Chapter 5: FULL RANGE CONE DESIGN

The underlying philosophy of wide band cone design is to work ***with*** the natural laws instead of ***against*** them. We have shown that radiation from a cone at low frequencies is intrinsically independent of frequency whilst at the higher frequencies concentric wave modes can extend the response albeit in a somewhat uncontrolled manner. Wide band design aims at controlling the generation and progression of these concentric waves whilst minimising the production of 'bell' modes.

This has been achieved by the development of specific cone profiles designed to control the concentric wave velocity in the cone such that the effective cone radius is a predetermined function of frequency. This deceases the effective mass and broadens the directivity. These characteristics have to be carefully balanced to achieve the maximum high-frequency extension together with good stereophonic imagery. Work on this was started by the author in the 1950's and has continued ever since. From the start there has been no tractable mathematical way to pre-determine the optimum co-ordinates for controlled flexure profiles, and these have only been achieved by painstaking developmental procedures. It is only during the last few years that computer technology has been available to confirm the validity of this work.

Fig: 12, **'a', 'b'** and **'c'**, below is a graphic impression of how controlled flexure reduces the effective cone radius and therefore effective mass as frequency is increased. In this case the outer flexing part takes on the roles of suspension and restoring force where the force/displacement characteristic needs to be linear. A straight-sided profile is shown for clarity.

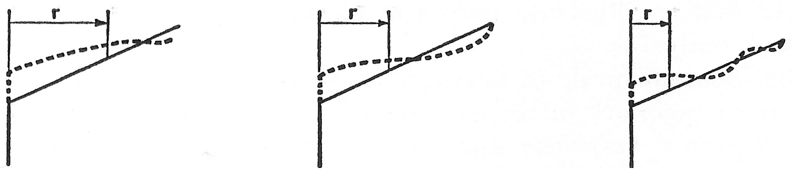

Fig: 12. **a** **b** **c**

Flexing involves alternate displacement and restoration of a material about its normal state and in order to preserve of the low level detail within the sound, this flexure needs to have a fast and linear response to the driving forces from the voice coil. This requires true elasticity as defined by Hooke's Law. This is a characteristic of materials having crystalline structures where the elasticity is due to intermolecular forces. The light metal alloys are the obvious practical choice for this whereas paper and synthetic materials are elastomeric and depend for their elasticity upon the folding and unfolding of long molecular chains - a non-linear and relatively slow process. It should also be noted that at high frequencies and low levels the amplitude of the cone displacement is in the order of microns and would be lost in the thick amorphous structures of many conventional cones. The high frequency limit is defined where the effective mass of the cone approaches the non-reducing mass of the voice coil. The latter should, therefore, be as light as possible. The low frequency limit is determined by the resonant frequency Fs.

FLEXING CHARACTERISTICS of a100mm WIDE BAND CONE.

These graphics show the generation of controlled concentric modes and the resulting effective reduction in cone diameter. The red and green areas indicate forward and backward motion respectively. The graphics show the cone just entering the forward phase of its cycle.

Fig: 13a.

At 4kHz the cone is just moving out of its piston range as indicated by the green edge.

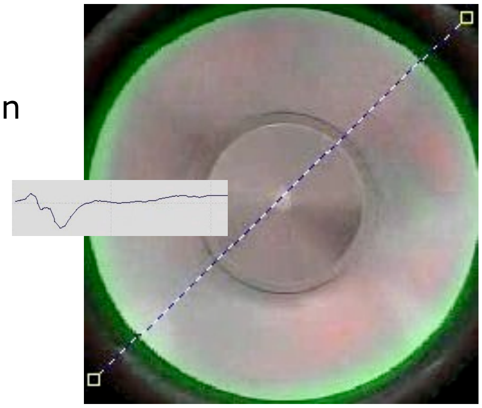

Fig: 13b.

At 10kHz, the effective reduction in cone diameter is clearly seen concentric flexing waves travelling outwards to be absorbed at the periphery. The net sound pressure level due to these waves is negligible.

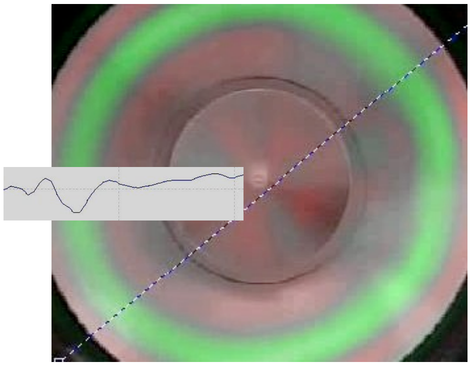

Fig: 13c.

The progression is shown at 17kHz. In this case the effective diameter has reduced to that of the dust cap, which could be regarded as a tweeter with the cone body as its suspension. the progressively reducing amplitude of the concentric waves shows good the absorption at the rim termination.