Coaxial Cable Antenna Traps

These traps are neat, compact, cheap and easy to assemble. If you're a ham, that's got to sound interesting!

By Robert H. Johns,* W3JIP

Both the coil and capacitor of a parallel-resonant antenna trap can be made from the same length of coaxial cable. This type of trap construction offers several electrical advantages and is easy for the home builder to construct.

The Concept

Parallel-tuned circuits, such as shown in Fig. 1A, are common. An inductance, L, is tuned to resonance by means of a capacitor made from a piece of coaxial cable. The capacitor is formed by the capacitance existing between the inner and outer conductors of the cable. By proceeding one step further, both the inductor and capacitor of the resonant circuit may be made from the same length of coaxial cable. This is shown in Fig. 1B where the cable is formed into a coil. The upper end of the braid (X) has become the right side of the inductor and the lower end (Y) has looped around and joined the antenna wire and inner conductor from the other side of the coil to become the left end of the inductor. Note that the inner conductor is cross-connected to the outer braid at the opposite end of the coil; this is essential. Were it joined to the braid at X, there would be no capacitor formed, since there would be no voltage difference between the conductors at X and by transformer action, all points along the cable would be at the same potential.

To help visualize the inductors and capacitors formed by this connection, the inner conductor and outer braid coils are separated as shown in Fig. 1C and placed end to end. The cross connection is joining the two in series, X to Y, in the middle. The capacitors indicated by the dashed lines are representative of the distributed capacitance between corresponding points of the two coils and the capacitance between the inner and outer conductors of the cable. Antenna traps made this way have excellent Q. High Q is desired for a trap in a multiband antenna because at frequencies lower than the one

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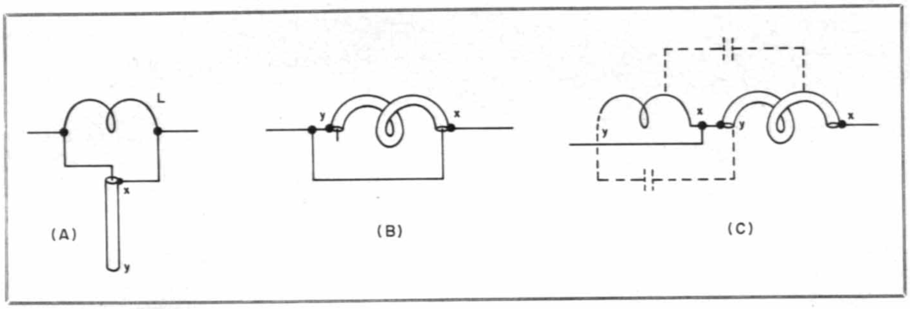

Fig. 1 — The simple trap at A uses a length of coaxial cable for the network capacitor. At B, a single piece of coaxial cable serves as both the coil and capacitor. The presentation at C is explained in the text.

to which it is tuned, it becomes a loading coil.

Coaxial cable capacitors have good high-voltage ratings and don't change capacitance with temperature. Assuming the impedance at the end of a dipole to be as high as 8000 ohms, a kilowatt of power in the antenna would develop 3000 volts rms at the end of the dipole to drive the resonant current in a trap located there.[1] While it is difficult to estimate the actual coaxial cable trap ratings, I have tested traps made with RG-58/U at a 1-kW input power level and they held up nicely. High Q, conservatively rated traps could be made from RG-8/U cable with some increase in construction difficulty and weight. The weakest point (at which the cable might arc over if not insulated properly) is at the free end of the inner conductor, point Y, in Fig. 1. Any sharp points exposed to the air at that location require attention.

[1]Notes appear on page 17.

Traps for Wire Antennas

Figs. 2 and 3 show a trap made for use

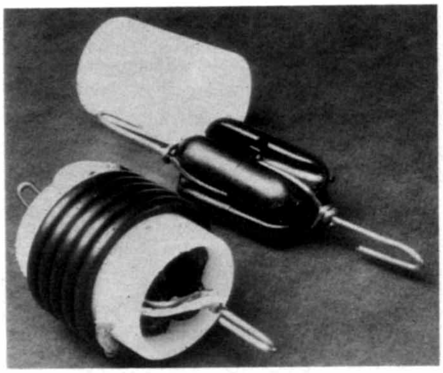

Fig. 2 — The construction of a coaxial-cable trap. Copperweld wire loops are first attached to the egg insulator. Holes are drilled in the polyethylene form to pass the cable leads as described in the text. The form is a snug fit around the insulator.

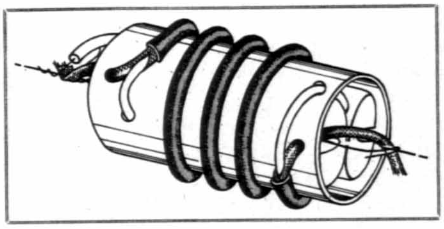

Fig. 3 — The braid of the coaxial cable is used to form the trap coil; it is soldered to the no. 14 Copperweld wire which is looped through the insulator and used for attachment to the antenna wire. At the right-hand side of the trap, the inner conductor is separated from the braid and passed through the inside of the trap. At the left end of the trap it is soldered to the braid and antenna wire, forming the cross connection. The inner conductor emerging from the coax at the left of the trap is held in place merely by means of a hole drilled through the coil form; no solder connection is made.

with a dipole, inverted V or other wire antenna. The coaxial cable, RG-58/U, is wound on a 1/8-in. (3.2 mm) wall polyethylene tube coil form 1-1/2 in. (38 mm) in diameter that is force fit over a plastic egg insulator. This assembly is lightweight, strong and inexpensive, and also helps in making the necessary cross connections. The thick-walled tubing aids in insulating the free end of the coaxial cable inner conductor.

To make a trap, several inches of the cable jacket are removed, the braid loosened, and the inner conductor and dielectric fed through a hole in the loosened braid. Two pieces of Copperweld wire should be attached to the egg insulator (Fig. 2); they furnish tie points for the antenna wire and traps, and the capacitance between them will be part of the completed trap. As shown in Fig. 3, the cable braid is passed through a hole in the polyethylene tubing at the right-hand side of the coil and is soldered to one piece of the Copperweld wire on the insulator. The center conductor passes through another hole in the coil form 90 degrees beyond the first hole and is routed through the egg insulator beside the other piece of Copperweld wire and soldered to it at the opposite end. (This is the cross connection shown in Fig. 1B.) The required number of turns of cable may be determined from Table 1. Wind them tightly onto the coil form. Once again, separate the braid and center conductor. Pass the braid through a hole in the form and solder it to the Copperweld wire (as shown in Fig. 3) at the left of the coil. A diagonal hole is drilled into the wall of the coil form and the free end of the inner conductor of the cable placed into it to provide some degree of mechanical stability and electrical isolation; this end is left unattached.

When constructing a trap, one should keep in mind that both a coil and capacitor are being formed. The cable should be handled carefully, especially the dielectric between the inner and outer conductors. The mechanical arrangement does not require soldering close to the dielectric, which shouldn't be harmed if unnecessary heating from a soldering iron is avoided. It's better to heat a joint quickly with a large iron than cook the work for a long time with a small iron.

The coaxial cable is available with either a stranded or solid-center conductor. Stranded conductor cable is more flexible and is preferred. If solid-center conductor cable is used, it will require more care and patience in separating the braid from the dielectric and center conductor because of the stiffness of the cable. The lengths of cable given in Table 1 are measured between the holes in the tubing through which the braid passes. These lengths are about 0.4 in. (10 mm) longer than that required by a close-wound coil of the same number of turns. The coils can be tuned to the proper frequency with the aid of a GDO by spacing the coil turns on the form. An adjustment range of 5 to 10% is possible.

Once the traps are tuned to the desired frequency, they should be secured in position. Tape could be used, but I suggest covering the entire trap with a weatherproofing and insulating layer such as the silicone rubber coating produced by Dow Corning. This compound is brushed on and will set overnight. It is intended as a roof-mending product, but has excellent insulating properties as well. It is available in quart (0.95 liter) sizes at most discount stores. The trap shown in Fig. 4 has been coated with this material. Silicone rubber caulking material that is widely available in tubes may also be used.

Fig. 5 contains the dimensions of a five-band trap dipole for 75 through 10 meters. It may prove to be a bit short on 75 meters since the antenna with which the measurements were made was only about 20 ft (6 m) high at the center and drooped to about 8 ft (2.4 m) at the ends. Notice that the antenna is not as short or as heavily loaded by the traps as some trap dipoles. The coaxial traps are relatively small and do not offer much loading inductance on the lower-frequency bands. This provides an advantage in antenna bandwidth, each dipole exhibiting a low SWR over almost as broad a range as a normal half-wave dipole. Trap antennas which are heavily loaded by the trap coils display a narrow bandwidth.

The reason for this loading coil behavior can be seen in Fig. 6, where the sum of all the distributed capacitance is shown as C. The inductance of the circuit is comprised of the inner and outer conductors of the coil in series. The antenna connections are "tapped down" on the outer braid half of this coil. At resonance, the trap still presents a high impedance. Below the resonant frequency of the trap, the loading coil inductance is much less (perhaps 25%) of the total inductance, producing a very small loading coil at below-resonant frequencies.

Traps for Verticals and Beams

The coaxial cable trap can be incorporated into antennas made from tubing by wrapping the cable on an insulating

Table 1
Construction Data for the Traps

Band of Resonance (meters)	On 1-1/2-in. (38 mm) form Number of turns RG-58/U	Coil length (mm)	On 7/8-in. (22 mm) form Number of turns RG-58/U	Coil length (mm)
10	3-3/4	30	6-1/2	50
12	4-1/2	30	7-1/2	55
15	5	35	8-1/4	55
17	5-3/4	35	9-1/2	60
20	6-3/4	45	12	80
30	9-3/4	60	17	100
40	12-3/4	75		

In. × 25.4 = mm

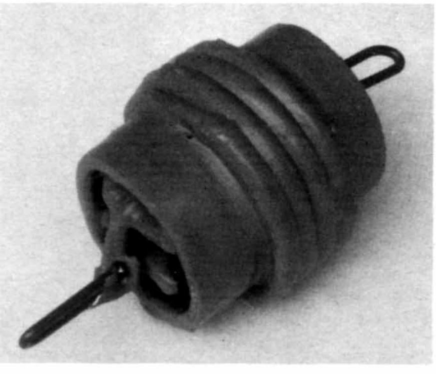

Fig. 4 — A coaxial cable trap with a silicone rubber coating.

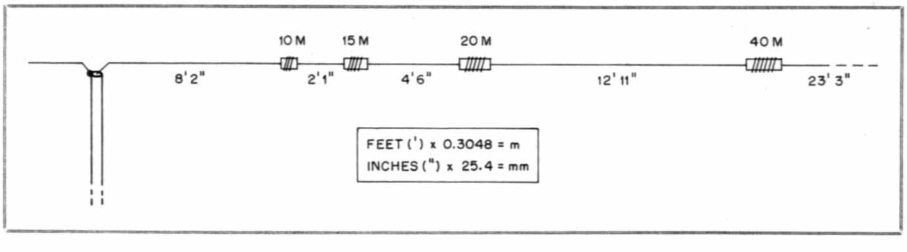

Fig. 5 — A 75- to 10-meter dipole using the coaxial-cable traps. One half of the antenna is shown.

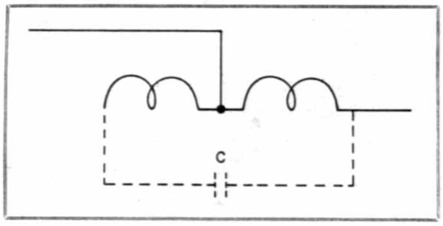

Fig. 6 — The entire coil formed by the inner and outer conductors in series is contributing to the trap inductance at resonance. Below resonance, when the trap is acting as a loading coil, only the outer braid is active, producing a much smaller effective loading inductance than that normally encountered with other types of traps.

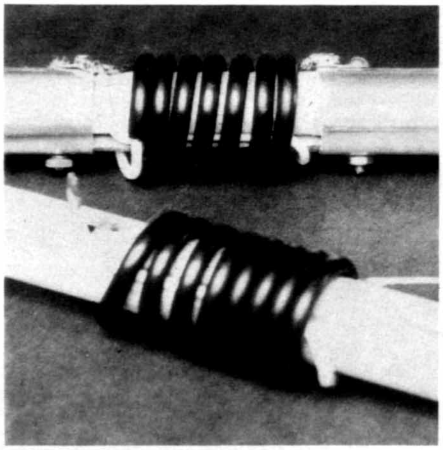

Fig. 7 — These coaxial-cable traps are wrapped on wooden dowels. The inner conductor of the cable at the right-hand side completes the cross connection at the left end by passing beneath the turns of the coil through a slot made in the dowel. The free end of the inner conductor at the left-hand end is tucked into a hole in the dowel.

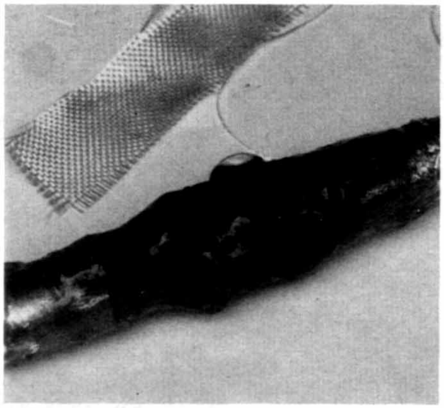

Fig. 8 — This trap has been reinforced by a fiberglass sleeve, as described in the text.

section between the tubes. A wooden insulating section may be made from rock maple dowels, which are sold in most hardware stores. Wood is a perfectly good insulating and support medium for antennas when it is protected from moisture. With modern materials like potting plastics or silicone rubber to coat the dowels, we don't have to boil them in paraffin like grandpa did.

Fig. 7 shows a trap mounted on a 7/8-in. (22 mm) dia dowel placed between two lengths of 1-in. (25.4 mm) dia aluminum tubing. Dowels that are 1/8-inch (3.2 mm) smaller in diameter than the tubing will telescope nicely, provided the tubing wall thickness is 0.058-inch (1.5 mm). Dowels can also be used to join sections of 3/4-inch (19 mm) diameter aluminum tubing and 1-1/4-inch (32 mm) diameter TV masts.

A lengthwise slot is sawed in the dowel to pass the inner conductor of the cable beneath the coil turns to make the cross connection. The braid of the cable trap is soldered to a lug that is held to the tubing by means of a bolt passed through the tubing and the dowel. Tuning of the trap is done by spacing the cable turns on the form. This should be done before attaching the tubing, as the presence of the tubing will lower the apparent trap frequency, and resonances in long lengths of tubing can be coupled to the GDO, producing confusing results.

While a hardwood insulating section secured between lengths of tubing is strong enough for beams and most verticals, it might not be strong enough to use when a 10-meter trap is mounted near the base of a large, unguyed vertical antenna. In such a case, additional strength may be obtained by building up a fiberglass sleeve around the trap and ends of the tubing, as shown in Fig. 8. Fiberglass repair kits for automobile bodies are available in auto parts stores. If you aren't familiar with the use of these materials, make a practice trap first. Since the resin is messy and has an obnoxious odor, the work should be done outdoors.

Approximate lengths for a vertical antenna can be taken from Fig. 5. Lengths for triband beam elements proved to be almost the same as those of a half-wave dipole. Start with those lengths and make the elements shorter as required. A simple 40-, 15- and 10-meter vertical using a single (10-meter) trap has been described.[2]

Amateurs are encouraged to build these traps for their own use. Manufacturers are cautioned that a patent application has been filed for these traps and all rights under the patent code will be enforced. Kits are also available from the author to aid in assembling the traps described in this article.[3] QST

[1] *The ARRL Antenna Handbook,* thirteenth edition, p. 109.
[2] Johns, "Three Band Trap Vertical," *Ham Radio Horizons,* December 1980.
[3] R. H. Johns — Scientific Instruments, 3379 Papermill Rd., Huntingdon Valley, PA 19006. Parts and coaxial cable to construct two traps for wire antennas: W10, W15, W20 — $4.90; W40 — $5.40. Parts and cable for one trap for antennas made with tubing: T10, T15 — $3; T20, $3.50. Please add $1 for postage. The ARRL and *QST* in no way warrant this offer.

Strays

TA PROFILES

☐ The talents of ARRL Technical Advisor Paul M. Wilson, W4HHK, of Collierville, Tennessee, are sincerely appreciated. He is our specialist for vhf/uhf meteor scatter, EME and related modes of communication.

Licensed as W4HHK since 1941, Paul now holds an Extra Class license, plus Radiotelephone First and Radiotelegraph First Class licenses with a Radar endorsement. His primary interests in Amateur Radio are vhf/uhf and cw. He received an ARRL Technical Merit Award jointly with W2UK in 1955 for 144-MHz meteor-scatter work, and jointly with W3GKP in 1969 for 2300-MHz EME work. Several "firsts" can be added to Paul's achievements in Amateur Radio: first 144-MHz meteor-scatter contact, first 2300-MHz EME contact, and first confirmed amateur reception of NASA's Apollo Missions on "S" Band (2.2 GHz) as Apollo X spacecraft orbited the moon (see "The World Above 50 MHz," January 1954, December 1970 and August 1969 *QST*).

Paul has written technical articles for *QST* and has been a member of ARRL since 1940. He is also a member of Army MARS, Society of Wireless Pioneers, Mid-South Amateur Radio Association and Central States VHF Society.

Retired from his position as a studio engineer with WMC-TV, Paul now has more time for Amateur Radio, photography, camping and traveling with W4UDQ, his wife, "D.B." — *Marian Anderson, WB1FSB*

TA Paul Wilson, W4HHK, stands before his towering 18-ft dish antenna.