N.R.C. ANTENNA REFERENCE MANUAL

3RD EDITION — MAY 1978

This is the first of what we hope will be a series of reprint reference manuals, each devoted to a different subject area of medium wave DX'ing. Most of the articles herein first appeared in DX NEWS and have since become a part of the NRC Reprint Service. Several have been updated for inclusion in this manual. Every effort has been made to include the most popular and the most generally useful articles herein. We wish to thank the following authors whose works go to make up this manual: Gordon P. Nelson, Dave Fischer, Russell J. Edmunds, Don Kenney, Tom Sundstrom & Jerry Starr. ** NJPC

The NRC has numerous other articles dealing with the subject of antennas. Those which have appeared in DX NEWS are generally available through the NRC Reprints Service. A copy of the complete listing of available reprints may be obtained by sending a self-addressed, stamped envelope to NRC Publications Center, P.O. Box 401, Gales Ferry, CT 06335. Other articles, generally the work of non-members and professional researchers, are more technical in nature, and are available through the NRC Monographs Service. Address enquiries to the Publications Center. The NRC also publishes many other useful materials for medium wave DX'ing. For a copy of the NRC Information Packet, and a sample bulletin, write to NRC Membership Center, P.O. Box 118, Poquonock, CT 06064.

Membership in the NRC is open to all interested medium wave DX'ers. Dues, which help to defray the costs of club operations and the publication of DX NEWS, the club bulletin, which appears 30 times a year, are $15.00 in the United States and Canada. Foreign rates are available upon request. A $1.00 one time fee is charged for all new members to cover the costs of processing the application. Membership also entitles the DX'er to a free copy of "Getting Started in Medium Wave DX'ing", which normally sells for $1.25. Address all enquiries to the Membership Center , address above.

NRC also publishes the Receiver Reference Manual, containing many articles on the subject of receivers. Cost is $2.50 postpaid, from the Publications Center, address above.

for the National Radio Club, P.O. Box 32125, Louisville, KY 40232

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FET ALTAZIMUTH LOOP ANTENNA

The loop antenna is particularly suited for MW DX'ing for a number of reasons: (a) Because it is a magnetic antenna, it will actually pick up less local electrical noise than a long-wire antenna with equal signal pickup. (b) Because a properly designed loop antenna is actually a tuned circuit, the antenna selectivity will greatly reduce spurious and overload effects from powerful local stations. (c) The directional pattern of the loop antenna often permits separation of distant stations on the same frequency. (d) The null of the loop pattern can be used to greatly reduce the pickup from local stations. (e) A good loop antenna can serve as a simple but highly accurate direction finder to aid in the location and identification of distant MW stations.

While loop antennas have been used by MW DX'ers for many years, loop design has progressed very little since the 1930's; the loops commonly in use today all suffer from the same basic design limitations: poor nulling of local stations, relatively low signal pickup, broad low Q tuning characteristics, and distorted pickup patterns which produce unreliable direction finding.

The antenna described in these plans* incorporates a number of new features stemming from the author's extensive experience with the theory and design of magnetic antennas. Properly constructed, this 35 inch square antenna will provide signal output equivalent to many 100 foot long-wires, but with considerably less local noise pickup. The use of totally balanced geometry and circuitry eliminates "vertical effect" - the most common cause of poor performance in other loop designs. The exclusive "altazimuth" design permits the user to compensate for polarization wave tilt from local signals, thus providing remarkably deep nulls on local stations; in many locations it will be possible to totally eliminate pickup from locals, thus permitting the DX'er to log distant DX stations on the same channels as locals! The physical and electrical characteristics of this antenna have been very carefully chosen to provide maximum signal pickup and tuning selectivity without imparing the tuning range; the use of a special low-loss tuning capacitor with linear characteristics eliminates "top band bunching" and provides unusually easy tuning.

The Field Effect Transistor amplifier was designed especially for this application. In addition to supplying more than 25 db of low noise gain, the use of balanced input circuitry and FET's featuring unusually high input impedance reduces tank loading to an absolute minimum; as a result, both output voltage and tuning sharpness are extremely high compared with ordinary designs. Balanced cross-neutralization provides for unusual stability and permits relatively careless construction practices. The special low-capacity feedline described within provides total elimination of "vertical effect" with minimum losses; the Q-gain control permits the operator to control the output voltage of the loop over a wide range to meet all possible signal environments - from the shadow of a 50 kw local to the quietest Monday morning of the year.

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*While this antenna is primarily designed to be used with the balanced FET amplifier described within, only a few changes are needed to permit operation without the amplifier - the basic design remains unchanged. Omission of the special amplifier will reduce signal pickup and tuning sharpness; the ability to null local stations, reject local electrical noise, and make DF measurements will not be affected if the amplifier is omitted however.

(B)

PARTS NEEDED FOR ALTAZIMUTH LOOP

WOOD:

A. Cross arms (3/4" x 1-5/8" stock; total of 8' needed)
B. Tilt arms (1-1/4" x 1-1/4" stock; total of 4' needed)
C. Mounting shaft (1" dowel; 36" long)

PREFERABLY ¼" PLASTIC; PLYWOOD ACCEPTABLE HOWEVER:

D. Arm plates (3 identical)
E. Terminal arm plate (one needed)
F. Center braces (2 identical)
G. Spreaders (8 identical)
#H. Terminal block plate
I. Tilt lock plate (one needed)

MUST BE PLASTIC:

J. Capacitor mounting plate (need one)

> ¼" polystyrene is available in foot-square sheets from sources such as Lafayette, etc.; the relatively high price makes it desirable to obtain the small pieces needed locally.

K. Tuning capacitor, 325 pfd linear wavelength; Hammarlund MC-325-M,

L. Tuning range switch, miniature toggle;
M. Tuning range capacitor, 200 pfd, dipped silver mica;
N. Q-gain control, 2 megohm, log taper; Mallory Migetrol U55;
O. Tank coil, #12 gauge stranded wire, plastic insulation (125' needed if FET amp used; 100' if amp omitted); available commonly in 100' spools
#P. Link coil, #14 gauge hookup wire, plastic insulation (25' needed)

Q. Tuning shaft extenders (2 needed), 6" brass, ¼" diameter;
R. Tuning shaft couplers (2 needed), ¼" to ¼";
S. Plastic knobs, ¼" shaft (2 needed)
#T. Terminal strip, 3 connection, Cinch-Jones Series 164;

U. FET amplifier
V. Transmission line; 2 pieces of air-cored, low capacity cable; this type has no RG designation is is used only for automobile antenna leads; 36" universal extension lead;
W. Setting circle, 360° protractor; available from drafting supply store
X. Bearing pointer (stiff wire, etc.)

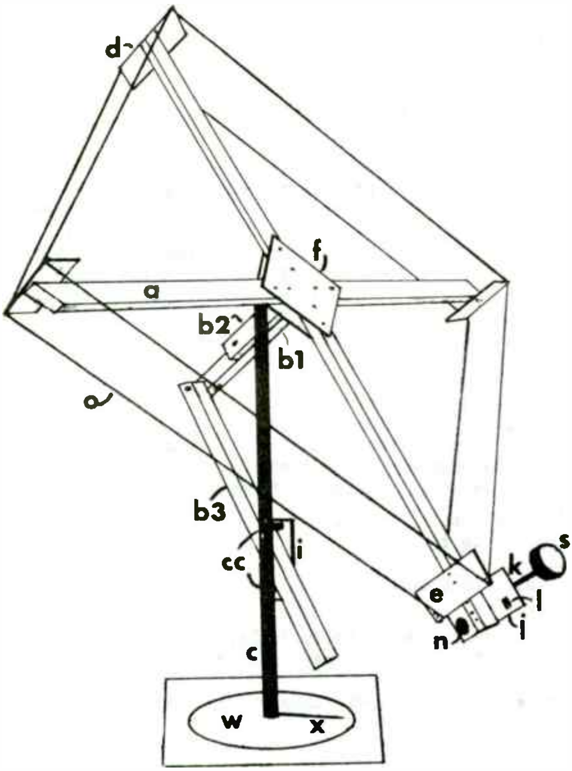
AA. Bearing angle
BB. Tilt angle
CC. Tilt angle lock nuts

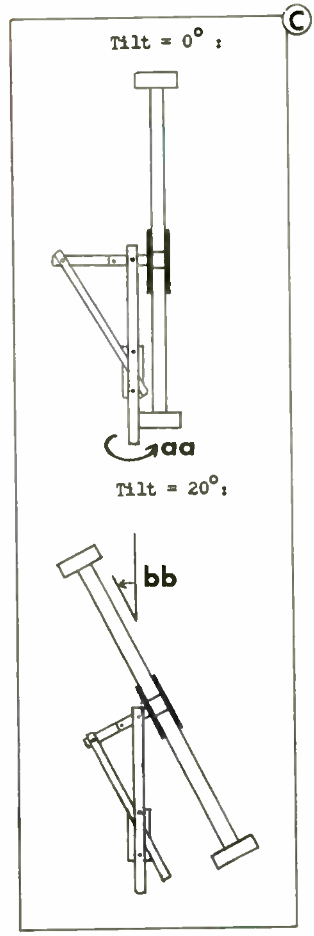
<u>Small parts not shown on Figure 1</u>

8 1/4" machine bolts, 1-½" long, with wingnuts and washers
3 1/4" machine bolts, 2-½" long, with wingnuts and washers
2 1/4" machine bolts, 3" long, with wingnuts and washers
1 1/4" machine bolt, 3-½" long, with wingnut and washer
16 Number 6 round headed wood screws, 3/4" long
2 Number 6 machine screws, 3/8" (to mount tuning capacitor)
2 Solder lugs, #6 hole
#4 Number 6 machine screws, with nuts (for terminal strip)
1 Number roundheaded wood screw, 1-½" long (brace to tilt arm)

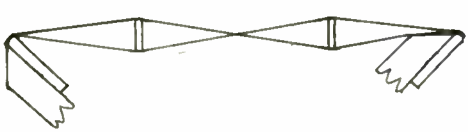
# indicates a part needed only if amplifier not used

Hammarlund Tuning Capacitor, & Mallory Q-Gain Control available from G. R. Whitehouse & Co., Newberry Dr., Amherst, NH 03031. Other parts from your local supplier.

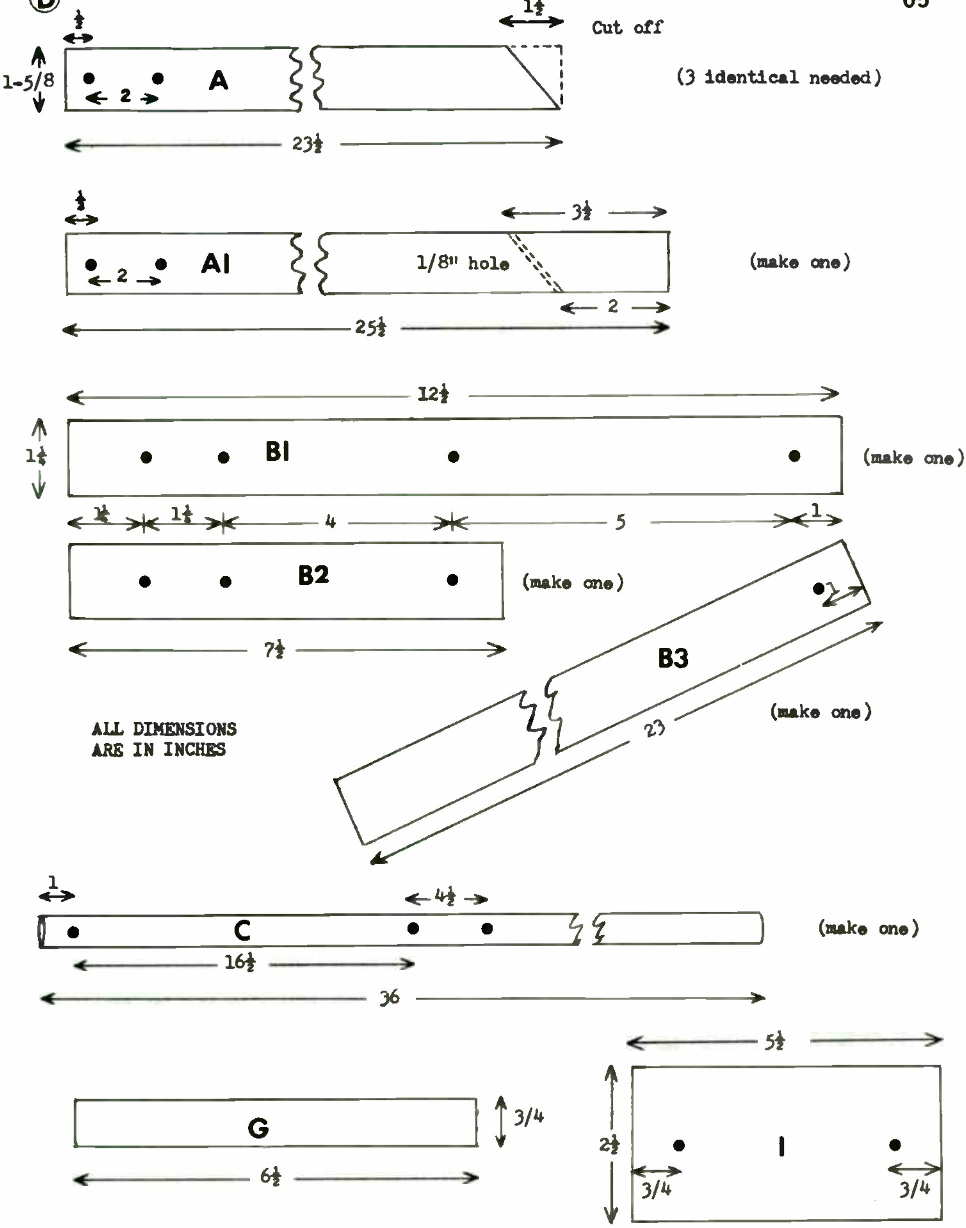




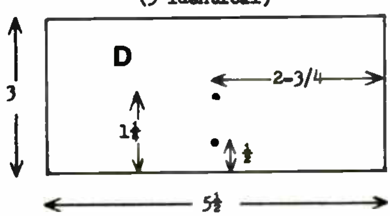
Altazimuth loop set at about 20° of tilt. Only the end turns of the winding are shown and the spreaders are omitted for simplicity. The two holes which would be used to mount either the FET amplifier chassis or terminal block (if FET's are not used) are visible below plate "e". The two wingnuts on plate "i" are used to look the loop in a tilted position.

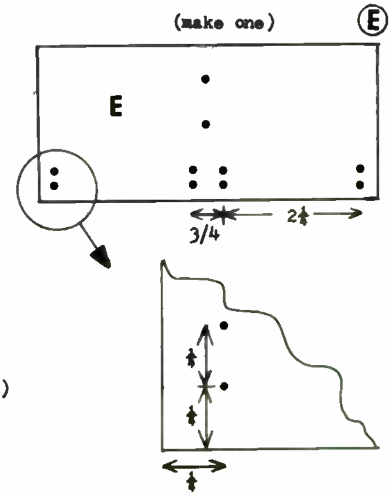


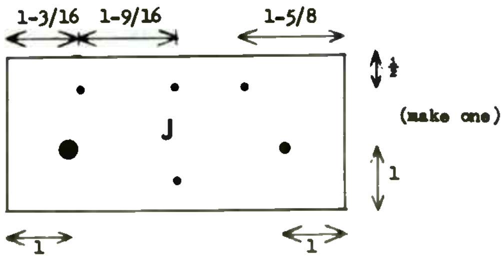
Side view of winding on one side of loop, showing the spreaders which have been "woven" through the windings and then twisted.

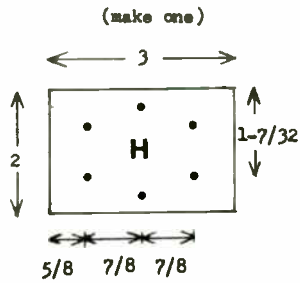


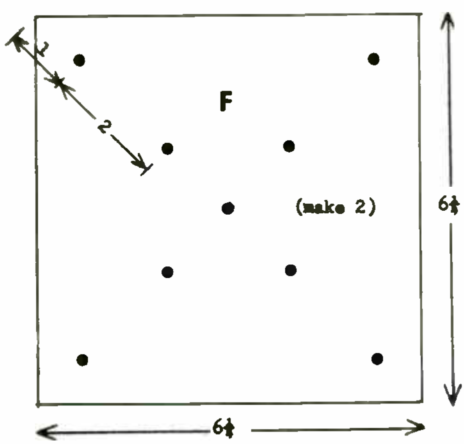
All holes shown on this page are ¼"









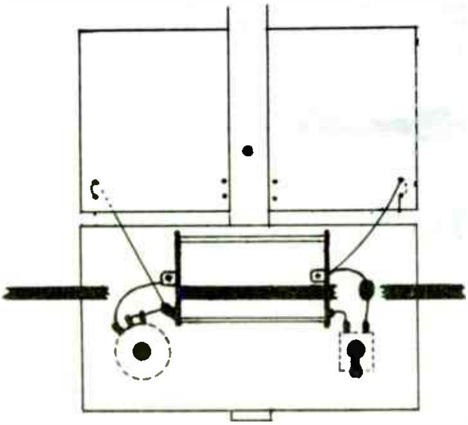


• = 1/8" hole
• = 1/4" hole
● = 3/8" hole

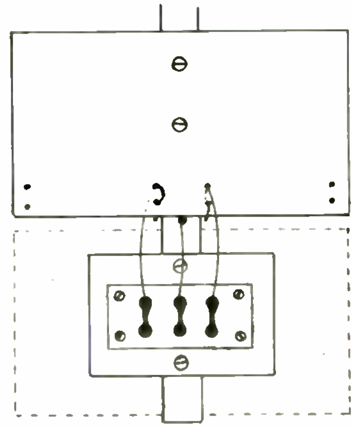
FEEDLINE. Cut plugs off extender leads and pull out the fine wire inside; replace with fine insulated hookup wire. The exact size is not important but the finer the better. Strip back insulation on each end, and untwist about 1" of shield. Twist the shields together at one end; tape the cables together every 6" or so along their lengths. Cut the far ends so they are even and connect shields together after stripping back 1" of insulation. Carefully cut off a patch of insulation on each cable a foot from each end and solder the shields together.

F

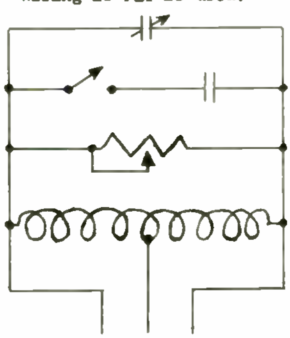
Terminal arm plate and tuning capacitor & Q-gain wiring



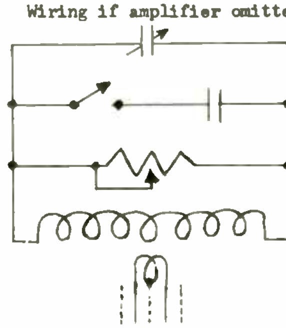
Terminal arm plate seen from other side with terminal block



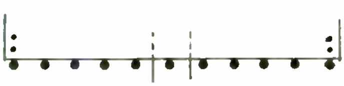
Wiring if FET is used:



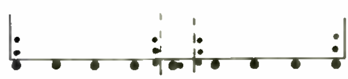
Wiring if amplifier omitted:



Terminal plate wiring if FET used:

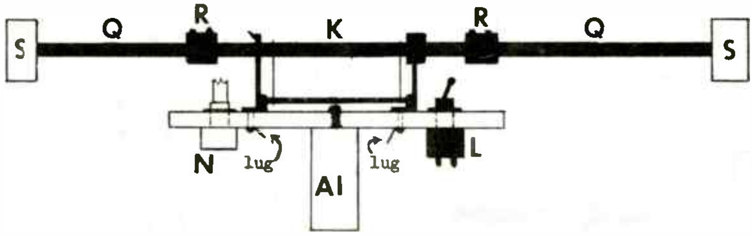


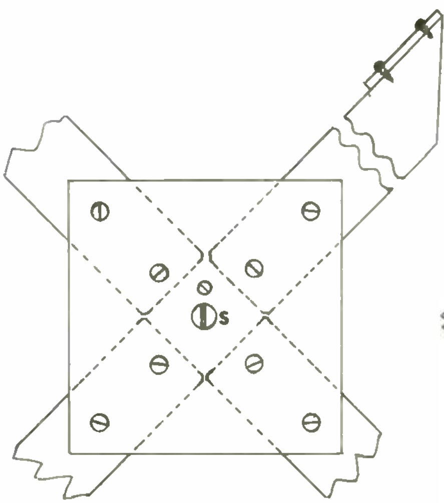
Terminal plate if FET omitted:



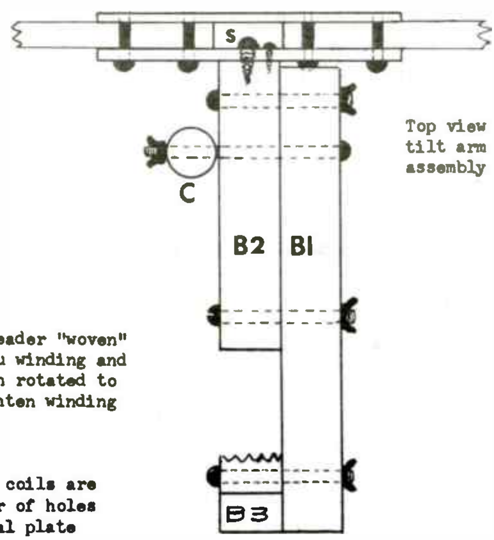
Wiring instructions: fasten wire to one end of terminal block by weaving in-and-out of holes as shown on previous page. Wind half of tank coil, keeping wire tight and straightening out bends and kinks as you go; feed remaining wire through the hole in the arm and finish winding. Note that both 8 and 10-turn tanks are symmetrical, with the center winding passing through the arm-hole; the same is true of the link coil. After winding is completed and has been tightened up, "weave" the spacers through the winding (over, under, over, etc.) and twist spacer 90° - this tightens up the winding and reduces the distributed capacity.

Tuning capacitor assembly viewed from underneath, showing extended shafts, range switch, and Q-gain potentiometer. Note that the tuning capacitor has only one terminal with a solder lug (on top); the second connection to the capacitor is made to the solder lugs on the mounting screws underneath as shown.



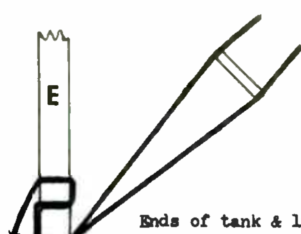


Side view of center plate assembly. The heavy screw marked "s" mounts the loop frame onto the tilt arms; a second smaller wood screw slighly off to the side will prevent the face from working loose. Note that screw "s" must be fastened to B2 before bolting center plates together!



Top view of tilt arm assembly

side view



spreader "woven" thru winding and then rotated to tighten winding

to tuning capacitor

Ends of tank & link coils are fed through the pair of holes on bottom of terminal plate

BALANCED FET AMPLIFIER FOR ALTAZIMUTH LOOP ANTENNA

This amplifier, like all similiar high gain RF circuits, can oscillate or show other signs of feedback instability if carelessly constructed with overly long leads. The cross-neutralizing capacitors in this circuit should help to eliminate any such problems and the unit should operate properly the first time if the instructions are followed carefully.

T1, T2	2N4416A Type N Field Effect Transistors, p referably a matched pair. Made by several companies, including Texas Instruments and Crystalonics (need 2)
R1, R2	5 Kohm dual potentiometer, linear taper; IRC 46E1890C, Type 45 D502 MD502 16
C1-C5	0.01 mfd, 75 volt microminiature capacitor.
L1, L2	10,000 microhenry miniature shielded coil, Nytronics WEE-WEE 10,000; J.W. Miller #9250-106 (need 2)
C6, C7	miniature trimmer capacitor, 1.5-7 pfd; ERIE type 503-000 10A, (need 2)

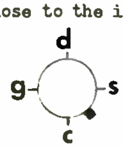
1 Aluminum minibox, 4" x 2-1/8" x 1-5/8", AMC type 1002,
1 Sheet of Vectorboard;
1 Package of Vectorpins;
2 Transistor sockets, 4 pin printed circuit type;
4 Solder lugs, Number 6 hole (see loop parts list)
6 Insulated feedthrough terminals, Number 6 hole

PARTS FOR OPTIONAL BATTERY CONDITION METER

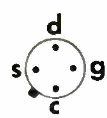
1	Milliammeter;
R3, R4	10 ohm resistor, ½ watt (need 2)
R5	12 ohm resistor, ½ watt
C8	0.01 mfd, 75 volts (see above)
1	Switch, any type

BUILDING INSTRUCTIONS

1. Drill holes in chassis box as shown in diagram.
2. Scribe the Vectorboard on a 9 hole by 9 hole square with a sharp knife and break out piece to serve as amplifier mounting.
3. Wire the bias control pots and leave about 3" of hookup wire to be connected later; mount pots in box as shown.
4. Mount the input and output terminals as shown.
5. Now wire the Vectorboard. Lay out the parts on the board in roughly the same relative positions as on the schematic. Push 3 pins into board on input and output edges as shown; these pins will line up with the input and output terminals on the chassis when the board is put into the box.
6. Mount transistor sockets on board in position shown by pushing socket pins through board and bending over on far side. Note that the gate pins on the sockets will be very close to the input pins on the board.



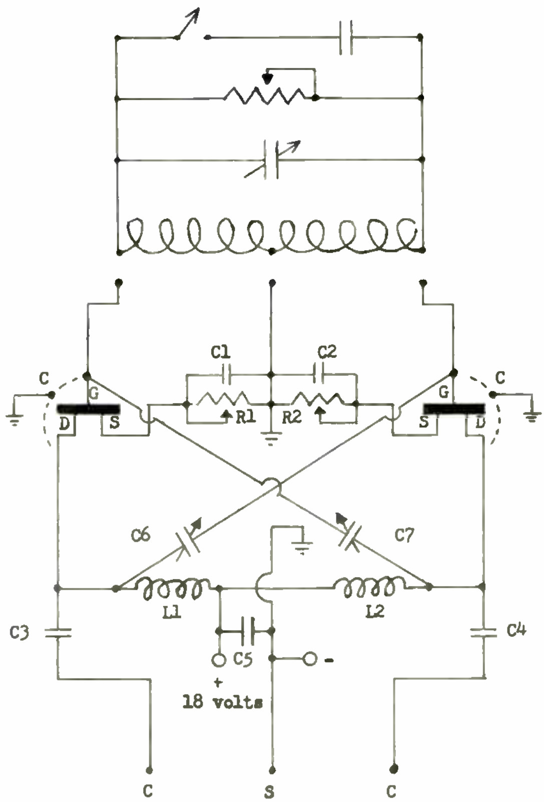
2N4416A FET leads viewed from above

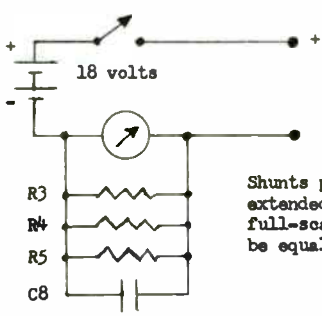


Viewed from under-side

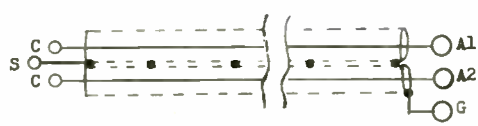
2N4416A loop amp FETs in matched pairs are available from Gerald Koske, 10204 Thayer Rd., RR #1, Ringwood, IL 60072 to MEMBERS ONLY for $8.00 per set. Unmatched FET's may be purchased through your local supplier.

Parts R1,2; L1,2; C6,7 available from G. R. Whitehouse & Co., See p. 3.





Shunts produce an extended meter range; full-scale will now be equal to 20 mA.



Double balanced feedline is run from FET output to receiver as shown above.

7. Mount the remainder of the components on the board as shown; parts with dotted outlines are on the under-side of the board. Push pins into board wherever needed to support the component or to pass through from one side of board to the other. Leave installation of the cross-neutralizing capacitors (C6 & C7) until last. Keep all leads as short as possible; in most cases no hookup wire is needed, the com component leads will be long enough to reach by themselves.
8. Since the neutralizing capacitors run diagonally across the board, their leads must pass over the rest of the circuitry. They must be mounted in a position such that the adjusting screws can be reached through the holes in the chassis box (A and B), and one terminal of each capacitor must be firmly soldered to a Vectorpin so that the capacitor won't rotate when it's adjusted.
9. Slide the board into the chassis box under the protruding input and output terminals; the terminals should then line up with the corresponding pins on the board. After checking to make certain that the neutralizing capacitors are lined up with the adjustment holes, solder the terminals to the board pins. From here on, anything that has to be done on the "down" side of the board will require that these 6 terminals be unsoldered - so don't install the board too early!
10. Connect the leads from the potentiometers to the appropriate places on the top of the board; trim the leads to the shortest possible lenth. Also connect the wires for the battery to the board; used a twisted pair of hookup wire.
11. Now comes the only tricky part: installing the FET's in their sockets. Study the positions of the transistor leads as shown very carefully. Bend the leads on each transistor very carefully into a pattern that will permit them to be plugged into the sockets as shown. Trim the leads so that they'll be as short as possible without shorting when the transistor is seated. At this point it is very easy to make a mistake with the lead positions so go very carefully. This completes the assembly of the amplifier.

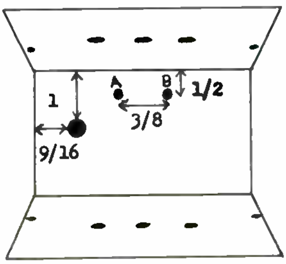
TESTING THE AMPLIFIER

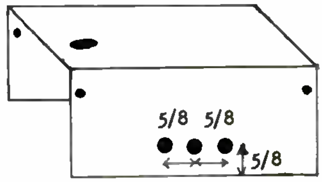
After the amplifier has been completed it is wise to check it out before connecting it to the loop or beginning the neutralization procedure. These checks can be omitted if you never make errors - or they'll have to be skipped if you don't have the equipment. The worst that can happen is a burned-out FET, fortunately.

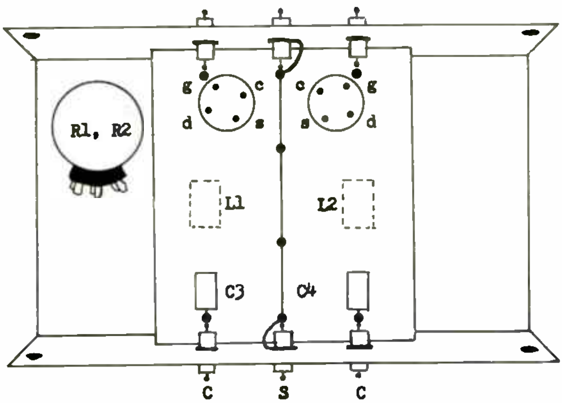
1. With battery power disconnected, measure the resistance from each of the input terminals to ground with a VTVM. If the transistors have been correctly fitted into the sockets and are both good, the resistance should be about 4 million ohms. If something has gone wrong it'll either be much lower or infinite. This simple check can be used to check the conditionsof the FET's if you suspect damage from nearby lightning strikes, etc.
2. Now short both input terminals to ground. Connect VTVM to one of the Source terminals and measure the DX voltage to ground with a VTVM; with an 18 volt battery, this voltage should vary from zero to + 3 or 4 volts as the bias pot is rotated from one side to the other. For any particular setting, the Source voltages on both FET's should agree within 10% or better; this indicates that both units are at the same operating point.

FINAL ADJUSTMENTS OF AMPLIFIER

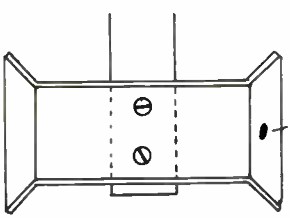
1. Connect the amplifier to the loop as shown; connect amplifier output to receiver with double balanced line. Connect battery power and set bias pots in midrange; if the battery meter is used it will indicate a total current drain of about 8 mA. Tune receiver to a fairly strong station in the bottom of the band and try to peak the signal with the loop tuning capacitor. If the signal won't peak, switch in the range extending capacitor. If all is well, the station should peak up very sharply with the tuning capacitor most of the way closed; the signal output and tuning sharpness should vary over a wide range as the Q-gain control is rotated. If the amplifier breaks into oscillation at this point, it will have to be neutralized. If oscillation does not occur, keep tuning up into the band until it does.

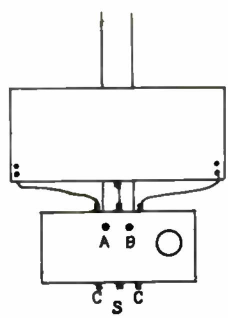






Use solder lug under center input and output terminals to establish chassis-ground.





2. When instability is finally encountered, neutralization can be started. With the amplifier oscillating (it may appear to be totally blocked), try rotating first one and then the other of the neutralizing capacitors; at one particular pair of settings the amplifier should come out of oscillation and operate properly. Now tune up to a station at the very top of the band (don't forget to switch out the range extending capacitor when operating at the top of the band); if instability is again encountered, a further very slight adjustment of the neutralizing caps will clear it up. Once the amplifier is neutralized for operation at the top of the band it will operate throughout the rest of the band; once set, these caps should require no further adjustment unless FET's are changed.

USING THE FET ALTAZIMUTH ANTENNA

Controls.

a) Tuning capacitor. Rotate to peak desired station; switch in range capacitor to tune to bottom part of band.
b) Q-gain control. Rotate to reduce antenna pickup as desired.
c) FET bias control. Adjust for maximum gain without distortion or spurious pickup.
d) Neutralization capacitors. Ignore once properly set.

To eliminate a local station.

Starting with the loop frame vertical (tilt angle = 0°), rotate the loop until the station pickup is minimized. Now unlock the tilt arm and tilt the loop about 20°; rotation will now give a deeper null on one side than on the other. Continue to increase the tilt angle while rotating back and forth through the null position. At one particular combination of tilt and rotation (and one position only!) the local signal will suddenly drop to a very low level or completely disappear into the background noise. This setting is extremely critical - movement of the loop frame by only a fraction of an inch from this setting often changes the pickup by 20 to 40 db; this is the reason for the unusually sturdy nature of this loop design. On some stations this setting will appear to slowly drift about by a small amount because of small amounts of signal scattered from the ionosphere directly overhead.

The actual null depth (i.e., how much a local can be reduced) depends upon a number of uncontrollable factors, including the nature of the transmitting antenna, the ground between the receiver and transmitter, and the presence of reradiation from local power and phone lines. Under the best of conditions the unwanted station can be reduced by at least 80 db; in the worst case observed by the author the null was still 38 db. When a very powerful local is very deeply nulled out, the remaining audio will sound extremely distorted - almost like single sideband; in this case the signal is being picked up as the result of scattering from the overhead ionosphere and no deeper null is possible.

To eliminate a distant station.

Adjust both rotation and tilt to minimize the undesired signal; because the polarization figure for a skywave changes with time, frequent readjustments will be necessary.

To make direction finding measurements.

Set the bearing pointer on the loop shaft so that it is pointing perpendicular to the face of the loop. Adjust the setting circle so that 0° corresponds to due North. Lock the loop in the vertical position (ALL DF MUST BE DONE WITH TILT = 0°!!). The angle shown on the setting circle when a particular station is nulled to its lowest level will then correspond to the great circle bearing to the station. Average a number of readings taken over a space of several minutes to obtain greatest DF accuracy.

CORRECTIONS TO PLANS:

1. The plate on the lower right hand corner of page (D) is "I"; the plate between "D" and "F" on page (E) should be "J". Lettering broke up during printing.
2. On page (C) , the letter next to "L" is a lower-case "J".
3. On page (E) , plate "J" is also 5½" x 3"; the pair of holes in the center of plate "H" on same page are ½" from the edge of the plate.
4. The Range extender capacitor "M" is the blob shown connecting the toggle switch and the tuning capacitor frame in the upper left hand drawing on page (F).
5. There are no notches on the plates to keep the wire in place; the spreaders, once woven through the windings and twisted, tighten up the wires so much that no notches are needed.

PARTS AVAILABILITY:

1. There is no single supplier which carries all of these parts; some must come from Lafayette and some from Newark. The Lafayette items are all shown in the newest edition of the Lafayette Industrial catalog; catalogs from both suppliers will be sent by them upon request.
2. If 2N4416A FET's cannot be easily obtained, the more common 2N4416 can be substituted without too much effect, although the former is more desirable. For best results with the FET amplifier, use a pair matched on the basis of transconductance.
3. The Q-spoiling potentiometer, "N", is primarily for use with the FET amplifier; it will have relatively little effect on the performance of the unamplified loop except at its most extreme setting.
4. The tuning range switch, "L", may be SPST, SPDT, etc.; it is only used to switch "M" into the circuit; if multisection switches are used the extra sections just remain unconnected.
5. Longer feed-line than the 36" material specified is also available from Lafayette if needed; Lafayette item 11 T 7408 is identical except is 54" long. Automobile radio repair shops often have extenders as long as 72" in stock; check locally.

ASSEMBLY SEQUENCE:

1. Fasten one center plate "F" to arm B2 with wood screws as shown on page (G).
2. Lay the 4 crossarms (with the slanted ends properly oriented as shown on page (C)) and "sandwich" them between the 2 center plates with bolts as shown on page (G) . Make certain the arms are at right angles to one antother before tightening the whole arm assembly.
3. Fasten the 3 arm plates ("D") to the arms with wood screws; mount the terminal arm plate ("E") on the long arm as shown on page (F) .
4. Mount the tuning capacitor mounting plate on A1.
5. Fasten the tuning capacitor ("K"), Q-gain pot ("N") and range extender cap switch ("L") on the mounting plate as shown on page (G) .
6. Wind the tank coil with the proper number of turns (see page (N)).
7. Wind the link coil and mount the terminal block plate if FET's are not used.

8. Connect the two free ends of the tank coil protruding from the edges of plate "E" to the tuning capacitor lugs. Make certain you connect one wire to the lug on the capacitor mounting screw (see page (G)) and the other wire to the lug protruding from the bakelite insulator on the top of the capacitor. Miswiring this tuning capacitor is the most likely mistake you'll make so be careful!

9. Now wire in the range extending capacitor and switch and Q-gain control as shown on page (F) . Keep wiring as short as possible.

10. If FET amplifier is not used, connect the two ends of the link coil to the terminal block as shown in the upper right hand corner of page (F) . Scrape the insulation off the center of the link-coil next to where it passes through the wooden arm and solder a short lead to the bare spot; connect this lead to the terminal block as shown on (F). When you scrape the insulation off, be careful not to nick the wire.

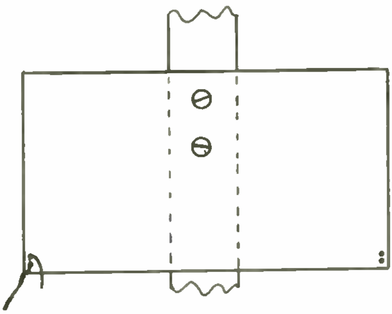
11. If the FET is to be used, mount the completed amplifier on the loop at this time. Run the shortest possible leads from the ends of the tank coil to the two input terminals of the amplifier as shown on page (K); bare the center of the tank coil and connect the center tap to the amplifier as shown.

12. Now connect arm B1 to the stub protruding from one side of the center plate ("B2"); also bolt B3 to B1. Now bolt the entire assembly to the mounting shaft.

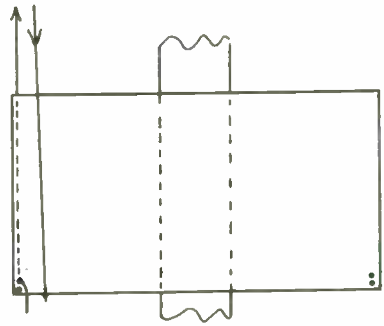
13. Lay arm "B3" against the mounting shaft and bolt on the tilt lock plate ("I"). The wingnuts ("CC") will then tighten the lock plate against A3 and will allow the operator to freeze the loop at any desired tilt angle.

14. Adjust the spacing of the turns where they pass over each end plate so that the distance between adjacent turns is even. It is important that the loop winding be as symmetrical as possible relative to the center tap if the FET amplifier is used.

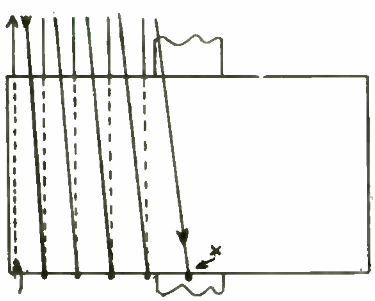
15. Now "weave" the spreaders in and out of the windings; two spreaders on each side. When all of the spreaders have beed threaded into the windings, twist them 90° one at a time. After all 8 have been twisted, the windings should be under relatively great tension. This eliminates detuning due to vibration of the wire and reduces the distributed capacity of the winding by increasing the average distance between adjacent turns.



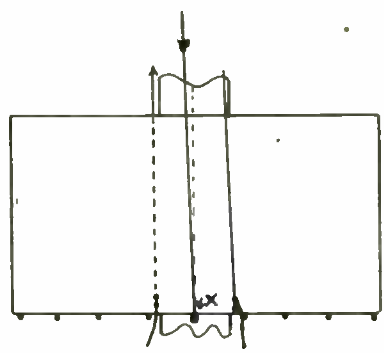
Begin winding tank coil by weaving end of wire through the pair of holes on end of plate for strain relief. See bottom left-hand corner of page G for detail.



One complete turn has been wound around the loop.



After 5 complete turns have been added, the wire passes through the hole drilled through arm A1; winding then continues as before until a total of 10 turns have been made. Pass end of winding through the pair of holes on right side of plate to anchor. Strip insulation away at point "x" for center tap. Spacing between adjacent turns should be made exactly <u>one-half inch</u>!



If the FET's are not used, wind an 8 <u>turn</u> tank instead; pass through hole in A1 after 4 turns have been added. The <u>link coil</u> consists of <u>2 turns</u> as shown above; the ends are anchored through the holes near the center of the plate. Note that the middle of the link coil also passes through the center hole as well as the tank coil! Spacing between adjacent turns is 5/8" for the tank coil if 8-turn tank is used. Make the link center-tap at point "x".

Ⓟ

Because the FET Altazimuth loop antenna permits the nulling-out of powerful local signals to a much greater degree than any previous loop design, a number of novel effects may be noted when you attempt to null out a nearby station.

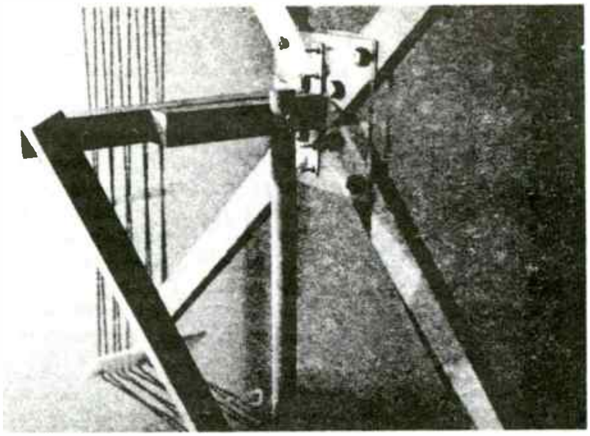
You may find that the signal from your local will drop from say S9 + 80 db to S4; in the daytime you may hear nothing but noise with your local nulled out. In this case you will have reduced the local signal so greatly that you are just hearing the background noise level - exactly as if the station had actually signed off the air. In this case the null depth is said to be greater than the signal-to-noise ratio for your location and the station in question. At night you should hear distant DX stations on the channel.

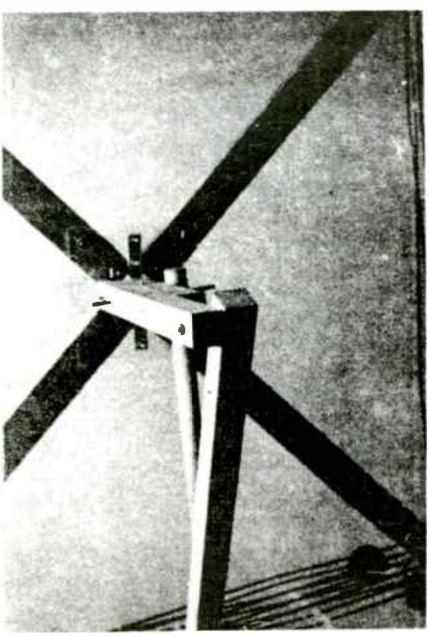
If you've got an extremely powerful local - say a 50 kw'er within a few miles - you may not be able to totally eliminate the station. Instead, a very weak and highly distorted bit of signal will resist complete nulling. This final vestige of the local station is the signal actually being backscattered from irregularities in the ionosphere directly overhead; the distortion is caused by the random phase cancellation of this scattered signal. This very weak signal (equivalent in power to only a fraction of a watt in most cases) cannot be totally eliminated by any antenna.

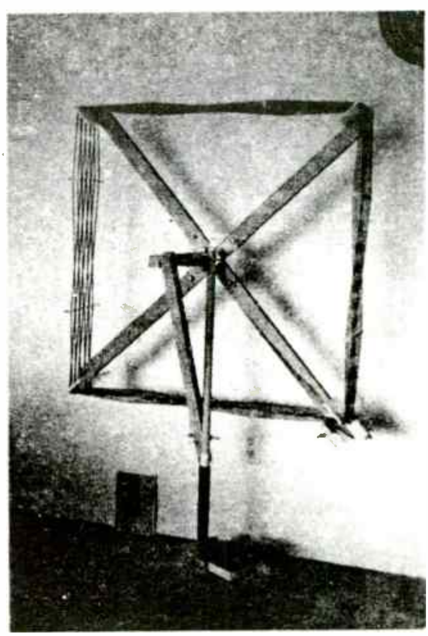
If you have another powerful local station in the neighborhood and its frequency is within a few hundred kHz of the station you're trying to eliminate, you may encounter a strange phenomenon that was rarely observed before the invention of this antenna - the "Luxembourg Effect". An example will help to illustrate this effect. When the author nulls his superlocal WRKO on 680 kHz (0.4 volts per meter of signal!) during the daylight hours, the signal from local WCAS (740 kHz) is heard very faintly in the background mixed in with the highly distorted skywave backscatter from overhead. This is not a typical spurious response (e.g., not an image or sum-and-difference mixing in local phone lines, etc.) but is actual crossmodulation produced in the ionosphere directly overhead. In the example just cited, the programming of WCAS is actually being transferred to WRKO's signal by slightly nonlinear processes in the ionosphere; this transferred signal is then picked up by means of the backscatter returned from overhead. The amount of signal actually transferred from one carrier to the other is very slight and this effect is never observed unless the Altazimuth loop is used to eliminate all of the direct and groundwave pickup from the local station; in that event the small fraction of watt of effective Luxembourg effect then becomes obvious.

If you have many phone or power lines nearby or are attempting to use this antenna in a steel-frame building you may find that a few of your powerful locals will not null as deeply as others. This is caused by reradiation from nearby metallic objects and cannot be eliminated. (The technical explanation for this effect is that the polarization of the incoming wavefront has become significantly elliptical).

Gordon P. Nelson







Some Tips on Loop Construction
(To be used in conjunction with NRC Loop Plans) by Jerry Starr

So you're gonna build a loop? Once you get it working, you'll love it like a member of the family...once you've got it working! The Good Admiral's recent series of articles on loop problems should be required reading before taking on the project. Some years ago I made a stab at loop building and am now writing this in hopes that future loop-makers will not make the same boo-boos that had me talking to myself.

First of all, make it mechanically strong. Don't select masonite for the center brace. After carefully drilling all the holes, I fould that the masonite curled up at the edges when the bolts were tightened. The plane of the loop will be far better if you use a good healthy chunk of 3/4" plywood at least 15 inches square. Use heavy half-inch bolts 2½" long with sockwashers on both sides of the plywood, and large wingnuts for tightening up. Tighten up the nuts until the washers bite into the wood. Retighten after a few days to take up the slack resulting from "give" in the wood. If everything isn't good and tight, you'll have a droopy loop after a few weeks.

For the crossarms, use at least 1" dowels, or square stock. These are sometimes hard to find at the local hardware emporium; I let a smiling salesman sell me 3/4" dowels which bend like a fishing rod when the loop is wound tightly. The 1" variety is much more sturdy. (Since it is very important that the plane of the loop be flat, make like Robin Hood and "sight" down the crossarm stock to make sure you aren't being sold warped wood - G. Nelson).

Mounting is always a problem. After being the victim of a falling loop on more than one occasion, I purchased a tripod-type Christmas tree stand with a wide base and it hasn't tipped over yet. The adjustment screws in the stand also make it easier to plumb the whole works. (An alternative solution to the mounting problem, which has proved quite practical, is to run a long shaft through the loop plane extending both above and below the loop. If the length of the shaft is the same as the distance from the floor to the ceiling, it is easy to pivot the rotation shaft at both the floor and ceiling. Anyone who's ever seen a "pole lamp" can take it from there. - G. Nelson).

The latest NRC loop plans (as of 1968) suggest a method of rotating the loop by connecting the support dowels with a piece of "Redi-Thread", thus allowing the top section to rotate on the bottom dowel. Forget it. First of all, unless the holes in the dowel ends are drilled exactly (which is tough if you don't have a large-bedded lathe) you will end up with a severe case of loop-lean. Even if the holes are exact, constant rotation eventually enlarges the hole, the top-heavy construction will tend to bend the rod, and the loop ultimately ends up on the floor (and possibly the trash). Here's a much more sturdy method of pivoting. Beg, borrow or steal a two-foot section of conduit or antenna mast with a one-inch inside diameter. The bottom end of the upper loop supporting dowel is inserted into the conduit at least 10". Drill two ¼" holes completely through the conduit, and another at right angles 6" lower. Tighten bolts through both of these holes so the conduit is firmly fixed to the support dowel (upper). Now you can slide the whole loop frame over the lower support dowel which is firmly fixed to the Christmas tree stand. The end result is that of a large sleeve-bearing rotating around the lower dowel. Since the conduit's inside diameter and the dowel's outside diameter are the same, a snug fit will result - keeping the upper and lower dowels in good alignment and permitting easy rotation. Rotation may be uneven if the mating ends of the dowels are rough, if this is the case, place a penny on the top of the upper dowel before sliding the upper part in. This will act as a bearing. If the fit is too tight, a little light sanding of the lower dowel will do the trick. Do NOT oil the wood as this will make it swell and bind up the free rotation of the loop. (Once the diameter of the freely rotating dowel has been fixed by sanding, a liberal quantity of powdered graphite lubricant will guarantee smooth rotation without warping the wood; also, too much plumbing and too little woodwork can possibly result in the presence of so much metal tubing near the loop windings that the antenna pattern will be distorted - go heavy on wood and plastic and use metal sparingly - G. Nelson).

Now we're ready to wind the loop. Use stranded, insulated wire; I wouldn't recommend wire smaller than 16-guage. (AWG) Thinner wire stretches too easily and you'll be re-tightening every other week. Don't do as I did and yield to the temptation to solder together some lengths of scrap wire to save a little money - buy the wire you'll need all in one piece. (A loop 3-feet per side, square, with 10 turns needs about 125 feet of wire, most economical is to buy 2 100' spools and make one soldered splice-R. Foxworth). Winding the loop requires the patience of Job. It would seem natural to lay the loop on the floor to wind it. Not good. When you pick up the wound loop, the frame will flex and you'll have to retighten the windings or possibly even rewind it all over again. Erect the loop frame first, then wind it while in its final position. If you're not so tall, grab a chair. This method is more time consuming but will result in a more tightly wound coil. (A tuned loop isn't one that makes like a guitar when rotated. The windings should not vibrate when the loop is turned. A trick invented by the ancient Indians to firm-up weaving looms: "weave" a short, flat piece of wood or 1/8" plastic into the winding in several places - under the first turn, over the second, under the third, etc. Do this at 3 or 4 places on each side of the winding, and the loop will be "firmed up" greatly. Doctor's tongue depressors or popsicle sticks are good for this. _G. Nelson).

If you're handy with chassis tools, the tuning network should be mounted in a small aluminum box bolted to the loop support dowel directly below the loop windings. Do NOT place the tuning network (and especially not a FET preamp) INSIDE the loop windings. Binding posts or terminal blocks make for easier connections; you'll need about 6 of them, one for each end of the multi-turn tank coil, one for each end of the single or double turn take-off link (if no FET preamp used) and 2 for the feedline to the receiver. Binding posts are a lot easier to use than having to solder all of the external connections. If coax is used, BNC type RF connectors may be used, but are harder to connect initially.

Use only shielded, two-conductor cable for the feed-line to the receiver. Belden 8641 is fine and available at most any radio parts store. Keep the cable as short as possible. Connect the shield to the receiver ground terminal. (Balanced output preamps can be used with two parallel runs of single-conductor coax, bond the shields every foot or so and lace together with string -R. Foxworth).

Now a few fine points. The variable capacitor called for in the NRC Loop Plans usually comes with a large 3/8" diameter shaft. Trying to find a knob to fit this shaft is almost impossible, and you can't leave the shaft bare since hand-capacitance will cause severe detuning everytime you touch the metal shaft. An adapter shaft is available to accept the almost universal ¼" shaft knob; available from Allied Radio, part no. 47 B 1109. The large Davies knob (Allied p/n 47 B 4126) makes for easy tuning. If you use a FET booster and find that tuning has become so sharp that an ordinary knob will not do, try one of the inexpensive Japanese-made vernier knobs offered by Radio Shack, Lafayette, Allied etc.; it'll be a bit harder to mount but will be much easier to use. -G. Nelson)

Of course there are lots of other considerations in loop construction but they have been covered quite completely in the previously published loop plans and in the Nelson articles. Read them well before starting construction of your loop, and visit a DXer with a good loop before you begin work on your own. If your loop works like it should, you'll probably never use your old antenna again - you'll wonder how you ever DXed without it.

-30-

Editor's addenda: While a set of NRC loop plans (including both box and spiral types, along with plans for the FET loop booster, will hopefully be out by summer (published in 1969, see Reprint A-11), Jerry's comments are invaluable for those who'll build a new loop or improve an old one before then. You'll still stick with your impressive longwire, you say? One of the NRC's most talented, experienced and respected "old timers" recently wrote, "An old DX buddy came over the other day and we put a loop together. He had put in more effort than I, as he wished to prove how effective a loop can really be, compared to an Inverted-L antenna. I've been heard to say many times 'how can that small loop compare with that high, goodlooking L antenna that has given me all the continents and all the pleasure that goes with it? Well that loop has shown me things that I didn't think possible - just things you dream of and wish were true. -g. Nelson.

RANDOM THOUGHTS ON THE CONSTRUCTION OF A FET ALTAZIMUTH LOOP ANTENNA

by Russell J. Edmunds

First, let me establish the premise that all NRC'ers should endeavor to obtain a FET altazimuth loop, since with the advent of the loop kit, there is no good reason whatever for denying oneself this necessity. There are, however, several variations which can help to alleviate some of the drawbacks to a loop, of which, perhaps the physical size of the loop is the most important. The mounting of the loop has a great deal to say regarding the amount of space it will take up. While it is presently impractical to attempt to make the FET altazimuth loop conveniently portable, it can be made semi-portable, or at least moveable. This can be done by two methods. First, is a method which was demonstrated at the 1969 Convention by Duane Giese. This is the concept of employing a tripod as a mount, which is done by purchasing a folding antenna base (Allied Radio part number 11B 2043W for example), and obtaining a one-foot length of 1" inside diameter steel pipe. The pipe is held into place at the inside of the antenna mount by means of the setscrews supplied with the mount, then the dowel of the loop is slipped into the pipe.

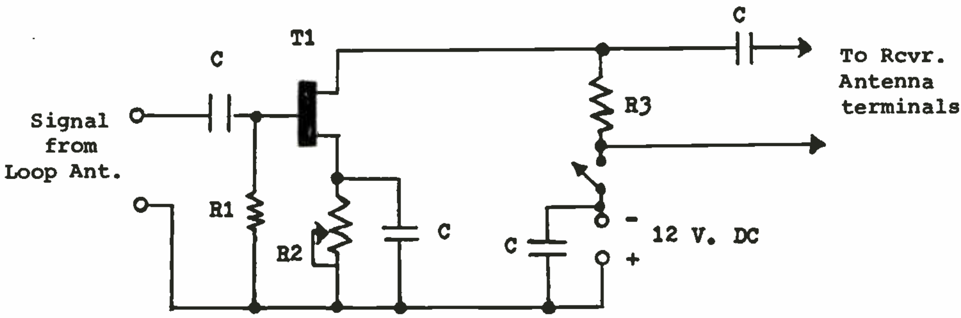
The other method is to purchase the same section of pipe, threaded both ends, and a pipe fitting known as a floor flange. This attachment should accept the thread on the section of pipe, and can then be bolted into a 2 foot square piece of 3/4" plywood. This gives a solid mount for a loop, which can be made moveable by the addition of plastic casters to the underside of the base. If these casters are positioned even moderately carefully, there should be no problem of stability.

Another problem which has plagued loop builders in the past is a convenient way to avert the friction problems generally encountered in the rotation of the loop itself, as well as in the tilt arm for the altazimuth loop. This problem is neatly solved by the procurement of a type of liquid plastic known as "Varathane". This product is produced by a company called "Flecto" and is advertised as a liquid plastic especially suited to coating wood. It appears to be almost totally frictionless, and in addition, it is impervious to almost everything from acid to abrasives. Furthermore, it can be used to coat the entire wooden superstructure of the loop to retard warping or other undesirable dimensional changes.

Still another problem, although less severe, is in the length of the transmission line used in balancing the loop. The specified length will probably be a bit short, and the reader is advised that this does not mean the end of the world, it simply means that you should try to purchase about twelve feet of auto antenna cable, either in one section, or in two. DO NOT try to couple two shorter lengths. This will allow a transmission line of up to six feet, which should be all that is necessary.

Finally, do not despair if you have built a loop without the FET amp, and your Q-spoiling potentiometer (component "N" in original plans) seems to be ineffective. This is because this item is designed primarily for use with the FET, and is inserted in the plans because it is actually a part of the basic sans-FET loop circuit. With these thoughts in mind, you may well find that you are even more pleased with your loop than you would have been without them.

SIMPLE AMPLIFIER TO BOOST SIGNALS FROM A LOOP ANTENNA



C = 0.01 mfd. 100 volts or greater

R1 = 100,000 ohms, ½ watt or greater

R2 = 1,000 ohm potentiometer, ½ watt or greater

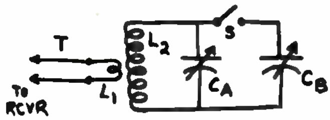
R3 = 300 to 1,000 ohm resistor;exact value depends upon the transistor used. Try different values until maximum amplification takes place.

T1 = P type Field Effect Transistor; Fairchild 2N4360 or equivalent. Most common P-junction Field Effect units will function in this circuit. An "N type" transistor may be used if the battery terminals are reversed in polarity.

CONSTRUCTION HINTS: Build the amplifier in a metal box and keep all wires short. Do not overheat the transistor. Keep input leads well away from the output leads. Install the battery inside the case. R2 is the gain control; keep gain as high as possible without producing oscillations in the amplifier. Experiment with the value for R3 to obtain the best performance. Optimum value with the 2N4360 transistor is about 910 ohms. Turn off the battery when the amplifier is not in use. Expected gain of this amplifier is 10 to 20 db. or up to 4 S-units.

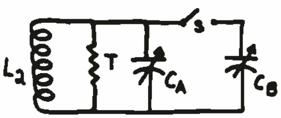
DCL: DIRECT COUPLED LOOPS

The usual loop is one that is inductively coupled (ICL) and has the following schematic diagram:

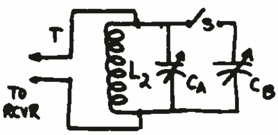


where T is the feedline connecting the loop to the receiver and can be made from two-wire twisted cable (of the homebrew type) to coaxial cable or shielded two-wire cable. L_1 is the inductive coupling which is usually one turn and almost never more than three turns. L_2 is the main loop winding usually containing 5 to 15 turns of wire--the number of turns depends upon the geometry of the frame-crossarm structure that is used, upon the spacing between the wires and the variable capacitor(s) C_A and C_B used as well as a few miscellaneous parameters of relatively small significance. The switch S is used to connect C_B in the circuit to achieve resonance (signal peak) on the low end of the BCB. In almost every BCB loop, $C_A$and C_B are actually two separate variable capacitors, but are mounted on the same frame and have a common rotating shaft--indeed, loop builders commonly use or consider for use only one type of variable-- the popular "standard broadcast" 2-section 365-10 picafarad variable used by almost all radio manufacturers in the "All American Five" table radio as well as most other AM radios. The antenna is L_2, C_A-C_B and can be called in EE-parlance: a parallel tuned tank circuit. Radio waves passing through L_2 induce a voltage causing current to flow and by adjusting C_A-C_B the parallel tank is adjusted to achieve resonance--a condition in which the siganl in the antenna "peaks". L_1 "looks" into L_2 by magnetic coupling since current flowing in L_2 causes current to flow in L_1 and this induced current-voltage is what is carried to the receiver by T. Now the interesting thing is that the antenna circuit L_2, C_A-C_B is extremely inefficient and actually "intercepts" very very very minute amounts of energy from the passing radio wave. Further, the coupling between L_1 and L_2 is at most "fair" so that an even smaller amount of signal is carried to the receiver--the figures are almost unbelieveably small compared to the energy of the passing radio wave. In fact, looking at a loop theoretically on paper, it would appear to be a totally useless antenna. In practice things are even worse than paper calculatious, but as we all know--loops work!!! One can only try to increase the efficiency of a loop by getting the best variable capacitor available and then design L_2 to have optimum properties and to improve upon the "sampling probe" L_1---exactly what Gordon Nelson has beautifully accomplished in the state-of-the-art loop, the FET-Altazimuth.

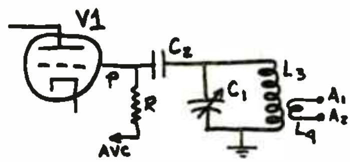
The purpose of this writing is to discuss the latter condition--a way in which L_1 can be eliminated and a direct connection to the antenna L_2, C_A-C_B made which gives a very significant improvement in siganls delivered to the receiver---the DCL, direct coupled loop, an arrangement in which the line T is tapped to L_2 directly or by means of a FET preamplifier. The problem is that no superior or proper circuitry is easily accessible to exactly "match" L_1 to L_2 so that maximum energy is transferred to the receiver. So, what is the next best alternative is to voltage feed L_2 and we want to bring this voltage right to the receiver so it can be utilize the loop signal to a much greater degree. But it is extremely important that this "voltage sampler" does not appear to L_2 as a low value of "resistance". Examine the following circuit diagram:



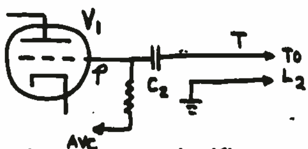
The line T and what it connects to in the receiver can be viewed as a "resistor" hooked across the ends E_1 and E_2 of L_2. If T has a very low "resistance", then the voltage induced by the passing radio wave across the ends E_1 and E_2 of L_2 is severely reduced and things are worse than before! Hence, to preserve the maximum (or very nearly so) voltage across L_2, T must have the highest "resistance" (impedance) possible. In practice if T is at least one megohm (one million ohms), results are good. So suppose you take that loop you are now using, remove L_1 and connect T across L_2 (same as connecting it across C_A):



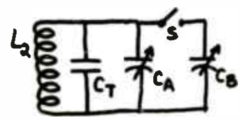
If you then attach T to your receiver as before, you get nothing because in the conventional receiver you have this circuit (T connects to A_1, A_2):



But L_4 is just a few turns of wire wound around one end of L_3 and it simply "short circuits" L_3--result: TILT!! So, connect T to V_1, the RF stage as follows, removing C_1, L_3, L_4:

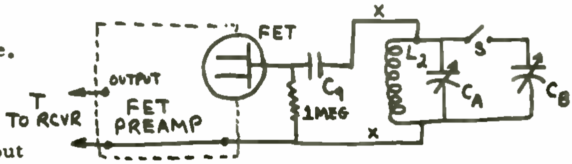


Then voltage V in the loop is delivered to the control grid, pin "p", of V_1, the first RF stage and T as a "resistance" is very high--likely something on the order of a megohm. Further, the varying voltage V applied to p is exactly what "makes V_1 operate". Now you have a very significant amount of the antenna voltage delivered to the receiver. But, as life goes, so goes the law of nature: You cannot have your cake and eat it too!! T also has capacitance associated with it and it appears across the circuit as C_T below:

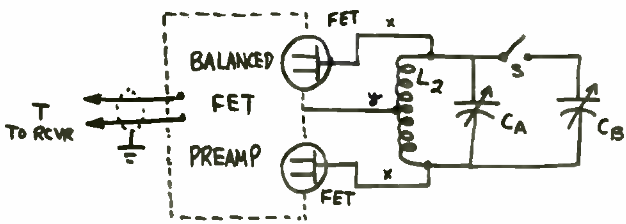


The result is that your loop which previously tuned to 1600 khz does no longer! The larger C_T the lower the highest "peakable" frequency will be. The first remedy is to remove turns from L_2, but this reduces L_2 signal pickup--undesirable but the result in some cases will still result in a significant improvement in signal strength. The value of C_T for a given type of line T depends on the length of T, the longer T, the larger C_T and the geeater the reduction in top end frequency peak. Suppose for instance T is RG-58/U coax, then if T is L feet long, $C_T \doteq$ 30 L picafarads. Now C_A-C_B reach 365 picafarads or so to tune the loop at 540 khz. About 10 feet of RG-58/U will then lower the highest frequency peak attainable to the very low end of the BCB and to compensate too many turns (if not all?) of L_2 would have to be removed. The lowest valued line in capacitance per foot commonly available is 300 ohm TV twinlead which runs about 5 to 7 picafarads per foot. Thus 10 feet of TV twinlead gives C_T a value of 50-70 picafarads, not as severe. Also, reducing the value of C_2 will compensate to some degree for the increased length of T, but this also reduces signal voltage at pin "p" of V_1. The DCL gives then a very significant improvement in signal-to-noise ratio at the receiver. Clearly, under these conditions T should be as short as possible.

If T were almost of zero length, then V_1 would be mounted at the antenna itself and this can be accomplished by installing a high-impedance to low-impedance "transformer" with lots of gain (better known as a FET preamp) right at the antenna. In fact, this is exactly the situation in the FET-Altazimuth loop when used with the FET's--it is a DCL! In this case no receiver modification need be made, T connects to the output of the FET and connects to the receiver in the normal manner, T can be made of a nominal length of cable and in addition even more gain in siganl is obtained. Gordon Nelson has published two FET preamp circuits which are applicable here--one is a single-ended unbalanced input unit, the other is that FET preamp used in the FET-Altazimuth loop which is a balanced input/output push-pull unit having extremely high input impedance and superior high frequency stability. Information on these units can be obtained from Gordon at NRC headquarters. Since most loops are used in the unbalanced feed arrangement, the single-ended FET can be connected as follows to your present loop under DCL conditions:



and wires "x" should be as short as possible. Some care must be taken in this case to maintain high end stability of the FET, but the effort is well worth it since L_2 is relatively "undisturbed" so the voltage drop in the antenna is kept at a minimum. The FET preamp of the FET-Altazimuth loop connects to L_2 as follows:



Again, wires "x" and "y" should be very short! Connection "y" on L_2 is at the exact middle of the L_2 winding. Mounting this FET preamp much like it is described in the FET-Altazimuth loop is to be reccommended. In all these cases, a little patience and reflection upon the problems that can arise will give you the necessary steps to take to eliminate them. The end result is a loop antenna, the DCL, which will prove to be a most significant antenna over the customary ICL--something a serious BCB DXer can now discard as inferior! You can start by removing L_1 from your ICL and employing the above techniques to suit your needs. Of course, the FET-Altazimuth loop is a further improvement in that L_2 has been optimized to have the desirable properties necessary for BCB DXing.

THE BCB DX'ERS BEVERAGE

- Gordon P. Nelson

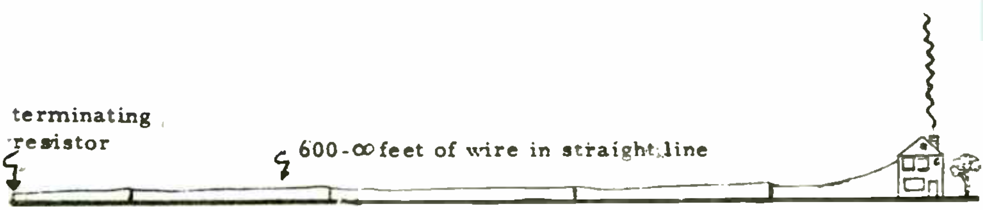
Jerry Conrad is now beginning to report some remarkable DX reception with his new Beverage antenna and this would seem to be a good time to present a long-planned article on this unique but little-known type of MW antenna. Very few DX'ers are fortunate enough to have adequate space for the construction of a Beverage antenna; this, plus a shortage of information in the amateur press, has meant almost total neglect of the Beverage for MW DX'ing.

The Beverage type of antenna was first described by Harold H. Beverage in 1923 for the reception of LW signals and belongs to the class of antennas known as <u>wave antennas.</u> While superficially the Beverage seems to be no more than just an unusually long "longwire", it actually operates on an entirely different physical principle from more common types of antenna. The Beverage is most useful on the long and medium wave bands and, like the loop antenna, loses efficiency so rapidly with increasing frequency that it is poorly suited for operation on higher frequencies.

Again as with the loop antenna, the Beverage is useful only for reception and has little application for transmitting; in the case of the loop because of the low radiation resistance in comparison with other losses and in the case of the Beverage due to the excessive ground losses experienced.

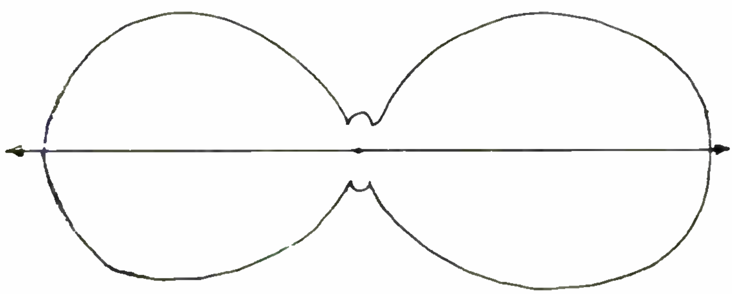
The most important application for the Beverage antenna is in the field of radio intellegence monitoring - a potential recognized and exploited by both sides during WWII; the German intellegence agencies regularly monitored MW East Coast U.S. stations from a site near Warnsee while Americans kept abreast of internal Japanese affairs by monitoring low-powered Japanese BCB domestic outlets with Beverage installations on Kauai, Hawaii and later on Guam. Modern installations for this sort of work frequently employ complex arrays of wave antennas arranged in parallel or radial configurations and in many ways these represent the "ultimate" in MW DX'ing antennas!

How does a Beverage antenna work? The figure below shows a typical wave antenna for long or medium wave DX'ing; essentially it's nothing more than a very long piece of wire streched out in a straight line and supported a few feet above the ground. The exact height above the ground is not critical;



3 to 10 feet high is the usual range. Even the length is relatively uncritical - the Beverage is a broadband antenna and the longer it is in terms of signal wavelengths the "tighter" the pattern becomes. The Beverage effect begins to become significant when the antenna reaches about half a wavelength in size; this corresponds to 1825 feet on 540 kHz and 620 feet on 1600 kHz; as shown in figure 2, further increasing the length of the antenna (in terms of wavelengths) has the effect of narrowing the "field of view", reducing the pickup off the sides, and increasing the pickup for stations in the center of the "beam". While not obvious from the pattern diagrams, increased length also results in improved signal-to-noise ratio due to noise phase cancellation effects. With a very long Beverage, say 10 wavelengths (7 miles long on 540!) extremely quite and stable reception can be experienced from stations totally inaudible on other antennas. Before you rush out to set up one of these remarkable antennas, be forewarned that with the present high cost of copper, a thousand feet of 7x22 wire will cost in the vicinity of $20...

One wavelength:



Two wavelengths:

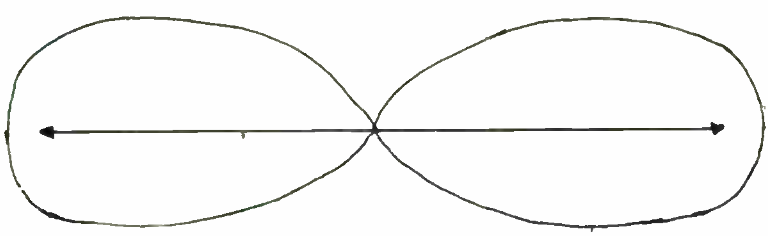


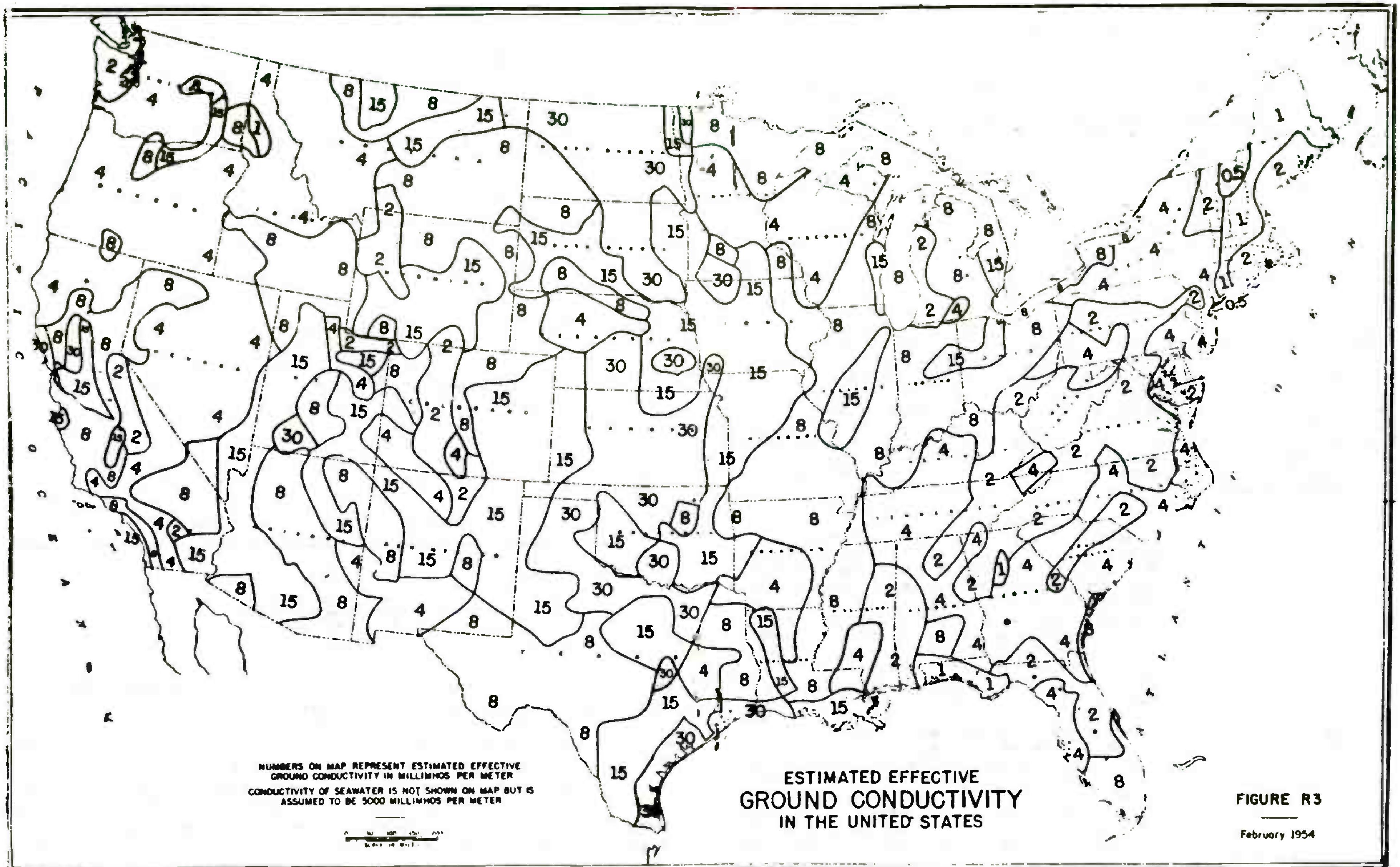
Figure 2. Rough radial pickup patterns in horizontal plane for typical one and 2 wavelength Beverage antennas.

The next figure explains just how the Beverage antenna works and why the performance depends critically upon the nature of the terrain under the antenna. In the first case we show what happens when an incoming skywave MW signal reflects off a perfectly conductive earth (say you built your wave antenna over a solid silver field for example...); in the vicinity of the earth the electric component of the signal wavefront is exactly perpendicular to the ground (per basic Maxwell). In the next case we have built the Beverage over a well conductive real earth, say a salt marsh or swamp. Because of the imperfect nature of the ground under the antenna, there will be a small component of the electric field of the wavefront parallel to the ground in the direction of propagation. The poorer the conductivity of the ground under the antenna, the larger this forward signal component will be; in the last figure the signal is reflected from a poorly conductive ground such as solid Continental Shield granite in New England - the forward component is now quite significant. The Beverage antenna simply sums up all of the forward components from the incoming signal and delivers the summed voltage to the receiver. The better the ground the weaker the forward component and the longer the Beverage must be to deliver the same summed voltage to the receiver; thus the performance of a particular Beverage will depend primarily upon three factors: (a) length of conductor; (b) conductivity of ground under the receiver; and (c) frequency.

Note that the patterns on the preceeding page show that the Beverage is basically a symmetrical antenna; pickup will occur from stations both forward and backward in the direction the antenna points. Reception from the back lobe takes place because the summed signal is essentially reflected back towards the receiver from the far end of the antenna if that end is left "free". If instead the far end of the antenna is connected to a good earth ground (copper pipes driven into the ground and soaked with concentrated salt solution, a cold water pipe, etc.) through a resistor of the proper value, the back lobe pickup will be dissipated in the terminating resistor, no reflection will take place from the far end of the wire, and the only signals delivered to the receiver will come from the forward direction! The exact value of the terminating resistor is the same as the characteristic impedance of the wire as considered to be a single transmission line with ground return. This is not an easy quantity to calculate or measure and the value of the resistance is usually determined experimentally by trying different values until back lobe pickup is minimized. Values in the 400 to 1000 ohm range are typical.

Because of daily and seasonal variations in the effective electrical properties of the ground under the antenna, the actual value of the terminating resistor which best reduces back lobe pickup will vary with time; in the most sophisticated modern installations the exact value of the terminating resistance may be remotely changed from the receiver site to optimize performance under specific conditions.

For maximum signal transfer into the receiver the input impedance should also match the characteristic impedance of the antenna lest part of the signal


NUMBERS ON MAP REPRESENT ESTIMATED EFFECTIVE GROUND CONDUCTIVITY IN MILLIMHOS PER METER
CONDUCTIVITY OF SEAWATER IS NOT SHOWN ON MAP BUT IS ASSUMED TO BE 5000 MILLIMHOS PER METER
ESTIMATED EFFECTIVE
GROUND CONDUCTIVITY
IN THE UNITED STATES
FIGURE R3
February 1954

ANTENNA TUNING DEVICES FOR THE LONGWIRE

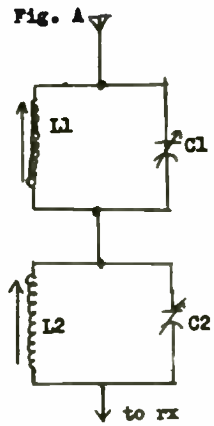
ON THE BROADCAST BAND

By Russell J. Edmunds

Although it has been established beyond any reasonable doubt that the loop antenna is the best suited for Broadcast Band DX, it still is necessary for many DX'ers, due either to a lack of space or insufficient technical knowledge to construct a loop, must make do with a longwire antenna system. As many DX'ers have noticed, the major problem encountered in the use of a longwire antenna is a means of trimming it electronically in order to produce selective peaks in the desired signals. While many manufacturers of communications receivers attempt to compensate for any mismatches that may occur between the longwire and the receiver, the greatly varying characteristics of each individual longwire make it impossible to build a trimming circuit capable of adjusting for any great quantity of variables. It is for this reason then, that many DX'ers have found it advantageous to investigate an external antenna trimmer which is best suited to their own particular longwire system.

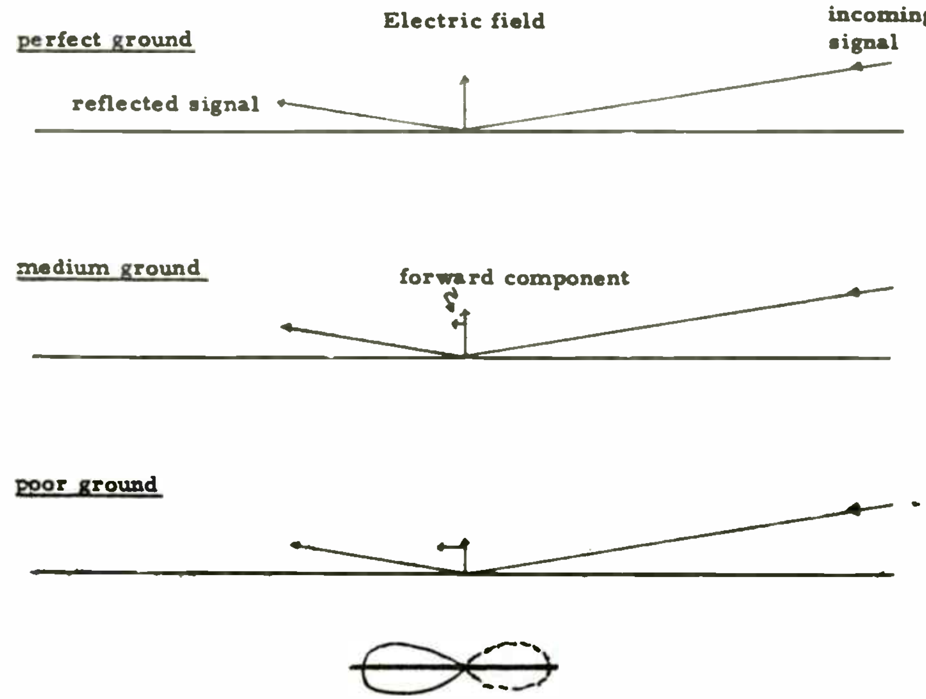
In this article, we will explore some of the more common and most easy-to-assemble tuners. Probably the most versatile of all antenna trimmers is that shown in Figure A, which employs two simple trimming circuits, connected in series with each other. In each circuit (they are identical) we connect a 365 pf. variable capacitor in parallel with a Hi-Q ferrite loopstick antenna, and then connect the antenna to one side of circuit number one, the receiver lead-in to the opposite side of circuit number two, and then connect the remaining sides of the two circuits to each other. The only major consideration to be taken in the use of this tuner is to keep your hands clear of any metal parts while using the tuner, as body capacitance may prevent accurate tuning. The major benefit of this tuner is in its ease of construction and use, while still providing trimming for a great many different antenna lengths.

Fig. A



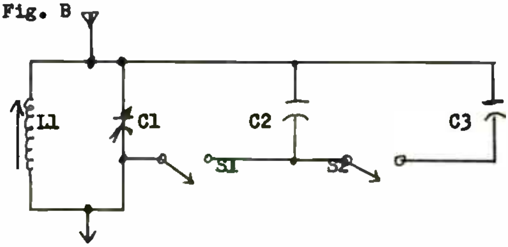
Another type of tuner for the longwire is one primarily used with longwires in excess of 125 feet in length, or where the longwire system consists of a continuous geometrical pattern. It was successfully used by the author for about three years with a triangular longwire array featuring forty-foot sides. This tuner, while slightly more complex, is based upon a principle similar to that used in the previous example. The schematic for this tuner appears in Figure B, below. Initially, we have the same basic circuit as before, with the 365 pf. variable capacitor and a BCB ferrite loopstick connected in parallel, however, we must add still more capacitance to compensate for the added inductance in the system. This is done by adding two fixed capacitors of equal value in parallel with the existing circuit. It will be noted here that these two capacitors should be as close in value to 365 pf. as possible, so that there will be no "dead spots" within the tuning range of the tuner. For this reason, if you are unable to get fixed capacitors of a value between 360 pf. and 370 pf., it is suggested that you use values less than 365 pf. so that when adding these capacitors you will have an overlap rather than a "dead spot". By adding S.P.S.T. switches in parallel with the fixed capacitors, you create three separate tuning ranges.

Beverage terminated by resistor R_t becomes unidirectional -



be reflected back towards the far end of the receiver. By the same token, receiver ground should be as good as possible although ordinary capacitative coupling to power line ground will probably prove adequate. Note Nature's little irony in the matter of the necessary connections to earth ground: the poorer the ground conductivity the better the Beverage effect - and the harde it is to make a good earth ground at the ends! Ideally a patch of rocky desert between two salt marshes would be just the thing but try telling that to a real estate agent sometime... The attached maps give a rough idea of the effective ground conductivity in the U.S.; the lower the number the poorer th conductivity and the better the Beverage antenna will perform. Note that sea water in comparison is 5000 or more. In conclusion let us remind you that chopping down power or phone lines for the wire is a federal offense...

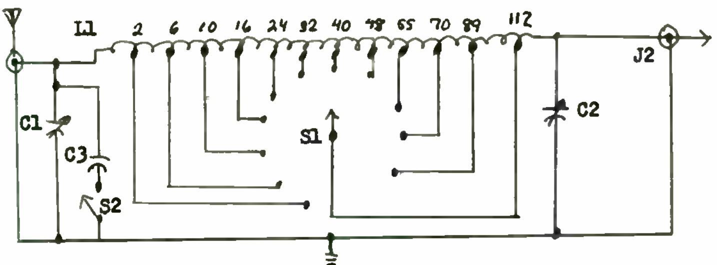
Fig. B



Still another type of antenna tuner employs a coil which must be wound by the DX'er himself. This type of tuner is more complicated to build, but is well worth the effort. There are two tuners of this type, and as they are the most common ones, they will both be discussed herein.

The first is shown in Figure C, and features two variable capacitors, one fixed capacitor, the coil, and a rotary position switch. The coil, (L1) consists of 112 turns of # 18 guage wire on a coil form with a diameter of one and three-quarters inches and a length of four and five-sixteenths inches. The coil should be tapped as it is wound at 2, 6, 10, 16, 24, 32, 40, 48, 58, 70, 89, and 112 turns. Each of these taps is, in turn, connected to a different position of the rotary switch, while the tap at 112 turns is connected to the rotator (or pole) of the switch. The rest of the circuit is then constructed as shown. It is advisable to connect the metal chassis, should you use one, to ground.

Fig. C



Parts List:	C1 - 250 pf. variable	S1 - Single pole 12 position shorting type rotary switch
	C2 - 365 pf. variable	S2 - S.P.S.T.
	C3 - 270 pf. fixed	
	J1, J2 - RCA phono jacks	L1 - see text

* *

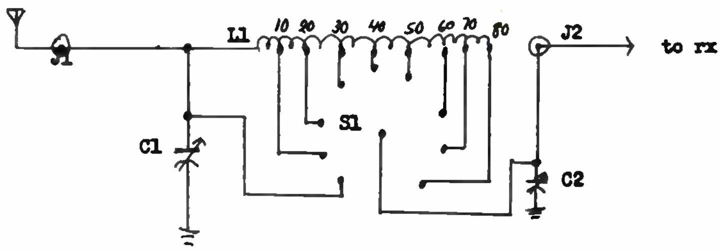
NOTE: For all tuners calling for BCB Hi-Q Ferrite Loopsticks, use either J.W. Miller part # 2001, Allied Radio part # 54 B 4398 or equivalent.

All S.P.S.T. switches should be either slide switches or toggles equipped with plastic handles to avoid body capacitance straying into tuner.

This particular tuner is technically a "Pi-Network Coupler", as is the following one. Both function best when the antenna runs a straight-line distance of 30 to 100 feet. As the length of the antenna approaches 100 feet, C3 in Figure C will be required in the circuit for most of the band, and may need to be increased in value in order to operate effectively at the low end of the band. At other lengths, C3 will only be needed at the low end.

The fifth antenna tuner to be discussed is similar in both theory and construction to the previous one, although it is perhaps a bit easier to build. It too, employs a self-wound coil, two variable capacitors, and a rotary switch. The coil consists of 80 to 180 turns (for full BCB coverage, at least 120 turns are recommended) of AWG # 18 enamelled wire on a coil form with a diameter of one and one quarter inches, and a length of four inches, tapped every ten turns. When purchasing both wire and the rotary switch, be sure to buy enough wire and a large enough switch to accomodate a coil of 180 turns, should you find it necessary to lengthen it. This simply means an 18 position switch. For simplicity's sake, the diagram below (Figure D) will depict only 80 turns, as the same principle is followed regardless of the number of turns.

Fig. D



Parts List: L1 - see text
J1, J2 - Coaxial cable connectors
C1, C2 - 365 pf. variable
S1 - Single pole, 8-18 position rotary switch

* *

The above tuner will work very nicely with a straight-line antenna of 30 to 100 feet also. You may find it necessary to add a fixed capacitor of 250-300 pf. in value in parallel with C1 for operation with longer antennas and/or low-band stations. Shields of coaxial connectors should be grounded to the chassis (if used) and to the frames of the capacitors. This particular tuner, as well as the previous one, may also double as a coupler-trimmer for a ham transmitting antenna, should you be using a longwire for that purpose.

Finally, we shall discuss the antenna tuning problem as it pertains to the DX'er who uses a transistor (battery-operated) receiver, or a simple table radio, or, in fact, any set which is not provided with external antenna connection terminals. As many DX'er have already discovered, the NRC loop is based upon the principle of inductive coupling, as the main turns of the loop are not electrically connected to the receiver. On a communications receiver, the coupling turn on the loop frame is wound around the main turns, and then connected to the antenna terminals on the set. With a receiver without antenna terminals, the smaller models may be held within the physical circumferance of the loop, which is then tuned normally. When circumstances do not permit the use of a loop, however, many DX'er become stymied by the problems involved in connecting an external antenna to their sets.

The answer is a Passive Booster, which operates on the same principle of inductive coupling as does the loop. In fact, this same booster may be used to couple a loop to a set without antenna terminals which is not physically able to be placed within the frame of the loop. The longwire (or loop) is connected to a tuning circuit as shown in Figure E, and, by placing the ferrite loopstick in close proximity to the built-in antenna in the receiver, an inductive coupling is achieved. C1 is a 365 pf. variable capacitor, and L1 is a BCB Hi-Q ferrite loopstick.

Fig. E-1

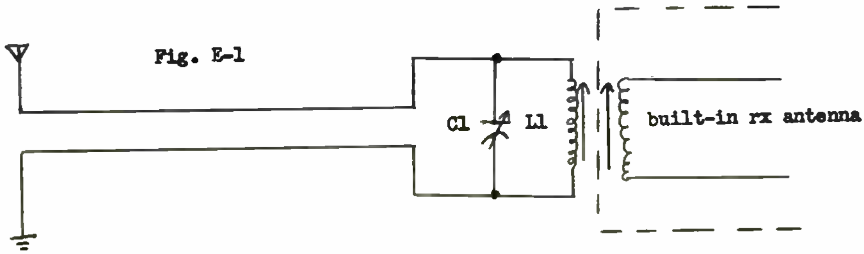
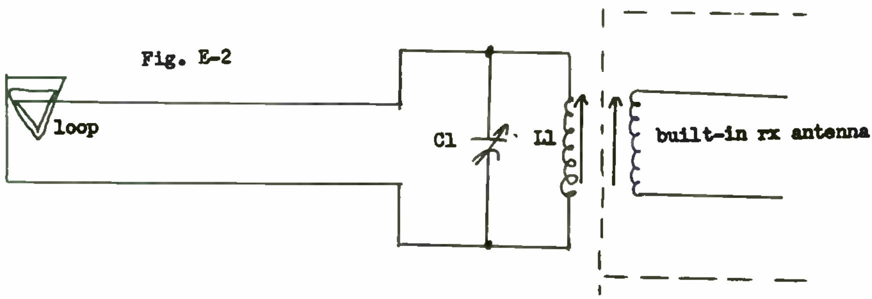


Fig. E-2



ALTERNATIVE METHODS OF AMPLIFICATION FOR AIR-CORE LOOPS

Russ Edmunds

Over the past few years, the BCB DXing fraternity has become greatly interested in loop antennas to replace the "traditional" longwire. This increased interest has evolved from research into and development of loop antennas suitable for DXing under today's overcrowding of the BCB. Most of the loop plans published to date have included different types of amplifiers to increase the amount of gain delivered to the MW receiver. The following comments are directed toward the area of loop amplification.

The most publicized and most effective loop amplifier developed thus far is the amplifier designed by Gordon Nelson for use with the NRC 4-foot Altazimuth loop. This amplifier provides variable gain in excess of 20 db. and utilizes a dual, balanced input and output. However, many of the loops in existence today are not NRC ALTAZIMUTH LOOPS, and therefore possibly not suitable for a balanced input amplifier. Also,one must not forget that many receivers are not equipped to accept a balanced input. Although this problem can be solved by use of a matching transformer or "balun", the cost to the often pennywise DXer may seem unjustified. One alternative to this seeming dilemma is to construct the single-ended 2N4360 amplifier noted in another NRC article; this amplifier is suitable for use with receivers having only one antenna terminal and a ground connection.

Another alternative is to purchase one or two of the commercially-available BAX-1 RF amplifiers from the International Crystal Manufacturing Company. These units come as kits and are easily assembled in an hour or so from the instructions provided. If your receiver has an unbalanced antenna input, only one BAX-1 unit is required; if the input is balanced, two BAX-1's should be used in parallel to create a "balanced" condition. However, it may well be that the two BAX-1 units you purchase will not have equal outputs in terms of gain and some semblance of loop imbalance will result. The solution here is to purchase a third unit and utilize the two most closely matched ones.

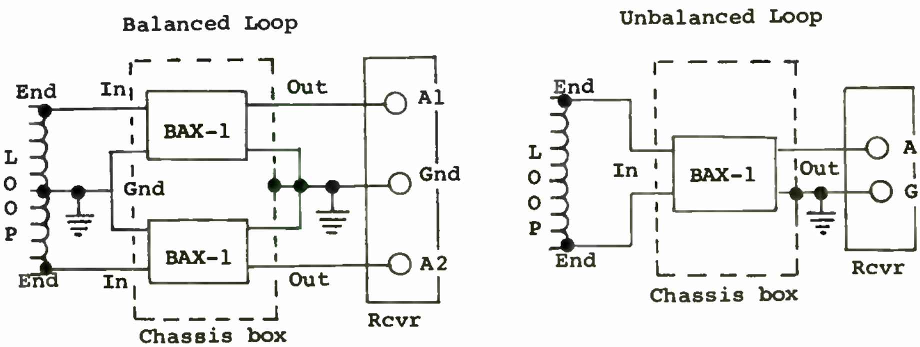
These BAX-1 amplifiers can be modified slightly to provide increased gain if desired. The modification to the BAX-1 amps is useable primarily in areas where there are no extremely strong local stations on the BCB. The BAX-1 kits include two 2.5 microfarad electrolytic capacitors for use in the broadband circuit; since our concern is the frequency range in the area of the Medium Wave BCB, a substitution of two 0.001 microfarad capacitors for the 2.5 microfarad electrolytics may be effected. Of course, if you find that your receiver overloads, it will be necessary to eliminate the substitution.

Another source of overload problems with the BAX-1 amp might result from excessive battery voltage; regardless of what the manufacturer's instructions state, you should use 9-volt batteries. The author has found the Eveready # 266 battery to be an excellent power source, as it has a relatively long life.

The BAX-1 amplifier kit comes with some miscellaneous hardware to be used for mounting the amplifier and some suggested schematics for its use as an antenna-gain amplifier. The manufacturer's schematic leaves something to be desired when one is attempting to make connection to a loop antenna; follow the wiring instructions below in diagram "A" of the ensuing appendix. As for the hardware, its inclusion should immediately tell you something: the mounting hardware means that the amplifiers MUST be mounted inside a well-shielded aluminum minibox in order to prevent such nasty side effects as vertical pickup, which primarily results in distortion of the loop's null pattern, or pickup and amplification of undesired images, TVI, harmonics, taper noise, general noise and so forth. Therefore it is urged that a small, aluminum minibox measuring approximately 2¼ x 2¼ x 4 inches be procured and mount the BAX-1 amplifier(s) inside it. Feed the battery power into the minibox by means of a nice shielded coaxial cable which is affixed to the batteries by means of convenient clips made specifically for the purpose. An on/off switch is suggested to naturally turn the unit on and off by removing or replacing the battery power. For the same reasons that make the minibox necessary, it is imperative to keep the output leads between the amplifier and the receiver, as well as the coaxial leads from the batteries as SHORT AS POSSIBLE; this means no more than 6 inches.

* *

APPENDIX: DIAGRAM "A"



BAX-1 RF Amplifiers are available @ $3.75 each from: International Crystal Mfg. Co., 10 North Lee, Oklahoma City, Oklahoma 73102, USA

* *

THE N. R. C. TWO--FOOT LOOP -- R. J. Edmunds

If you're unable to construct the usual 4" loop due to space problems, or if you want a portable loop for DX'ing while travelling, the 2-foot altazimuth amplified loop will satisfy your needs. It is relatively inexpensive to build, and fairly easy as well. The design concept is, of course, similar to most other air-cored box loops, and is patterned after Gordon Nelson's 4-foot FET altazimuth loop for which plans appeared in these pages a few years ago. Basically, we have reduced the size by about one-half, and compensated as many other factors as necessary to accomodate this size reduction. The result is a loop which will easily fit in an automobile trunk, a loop which will easily mount atop a convenient table or cabinet, or a loop which will even fit into a very large suitcase or moderate-sized trunk when broken down WITHOUT unwinding the main coil.

The 2-foot loop is amplified by two parallel International Crystal BAX-1 broadband RF amplifiers (see discussion in earlier article "Alternative Methods of Amplification for Air Core Loops" also by this author) which are well shielded, and mounted as near to the back of the receiver as possible to prevent undesirable vertical pickup effects. The main or tank coil consists of 19 turns of #16 guage wire, and the link coil consists of 2 turns of either the same or of #18 guage. The feed line is described in the plans later on.

The diagrams following this text will provide all the construction details which should be necessary for one who is familiar with box-loop antennae at all. If the reader is not, he is encouraged to do further research before attempting this project. The parts list will follow the diagrams for construction, and photographs of the finished product from several views will conclude this article.

The loop may be mounted in any of several ways. It can be used with a tripod array as used by this author, which is really a roof-mount antenna support; or it can be affixed to the vertical surface of a cabinet so as to protrude above it; or it can be affixed to a table top. A separate stand can also be made if one is desired. The tripod mounting is achieved by closing off the bottom end of the small section of pipe which provides the rotation mounting, or simply by drilling a small hole through the support dowel just above the point where it is covered by the pipe and running a small nail or metal rod to prevent the dowel from sinking any further into the pipe.

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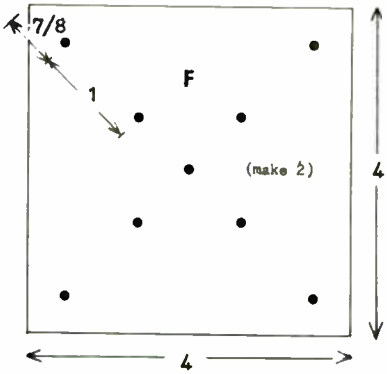
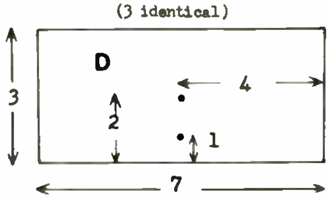
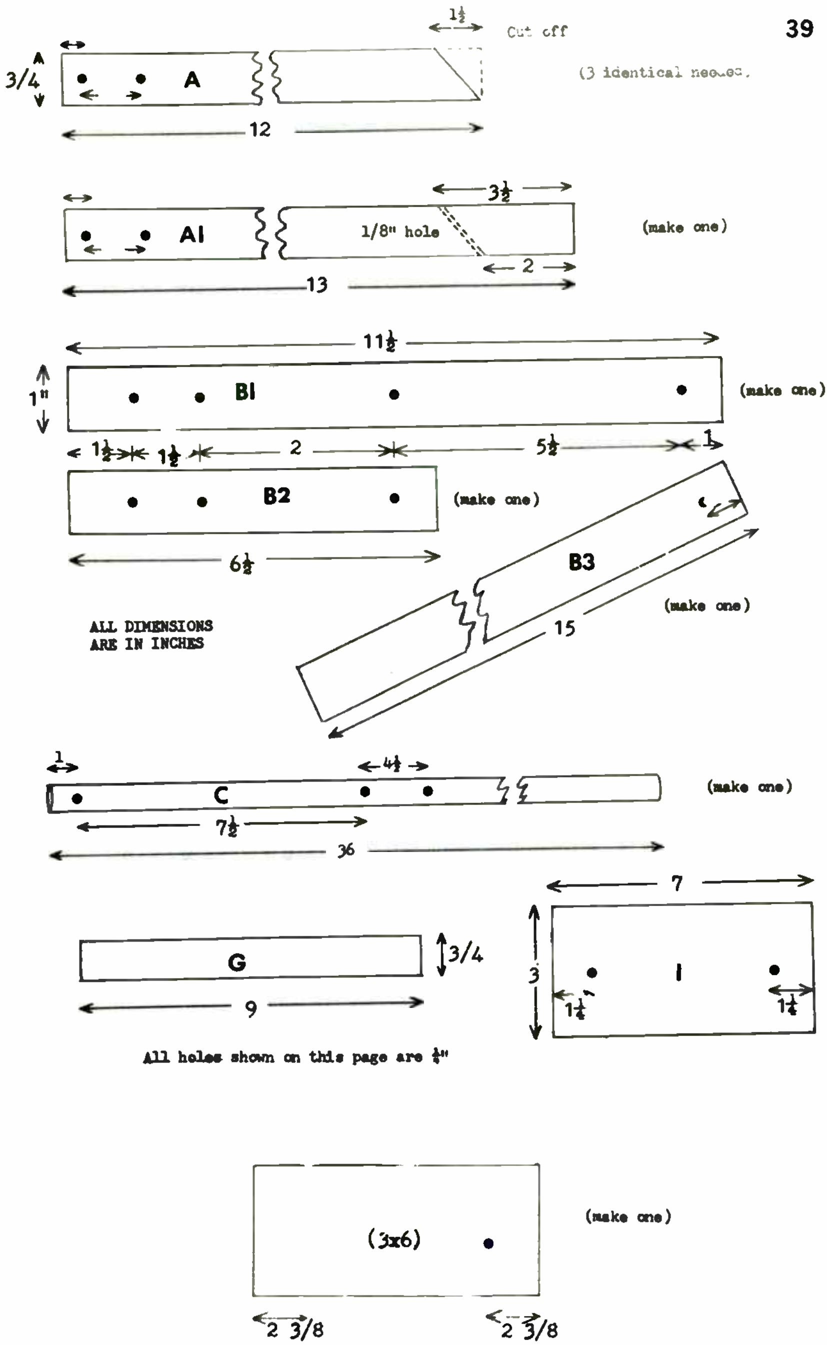
(Letters in diagrams refer to designations of the parts list)

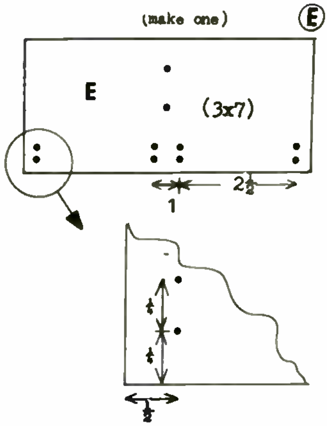




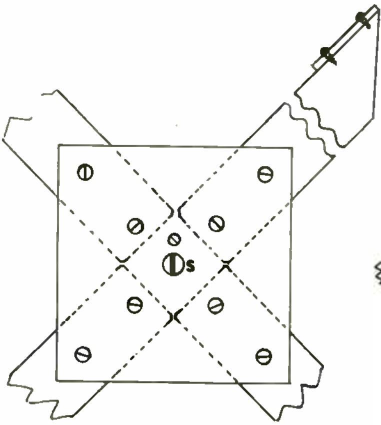


ALL DIMENSIONS ARE IN INCHES

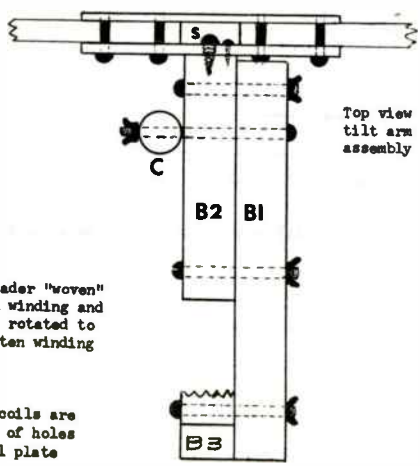
All holes shown on this page are ¼"



FEEDLINE: Cut plugs off extender leads and pull out fine wire inside. Replace with fine insulated hookup wire. Strip back the insulation on each end and untwist about one inch of shield. Twist the shields together at one end, tape the cables together every 6" or so along their lengths. Cut the far ends so they are even and connect the shields together after stripping back 1" of insulation. Carefully cut off a patch of insulation on each cable a foot from each end and solder the shields together.

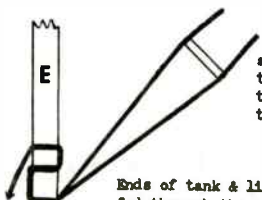


Side view of center plate assembly. The heavy screw marked "s" mounts the loop frame onto the tilt arms; a second smaller wood screw slighly off to the side will prevent the face from working loose. Note that screw "s" must be fastened to B2 before bolting center plates together!



Top view of tilt arm assembly

side view



spreader "woven" thru winding and then rotated to tighten winding

Ends of tank & link coils are fed through the pair of holes on bottom of terminal plate

to tuning capacitor

(Letters correspond to diagrams preceding)
Part K available from G. R. Whitehouse & Co., Newberry Dr., Amherst, NH 03031 .
Parts U available from International Crystal Co., 10 No. Lee, Oklahoma City, OK 73102
All other parts should be available locally .

WOOD:
A) Cross arms (3/4" x 1-5/8" stock; a total of 5' needed)
B) Tilt arms (1" sq. stock; a total of 3' needed)
C) Mounting shaft (3/4" dowel; 3' long)

Preferably plastic, plywood acceptable however:
(1/8" Bakelite is extremely suited to this purpose)
D) Arm plates (3 identical)
E) Terminal arm plate (1 needed)
F) Center braces (2 identical)
G) Spreaders (4 or 8 identical - see note below)
I) Tilt lock plate (1 needed)

MUST BE PLASTIC:
J) Capacitor mounting plate (1 needed)

OTHER:
K) Tuning capacitor, 325 pfd linear wavelength; Hammarlund MC-325-M,

L) Tuning range switch, miniature toggle;
M) Tuning range capacitor, 200 pfd, silver dipped mica;

O) Tank coil, #16 gauge stranded wire, plastic insulation (115' needed, comes in 100' spools)
P) Link coil, #16 (or #18) gauge stranded wire, plastic insulation (15' needed)
Q) Tuning shaft extender (1 needed) , 6" plastic. ¼" diameter
R) Tuning shaft coupler (1 needed) , ¼" to ¼";
S) Plastic knob (1 needed) ¼" shaft.
T) Terminal strip, 3-connection Cinch-Jones Series 164;
U) Loop amplifiers: International Crystal BAX-1 Broadband RF amplifiers (2 needed)
V) Transmission line; 2 pieces of air-cored, low-capacity cable; this type has no RG designation and is used only for automobile antenna leads; 36" universal extension lead, (You may need more length, depending on how the loop is to be mounted. If so use anywhere up to 72" length, also commonly available)
W) Batteries, Everready #266 or #276 (2 needed, one for each BAX-1)
X) Mounting shaft stand: 1' length of 3/4" inner diameter pipe, threaded outside one or both ends; and floor flange threaded to accept pipe segment. (floor flange needed only for bolted upright mounting. Not necessary for tripod or alongside-cabinet mounting)

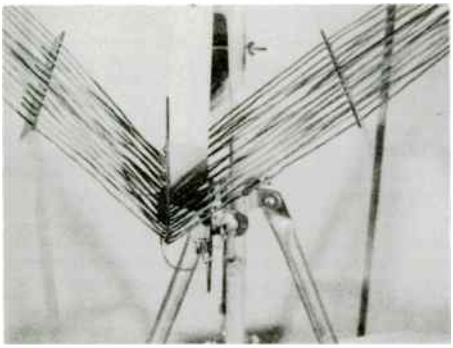
NOTES: With a loop of this size, although 8 spreaders are ideal, the coil may be too tightly wound to accept them. Use four, and, if at a later date the coil should appear to have slackened significantly, try adding the others

SMALL PARTS NOT SHOWN IN DIAGRAMS:

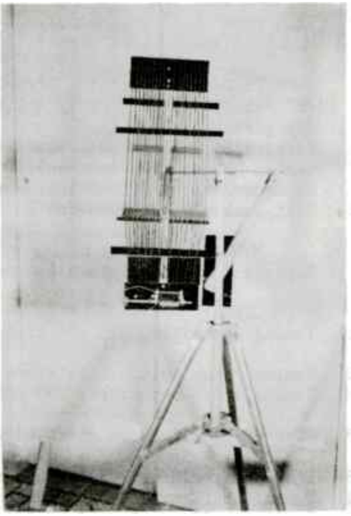
7) machine bolts , round head, with wingnuts and washers, size 1½ x 6.
2) machine bolts , round head, with wingnuts and washers, size 2½ x 6.

3) machine bolts, round head, with wingnuts and washers, size 3x6
1) machine bolt, round head, with wingnut and washer, size 4 x 6.
10) Number 10 round headed wood screws, ½" long. (to mount arm plates)
2) Number 6 machine screws, 3/8" long (to mount tuning capacitor)
2) Number 6 round headed wood screws 1½" long (to brace loop to tilt arm)
2) Number 6 round headed wood screws ½" long (to mount terminal strip)

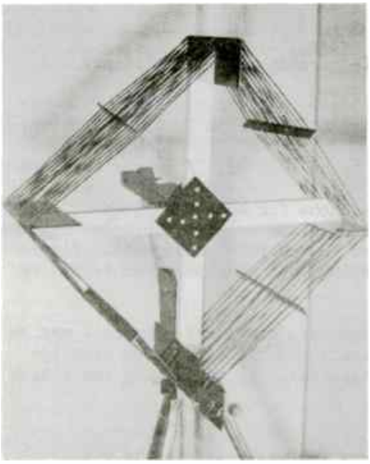
NOTES: 1½ x 6 bolts for braces/arms; 2½ x 6 bolts for lower two mounting bolts on B1 in top view of tilt arm assembly; 3 x 6 bolts for tilt arm lock plate; 4 x 6 bolt to mount tilt arm assembly to mounting shaft.



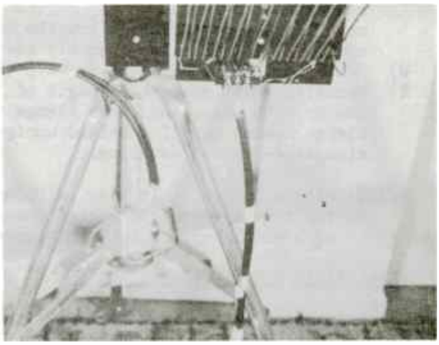
1. Capacitor mounting plate, tripod mount, front view.



2. Tripod-mounted 2' loop, side view



3. Tripod-mounted 2' loop, front view



4. Terminal strip, feedline, and amplifiers (in box)

HQ TESTS THE "SPACE MAGNET" LOOP ANTENNA

Many members of NRC and IRCA have recently received copies of the advertisement shown on the opposite page along with a note to the effect that "The attached is being sent to a few nearby DX'ers. I have made a couple of these for $29.50 (plus postage) and while it has turned out to be a hard way to 'make a buck', I would like to build a few more in order to obtain some exposure for the device before constructional details appear in DX Monitor". To date there has been no mention in DXM of the upcoming availability of the plans and flyers have gone out to many (if not essentially all) of the membership for this commercial item (the name "Space Magnet" has been trade-marked by the manufacturer). We were able to obtain one of the fairly early versions and have been testing it extensively under actual DX'ing conditions in side-by-side comparison with the big NRC Altazimuth Loop (plans in Volume 37, Number 1 of DX NEWS); we've also determined some of the characteristics of the "Space Magnet" using laboratory test equipment.

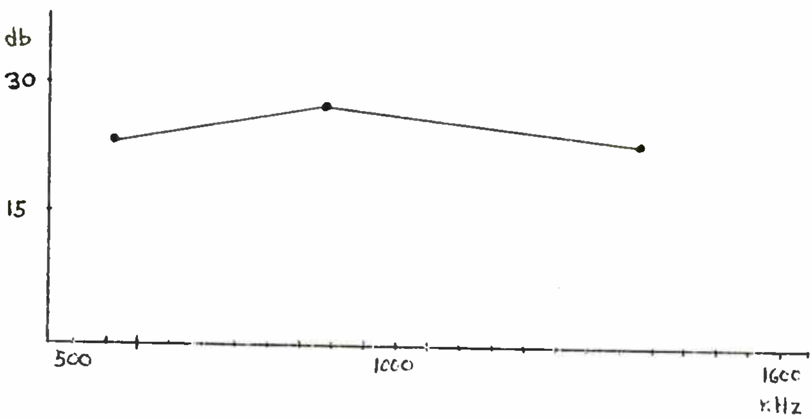
Electrically the SM-1 consists of large ferrite rod, 12" long and 5/8" in diameter, wound with a multi-turn tank coil of rather heavy Litz wire and resonated with a miniature Japanese tuning capacitor. The output of the one-turn link coil is fed directly into the base of the first stage of a two transistor RF amplifier in ordinary common-emitter configuration (bipolar transistors and not FET's are used). The output of the amplifier is to be connected to the receiver with the short piece of miniature coaxial cable supplied. The aluminum box surrounding the ferrite and amplifier forms the "electrostatic shield" and, while not visible in the photograph, is open on the ends. Tuning is performed with a Micronta vernier dial (uncalibrated) and there is no provision for altazimuth operation, i.e., the entire box rotates but cannot be tilted. The amplifier is powered by a small 9 volt battery mounted outside and there is no provision for varying the gain or sensitivity of the amplifier.

After checking that the battery was good, we hooked it up and arranged so that we could rapidly switch from the big loop to the SM-1 for relative comparison. It being early evening, we set the receiver on 764 kHz and tuned in Dakar with the big loop; conditions were pretty good and we found an S8 carrier with fair audio and lots of WABC splash. Switching to the "Space Magnet" we were impressed to find almost an identical signal from Dakar - until we remembered that the big loop was still tuned to Dakar and the SM-1 was obviously just picking up the near field of the big loop! Upon detuning the big loop to eliminate the interaction, the signal dropped to about S3. On our equipment this corresponds to a drop in signal strength of about 25 db (exact figures appear later in this article) and this later proved to be typical of the relative pickup of the two loops. The tuning of the SM-1 appeared to be quite sharp but as we rotated the SM-1 to check on the null depth we discovered the first serious design flaw: the aluminum case is RF "hot" and touching the case to rotate the antenna, or even coming near with your hand, drops the signal pickup substantially. This is one symptom arising from the fact that the SM-1 is electrically imbalanced - a point we to which we shall return shortly in connection with null depth. Since the chassis is "hot", the antenna must be rotated by holding onto the insulated tuning knob; because of the sharp tuning of the vernier, this frequently necessitates retuning. This problem could be easily eliminated by attaching an insulated knob to the aluminum shield.

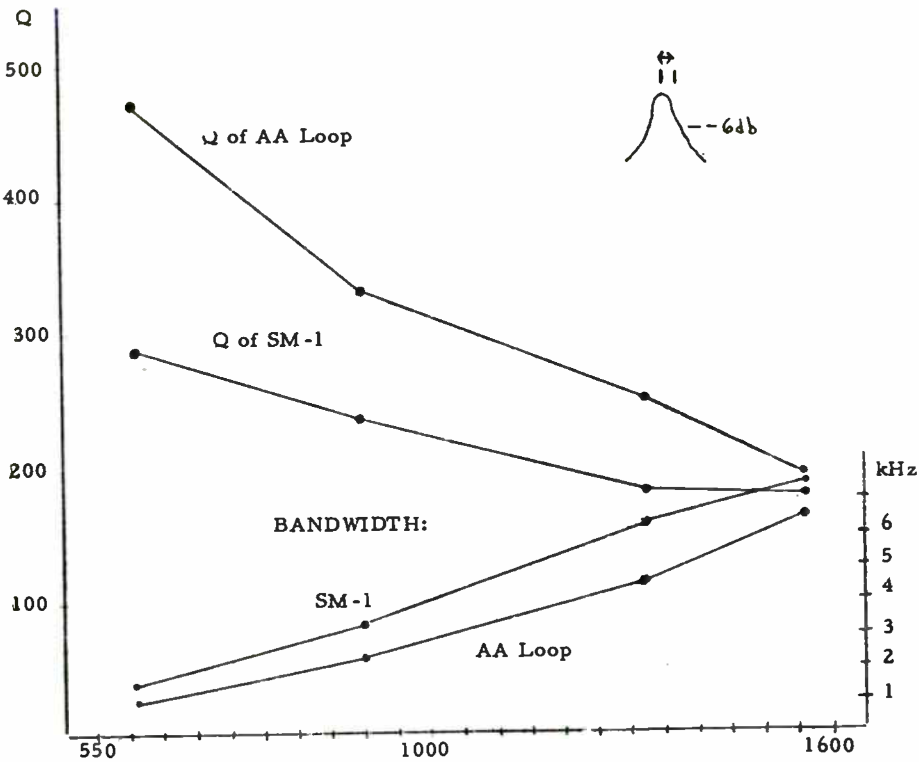
The 25 db drop in signal pickup with the SM-1 means that the big loop is delivering something over 10 times as much signal as the SM-1; not bad at all, we thought, since the physical diameter of the SM-1 tank coil was only 5/8". But as we swung the SM-1 around to null out Dakar we discovered a second design problem; Dakar's signal, only S3 to begin with was indeed totally nulled out - but instead of then hearing just background band noise, a very distinct "hiss" generated by the SM-1 amplifier was audible. Switching back to the big loop and nulling out Dakar yielded just background band noise with no trace of the noise generated by the twin loop FET's.

The reason for the apparent sensitivity of the SM-1 then became obvious; the gain of the two transistor amplifier is very high. But, since the noise generated by the transistors is also being amplified by the same amount as the loop signal, much of the apparent gain is "empty gain", that is, it's accompanied by a proportional increase in the amount of noise generated by the amplifier itself. In practice this means that weak signals just at the threshold of atmospheric noise are obscured by the noise generated by the SM-1 amplifier. This background amplifier hiss frequently impaired the audio quality of weak signals; signals buried in the noise generated by the SM-1 were frequently readable on the big loop. Whether this poor signal to noise ratio is common to all "Space Magnets" or is due to a noisy transistor in our particular unit is unknown.

Figure 1 shows the relative drop in signal strength upon switching from the big loop to the SM-1; measurements were made oscillographically using a precision Telonic RF attenuator checked against MIT calibration standards. Note that this is just the apparent difference in pickup, neglecting the critical noise factor.



The next quantity we measured was the tuning sharpness or Q of the antenna. Up to a point, the higher the Q the better; the high antenna selectivity helps greatly to reduce overload and spurious responses from powerful local signals. Too high a loop Q, however, is frequently undesirabl because the "sharpness" of the tuning can actually cut sidebands on the desired signal and produce "muddy" audio. This is particularly damaging if you have gone to the time and trouble to get a flat IF passband with the use of mechanical filters. In the Altazimuth loop design the Q control permits the operator to "open up" the tuning characteristic to obtain better audio when he so desires; this is most important at the bottom of the band. In addition to the relative Q values, we have also plotted the 6 db bandwidth for that frequency and Q; as shown in the diagram this is how wide the loop passband is from center to a point 6 db down.



From the passband figure it is obvious that both antennas have high enough Q on the bottom of the band to cut sidebands by a significant amount; the lack of a Q control on the SM-1 is thus a real disadvantage.

The next measurements were for null depth. The unbalanced circuitry of the SM-1 results in pronounced null-blunting and skewing; see last week's issue of DX NEWS for more information on the cause and effects of null skewing. The measurements were made on our local Boston area stations at high noon; none of these stations is more distant than 14 miles; some, such as WCAS and WCOP are within a mile or two. For the Space Magnet we have given the depths of both nulls and the deviation of null azimuth from the ideal figure of 180°. The latter figures were made with the aid of 10" circular setting circle which we mounted on the base of the SM-1. The Altazimuth antenna was both rotated and tilted to obtain null; asymmetry figures for the Altazimuth loop are not given because the nulls are uniformly within 0.05° of true and within 1/2 db in depth. In the event that the signal was nulled down so far that only backscattered skywave was audible, we've given an indication of the minimum value of the null depth; with no carrier remaining this is a difficult measurement to make at best.

STATION	SM-1 NULL DEPTHS		NULL SKEW (degrees)	ALTAZIMUTH NULL DEPTH
WEEI	14 db	7 db	4	greater than 80 db
WRKO	15 db	6 db	5	greater than 80 db
WCAS	14 db	29 db	4	greater than 70 db
WHDH	8 db	6 db	3	26 db
WBZ	24 db	22 db	2.5	greater than 80 db
WILD	26 db	30 db	5	greater than 65 db
WCOP	22 db	18 db	2	greater than 80 db
WCRB	23 db	20 db	1.5	greater than 70 db
WHIL	22 db	17 db	5	44 db
WMEX	8 db	13 db	5	greater than 80 db
WNTN	11 db	15 db	5	greater than 70 db
WUNR	10 db	14 db	5	greater than 65 db

The next property we checked out on the SM-1 was the shielding; according to the flyer, it is "completely shielded from electrostatic noise". Loop antennas are shielded by surrounding the windings with a conductor which does not form a complete shorted turn. Circular aircraft-type DF loops are usually shielded with a toroidal metal shield with an air-gap someplace along the periphery and the SM-1 is shielded by the aluminum case along the outside of the assembly. What are the effects of shielding a loop antenna? The primary reason for shielding a loop antenna - and the reason why virtually all loop direction finders used for navigation purposes are shielded - is that shielding will reduce the pickup of very nearby electrical noise. By very nearby we mean just that: noise that is being generated so near to the antenna that the actual dimen ions of the antenna become significant. Loops intended for aircraft and shipboard use have traditionally been shielded because their exposed locations tend to generate severe electrical noise due to static electrical discharges from the antenna structures themselves. Because the noise-generating discharges from navigation-type loop antennas occur very near the antenna, electrostatic shielding is essential to reduce the static produced by these nearby static discharges.

Electrostatic shielding of a loop antenna is not necessarily always desirable though. The presence of the shield around the loop winding reduces the Q of the primary pickup coil and results in a reduction of loop pickup of about 6 db (a factor of two). The exact pickup reduction depends upon the distance from the the shield to the coil, the width of the gap in the shield, the frequency, and a number of other physical and electrical parameters better measured than calculated... Note that the roughly 6 db signal pickup reduction introduced by the presence of the shield is effectively a reduction in antenna pickup; that is, the presence of the shield, local noise effects neglected, significantly degrades the signal to noise pickup of a loop in the event that the loop pickup and input amplifier noise levels are roughly the same.

To check out the shielding of the SM-1 we set up an electrically very noisy discharge tube at some distance from the two loops under test. This tube was a defective fluorescent bulb which generates very strong noise spikes; careful shielding of the power lines guaranteed that only near-field pickup took place. At a distance of 5 feet the SM-1 was very significantly quieter than the big FET Altazimuth loop; the relative signal to noise pickup compared to a standard distant reference signal was at least 20 db in favor of the SM-1. But when the noise generator was moved to a distance of about 40 feet (which is relatively large compared to the dimensions of either loop) there was no measurable difference in signal to noise ratio between the SM-1 and the larger antenna. We then removed the shield from the SM-1 (with the noise source still 40 feet away) and measured an increase in signal and noise pickup of about 5 db; i.e., both the signal and noise increased by the same amount within the error of measurement.

The shielding on the SM-1 is quite significant but only if the noise source is very nearby, within roughly 20 feet, for example. Beyond that distance, the effect of a bad BCB noise source such as a neon sign or SCR light dimmer appears to be the same for either a shielded or unshielded loop. This is consistent with the reported near-field loop effects reported in the literature over the years.

For the loop-using DX'er this means that use of the SM-1 will permit the logging of otherwise inaudible stations if and only if the local noise is generated by appliances within a distance of say 30 feet; otherwise there will be no significant improvement in electrostatic signal to noise pickup between the shielded SM-1 and an ordinary unshielded magnetic loop. The removal of the shielding from the SM-1 will result in a pickup improvement of up to 5 db, however; if you happen to be in an electrically quiet area and are trying for a weak signal right at the level of the noise generated by the SM-1 front-end amplifier, this additional gain can make all of the difference between a certain logging and not. Whether or not the shielding of the SM-1 is an advantage or not depends upon a number of rather complex factors: the location of nearby noise sources, the gain and noise figure of the receiver in use, local background noise level, etc. Generally speaking, urban DX'ers -especially apartment dwellers - should notice a significant improvement in local noise rejection using an SM-1; DX'ers out in the sticks will probably feel that the SM-1 is not delivering as much signal as a longwire, especially while DX'ing during mid-day or during quiet MM's.

Overload and crossmodulation are extremely difficult to measure accurately. The only technique for measuring overload that we've found to be satisfactory for loops is to compare the azimuthal pickup for the loop-amplifier under test with that expected from an ideal cosine pattern. (The effects of loop pickup from sources other than the loop's magnetic dipole pattern are very minor in the pattern peak as compared to the effective null distortion produced). Using this technique we found that the SM-1 was rather sensitive to overload compared to the FET Altazimuth loop; while the response of the Altazimuth loop tended to "flatten out" on very strong locals such as WRKO, WHDH, and WCOP, the SM-1 began to flatten out at least 30° earlier to pattern center peak than did the AAL. Audio on our most powerful local stations was noticeably distorted on the SM-1 but not so on the AAL.

Since receiving the original flyer for the SM-1, we've gotten a copy of an updated version featuring a "deluxe" model of the SM-1 containing a 'distant - local' switch, presumably to compensate for the SM-1's overload sensitivity. While we haven't seen a schematic for the improved version (available for about $5 extra), it's hard to imagine any circuit alterations capable of reducing overload sensitivity without adversely affecting the signal to noise ratio of the antenna-amplifier combination.

The next problem we checked for was one we had experienced quite some difficulty with in the design of the Altazimuth antenna: crossmodulation in the loop amplifier. Croosmodulation is the undesired transfer of programming from a strong signal to a weaker signal on a nearby channel. If, for example you have a very strong station locally on 1030 kHz, crossmodulation would show as the programming audio from the 1030 station appearing also on 1020 and 1040 kHz weakly in the background. Many DX'ers have experienced this effect one time or another - it is one of the first symptoms to start showing up when an RF or mixer tube goes bad. Ordinary transistors (i.e., non-field effect types) are often quite bad about crossmodulating; while FET's are supposed to be quite immune to this defect, it's been our experience that this is only so when proper care is taken in the selection of the operating point. We tested each antenna for crossmodulation by carefully tuning each to 1500 kHz (peaking each on a 1500 kHz local signal generated by the frequency meter) and then checking for the presence of audio from 50 kw local WMEX on 1510 kHz. 1500 kHz is very close to clear here under those circumstances - just the slightest traces of WFIF and WTOP - and this has always served us as a very sensitive test for crossmodulation. Under the test conditions we found weak but definite traces of WMEX audio on 1500 kHz due to crossmodulation in the SM-1 amplifier. It's pretty much meaningless to try and assign a quantitative figure to crossmodulation in this type of test; the effective audio transfer is great enough however to be a nuisance if trying to DX weak channels adjacent to locals on a quiet MM, for example. When the same test was tried on the FET Altazimuth loop, crossmodulation varied from undetectable to very much worse than the SM-1 depending upon how carefully the FET amplifier was adjusted for neutralization! This is a significant problem in the FET loop with some transistors; crossmodulation can appear to be a problem on the top of the band if sufficient care is not given to the cross-neutralization adjustment. Adjustment of the neutralizing caps will always eventually clear up the problem but the adjustment is sometimes more critical than we'd like.

In summary then, the relative performance of the SM-1 and FET Altazimuth loops is as follows:

a. Apparent signal pickup. The FET AA loop provided a bit more than 20 db gain improvement over the SM-1 as judged from the oscillographic equivalent of a straight S-meter reading. This corresponds to a difference in signal strength of about 10.

b. Relative signal pickup (including amplifier noise). Because the noise generated by the SM-1 amplifier in the unit we tested was stronger than background atmospheric noise level, the actual useful gain of the FET loop is considerably in excess of the 23 db apparent "S-meter" difference recorded.

c. Tuning sharpness (Q). The Q of the SM-1, while less than that of the FET AA, is nonetheless very high - a feature which can lead to the loss of some audio quality on the bottom of the band due to sideband cutting; this problem can be eliminated with the use of the Q control on the FET AA however.

d. Null depth (ability to eliminate a very strong local). Due to the basic electrostatic imbalance in the SM-1 design and its inability to compensate for wave tilt (i.e., only rotation, no tilting), some stations which can be easily be totally eliminated with the FET AA loop will demonstrate only shallow nulls on the SM-1. Under some circumstances of signal wavefront polarization figure, frequency, etc., the SM-1 can show nulls as deep as the FET AA but, because of the superior electrostatic balance of the AA, the SM-1 will never show nulls deeper than the AA's.

e. Pattern symmetry (direction-finding accuracy). Again, because of the unbalanced configuration of the SM-1, the pattern is skewed; while fine for rough direction finding on stations, attempts to use the SM-1 for close DF work on skywave signals (within say, plus or minus 5 degrees) will show significant and unpredictable errors due to the interaction of wave polarization effects with the distorted pattern of the SM-1.

f. Overload (distortion on strong signals). SM-1 is significantly more prone to overload than is the AA loop; this defect has been presumably cured in the improved version now available at additional cost.

g. Crossmodulation (strong signal audio transfer). FET AA loop superior to SM-1 only if carefully adjusted, otherwise inferior (especially at the top of the band).

h. Shielding efficiency (near-field noise quieting). In the presence of very nearby sources of electrical noise (within say 20 feet; in the next apartment, for example) the SM-1 will provide a significantly quieter signal than the larger loop; beyond that distance the performance is essentially identical as best we can tell.

Lest we appear to finish this comparative review on a seemingly discouraging note we hasten to point out that the SM-1 will very likely outperform any unamplified non-altazimuth loop you might be using now. Compared, for example, to an old NRC box loop or an IRCA spiral used with a relatively insensitive receiver, the SM-1 should be a distinct improvement as far as the rejection of spurious responses and local noise is concerned and may, in some but not all cases, show better nulling and improved weak signal pickup (bearing in mind signal to noise ratio). DX'ers using simple loops and insensitive receivers will notice a considerably more dramatic improvement when switching to the SM-1 than those using highly sensitive receivers such as the HQ-180, etc. By the same token, the DX'er who replaces an outside longwire with an SM-1 may or may not find it to be superior (direction properties ignored); local noise generators, the sharpness of the antenna tuning for the longwire, receiver noise level - all these factors must be considered. One class of DX'er who's guaranteed to notice a great improvement in reception upon switching to an SM-1 is the urban DX'er who's been getting by with a short piece of wire in a noisy apartment building! The gain, compact size, noise rejection, and directional properties of the SM-1 should seem very impressive indeed!

THE SPACE MAGNET ---- HOW GOOD IS IT ??

-- Don Kenney

Author's note. This article appeared originally in the January 23rd issue of DX Monitor. Some additional comments have been added at the end of the article

Recently two articles have appeared in the BCB club bulletins reviewing a ferrite core loop antenna known as the Space Magnet. One by Percy Kesteven (DX Monitor, Dec.19th, 1970 was highly complimentary. The other by Gordon Nelson (DX News, Dec. 19th, 1970, Page 11) was much less so. What's the real story?

I've had the opportunity to test a Space Magnet which was kindly lent to me by Dick Nelson. Testing included comparison with a 30 inch balanced loop using a push-pull FET pre-amp, as well as with a 14" long ferrite core loop. All of the tests run by Gordon Nelson were either run independently or re-run, albeit with rather limited test equipment.

Those who bore easily should now skip directly to the section entitled CONCLUSIONS.

WHAT IS THE SPACE MAGNET?

The Space Magnet is a 12 inch ferrite core loop antenna. It comes in a 3"x3" x12" aluminum shield which is mounted on a wooden base. It has vernier tuning dial and includes a bipolar transistor amplifier powered by an easily accessible (and inexpensive) 9 volt transistor radio battery. It sells for $29.95. A deluxe version wound with litz wire and including a local/distant switch is availible for $34.95. The version tested was a hybrid -- it was wound with litz, but did not include the local/distant switch. The source for these antennas is Worcester Electronics Laboratory, R.D.1, Frankfort, New York, 13340.

DOES IT WORK?

Yes. About the second thing I heard when I turned it on, on the evening of Nov. 4th was a TA carrier on 1034. Despite the dismal conditions dring the late Fall and early Winter, a considerable number of foreign stations were noted. The one extended DX session I tried with it produced loggings from 14 countries prior to midnight PST. As far as the capability to pull in remote stations at night and to loop out interference, the performance seemed very close to that of the air core loop.

DOES IT HAVE ADVANTAGES OVER AN AIR WOUND LOOP?

Yes. It is portable. It is attractive. It is already assembled. If you travel a lot, or are in the military, or are married (women and loops do not seem to be very compatible), this may be the answer to your problems. This antenna will (or can be simply modified to) fit into a suitcase. Furthermore, even though the wife, girl friend, or platoon sargent may not like it, they will like it about six orders of magnitude more than they like an air core loop.

The fact that the loop is already assembled should appeal to those lacking in either the ability or the desire to build things as well as to those lacking the tools. The cost is comperable to the cost of an air core loop of comperable performance, with the construction labor figured at about 10¢ an hour. For an air core loop of superior performance, such as the NRC alt-azimuth loop, figure $15-25 for the parts and about 50-100 hours construction and debugging time.

DOES THE SPACE MAGNET HAVE DEFECTS?

Yes. Quite a number, in fact. Most of them appear to be fairly minor under most conditions. Part I of Nelson's article discussed some of them. [Note only part I is discussed since this was written prior to the appearance of. Part 2 in the Jan 23, 1971 issue of DX News.]

In discussing these faults, it must be remembered that Nelson is discussing the deficiencies of the Space Magnet relative to the theoretical "ideal" loop antenna. The NRC alt-azimuth loop would appear to approach this "ideal" loop very closely. The Space Magnet is not as close an approach to the "ideal" loop, but then neither are the miscellany of DCL, box,spiral, etc. loops in general use.

Nelson noted a number of defects. I'll discuss these in the order in which he brought them up:

1. The aluminum case is RF hot and causes a change in loop tuning when one touches it, or brings one's hand near it. The concept certainly makes sense, but no such effect could be observed here with either the HQ-160 or Heath GR-78 so long as the Space Magnet ground lead was connected to receiver ground. [Note: See additional comments at end of article.]

2. Sensitivity is inadequate. Tests here simply do not bear that out. Using a Heath GR-78 with a 2.1kc mechanical filter, it is possible to listen to barely audible external mixing products fade up to readability as atmospheric noise levels drop at dawn. This would not be possible if transistor noise levels were comperable to nighttime atmospheric noise levels. Possibly, the unit tested by Nelson may have had a noisier transistor. [Note: the unit tested by GPN was also wound with litz]

3. The Space Magnet Q is high enough to cause "distortion".[Note. As GPN has correctly pointed out to me, this is the wrong word. The actual effect is that caused by any sharply tuned circuit such as a Q-multiplier, a roll-off of the higher audio frequencies. "Distortion" is something else entirely, but I can"t think of a word that adequately describes the actual effect, so "distortion" will be used incorrectly for the remainder of this paragraph.] My rather primitive Q measurements agree with Nelson's. However, I personally do not find the audio passband distortion to be objectionable. Some DXers may. The "distortion" can be minimized by tuning the Space Magnet 1 kc or so above or below the signal being tuned. Perhaps if enough DXers complain, Mr. Worcester might incorporate a Q-control on future models. Those with inexpensive receivers may appreciate the extra selectivity availible from the Space Magnet because of the high Q.

4. Nulls from the Space Magnet are skewed and are of unequal depth. This test was repeated on several local stations. Some skewing and blunting of nulls was observed. It was evident that much of this was due to signal pickup on the feedline from the antenna to the receiver. Skews of 5^{o} on KHJ and KFI were cut to 1^{o} when the test set-up was cleaned up to minimize lead lengths. It is important that the lead connecting the Space Magnet to the recevier be as short as possible.

Although the Space Magnet was not designed to be tilted, it can (just barely) be done. This was done with KFI to get a null depth measurement. I have little faith in my test equipment when it comes to measuring attenuations of over 20db. The comparison of results would have been simplified if Neson had published null depth figures for an untilted NRC loop.

STATION	NULL DEPTHS		SKEW	TILTED NULL-DEPTH
KLAC-570	12db	13db	1^{o}	
KFI-640	18db	17db	1^{o}	Estimated at least 40-50db
KHJ-930	24db	24db	1^{o}	
KFAC-1330	12db	13db	less than 1^{o}	
KDAY-]580	13db	13db	unknown	

The skewing on KDAY would have required many more measurements as the null was shifting rapidly over about 10^{o}:

This data indicates that the Space Magnet is not as good an approximation to the ideal loop as is the NRC loop, but that its performance is quite good.

The Space Magnet would be more useful if it included a provision for tilting the antenna.

5. Another defect is the fact that the bipolar transistors used in the amplifier will cross-modulate on strong signals. Thus when the loop is tuned through a strong signal, the station's signal will turn up superimposed upon whatever signal the receiver is tuned to. The Q of the Space Magnet is high enough so that this is not a problem at my Santa Monica location, but it could be a problem for those who live close to a transmitter. Close to a transmitter, the signal may get strong enough to impress itself upon adjacent channels. Thus at some distance from KNX-1070(for example), KNX will become so strong that it cross modulates onto signals on 1060 and 1080 even though the antenna is tuned to 1060 or 1080. Even closer, 1050 and 1090 (what loss?) will be taken out, etc. The deluxe version of the Space Magnet handels this by means of a local/distant switch which is intended to sacrifice some amplifier gain to get better cross-modulation performance. If you've had past problems with strong signal overload of your equipment at your location, I'd recommend purchase of the deluxe version.

A second problem with cross-modulation is that the DXer must be aware of it. It is fairly easy to imagine even an experianced DXer tuning to 720 on a Sunday evening, and inadvertantly tuning the loop to semi-local (and very loud) XETRA-690. The result - a logging of a mystery Mexican on 720 with La Hora Nacional

6. Another problem is not so much a defect as a peculiarity. Signal levels from such nuisances as external mixing products and TV local oscillator signals tend to vary widely in a relatively small area. The Space Magnet is small enough so that its performance may vary widely when moved a small distance. I discovered this the hard way, by placing the antenna on a workbench which had a power line running along its bottom side. The result was almost intolerable TV oscillator harmonics every 15kc. Moving the antenna three feet cut the buzz level by 20 db.

CONCLUSIONS.

The Space Magnet is a compact, attractive antenna suitable for serious DXing under Winter nighttime conditions. It will certainly outperform long-wire antenna (with the exception of the Beverage) and loops without pre-amps. It can probably be expected to perform on a par with many loops utilizing pre-amps. It can not be expected to outperform large balanced loops utilizing FET pre-amps.

It should have a strong appeal to those with limited mechanical ability or inclination, and to those who are looking for a compact loop for use when traveling. Those who have had difficulty with strong signals from locals overloading tneir equipment, or who are interested in very weak signal (daytime) reception should consider paying the extra $5.00 for the deluxe version of the antenna.

RECOMMENDATIONS TO SPACE MAGNET OWNERS

1. Keep the lead from the antenna to the receiver short (6 inches would be a good goal to shoot for.)

2. Move it around some while trying it out. It may perform better in some parts of the room than in others.

3. Check the battery from time to time.

4. Make sure that the antenna ground wire (the outside of the shield) is connected to the receiver ground terminal.

5. Make sure that the antenna and the receiver are tuned to the same frequency.

ADDITIONAL COMMENTS:

GPN has made numerous perceptive and interesting marginal notes on the draft of this article. Originally, I had intended to include most of them as footnotes to this article, but it's obvious that I will not have time to do so. I have corrected a few obvious problems such as my misuse of the word "distortion." I will not attempt to summarize his views. I imagine that he will do so himself if he feels strongly enough about them.

The shift in tuning caused by the shield being RF-hot was finally observed, after GPN pointed out to me where to look. Indeed, when a ferrite core loop is tilted to obtain a very deep null, the null depth does vary when one touches the case. This is not an intolerable problem, and anybody who goes to the effort to arrange a mechanical setup which permits tilting of the ferrite core loop, can set it up such that azimuth and elevation can be altered without actually touching the metal of the case. The tuning shift is unnoticably small under normal DXing conditions.

Another point of interest is that many of the "defects" in the Space Magnet are correctable if one is convinced (as I, for one, am not) that they are serious defects. The lack of alt-azimuth tilt capability can be corrected by a fairly simple mounting. The lack of sensitivity (if it exists) can almost certainly be corrected by the use of transistors selected for low noise figure. The problem of unbalanced pickup and feed can certainly be dealt with by the use of balanced pickup and feed using either push-pull amplifiers or baluns. The cross-modulation problem (if it is real and serious) can be dealt with by careful selection of semiconductors and circuitry. This means that a "near-ideal" antenna combining the compactness and portability of the Space Magnet and the (somewhat) superior qualities of the NRC alt-azimuth loop is probably feasible.

Finally, I can only say that I am convinced that the performance of the Space Magnet under everyday DXing conditions is so close to that of a large air loop, that no significant difference will be observed in the stations logged by two DXers of equal ability,interest,and luck using the two types of antennae. I, myself,have switched to the use of a ferrite core loop and never again expect to own an air core loop.

-- Don Kenney

MODIFICATIONS TO THE WORCESTER SM-1 ANTENNA

by Thomas R. Sundstrom

The SM-2 has been in use here for well over a year now and does meet a need for a large group of DX'ers who, for one reason or another, can't or won't "roll their own." Unfortunately, its biggest drawback is that it requires a 9 volt battery...and in this shack a couple of nights of forgetting to turn it off will result in one dead battery. After replacing several batteries I decided to make the SM-2 run on a.c.

A Heath IM-18 1-15 volt dc power supply was recently purchased, and this fits the bill quite nicely. Both voltage and current are independently controllable; I find the SM-2 functions quite well at 9 volts 10-15 ma., well below the 300+ ma. a 9 volt battery puts out.

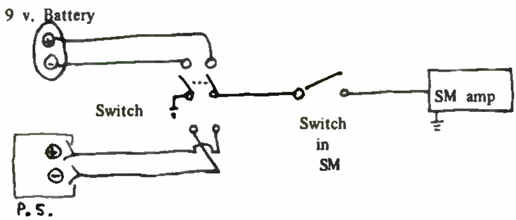
Using alligator clips (Radio Shack 270-378) attached to the SM-2's battery clip, this worked for awhile until a lead in the battery clip broke. We set out to make the a.c. hookup a bit more permanent.

A miniature DPDT toggle switch (Radio Shack 275-1546) was installed between the SM-2 on-off switch and the battery holder. The 5-way binding posts, one red and one black (Radio Shack 274-661), were mounted to the right of the battery holder, at the bottom of the same plane as the battery holder screws.

One side of the DPDT switch was wired to the binding posts, and the second side to the battery clip for the 9 volt battery. The centre pair of lugs on the DPDT went to the on-off switch (positive lead) and the ground lug (negative lead). Watch the polarity in wiring the switch, i.e., keep the positive wiring on one side of the switch.

I could have replaced the SM-2's original SPST switch with a DPDT and have one switch serve both purposes, i.e., when switched to a.c. the battery would be cut off, and vice versa; I opted for the method described because I frequently turned off the SM-2 without turning off the IP-18 for purposes of clearing the receiver/Heath SB-620 panadaptor screen to punch up 10 kHz. markers to calibrate the SB-620's baseline. I believe there is less damage to associated parts to minimise the "surge" of current within the IP-18; as stated before, the SM-2 seems to require voltage and only a very minimum of current.

At least with this power supply I do not seem to have any a.c. hum pickup, but I suppose the purist would be able to detect some. In any case, I dressed the leads around the switch and binding posts close to the outer aluminum shell inside the SM-2. In weak signal conditions I can easily switch to the battery and remove the trailing IP-18 power supply leads, but to my untrained eye, there seems to be no material differences in the SM-2's performance with the modifications described. As an aside, I would imagine an unfiltered power supply would cause problems but the IP-18 seems to be quiet and also provides me with voltage and current for other projects around here.



THE DEGENERATE LOOP ---- AN EXCELLENT ANTENNA COUPLER

-- Dave Fischer

In what follows you may find a useful unit which will improve those signals off that long wire, short wire, or mattress spring antenna you've been using, a unit which will give a sharp peak on signals at each frequency across the band -- an antenna coupler made from scraps!

If you have a loop antenna, then you may well have discovered that clipping that random length wire antenna to one side of the tuning condenser turns the loop into a sharp antenna coupler having a very sharp "signal - peak" at resonance, although the directive properties of the loop are destroyed.

Nevertheless, if you don't have a loop and are using that AC-DC table radio or communications receiver on a random length of wire or doublet antenna, then the degenerate loop antenna coupler is a terrific addition to your system. A good design on this coupler will require adjustment for a new peak on signals every 10 kcs over the band and will make that low end of the band come alive with signals!

Now, I've built a large number of antenna couplers in my time based on my own calculations and designs and made from just about anything and everything that was handy and having all shapes and sizes and circuitry! From this almost endless variety of possibilities I've selected a unit based on the fact that everyone can get hold of a 4 inch diameter (paper, cardboard) cylinder about 6 inches long (that 1 lb, 2 oz oatmeal box is just perfect!!) and a standard AM table radio two section tuning condenser with a capacitance range somewhere between 30 and 360 mmfd. Finally, since coil winding is a ticklish undertaking unless one is using a close wound winding I have decided to design for close-wound one-layer, coils (no spacing between the wire as it is wound on the coil form.)

CONSTRUCTION: Takes less than 30 minutes. Materials Needed: (1) 4 inch diameter (paper -cardboard) cylinder about 6 inches long, (1) 365 mmfd standard-type two-section variable tuning capacitor, (1) single-pole, single-throw toggle switch, and 66 to 100 feet of wire for the coil--the exact amount depends on the number of turns required to cover one inch on the coil form. Wire should be insulated and take 16 to 19 turns to wind a one inch long single-layer coil. (I used Belden 8530 #22 solid copper insulated hook-up wire--16 turns per inch). Winding the coil: The coil is to be 4 inches in diameter and is a single-layer coil--that is, only one layer of wire is to be wound on the coil form. It is a close wind: no space between wire as you wind it on the coil form. The coil should be very near 4 inches long and this requires 64 turns with 16 turn per inch wire or 76 turns with 19 turn per inch wire. Wiring the unit: See Diagram Sheet.

The coupling to the receiver is of course important. Figure A represents the most popular for the basic circuit: use the same kind of wire used to wind the main coil. Wind no more than 3 turns in the coupling winding. Tape this winding onto the main coil. This small winding is to be wound in the same direction of the main winding and should be placed directly over the center turns of the main coil. Form a twisted pair type cable with the remaining wire of this small winding and connect the ends to the receiver. Figure A is to be preferred for communication-type receivers while Figure B is good for use with an AC-DC table-type radio. This is the same type of coupling as Figure A except that a 0.01 or 0.001 mmfd fixed paper capacitor is placed in series with one of the leads in the coupling coil. To do this, connect C_1 to the chassis of the receiver and connect one side of the coupling coil to the other end of C_1. That lead of the coupling coil not connected to C_1 should be looped through or wrapped around (leave the insulation on it!!) the antenna coil, loopstick or loop antenna that is already in the radio. There is another method which works fine but does not use a coupling loop: this works well for a transistor radio for instance--Connect a C_1 fixed capacitor to the frame of the variable tuning capacitor. From the other end of this fixed condenser run a single wire to your radio (leave the insulation on it!!) and wrap this around the antenna in the set. When wiring the loop and coil, keep all leads to the receiver or tuning condenser as short as possible to prevent stray pickup of signals, etc. Also, the connection of the outside antenna "disturbs" the basis circuit (depends on the length of the antenna) so that some "pruning" of the coil may be in order: if you cannot peak on the low end of the band with both sections connected and the plates nearly meshed, then add a few turns to the main coil. If you cannot peak near the high end with only the small section of the variable connected and with the plates unmeshed, then remove a few turns from the coil. The switch is to connect C_B to the circuit to tune the low end of the band. You might also try connecting a C_1 fixed capacitor in series with the antenna lead. Finally, keep the outside antenna insulated from ground and when mounting the components making up the antenna coupler, keep the variable insulated from ground and the coil away from metal objects. I think you'll find the unit a real performer and that you'll have to run the volume a little lower than before! (If you should have any difficulty, then write me at once and I'll do what I can to help -- DF)

Figure A:

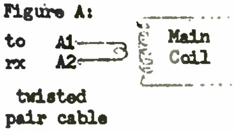
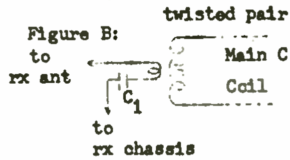
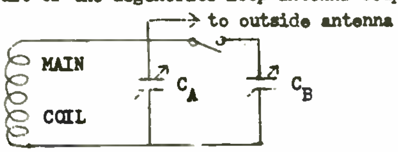


Figure B:

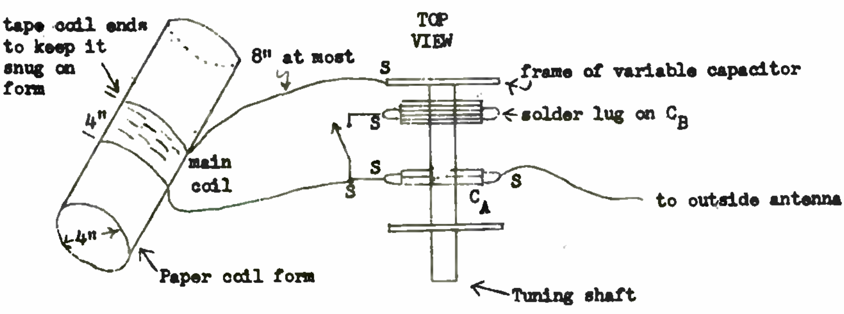


Basic Circuit of the degenerate loop antenna coupler:



C_A is that section with the smaller number of plates

Wiring diagram:



(S: means a soldered connection)

BALANCED AND UNBALANCED LOOPS

..... r. j. edmunds

During the past five years, perhaps more has been written about various types of loop antennas for use on the Braodcast Band than on any other subject in the hobby. We have seen simple unamplified loops, the NRC FET altazimuth loop, the degenerate loop, the two-foot loop, the Space Magnet and the Dymek antenna, as well as almost endless individual variations on several of these forms. It seems that throughout these discussions, much reference has been made to the concepts of balanced and unbalanced loops, but yet the basics of these ideas are obscure to a large number of DX'ers, both loop users and non-users alike. This brief explanation is now intended to fill that void.

In principle, the balanced loop is superior to the unbalanced loop in one very significant way, namely, accuracy in directionality. Early loops were frequently unbalanced in that their primary purpose was the ability to peak and null stations at will, and not too much attention was paid to the concept of direction-finding, or using the loop to help in identifying stations by their bearing. It was expected to perform the tasks of peaking and nulling somewhat selectively, while at the same time adding signal pickup in the peak sequence. This latter consideration led to the introduction of amplification for loop antennas. At first, simple transistor amplifiers were used, again, because the need for accurate directionality was not as apparent.

As time went on, however, DX'ers began to see the need and the value of an antenna which would not only peak and null stations, but be accurate in so doing. Due to the vagaries of signal propagation which need not be discussed here, a design concept known as electrostatic balancing became important. The end result of balancing was and is that the signal input on one side of a loop be as nearly equal to that found on the opposite side of the loop as possible, thus creating a symmetrical receiving pattern for both nulling and peaking. Each "side" of the loop would have to have the same electrostatic properties with respect to ground in both the null and peak modes. This was accomplished by altering the loop circuitry slightly. Instead of connecting one end of the loop's transmission or link coil to the antenna terminal of the receiver and the other end to ground, a center tap on this coil was introduced to become the ground, and the two ends of it were to become two identical signal inputs. The complications begin to arise when we consider that many receivers are equipped with only antenna and ground terminals, and can therefore not accomodate such a loop without some more sophisticated coupling arrangement. While such arrangements are possible, they are very rarely used due to the complications which are inherent electrically, as well as the consequent cost of such alterations. This problem directly led to the proliferation of several variant types of loops and amplifiers. Many communications receivers happily, are equipped with terminals for two antenna inputs as well as ground. As such, they can be used either with an unbalanced or a balanced loop.

As a necessary part of the balancing process, the amplifiers used must also be balanced accordingly, and thus the NRC FET altazimuth loop amplifier was born to fill this need. Other improvements, such as higher efficiency amplifiers, for less noise pickup or generation were introduced. The altazimuth (or tilt) function was added to many loops to increase the efficiency of the nulling capability, especially for nulling troublesome local signals.

The loop antennas described in this booklet fall into both the balanced and unbalanced categories, some with the capabilites for operation either way. Pragmatically, any air-core loop can be used in either way, simply by virtue of the methods described in paragraph 3 above. Most ferrite-core loops, which are generally commercially-produced, are of the unbalanced variety, partly due to the more time-consuming (and hence expensive) complexities of a balanced amplifier. Likewise, one quasi-commercial supplier, Ralph Sanserino, of Huntington Beach, California, produces an air-core loop which comes with an unbalanced amplifier. Although the address of the supplier of this loop, and of some others, is supplied in this booklet, it is not specifically discussed here, due to space limitations, and similarity of design to others so discussed.

As a guide to the loop-builder or loop-purchaser, we hereby present a brief capsule listing of the most prevalent varieties if MW loops, their distinguishing characteristics, and their availability. As will be noted, all of the loops which are discussed herein in detail are construction projects, with the exception of the Worcester Space Magnet series.

Antenna Type	Properties	Availability
NRC 4' Loop (air-core)	Large size, extremely high signal pickup, either balanced or unbalanced operation possible.	Construction project.
NRC 2' Loop (air-core)	More compact size, somewhat reduced signal pickup, balanced or unbalanced operation possible	Construction project.
Degenerate loop (air-core)	A simple loop, generally with moderate signal pickup and generally unbalanced.	Construction project.
Sanserino Loop	Similar to, but less bulky and and less expensive than the 4' loop. Balanced or unbalanced operations. Moderate signal pickup. Moderate noise factor.	Kit form, from Ralph Sanserino, 8422 Crane Cir., Huntington Bch., CA 92646.
Space Magnet (ferrite core) (available in several models)	Moderately high pickup, compact size, unbalanced operation only. Some models have altazimuth function, some with distant-local anti-overload switch.	Worcester Electronics Laboratories RD # 1, Frankfort, NY 13340.
Dymek DA-3 (ferrite core)	Compact size, ac operation option, altazimuth, aesthetic design, moderate signal pickup, erratic performance thus far in tests.	McKay Dymek, 675 N. Park Ave., Pomona, CA 91766.

Amplifiers (for air-core loops)	Properties	Availability
NRC FET amplifier	Balanced, low-noise factor. Designed for 4' NRC loop.	Construction project.
NRC 1-transistor amplifier	Unbalanced, moderate noise factor	Construction project.
BAX-1 amplifier(s) (broadband RF amplifier)	Breadboard kit. Unbalanced, but two with measurably similar characteristics may be used to achieve balance or near balance. Extensive case shielding necessary. Inexpensive.	International Crystal Co., 10 N. Lee, Oklahoma City, OK 73102.

No doubt other loops are in existence which function well for medium wave, as well as other amplifiers. Those listed above are as stated, the most widely used varieties.

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