VLBA ACQUISITION MEMO #372

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Subject: Contours of "triple-cap"-heads

The equilibrium contour for a single-cap-head has a radius of curvature R given by [1]

$$R = (p + L) \ / \ \theta \tag{1}$$

where p = characteristic bending length of the tape. θ is the half-wrap angle and L is half the head length. For a head with multiple contact areas (see VLBA Acquisition Memos 305, 356, and 365) made of the same material an equilibrium contour will be established when -

1] The radius of curvature is uniform.
2] The boundary conditions between contact regions are satisfied.

The first condition establishes a constant pressure (for low tape speeds - fluid mechanics are ignored in this static analysis) which results in a uniform wear rate across all areas of contact.

In the regions where the tape is not supported, the tape profile (after a constant and a slope are removed) is given by

$$\left(\frac{p^2}{R}\right) e^{-x/p} \tag{2}$$

where x is the distance from the edge of a contact region. The boundary condition of continuity in slope across the head whose geometry is given in Figure 1 is

$$\theta = (L1/R) + \left(\frac{2p}{R}\right)\left(1 - e^{-L2/p}\right) + \left(\frac{2L3}{R}\right) + p/R \tag{3}$$

in order for the individual slopes to add up to the half-wrap angle θ. From (3)

$$R = \left(L1 + 2p\left(1 - e^{-L2/p}\right) + 2L3 + p\right) / \ \theta \tag{4}$$

The deviations of the contour from a straight line can be computed in a straightforward manner by joining the individual sections. Table 1 gives the radius of curvature and "deflections" for $x1 = 150; x2 = 350$ and $x3 = 450$ microns.

Tape Thickness µm	Characteristic* Bending Length µm	Radius of Curvature	*d1*	*d2*	*d3*
1	2	2936	3.8	14.2	21.1
10	65	4786	2.4	10.8	17.1
16	132	5987	1.9	9.2	14.9
26	274	7923	1.4	7.3	12.0

* for $Y = 6.5 \times 10^5$ *psi*, $T = 0.5$ *lbs* (10" H_2O)

Sensitivity to tape tension and thickness

One of the major advantages of a long head (large $L >> p$) is that the radius of curvature becomes relatively insensitive to tape thickness and tension because changing p has little influence on the value of R. For example, dropping the tension of 16 µm tape from 10" to 5" H_2O increases the value of p from 132 to 187 microns which in turn allows (4) to be satisfied with an effective reduction in L3 from 50 to 15 microns. A gap opens at the outer edge of the outrigger leaving full contact across the entire "center-cap". Also with a single-cap and $L \sim p$ increasing the tension or going from a thick to a thin tape can result in the tape lifting off the gap and contacting only at the edges of the head. This occurs when $g_i > g_s$ in equations 5 and 6 of [1]. When the distance from the gap to the outer edge of the outrigger is greater than the characteristic length of the tape this "lift-off" condition cannot occur.

[1] Rogers and Hinteregger, "Measurement of magnetic tape abrasivity by interchanging tape thickness", *Tribology Transactions*, vol. 36, pp. 139-143, 1993.

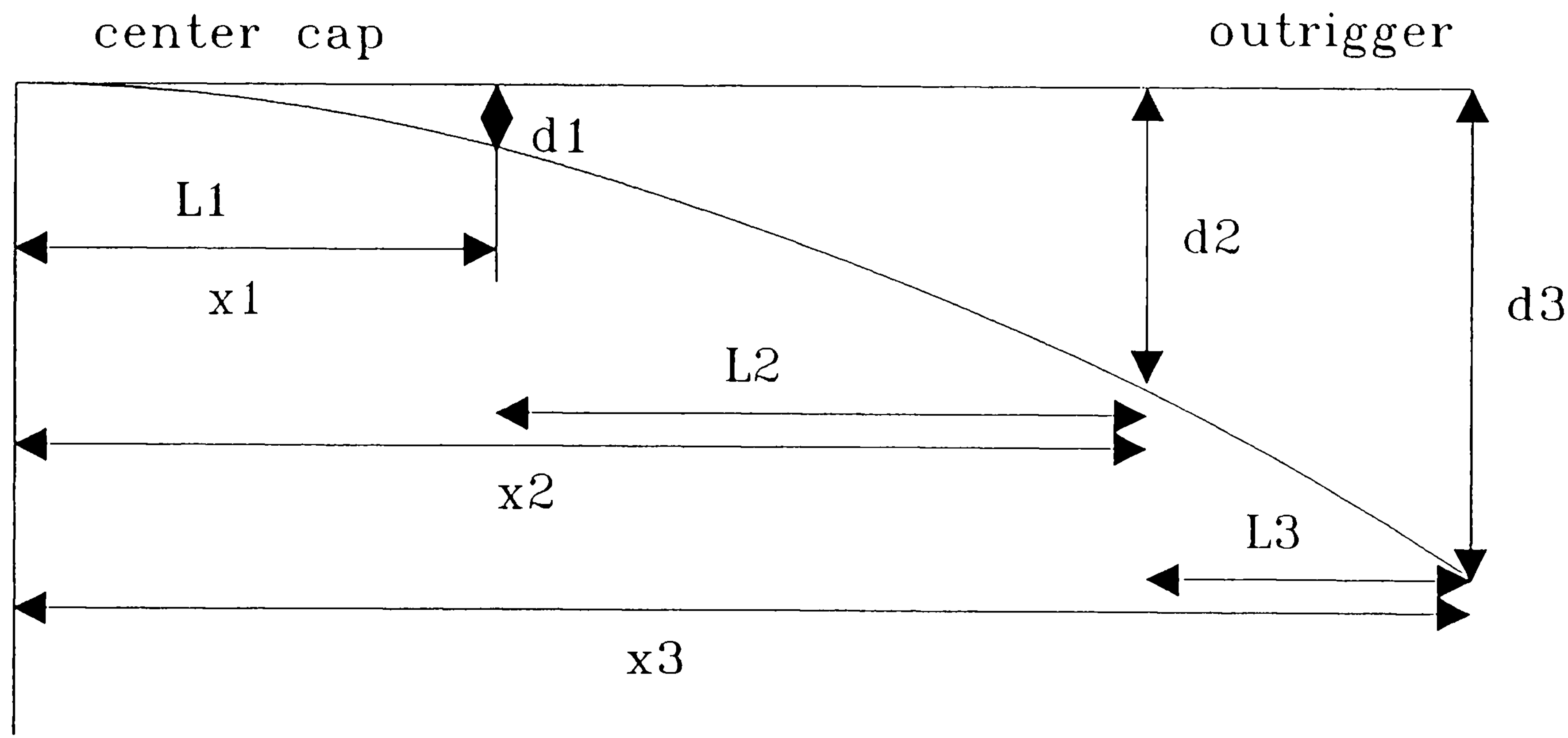

Fig. 1 Profile for 16 um tape x1=150;x2=350;x4=450
vertical scale expanded by factor of 10