VLBA ACQUISITION MEMO #356

C. Peck,

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

24 May 1993

Telephone: 508-692-4764
Fax: 617-981-0590

To: VLBA Data Acquisition Group

From: Alan E.E. Rogers AEER

Subject: Methods for further reduction in head flying and head wear

The head flying model (see VLBA Acquisition Memos, 282, 273, 264, and 254) shows that flying occurs, provided:

1] An entrance is opened by a change in tape angle which is brought about by the pressure increase on the path to the headstep, a reduction in operating tension or a previously defined contour with too small a radius, and

2] The tape can be supported by the air bearing. That is, if the tape speed is sufficient to produce a sufficiently high bearing number.

The second condition is not really under our control unless we limit speeds or use high tension. However, we can limit flying by preventing an entrance from opening. We have reduced the change in tape angle by reducing the pressure build-up (the approach angle has been increased from 5° to 15°, see VLBA Acquisition Memo #305). Other methods which were considered (see VLBA Acquisition Memo #264) were:

a) Use of the "triple cap"
b) Air relief grooves

With the use of the softer spacer material to prevent gap recession (see VLBA Acquisition Memos 286 and 272), a desire to reduce the operating tension in order to increase the tape life, and the desire to increase head life it is worthwhile to reexamine the question.

The use of additional tape bearing surfaces, as in the "triple cap" head, is analyzed here with sufficient detail to warrant some actual tests. The geometry being considered is shown in Figure 1. This geometry provides a compensating negative pressure to counteract the pressure build-up at the entrance to the headstep. The pressure, P, from a solution to the Navier-Stokes equation near a corner is

$$P = \left(\frac{6\mu V}{r}\right)\left(1/(\phi\cot\phi + \phi\tan(\phi - c) - 1)\right) \tag{1}$$

$$\text{where} \qquad c = \tan^{-1}\left((1 - \phi\cot\phi)/\phi\right) \tag{2}$$

$$\text{and} \qquad \phi = \textit{opening angle}$$

when $\phi = \pi/2$

$$P = \left(\frac{6\mu V}{r}\right) \times 0.68 \tag{3}$$

and when $\phi << \pi/2$

$$P \approx \left(\frac{6\mu V}{r}\right)\left(1/\phi^2\right) \tag{4}$$

where r = *distance from corner apex.*

If we assume that the outrigging contacts are a much softer material the average outrigger contact pressure will be small and a low tape speed will not alter the tape geometry. At speed the air pressure will bend the tape and slightly alter the tape path. For distances short compared with the characteristic bending length of the tape the tape responds like a beam while for larger distances it responds like a foil under tension. In the case of the foil approximation

$$\frac{d^2y}{dx^2} = P/T \tag{5}$$

and $$\alpha = \frac{dy}{dx} = \int \frac{P}{T}\, dx \tag{6}$$

where α = *deflection angle*

$x = r$

As long as the tape acts like a foil the negative pressure extending from the outrigger apex cannot prevent a opening developing at the edge of the headstep since the slope α is not significantly effected. In order to prevent an opening the negative pressure should be at least sufficient to cancel the positive pressure at a distance equal to the characteristic bending length p from the headstep. For this condition

$$\frac{0.68}{p} = \frac{1}{\phi^2 B} \tag{7}$$

where ϕ = *outrigger apex angle*

B = *distance to outrigger*

For $B = 500$ *microns and* $p = 100$ *microns the condition is satisfied with* $\phi = 30°$. Some added margin is needed so that a 20° angle might be a good starting point for some empirical tests.

In addition to possibly improving the existing headstack the theory and experimental tests of multiple tape bearing surfaces needs to be examined for the design of the next generation of heads.

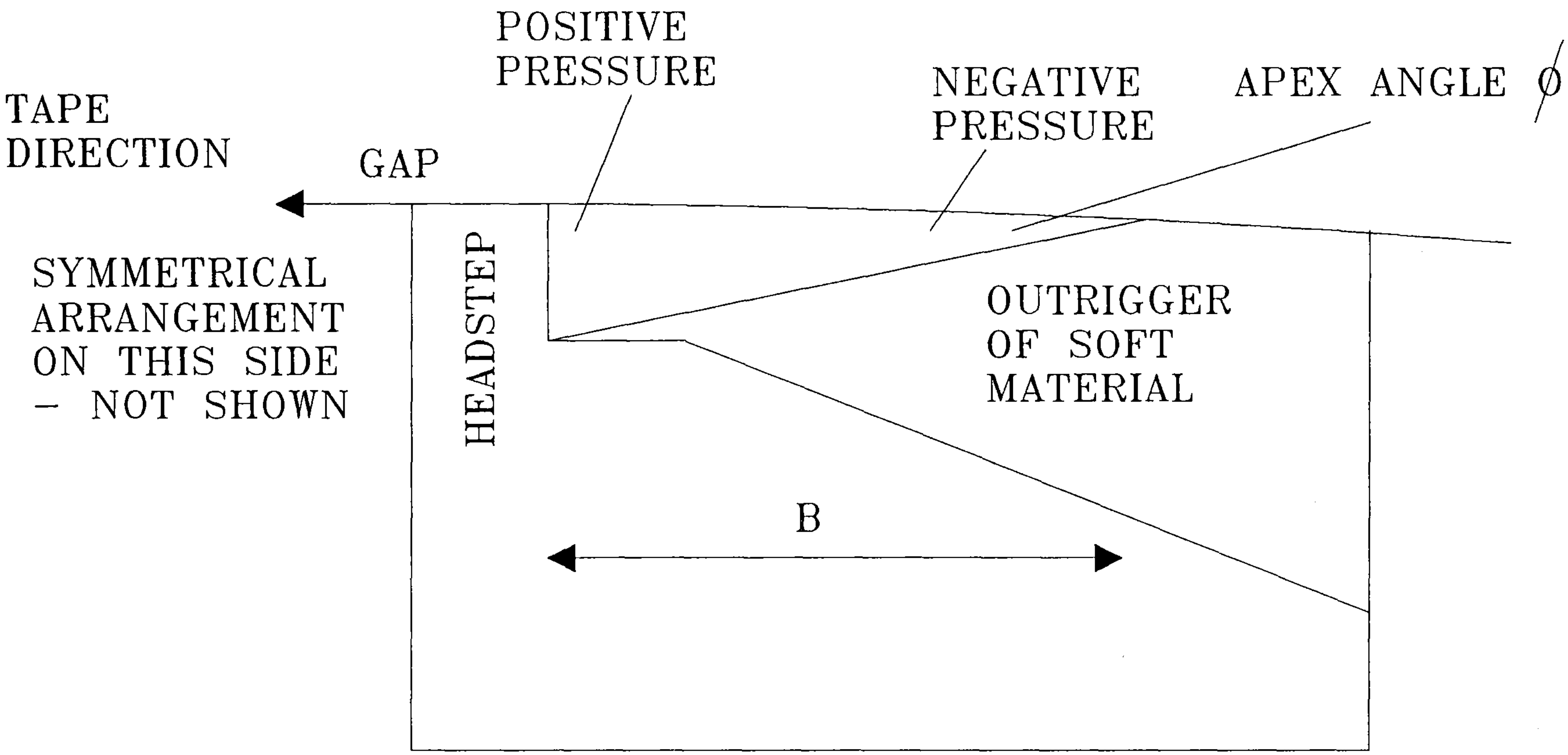

Fig. Added tape bearing outrigger to prevent flying