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A Compact Hybrid Antenna for 2 m, 70 cm and 23 cm

Many UHF amateurs would like to work VHF, UHF and SHF in various modes. This means, of course, a certain outlay in the provision of antennas. In my case, additionally, there is the problem concerning the lack of available space – and I am certainly not the only radio amateur to suffer this! It is for this reason that the antenna form selected (fig. 1) could also be of interest for others.

Out of the following requirements placed upon the antenna system, a suitable design crystallized.

- Able to work 2 m, 70 cm and 23 cm
- Provision to work even higher frequencies
- Switchable polarizations (horizontal/vertical)
- Compact form
- Enough gain for satellite working
- Within a limited framework, should be possible to work 23 cm EME

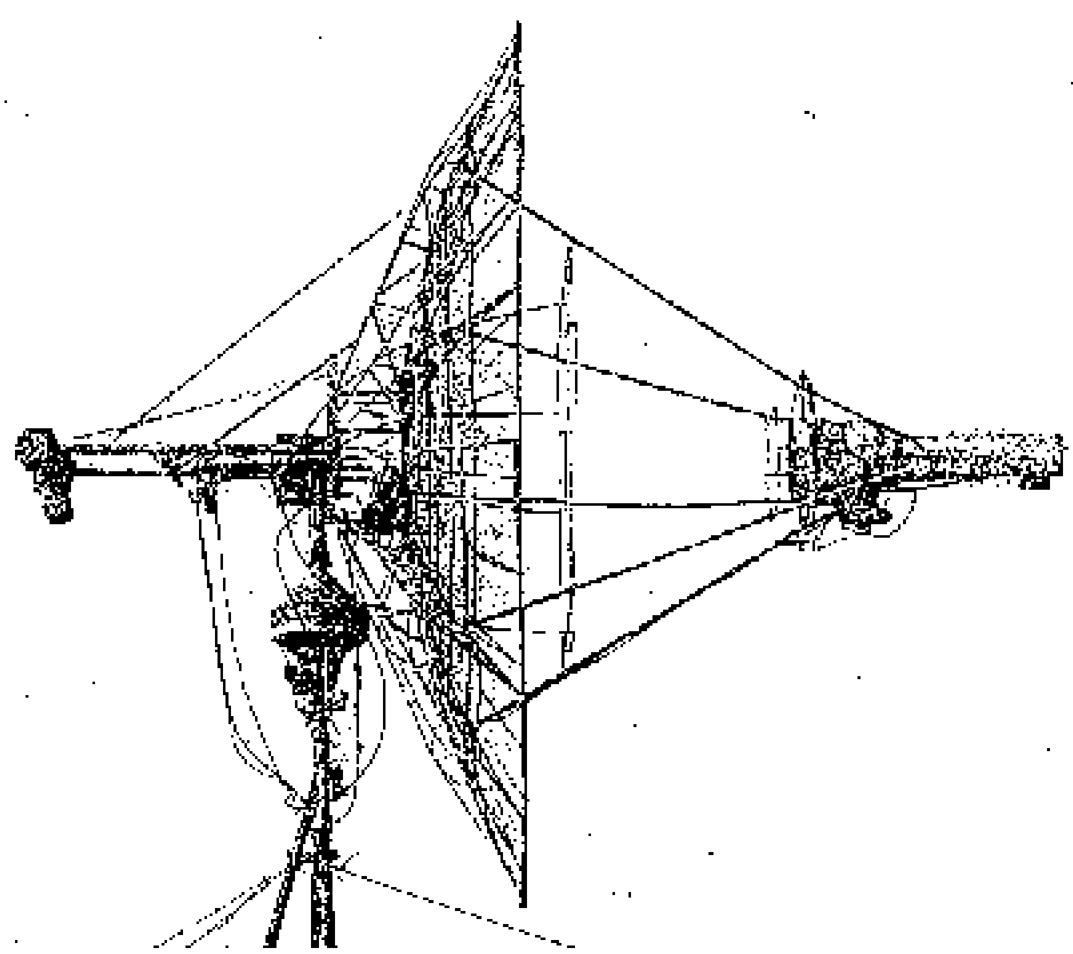


Fig. 1:
OE 5 JFL hybrid antenna for 2 m, 70 cm and 23 cm

1. CONCEPTUAL CONSIDERATIONS

The last of the above demands dictated a parabolic dish antenna for the 23 cm band (1296 MHz). The smallest diameter of such an antenna, capable of working 23 cm EME, is 2 metres. Yagi antennas for 2 m (144 MHz) and 70 cm (432 MHz) could then be constructed about the dish antenna. This was successfully tried for the 70 cm band antenna but only for one polarization and there was still a problem of where to site the 2 m band antennas.

With this, a further round of considerations was undertaken with the idea in mind to increase the main dish diameter until it was also viable for the 70 cm band.

The calculation was quite simple: If a dish, greater than 1 metre diameter, gives good 23 cm results, a 3 metre-diameter dish would produce about the same results on 70 cm. The increase of 1 m from 2 metre to 3 metre would also increase the gain on 23 cm by some 3.5 dB.

Using a universal (hybrid) radiator comprising a horn for 23 cm and a switchable polarization NBS antenna (fig. 2) for 70 cm, the demands for these two bands were amply fulfilled inasmuch that a 3 metre dish with an f/D ≈ 0.5 may be very well illuminated.

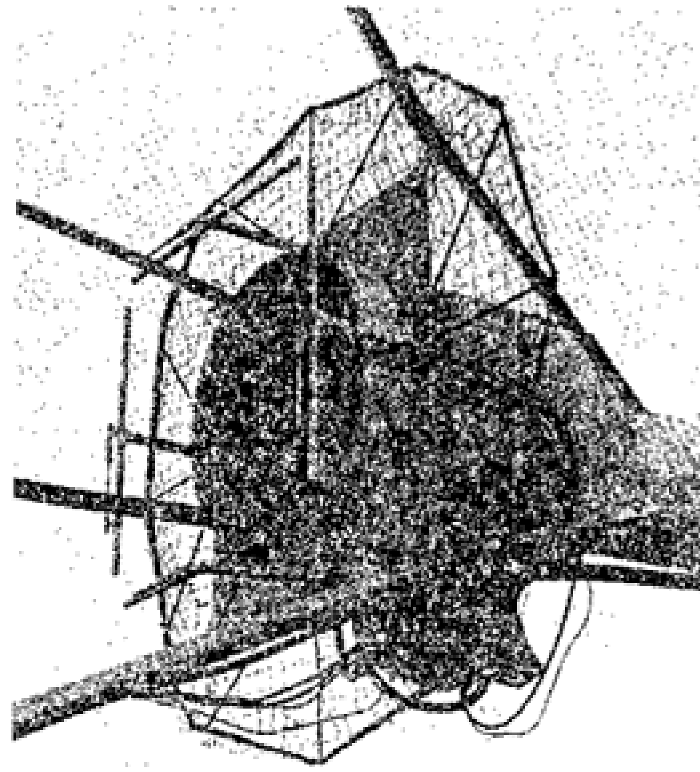


Fig. 2: Feed arrangements for 23 cm (circular) and 70 cm (H or V switchable)

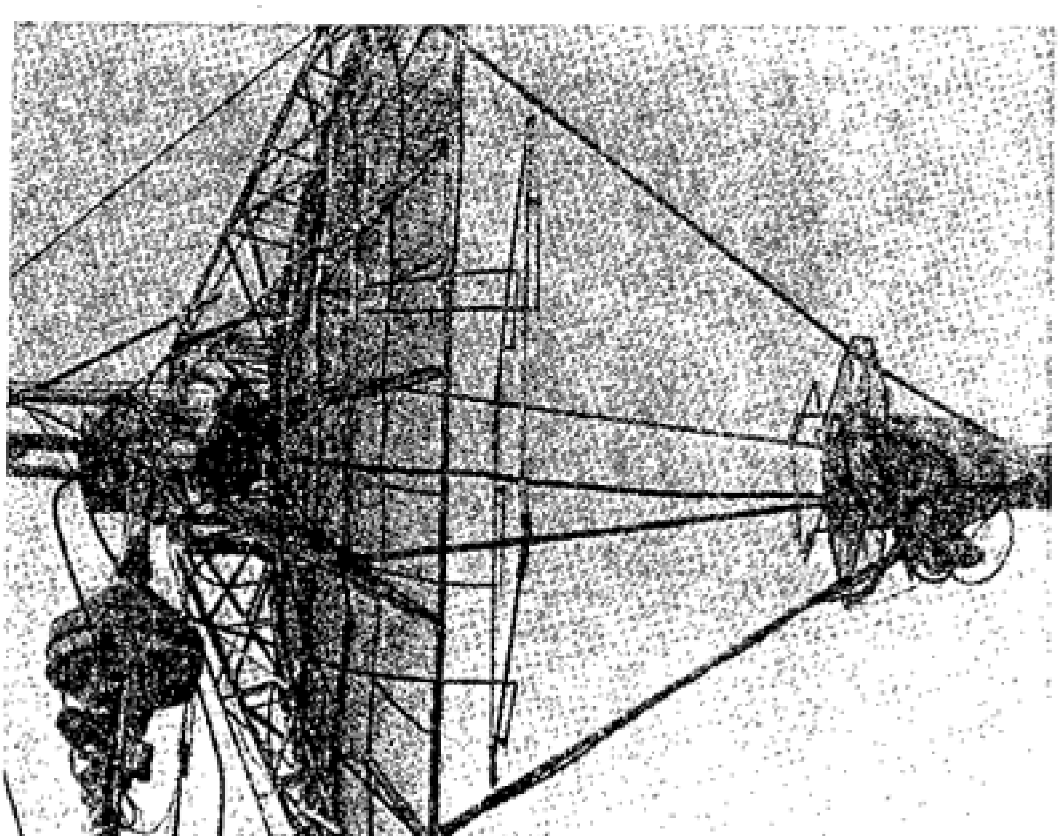


Fig. 3: Right against the surface of the dish are located the four 2 m dipoles for H and V polarization

In order that the installation be equipped for the 2 metre band, Yagis can be mounted around the dish. The parabolic dish diameter of 3 metres entailed having a stacking distance of some 4 metres. Sixteen-element long Yagis would have been very suitable for this application. As the elevation of the antenna had also to be variable with its attendant mechanical problems – quite apart from considerably higher weight and space considerations – the following solution was arrived at:

The parabolic dish can also serve very well as a reflecting surface for the 144 MHz dipole. The 2 metre antenna then becomes very similar in conception to that of the 70 cm feed system. The NBS antenna has two stacked dipóles (λ/2 long, λ/2 apart) and λ/4 from the reflector surface mounted about it. The gain of these antennas approximates 8 dB_d. Increasing the stacking distance to 0.6 λ will increase the gain – and that is an option. In addition, the curvature of the reflector also proves itself to be beneficial. A disadvantage is, however, a certain deleterious influence of the four 144 MHz dipoles upon the gain at 70 cm and 23 cm. The dipole mounting is effected quite simply by means of plastic support insulators affixed to the four horn support struts. The latter, in turn, are supported at a suitable distance from each other by the fixations at the reflector surface (**fig. 3**).

2. IMPLEMENTATION

The theme of this article is not how a parabolic reflector with an f/D of 0.5 is designed and constructed but it is intended largely as an inspiration for related ideas. For example, for the feed horn is a design taken from the RSBG's "VHF-UHF MANUAL".

Fig. 4 shows a frontal view of the hybrid-feed system for 23 cm and 70 cm giving its main dimensions. Further detail can be seen in the side-view diagram of **fig. 5**. Finally, the 70 cm-dipole matching is shown in **fig. 6**.

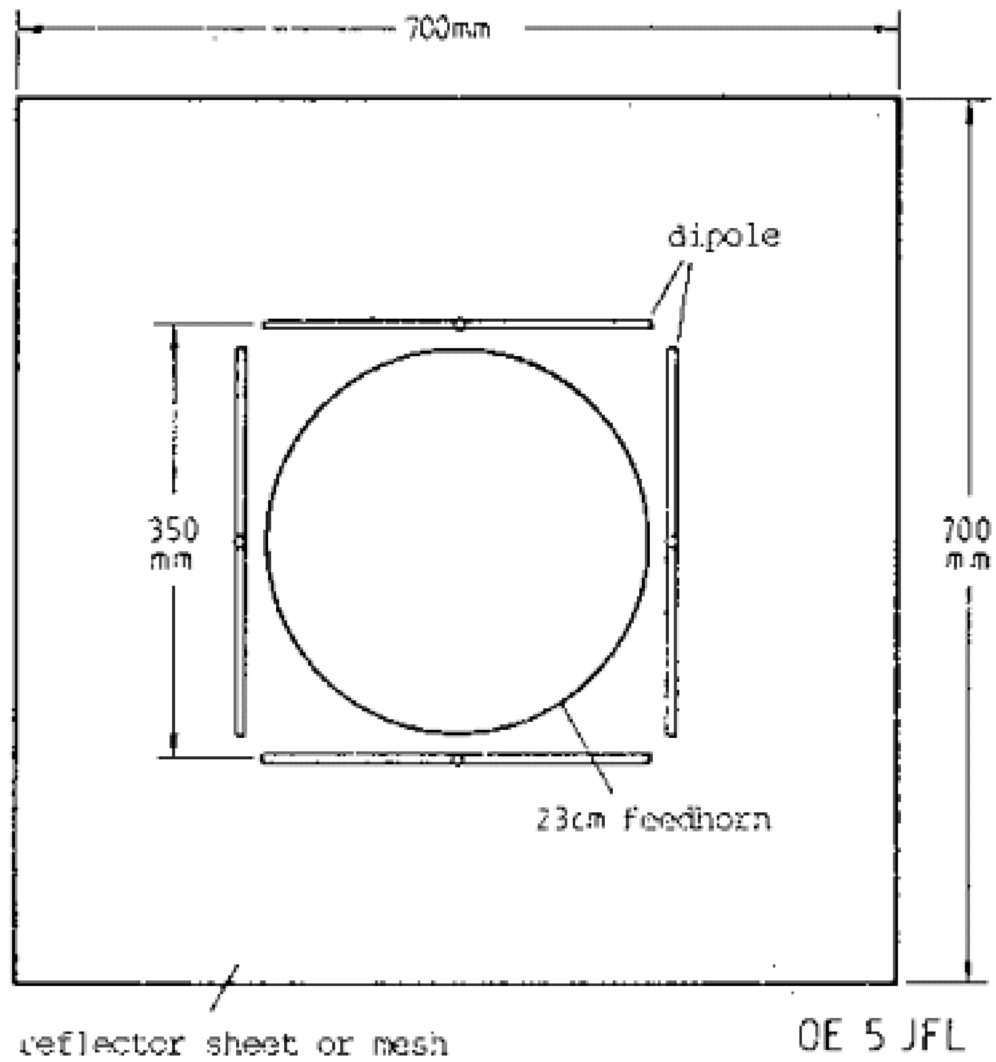


Fig. 4: View looking into the hybrid feed for 23 cm and 70 cm for an f/D = 0.4...0.6

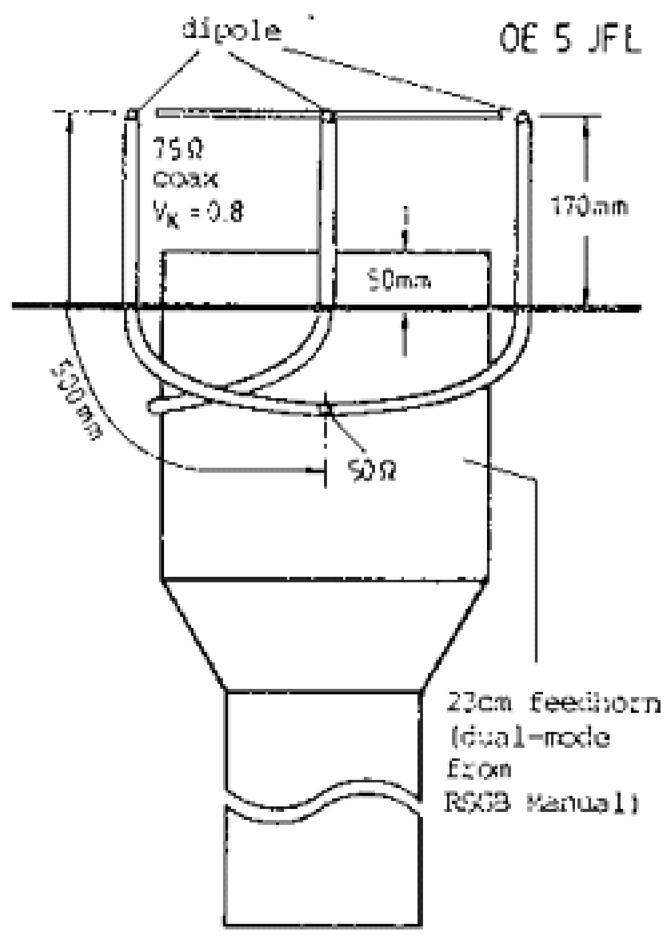
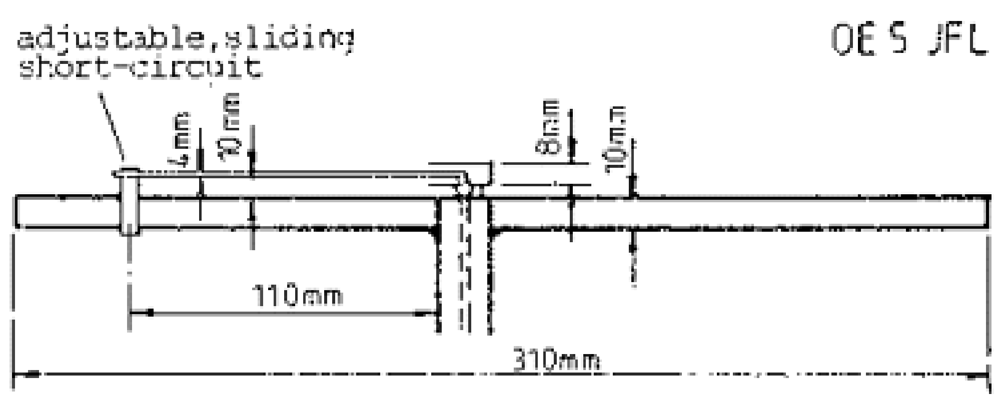


Fig. 5: The side elevation of fig. 4 showing how each pair of 70 cm dipoles is connected



insert depth C: 5 to 10 mm
insulation: 1 mm Teflon

Fig. 6: Matching the 70 cm dipoles

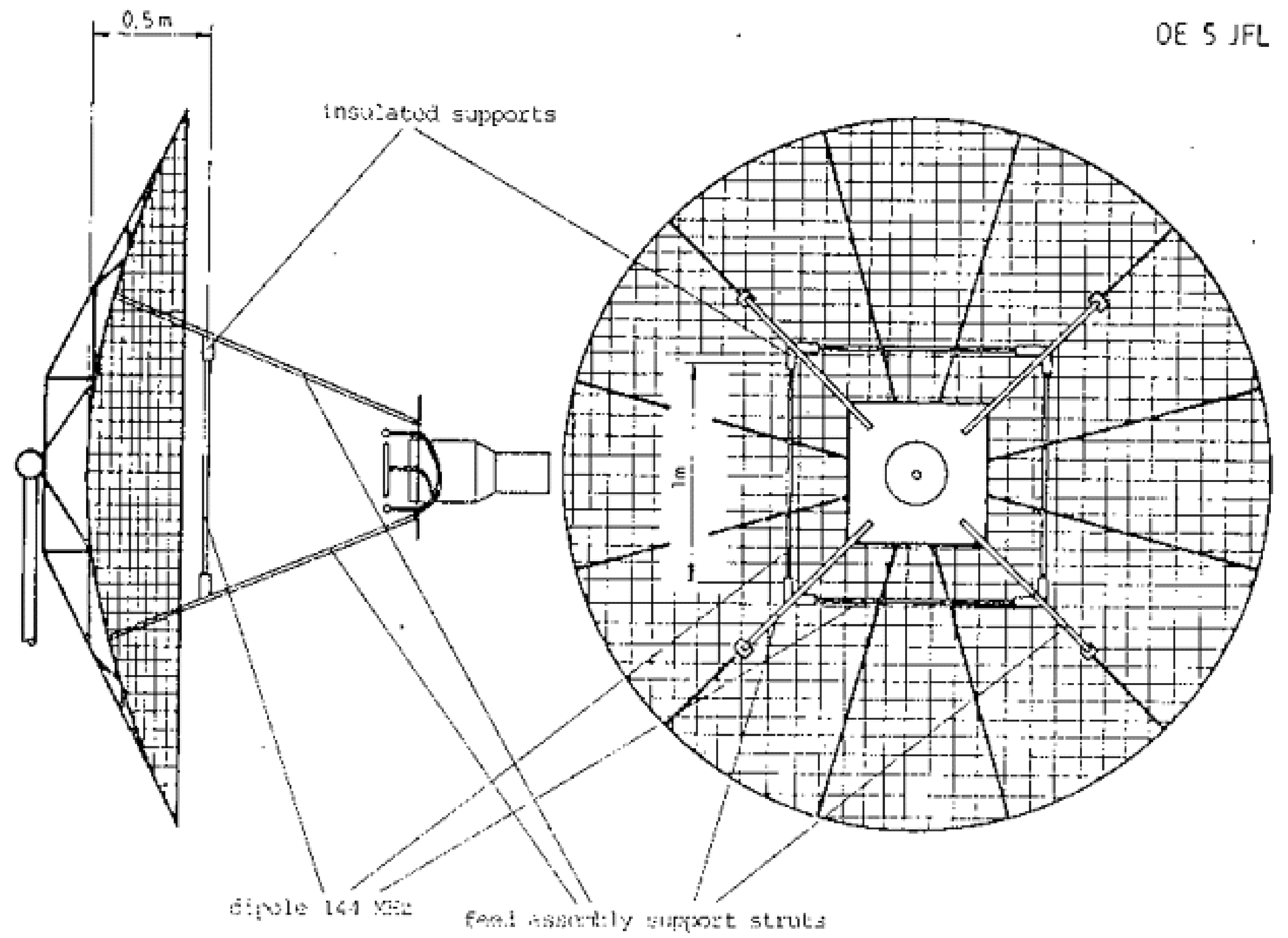


Fig. 7: The complete arrangement

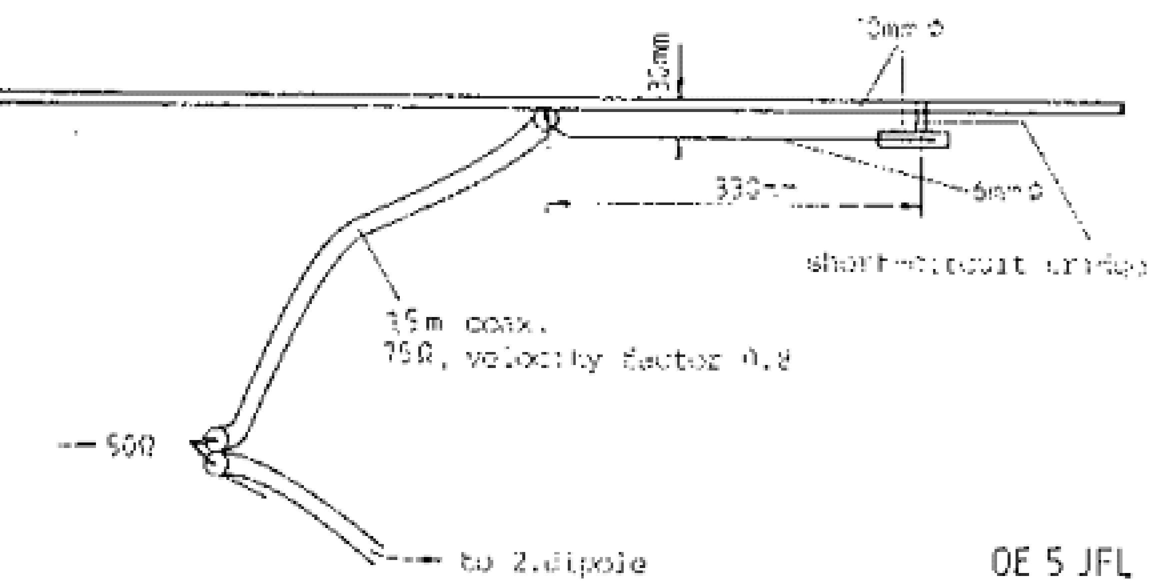
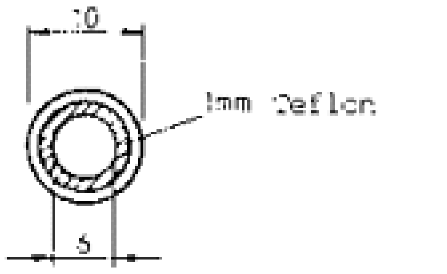


Fig. 8: Matching the 144 MHz dipoles



'inner conductor' protrudes 5cm approx.

Fig. 9: The gamma-match capacitor

Figure 7 shows the arrangement of all three feed systems mounted looking in to the parabolic dish. The four 144 MHz dipoles are matched by a "gamma-match" and via a one-wavelength 75 Ω cable between dipole pairs, see fig. 8. The necessary capacitors are constructed in accordance with fig. 9.

3. WORKING EXPERIENCE

My parabolic dish has a diameter of 3.3 m. Working via the OSCAR 10 satellite is easily possible but the receiver pre-amplifier should be mounted immediately in the vicinity of the antenna. The switching of the polarization has proved a worth-while provision and is particularly useful for experimentation in ES and MS.

Moon-bounce (EME) contacts are possible on 1296 MHz but only if the distant station is using a parabolic dish of at least four metres in diam-

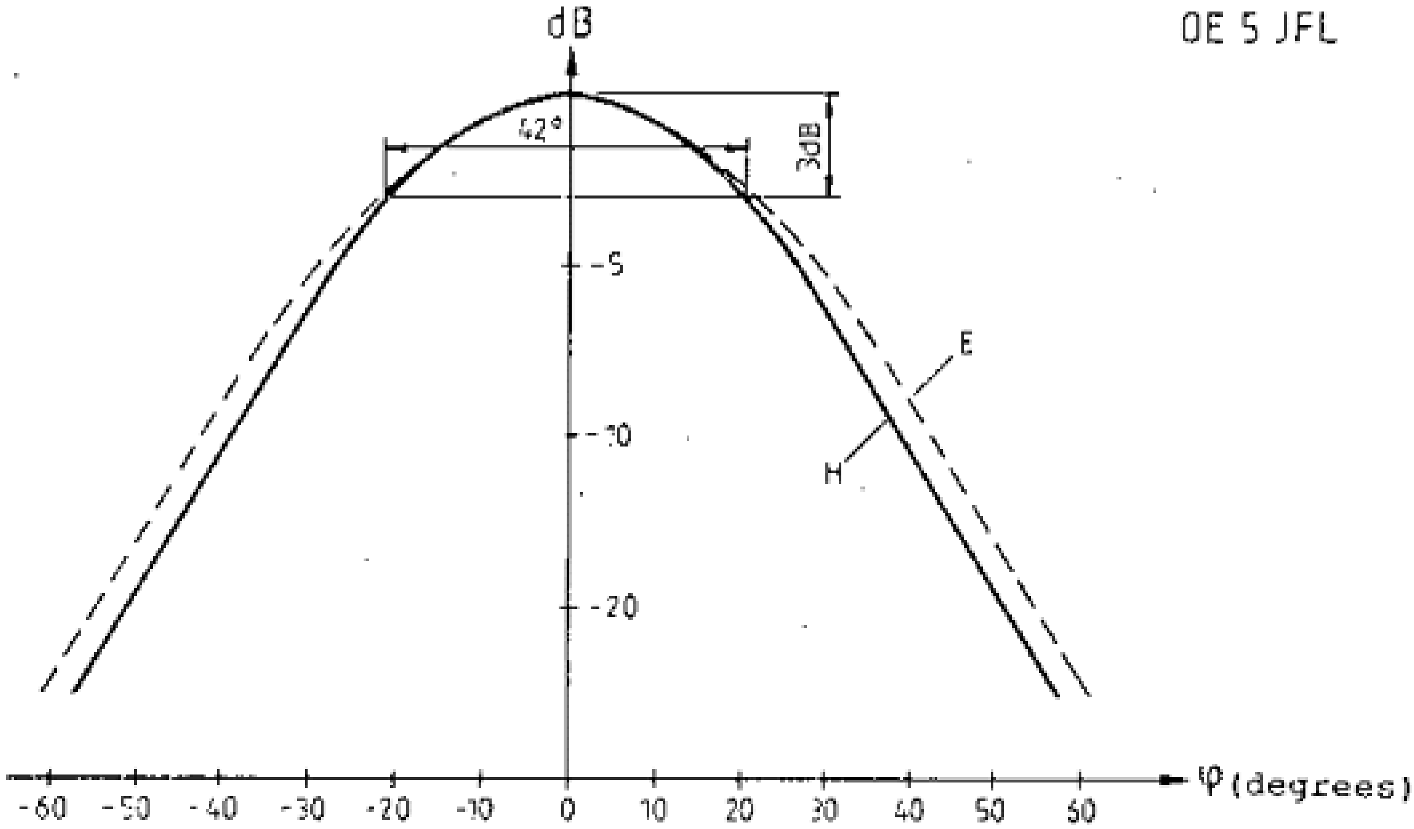


Fig. 10:
The 2 m antenna polar characteristic taken at 144 MHz

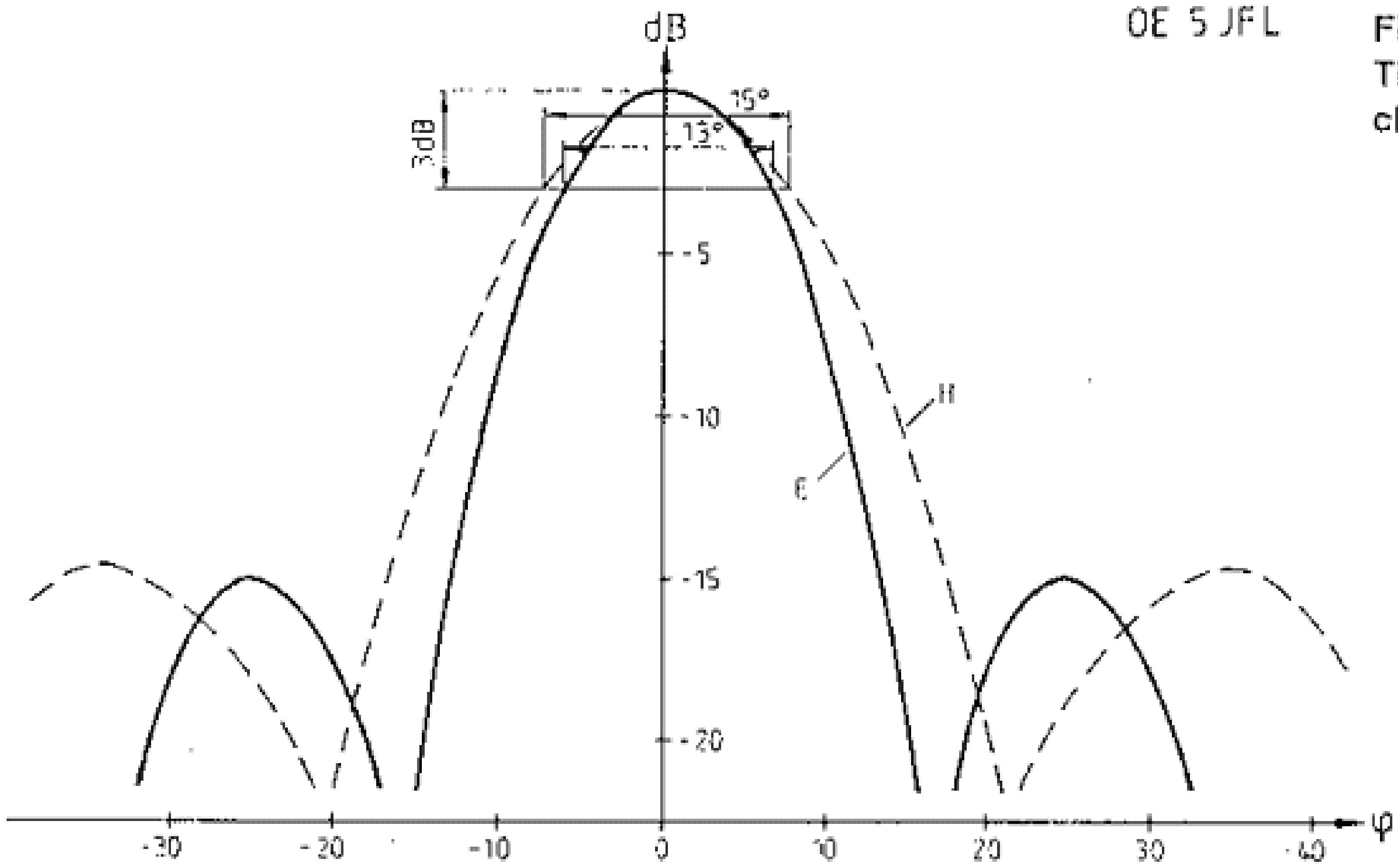


Fig. 11:
The 70 cm antenna polar characteristic taken at 432 MHz

eter. Using 200 Watts of RF power, it is sometimes possible to hear one's own moon-reflected signal.

In the 70 cm band, EME signals can be heard, from stations with large installations, in a 200 Hz bandwidth and with a 10 dB (S + N)/N.

If the shadowing effect of the feed and the influence of the 144 MHz dipole is not taken into account, the parabolic system using a 3.3 metre dish at an efficiency of 55 %, is calculated to give the following gains:

23 cm : 28 dB_c
70 cm: 18.5 dB_d
2 m: 8 dB_d (approx. using NBS standard)

3.1. Polar Diagrams

The polar diagrams were measured with the results shown in **figs. 10, 11 and 12**. The fol-

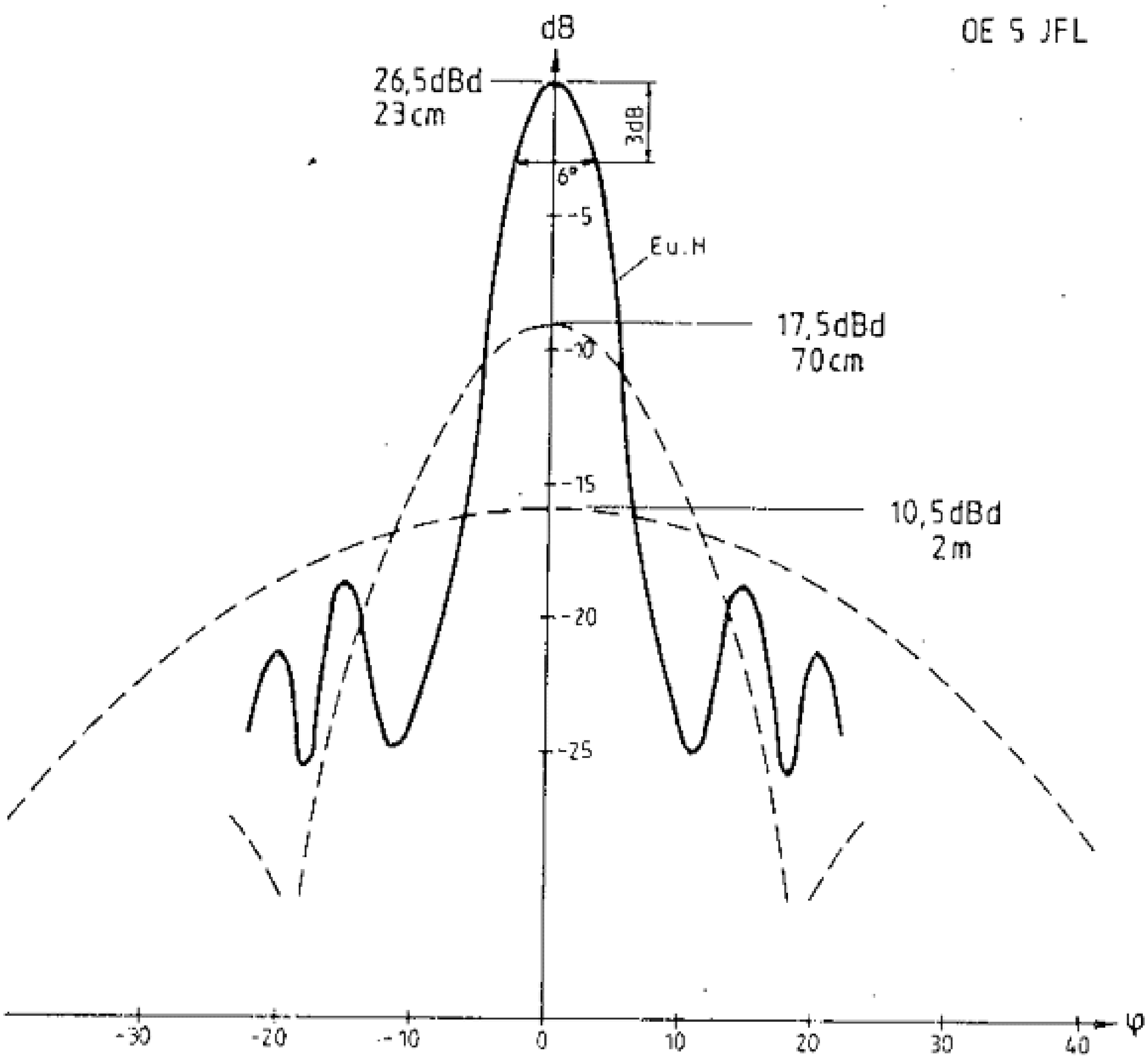


Fig. 12: The 1296 MHz polar characteristic. The main lobes of the 2 metre and 70 cm antennas are shown superimposed for comparison purposes.

lowing gains were determined from them by integration, taking the side lobes into account:

23 cm:	26.5 dB_c
70 cm:	17.5 dB_d
2 m:	10.5 dB_d

At 23 cm, the gain deterioration is around 1.5 dB, comprising 0.5 dB due to shadowing effects and another 0.5 dB due to non-optimal reflector illumination (i.e. f/D = 0.45). The remaining 0.5 dB can be put to the account of the 2 m dipole.

At 70 cm, the 1 dB loss is divided equally between shadowing and the influence of the dipoles.

These losses seem to me to be bearable as the saving of additional antennas for 144 MHz has been made.

If it should be desired to obtain the same antenna performance in the normal manner, i.e. using a dedicated mirror for 23 cm and Yagis for 70 cm and 2 m, the following antenna specifications would be required:

23 cm: Dish diameter of 2.8 metre (approx)
70 cm: Two stacked 4 m long Yagis for each polarization
2 m: An 8 element, 3 m long Yagi for each polarization

Altogether, six long Yagis and a parabolic dish antenna – certainly not conductive to a compact construction! In addition, there would be mutual coupling interference between antennas leading to a high likelihood of gain reduction.

P.S. The damage to the parabolic reflector which is evident on the photographs, was caused by ice rain last winter.