when subjected to both periodically varying fields (sinusoidal and square wave) and pulsed fields (risetimes varied from 1–3 μsec). Identical conclusions were reached from analysis of the data from both instruments. Only typical results obtained from the four cell instrument are presented.

The response of the ^{85}Rb magnetometer to fields which varied sinusoidally with an amplitude of 3.7 kγ and with a frequency of 6 kHz is shown in Fig. 1. Analysis of these data showed that the compressed signal frequency varied between 33 and 67 kHz (the Larmor frequency varied from 233 to 267 kHz) and corresponded to the field changes. The magnetometer followed the periodic changes in field with no detectable lag in response. Similar results were obtained for fields changing at frequencies up to 38 kHz and for amplitudes as high as 8 kγ.

The response of the magnetometer to a pulsed field change of 11 kγ which occurred in <3 μsec is shown in Fig. 2. Analysis showed that the Larmor frequency changed from 250 to 199 kHz within a Larmor period and corresponded to the 11 kγ field change. Similar results were obtained when the field was pulsed as high as 19 kγ. In all cases the change in the signal frequency occurred within a Larmor period and corresponded to the field change. These results are in agreement with the theoretical predictions of Bloom.[1,3] It is concluded that the frequency response of these magnetometers is at least as great as the Larmor frequency of the precessing atomic moments.

When the sweep rate of the oscilloscope was decreased so that a time interval of the order of milliseconds after a pulsed field change was examined, an attenuation of the signal amplitude was observed. The duration of the attenuation increased with an increase in the magnitude of the field change and depended upon the rise and fall characteristics of the transient field. This attenuation may have been due to a disruption of the phase and amplitude relationships between the rf field, which produced resonance in the optically pumped Rb vapor, and the precessing atomic moments.[1,3] Gain controls are normally included in the magnetometer amplifiers to keep the rf field down to a safe value. Since amplitude attenuation was observed in these experiments, it is concluded that the amplifier gain controls in these instruments were not adequate to compensate for such large field excursions.

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[5] The instruments were developed under contract by Varian Associates, Palo Alto, California.

Simple Light Chopper for Vacuum Ultraviolet Spectroscopy

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The advantages of phase sensitive detection methods in optical spectroscopy systems are well known.[1] Modulation of the light signal is usually effected by a slotted chopper wheel or some such motor driven device. Unfortunately, this approach is unsuitable for most vacuum uv spectroscopy experiments inasmuch as it requires cumbersome coupling of the driving motor through a vacuum fitting or else inclusion of the motor within the vacuum chamber itself. This note describes a simple solution to this problem through employing a small tuning fork, entirely resident in the vacuum, as the chopping element.

The tuning fork unit and driver were purchased from American Time Products[2] and is called a type 40, one of their standard line. The over-all length of the device depends on the chopping frequency desired, being about 70 mm for our choice of 200 Hz. The fork has a reference coil

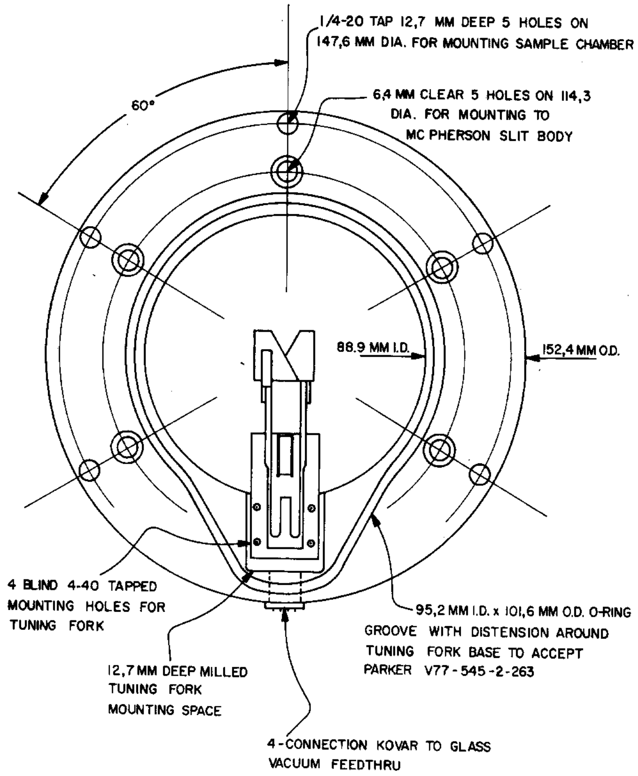

Fig. 1. Front view of the tuning fork chopper mount. The over-all shape is that of an annular ring with dimensions shown and 19.05 mm thick. The material is free-machining brass. The exact positioning of the tuning fork itself depends on the frequency used. We show above approximately that for 200 Hz. The Kovar-to-glass connector is soft soldered in place and is for the purpose of supplying electrical connections to the tuning fork driving and sense coils.

which senses tine motion and feeds the signal into an amplifier whose output in turn powers the fork driving coil. Thus the amplifier works in a positive feedback mode with the reference coil also supplying the reference signal for the phase sensitive detector.

The mounted chopper is shown in Fig. 1. A 152.5 mm diam, 19.05 mm thick brass disk formed the starting piece for the chopper holder. A 89 mm diam hole was then cut for the optical path. In order to support the fork assembly so that all its components would be behind the front surface of the annular ring, a recessed mounting platform 12.7 mm deep with area approximately 25.4 by 25.4 mm was milled out as indicated in Fig. 1. A small hole from this platform to the bottom of the ring was drilled for the purpose of bringing in the necessary four electrical connections. Five bolt holes were placed as shown for mounting to the McPherson 235[3] vacuum uv spectrometer slit body. Because our chopper was to be positioned at the exit slit housing, five additional holes were drilled and tapped for the purpose of affixing the sample chamber. A distended O-ring groove, enclosing the entire tuning fork, was then cut into the front surface of the ring. This was done by machining part of the groove on a 101.6 mm diam circle almost up to the fork platform and then finishing by placing an O ring of the given oversize in this groove and tracing the resulting distension (see Fig. 1).

When the completed assembly is bolted to the McPherson, the distance between the exit slit and tine vanes is about 25.4 mm. This is sufficiently close to yield, in conjunction with the vane shapes shown, a clean square wave chopped light beam, hence maximum first harmonic amplitude, when a masked grating ($f/34$) is used. If the grating is unmasked ($f/11.4$), only a slight degradation of the side of the square wave is observed. None of the tuning fork components seem to give rise to serious outgassing problems in a technical vacuum environment; we were able to maintain pressures in the 10^{-6} Torr range without difficulty.

Although we have not yet found it necessary, it is in principle possible to replace the existing metal vanes with ones comprised of quartz or LiF. In this way, the chopper can be made to discriminate against long wavelength scattered light while performing measurements in the vacuum ultraviolet.

The author wishes to express his indebtedness to J. Penfold and M. Nichols for the construction of the holder and suggestions pertaining thereto.

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[1] R. H. Dicke, Rev. Sci. Instrum. **17**, 268 (1946); R. D. Moore, Electronics **35**, 40 (1962); R. D. Moore and O. C. Chaykowsky, Tech. Bull. 109, Princeton Applied Research Corp., 1963.

[2] American Time Products, Bulova Watch Co., Inc., Electronics Division, 61-20 Woodside Ave., Woodside, New York, 11377.

[3] McPherson Instrument Corp., 530 Main St., Acton, Mass. 01720. The monochromator slit body contains an O-ring groove providing a vacuum seal for the back side of the chopper holder.

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Erratum

Techniques and Instrumentation for Measuring the de Haas–van Alphen Effect in Metals

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Due to an unfortunate oversight an important reference on the field modulation detection technique was omitted. This reference should be included as part of Ref. 5 and is A. Goldstein, S. J. Williamson, and S. Foner, Rev. Sci. Instrum. **36**, 1356 (1965).