat anchor."

Fair Radio Sales, P.O. Box 1105, Lima OH 45802, has a broad selection of surplus variable capacitors at prices ranging from $1.25 to several dollars. (New variable capacitors bear prices that equal a day's wages or more! Surplus is better.) However, before spending scarce dollars, check with local hams and the flea markets at hamfests for a suitable capacitor. Also, Radiokit at P.O. Box 973, Pelham NH 03076, tel: (603) 635-2235, carries a number of suitable capacitors. Two good candidates are their model number 284130 for higher power, and number 23100MK for under 100 watts.

Aluminum sheets two feet square are often available in hardware stores as "Reynolds® Do-it Yourself" supplies. Hardware and building supply stores also usually have two-foot-wide aluminum flashing for sale. Either will be suitable for the top hat, which is 18 inches in diameter.

Scrap PVC pipe and wood for the antenna base may often be found in scrap piles behind hardware and building supply stores, although the short length of pipe needed should cost less than a dollar purchased new. It can be either larger or smaller in diameter than that specified herein. Its only function is to provide stability to the tubing helix.

Construction

The helix consists of 15 turns of 5/16-inch copper tubing about 4-3/4 inches in diameter, with the turns evenly spaced over a length of 14 inches. The total length of tubing is about 19 feet. The helix was formed by winding around a cardboard tube about 3-1/2 inches in diameter, springing to its final diameter when removed from the cardboard. Ends of the tubing are flattened and drilled to accept long machine screws, then slipped over the PVC pipe and bolted through it. The pipe is about 18 inches long and about 2 inches in diameter.

NOTE: The dimensions given are those of my antenna. You may make any changes *within reason* in any of these dimensions. Tubing of larger or smaller diameter can be used; overall tubing length can be greater or a bit less. Helix diameter can be reduced and length extended. The result of such minor changes may change the position of the tap point for one or more bands but otherwise should make no important difference.

The top hat is an 18-inch diameter disc of aluminum sheet with an area of over 254 square inches. It need not be round as long as the area is close to 254 square inches. The effective capacitance of the top hat is important to both the frequency range covered and to the Q of the antenna.

The top hat can be attached to the top of the PVC pipe with epoxy or hot glue. A ground lug attached to the underside of the tip hat near the PVC pipe is used to connect a short wire jumper between it and the top of the helix.

The lower end of the PVC pipe can be mounted on a short piece of wood, plywood or plastic, using brackets and machine screws. It may also be attached with epoxy or hot glue, although this will not produce a very strong joint.

The tuning capacitor must have both rotor and stator plates insulated from ground because it is in series with the RF from the transmitter or transceiver and the tap on the helix. Either a length of insulating shaft or a large plastic knob must be used on the tuning capacitor shaft, which will be "hot" with RF. Mount the capacitor on the base near the PVC pipe.

An SO-239 RF connector can be connected to a bracket attached to the antenna base near the tuning capacitor. Mount a ground lug under two of the screws holding the connector on the bracket. Connect a wire jumper from one ground lug to the base of the helix. The other ground lug is the connection for the four RF ground wires mentioned earlier.

Connect a wire jumper between the center terminal of the SO-239 to either the rotor or stator of the tuning capacitor. Solder both connections.

Strip some insulation from both ends of a flexible stranded wire of AWG #16 or larger and about 10 or 12 inches long. Connect one end to the unused terminal on the tuning capacitor, and solder.

Connect a spring clip to the other end of this wire. An alligator or crocodile clip may be used, but a small spring clip of the type used on automobile jumper cables and battery chargers works best. This clip is used to establish the tap point of the helix for each band, and must make a solid, low resistance connection.

Operation

Attach the ground wires to the unused solder lug on the SO-239 connector and stretch them out more-or-less in a straight line. Using a coaxial jumper, connect the RF output of your transceiver or transmitter to the SO-239 on the antenna, providing your rig includes a means for monitoring SWR. If it does not, an SWR meter must be connected between the transmitter or transceiver and the antenna.

If you've followed the measurements given in this article closely, position the tap on the helix as indicated in the table. If your antenna differs in dimensions, the proper tap point must be determined experimentally.

Apply 10 to 25 watts to the antenna and adjust the tuning capacitor for the lowest SWR. In some installations it may be necessary to move the tap point on the helix one-half to one turn higher or lower to achieve an SWR of 1.1 or 1.2, although if the SWR is at least below 1.5:1, modern solid-state rigs will operate satisfactorily.

Monitor the SWR when you change frequencies or bands, and change the tap position and adjust the tuning capacitor as necessary to maintain low SWR.

Conclusion

The Heli-Hat antenna is omnidirectional and radiates much of the RF at the low vertical angles best for DX. It is a high-Q antenna with a narrow bandwidth around the operating frequency, resulting in the reduction of QRM and QRN on receive, and greatly reducing the level of any harmonic energy that might be present in the output of the transmitter or transceiver. It covers all four ham bands from 17 through 10 meters and is easily tuned for a very low SWR. The antenna is easily set up indoors or out, and is easy to conceal when not in use. It can, in many cases, be constructed wholly from scrap.

Although the Heli-Hat antenna was designed to cover only the four highest HF bands, theory suggests it also could be tuned on 6 meters, and possibly 2 meters as well, by tapping the helix closer to ground. Not having equipment for these bands, I was unable to check for operation on these frequencies.

Too, if the helix is made from a longer length of tubing, and perhaps has a larger top hat, it should be possible to extend the lower frequency limit to include the 20 meter band without making the antenna much larger.

Although the Heli-Hat antenna is not intended to compete with a 6-element monoband beam on a 100-foot tower, it will give a good account of itself on the four ham bands for which it was designed, especially on crowded bands where its high Q is a distinct advantage.

This antenna also can be a starting point for experimentally minded hams who may be interested in modifying it to cover other frequency ranges. 73

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