loop antenna

receiving aid

A method for improving signal-to-noise ratio on the lower-frequency bands

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You've heard it before and it's worth repeating: "If you can't hear 'em, you can't work 'em." Most hams I've talked to or heard on the air on the lower frequencies use quarter- or half-wave antennas in vertical, horizontal or inverted-vee configurations. While these antennas do a creditable job of transmitting rf, they can be noise collectors for receiving because of their physical size and proximity to man-made noise sources.

Presented here is a scheme that uses a fet preamp or a Q multiplier with a loop antenna which is easy to rotate from the operating position and will allow you to discriminate between signals and noise. The loop is only 18 inches (46cm) on a side with two windings spaced 2 inches (5cm) apart. A complete parts list and construction drawings are included. The loop structure can be made with a few pieces of wood, and the electronics are simple and inexpensive.

loop antennas

The rotary beam, if designed properly, discriminates well between the desired signal and interference. However, not many amateurs are fortunate enough to have a rotary beam for the lower amateur frequencies. If we sacrifice some gain and use a small loop that will give reasonable attenuation on an interferring signal or noise, we'll have a desirable receiving aid. Such an antenna has been around for years and its characteristics are well documented.[1,2]

Largely ignored by today's amateurs, the loop antenna was a standard piece of equipment in early ham stations but was generally huge and cumbersome because of the low frequencies in use in those days. The loop doesn't have to be large to be an effective noise discriminator on the lower amateur frequencies in use today. The entire assembly, including antenna and preamp or Q multiplier, can be mounted on your receiver. Used properly, this combination could mean the difference between solid reception and frustration.

Loops have a pattern that exhibits maximum response in the plane of the loop and minimum response in a plane normal to the loop (**fig. 1**). Note that this response is exactly opposite to that of a quad antenna. This suggests that a small loop antenna with appropriate electronics might be useful as a noise discriminator on the higher amateur frequencies when used as a receiving aid with a quad.

receiver input impedance

A loop antenna with its tuning capacitor is a common LC circuit. It could be substituted for the tuned circuit in your receiver rf amplifier. Few hams, however, would want to make the circuit modifications. Most modern receivers use a low-impedance antenna input; and since the basic loop has a high impedance, we need a one-turn loop coupled to the large tuned loop to act as a low-impedance transformer to the receiver input. See **fig. 2**.

design examples

The first thought that might enter your mind when constructing a loop is to use the number of turns required for the lowest frequency desired, and provide taps in the winding for the higher frequencies, which is not an uncommon practice with coils. My experience using this means has proved that it is not practical. For some reason, the unused turns seem to saturate the loop, and a sharp resonance becomes hard to achieve. Also the directivity pattern becomes questionable. I've found that it's better to wind two separate loops on the same frame, with the most spacing you can provide between the two windings, e.g., about 2 inches (5cm) will provide excellent performance. I've also found that as far as the LC ratio is

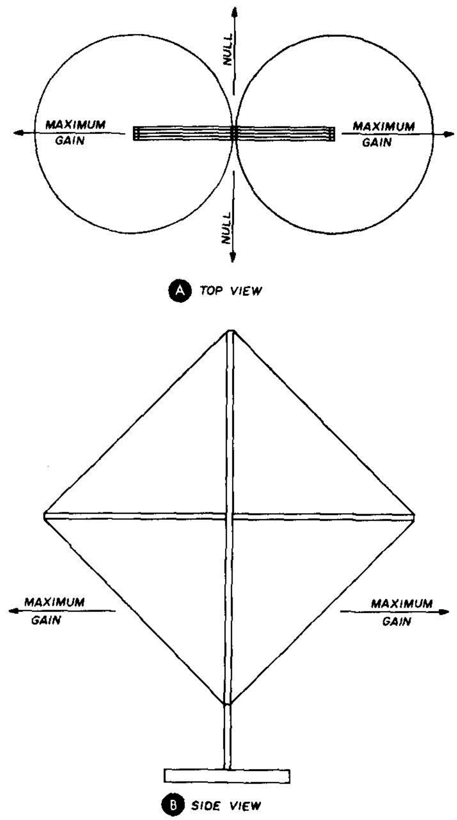

fig. 1. Loop antenna field strength patterns.

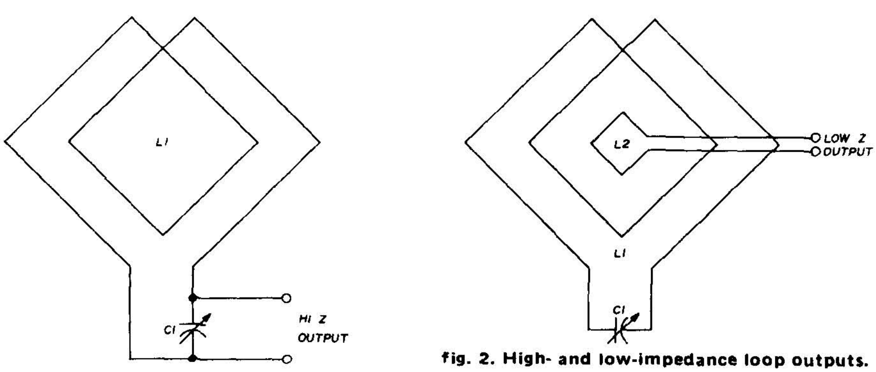

fig. 2. High- and low-impedance loop outputs.

concerned, the higher the capacitance (within reason), the more effective the loop performance.

An example of this is the loop that I will describe. It is approximately 18 inches (46cm) on a side and contains two windings spaced 2 inches (5cm) apart. One winding consists of two turns spaced 1/4 inch (6.5mm) and covers 40 and 80 meters. The other winding consists of 5 turns spaced 1/4 inch (6.5mm) and covers 80, 160 and the high end of the broadcast band. With this arrangement, the loop is more effective on 80 meters using the 2-turn loop with high capacitance than the 5-turn loop with low capacitance.

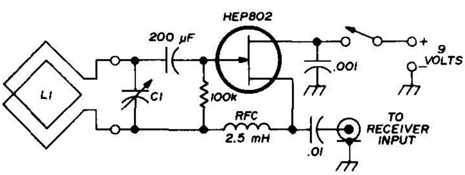

fig. 3. Fet preamp for the loop antenna.

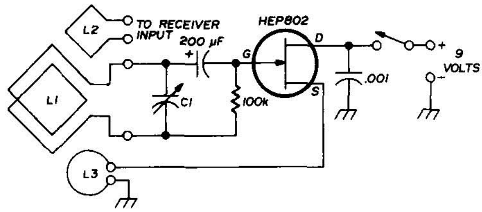

fig. 4. Loop antenna with Q-multiplier. Regeneration control is by means of L1, L3 coupling.

Loop with preamp input. While the loops performed satisfactorily in their basic configuration, as my first experiment I decided to add an rf amplifier using a solid-state device, and the circuit of **fig. 3** evolved. Here the loop is connected to the gate of an HEP-802 fet and output to the receiver is taken from the source. Results were good, but I felt that the null could be improved, perhaps by increasing circuit Q.

Loop with Q-multiplier input. Recalling the principles of the Q multiplier, I decided to substitute such a circuit for

table 1. Parts list for loop antenna.

item	quantity	description	dimensions	use
1	4	wood strip	1/2 x 3/4 inch	loop frame
2	3	support	fig. 6A	loop wire
3	1	support	fig. 6B	bottom loop wire
4	2	loop frame brace	fig. 5	feedback loop L3
5	1	base	to suit	loop support
6	2	support bracket		loop frame
7	2	angle bracket		
8	2	circuit board	3 inches (76mm)	fig. 3 and 4
9	1	wood dowel	see text	feedback loop L3 support
10	1	wood strip	see text	support for ends of L3

The variable capacitor I use came from an old BC set. I wired its two stators in parallel and assume it has a maximum capacitance of 600 pF. I use a small dpdt switch to select the desired loop.

the fet preamp (see **fig. 4**). Feedback control is obtained by an adjustable loop of wire, L3, coupled to the loop, L1. Receiver input is taken from L2. By rotating L3 within the field of L1 the desired amount of regeneration can be

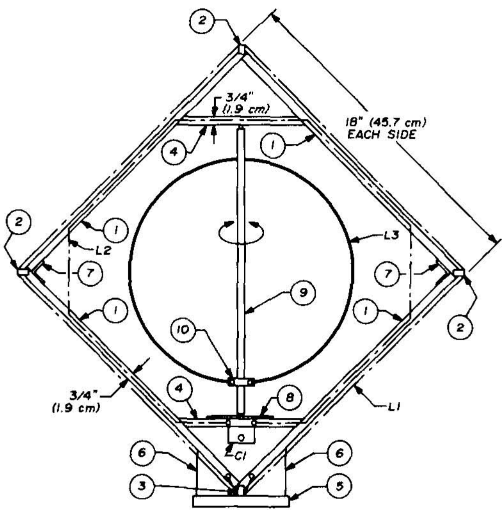

fig. 5. Construction details. Circled numbers refer to table 1. L3 and pieces 9 and 10 are required only if a Q multiplier is used.

obtained, circuit Q is improved, and the null is much more pronounced. Better control is obtained for separating noise from the desired signal.

Note that a loop antenna can also be used as an absorption wavemeter. When using it with solid-state devices beware of placing the loop in a strong rf field.

construction

Fig. 5 and the parts list (**table 1**) should be self-explanatory. The basic loop contains two windings: a two-turn loop for 40 and 80 meters and a 5-turn loop for 80, 160 and the high end of the broadcast band. Four turns can be used if operation on the broadcast band is not desired.

The structural support for the loop wire is made from two strips of wood fashioned in a cross. The simplest winding is made by starting the wire from the outside, winding around and around, to the inside. The wire is supported on the cross arms with tacks or notches. The size of the frame, number of turns, and spacing will be determined by the desired frequency coverage.

Another winding pattern is made as a large, square-shaped, wide-spaced solenoid. In this case, short strips of wood are required at the appendage of the supporting arms, with notches to support the wire. Here again the size, number of turns, and spacing will depend on the frequency range desired.

Incidentally, there is a school of thought that reasons as follows: Since the maximum gain of a loop antenna is in the plane of the wires, a loop wound in a wide-spaced solenoid configuration and mounted in a diamond position (points of the square top and bottom) will have a better capture area. While I can't prove it, I am inclined to agree.

Since the wire is the only important element of a loop, the basic construction of the frame can be left to your ingenuity and materials on hand. The frame, of course, should be made with insulating material. I suggest that the wood frame be painted with coil dope.

Fig. 6 details the loop wire support arms. Note that one extra notch for wire is required in the bottom arm due to the winding pattern. I formed the notches in the support arms in the following manner. I drilled the required number of holes in the arms on a line

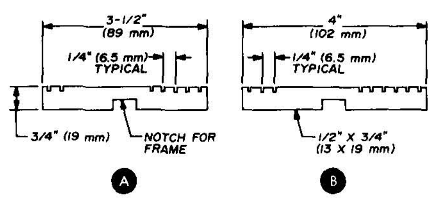

fig. 6. Loop wire support arms.

about 1/8 inch (3mm) in from the outside edge, then clamped the supports in a vise and cut slots into the holes with a hacksaw. Next I folded a piece of sandpaper and widened the slots to suit the wire size. A piece of string a little larger than the wire diameter, rubbed over a candle and worked into the slots, made it easy to obtain proper tension in the loops when securing the ends.

The feedback-loop support dowel should be cut 1/4 inch (6.5mm) shorter than the space between the supports. The ends of the dowels should be drilled on the vertical centerline to take a short length of heavy wire. This wire should project 3/8 inch (9.5mm) at the top and 1/8 inch (3mm) at the bottom. The supports should be drilled at their centerline to accept the wire. The dowel is inserted into the top support first, then swung in to the bottom support hole. Rotation to obtain proper feedback is by manual adjustment. In constructing the loop frame, I cut all pieces to proper length and shape, then assembled them using *Pliobond* cement and a few brads.

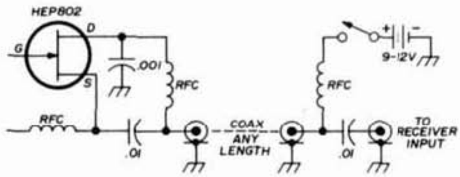

fig. 7. Suggested power feed for a remote loop with fet preamp.

Fig. 7 is a suggested circuit to supply power to a loop antenna preamplifier through the coaxial transmission line when the loop is in a remote location. I suggest that the voltage drop that might occur in the two rf chokes be checked and, if warranted, the voltage increased.

references

1. Frederick E. Terman, *Radio Engineers' Handbook*, McGraw-Hill, New York, 1943, page 813.
2. Keith Henney, *Radio Engineering Handbook*, McGraw-Hill, New York, 1959, pages 3-26, 19-7, 19-21, 19-116, 19-184.

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