line and curve 1 is the pressure p_{w2} at the sample–air interface. After p_{w2} is determined, K can be calculated from eq. (4):

$$N_w = K\,DP/RTz_l \, [(p_{w1} - p_{w2}) \ln (p_{a2}/p_{a1})]/(p_{a2} - p_{a1}) \quad (4)$$

Where z_l is the film thickness and K is a dimensionless parameter representing the ratio of the fraction of cross-sectional area available to diffusion to the tortuosity of the passages.

K obtained in this manner should be independent of test conditions, i.e., humidity, temperature, and the height of the air layer between the desiccant and the sample. Table I shows K calculated from the limited amount of experimental data taken at various water vapor pressures.

TABLE I
Values of K at Various Water Vapor Pressures

Water vapor pressure, mm. Hg	K	
	Material A at 90°C.	Material B at 67°C.
50	—	0.0226
100	0.0193	0.0242
150	—	0.0275
200	0.0189	
300	0.0178	
400	0.0188	

We thank Dr. J. H. Hollister for his helpful discussion.

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Optical Transducer for Detecting Resonant Frequency and Free-End Amplitude of a Vibrating Reed (Low Driving Force)

In the vibrating reed or resonance method of mechanical dynamic testing the amplitude of vibration, as related to frequency, at the free end of the reed is a variable that is difficult to measure accurately. In one method of mechanical dynamic testing[1] the reed's free-end amplitude is measured at reed resonance and at discrete frequency increments above and below resonance. The transducer described in this note was designed to meet the above requirements. While inductance,[2] capacitance,[3] and optical transducers[4] have been successfully used for this work, the optical transducer has certain inherent advantages in regard to the detection of the free-end vibration of a reed.

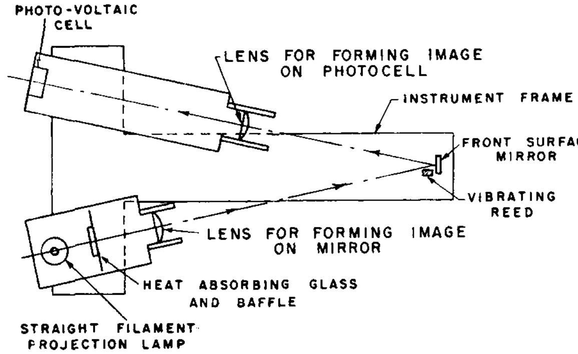

Fig. 1. Diagram of optical system.

To sum up these advantages, the optical transducer does not add friction or mass and/or electrostatic or magnetic fields, all of which are possible sources of error and add a compensating factor to the measurements. In contrast, there is never any "factor" to be added to or subtracted from an optical transducer measurement.

Shadowing or occluding a light source of constant intensity is an obvious and widely used method of photoelectric detection. As an example, a method of varying the output of a photocell employing a shaped aperture and shadowing the source of incident light was employed by B. G. Leary in a study of textile yarns.[5] On the other hand, a light intensity change of the source illumination also has an intrinsic advantage. The transducer described herein is a combination of these two approaches to photoelectric detection.

Essentially, the techniques employed in the design of this transducer consist of focussing a magnified image of a straight filament tungsten projection lamp onto a front surface mirror which in turn reflects the light of this image back toward a photovoltaic cell. Some degree of image magnification for the lamp filament is desirable, but the actual amount strictly is arbitrary. A second lens is used to focus an image of the illuminated front surface mirror onto the photo cell. In this case the magnification might just as well be unity for practical purposes. The filament image acts as the source of light for the photo cell and the light of this image is occluded by the reed sample. Since the edges of the filament image are irregular, the light return mirror is made to a definite rectangular shape, the long side of the rectangle being parallel to the filament. The mirror area is smaller than the image area, thus eliminating the fuzzy edges and giving a geometrically precise light source for the photocell to look at. This arrangement is analogous to a brightly illuminated slit, with the advantage that the projector and photocell are on the same side of the vibrating sample. The apparatus is illustrated in Figure 1.

In use, the light from the filament image is periodically occluded by the vibrating reed, resulting in corresponding light intensity change on the photocell. In this particular instance the occlusion is sinusoidal; therefore the photocell response will be sinusoidal. The photocell output is put into a sensitive oscilloscope. The oscilloscope trace will accurately show the resonant point of the reed. The free-end amplitude can be measured if the system is calibrated; also, frequency can be measured, depending on the characteristics of the oscilloscope.

The advantages of this transducer are: (*1*) as a result of the geometry and relative positions of reed and mirror, a large light change occurs for a small reed translation; (*2*) the reed being studied can be placed practically coincident with the plane of the most intense light concentration, with no ill effects on the sample, such as undesirable heating; (*3*) there is a minimum number of optical parts, no moving part, and only one electronic part, the photovoltaic cell; (*4*) the optical parts including the photocell are always in permanent, precise alignment; (*5*) the device can be very speedily applied and adjusted to the reed being studied; this includes the ability to "reach" into an environmentally controlled test chamber.

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An Intercomparison of Methods for Calculating Normal Stresses

The purpose of this note is to describe the results of an intercomparison between certain methods of calculating normal stresses. For example, Bagley[1] has outlined a method, originally proposed by Philippoff and Gaskins,[2] for separating elastic and viscous effects from a Poiseuille flow experiment. This method relates the total end correction e, derived experimentally by plotting pressure drop versus different length-to-radius ratios at constant nominal shear rate, to the recoverable shear strain S_R, under the assumption of the validity of Hooke's law in shear.[3] Although Bagley does not proceed further under this assumption one can, in principle, also compute a component of the elastic (normal) stress from the relation:[3]

$$p_{11} = \tau^2/\mu = \tau S_R \qquad (1)$$

where τ is the wall shearing stress corrected for end effects, and p_{11} is the normal stress in the direction of the 1-coordinate.

In contrast, a different method, yet one which also embodies the principle of the Poiseuille flow experiment, has been proposed by Metzner and associates.[4] It involves a force balance in terms of the momentum flux and the tensile elastic stress, and a measurement of the Barus effect;[5] here the diameter d_j of an extrudate jet emerging from a capillary of internal diameter D is expressed in terms of a swelling index $\beta = d_j/D$. The total normal stress component p_{11} is then computed from the relation:

$$p_{11} = \frac{\rho D^2}{64\, n'}\left(\frac{8V}{D}\right)^2 \times \left[\frac{(n'+1)(3n'+1)}{(2n'+1)} - \frac{1}{\beta^2}\left\{n'+1+\frac{d\ln\beta}{d\ln\left(\frac{8V}{D}\right)}\right\}\right] \qquad (2)$$

Here ρ and $(8V/D)$ denote the fluid density and nominal shear rate, respectively, while n' is the flow index in the power law flow model.

Now McIntosh[6] recently investigated the swelling of jets in a 2% solution of carboxymethylcellulose (CMC) over a wide range of shear rates. Fortunately he also obtained data relative to the Bagley end corrections for the same conditions as the jet experiments. As a matter of interest we have computed p_{11} values for both the end correction and jet expansion procedures by applying eqs. (1) and (2), respectively, to McIntosh's original data. The end correction method was applied only over the range of shearing stress where e exhibited a linear dependence on τ; the same restriction was used in applying the jet expansion method, even though the power law flow model was valid over a much wider range of shearing stress.

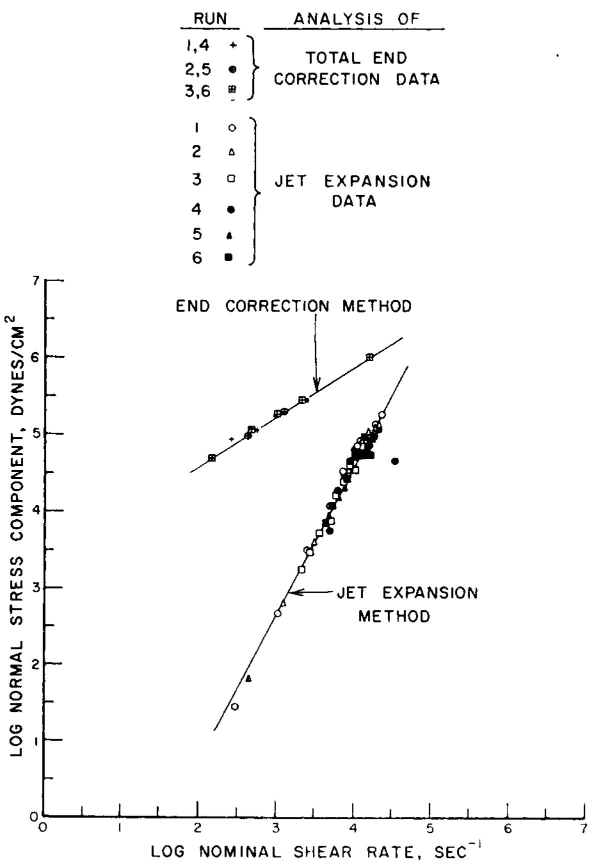

Fig. 1. Comparison of normal stress predictions for a 2% CMC solution (original data from reference 6).