# a measure of progress

1. Light-emitting diodes
2. Of calculators, computers and time-sharing
3. Atomic absorption photometer
4. Diagnosis by ultrasound
5. Frequency & time standards

## 1. Solid-state light bulbs

If you want a light that won't blow out or a display that won't fail, you start thinking about devices with no parts to rattle. That immediately eliminates incandescent bulbs with filaments and even glass glow lamps filled with gas. Next, you consider solids or electroluminescent powders that glow when electric current is applied.

One such device Hewlett-Packard has some experience with is the gallium arsenide diode. But it glows in the infrared range, invisible to the eye. Used with a silicon detector it works very well in tape readers or encoders. Still, we wanted a visible light source—so our engineers developed a diode using gallium arsenide phosphide. A small chip 21 mils by 21 mils glows brightly with a soft red light visible for several yards. And it's almost indestructible. Put a diode beside each circuit on a plug-in card, and years from now if the circuit goes bad, the diode will glow to indicate the failure.

Better yet, line some chips up in a matrix five by seven on a side, add a tiny integrated circuit driver for logic control, and you have a device that will flash numbers (shown above, enlarged) from 0 to 9. A somewhat more sophisticated integrated logic circuit could handle letters of the alphabet, as well. The whole assembly mounted on a substrate measures only a half-inch wide, one inch high and less than two tenths of an inch thick. And an entire display needs only five volts to drive it.

This Hewlett-Packard solid-state readout device is ideal for counters, voltmeters or any display that must have high reliability and be insensitive to shock and vibration. But considering its small size, low voltage drive and inherent long life, it may become the economical choice for any small indicator. If you would like more information for your own applications, write for our Solid-State Display pamphlet.

## 2. How to bridge the whole computational gap

Depending on the volume and complexity of your mathematical problems, you might need machine help that runs the gamut from a small desk calculator to a time-shared computer with 16 terminals running simultaneously. Hewlett-Packard feels fortunate that now we can offer you just such a range of computing power.

Our 9100A Computing Calculator, at $4900, is a desk model designed for ease and simplicity of operation, starting with the keyboard. Yet you can perform all the common math, algebra and trig functions on it without learning any special computer language. You simply press the *log* key, the *sin* key, the $\sqrt{\ }$ key and so on to call these functions out of memory. Using different levels of memory, you can build routines to solve rather sophisticated problems, such as computing the attenuation characteristics of electronic filters with hyperbolic functions. And on one wallet-size memory card, you can store two 196-step routines for future use.

For applications requiring greater power and flexibility, HP offers a family of three computers so you can buy the computer most suited to your needs. All of them can handle three high-level computer languages—FORTRAN, ALGOL and Conversational BASIC. The latter is so close to English you can learn it in three to four hours. The smallest computer, the HP 2114A, costs $9950. You can get it with 8000 words of memory and a teleprinter for $15,950. You also get 16-bit words, 2.0 microsecond memory speed, and 8 channels of input/output capability.

But if you have a number of people who need to use a computer at the same time, then for $89,500 you can get the HP 2000A Time-Shared BASIC System. It can handle up to 16 Teletype terminals at once, with each user thinking he has the computer to himself. In this system we use our largest computer, the HP 2116B, with 16,000 words of core memory and a disc memory with 348,000 words of storage. The same simple Conversational BASIC language is used, but here we have included additional safeguards. The system checks each input statement for format and syntax as it is entered. Additionally, the computer echoes the instruction back to the originator. If there's a transmission error, the originator knows immediately. With these features, 16 persons can have simultaneous error-safe computer power to solve 16 problems at once.

For additional information on any one or all of the Hewlett-Packard solutions to computing problems, write for the 9100A Calculator brochure, a more complete discussion of Hewlett-Packard small computers, or a brochure on HP time-shared computer systems.

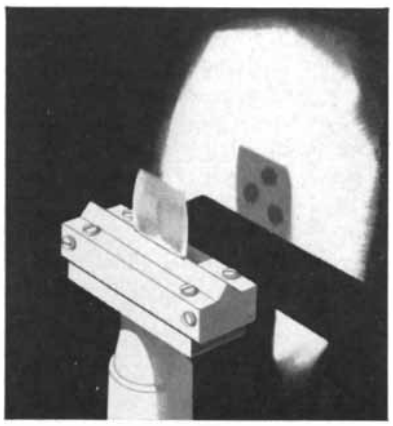
9100A Calculator

2114A Computer

2000A Time-Shared System

## 3. Measuring the shadow of an atom

More and more people today are tracking down very small amounts of metals dissolved in liquids. Doctors routinely test biological samples. Public health officials keep tabs on water pollution. Agronomists check traces of metals in soils, fertilizers and crops. Engine designers look for evidence of motor wear in oils. And industrial chemists scruti-



nize impurities in plastics and plating solutions.

There are a number of techniques and most are difficult and time-consuming. But one method—Atomic Absorption—is gaining vogue because it is fast, simple, specific and sensitive. You spray a sample solution into a very hot flame to release the metal as free atoms. You direct a beam of light through the flame into a very sophisticated light meter. The particular light source used emits a wavelength that is resonant with the natural frequency of the vaporized metallic atoms—and, hence, readily absorbed. The more atoms present, the more light is absorbed and the less gets through. The amount absorbed is read out on a meter already calibrated to tell the concentration of metal in solution.

Hewlett-Packard has developed a pushbutton atomic absorption instrument that is easier, faster, safer, more reliable and more economical. We installed six light sources for six different metals on one turret. The sources not in use at the moment are always at operating current. We designed a wide burner to spread the flame for quieter operation and greater sensitivity.

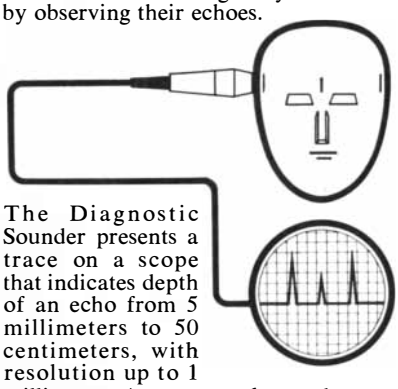
We developed a novel optical system which cancels out variations in flame intensity and electronic circuits. Filters in the optical system are changed by pushbutton to match each light source. And the electronic circuits provide both direct meter readout of concentration and a recorder presentation for a permanent record.

The advantages of the HP 5960A Photometer cost you $4400. If you'd like to make more measurements with less effort, write for Bulletin 5960.

## 4. Sounding out problems in the body

Bats, porpoises, sailors and engineers are old hands at using sound to search for objects the eye can't see. Bouncing echoes off things—in the depths of oceans, far underground, or inside metal castings—is often the simplest, easiest or safest way to detect and measure the unknown. Now doctors have joined these specialists in ultrasonics by applying echoes to problems of the human body.

Low-powered, high-frequency sounds bounced off the brain's midline can suggest to the doctor that a tumor or concussion has shifted the brain out of position. These sounds are painless and harmless. They bounce off plastic objects and soft tissues that X-rays can't detect. The echoes are viewed on the face of an oscilloscope immediately as the search is in progress. And distance to the object is measured directly. The instrument can be used for looking at both fixed and moving body structures by observing their echoes.

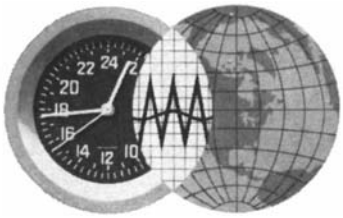


The Diagnostic Sounder presents a trace on a scope that indicates depth of an echo from 5 millimeters to 50 centimeters, with resolution up to 1 millimeter. A scope marker and counter dial make distance readings easy to record. An audible signal helps the operator discriminate between one target and another. Records may be made either by scope camera or by strip-chart recorder.

If you'd like more information about how the Diagnostic Sounder may be applied in cardiology, neurology, internal medicine, obstetrics, gynecology or surgery, write for the HP Diagnostic Sounder Brochure.

## 5. Can you spare a second in 3000 years?

If you want to keep time to the nth degree, you might come to Hewlett-Packard for one of our Frequency & Time Standards. We make four types: cesium beam atomic, rubidium atomic, quartz crystal—and for the most particular applications, research hydrogen masers. All generate frequencies so precisely known and controlled that they are used throughout the world as standards for frequency and its counterpart, time.



Take quartz oscillators. If you keep them turned on continually and protect them from shocks, the best of them make excellent frequency standards. The HP 106A, for example, is accurate to better than 5 parts in $10^{11}$ per day and costs $3750.

For people who need a primary standard with no known drift, we make the 5061A Cesium Beam Frequency Standard—one of the world's international standards for time. It has an absolute accuracy of $\pm 1$ part in $10^{11}$ for the life of its cesium beam tube. That's equivalent to an error of 1 second in over 3000 years. We've flown this one around the world several times to coordinate primary timekeeping centers in as many as 18 countries. The cesium frequency standard costs $14,800.

In between is our newest atomic standard—the rugged, lightweight 5065A Rubidium Frequency Standard at $7500. The singular advantage of the rubidium standard is its superior electrical quietness over short periods.

There are technical data sheets for each of these standards, plus an article about the Flying Clock Experiment in the HP JOURNAL, Vol. 19, No. 4.

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