ring is pressed by the hydrostatic pressure against the narrow edge b, while part of b and an area with height d are unsupported. The dimensions of d and b have to be chosen carefully in order to prevent the ring from yielding.

In this laboratory, during the last few years, seals made of steel and Be–Cu of internal diameter varying from 0.4 to 25 mm have been used successfully up to 12 kilobar, while an internal diameter of 55 mm has been used up to 3 kilobar. The thickness of the ring varied from 0.15 to 0.6 and the height from 2.5 to 8 mm, while the projected height c (Fig. 2) ranged from 0.1 to 0.7 mm. The hardness of the seal is always somewhat higher than that of the pressure vessel. When the ring is formed the distance d is about 0.2 mm. Tightening the closure a little bit makes the seal vacuum tight. In those cases where the apparatus has a limited space and the height of the ring is much reduced, the seal tends to deform. It is therefore advisable to preform the closure by using an auxiliary piece which fits exactly inside the ring and by applying the working pressure to the vessel.

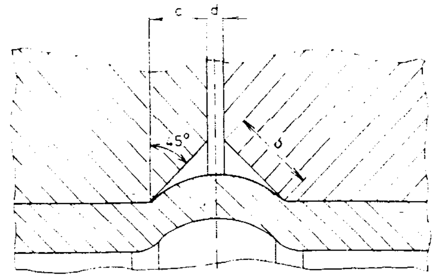

FIG. 2. Detail of the closure.

The seal has been used mainly in the temperature region 90–300 K and gas pressures up to 10 kilobar. It is interesting to note, however, that some experiments have been carried out also at liquid helium temperature and pressures up to 3 kilobar with very good results.

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Comment on the equivalent noise bandwidth approximation*

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There is an ambiguity when the equivalent noise bandwidth (ENBW) is used to calculate the response to noise of an ac voltmeter. This difficulty can be overcome by a more complete definition of the ENBW.

The equivalent noise bandwidth (ENBW) of a network is usually defined in terms of the magnitude of the transfer function,[1]

$$\Delta f = \int_0^\infty |G(f)|^2 G_0^{-2}\, df, \tag{1}$$

where Δf is the ENBW, $G(f)$ is the voltage gain (i.e., transfer function), and G_0 is the gain at some reference frequency. This reference frequency is usually chosen to be the center frequency of the pass band or to be the frequency where $G(f)$ is maximum.[2] Clearly the choice of the reference frequency, and hence of G_0, will affect the value of Δf. Therefore Δf is undefined to the extent that we are free to choose G_0. This indefinability does not normally cause any difficulties since the useful quantity is $G_0^2\Delta f$.[2] Equation (1) can be rewritten to show this product explicitly:

$$G_0^2\Delta f = \int_0^\infty |G(f)|^2\, df. \tag{2}$$

Since the right-hand side of Eq. (2) involves quantities that are fixed properties of the network, $G_0^2\Delta f$ is a constant.

However, a difficulty does arise when the ENBW is used to calculate the response of a nonlinear device such as an ac voltmeter. When an ac voltmeter is used to measure bandwidth-limited white noise, the output of the meter is seen to fluctuate about a mean value. We are interested in relating these fluctuations to the ENBW of the signal.

For simplicity, we will consider the following situation. An initial voltage signal (V_i) that is white and has a power spectrum of unity ($d\langle V_i^2\rangle = df$) is passed through a network whose transfer function is $G(f)$. The resulting signal (V) will have a power spectrum of $d\langle V^2\rangle = |G(f)|^2\, df$. This signal is then detected by a mean square meter that incorporates a simple RC filter. The output of the meter will be $V_0 = \langle V^2\rangle + \nu$, where ν is the fluctuating part of the output. If we let α be the relative mean square fluctuation, then

$$\alpha = \langle \nu^2\rangle\langle V^2\rangle^{-2}. \tag{3}$$

This is often written as a function of Δf,[2]

$$\alpha = (2\tau\Delta f)^{-1}, \tag{4}$$

where $\tau = (RC)^{-1}$ and where it has been assumed that

$(2\pi\tau)^{-1} \ll \Delta f$. The question is, what is meant by Δf in Eq. (4)? We can only assume that this is an ENBW associated with one of the usual definitions of G_0. This may be a good assumption for some networks, but it is by no means a general result. To find a more general interpretation of the Δf in Eq. (4), we must first find an expression for α in terms of $G(f)$.

Rice[3] found that the power spectrum of ν can be expressed in terms of the power spectrum of V. He showed that

$$d < \nu^2 > = \left[\int_{-\infty}^{\infty} |G(f)|^2 |G(f-g)|^2 dg \right] \times [1 + (2\pi\tau f)^2]^{-1} \, df, \quad (5)$$

where $G(-f) = G(f)$. If the integral over g is slowly varying over the frequency range $|g| \lesssim (2\pi\tau)^{-1}$, then $d < \nu^2 >$ can be approximated as

$$d < \nu^2 > \approx 2 \left[\int_0^{\infty} |G(g)|^4 dg \right] [1 + (2\pi\tau f)^2]^{-1} \, df. \quad (6)$$

The substitution of Eq. (6) into Eq. (3) gives

$$\alpha \approx \int_0^{\infty} |G(f)|^4 \, df \Big/ \left[2\tau \left[\int_0^{\infty} |G(f)|^2 \, df \right]^2 \right]. \quad (7)$$

Equation (7) can be made to look like Eq. (4) if Δf is chosen such that

$$\Delta f = \left[\int_0^{\infty} |G(f)|^2 \, df \right]^2 \left[\int_0^{\infty} |G(f)|^4 \, df \right]^{-1}. \quad (8)$$

The corresponding value of G_0^2 will then be

$$G_0^2 = \left[\int_0^{\infty} |G(f)|^4 \, df \right] \left[\int_0^{\infty} |G(f)|^2 \, df \right]^{-1}. \quad (9)$$

While Eq. (7) was derived for a mean square meter, similar expressions can be derived for rms and average responding meters and for meters incorporating different types of filtering.[3–5] For example, rms and average responding meters incorporating a simple RC filter will have a fluctuating output given by

$$\alpha \approx (8\tau\Delta f)^{-1}, \quad (10)$$

where Δf is defined by Eq. (8).

In conclusion, I would like to point out that the use of Eqs. (8) and (9) would remove the ambiguity in the traditional definition of the ENBW and allow the ENBW approximation to be extended to cover a common class of nonlinear devices.

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Simple goniometer for precise grinding and electropolishing of single crystal surfaces*

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A simple goniometer, which can be used to rigidly support a crystal in a precise orientation through all phases of surface preparation, including mechanical, chemical, and electrochemical polishing, is described.

Preparation of macroscopic single crystals for surface research often involves orienting a sample to a specific crystallographic orientation using some type of x-ray diffraction technique and then cutting, mechanical polishing, and possibly chemical and electrochemical polishing of the sample. The cutting and mechanical polishing steps require a mechanical support for the crystal that maintains the desired orientation. Chemical and electrochemical polishing are typically performed by dipping the crystal in a chemical bath for a short period of time so that the orientation of the crystal face will not be seriously affected. This note presents a simple goniometer which can rigidly support a crystal in a precise orientation through all phases of surface preparation and even allows precisely oriented electrochemical polishing. The precision of the alignment is limited only by the x-ray diffraction technique employed and alignments better than 0.1° have been obtained routinely. The goniometer has been successfully used in the preparation of single crystal aluminum,[1,2] tungsten,[3–5] iridium,[6] gold,[7] and copper.[8]

Figure 1 shows a schematic of the goniometer. Its design is based on an earlier model by Bond.[9] The crystal to be prepared is attached to the end of a stainless steel, spring-loaded piston. The piston fits inside a shaft which is positioned in an aluminum housing by two pairs of adjustment screws and two spring-loaded stops. The screws and stops are tightened against flats machined on the shaft, thus preventing the shaft from rotating and providing enough friction to keep the shaft