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the irca technical column

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"40 Loopholes"

A Loop Antenna Bibliography, compiled and abstracted by date
by Ben Peters

date source, page references, author, title, description

1907 Electrical Engineering(England); Volume 2, pp. 771-775; Volume 3,
1908 pp. 348-351/507.
E. Bellini and A. Tosi: "A directive system of wireless telegraphy'

Description with diagrams of probably the first circuits formed by two open or closed loops, at right angles to each other. Also, a radio goniometer (invention claimed by A. Artom; see his biography in IRE Transactions Aeronautical and Navigational Electronics, 1957; Volume ANE-4, No. 2,pp 45-47). Capable of directive reception and direction finding through 360°, using fixed antennas.
(See British Patents 22879 and 145949 by E. Bellini, for a goniometer using differential capacitors instead of coils)

1913 British Patent 4514, 2 pages, C.S. Franklin (Marconi)

Description of a large loop (half a wavelength between vertical conductors, which would normally mean its directivity is not nearly as sharp as a small loop) with the good directional properties of a small loop. Uses capacitors all around the loop with values to compensate for the inductance of the length of wire between those capacitors.

1914 British Patent 24098, 5 pages, C.S. Franklin (Marconi)

Description with diagrams of two compact circuits, each formed by 3 loops, capable of uni-directional reception without using an "open" antenna (a random wire or vertical)

1915 British Patent 5783, 5 pages, C.S. Franklin (Marconi)

Description with diagram of a large circuit formed by four loops (two pairs of crossed loops), capable of nulling a very nearby transmitter and capable of receiving uni-directionally in two opposite directions by using two receivers connected to this circuit.

1919 Proceedings of the Institute of Radio Engineers USA ("Proc. IRE") Volume 7, pp. 207-256/543-553; R.A. Weagant: "Reception thru static and interference"

Description with diagrams of experiments and of the very good results obtained with both physically large and compact circuits, formed by 2 or 3 loops, or one loop and an "open" antenna.
Same subject is covered in British Patents by Weagant, all 1919: 129625, 132548, 138586, 138488.
In Wireless Age (USA) 1920, Vol. 8, No. 3, page 18 Weagant's underground version is described, with two co-planar loops connected "galvanically opposing"

1919 British Patent 13017, 5 pages, H. Richmond (Marconi)

Description with diagrams of compact circuits, formed by two fixed or "fixed rotatable" loops at right angles to each other and with a small moving link coil, capable of nulling a station lying in a different direction from the desired station, without reducing the strenght of the latter.

1920 British Patent 136524, 8 pages, H.J.J.M. de Regnauld de Bessescize

Description with diagrams of comapct circuits formed by two or three loops capable of nulling a nearby powerful transmitter, allowing reception of stations further away.

1920 Proceedings of the Institute of Radio Engineers (USA), Volume 8, pp 358-415, G.W. Pickard: "Static elimination by directional reception"

One of the earliest researchers of loop antennas gives some interesting loop history and describes, with diagrams, circuits formed by loop(s) and open antenna(s), using part of the loop itself as the "open" antenna in some circuits; capable of a cardioid pattern.

1920 British Patent 149532, 5 pages, J. Hollingworth.
Description with diagrams of circuits formed by 3 or more loops, capable of omni-directional reception patterns ranging from approximate to nearly perfect, depending on the number of loops.

1920 British Patent 143580, 3 pages, E.R. Clarke.
Describes how to reduce the inductance of a very large loop, thus allowing for a much greater area to be occupied by the loop. A one turn loop of 5 feet diameter is described; the turn is formed of several wires (connected in parallel at certain points) in cage form.

1921 The Radio Review (England), Volume 2, pp. 60-65/231-248; T.L. Eckersley: "The effect of the Heaviside Layer on the apparent direction of electromagnetic waves"
Description with diagrams of a medium sized circuit, formed by 2 loops (one vertical and rotatable, one a very big horizontal loop) for research on deviations of the incoming wave-fronts.

1921 British Patent 146997, 10 pages, J.L. Hogan.
Description with diagrams of compact as well as large-sized circuits, formed by two "open" antennas; formed by two loops; or formed by a loop and "open" antenna. Stresses the importance, for satisfactory phasing,of the two antennas having equal sensitivities for the desired signal, and having unequal sensitivities for the desired signal.

1921 The Radio Review (England), Volume 2, pp. 394-403, G.M. Wright and S.E. Smith: "The Heart-Shaped Polar Diagram and its behaviour under night variations".
Description with diagrams of a compact circuit, formed by 2 loops at right angles to each other and an "open" antenna, capable of a cardioid reception pattern. Also described are the variations "night-effect" can have on this pattern, although without affecting the proper null position.

1921 British Patent 158927, 5 pages, C.S. Franklin (Marconi)
Description with diagrams of a medium-sized circuit which can be made more compact with even greater directional properties, at the expense of gain. Formed by several loops (or combinations of loops) allowing a very sharp uni-directional pattern in both the horizontal and vertical plane.

1922 Scientific Papers of the Bureau of Standards (USA), Vol. 17, No. 431, pp. 589-606; G. Breit: "The field radiated from two horizontal coils"
Description with diagrams of medium sized circuits, formed by 2 or 4 loops, capable of producting pronounced directive beams at about 45° altitude.

1922 Scientific Papers of the Bureau of Standards (USA), Vol. 17, No. 428, pp.529-566; F.A. Kolster and F.W. Dunmore: "The radio direction finder and its application to navigation."
Description with diagrams of what a loop is, how it works, how it should be constructed, how certain undesirable effects of the loop's performance can be eliminated, how a loop as direction finder works (with the additional problems then encountered) and how a uni-directional (and cardioid)reception pattern is obtained and made use of.

1924 Journal of the Instituion of Electrical Engineers (England), Vol. 62, pp. 249-264; R.H. Barfield: "Some experiments of the screening of radio receiving apparatus"
Description with diagrams of several reasonably compact screening arrangements, formed by a cage of wires in galvanically open or closed loops, in or near which a receiving loop or loops are situated. Both electrical and magnetic screening are dealt with.

1925 Wireless World (England), July 15, pp. 84-87; N.W. McLachlan: "Interference" part 2
Discusses directional reception and reception using selective circuits; gives a very interesting diagram of the reception pattern of 4 "cascaded" loops--a very elongated figure of 8.

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1925 Proceedings of the Institute of Radio Engineers (USA), Vol. 13, pp. 477-506; J.H. Morecroft and A. Turner: "The Shielding of Electric and Magnetic Fields"
Description with diagrams of shielding using coils (not loops per se) and metal plates.

1925 Experimental Wireless and the Wireless Engineer (England), Vol. 2, pp. 828-837; E. Green: "The Polar Curves of Reception for Spaced Aerial Systems"
Description with diagrams of several large circuits, formed by "open" antennas, or formed by various combinations of loops, based on C.S. Franklin's work; capable of sharp and/or unidirectional receiving patterns.

1925 Proceedings of the IRE (USA), Vol. 13, pp. 685-707; H.T. Friis: "A new directional receiving system"
Description with diagrams of experiments and results using compact and large circuits, formed by one loop and an "open" antenna (here an interesting capacitor type: two 15' x 15' pieces of wire netting in a horizontal plane with 6" between them. Also one formed by two loops. The first combination locates the direction of atmospheric interference and the second defeats it.

1928 British Patent 280224, 4 pages, L. Bouthillon.
Description with diagrams of compact and medium-sized circuits formed by a number of loops, either in co-planar configuration, where adjacent loops are connected series opposing, or in co-axial (parallel plane) configuration, where adjacent loops are connected in series aiding. Both configurations can give very sharp directivity depending on the number of loops used.

1928 Wireless World (England), August, pp.186-188/247-251; R.L. Smith-Rose: "Radio Direction Finder for the Experimenter"
Description with diagrams of "antenna effect" of a loop, tells how screening defeats this effect, and gives thorough construction details for a sharp nulling screened loop (the screen being formed of a 'tube' of parallel connected wires enclosing the tank winding of the loop); see also the same magazine, 1926, August, pp. 193-197 on this subject.

1928 British Patent 278743, 3 pages, Radio Holland.
Description with diagrams of a compact circuit formed by two large fixed co-planar loops, one of which has a variable area, while the other has a small rotatable direction finding loop located in its center. Interference from a re-radiator (e.g. a ship's mast) can now be nulled and correct bearings ascertained.

1930 Wireless World (England), August/September, pp190-192/232-234; R.L. Smith-Rose: "Effective Screening"
Description with diagrams of how a loop or loops can be used as a screen to screen an area or room.

(This bibliography will be concluded in the next Technical Column)

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Wilhelm Herbst of WH Publications in Germany writes that the book mentioned in the June 14/86 DXM "The Wave Antenna for Reception of Medium and Long Waves" by Walter Schulz is available to North Americans exclusively through Gilfer Shortwave Inc., 52 Park Avenue, P.O Box 239, Park Ridge, NJ 07656 for a price of 7.95. As Gilfer is the American distributor, they don't want you ordering from Germany!

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In the February 1986 QST, there was an article by Robert C. Sommer N4UU, "A Simple Effective Receiving Aid" which described an audio processing unit which splits received audio into two channels, one through a low-pass audio filter, the other through a high-pass filter, both with cut-offs at 900 Hz for phone reception. The resulting "stereo" signal is supposed to give the listener the impression that the desired signal is coming from the middle of the speakers or phones, while interference is relegated to the sides. The listener can then concentrate on the signal to the exclusion of interference. Has any MW or SWBC DXer tried this system?

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Variable capacitors are hard to come by at reasonable prices these days. Ben Peters, Lynbaansgr. 318, 1017 WZ Amsterdam, Holland has been hunting down surplus air variable capacitors in his area, 2 or 3 gang, many with reduction drives for up to $5 plus shipping of about US$2. I have details on these capacitors (address at top of column) or write to Ben directly. Maximum values for the capacitors are from 330 pF to 500 pF, and they are new/unused.

DX Report from trip to El Paso, TX (May 1986) -- Mark Connelly

A recent two-week business trip to El Paso, TX gave me the chance to DX from the western USA for the first time. The receiving set-up used was the Sony ICF-2001 receiver with the Palomar Loop. An MWT-1 tuner was brought: its regeneration capability was used occasionally to improve the ICF-2001's mediocre selectivity. The hotel (the Residence Inn, on Montana Ave.) was surprisingly RF-noise-free and its walls didn't impede signals or "goof up" loop operation.

Only a handful of stations audible at home in Massachusetts could be heard in El Paso; indeed, there's more reception commonality between Ireland and Boston than between El Paso and Boston. An unfamiliar QTH/new DX environment forces one to observe that most fundamental DX commandment: assume nothing until an ID is heard.

My preconceptions of western DXing offering the chance of far greater range due to "uncrowded" channels and that receiver sensitivity would become more important than selectivity and 'pest'-nulling ability were completely shot in the foot! The band is nearly as crowded in the Southwest as in the Boston-to-Washington "Northeast Corridor". Regional channels that sound like "graveyards" and "clear" channels that sound like regional channels are all too common. Mexicans, many of which weren't listed in my 1985 World Radio-TV Handbook (WRTVH), were everywhere. As on trips to Cape Cod and to Baltimore (and unlike at home in Billerica, MA), Spanish (hereafter abbreviated SS) was heard at one time or other on most channels. The differences: SS heard on Cape Cod originates mostly in Venezuela & Colombia, SS heard in Baltimore is primarily from Cuba, and that heard in El Paso comes almost exclusively from Mexico.

Specific Comments

Daytime:

The El Paso, TX/Juarez, MEX airwaves are jam-packed with loud local stations. Most of these are in SS. The hotel QTH (next to the airport) seemed to be "RF alley": a nearby mountain bristled with AM, FM, and TV towers. On many channels, slop from one local ran into slop from another (say, 9 kHz away). Luckily, a good chunk of these 'pests' were daytime-only. Bandscans later in this article list these stations.

Evening (Domestic DX):

The clear channels had predictable occupants. KWKH-1130 from Louisiana was massive (stronger than WWL). With their westward signal, KWKH should be a pest in New Zealand! Sunset-skip listening was not all that productive. Really low-angle stuff from the east wasn't enhanced at sunset in the manner noted at eastward-facing coastal sites (in MA, ME, etc.). Of course, late May is not a particularly good period of the year for robust longhaul DX (that doesn't preclude regular sunset receptions of Africans & Iberians on Cape Cod, however). Regional channels were too jumbled for much useful DXing until short-skip daytimers went off, leaving the usual 3 or 4 nighttimers-per-channel behind to battle it out. I rediscovered a frustrating aspect of domestic DXing: having a beautiful signal during a song - then, by the time that a possible ID would occur, another station came up and clobbered the first one. It was possible to sit on a channel for an hour, hearing 3 or 4 strong stations swapping dominance, and still not get a single ID or even ads with local place-names. This is usually not a problem encountered with foreign (TA) DX: you generally get only one TA dominant per channel at a given time; language alone is often a giveaway to the station's identity. Dogged perseverence, rather than remarkable receiver-antenna-location characteristics, seems the key element to domestic DXing success. Interestingly, in El Paso, the "graveyard" channels were less crowded than in the eastern US; they differed little from the regionals (several distinct signals were usually discernable, rather than an incoherent rumble-jumble).

Midnight to Dawn (Domestic DX):

This was definitely when the action was. Some of the night locals and some of the skip Mexicans went off around local midnight and opened

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(the conclusion of Ben Peters loop antenna bibliography from last time)

1930 United States Patent 1747262, 5 pages, J.H. Pressley.
Description with diagrams of several compact circuits, formed by a loop with many turns and a dipole, or a loop with many turns and a small loop at right angles to it; and a loop with a particular form of split winding, all capable of defeating the "displacement current" effect in a loop with many turns, which blunts nulls.

1930 British Patent 306487, 6 pages, F.A. Kolster and GUG. Kruesi.
Description with diagrams of a compact circuit, formed by a loop with three instead of two vertical sides, capable of uni-directional receiving patterns and a cardioid receiving pattern.

1931 United States Patent 1821650, 4 pages, F.A. Kolster.
Description with diagrams of a compact circuit, formed by two loops at right angles to each other, which achieves a more pronounced directional effect (an elongated figure 8) compared with the pattern of a normal loop.

1937 United States Patent 2082812, 4 pages, R.H. Worrall.
Description with diagrams of a compact circuit, formed by two horizontal and one vertical loop, rotatable as a whole and capable of nulling/direction finding regardless of the state of the polarization of the incoming wave (night effect).

1938 Gesammelte Vorträge der Hauptversammlung 1937 der Lilienthal-Gesellschaft für Luftfahrtforschung, Verlag von E.S. Mittler und Sohn, Berlin, Germany; pp307-337; T.L. Eckersley: "Fundamental problems in radio direction-finding with reference to aircraft navigation" (Note: This is in English and is very fundamental loop literature, but might be hard to find; if your efforts fail, especially with this one, but also with others, I am willing to make a copy of mine. Ben Peters, Lynbaansgr.318, 1017 WZ Amsterdam, Holland.)
Describes what is going on when direction finding on shortwaves and goes into detail with diagrams about a medium sized circuit formed by two co-axial loops, capable of the most correct bearing possible, free of polarization error, much better in fact on many occasions than an Adcock direction finder which is constructed with open antennas.

1938 British Patent 488611, 8 pages, J. Plebanski (Marconi).
Description with diagrams of a compact circuit, formed by two loops at right angles to each other, capable of a 'phase' cardioid, as opposed to the normal 'amplitude' cardioid, receiving pattern which occurs when using an "open" antenna as the second antenna. Also described is how to obtain (with the same two loops and without an "open" antenna) only one extremely sharp null.

1939 British Patent 532164, 11 pages, K.H. Meier.
Description with diagrams of a compact circuit formed by two loops at right angles to each other, capable of omnidirectional reception, normal figure 8 directive reception and uni-directional reception (cardioid), all without the help of an "open" antenna.

1940 Journal of the Institution of Electrical Engineers (England), Vol. 86, pp. 396-398; R.H. Barfield: "The performance and limitations of the Compensated Loop direction finder".
Discussion with diagrams of circuits formed by one loop and one dipole or one loop and two dipoles, suggested by different investigators to achieve freedom from polarization error. Compares them with Adcock direction finders.

1940 United States Patent 2190717, 4 pages, R. Kümmich, H. Rukop.
Description with diagrams of medium sized circuits, formed by two, three or more loops, rotatable as a whole, rotatable in a fixed relation, and fixed loops; some capable, others not capable of nulling/direction finding under conditions of night effect.

1943 Proceedings of the IRE (USA), Vol 31, pp.5[illegible]/364; G.F. Levy: "Loop antennas for aircraft".
Description with diagrams of low-impedance and high-impedance loops, discusses factors factors limiting good loop performance and the beneficial effect of loop screening. See also: Journal of the Franklin Institute (USA), 1919, Vol 188, pp. 289 ff.; A.S. Blatterman: "Theory and Practical Attainments in the Design and Use of Radio Direction Finding Apparatus Using Closed Coil Antenna", for material used by Levy (and much more)

1945 Proceedings of the IRE (USA), Vol. 33, pp. 307-318; F.E. Terman and J.M. Pettit: "The Compensated Loop Direction Finder".
Description with diagrams of various polarizations effects on a loop direction finder and of a circuit, formed by a loop and a dipole, capable of nulling/direction finding under conditions of night effect at almost all times. According to the authors, this combination deserves more attention than it has been given by previous investigators.

1947 Journal of the Institution of Electrical Engineers (England), Vol. 94, part 3, pp. 99-107/133; W. Ross: "The development and study of a practical spaced-loop radio-direction finder for high frequencies".
Description with diagrams of relatively compact circuits, formed by two co-axial loops, capable of direction finding free of polarization error. Information and diagrams on how horizontal loops should be set up for this purpose (if at all) are also given, as well as several references.

1961 Proceedings of the IRE (USA), Vol. 49, pp1222-1223; "Correspondance"/O.K. Nilssen: "A non-directional ferrite rod antenna arrangement suitable for AM radios".
Description with diagrams of compact circuits, formed by two ferrite loops at right angles to each other, in which a non-critical 90° phase shift is introduced by simple means. This is capable of omnidirectional reception.

1966 Proceedings of the Institution of Electrical Engineers (England), Vol. 113, No. 1, page 49-61; P.J.D. Gething: "High Frequency Direction Finding".
Gives very clear (the only one available?) overview of direction finders used and in use internationally. Several photographs are included of apparatus, and the interesting bibliography has 199 references. This alone is worth getting a copy of this article.

1982 Radio Communication (England), November, pp.944-949; J.A. Lambert: "A directional active loop receiving antenna system".
Description with diagrams and constructional details of large systems, formed by several co-planar or co-axial loops, with reception patterns steerable in the horizontal and vertical planes.

The above mentioned magazines, journals etc. should be available in, or through the help of, any good library, especially of a university with an electrical or electronic engineering department. The complete patent specifications, (possibly also the British ones) should be available from your patent office or the like. Any loop information you think interesting would be welcomed by me: Ben Peters, Lynbaansgr. 318, 1017 WZ Amsterdam, Holland.

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The final article, by J. A. Lambert, mentioned above is quite interesting. Loop antenna arrays have been developed commercially by such companies as C & S Antennas in England and E.M.I. Electronics in Canada, which became Hermes Electronics. They were intended for use in point to point communications in the 2 to 32 MHz range. At the higher frequencies, such arrays can have very sharp directivity in both horizontal and vertical planes. The directivity appears to be a function of element spacing and number of elements, but it is claimed that such arrays take up less space than rhombic, log-periodic or Wullenweber arrays. As in other types of antenna arrays, there are two basic configurations, endfire and broadside (see figure on next page).

Endfire arrays tend to have a wide horizontal beamwidth and a narrow vertical beamwidth, while broadside arrays deliver a narrower horizontal beamwidth with a wider vertical beamwidth.