Oxygen has sharper lines and is less sensitive to power saturation than ammonia.

A second type of ammonia clock using a self-excited oscillator and frequency divider exactly analogous to a quartz crystal clock is also under development. This depends for its success on development of suitable microwave amplifier tubes. Such tubes having gains of approximately 13 db have now been developed so that construction of a complete unit can be begun.

A third clock using cesium in an atomic beam technique is nearing the stage of manual (rather than automatic) operation. Elimination of collision and Doppler broadening and power saturation allows the highest potential accuracy of any method under development. A spectral line width 300 times narrower than ammonia is expected with the possibility of accuracies of one part in 10^9 to 10^{10} or better being achieved. Work

is also proceeding on investigation of nuclear electric quadrupole lines in crystals such as iodine for relatively portable clocks using solid samples and covering a wide frequency range. Temperature control will be necessary in this method.

A program is under way for development of a precision microwave spectrograph for measurement of fluctuations in the length of the day, such as those of annual period and magnitude of about 1 part in 60 million. The possibility of a millimeter-band interferometer driven by an atomic clock so as to base both length and time standards on one spectrum line is also being considered. If clocks which are long-running and good to one part in a billion or better can be developed, a comparison between atomic time and the mean sidereal year should eventually be possible.

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ABSTRACTS*

Babcock, Harold D. and Horace W. Babcock.
The ruling of diffraction gratings at the Mount Wilson Observatory.

The newer ruling engine of the Mount Wilson Observatory is now producing sizeable diffraction gratings of high quality in all respects. Several recent gratings are $7\frac{1}{4}$ inches wide with grooves $5\frac{3}{4}$ inches long, and one is 8 by $5\frac{1}{4}$ inches. Curved-edge ruling diamonds, developed here, have been used in blazing these gratings to specifications for astronomical use. High luminous efficiency is combined with practically complete absence of scattered light, either general or local in the spectrum. Resolving power of 500,000 is achieved. Rowland ghost intensity is held to about 0.00004 in the first order of 15,000 line per inch rulings and is negligible. Most ruling to date has been at 300, 400, 600, or 900 grooves per millimeter, but other spacings are available. The rather considerable modifications of the Rowland-type engine are described, with particular reference to the monorail diamond carriage, the coupling of the nut to the grating carriage, the end-thrust bearing of the screw, the use of Nitralloy steel ways, and the spacing mechanism.

That the principles of this entirely mechanical, single-screw machine are thoroughly sound is attested by the quality of its products. Blazed plane gratings have almost entirely supplanted prisms in fast stellar spectrographs of both short and long focus.

Our methods of testing gratings are outlined and a formula is proposed for the evaluation of gratings.

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Bappu, M. K. Vainu. A spectroscopic study of Wolf-Rayet stars.

A study has been made of the profiles and total intensities of the emission lines of seven bright Wolf-Rayet stars in Cygnus, three of which belong to the carbon sequence and the rest to the nitrogen sequence. The well known eclipsing binary CQ Cephei was also included on the program, and the variations in the profiles of the emission lines and their total intensities during a cycle investigated.

The broad emission band $\lambda 4058$, tentatively identified as due to NIV, has been found to be split into three components with wave lengths of 4044, 4057, and 4066 Å. The lines $\lambda 4044$ and $\lambda 4066$ have been tentatively identified as due to NII and CIII, respectively. The line $\lambda 4066$ CIII is moderately strong in carbon stars and as carbon lines have been found in nitrogen stars this identification is probably correct. The flat-topped nature of $\lambda 4058$, as shown by Beals to exist in BD 35°4001, can then be explained as due to the

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