

USING 2 LOOP ANTENNAS TO GENERATE ASYMMETRICAL RECEIVING PATTERNS

MIKE LEVINTON, NRC

DECEMBER 29, 1973

DXERS WHO ARE FAMILIAR WITH THE WORCESTER SM-1 ANTENNA MAY HAVE EXPERIENCED HIGHLY SKEWED OR SHALLOW NULLS, AND NULLING PATTERNS WHICH VARY DEPENDING ON THE EXACT LOCATION IN THE HOUSE THE ANTENNA AND RECEIVER ARE SET UP. THE SM-1'S RELATIVELY SMALL MAGNETIC FIELD, IN COMPARISON WITH, SAY, A 4 FOOT BOX LOOP, MAKE THE ANTENNA HIGHLY SUSCEPTIBLE TO SKEWING FROM THE PLACEMENT OF LARGE METALLIC OBJECTS, ELECTRICAL WIRING, ETC., IN THE VICINITY OF THE LOOP. SUCH SKEWING EFFECTS MAY BE AT TIMES DESIRED BY THE DX'ER. IN PARTICULAR, A SKEWED LOOP RECEIVING PATTERN WITH A LOBE DIRECTLY OPPOSITE A NULL WILL PERMIT RECEPTION IMPOSSIBLE WITH A "NORMAL" LOOP. IN FIGURE 1, STATION X, A LOCAL, IS NULLED OUT BY A NORMAL LOOP WITH A FIGURE-8 RECEIVING PATTERN. SINCE STATION X AND Y ARE COLLINEAR WITH RESPECT TO THE DX'ER'S LOCATION, RECEPTION OF STATION Y WOULD BE DIFFICULT OR IMPOSSIBLE—PARTICULARLY DIFFICULT IF STATION Y IS WITHIN GROUNDWAVE RECEIVING DISTANCE ONLY. IN FIGURE 2, STATION X IS NULLED OUT WITH A LOOP HAVING THE SKEWED PATTERN SHOWN. THE PATTERN NULLS TOWARD STATION X BUT HAS A LOBE TOWARD STATION Y, PERMITTING Y'S RECEPTION.

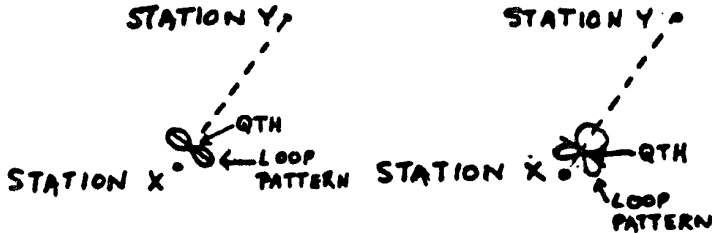


FIGURE 1

FIGURE 2

IS THERE SOME SIMPLE METHOD OF CREATING THESE ASYMMETRICAL PATTERNS WITH THE SM-1 WITHOUT COMPLEX ADDITIONAL EQUIPMENT? FORTUNATELY, THE DX'ER WHO HAS A SECOND ANTENNA—HIS OLD AIR-CORE LOOP—HAS ALL THE EQUIPMENT NECESSARY. THE TECHNIQUE IS TO PLACE THE BOX LOOP NEAR THE SM-1—ROUGHLY 1 TO 3 FEET AWAY, DEPENDING ON THE SIZE OF THE BOX LOOP—AND INFLUENCE THE SM-1'S FIELD BY TUNING THE BOX LOOP. BEST RESULTS HAVE BEEN OBTAINED BY PLACING THE LOOPS SO THAT THEIR AXES FORM AN ANGLE IN THE 60-90 DEGREE RANGE. (FIGURE 3). THE BOX LOOP IS NOT CONNECTED TO THE RECEIVER (THE SM-1 IS CONNECTED, OF COURSE). ALSO, BEST RESULTS HAVE BEEN OBTAINED WITH THE BOX LOOP'S PREAMP TURNED OFF.

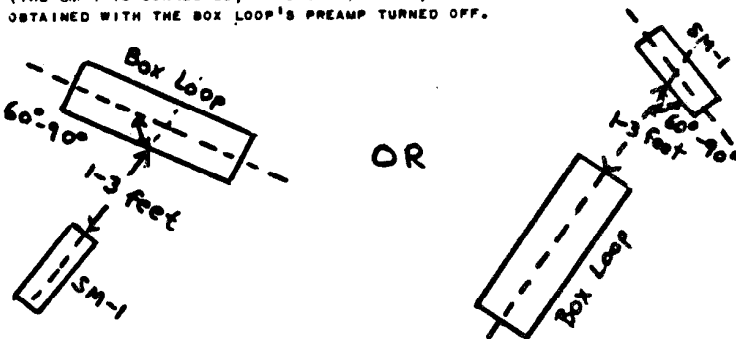


FIGURE 3. RELATIVE POSITIONS OF SM-1 AND BOX LOOP

NULLING TECHNIQUE: TUNE IN A STATION WITH THE SM-1 ONLY, WHICH YOU WANT TO ELIMINATE. THEN PLACE THE BOX LOOP IN A DESIRED POSITION AND TRY PEAKING THE STATION'S SIGNAL BY TUNING THE BOX LOOP'S TUNING CAPACITOR. THERE SHOULD BE A SHARP PEAKING POINT AS MEASURED BY THE RECEIVER S-METER.

THEN TRY ROTATING THE BOX LOOP. IF THIS DOES NOT WORK, TRY ROTATING THE SM-1 TO VARIOUS POSITIONS TO FIND THE BEST NULLING COMBINATION OF THE TWO LOOPS. IT MAY BE NECESSARY FOR SOME SM-1 SETTINGS TO REPEAK THE SIGNAL BY RETUNING THE BOX LOOP IN ORDER TO FIND A NULL WITH MINIMUM LOSS OF SENSITIVITY. A NEW SET OF PATTERNS CAN BE PRODUCED BY MOVING THE BASE OF THE BOX LOOP WITH RESPECT TO THE SM-1.

DEPENDING ON THE RELATIVE POSITIONS OF THE TWO LOOPS AND THE BOX LOOP'S TUNING, THE SM-1'S PATTERN CAN BE VARIED FROM A NEARLY SYMMETRICAL FIGURE-8 TO COMPLEX ASYMMETRICAL PATTERNS WITH MULTIPLE LOBES AND NULLS. THE GREAT ADVANTAGE OF THE VARYING NULL POSITIONS ON A CROWDED FREQUENCY SHOULD BE APPARENT.

THEORY: THE 2 LOOPS, ELECTRONICALLY SPEAKING, ACT LIKE TWO TRANSFORMERS AND THIS COUPLING IS PRESENT BETWEEN THE TWO LOOPS. PHASING DIFFERENCES BETWEEN THE PICKUP PATTERNS OF THE LOOPS ARE RESPONSIBLE FOR THE PATTERNS GENERATED BY THE SYSTEM. COUPLING BETWEEN THE TWO LOOPS TENDS TO DECREASE AS THE DISTANCE BETWEEN THE TWO LOOPS INCREASES, SO PAST A CERTAIN POINT THE BOX LOOP WILL HAVE NO NOTICEABLE EFFECT ON THE SM-1.

EXPERIMENTAL RESULTS: I HAVE TESTED THIS TECHNIQUE USING BOTH A 2 FOOT AND 3 FOOT BOX LOOP, AND IN 3 DIFFERENT LOCATIONS: DOWNTOWN PHILADELPHIA, PA (URBAN), ROCKVILLE, MD (SUBURBAN), AND COVE POINT, MD (RURAL), AND HAVE OBTAINED EXCELLENT RESULTS IN ALL THREE LOCATIONS. BEST RESULTS HAVE BEEN OBTAINED FOR DAYTIME LISTENING, WHEN THE SIGNAL INTENSITY IN A GIVEN DIRECTION IS RELATIVELY STABLE. AMONG THE MORE INTERESTING RESULTS INCLUDE 1) CLEAR DAYTIME RECEPTION OF WNAV-1430 IN PHILADELPHIA, IMPOSSIBLE WITH A SINGLE LOOP SINCE ORDINARILY WNJR IS COMPLETELY DOMINANT AND ROUGHLY IN LINE WITH ANNAPOLIS WITH RESPECT TO PHILADELPHIA; 2) CLEAR DAYTIME RECEPTION OF 250 WATT WJIC-1510 FROM ROCKVILLE, MD WITH 50,000 WATT WTOP-1500 PEST FIVE MILES DOWN THE ROAD; 3) RECEPTION DAYTIME OF EITHER WASA-1330 OR WESR-1330 IN THE CLEAR FROM COVE POINT, WITH PRECISELY THE SAME LOOP BEARINGS FOR EACH LOOP—THE ONLY DIFFERENCE BEING A SMALL CHANGE IN THE TUNING CAPACITOR SETTING ON THE BOX LOOP.

LIKE AN ALTAZIMUTH LOOP, THE TWO LOOP SYSTEM IS CAPABLE OF NULLING OUT VERY POWERFUL LOCALS. COCHANNEL STATIONS HEARD WITH A STRONG LOCAL NULLED OUT WITH THE TWO LOOPS MAY BE DIFFERENT FROM THOSE HEARD WITH AN ALTAZIMUTH LOOP, BECAUSE OF DIFFERENCES BETWEEN THE LOOP PATTERNS OF THE TWO RECEIVING SYSTEMS. IT HAS NOT BEEN FOUND NECESSARY TO TILT THE BOX LOOP IN THE TWO-LOOP SYSTEM IN ORDER TO OBTAIN DEEP NULLS.

SIGNALS RECEIVED WITH THE TWO-LOOP SYSTEM FREQUENTLY SOUND "CRISPER" AND "CLEANER" THAN THOSE RECEIVED WITH THE SM-1 ALONE, DUE TO THE ELIMINATION IN MANY CASES OF SIDEBAND SPLASH, SPURIOUS SIGNALS, COCHANNEL INTERFERENCE, ETC., THROUGH TUNING THE BOX LOOP. THE BOX LOOP ALSO SERVES AS A VARIABLE QCONTROL FOR THE SM-1'S CIRCUIT.

LIMITATIONS OF TWO-LOOP TECHNIQUE: USE OF THE TWO-LOOP SYSTEM AT NIGHT RESULTS IN RATHER UNSTABLE NULLING CONFIGURATIONS. THE WORST SITUATION TURNS OUT TO BE WHERE SEVERAL STRONG SKYWAVE STATIONS FROM DIFFERENT DIRECTIONS ARE SIMULTANEOUSLY RECEIVED ON ONE FREQUENCY. HOWEVER, SITUATIONS WHERE WEAK GROUNDWAVE AND/OR SKYWAVE SIGNALS ARE COLLINEAR WITH THE DESIRED STATION, THE TECHNIQUE HAS BEEN PROVED EFFECTIVE. (EXAMPLE—WVDC-1260 WITH A CLEAR LISTENABLE SIGNAL FROM PHILADELPHIA DURING THE EVENING—QRM FROM W8UD (GROUNDWAVE) AND WEZE (SKYWAVE) FROM THE NORTHEAST ELIMINATED, LEAVING WVDC (SOUTHWEST) MOSTLY IN THE CLEAR WITH OCCASIONAL MINOR WNDR (NORTHEAST) QRM.)

IT IS NOT CLEAR HOW WELL THE TWO-LOOP TECHNIQUE WILL WORK WITH RECEIVERS WITH RELATIVELY POOR REJECTION OF SPURIOUS SIGNALS. RECEIVER USED WAS A DRAKE SPR-4, WHICH HAS A RELATIVELY GOOD SPURIOUS SIGNAL REJECTION. OCCASIONALLY TUNING THE BOX LOOP AWAY FROM THE "PEAKING" POINT INTRODUCED SPURIOUS SIGNALS, WHICH WOULD DISAPPEAR WHEN THE LOOP WAS PROPERLY RETUNED.

ALSO, THERE SEEMS TO BE SOME LOSS OF SENSITIVITY IN RECEPTION OFF THE "BACK" SIDE OF A NULLED LOCAL OR SEMILOCAL. THIS MEANS THAT A WEAK STATION ROUGHLY COLLINEAR WITH THE LOCAL MIGHT BE AUDIBLE IF THE LOCAL WERE OFF THE AIR BUT UNDETECTABLE WITH THE TWO-LOOP SYSTEM UNDER ORDINARY CIRCUMSTANCES.

CONCLUSIONS: THE TWO-LOOP SYSTEM OF THE SM-1 AND BOX LOOP HAS THE ABILITY TO RECEIVE MANY STATIONS INAUDIBLE WITH A SINGLE LOOP, AND TO IMPROVE THE QUALITY OF RECEPTION OF OTHERS BY ELIMINATING SPLATTER, COCHANNEL QRM, SPURIOUS SIGNALS, ETC. MOST STABLE RECEPTION CAN BE OBTAINED FOR DAYTIME GROUNDWAVE SIGNALS.

RECEPTION USING THE TWO-LOOP SYSTEM IS SIMILAR IN SOME RESPECTS TO THAT OBTAINED FROM A UCL (CARDIOID ARRAY) OF THE TYPE DESCRIBED BY RON SCHATZ AND OTHERS IN DX NEWS AND DX MONITOR. THE TWO-LOOP SYSTEM DOES NOT GENERATE CARDIOID PATTERNS, BUT BOTH SYSTEMS HAVE THE ABILITY TO RECEIVE IN DIRECTIONS OPPOSITE TO THE NULL(S). THE GREAT ADVANTAGE OF THE TWO-LOOP SYSTEM OVER THE UCL IS THE ABSENCE OF A SEPARATE TUNING UNIT TO MATCH THE OUTPUTS OF THE TWO ANTENNAS.

THIS PROVIDES FOR MUCH SIMPLER OPERATION OF THE TWO-LOOP SYSTEM OVER THE UCL.

ANY DX'ERS WHO HAVE EXPERIMENTED WITH SIMILAR SYSTEMS OR WHO KNOW MORE ABOUT THE THEORY OF TWO-LOOP SYSTEMS—ANY COMMENTS WOULD BE GREATLY APPRECIATED. ADVICE ON THEORETICAL ASPECTS OF THIS ARTICLE WAS PROVIDED BY MR. JOE GWINN OF THE FCC.

NOTES:

- + TUNING THE BOX LOOP'S PREAMP ON LOADS DOWN THE SM-1'S LOOP CIRCUIT. THIS RESULTS IN SUCH UNWANTED EFFECTS AS WHISTLES, SPURIOUS SIGNALS, ETC., NOT PRESENT WITH THE PREAMP TURNED OFF.
- ↔ THERE ARE SITUATIONS WHERE NO PEAKING POINT IS PRESENT, SUCH AS THE LOOPS BEING TOO FAR APART OR FOR SOME RELATIVE POSITIONS OF THE LOOP AXES, PARTICULARLY WHEN THE LOOP AXES ARE APPROXIMATELY PARALLEL RATHER THAN IN THE 60-90 DEGREE RANGE.