VLBA ACQUISITION MEMO #302

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Subject: Mechanical model for reel table alignment needed for low speed running

The allowable reel table alignment tolerance was reported in VLBA Acquisition Memo #300. The following model is given to explain the observed dependence on tape thickness and tension:

Assume the tape starts to bend up on the I/O flange. With an angle ϕ as illustrated in Figure 1a. The excess tension in the edge strip is

$$Y(a/R)\ (ta/\sin\phi)$$

where

Y = Young's modulus (8×10^5 *psi*)

R = I/O roller radius (0.75")

t = tape thickness (16 μm)

a = amount edge is raised (producing a strain of (a/R)).

This tension will produce a force in the z direction of

$$F_w = Y(a/R)\ (ta/\sin\phi)\ (L/R)\ \sin\phi$$

where

L - length of the region bent up at edge (see Figure 1b)

which must balance the force produced by misalignment

$$F_F = \mu T \theta$$

where

μ = coefficient of friction between I/O roller and tape (~0.2)

T = Tape tension (15" = 0.67 lbs)

θ = wrap angle (~3 radians)

For a misalignment angle α the length of the bent up region will be approximately (see Figure 1c)

$$L = a/\alpha$$

Equating the forces $F_W = F_F$

$$\alpha = Y(a/R)^3 \left(\frac{R}{\mu\theta}\right)\left(\frac{t}{T}\right)$$

To avoid damaging the tape the ratio (a/R) should be less than about 1.4×10^{-2} (often called the "Cuddihy" limit). In this case

$$\alpha < 0.003 \textit{ radians (or 25 mils at a distance of } 8'')$$

which is in fair (given the approximate nature of the model) agreement with the measurements. It also shows that a greater tolerance could be obtained with a larger I/O roller and reduced friction. At high tape speed the friction is eliminated as an air bearing is formed. In this case the tolerance theory of VLBA Acquisition Memo #279 applies.

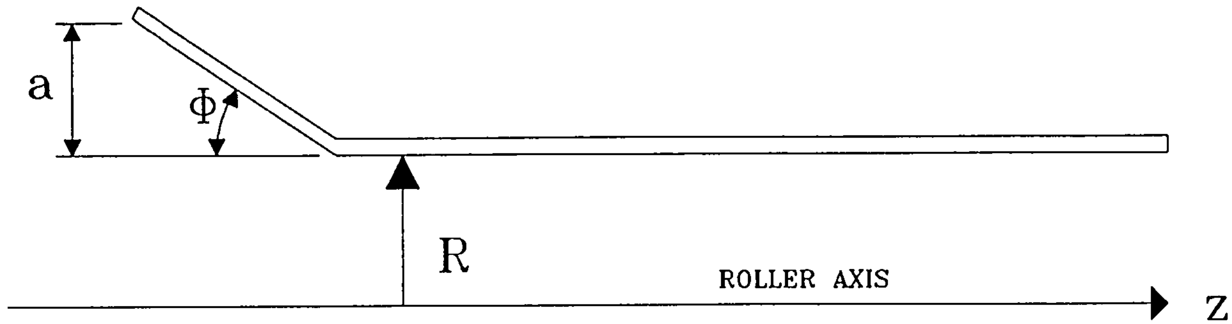

FIG 1A TAPE EDGE BENT UP ON ROLLER FLANGE

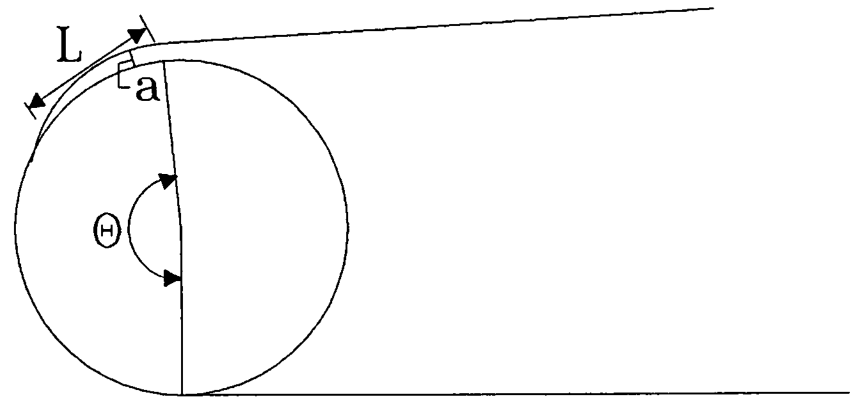

FIG 1B TAPE AROUND I/O ROLLER

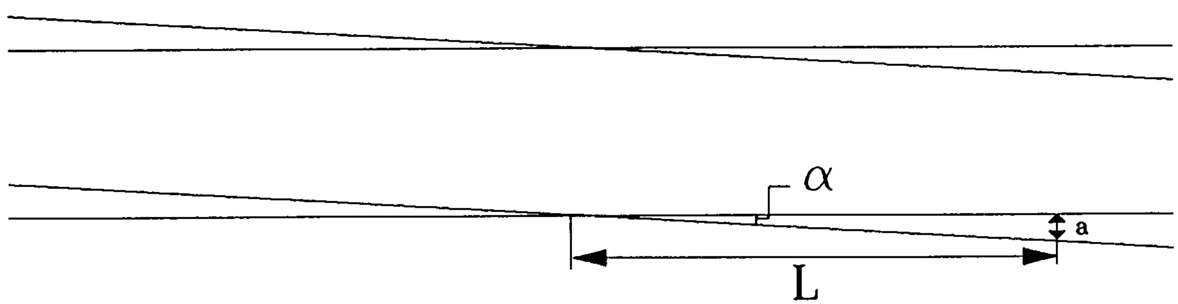

FIG 1C VIEW OF TAPE ENTERING AT AN ANGLE