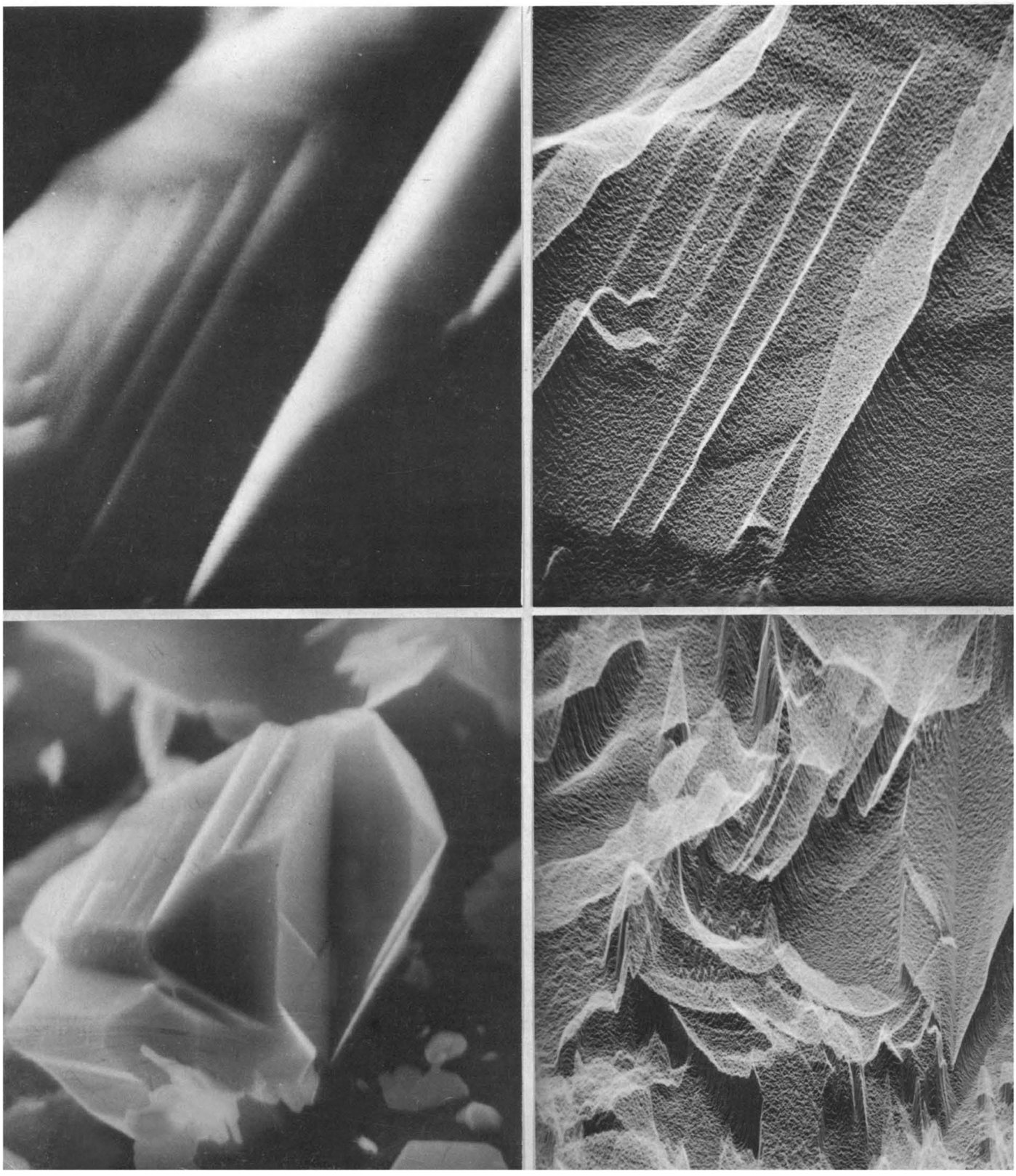
SCIENCE

18 July 1969
Vol. 165, No. 3890

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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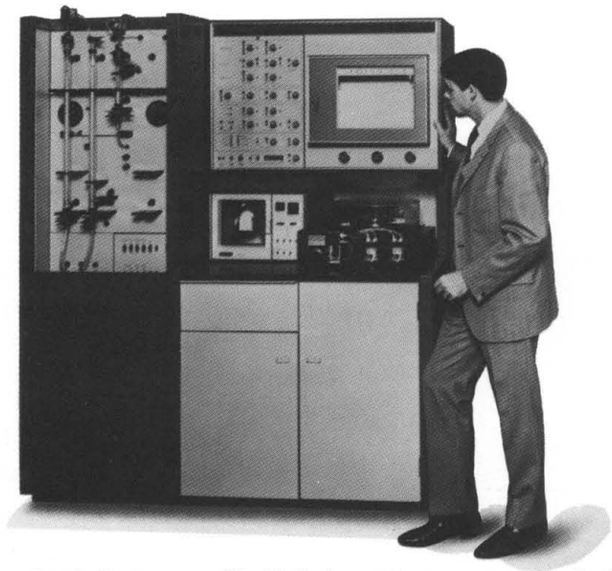

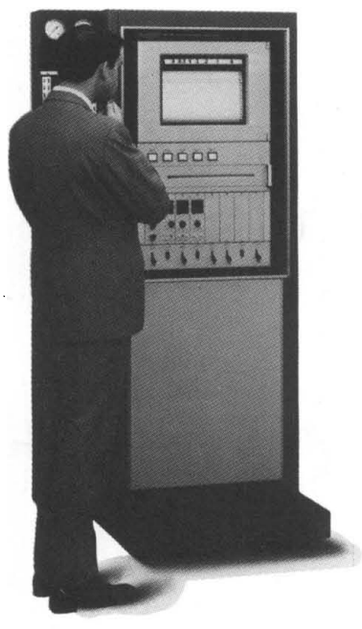

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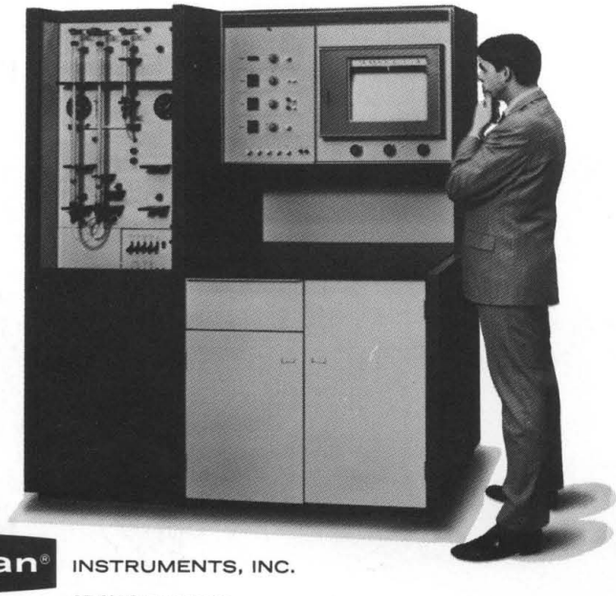

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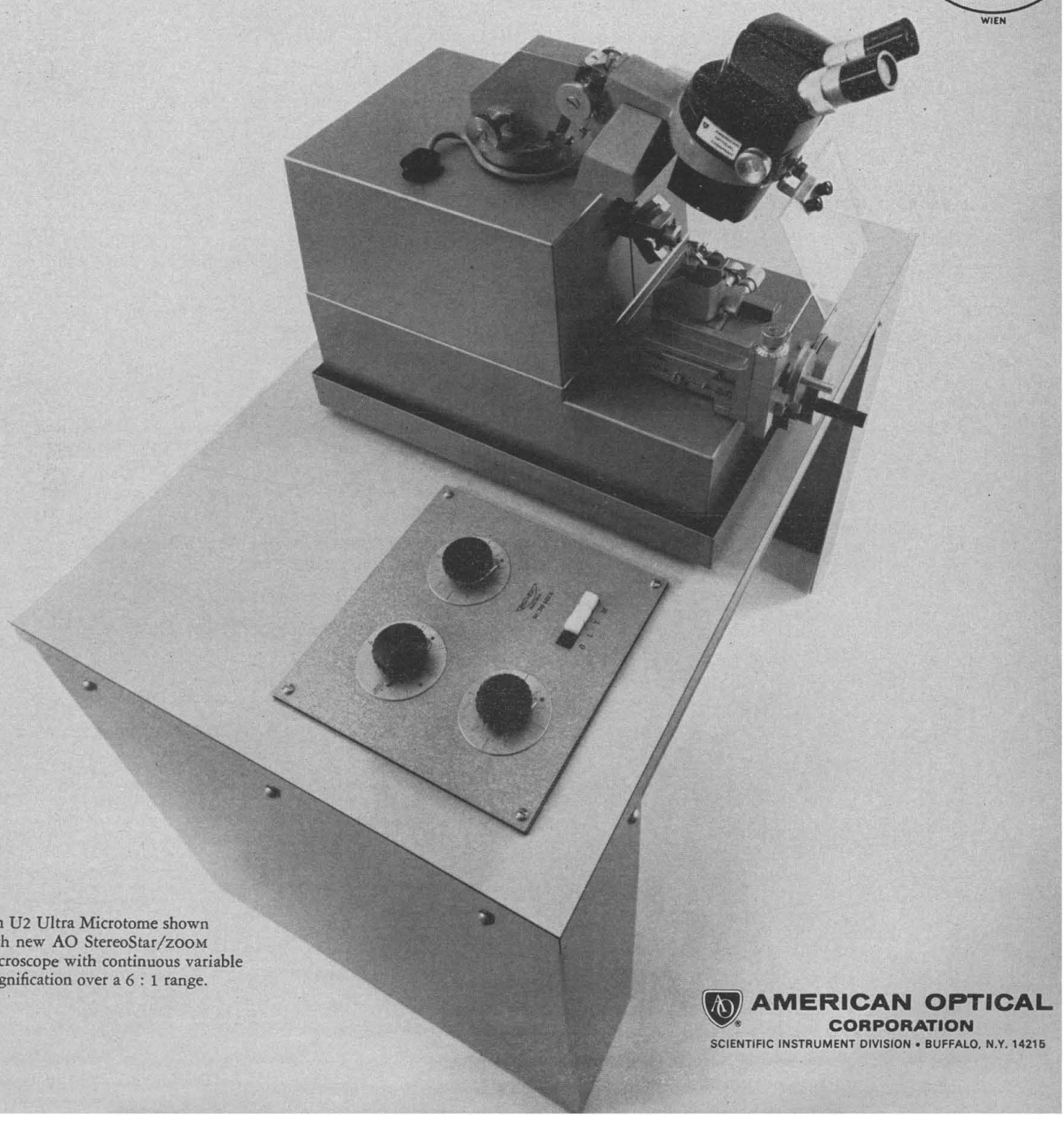

Om U2 Ultra Microtome shown with new AO StereoStar/ZOOM Microscope with continuous variable magnification over a 6 : 1 range.

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18 July 1969
Vol. 165, No. 3890

SCIENCE

SCIENCE is published weekly on Friday and on the fourth Tuesday in September by the American Association for the Advancement of Science, 1515 Massachusetts Ave., NW Washington, D.C. 20005. Now combined with **The Scientific Monthly**®. Second-class postage paid at Washington, D.C. Annual subscriptions $12; foreign postage: Americas $3; overseas $5; single copies, 50¢ (back issues, $1) except **Guide to Scientific Instruments**, which is $2. School year subscriptions: 9 months, $9; 10 months, $10. Provide 4 weeks notice for change of address, giving new and old address and zip codes. Send a recent address label. SCIENCE is indexed in the **Reader's Guide to Periodical Literature.**

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Surface detail of an epitaxial crystal of chalcopyrite on a magnetic substrate. Normal mode photographs (upper and lower left, about × 26,000 and 5,200, respectively) on a scanning electron microscope have greater brilliance at topographically high spots, whereas Y-modulation photographs (upper and lower right) show actual contours of the surface. An improvement in resolution is obtained by using this new technique [T. K. Kelly, Imperial College of Science and Technology, London, England]

Pollution that assaults the lungs, the digestive tract, the ear ...and how effective instruments can lead to abatement

The Lungs

Until very recently, Molecular Rotational Resonance (MRR) Spectroscopy often seemed like a brilliant scientific breakthrough destined to remain an ivory tower curiosity for lack of a practical application in the real world of quantitative analysis.

In its pristine form, MRR allowed the scientist to look into molecular structure by measuring changes in the absorption of microwave energy which result from transitions between rotational energy levels in a polar molecule. Because differences exist in the composition or geometry of individual molecular species, there is a characteristic MRR spectrum for each molecule. Absorption peaks are unique for each molecule and MRR readily differentiates between them, even in a complex mixture, because of its inherent specificity. In the usual case, measuring the frequency of a single absorption line completely identifies the molecule.

MRR has recently been shown to be a practical quantitative tool too. In a paper published in the *Journal of Chemical Physics* (46, 3698, 1967) the response of the HP 8400B MRR Spectrometer was shown to be linear with concentration from the lowest detectable limit to 100%. More recent work with common air pollutants (SO_2, NO_2, hydrocarbons) has demonstrated that MRR gives a quantitative response for each gas, even in the complex mixtures that are commonly associated with air pollution samples. The actual sensitivity limit for SO_2 has been determined at 3.5 nanograms without using concentration techniques (... this corresponds to a concentration of 11.6 ppb in a one liter sample). To further enhance its usefulness in the quantitative analysis of air pollutants, most MRR experiments are carried out at low pressures—typically 10-15 μ Hg—a condition that greatly reduces the rate at which the pollutants react with each other.

Precisely where the MRR Spectrometer fits into the pattern of analytical chemistry is still being studied. Based on the work reported above, it certainly should be considered for air pollution analysis, especially for calibrating on-site air pollution monitors. Results of experimental work in air pollution and other significant analyses with the MRR Spectrometer are published regularly in *Molecules and Microwaves*, a copy of which awaits your request.

The Digestive Tract

In the days before Rachel Carson's *Silent Spring*, the only popular connection between pesticides and the human digestive tract was benign: one was reassured that large parts of the world would be hungry, even suffer famine, except for the beneficial effect of pesticides on agricultural production. Nowadays, it's more common to hear warnings from respected scientific sources that pesticides constitute a real and present danger to life on this planet because they are ingested as residues in the food we eat and the liquids we drink.

These are not mutually contradictory arguments so much as they are accurate descriptions of both sides of the split personality of pesticides. The only conceivable solution to this very human dilemma is better control of the use of pesticides, and more careful analysis of pesticide residues in foodstuffs.

Enter the gas chromatograph (GC). While the men engaged in pesticide detection are many and far-flung, instrumentation for this sensitive work falls almost solely on the GC. On this basis, Hewlett-Packard has directed much research effort towards perfecting both instrumentation and technique. Although pesticide detection is still most often recorded in the nanogram range, an HP GC—more than four years ago—separated a laboratory pesticide sample at the picogram level. Most of this chemical detective work is being performed on the HP Model 402 High-Efficiency GC—an instrument perfected especially for this and other biochemical research. HP's pesticide analysts prefer to use this instrument equipped with an electron capture type of detector. The latter employs a radioactive tritium source to produce electrons whose capture by the pesticide molecules is a direct measure of their presence. Recently, HP chemist-designers have perfected a new electron capture detector that employs a radioactive Ni^{63} source that is more stable at higher temperatures thereby holding out a promise of more searching pesticide detection than the older tritium type can accomplish.

Sometimes the inherent difficulty of pesticide analysis is resolved by improvements in technique rather than hardware. HP chemists have developed special techniques for the analysis of pesticide residues in many foodstuffs, and sample extraction techniques for the analysis of bovine and human milk.

If you'd care to pursue this subject in more depth, write for Applications Lab Report 1003, yours on request.

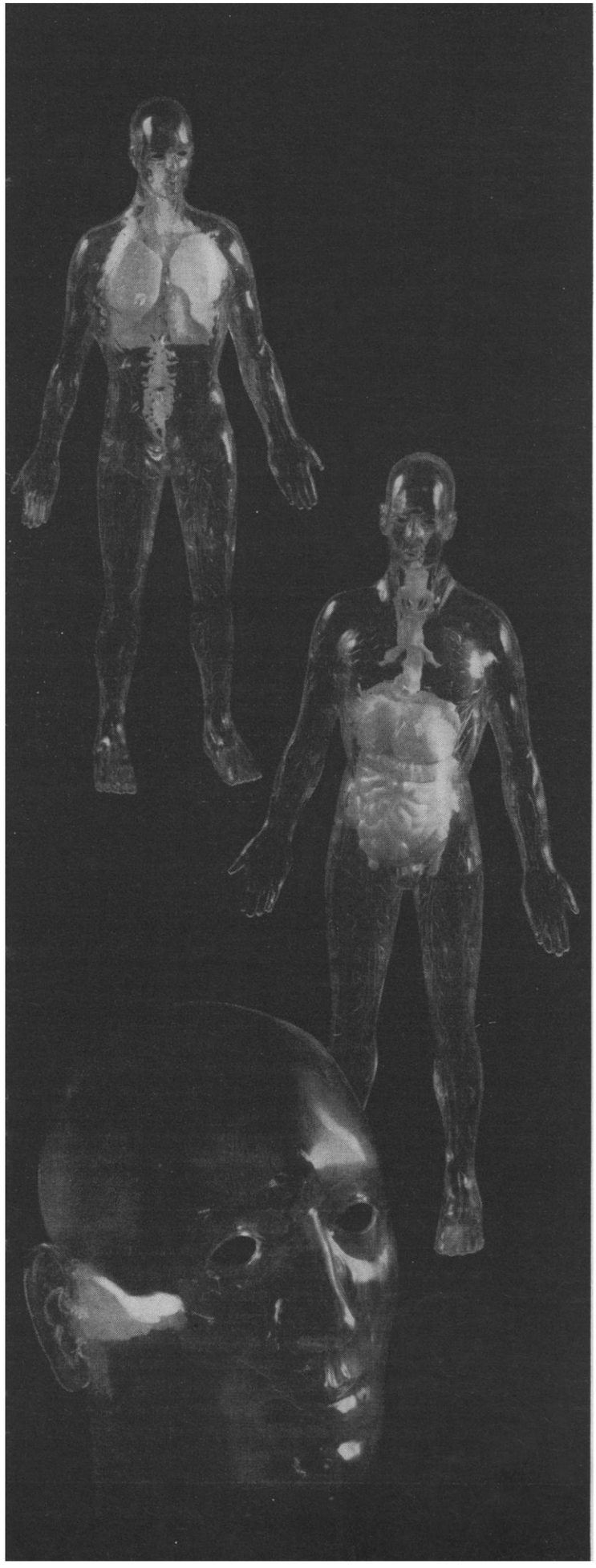
The Ear

Well played by a fine orchestra, Brahms can only be described as beautiful. But reproduced too loud on a cheap phonograph, it's noise. An increasingly widespread and serious form of pollution, noise can make us uncomfortable; prolonged loud noise damages hearing; very loud noises can cause pain, psychosis and even death.

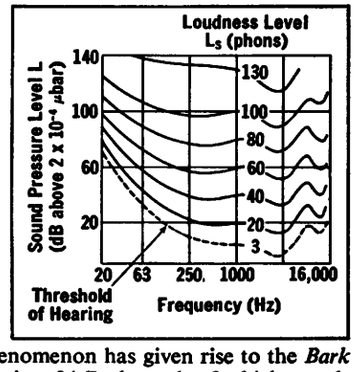
Obviously the time has come to control this form of 20th century environmental pollution. When HP scientists turned their talents to noise measurement, they ran into a very unusual problem. Objectively sound is simply a matter of rapidly changing air pressure, easy to measure with traditional sound level meters. But noise is really not an objective phenomenon: what the ear hears is a subjective sensation of loudness involving complicated physiological and psychological mechanisms.

For an instrument to measure sound as the ear hears it, it must imitate the unique properties of the ear. Take loudness level which is traditionally measured in *phons*. Although the logarithmic phon scale covers the large dynamic range of the ear—120 dB—it does not fit a subjective loudness scale. The trouble is that a noise that sounds twice as loud as another does not measure double the number of phons. So a subjective measure of loudness was developed by international agreement in which the unit is a *sone* and whose scale corresponds closely to the subjective sensation of loudness. For example, the comparison between a jet takeoff and a quiet conversation is 3:1 in phons (120 vs. 40) ... and a much more realistic 60:1 in sones (256 vs. 4).

Neither is the frequency response of the human ear a straightforward thing: the ear responds differently to sounds of different



frequencies and loudness levels. Although there is a small variation from person to person, normal ears agree within a few dB with the plot reproduced here (ISO Recommendation 226).



An even more significant peculiarity of the ear is its response to the pitch and bandwidth of a noise. Broadband sounds, like those of jet aircraft, seem much louder than narrow-band noise of the same sound pressure level. Thus accurate loudness measurements can be made only by taking into account the spectral distribution of the sound and relating it to empirically determined critical bandwidths. This phenomenon has given rise to the *Bark* scale: the audio range comprises 24 Bark, each of which equals the ear's critical bandwidth at a given center frequency.

Probably the most significant difference between objective and subjective measure of loudness occurs when two sounds are presented to the ear simultaneously. If the two sounds are widely separated in frequency, their partial loudnesses simply add to form the total loudness. But if they are not separated by a critical bandwidth, one sound masks the other: the closer together, the greater the influence. The noise analyst expresses this characteristic quantitatively in terms of *loudness density*, in sones/Bark.

The HP 8051A Loudness Analyzer is, in effect, a calibrated electronic ear that takes all of these subjective reactions of the human ear into consideration in measuring loudness based on ISO Recommendation 532 (Zwicker's Method). It listens to sound through a calibrated microphone or tape recorder, automatically produces a continuous spectral analysis and displays it as a plot of loudness density vs. subjective pitch. The instrument also computes and displays the total loudness of the sound, that is the integral of the Zwicker diagram.

The instrument is a great help in noise abatement studies because it shows how noise reduction techniques can be applied most effectively. Its spectral analysis points the finger at the most obvious sound-producing component, suggests what kind of sound-absorbing material may be needed, offers quick *before* and *after* comparisons of noise abatement programs.

A much more complex and versatile instrument for audio spectrum analysis, the recently announced HP 80501A Audio Data Processor combines the equivalent of a Loudness Analyzer with a powerful HP 2115A Digital Computer. The 80501A measures loudness with Kryter, Stevens, TALARM, SAE or dB weightings depending on the choice of standard computer programs. Results are available immediately: for example, the 80501A yields a complete analysis of aircraft noise while the plane is still overhead.

Our new 116-page Acoustics Handbook does justice to this rather complex subject. For your copy, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

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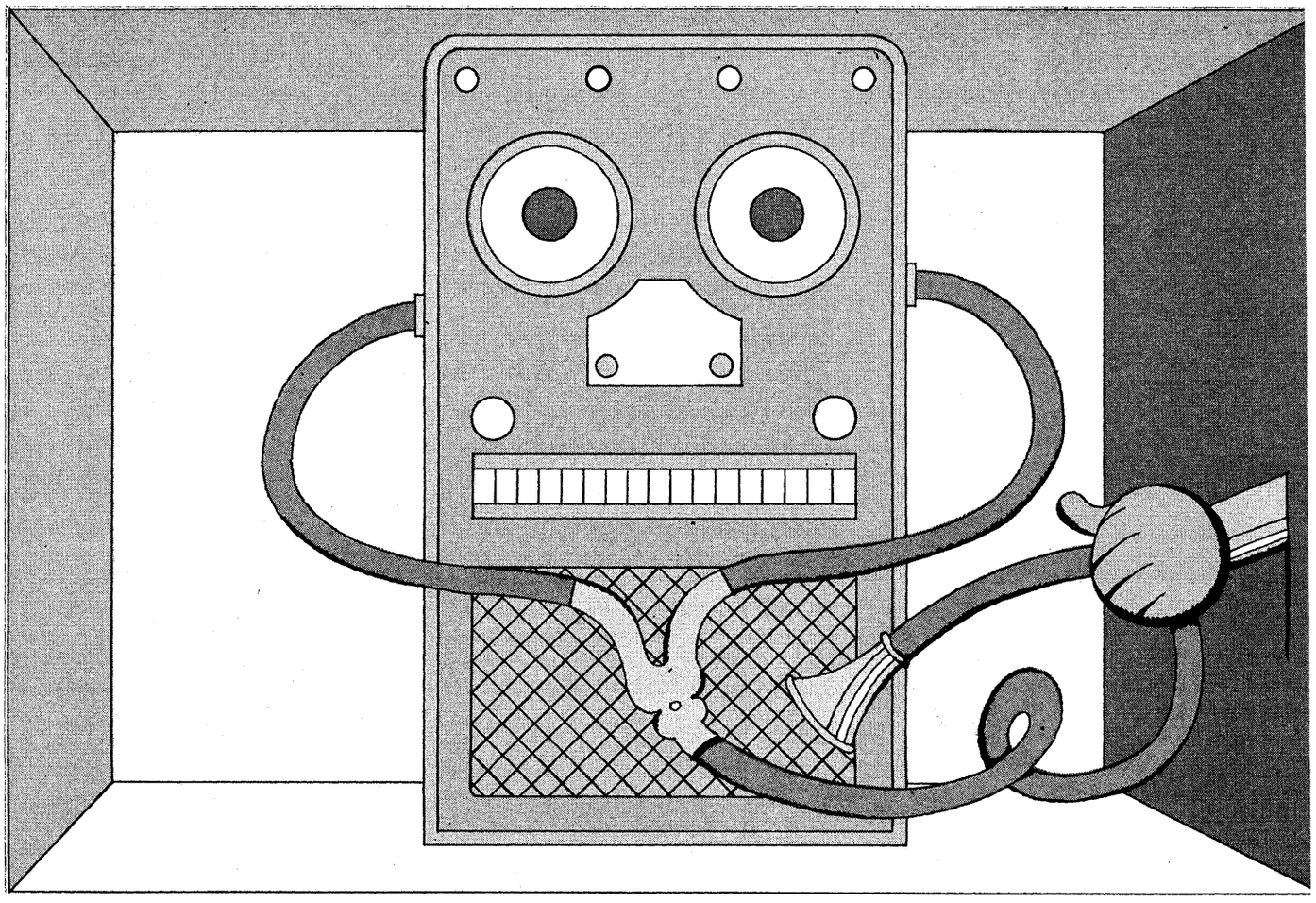

No time for downtime

A machine as complex as the Bell System's new Electronic Switching System (ESS) must help with its own maintenance. Consider, for example, that an ESS installation in a single Bell System central office can perform nearly a billion and a half switching, logic, and memory operations per second. And that we expect it to provide service for 99.999 percent of the next 40 years. Also, that the system employs a totally new concept: "stored program control." That is, each of the many actions in connecting one telephone with another is governed by a central digital data processor which draws upon program instructions and other stored data; new and revised features are incorporated by changing memory content rather than by rewiring.

All of this makes traditional servicing obsolete, and calls for advanced ideas in reliability and maintenance of electronic equipment.

Vital units such as the central data processor and the memories operate in pairs; if one unit ever falters, its twin maintains service. But, because there is no standby until the defect is repaired, ESS itself helps with the work. For instance, there are three principal fault-detection schemes:

"Match and Check Circuits" constantly compare critical information in duplicated units.

"Audit Programs" check that the system's temporary memory reflects what is actually going on.

"Exercise Programs" use the brief intervals between telephone calls to check all circuits, including those for maintenance.

If a fault is found, alarms operate and "fault recognition" programs take over. These automatically find the defective unit and reroute the information flow through its duplicate. Or, if the problem is simply a memory error, it is corrected. Such actions take less than a millisecond; office operation is unaffected.

Finally, "diagnostic programs" test any faulty unit, store the results, and print them out with a reference number. A craftsman looks the number up in his "ESS Troubleshooting Manual" and finds a list of possibly defective circuit packs. He replaces one or more of them to clear the problem.

Over half of ESS—circuits and store program—is devoted to maintenance. But only with modern techniques can so complex a system meet today's communications needs.

From the Research and Development Unit of the Bell System—

Bell Labs

13) Warts or lichens from the leg of a horse powdered and drunk in water, 28:19.

14) Slough of a snake. But, when taken with wine and frankincense, it aids labor, 30:14.

15) Sisymbrium. Women going with child must take heed how they eat sisymbrium (cress, thymbraeum, watermint) unless the fruit of their bodies be dead within them, for if it be but applied outwardly, it will send it forth, 20:22.

Many of these substances might have been put in the flame of an ordinary Roman lamp and used to fumigate a room or a woman. Castoreum was sometimes used with powdered shellfish (ostracium or onyx—Pliny was not sure what these were), or with perfume as a suffumigant to treat pain in the womb. Galbanum was used regularly as incense and still is. It is one of the ingredients that the Lord directed Moses to put in the incense used before the decrees in the tent of meeting, *Exodus* 30:34-38. Thus, castoreum or galbanum may have been the abortifacient in the smoke of Roman lamps.

For moral reasons Pliny probably has omitted other drugs that abort, 25:3. He asks about "those Greeks": "What color and pretense had they to set down medicines and receipts to cause women to slip the untimely fruit of their womb . . . I am not for them that would send the conception out of the body unnaturally before the due time: they shall learn no such receipts of me, neither will I teach any how to temper an amatorius cup, to draw either men or women into love, it is no part of my profession." Also he would have nothing to do with magic or witchcraft.

If putting out common lamps in the customary way usually induced abortion then there would have been few viable births. Obviously there was something extraordinary about the Roman lamps that induced the abortions or perhaps the account is exaggerated or incomplete. In my opinion, Pliny, in spite of his denial has given items that depend on magic for their operation. Possibly "magic" has changed its meaning over the centuries.

HOWARD MCCULLY

Four Hermosa Place,
Menlo Park, California 94025

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18 July 1969, Volume 165, Number 3890 **SCIENCE**

The President Need Not Wait

For 2 years Congress and the President have been stalling on Selective Service reform. It started when the Selective Service Act of 1967 did not follow the President's recommendations, the advice of his special commission on Selective Service, the advice of an independent panel appointed by the House Armed Services Committee, or the recommendations of many educators. The bill adopted was widely considered to have serious faults, but Congress has not amended it, and neither President Johnson nor President Nixon has used existing administrative authority to make corrections. On 13 May, President Nixon asked Congress to amend the 1967 Act. But Congress has been deaf to the request, and the President has not repeated it. The score on Selective Service reform is still tied at 0 to 0.

In the long run, the President hopes for a wholly voluntary military service. For the immediate future, he has asked only for what was requested in 1967: abolition of the requirement that the oldest eligible men be called first, establishment of a prime age group (age 19), and use of a random method of selection to determine the order in which men are called for induction. These changes would satisfy the military wish for a younger group of draftees than they are getting now, and would greatly benefit all young men by making the period of prime draft vulnerability 1 year long instead of 7 years long.

Reducing each man's period of prime vulnerability—and hence of uncertainty—to a single year that would come at age 19 or, if he chose a college deferment, in the year immediately following graduation would largely eliminate the present disruptive uncertainties of planning by universities, graduate students, and prospective graduate students. Under the present system, as reported in *Science* last week, first-year graduate enrollment of male U.S. students dropped last fall by 5.6 percent below the 1967 level (the trend line would have predicted an increase of 5 to 10 percent); over 15 percent of this smaller group either entered service during the academic year or finished the year with induction orders in hand; and enrollment is more uncertain for this coming fall than it was last year, and probably will be cut more deeply.

The difficulties young men are having in planning their lives; university difficulties in arranging for an unknown number of graduate students who will be allowed to remain for an unknown time, and uncertainty over how many teaching assistants may be called for induction during the year; concern about the predictable dip of new entrants to the professions—all these are results of the failure to correct the faults of the 1967 Act.

The President need not wait for Congress. Using authority he already has, but by means slightly different from those he recommended to Congress, he could achieve the objectives of the requested legislation. If he does not wish to go that far, he could, by Executive Action, allow graduate students to complete a full academic year after they are first ordered for induction. The men would be inducted at the end of the year, but in the meantime they and their universities would have had a year of uninterrupted work. This improvement is being considered in government agencies. Unless it is made almost immediately, another year of uncertainty and confusion will follow. This is likely, for the record justifies the pessimistic expectation that there will be no substantial change until the calendar forces both Congress and the Executive Branch to take action shortly before the Selective Service law expires on 30 June 1971.—DAEL WOLFLE

Now, a 200 MHz clock rate and expandable memory in a Multichannel Analyzer

The never-before-achieved 200 MHz clock rate ADC for the new Hewlett-Packard 5401A Multichannel Analyzer will add speed and flexibility to your spectrum analysis work. This precision instrument offers you a 12-bit ADC (4K resolution) and memory expandable from 1024 to 4096 or 8192 channels. Now get extremely high digitizing rate... on top of the outstanding linearity and stability specs, I/O flexibility, and multimode operation that HP has already contributed to nuclear and statistical analysis work.

Besides the price, under $12,000, not much more need be said.

Call your local HP field engineer for all the details on the new 5401A Multichannel Analyzer. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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