RADCOM TECHNICAL FEATURE

Five-Band Lazy-H Antenna

by Fred Brown, W6HPH

THIS ANTENNA provides more bands at a lower cost than a tri-bander. Essentially the Lazy-H (**Fig 1**) consists of two horizontal doublets or dipoles stacked vertically and fed in phase - an idea that dates backs to the thirties. A plot of free-space gain versus spacing of two half-wave dipoles is shown in **Fig 2**.

If the spacing is made 31 feet (9.45 metres) the frequencies indicated will fall on the curve at the points shown. Note that the gain will be more than 3dB on five amateur bands: 20, 17, 15, 12 and 10 metres, and more than 4dB on 17, 15 and 12 metres. However, this is the free-space gain. The actual gain when compared to a dipole at the same height above ground as the top of the Lazy-H can be more than 6dB, as shown by W8JK in his classic work *Antennas* [1]. The additional gain results from the lower angle of radiation of the Lazy-H; a typical vertical radiation pattern is shown in **Fig 3**.

If the dipoles are made a half-wave long on 20 metres, they will be full-wave dipoles on 10 metres, which will result in about 1.9dB more gain on that band than indicated in Fig 2, since the curve is for half-wave dipoles. There will also be slightly more gain on 12 and 15 metres.

So the Lazy-H can be a very effective DX antenna, as has been known for many years.

When compared to a 3 element full-size tri-bander, the Lazy-H has the advantage of providing more bands, five instead of three; and about the same gain, since the tri-bander has optimum element spacing on only one band (where the gain is about 6.5dB) and is a compromise on the other two bands.

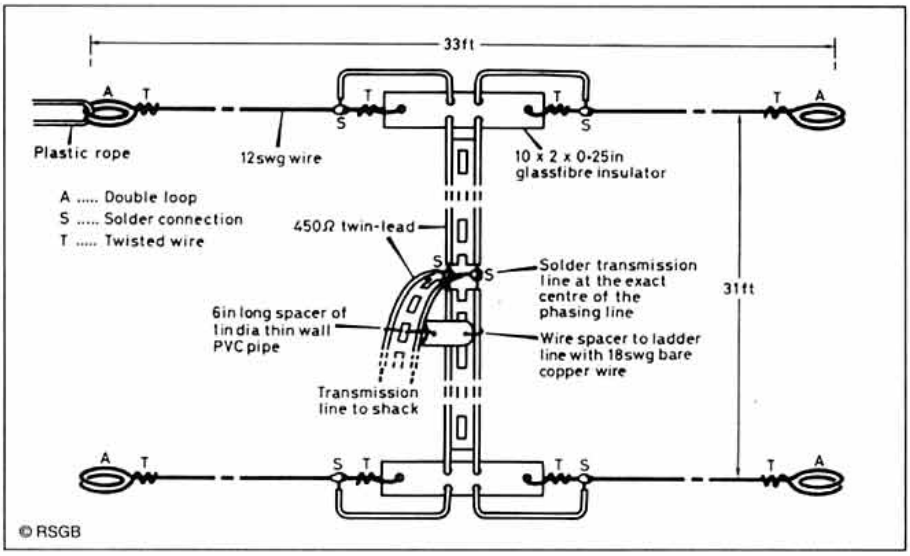


Fig 1: Construction details of the author's Lazy-H antenna.

The Lazy-H also provides constant gain across each band, whereas a tri-bander's gain will fall off at the band edges, especially on 10 metres. A further advantage of the Lazy-H is that it is easier and cheaper to construct than a tri-bander.

The bi-directional pattern of the Lazy-H can be both an advantage and disadvantage. The zero-dB front-to-back ratio does not discriminate against QRM off the back, but on the other hand it is sometimes nice to be able to work in opposite directions simultaneously.

FEEDING

THE FEED-POINT impedance of the Lazy-H will vary over a wide range as the frequency is changed. The problem of impedance matching at the antenna can be avoided with tuned feeders.

A match to 50Ω coax can then be accomplished in the shack with an antenna tuning unit. The SWR on the feeders will be high but transmission line losses will be low if a good low-loss line is used for the feeders.

In the old days amateurs used 600Ω open-wire line with six-inch spreaders spaced three to four feet apart. Such an arrangement will give you the ultimate in all-weather low-loss performance especially if Teflon or glazed porcelain spreaders are used. In my case I

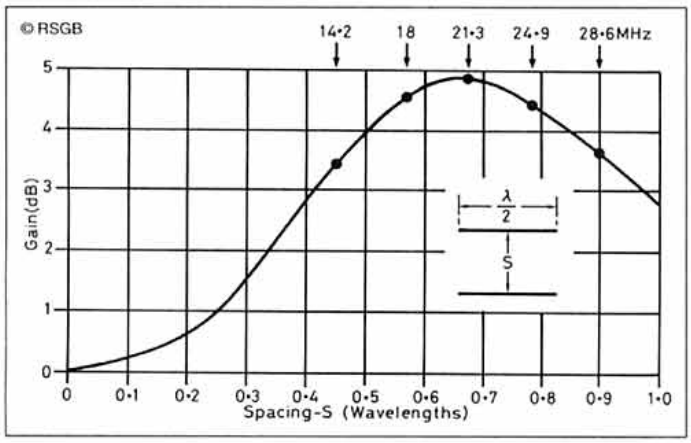


Fig 2: Gain over a dipole of two half-wave elements fed in phase. If the spacing S is made 31 feet the frequencies shown will fall on the curve at the points indicated.

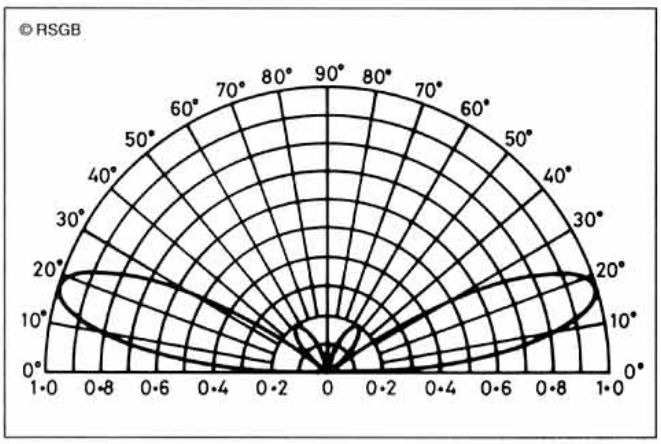


Fig 3: Vertical-plane radiation pattern of a Lazy-H where the lower element is .5 wavelength above ground and the upper element is at a height of one wavelength.

simply used 450Ω ladder-line twin-lead [2] for both the transmission line and phasing line. This stuff is easy to work with and sufficiently low-loss for line lengths up to 75 feet or so, at least when dry. Construction details are shown in Fig 1.

THE ASTU

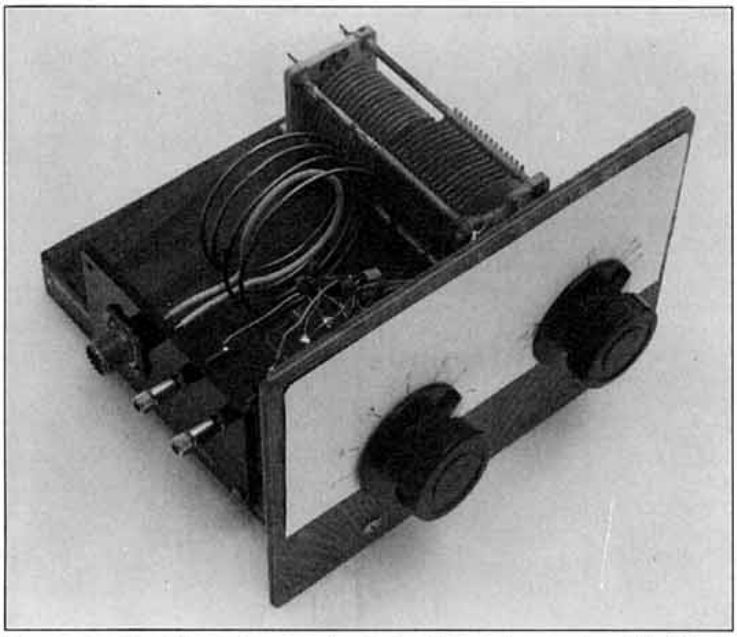
I WANTED THE Antenna System Tuning Unit to serve also as a balun and so the configuration shown in **Fig 4** was adopted. This ASTU will match the antenna on all 5 bands to 50Ω coax and the SWR will be less than 1.5. Most of the construction details should be apparent from Fig 4 and the photo.

If you run any amount of power it is important that the fixed capacitors be high-voltage types (3kV or higher). After I cremated several 500V units, W6MMU suggested that I make the capacitors of double-sided circuit board. Since one side of the capacitors are a common connection, only one side of the board need be etched. Dimensions are shown in Fig 4(b) for common 60mm fibreglass board. This type of board has a capacity of 25pF per square inch.

The dimensions of the smaller capacitors in Fig 4(b) do not calculate out proportionately, and this is because of fringing. If you work out the dimensions on the basis of area alone, and neglect fringing, the smaller capacitors will come out too large. However, the values are not particularly critical. The 50pF capacitor I did not include on the board because 50pF high-voltage capacitors are a standard television receiver replacement part and readily obtainable.

If an eight position switch is used for S1, the extra position can be used for connection to a separate six metre ASTU.

The one turn link is centred in the inductance and it is impormtant that the link be the diameter given. A full-size link will not work unless it is pulled out of the coil a little.



The construction of the Antenna System Tuning Unit can be seen from this picture.

WIRE VERSIONS

MY LAZY-H IS stretched between two fir trees which happen to be conveniently located near the shack. I reinforced the smaller tree at the top with one inch steel pipe, which I strapped to the trunk with steel tape. I also stretched a stout rope between the trees to prevent them from snapping the antenna by separating in a high wind.

A disadvantage of the Lazy-H is that you need at least 50 feet of height. Fifty feet will put the lower doublet only 19 feet above the ground, which is the minimum height I would recommend. If you don't have two 50 foot masts separated by more than 34 feet, or trees that will serve the same purpose, you might consider the inverted-V form shown in **Fig 5**.

This version uses only one mast to support two Lazy-Hs at right angles for 360 degree coverage. The doublets also serve as guy wires. Two separate transmission lines are brought into the shack for switch selection of the desired array.

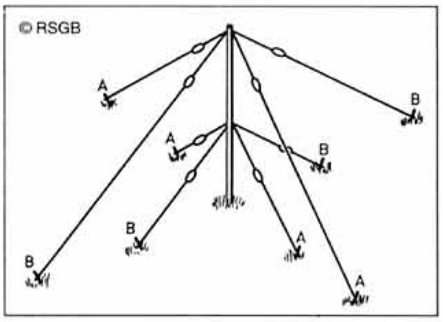


Fig 5: Two Lazy-Hs at right angles in inverted-V form can be placed on one mast for 360 degrees coverage. In this view one Lazy-H is marked A-A-A-A and the other B-B-B-B. Separate transmission lines are brought into the shack for switching between arrays.

DIPOLE VERSION

THE LAZY-H CAN also be made with tubing dipoles mounted on a mast, as shown in **Fig 6**, and this will permit rotation. Since the antenna is bi-directional, only 180 degrees of rotation will be needed. The rotating mast can be guyed through slipping guy rings, and if guyed near the upper dipole, the guys will have to make an angle of at least 29 degrees from the mast in order to clear the lower dipole.

The guy 'wires' should be non-metallic such as plastic rope. This version has the advantage of requiring much less real estate than that shown in Fig 5. It also permits exact placement of the pattern nulls for QRM reduction.

PATTERNS

ON 20 METRES the azimuth pattern will be the same as a half-wave dipole and on 10 metres the pattern will be the same as a full-wave dipole. Both of these patterns have been published in the *ARRL Antenna Book* [3] as well as many other publications.

On 17, 15 and 12 metres the radiation

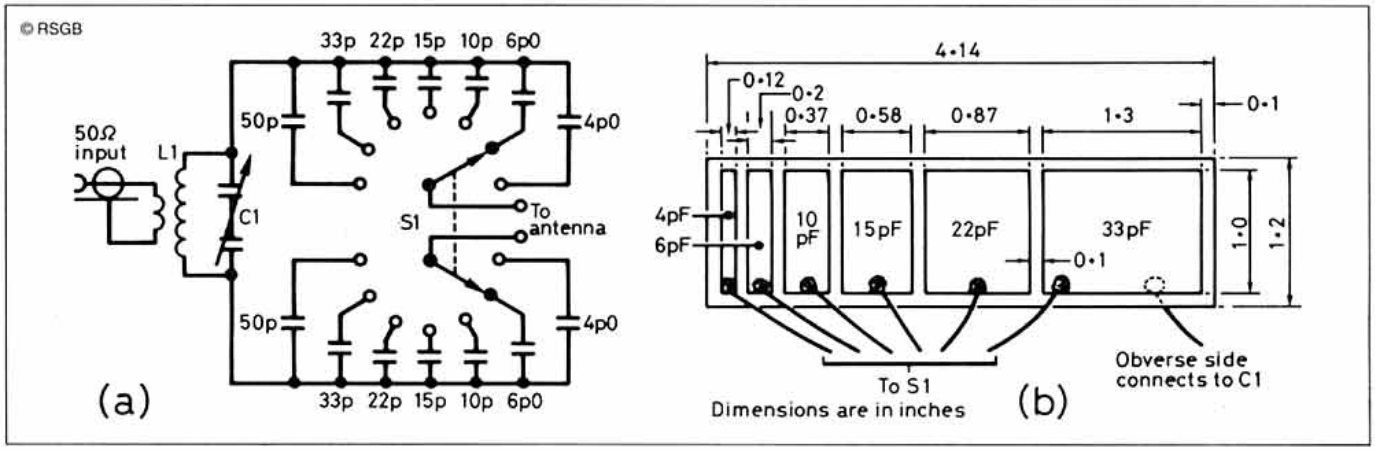


Fig 4(a): This Antenna System Tuning Unit will match 50Ω coax to the tuned feeders on all 5 bands. C1 is a 175pF per-section split-stator variable. L1 is 4.25 turns of #10 (12 SWG), 3 inches diameter, 1 inch long, air wound. The link is one turn, 1.9inch diameter, centred between the turns of L1. S1 is a two-wafer, 7 position ceramic rotary switch. For power levels above 100 watts all fixed capacitors should be 3kV or higher. Fig 3(b) shows dimensions for construction of high voltage capacitors from double-sided circuit board. The capacitors can be made with the above dimensions from 25pF-per-square-inch circuit board. Two such boards will be needed.

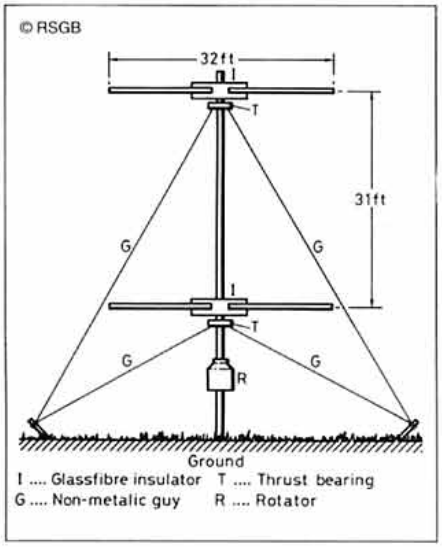


Fig 6: A Lazy-H made with tubing dipoles can be made into a fully rotatable array.

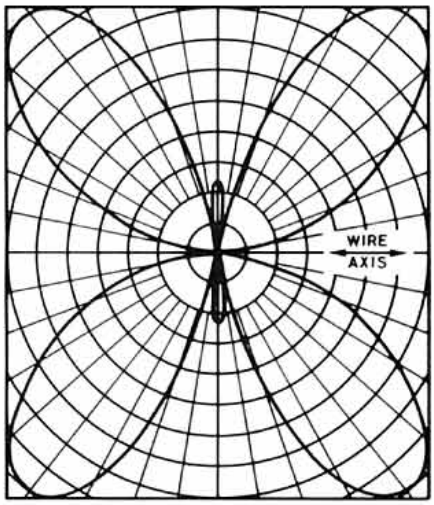


Fig 7: On six metres the azimuth radiation pattern has 4 main lobes with maxima at 49° with respect to the wire axes. At this frequency the broadside lobes are insignificant.

pattern will be something between the half-wave and full-wave dipole patterns. On all five bands the pattern consists of two lobes broadside to the wire axes, the only difference being that, as the frequency increases, the lobes become narrower.

At frequencies above 30MHz, the broadside lobe continues to narrow but minor lobes begin to appear on either side of the main lobe. As the frequency is raised further these minor lobes grow in amplitude until at 50MHz they are much stronger than the broadside lobes, as can be seen in the diagram above (**Fig 7**).

OTHER BANDS

EIGHTY AND FORTY metre operation can be achieved by tying the feeders together and using the antenna - transmission line combination as a top-loaded vertical in conjunction with an RF ground or counterpoise.

On six metres the Lazy-H will give about 6dB of gain, but not in the broadside direction. The radiation pattern will be as shown in Fig 7 [4]. A separate ASTU will be needed for six metres. The free-space vertical-plane pattern of the Lazy-H on 6 metres shows a null at an elevation angle of 18.4° which may limit its performance on short-range sporadic-E contacts.

RESULTS

MY LAZY-H IS oriented towards Europe, which puts the back lobe on New Zealand. Signal reports from both directions have been truly gratifying and it easily surpasses a very good dipole [5] at 75ft.

REFERENCES

[1] *Antennas, First Edition,* J D Kraus, McGraw-Hill Book Company, Fig 11-32, page 313.

[2] Available from Amateur Electronic Supply in the US, or from W. H. Westlake (Tel 0409 2537590) in the UK.

[3] *The ARRL Antenna Book, 15th and 16th Editions,* pp 3-11, Fig 17 and pp 8-32 Fig 40. [16th Edition available from RSGB Sales, see this month's *RSGB Book Case* on pages 104/105 – *Ed*].

[4] Thanks are due to W6MMU for calculating this pattern on his computer.

[5] 'A Five-Band Dipole', *Ham Radio, September 1988;* page 76, Fred Brown, W6HPH.