June 2011
Volume 11, Issue 12

ANODE

Inside this issue:

Special points of interest:

- Contact details on back page (corrected & updated July 2010)
- Ham-Comp Latest on web site.

[I promise to have this up-dated ASAP. JB]

Anode Editor's Comments

Volume 11, Issue 12
June 2011
[The last of the Club's year]

The Club's AGM
At the clubhouse on Saturday, the new committee were voted in to their positions. No radical changes just some old friends re-appointed. David Cloete ZR6AOC was voted in to the position of accounting officer.

Also certificates and awards were handed out by the Chairman Phillip van Tonder ZS6PVT. The certificates were resized to A4 for printing this year and laminated by Geoff the Vice Chairman ZS6GRL.

Yours truly get a certificate from Phillip.

Awards

Phillip van Tonder ZS6PVT - [seen on right above] Radio Amateur Of The Year - Phillips pro active approach to the club and amateur radio and for helping grow club attendance and membership.

(continued on page 2)

Constructing a 'Crystal Set' in the 21st Century

Subject: parts for crystal set

Hi there,
I am an accountant with an interest in electronics. I want to build some different crystal sets with my grandson to get him interested. The difficulty is the variable cap – 365 pF. The set I want to build needs one ganged variable cap with a separate one.

Not just the ordinary set. Do you know where I can get some of these old capacitors? The set I have in mind can drive a speaker without any power. A bit of a challenge.

I am in Cape Town.
Kindest regards,
John White

Hi John

A very ambitious project for any constructor these days. I think the first question I would like to ask you is, have

(Continued on page 4)

Beating the Untraceable Buzz

(continued from page 1)

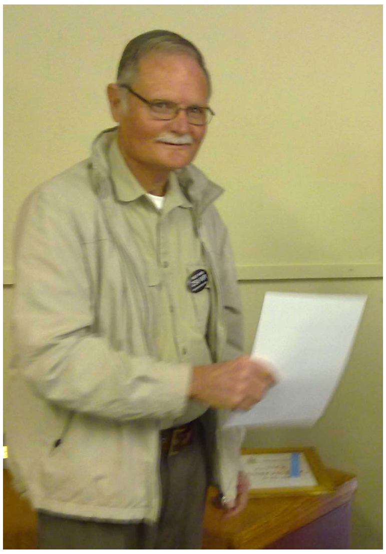
Geoffrey Levey ZS6GRL - Maintaining clubs website (www.zs6wr.co.za). Geoff's help with the website, constantly keeping it up to date and relevant.

John Brock ZS6WL - [seen on page 1] Compiling Clubs Monthly "Anode" Publication. Johns hard work with the Anode publication which he produces each month.

Romeo Nardini ZS6ARQ - Always been ON AIR during contests. Romeo is consistently heard participating in contests, and giving points to club members.

Johan van Vuuren ZS6JVV - [right] Club Assistance with equipment repairs and donations. Johan has donated a Motorola 2m radio for behind bar, as well as repairs to clubs linear amp. He has also assisted with many other club projects including upkeep of the lawn.

Nico Vorster ZS6NJV - [seen above] The 625 Award for club participation, promotion and upkeep - Nico has donated items to the club as well as a lot of time and work put into clubs upkeep and promotion



Willem Weideman ZS6WWJ - Club Promotion. [left] Willem's pro active approach and the many emails which he sent to help promote our flea markets which turned out to be very successful.

Viv Wells ZS6CAA - Life Membership. Viv is always heard on the Sunday Bulletins and is worthy of Lifetime Membership to the West Rand Club.

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Beating the Untraceable Buzz

(Continued from page 2)

Rory Crouch ZS6RBJ - Help in organisation of Lions Bicycle Race and Scopex. For participation and help with these events.

Club Attendance and participation certificates

Keith Liddle ZS6AGF - Participation in club events and regular club attendance

Roy Mckay ZS6RLM - Participation in club events and regular club attendance

Heather Holland ZS6YE - Participation in club events and club support

Jess Hawes ZS6YOT—[seen on right] Participation in club events and club support

Some of the award trophies

Constructing a 'Crystal Set' in the 21st Century

(Continued from page 1)

you a garden with trees or are you another resident of a 'cluster housing' estate?

The 'crystal set' uses a germanium diode and needs a fairly strong signal at radio frequencies to function correctly. It no longer uses a crystal of Galena with a 'cats whisker' wire connection. Thus you will need the longest wire aerial (antenna in American). Stringing a long wire up in a housing estate is usually frowned upon. Don't connect it to the electric fence!

In Southern Africa we have few Medium Wave transmitters of any high power. I am not at all sure if LM Radio is still transmitting. So I believe the best transmitter frequency to aim for is 6.190 MHz that of the BBC World Service. Transmitting from Botswana, it can be picked up during the day quite strongly and after dark easily by a crystal set.

You will also need a reasonable ground connection to maximise the received signal and help your wire aerial. It used to be a metal drain pipe going into the earth but a metal spike for the earthing of a TV aerial will do quite well. In the Transvaal, you would need to unplug the wire aerial during summer but you may not have to in Cape Town with its much lower lightning events.

The tuning capacitor may well be a problem as the old air spaced types are only available from hobby shops and are usually scavenged from veteran radios of last century. It may well be that you have an old or broken AM radio somewhere. If so, you could extract a suitable tuning / variable capacitor from the guts.

I have a couple of 'old' articles, written last century in scanned format. Would these be of any help to you?

best regards
John Brock
ZS6WL

For the West Rand Amateur Radio Club

His reply

Hello John,
Many thanks for your reply. Yes we live on a large plot so plenty space for an aerial. Over the years I have successfully built a few crystal sets (helping children with school projects.) but the parts are now becoming a problem as you well know. The diode is not such a problem but the capacitor is virtually impossible. I only have one which is already in a crystal set.

I found a diagram of a crystal set that will drive a speaker. This is the project that we want to build but it needs three of these impossible capacitors. I can't even find any old radios to rob.

I had so many a few years ago which I stupidly gave away. The newer small variable cap in the transistor radios does not work.

I will continue looking in junk shops etc and will let you know if I am successful with the project.

Kindest regards,
John White

Challenge!

Well West Rand Amateurs what do you think? Is it possible to construct a workable 'crystal set' today ?

Is there anyone in Cape Town to help John White ?

Low-angle Radiation

Describing how long-distance propagation can be improved by exploiting the natural terrain

BY L. A. Moxon,* B.Sc., M.I.E.E.
*Amateur station G6XN
[taken from Wireless World, April 1970]

Since first hearing transatlantic morse signals in the early years of short-wave radio, the author has been fascinated by communication over long distances using low-power. This interest has been maintained by the frequent emergence of new and intriguing problems. In particular, by the discovery, when resuming amateur activities after the war from a new location, that communication was easy with. Australia but almost impossible with anywhere else. Further, when Australian signals were at their best South Americans were usually weak or absent, clearly inconsistent with the usual theory of long-distance propagation by means of multiple earth-ionosphere reflections.

These mysteries were resolved by a process which stressed not only the importance of low-angle radiation, but also the need for more information on what constitutes a "low angle", A study of two medium length east-west paths has concluded that, for these paths angles as low as 1 deg., are desirable. but for the most part quantitative data is in short supply.

Recent speculation 2 has suggested dramatic possibilities from the use of very low angles of radiation,, perhaps even less than 1 deg., and it was with somewhat similar ideas in mind that a low-power (1 Watt output), transistor s. s.b. transceiver was designed and built,, light enough to be carried complete with aerial system up steep mountainsides.

It was hoped in this way to achieve efficient radiation at the desirable low angles whatever these might be, by exploiting natural ground features. An earlier exercise, complementary

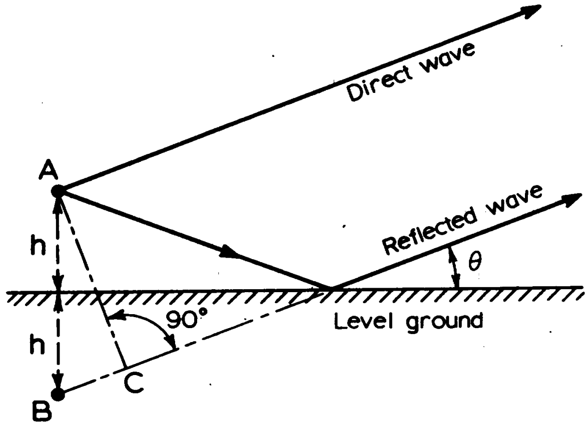

Fig. 1 When a horizontal aerial is erected at a height h over level ground, its image B is an antiphase. The direct and reflected waves are in phase at a distant point when BC= λ /2, i.e. when 2h sin $\theta = \lambda/2$ where θ is the angle of radiation.

to this, was aimed at maximising the low angle radiation obtainable from a flat site with limited aerial heights, accepting the inevitable low efficiency and consequent need for relatively high power, to produce a given signal level.

On the basis of these experiments, and such information as can be found in the literature, solutions have been sought to the following problems:
(a) How to select the best site for an Iif. aerial, for communicating with low power over distances of 3,000 miles or more.
(b) How to make the best use of a given site.

The discussion which follows does not necessarily apply to commercial h.f. circuits for which 24-hour availability is likely to be more important than good results over shorter periods.

Avoidance of cancellation

The difficulty of achieving low angles of radia-

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Low-angle Radiation

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tion arises from cancellation of the direct signals by the ground-reflected wave as shown by Fig. 1. This can, in principle, be prevented by one or more of the following procedures:

(a) Using a high mast so that the path difference for the two rays is lambda/2, which then add in phase giving 6 dB gain relative to free-space propagation. For 14 MHz and a radiation angle of 1 deg. this requires a mast height of 1,000 ft, which is unlikely to be popular with the neighbours.

(b) Using a steep ground slope, as in Fig. 2. If the slope is 45 deg. a height of only 25 ft is required at 14 MHz to bring the direct and reflected waves into phase. This height is not critical and only 3 dB is lost by dropping the height to 12 ft 6 in. or raising it to 3 ft 6 in. Moreover, there is the advantage of a single broad lobe in the vertical plane, whereas a large height as in Fig. 1 produces an interference-pattern with lobes and nulls alternating at 1 deg. intervals. The best angle of radiation is not necessarily always the lowest, and the optimum may well coincide with a null. So far all this is well known, but most references overlook the fact that the slope has to end somewhere. As first pointed out by Norton and Omberg this has important consequences, of which more later.

(c) With vertical polarization and perfectly-conducting ground, the phase of the reflection coefficient is reversed and efficient low-angle propagation is achieved independently of aerial height. This can be approximated by laying down a conductive earth-mat of sufficient extent. A beam aerial designed on this principle' has been found to operate under radio conditions which render conventional equipment useless. The installation uses an earth mat 1,800 ft long and 832 ft wide, containing 25 miles of copper wire. Such a system is obviously beyond amateur resources, but sea-water is sometimes available and is a good-enough conductor to act as a useful (though not ideal) substitute.

(d) With vertical polarization and imperfect ground there is a "pseudo Brewster angle". below which the phase of the reflection coefficient is reversed, so that for low angles and moderate or large aerial heights there is little to choose between vertical and horizontal polarization. In the vertical case, however, the reflection coefficient is less than unity so that cancellation is imperfect and some low angle radiation takes place, however, low the aerial. This principle has been exploited to produce a very effective, cheap and easily-erected beam for 7 MHz, as described later.

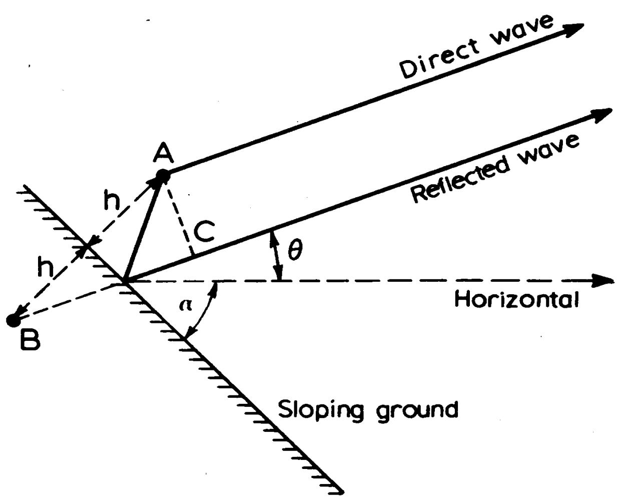

Fig. 2 With the aerial at a height h above ground sloping at an angle ∝ , the direct and reflected waves are in phase when 2h sin ($\alpha + \theta$) = $\nu\lambda/2$. For small values of θ this becomes 2h sin ∝ ≈ $\lambda/2$. This diagram is identical with Fig. 1 except for rotation through the angle α, and the increased ground angle.

Fresnel zones

Figs. 1 and 2 are oversimplified to the extent that reflection takes place not from a point but from a Fresnel zone which is defined by the fact that reflections from all parts of it tend to add in-phase.

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Low-angle Radiation

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Formulae for the sizes and required degrees of. flatness of these zones are to be found in the literature M. The size of the zone for the previous example based on Fig. 1 is very large, the near edge being at 21 miles range, and the far edge (ignoring earth curvature). at 85 miles. As the height is reduced and the angle of maximum radiation relative to the ground increases, the corresponding Fresnel zone contracts with the far edge moving in roughly as the inverse square of the angle.

For the example based on Fig. 2 the "near edge" is 25 ft behind the aerial and the far edge only 175 ft. down the slope. The shape is elliptical, its effective width being roughly 5 times the aerial height, and the ground need not be particularly flat. Obstacles with dimensions up to about a quarter of the aerial height are acceptable. Very long distances to the far edge (as in the first example) are reduced somewhat when due allowance is made for earth curvature'.

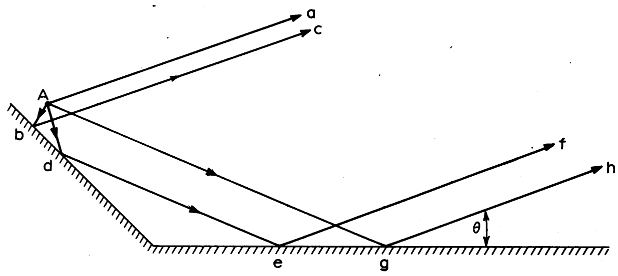

Fig. 3 Ground sloping down into the sea. The direct wave Aa, foreground reflection Abc, distant reflection Agh, and double reflection Adef add in phase if θ is small, $hg \approx \lambda/(4 \sin \theta)$, $h_s \approx \lambda/(4 \sin \theta)$, these being the heights of A above ground and sea respectively.

Double reflections

Discussion so far has been concerned with situations which may seem ridiculous, since amateur resources have been implied and angles of 1 deg. assumed. Even if the angle is increased to 5 deg and a loss of MB accepted, the Fig. 1 situation would require a 100 ft mast, and bottomless slopes exist only in mythology or mathematical fiction.

In practice, however, the steep slope is quite likely to sweep down like the Mountains of Mourne, or even Mull where the author conducted some experiments, to the sea, as illus-

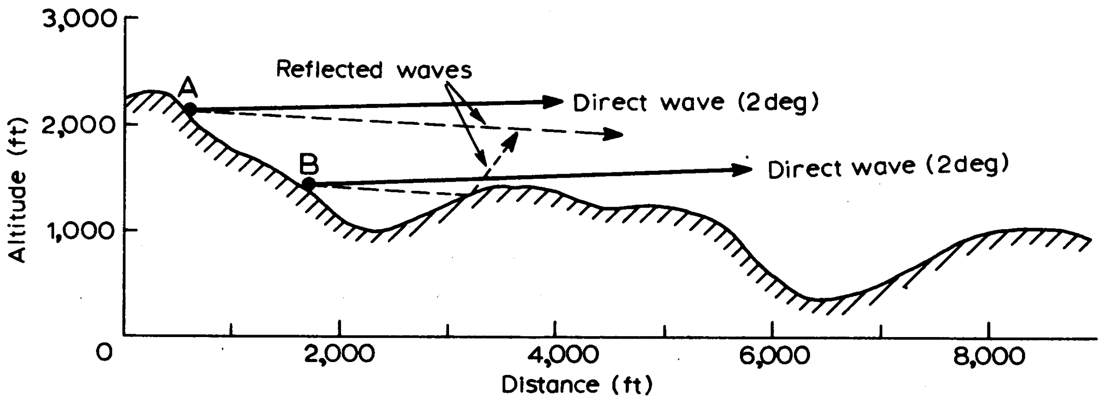

Fig. 4 Typical ground profile for mountainous country. Distant low-angle reflections are non-existent for transmitter at B, and probably unimportant (due to break up of Fresnel zones) for transmitter at A. In both cases low-angle reflections (not shown) are obtained from the foreground. (Isle of Mull, grid ref. NM 568332 bearing 104 deg.)

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Low-angle Radiation

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trated by Fig. 3. A flat plain, however, is also a possibility and will serve equally well for the next part of this discussion.

It will be seen that there are now four waves to be considered, including two single and one double reflection, and if all these can be made to add up in phase there is a possibility of obtaining not 6 but 12 dB gain compared with free-space propagation. This may appear complicated, but resolves Quite simply into a practicable combination of the two situations which have just been criticised as absurd; 6 dB gain being obtained from each of them.

For numerical consistency with the previous examples there is required only a sloping patch of mountainside extending for at least 25 ft above and 175 ft below the aerial. It should be centred on 1,000 ft altitude with an unobstructed view of the sea, of which the nearest visible point should be not more than 21 miles away.

Since the mountain is, in effect, being used as a “tall mast”, however, this entails the penalty of a multiple-lobe radiation pattern in the vertical plane (as in the case of Fig. 1 with a tall mast). So that if the appropriate angle of radiation happens to be not 1 deg. but 2 deg., signals will be almost completely cancelled and even if the operator were aware of this he would scarcely relish the idea of moving the aerial down 500ft to put the matter right. He might even prefer to sacrifice the 6 dB gain obtainable from the sea reflection. But at this point it becomes appropriate to consider the situation sketched in Fig. 4.

Locations such as this are usually easier to find than those corresponding to Fig. 3 and it will be noticed that the distant reflecting areas are either blocked off by the foreground or badly broken up, thus to meet the required specification for the Fresnel zones. If the distant reflections are sufficiently reduced, Fig. 2 becomes after all a valid representation for the practical case. and low-angle radiation should then be obtained. with a gain of 6 dB relative to free-space propagation.

Neglecting diffraction, this would be true for angles of elevation down to zero, assuming an aerial height of, say, 0.7 lambda above any 45 deg slope 200 ft in extent. For a 15 deg slope an aerial height of 2 lambda and an extent of 1,800 ft would be needed for the same result, but these dimensions are not critical and could probably be halved without serious loss of performance.

Polarization

With sloping ground horizontal polarization is preferable, because in the vertical case efficient use of the reflected wave is usually prevented by the Brewster-angle effect, tilting of the image, or both. In the case of flat ground, the best choice of polarization depends on the available aerial height, soil characteristics, and frequency.

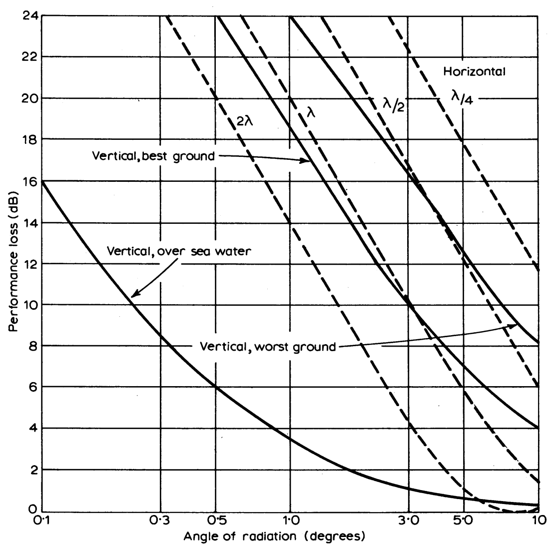

Fig. 5 Comparison of short horizontal and vertical radiators at h.f. assuming flat open country. "Zero loss" occurs with in-phase addition of the direct wave and a reflected wave of equal amplitude. Aerial heights are indicated in wavelengths for horizontal polarization (dotted curves). Vertical polarization curves are calculated for low height and a frequency of 7MHz; performance deteriorates slightly as frequency increases.

Fig. 5 has been calculated from handbook data for vertical aerials above various types of

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Low-angle Radiation

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ground' and on the basis of Fig. 1 for horizontal aerials at various heights. This provides a rough comparison between different aerials for given angles of radiation and soil conditions assuming, in the vertical case, heights low enough for the effect illustrated by Fig. 1 to be negligible.

In using these curves two points should be noted. Where horizontal polarization appears to be better, equally good results could usually be obtained with vertical aerials by raising them to the same height. The vertical aerial is then likely to be the more difficult of the two to support and feed. On the other hand height is usually the main problem in aerial construction. Horizontal supporting wires for vertical elements can be used to provide end-loading which allows considerable reduction of vertical length and, therefore, height.

Although the useful energy radiated per element is rather small, it is often easier at the lower frequencies to construct, say. a 5- or 10-element vertical array in this manner than to put up a horizontal dipole at a height which would give comparable performance.

Fig. 5 shows the possibility of radiation at 0.5 deg. elevation with a loss of only 6 dB by using vertical aerials surrounded by sea water, which may appeal to amateur enthusiasts with portable transceivers and a preference for paddling rather than mountain climbing.

Experimental results

The good results at 14 MHz in the direction of the long path to Australia mentioned earlier,, were attributable to a steep ground slope (22 deg.) in that direction. Aerial height was only 23 ft which was adequate for the down-slope direction but resulted in poor propagation in the opposite direction even for short ranges.

The use of a full-wave dipole, later backed by reflectors, produced a narrow azimuthal pattern, thus discriminating against directions other than towards Australia. Comparative tests were carried out over several years with the cooperation of numerous Australian stations plus a local amateur (G3DVM), whose location was more conventional, his aerial being located at a height of lambda/2 over flat ground.

Comparative reports. allowing for power differences and assuming 6 dB per S-point, usually indicated an advantage of about 8 dB in favour of the author's location and aerial system. Referring to Fig. 5, the loss for 6 deg. elevation at G3DVM would be 10 dB, and a loss of 2 dB would be applicable to G6XN for the same angle, which would, therefore, be the "most probable". It was noticed, however, that quite often the path remained open longer at G6XN with signal-strength differences reaching 20 dB or more. This would be consistent with radiation angles in the region of 12 deg. On other occasions the advantage in favour of G6XN almost disappeared, suggesting angles in excess of 10 deg.

It is interesting to note that good conditions on the long path to Australia occur when the path is mainly in darkness, and complementary ionospheric tilts might be expected at each end of the circuit due to the darkness-daylight transition. This leads to the chordal hop mode of propagation first described by Albrecht 6,7 depicted in Fig. 6, in which waves travel by successive F-layer reflections without intermediate ground reflection.

Note that the lower the angle at which the ray strikes the ionosphere, the less likely it is to be reflected, back to earth. Similar modes of propagation occur frequently on other long-distance paths especially 'north south paths'. Because of reduced D-layer absorption and ground-reflection losses, these modes tend to produce

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Low-angle Radiation

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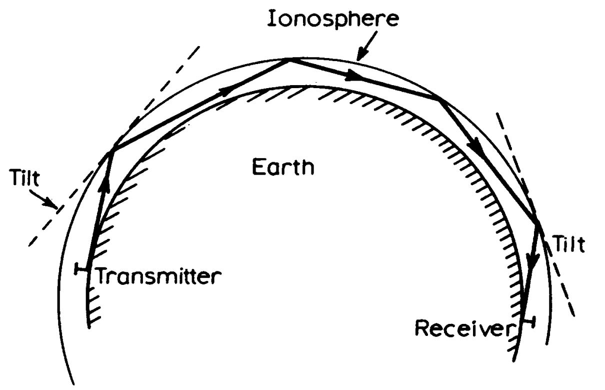

Fig. 6 Chordal hop. At the first and last reflection points, the ionosphere behaves as if tilted slightly towards the terminals. For tangential radiation (i.e. zero deg.), and tilt, however small, prevents a return to earth until a tilt of opposite sign occurs. (Ionosphere not to scale.)

Attempts to communicate with Australia over the long path were made from six different locations having features typified by Figs. 3 or 4, with success in every case. The inverted-V dipole when erected over ground sloping at angles of 30-40 deg. appeared roughly equivalent to a Quad aerial at the home location erected at a height of 50 ft, although direct comparison was not possible.

This result is consistent with the previous estimate of a 6-deg. angle of radiation since, from Fig. 5, a loss of 7-21 dB would be expected for the Quad despite its greater height, but this would be offset by an estimated 6 dB or so of aerial gain. Insufficient results have so far been obtained to establish the practical advantage, if any, of using distant as well as foreground reflections on the fines of Fig. 3.

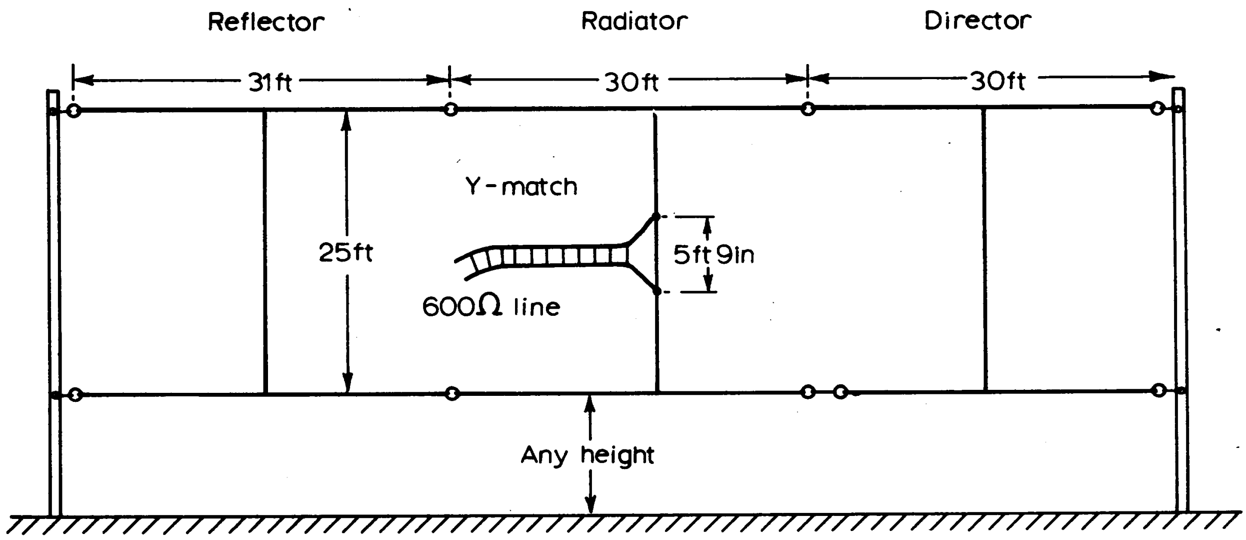

Fig. 7 Low-angle aerial for 7MHz. Height not critical. Reflector and director tunable, by adjusting length of verticals or of the lower horizontal wires. Dimensions approximate.

very high signal levels over very long paths.

Tests with the portable s.s.b. transceiver have been carried out from steep ground slopes, using an inverted-V dipole having its centre propped up to a height of 20-25 ft and about 1W of peak r.f. Power.

These tests were conducted in the 14 MHz amateur band, but other contacts were made with Australia on 21 MHz (short path), and with North America on 28, 21 and 14 MHz. In these cases

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The 'Montreal' FOX

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also, the combination of portable dipole plus steep ground slope appeared roughly comparable with the home "Quad". This was judged by the degree of difficulty in establishing contacts.

Fig. 7 shows one of the two "bays" of a 6-element 7 MHz beam using short end loaded vertical elements with the lower ends about 2 ft from the ground. Results over the long path to Australia included good DX contest scores and, on one occasion resulting from failure of the main transmitter, two contacts with only 5 watts of peak r.f. power (s.s.b.). Fig. 5 suggests that for an angle of 6 deg., a vertical array having 6 dB gain and located over average ground should. be roughly equal in low angle performance to a dipole at a height of 1 and 1/2 lambda or a Quad at 3/4 lambda.

Relative to typical aerials at a height of 50 ft the vertical array would, therefore, be expected to do much better at 7 MHz and be. roughly equal at 14 MHz; the latter estimate has proved to be over-optimistic since results, though good on 7 MHz, averaged about 6 dB down relative to the Quad at 14 MHz.

Conclusions

From most locations it is difficult with simple aerials to achieve efficient radiation at angles below 5 or 10 deg. Attempts to reduce the angle lead to rapid escalation of cost and practical difficulties,, and the difficulty of making cost-effective decisions is aggravated by lack of such information as how low - an antenna is desirable,, and for what percentage of the time. On the other hand. given freedom in choice of location, a low angle of radiation is readily achievable by exploitation of natural ground features and is within the means of amateurs equipped with portable apparatus, and a set of Ordnance survey maps.

Much could also be leaned from comparative tests from a number of fixed locations having different ground characteristics and various types of aerial.

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Wireless World, April 1970

The West Rand Amateur Radio Club
Established in 1938
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Web page: www.zs6wr.co.za

Bulletins (Sundays at …)
11h15 Start of call in of stations
11h30 Main bulletin start

Frequencies
Output: 439.000 MHz 7.6 MHz split
Input: 431.4 MHz (West Rand Repeater)
145,625 MHz (West Rand Repeater)
10,135 MHz (HF Relay when possible)

Radio Amateurs do it with more frequency!

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West Rand members - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

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We need your input! Email us articles, comments and suggestions please. zs6wr.club@gmail.com