# New Instruments

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*These descriptions are based on information supplied by the manufacturer and in some cases from independent sources.* THE REVIEW *assumes no responsibility for their correctness.*

## Ultrasonic Generators

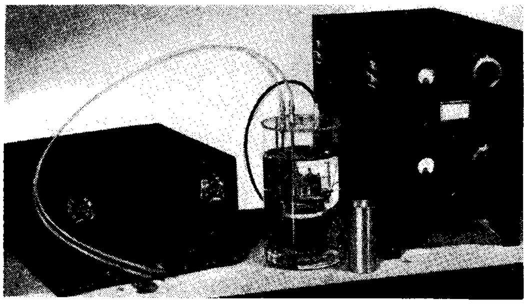
Central Scientific Company announce two new models of ultrasonic generators. They are portable, popularly priced, and generate high power.

These new ultrasonic generators are stable, efficient, and easy to operate for physical, chemical, biological, and industrial research or control.

The Ultrason generates mechanical energy in the crystal holder to vibrate solids, liquids, and gases.

Typical uses in chemical reactions and in other applications are:

to activate ozone to peroxide;
to remove fatty acids from semirefined oils;
to emulsify oils;
to disperse pigments;
to accelerate extractions;
to hasten or retard growth of bacteria, mold, and enzymes.



The U-300 Ultrason crystal delivers 300 watts of mechanical energy to the oil bath. A maximum of 10 watts of power per square centimeter of crystal area (a 76-mm crystal) is permissible without fracture of crystal. The crystal oscillating circuit is energized by 900 watts supplied by the low voltage, high frequency generator from a 115-volt, 60-cycle line. Model 100 Ultrason delivers a maximum of 6 watts at the crystal. Both units operate at 450 kc and provide instant and accurate reproduction of power and frequency conditions. The units are provided with built-in safety features and are designed for continuous operation and trouble-free service.—CENTRAL SCIENTIFIC COMPANY, *1700 Irving Park Road, Chicago, Illinois.*

## Atomic Clock

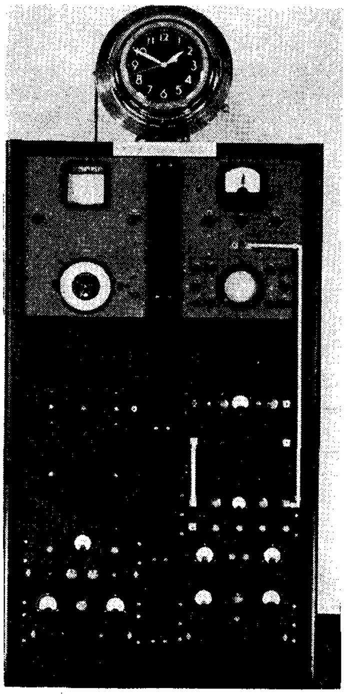
In a radical departure from all conventional methods of measuring time, an atomic clock—invariant with age and for the first time independent of astronomical observations—has been developed by the National Bureau of Standards. Based on a constant, natural vibration frequency of atoms in the ammonia molecule, the atomic clock is a scientific achievement which offers an entirely new primary standard of frequency and time. The principle of the atomic clock promises to free man from age-old methods of fixing time by the daily rotation of the earth on its axis as it revolves around the sun. Not only does the new clock promise to surpass in accuracy any time measurement heretofore known, but the primary standard, the earth, is very gradually slowing down. In addition, unaccountable fluctuations in the rate of rotation have sporadically lengthened and shortened the day by a few thousandths of a second. The new method offers an invariant master clock against which the variation in timekeeping of the earth could be measured.

This first atomic clock has run with a constancy of better than one part in 20 million and is already being improved. By use of the proper atomic system a potential accuracy of a part in ten billion is theoretically indicated.

Because it is a standard of frequency as well as of time, the new method may be applied to the precise control of radiofrequencies, eliminating the "drift" allowances in present band-width allocations, and thus providing additional room in the ultra high frequency bands. The maximum utilization of available space in the radio spectrum depends on the accuracy with which the frequency of an individual station can be controlled, especially at the higher frequencies where quartz-crystal control cannot be used. These higher frequencies, which are used by radar, television relays, and microwave equipment, could be controlled by atomic elements. Such control would also make possible the permanent establishment of radio channels on such an exact basis that tuning could be made as automatic as the dialing of a telephone number.

Based on a principle developed by Dr. Harold Lyons, Chief of the Microwave Standards Section of the Bureau's Central Radio Propagation Laboratory, the new clock was constructed under his direction and with the assistance of B. F. Husten and E. D. Heberling. According to Dr. E. U. Condon, Director of the National Bureau of Standards, the method should prove an invaluable tool for basic research and will affect every technical field where precise measurements of time and frequency are crucial.

In recent years, vibrations of atoms in molecules, giving rise to molecular spectrum lines, have been found in the very high frequency (microwave) region of the radio spectrum. Very precise measurements of these lines are now possible by using extremely sensitive radio methods. When it became evident that such spectrum lines could be used as new primary frequency standards, scientists at the National Bureau of Standards began seeking a means of utilizing one of these lines



to control an oscillator, which in turn could be used to drive a clock. Because the resulting equipment, the atomic clock, is controlled by the invariable molecular system of ammonia gas, it is independent of astronomical determinations of time and unaffected by temperature, pressure, and aging.

The National Bureau of Standards atomic clock consists essentially of a quartz crystal oscillator, a frequency multiplier, a frequency discriminator, and a frequency divider, all housed in two small cabinets on the top of which are mounted a special 50-cycle clock and a wave-guide absorption cell—a 30-foot copper tube wound in a compact spiral around the clock and filled with ammonia gas. The crystal oscillator generates a fundamental driving signal at a low radiofrequency. A frequency-multiplying chain transforms this into a microwave (very high frequency) signal, which is then compared with a natural vibration frequency of the ammonia molecule. If these two frequencies are different, an "error signal" adjusts the oscillator to bring them into agreement. The oscillator which is inclined to "drift" slightly with age—that is, change in frequency—is thus "locked" to the ammonia molecule. It can then control an electrically driven clock with extreme accuracy.

Present time and frequency standards are based on astronomical determination of the period of rotation of the period of rotation of the earth. Essentially, a telescope is pointed toward a star, and the interval between the exact moment it passes the cross hairs until the exact moment 24 hours later that the star reappears is taken as the standard of time. The "twinkling" of the star, which makes its position difficult to fix, affects the accuracy of such measurements. The atomic clock gives a time standard of high precision continuously available in any interval of time desired instead of every 24 hours, whether it is a millionth of a second or ten hours. Moreover, the atomic clock is invariable so that a given interval of time, whether measured today or a hundred years from now is truly reproducible. The atomic method automatically and continuously controls the rate of the clock without delay or human intervention and is independent of weather.

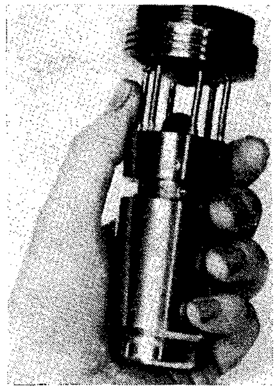
Another advantage of the atomic method is that if an atomic clock were run continuously over a period of a year, our knowledge of the length of the year could be improved. The time it takes the earth to travel around the sun (a year) is completely independent of the time it takes the earth to rotate once on its axis (a day). This independence causes all the trouble with the calendar, necessitating leap years so that the seasons will always come at the same time during the year. With an atomic clock measurements could determine whether the mean sideral year is more accurate than the mean solar day, as some astronomers believe may be the case.

In terms of the regular 24-hour-day broadcasts of time and frequency by the National Bureau of Standards, which serve the nation and much of the world for standards of radiofrequencies and time, an atomic clock means a precision of both time and radiofrequency standard signals hitherto impossible.

The atomic clock gives the Bureau a time standard analogous to the Bureau's new atomic standard of length furnished by the single isotope of mercury which, if adopted internationally, will provide man with the ultimate standard of length. Both of these recent developments stem from the application of atomic physics to practical problems.—NATIONAL BUREAU OF STANDARDS, *Washington 25, D. C.*

## Hydrostatic Impulse Gauge

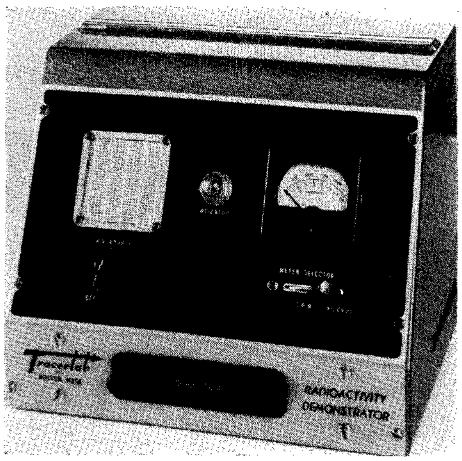
This mechanical, self-recording gauge may be lowered into a well or connected to a pressure chamber to measure directly the total impulse per unit area generated by pressure waves resulting from underground explosions or other high pressure sources. In operation, the



hydrostatic impulse forces mercury through a capillary passage and into a collector; the weight of mercury discharged is proportional to the impulse per unit area in p.s.i.-sec., from 10 to 400 p.s.i. The gauge is entirely self-contained and of simple construction, for convenience in field use. Its applications include geophysics, internal combustion studies, blast damage determination, and water hammer research.—ENGINEERING RESEARCH ASSOCIATES, INC., *St Paul 4, Minnesota.*

## Radioactivity Demonstrator

Tracerlab has developed its new radioactivity demonstrator in response to the need for an inexpensive instrument for teaching basic principles of radioactivity in high schools and colleges. Radiation is indicated by three different means: by loudspeaker, by a flashing neon light, and quantitatively with a counting rate meter. The meter reads in counts per minute and will indicate up to 2500 counts per minute. This instrument has sufficient accuracy to permit carrying out simple classroom and laboratory demonstrations of basic principles of radioactivity.




A removable shield is mounted in front of the Geiger tube, to completely eliminate beta-rays when it is desired to measure only gamma-radiation. A switch permits the meter also to indicate the voltage across the Geiger tube which can be varied from about 500 to 1100 volts. The instrument operates on 110 volts a.c.

Sources of beta- and gamma-activity are included at no extra charge, together with an instruction manual, experiments, and a discussion of radioactivity suitable for use in elementary lectures. With the radioactivity demonstrator it is