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CONSTRUCTION OF A 'BOX' LOOP ANTENNA

These plans are adapted from an article printed many years ago in the DXing Horizons magazine (no longer printed), written for the National Radio Club by Dan Phillips K4FMR and Vic Patton WN4OXL, and amended by useful suggestions from David Fisher and Chuck Sadoiau.

The advantages of the use of a directional loop antenna are many. Best known is the directional property. Stations which are not collinear (that do not form a straight line intersecting the point of reception) can be selectively nulled. This property is best demonstrated on stations at right angles to each other, or 90 degrees from reception point. By pointing the loop at one of the stns, it will be received with maximum signal while the other will have its minimum signal. Points of null and maximum signal are 90° apart on a properly constructed loop. Next, for stations which are collinear, the nulling (minimizing) effect is greatest on stns closer. Therefore, the weaker of 2 stns in the same direction can be better received by nulling the stronger stn if the stronger one is appreciably closer. This little known property is especially useful on locals. Next, the loop antenna adds to the selectivity of a receiver because the capacitor tuning the loop is quite selective. For this reason, the capacitor must be re-tuned every time the frequency is changed. This property greatly cuts down slopover. Depending upon the size of the loop built, it will generally have less gain than a good long-wire antenna. However, the additional gain on most communications receivers will more than compensate for this. Also, because of its directionality, noise is reduced about one-third more than the signal being received. For this particular box loop (4-foot), the gain is approximately equal to a well constructed 50 foot long-wire.

The plans presented here are for a box loop antenna which will cover the entire standard A.M. broadcast band (540 - 1600 kc/s) or, with minor alteration, can be made to do so. Loops of other sizes can be made using the same principle. The amount of wire affects the frequencies the loop will tune so loops of other sizes may require capacitors (variable) of difference capacitance. One rule to bear in mind; the larger the loop (the more wire used), the higher its gain.

The first thing to do is to study carefully the drawing on the fourth page of these plans. After all the parts are constructed and put together (except the wiring), the most important things remains--the wiring of the loop. If not wound according to instructions, the loop will not work properly. The hardest thing to keep in mind is the fact that the major portion of the wire is NOT connected directly to the receiver but inductively (indirectly) coupled by the one-turn link. It is the one-turn link that should be connected to the antenna and ground terminals of the receiver. The major winding is connected to and tuned by the capacitor.

In winding the loop, take about 180 feet of #18 stranded insulated wire (#'s 18, 19, 20, 21 are best; be sure it is stranded and insulated wire) and start winding from the bottom of the loop leaving plenty of wire with which to connect to the capacitor. Thus the wire is started at the connecting board (where the capacitor is mounted) and wound on either side notch of one of the bottom notch-plates. Then the wire is wound up to the same notch on the notchplate above it. Likewise, the wire should be wrapped around and around all nine notches and back to the capacitor mounting board by way of the notchplate on the bottom of the loop and opposite of the one on which you started. This main winding (one continuous wire with nine turns) is connected to the capacitor which is mounted on this connecting board.

Then, the very important one-turn link is added. Allowing plenty of wire for connecting to the 300 ohm line, connect the one turn link to one of the two remaining holes on the capacitor mounting board, wrap it around the center notch of each of the notchplates and back around to the last hole on the mounting board.

In connecting the main nine-turn winding to the capacitor, be sure you connect it properly. The most common mistake made in building both box and spiral loop antennas is incorrectly connecting the capacitor. Many a good loop is discarded because the capacitor is not made part of the circuit by connecting (incorrectly) both wires to two of the terminals on the capacitor. These terminals are common to each other and this method of connection isolates entirely the capacitor from the circuit. One wire should be connected to one of the terminals but the other must be connected to the chassis of the capacitor. If no terminal is provided, it will be necessary to solder to the side of the capacitor. The location of this connection is not critical as long as it does not interfere with the turning of the rotor blades of the capacitor.

To make the final connection to the receiver, take enough 300 ohm TV lead-in (RG59U coax is probably the best but not readily available and is rather expensive) to connect the one-turn link (truncated at the capacitor mounting board) to the receiver. On receivers with two terminals, an A- or antenna terminal and a G- or ground terminal, one side of the 300 ohm line is connected to each of the terminals. It makes no difference which one is connected to which terminal. For receivers having three terminals, one side is connected to the A- or antenna terminal and the other to the remaining two terminals (sometimes designated G- and Z- terminals). The connection to G- and Z- terminals can be made by connecting one side to either of the two terminals and connecting the two terminals with a tiny piece of wire. A little experimentation might be useful on receivers with the 3 terminals in case some alternate method is determined more beneficial. For receivers with one terminal (antenna only), don't panic and decide a loop antenna can't be used. Connect one side to the antenna terminal and (bearing in mind that the chassis of a receiver is ground) the other side to the chassis by soldering or by a screw.

For receivers with built in loopstick antennas or other such built-in antennas, the box loop can often be used to inductively tune this built-in antenna without any connection at all. In this manner, it can be used with interesting results on transistor radios (the small portable hand-held type).

Another interesting thing is to combine the box loop with the IRCA spiral loop. With the IRCA spiral loop built and connected in the usual manner, the box loop can be placed nearby and, with no connection, used to inductively tune the IRCA spiral loop. With this method, stns can be heard under very strong locals where the use of either antenna alone would not be sufficient. Such coupling is difficult for maximum results and every minute twist and turn of the box loop will result in radical changes in the received signal.

Permanent mounting of the box loop can be a problem. Because of its size (the one described herein), it is not too convenient no matter how much space you have. If quarters are very cramped, the problem is severe. Two common methods of mounting are (1) in a pipe which is mounted in a wood block and, (2) hanging from the ceiling (where this can be achieved without damaging the ceiling). By hanging it from the ceiling, if done properly, the antenna is not as much in the way and turning it can be less difficult. The obvious alternate to a large, cumbersome box loop (with its higher gain because of its size) is either a small box loop (anyone have wire sizes, capacitor value, etc. for a good 2' variety???) or the IRCA spiral loop which can be used quite conveniently almost anywhere. As an aside, a spiral loop of the size of the box loop described here can also be built. Its gain is similar to the box loop of the same size but is built in an entirely different manner. The IRCA spiral loop plans call for a 2' loop. By using longer dowels, it can be made much larger. The spacing between the wires is not changed (it remains ½") but the winding just continues until you reach the desired size. The theory of size versus % of nulling effect isn't known by this writer; maybe someone will comment. Is there a point at which there is no use in making either a box or spiral loop any larger?

Once again, remember when using the loop (any loop) that every change in frequency requires re-tuning the capacitor for maximum gain. And the capacitor should have a very sharp null. If not, the connection of the capacitor may be wrong or the coupling of the one-turn link and the main winding may not be proper.

If the antenna fails to cover part of the standard A.M. broadcast band spectrum, this can be compensated for by changing the value of the capacitor. Changing the amount of wire (the usual method when constructing spiral loop antennas) is, of course, more difficult. However, these plans have been tested and with the sizes given, performance should be proper over at least most of the band. By using a two-gang variable and using a slide switch to connect or disconnect at will the two gangs, one capacitor can be used to tune all parts of the band as well as parts below and above the 540 - 1600 kc/s portion of the band. In doing this, one gang of the capacitor would be in the circuit with the slide switch in one position and both gangs in the circuit with the switch in the other position.

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PARTS LIST

1 365 MMF Variable Capacitor (one or more gangs; connect just one gang if a two- or three-gang variable is used and only one gang is needed; don't connect to the terminal of one gang and the ground of another gang)

200 feet of number 18, 19, 20, or 21 stranded insulated wire

5 feet of 300 ohm TV lead-in (easily obtained at any radio-TV shop) (more or less may be used depending upon how far apart the receiver and loop are)

2 58" long pieces of 1" x 1" strips of wood for crossplates

1 36" length of same for center of loop to the base

16 one-quarter inch bolts each about 2 - 2½" long
16 washers and nuts to connect to the bolts

1 capacitor mounting board, 3" x 3" of ½" plywood, this is mounted at the bottom of the loop

4 plywood end plates (notchplates) (see insert A)

1 center plate of 6" x 6" piece of plywood, about ½" thick

OTHER REFERENCES

IRCA spiral loop antenna plans - directions for construction of a 2' spiral loop antenna, A1.

Direct-coupled loop plans (in connection with these plans) written by Dave Fisher, A3.