horizontal Yagi aerial at the same height does not in itself reduce the angle of radiation but concentrates more energy in the lower lobes at the expense of reduced radiation in any higher angle lobes. Additionally the beam widths of the lobes are reduced.

Having refreshed our memory regarding some of the elementary fundamentals which have been amply documented in manuals dealing with HF aerials let us examine the requirements in particular for 7/3.5/1.8MHz aerials.

Unfortunately we are now confronted by sets of dimensions of frightening proportions if we try to scale up what we do on the higher bands. The writer has seen one or two full size 7MHz Yagi beams and one almost full size 3.8MHz rotary beam. Needless to say problems of cost, local authority and neighbourhood relations rule out such ambitious projects for all but a tiny proportion of the amateur fraternity.

Back to reality

After day-dreaming about 3-element 3.5MHz Yagis at heights of 40m or more we come back to reality and settle for something far less spectacular. A good starting point in our deliberations is the fact that a horizontal dipole at a quarter-wavelength or less above ground is an excellent high angle radiator, which is good for short skip contacts but pretty poor for consistent DX working.

Over flat ground we need a height of a half-wavelength to achieve an angle of radiation of 30° which after all is not low. This means a height of 20m for 7MHz, 40m for 3.5MHz and 80m for 1.8MHz. Whilst no doubt heights of about 20m are reasonably practicable for a good number of amateurs, heights of 40m and above are not easy to obtain except in special circumstances.

To get the aerial problem for the lower amateur bands in perspective we should reflect that a typical 3.5MHz horizontal dipole erected at a height of 16m is equivalent to a 14MHz dipole at a height of only 4m. Few amateurs would use such an arrangement for DX.

From the foregoing it is easy to understand why the vast majority of amateurs have to settle for a compromise aerial for DX working on the lower frequency bands. Clearly the problem becomes harder to solve the lower the frequency and we need to look at the three bands 7, 3.5MHz and 1.8MHz separately.

7MHz

This is a difficult band for the telephony operator because he suffers more than a CW operator from saturation strength commercial signals. Moroever a CW enthusiast needs only to cover a very narrow frequency band but the telephony operator needs to receive from 7.04 to 7.30MHz even though in Europe he may not transmit above 7.10MHz. The writer remembers well the 7.0 - 7.3MHz band of the early Thirties when simple aerials and low power yielded worldwide contacts and it was a sheer joy to operate. Nowadays receiving a weak DX SSB signal on the skirt of a 100kW broadcasting station may be a tribute to modern receiver design as well as to the directional discrimination of the aerial in use, but it hardly makes for comfortable listening!

Without doubt the relatively few amateurs who have the resources and environmental conditions to erect a 7MHz rotary beam have a great advantage over less fortunate amateurs due to the appalling level of interference on this band. Positioning the beam to minimise the interference is usually more important than getting the maximum signal from the DX station it is desired to receive.

Size reduction

Constructional details of 7MHz rotary beams are outside the scope of this article. However several designs have been published (eg references 1, 2 and 3) and they have laid emphasis on shortened elements in an endeavour to keep the overall size to manageable proportions. Size reduction is achieved by inductive or capacitive loading or both (Fig. 1). An unfortunate practical result is narrower bandwidth and increased resistive losses. The author prefers capacitive loading rather than the use of inductors although, in practice, capacitive loading restricts the degree of size reduction which can conveniently be achieved. It should also be remembered that both gain and directivity will be inferior to that of a full size array possessing a similar number of elements, and a good impedance match may only be achieved over a very narrow bandwidth.

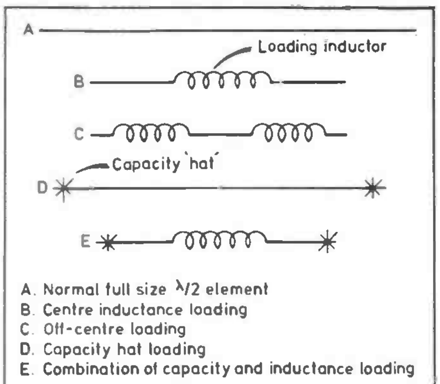

Fig. 1. Shortened half-wave resonant elements.

What are the non-rotatable wire alternatives? Of course these are many including the dipole, inverted 'V' dipole, long wires, verticals, slopers and loops or combinations of such radiators. If we assume that the average amateur has somewhat restricted real estate we can eliminate thoughts of long wires, Vee beams and rhombics especially if it is desired to cover a number of different directions. High dipoles and inverted 'V' dipoles can give a good account of themselves if erected at least 20m above ground although even at this height short skip signals are a problem on receive. Horizontally polarised full wave loops suffer from similar limitations.

Verticals

Vertically polarised aerials, in general, provide better low angle characteristics for DX operation. The vertical half-wave is a little awkward to feed and although theoretically it yields some 3dB more signal at low angles compared with a vertical quarter wave, nevertheless a good deal of the radiation from the lower part of the ½λ vertical may be absorbed by obstructions surrounding the aerial. It has been the author's experience that a ¼λ ground plane aerial using elevated radials will often outperform a ½λ vertical. The radials can slope downwards at about 45° so that they can be conveniently anchored to short posts or trees. **See Fig. 2.** This also has the effect of raising the driving point impedance and provide a reasonable match to 50/52ohm coax. Four ground plane radials are commonly used although the author has used from three to eight radials without noticing any dramatic change in performance.

A wooden mast is strongly recom-