SCIENCE

14 January 1966
Vol. 151, No. 3707

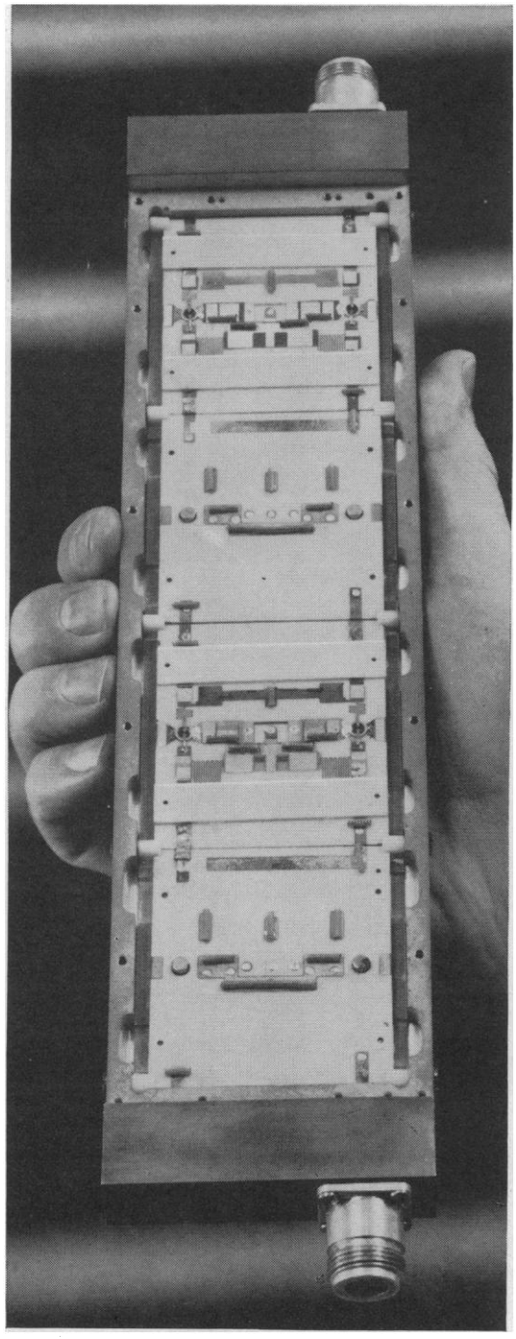
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

LOUIS THE PIOUS

Report from

BELL LABORATORIES

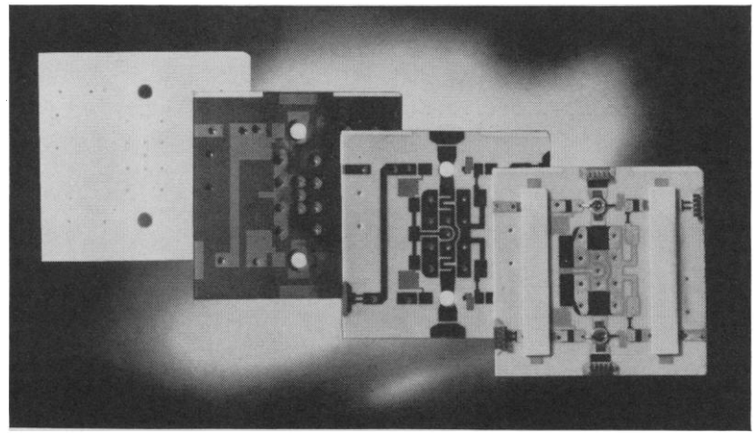
Integrated circuits at microwave frequencies



Laboratory model of a four-stage microwave amplifier which can provide up to 40-db gain and noise figures as low as 3 db in the 1- to 2-gigacycle frequency range. Similar amplifiers have been developed to operate at frequencies from 0.5 to 4 gigacycles with bandwidths of 1000 mc.

Engineers at Bell Telephone Laboratories have developed integrated circuits for use as amplifiers in the microwave range. Thin-film tantalum techniques are used to provide the precise, stable resistors, capacitors and transmission-line components required at microwave frequencies. Improved transistors provide up to 10 db of gain per stage and noise figures as low as 3 db.

A "balanced" design, using a power-splitting directional coupler, makes possible wideband, stable gain characteristics without the need for tuning adjustments. Up to the highest frequency for which these amplifiers are now usable—4 gigacycles—the electrical performance characteristics are equal or superior to those of low-noise traveling-wave tubes. In addition, they have the other advantages of solid-state circuitry, such as long life and reliability.



Thin-film techniques are used in the integrated microwave amplifier. Starting from bare ceramic substrates of about 2 x 2 inches (left), partially finished circuits are shown during the multi-step fabrication process. Circuit at right, complete with transistors, comprises one stage of amplifier. "Balanced" design with electrically similar transistors gives precise wideband amplification in the low-microwave-frequency range.

Bell Telephone Laboratories
Research and Development Unit of the Bell System

14 January 1966
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COVER

Manuscript of a poem, with portrait of Louis the Pious, the only son of Charlemagne to outlive him. The words of the poem are written on the picture and can be read like a cross-word puzzle. The letters around the cross and the halo also form verses. See review of *The Dawn of European Civilization: The Dark Ages*, page 185. [Fulda, Osterreichische National-bibliothek, Vienna]

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dibasic acids
glycerides
cis-trans isomers of fatty acid esters
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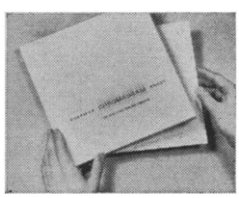
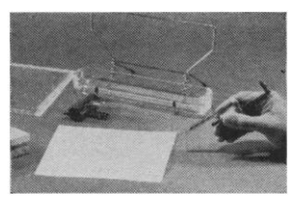
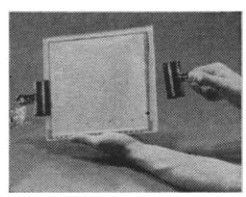
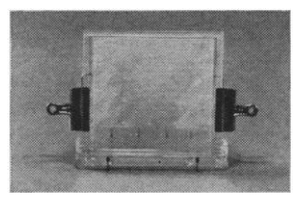
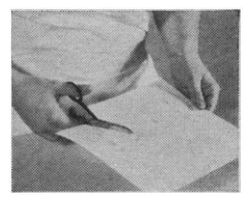
2,4-dinitrophenylhydrazones
fat-soluble vitamins
tocopherols
cholesterol and cholesterol esters
pesticides
antioxidants
some common dyes
photographic developing agents
ball-point inks

More analytical procedures are in the works, and we'll send them to you as they become available.

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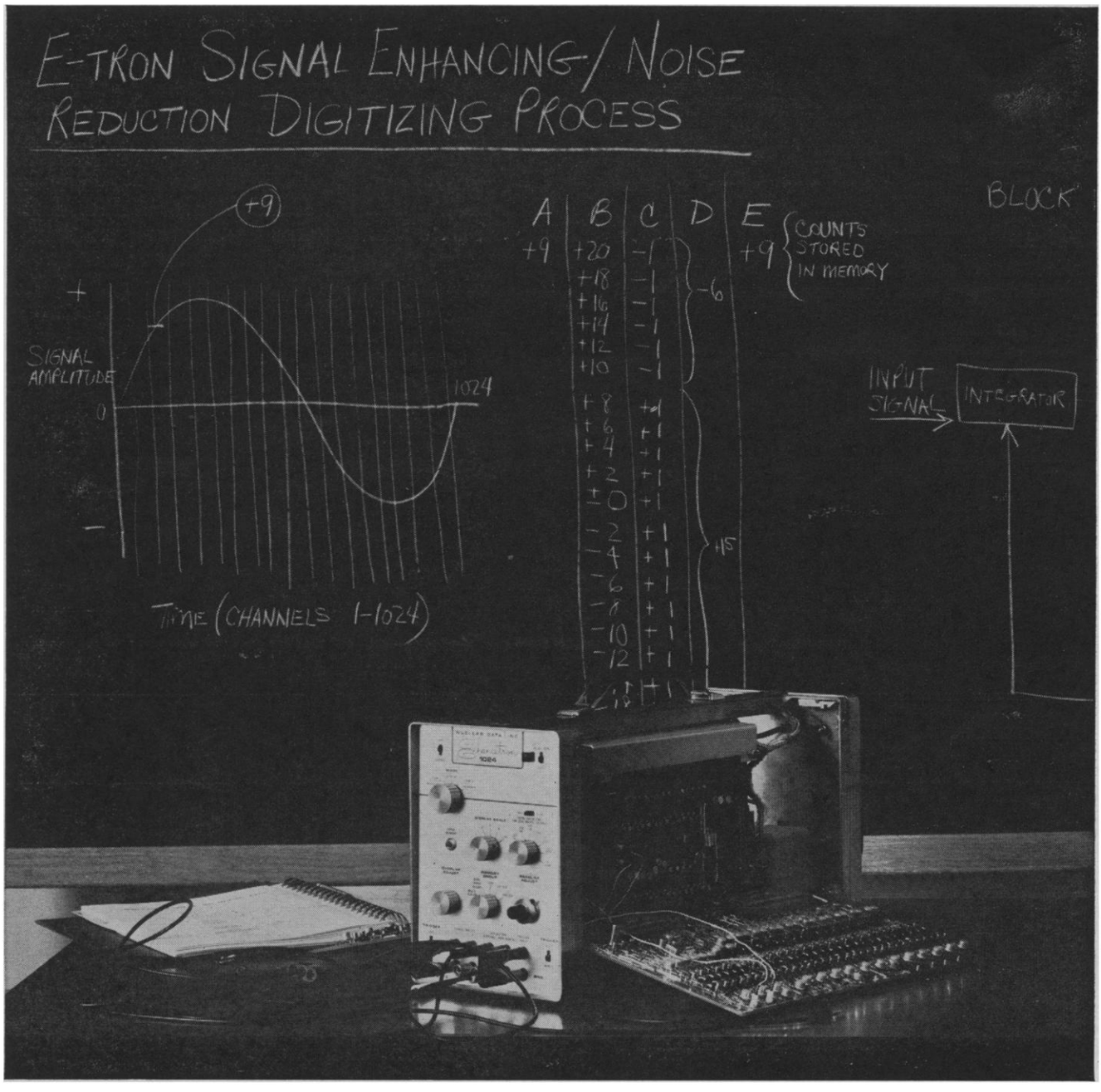

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Kodak reports on:

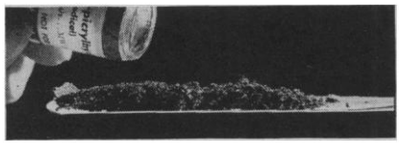
photorecording a 100 mc carrier . . . an odd chemical in a plain bottle . . . high-speed bibliography

How to write with a fine pencil

To the surprise of some, a 100-megacycle carrier turns out to be not beyond photographic recording at gratifyingly high density. The secret is to do it with a pencil of electrons and avoid phosphors and lenses. Various arrangements are being worked out to supply unusual sensitized goods for this purpose.

Inquiries of more than casual motivation on this subject are welcomed by Eastman Kodak Company, Special Applications, Rochester, N. Y. 14650.

See the free radical



Ordinarily you don't get to see free radicals, particularly outside of cryogenic equipment. Most free radicals are encountered only on blackboards; this one can be encountered in a familiar bottle, labeled EASTMAN 7703. It is *2,2-Diphenyl-1-picrylhydrazyl.* It is so intensely violet that it just looks black, but if you like you can imagine the weirdly unpaired electrons glittering at you. When Gomberg first proposed the concept of a stable free radical to explain some strange results in 1900, skeptics squelched him. A generation later the far more stable free radical we picture at left had been made and had been shown by magnetic measurements to exist mainly as the monomeric radical whether in solid state or in solution. The three phenyl rings seem to stabilize the odd electron even better than they did for Gomberg in his triphenylmethyl radical.

When *2,2-Diphenyl-1-picrylhydrazyl* regains its missing hydrogen atom homolytically from somewhere, it has to give up its preternaturally emphatic color along with its distinction and fades to a faint yellow. That's good. It means we can sell the compound to be used, not just admired. That same June '65 issue of *Analytical Chemistry* carries a paper on p. 899 that lays down some guidelines about how EASTMAN 7703 can serve as a colorimetric reagent for aromatic amines —primary, secondary, and notably tertiary. (The tertiaries get hydrogen for the reaction from the α-carbon of an alkyl group and then stabilize themselves by over-all electron delocalization.) The sheer intensity of the hydrazyl color promises sensitivity for the method, while differences in the reaction rate for different amines promise specificity.

The method was developed by Papariello and Janish, analytical chemists at Ciba Pharmaceutical Company, who are nice guys and figure we can stimulate a lot of other chemists to benefit from their work.

EASTMAN *7703 probably isn't the oddest of all the thousands of* EASTMAN *Organic Chemicals that can be ordered from Distillation Products Industries, Rochester, N. Y. 14603 (Division of Eastman Kodak Company). Let's hope your library has all four supplements in its copy of List No. 43.*

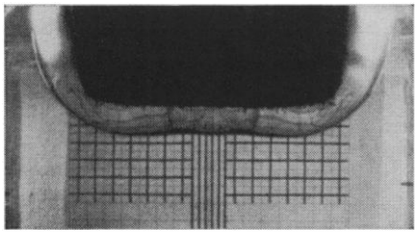
Collaboration with Mary Sarah

We approached a young lady of incredible beauty whose boss had gone out late to lunch and had left her with too light a work load. "Mary Sarah," said we, "please think of any ten numbers between 1 and 538 that come into your head and say them. In order, please."

Mary Sarah replied, "6, 71, 162, 210, 304, 396, 408, 479, 513, 535."

We did this for the following reason.

The 7th International Congress on High-Speed Photography met in Zürich this past September. To commemorate that event we put together a bibliography on high-speed photography for the period 1960-1964. On its cover appears the following frame from a high-speed motion picture study of explosion phenomena:



You may not fully understand its significance. Neither do we. That's the trouble with virtually all significant high-speed movies. They look pretty blah until the guys who planned and took them explain everything. Then your eyes may light up.

Some investigations with high-speed movies are brilliant engineering or brilliant applied physics or brilliant bioscience. Some are not very brilliant. Who are we to say which are which? Therefore we approached Mary Sarah. Of the 538 entries in the bibliography, here are the ones she picked:

6 Research Directed Toward the Attainment and Utilization of High Temperature (Multi-Frame High Speed Camera, Exploding Wire Phenomena and Plasma Acceleration). L.L. Bohn, F.H. Nadig, and T. Korneff, Temple U. Mar., 1958, 109p. (PB 138 435). — Exploding wires; Framing cameras; Plasmas; Rotating-mirror cameras; Image converters.

71 Study of the Process of Cutting Metals by High-Speed Cinematography (In Russian). C.P. Tambovtsev. Usp.Nauchn. Fotogr. 6, 174(1959). — Cinematography; Metals; Photomicrography.

162 The Astracon Tube and Its Application to High-Speed Photography. A.E. Anderson, G.W. Goetze, and H. Kanter. J. Soc. Mot. Pict. Telev. Engrs. 70, 440-42 (1961). — Image intensifiers; Cameras.

210 An Electronic Flash Adapter for Photomicrography. J.J. Lee and B. Freidman. J. Biol. Phot. Assoc. 29, 93-7 (1961). — Photomicrography; Flash tubes; Electronic flash.

304 Brit. P. 886, 829. High-Speed Camera Having Improved Kerr Cell Shutter Assembly. A.E. Huston. To United Kingdom Atomic Energy Authority, 9/24/58, 5p. — Framing cameras; Kerr cell; Shutters; Electro-optical devices.

396 The Use of High Speed Cameras for Metric Photography. L.L.Endelman. Soc. Phot. Instr. Engrs. J. 1, 128-30 (1963). — Framing cameras; Missile photography.

408 The LER-1 Recording Lux-Meter (In Russian). I. M. Gurevich, V. G. Baryshnikov, L.E.Finkel'shtein. Svetotekhnika No. 5, 16-19 (1963). — Oscillograph recording; Photometers; Light sources.

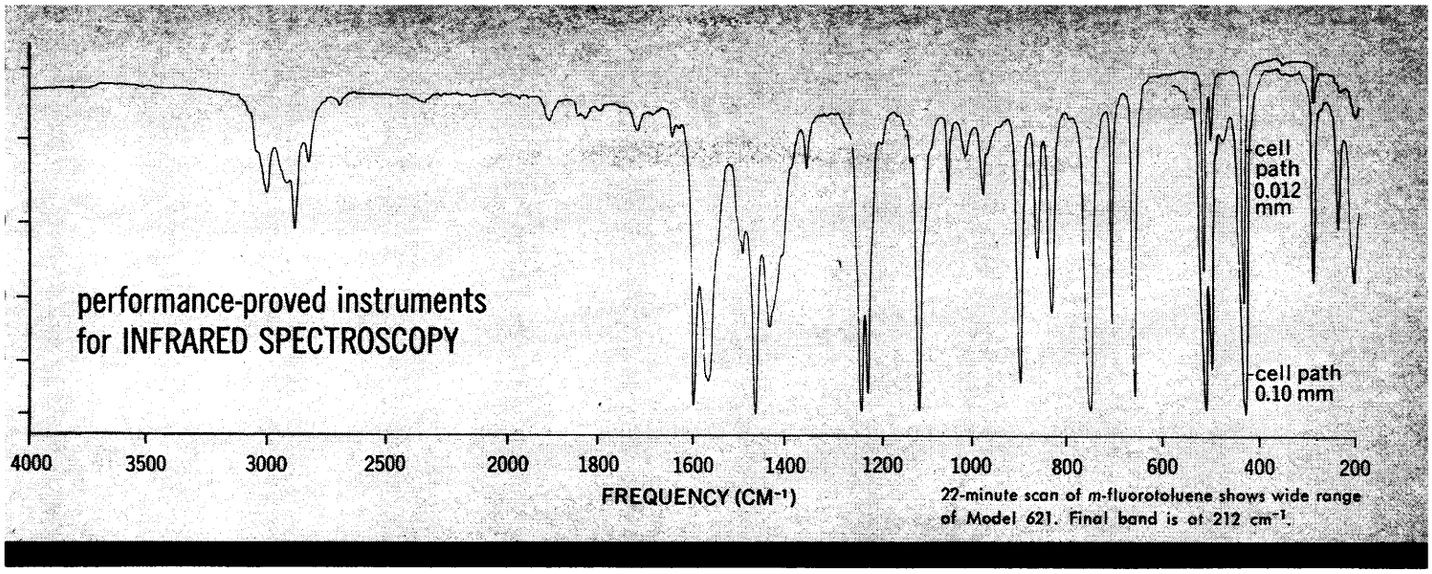
479 Twenty-Thousand Frames Per Sec. Amateur Cine World 8, 241 (1964). — Oscilloscope Photography; Flash synchronization; Motion-picture cameras.

513 A High-Speed Camera for High Frequency Electrocardiography. F.T.Mansure, P.H.Langner. Am. Heart J. 67, 88-91 (Jan. 1964). — Streak cameras; Streak photography; Medical photography; Oscillograph recording.

535 Brit.P. 961,441. Improvements in Optical Image Transmission Devices. J. N. Whyte. To Secretary of State for the War Department, London, 7/12/60-6/24/64. — Streak cameras; Rotating-prism cameras.

This will give you an idea of whether or not to send for a free copy of the 1960-64 high-speed bibliography from Eastman Kodak Company, Publications Service, Rochester, N. Y. 14650.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science



22-minute scan of *m*-fluorotoluene shows wide range of Model 621. Final band is at 212 cm^{-1}.

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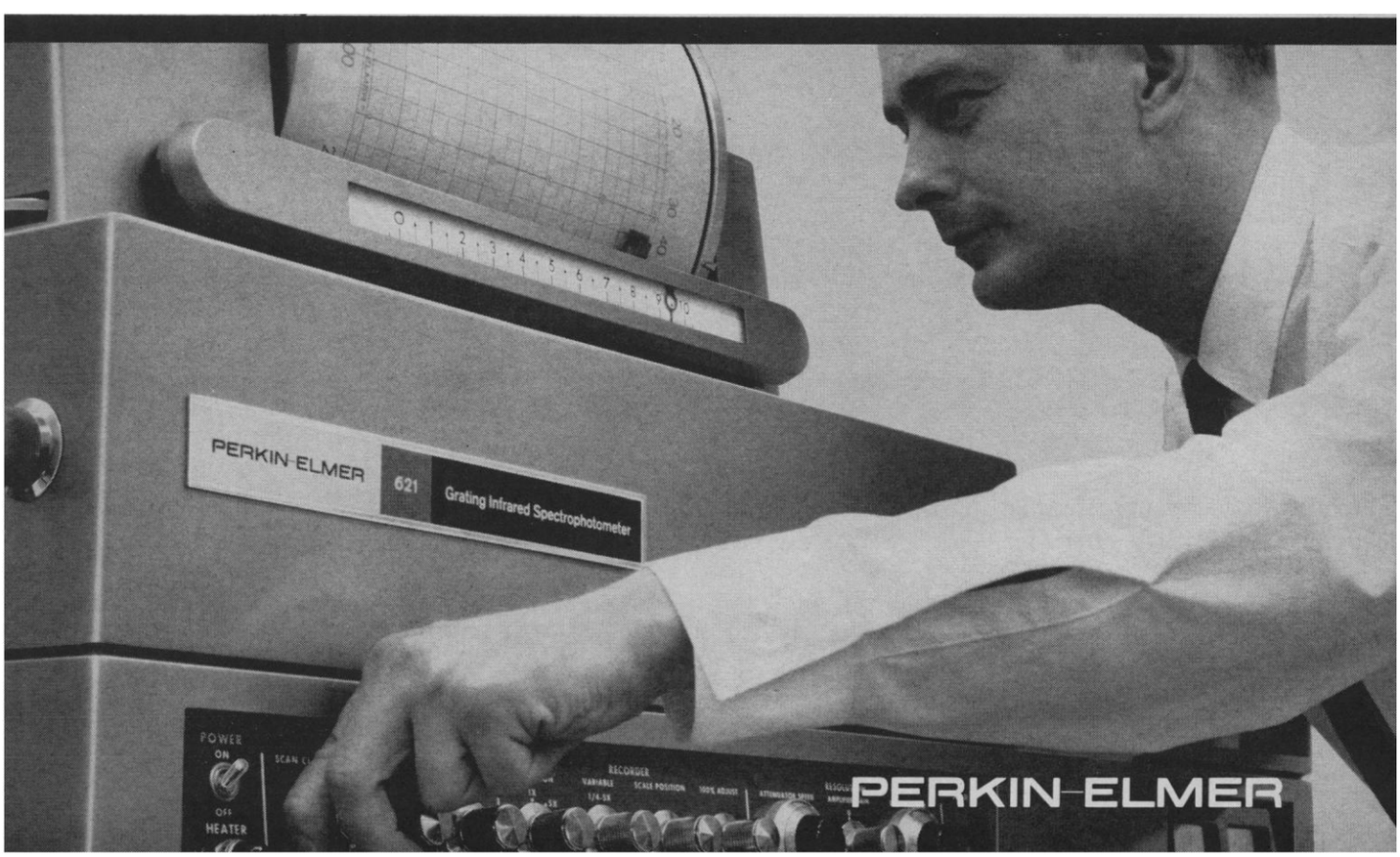
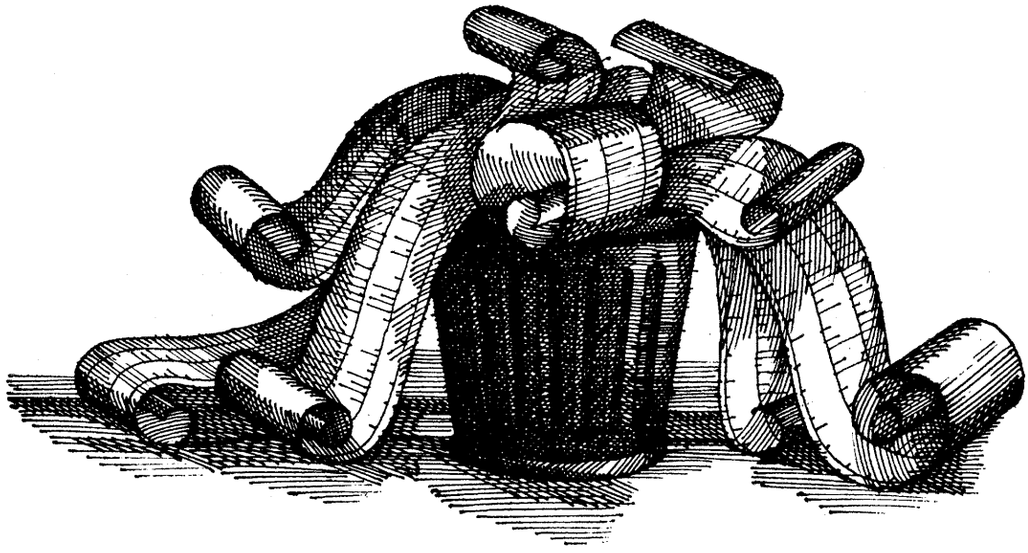
*U. S. Pat. No. 3,144,498





High-Resolution Mass Spectrometry and The chart paper flood

(A poignant tale with a pleasing end)

High-resolution mass spectrometry generates an overwhelming amount of invaluable data. Accordingly, it was bound to be useful for many applications. Take gas chromatography. Its marriage with mass spectrometry was a natural and was accordingly aided, abetted, and applauded by organic chemists, biochemists, and their friends. And this happy union is regularly blessed with issue: reams of chart paper requiring manual and mental baby-sitting. Very tiresome. Also quite unnecessary. Reason: the development of the new MS-9 data-handling system. This is a fast-scanning, high-resolution mass spectrometer which can monitor even microgram samples in effluents of gas chromatographs and yield spectra *in a form which can be computer-analyzed automatically* without inundating you in a veritable sea of chart paper.

From your standpoint (and ours) this is a major breakthrough and therefore is now worthy of at least some elaboration: this MS-9 mass spectrometer can eliminate your data-handling problem by enabling you to record spectra on magnetic tape either for instant playback through a recorder or for feeding directly to a computer for automatic analysis. In other words, the MS-9 doesn't abandon the user in the middle of the game by just spewing out data in difficult-to-use form and then quitting on you.

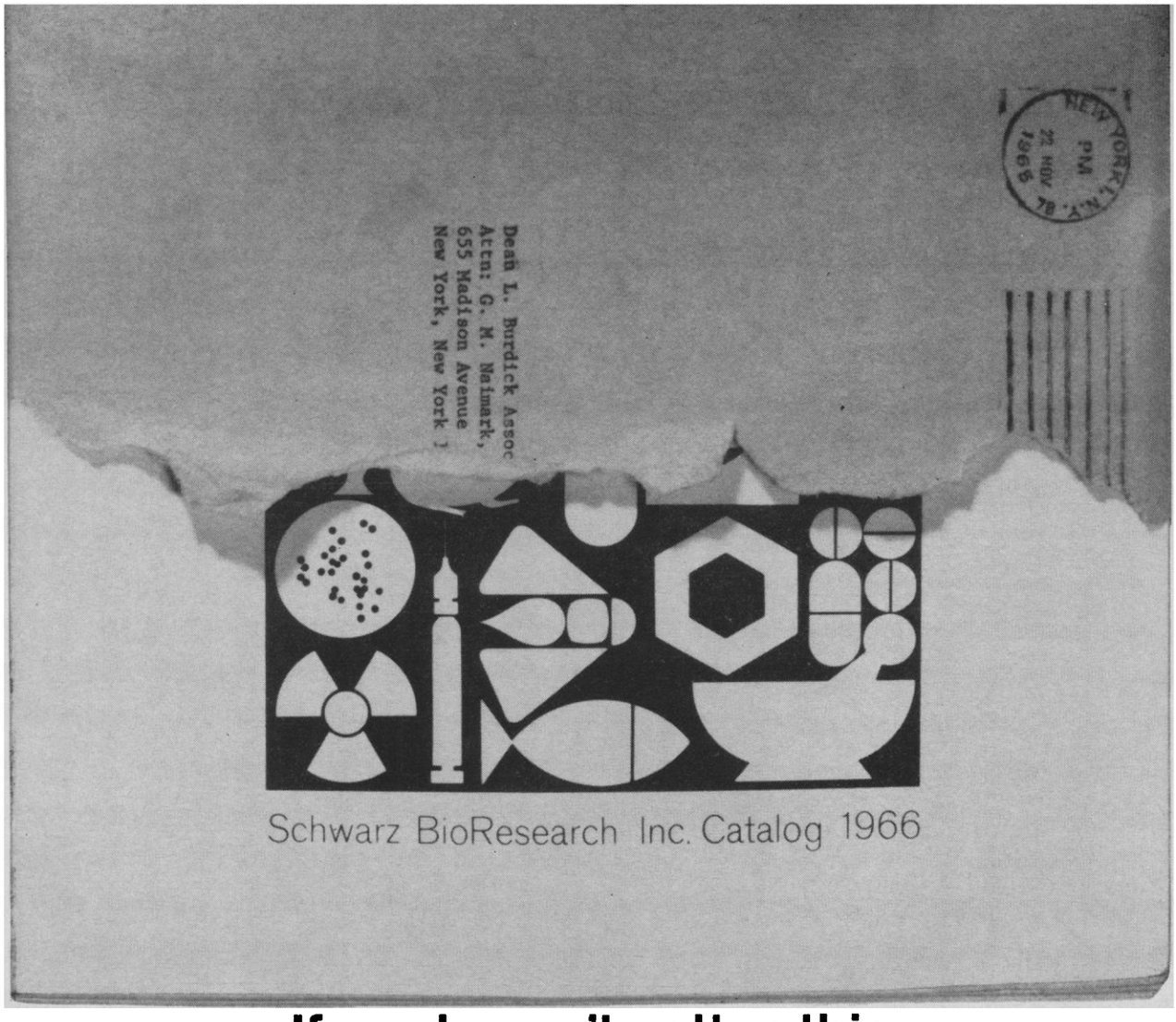
A few words about the MS-9's other specifications. This is a double-focusing instrument that is actually as simple to operate as a single-focusing mass spectrometer. And, although its over-all capabilities will intrigue the most advanced mass spectroscopist, even users who are not specialists in mass spectrometry will find the MS-9 easy to use with comfort and confidence. Its resolving power is uniquely high and guaranteed to be at least 33,000; switching from high to low resolving power can be done automatically by flicking a switch. It scans rapidly; it will, for example, scan a spectrum in 10 seconds at a resolution of 10,000. The sensitivity is high: microgram quantities can be studied at the highest resolving power. The data can be processed by your computer and the masses measured with such accuracy that the elemental composition of every ion can be calculated.

Obviously, this has been a grossly incomplete recitation of the many talents of the MS-9. Additional compelling information will be forthcoming at your request. Or consider this possibility: outline your specific problems and we'll tell you which of our line of mass spectrometers (the most comprehensive line around) is appropriate to your needs.

For further information on the MS-9, request bulletin number 97DL.

PICKER NUCLEAR: 1275 Mamaroneck Avenue, White Plains, New York 10605

PICKER AEI



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Orangeburg, New York 10962

Dear Sirs:

For some inexplicable reason I do not yet have a copy of your brand-new 1966 catalog whose picture abuts this coupon. I hear it includes a most comprehensive listing of hot and cold biochemicals. (Is it really true that it also features quite a few interesting new products?)

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200X in 10 seconds

With a Polaroid Land camera back and Polaroid Land film, you can see your photomicrographs of metal specimens 10 seconds after you take them.

You are always sure of your picture. If you don't get exactly the picture you want the first time, you'll know immediately, and can take another then and there.

You don't have to waste any time in a darkroom only to find out the picture isn't right—that illumination, or filtration, or focus, or field coverage is not perfect. And you never run the risk of having to repeat a difficult and time-consuming photomicrographic setup at a later date.

Because 10-second metallography has proven itself an invaluable laboratory tool, Polaroid Land camera backs (or the Polaroid 4x5 Land Film Holder) are offered as standard equipment with most well known metallographs.

Land camera backs are available for our roll or pack film formats. The 4x5 film holder, of course, accepts our 4x5 sheet films.

There are two basic Polaroid Land films for metallography, and they are available in all formats. There's a panchromatic black and white film, rated at A.S.A. 3000, which lets you shoot at low light levels with fast shutter speeds, and gives you a finished print in 10 seconds. And there's Polaroid color film which gives you an accurate full-color recording in 60 seconds.

The system is well worth looking into, don't you think? We'll be happy to supply more information. **Polaroid Corporation, Cambridge, Mass.**

Robert Hooke

The year just ended marked the 300th anniversary of the publication of Robert Hooke's *Micrographia*. It is unfortunate that Hooke has been so neglected by scientific historians that this anniversary was given little attention. Consisting primarily of a series of observations made with one of the first compound microscopes, this classic of science made its most reverberating contribution as the first description of cells. But it aptly reflects its author's versatility, brilliance, and esthetic sensitivity, for several times in the discourse Hooke digressed upon widely varied fields of science. By the preface alone he is established as a philosopher, a founder of scientific meteorology, an originator of the metric system, and the first to formulate a practical theory of combustion. There is hardly a realm of science to which Hooke did not at some time in his life make a significant contribution.

Through the years, the scant amount of information available has portrayed him as an irritable recluse, thinking of nothing but himself and his work. We are indebted to Margaret 'Espinasse (*Robert Hooke*, Univ. of California Press, Berkeley, 1956) for a sensitive interpretation of a variety of sources, showing him to be a warm and witty sort, spending much of his time in coffee-houses with his many friends. . . .

Hooke strongly upheld the exciting and increasingly popular brand of experimental science which was beginning to flourish in his day. And even though he knew the importance of "observations on material . . . things," he found time to rest his elbows on the table and reflect with awe on the possibilities inherent in the methods of science. . . . It is time that the name of Robert Hooke took its place among the great names of scientific history—Newton, Harvey, Pasteur, and the other much-publicized workers of former times.

GARY F. KELLY
37 Judson Street, Canton, New York

Gaits of Horses: Marey's Studies

To Hildebrand's almost comprehensive article "Symmetrical gaits of horses" (5 Nov., p. 701) should be added a note concerning the ingenious studies carried out a century ago by E. J. Marey, physiologist, physician, and a pioneer in the study of the gait of all animals and the flight of birds and insects. Marey studied the gait of the horse by attaching to the hoofs pressure pads which communicated to a kymograph carried by a rider (Fig. 1). In this way the pressure-time relations of the four hoofs were recorded continuously. The figure is taken from his book *Du mouvement dans les fonctions de la vie* (Baillière, Paris, 1868).

Marey's many books on experimental methods in biology and medicine are recommended reading for those desirous of a knowledge of the characteristics of laboratory instruments during the latter part of the 19th century.

L. A. GEDDES
College of Medicine, Baylor University, Houston, Texas

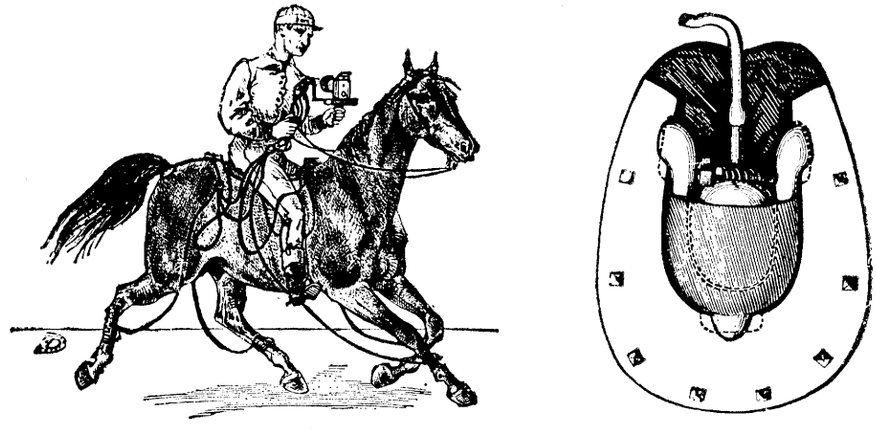
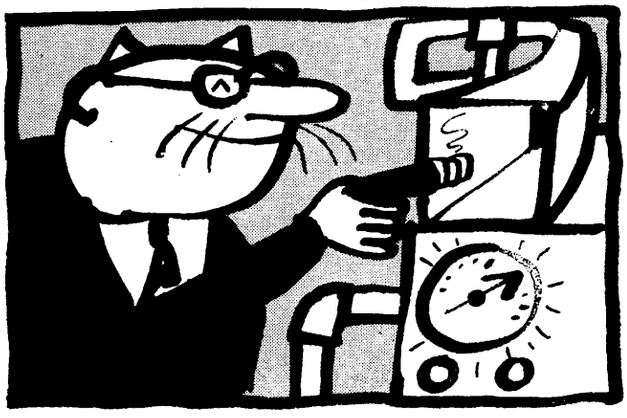


Fig. 1. Pressure on pads (right) attached to all four hoofs was recorded by the kymograph held by the rider.

. . . up to your neck? . . . trying to find a weak signal in a gooey background of noise.

The story is told that when the first crude version of the Dicke Microwave Radiometer — the heart of most present day radio telescopes — was being tested, one of the division heads expressed doubt that a piece of electronic hardware could be cajoled into responding to ordinary thermal radiation at microwave frequencies. The noise level in the primitive receivers of that time was at least 10 db above ambient thermal radiation levels, and it had been claimed that the Dicke radiometer had a sensitivity of 1/2°C. To make his point, this well-known physicist took his lighted cigar and held it up to the input wave guide of the receiver. When to his surprise the meter banged off scale, he smiled like a Cheshire cat in a cage full of ducklings.



The heart of the radiometer was the lock-in amplifier, and the technique of fishing a small signal out of a thick porridge of noise became known thereafter as the *"lock-in amplifier technique."* After the initial success with a lock-in amplifier the technique was used in a variety of places, including nuclear magnetic resonance measurements and microwave spectroscopy experiments. The practitioners of this black art have now increased to a reasonably large number, but a far larger number of scientists in all fields are still up to their necks trying to find a weak signal in a gooey background of noise.

Possible applications for the lock-in amplifier technique are almost endless, but in some scientific fields the amplifier is not even known, much less appreciated. The biological sciences offer many interesting challenges. Has anyone ever shone a light in a cat's eyes to see if it elicits a motor response? If the light were chopped at 5 cycles/sec. and a lock-in amplifier were connected to an appropriate strain gauge, this response could be studied, not only under conditions of very weak signal, but also as a function of chopping frequency.

Do astronomers realize that the lock-in amplifier can be used to "see" dim stars during the day? A rotating transparent disc carrying many tiny opaque spots can be used to modulate the light from the star while ignoring the background light.

These are only two of many possible applications of the lock-in amplifier technique. If you have a problem which you think might be solved by this instrument, our staff of experts would be happy to assist you.

Surprisingly, in spite of the increased use of the lock-in amplifier technique during the past 18 years, it has only recently become possible to buy such an amplifier.

Should one wish to add such an instrument to his quality research line, we would be glad to offer him a choice of units (ranging from $990.00 to $2250.00) and some application help (free!).

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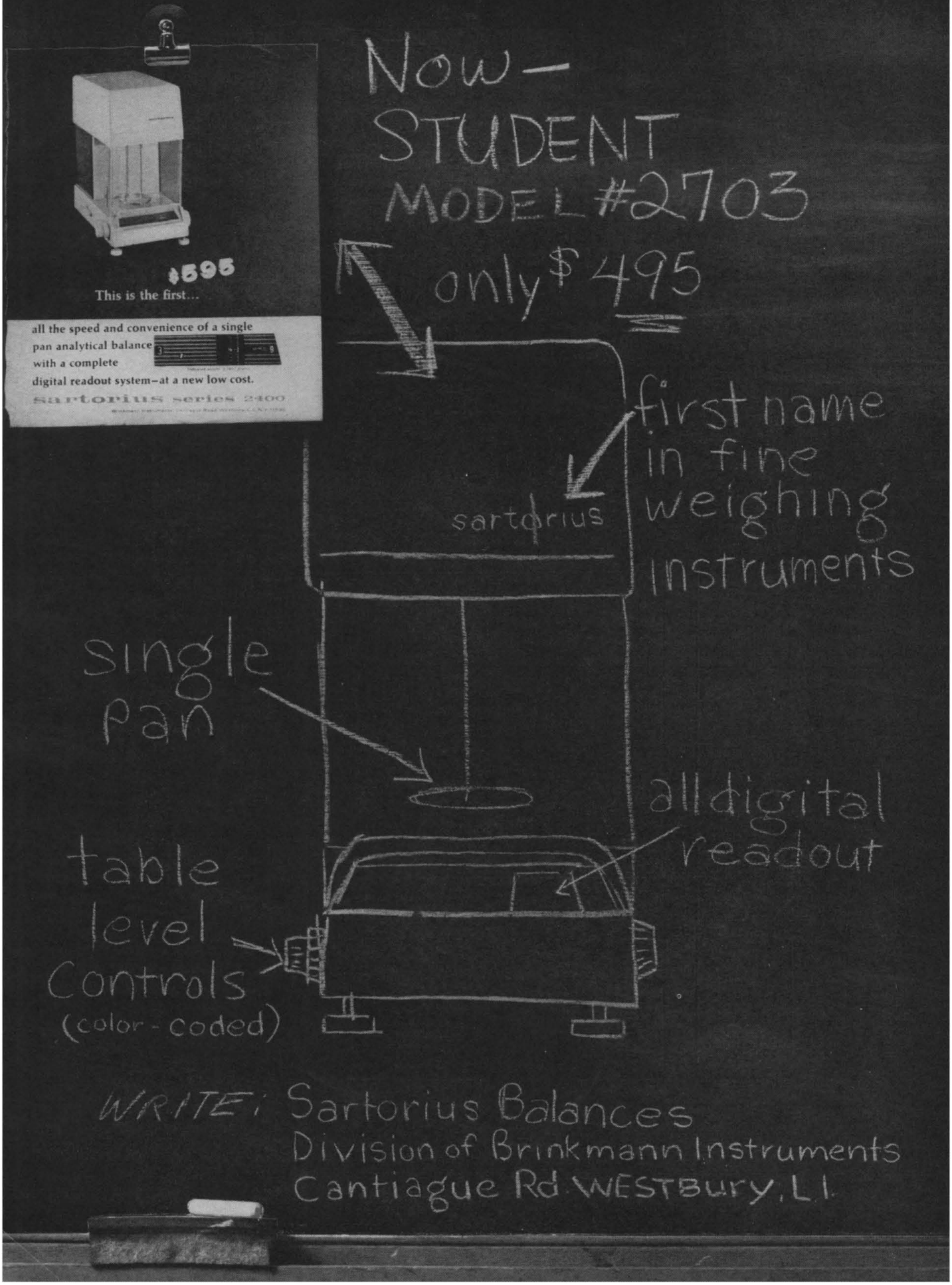
Social Science Research and International Relations

The repercussions of Project Camelot, a Department of Defense study of social conditions and movements in some other countries (*Science*, 10 Sept. 1965), led the President to ask the Secretary of State to establish procedures to prevent government sponsorship of foreign-area research that would adversely affect United States foreign relations. When the nationals of one country study sensitive or delicate issues in another country, problems are very likely to arise, and to have a special acuteness if the study is sponsored by government. American scholars studying social, economic, and political changes in other countries can be an embarrassment to their own country and a nuisance to their hosts; their work can arouse suspicions; and it may be difficult for nationals of the host country to distinguish private from public auspices. The President and the Department of State were, therefore, concerned with a real problem.

To meet that problem, the State Department has established an internal Foreign Affairs Research Council that will review and, if it approves, give clearance to foreign-area research proposals planned by other government agencies (*Science*, 19 Dec. 1965). This solution raises difficulties of its own. As a general principle, when parallel agencies of government have overlapping and perhaps conflicting interests, one of the interested parties is not the proper agency to settle disputes. The State Department, which now has the deciding voice, is properly concerned to avoid any political risk or embarrassment to the United States. The more zealously risk is avoided, the more likely it is that proposals that others consider valuable will be banned. If interagency disagreements do arise, it seems obvious that the risk or other disadvantages should be assessed in terms of the nature, methods, and personnel of the proposed study and should be weighed against the potential gains. Yet the State Department, which does not claim to be strong scientifically, has announced that it will not consider scientific or other aspects of a proposal, only its probable impact on foreign relations. Moreover, clearance requirements could be extended to other types of research conducted outside the United States. Clearance procedures are now restricted to social and behavioral studies intended to support the missions of operating government agencies, but the President's request could be interpreted or broadened to include oceanography, meteorology, and other fields.

The more restricted the exercise of the new authority is, the less reason there is to fear difficulties, and, of course, the less meaningful the new arrangements are. On the other hand, if the State Department uses its new responsibility vigorously, the system seems well designed to antagonize other government agencies, to alienate social scientists, and to deprive the nation of useful information that could be obtained if some of the banned studies had been permitted.

The whole situation—which the State Department has promised to review in a few months—is an indication that the ways in which studies in the social and behavioral sciences can be of use to the government are not so well understood as are the ways in which physical and biological studies can be useful. Donald Hornig recognized this difference in a recent address in which he admonished psychologists to study the problem of how their field could best aid government planning, work, and policy making. The National Academy of Sciences has also recognized the problem in establishing an Advisory Committee on Government Programs in the Behavioral Sciences. The Camelot affair and the dubious procedures adopted to prevent similar difficulties in the future indicate that there is indeed need for social scientists and government agencies to study their interrelationships and reciprocal responsibilities.—DAEL WOLFLE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February

2–4. **Aerospace and Electronic Systems**, winter conv., Inst. of Electrical and Electronics Engineers, Los Angeles, Calif. (A. S. Jerrems, Aerospace Group, Hughes Aircraft Co., Culver City, Calif.)

2–6. American College of **Cardiology**, Chicago, Ill. (W. D. Nelligan, 9650 Rockville Pike, Bethesda, Md. 20014)

3–4. American **Chemical Soc.**, 1st Middle Atlantic regional mtg., Philadelphia, Pa. (Philadelphia Section Office, ACS, 212 Harrison Laboratory, 34th and Spruce St., Philadelphia 19104)

3–9. **Medical Education**, congr., Chicago, Ill. (W. S. Wiggins, 535 N. Dearborn St., Chicago 60610)

6–9. American Inst. of **Chemical Engineers**, Dallas, Tex. (The Institute, 345 E. 47 St., New York 10017)

7–8. Perspectives in **Virology**, 5th mtg., New York, N.Y. (M. Pollard, Lobund Laboratory, Notre Dame, Ind.)

7–9. **Reactor Physics** in the Resonance and Thermal Regions, mtg., San Diego, Calif. (G. Joanou, General Atomic Corp., P.O. Box 1111, San Diego, 92112)

7–18. World **Meteorological Organization**, regional assoc. #5, 4th session, Wellington, New Zealand. (WMO, 4 Avenue, Giuseppa Motta, Geneva, Switzerland)

8–9. **Cost Aspects of Water Supply**, 8th sanitary engineering conf., Urbana, Ill. (J. H. Austin, 203 Civil Engineering Hall, Univ. of Illinois, Urbana 61803)

9–11. **Solid State Circuits**, 13th annual conf., Philadelphia, Pa. (K. H. Fischer, U.S. Army Electronics Command, Attn: AMSEL-KL-I, Fort Monmouth, N.J.)

10–11. **Snow**, eastern conf., Hartford, Conn. (G. Ayer, P.O. Box 948, Albany 1, N.Y.)

10–12. **Intermediate Energy Physics**, conf., College of William and Mary, Williamsburg, Va. (R. T. Siegel, Physics Dept., College of William and Mary, Williamsburg 23185)

13–16. **Radiation Research** Soc., 14th annual mtg., Coronado, Calif. (F. Smith, Biology Dept., American Univ., Washington, D.C.)

14–16. **Transplantation**, 7th intern. conf., New York Acad. of Sciences, New York, N.Y. (F. T. Rapaport, New York Univ. Medical Center, 550 First Ave., New York 10016)

14–18. Society of **Economic Geologists**, New York, N.Y. (J. O. Kalliokoski, Dept. of Geology, Princeton Univ., Princeton, N.J. 08540)

15–17. **Radioisotope Applications in Aerospace**, symp., Dayton, Ohio. (P. Polishuk, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio)

15–18. Treatment and Storage of Highly **Radioactive Waste**, symp., Richland, Wash. (W. H. Regan, Jr., U.S. Atomic Energy Commission, Washington, D.C. 20545)

16–17. **Voluntary Health**, 2nd natl. conf., Chicago, Ill. (Dept. of Community Health and Health Education, American Medical Assoc., 535 N. Dearborn St., Chicago, 60610)

16–18. Practical **Space Applications**, symp., San Diego, Calif. (C. Tross, Box 931, Rancho Santa Fe, Calif.)

16–19. National Soc. of **College Teachers of Education**, Chicago, Ill. (E. H. Goldenstein, Administration Bldg., 413, Univ. of Nebraska, Lincoln 68508)

16–19. Institute of **Management Sciences** annual mtg., Dallas, Tex. (W. M. Campbell, Atlantic Refining Co., P.O. Box 2819, Dallas 75221)

17–19. American **Educational Research** Assoc., Chicago, Ill. (R. A. Dershimer, The Association, 1201 16th St., NW, Washington, D.C. 20036)

18–20. American **Psychopathological** Assoc., symp., New York, N.Y. (F. A. Freyhan, The Association, Natl. Inst. of Mental Health, c/o St. Elizabeths Hospital, Washington, D.C. 20032)

19. **Pleistocene of Ohio**, interdisciplinary conf., Ohio Acad. of Science, Columbus. (J. L. Forsyth, Dept. of Geology, Bowling Green State Univ., Bowling Green, Ohio)

21–25. **Analytical Chemistry and Applied Spectroscopy**, Pittsburgh, Pa. (R. E. Hein, Mellon Inst., 4400 Fifth Ave., Pittsburgh 15213)

21–25. Society for **Nondestructive Testing**, spring natl. conv., Los Angeles, Calif. (E. L. Criscuolo, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md. 20910)

21–25. **Non-Elastic Processes in the Upper Mantle**, symp., Upper Mantle Committee, Intern. Union of Geodesy and Geophysics, Newcastle, England. (D. C. Tozer, School of Physics, The University, Newcastle-upon-Tyne, 1, England)

22–26. Canadian Assoc. of **Radiologists**, 29th annual, Montreal, Quebec. (The Association, 1555 Summerhill Ave., Montreal)

23–25. **Biophysical** Soc., 10th annual mtg., Boston, Mass. (J. Baruch, Bolt, Beranek and Newman Inc., 50 Moulton St., Cambridge, Mass. 02138)

24–26. American Acad. of **Forensic Sciences**, Chicago, Ill. (S. R. Gerber, Law-Medicine Center, Western Reserve, Univ., Cleveland, Ohio 44106)

24–26. Interdisciplinary Aspects of **Radiative Energy Transfer**, Philadelphia, Pa. (J. J. Welsh, Space Sciences Laboratory, General Electric Co., Box 8555, Valley Forge, Pa.)

25–26. **Thoracic** Soc., spring mtg., London, England. (H. M. Foreman, Sully Hospital, Sully, Glamorganshire, England)

27–3. American Inst. of **Mining, Metallurgical, and Petroleum Engineers**, annual mtg., New York, N.Y. (The Institute, 345 E. 47 St., New York 10017)

27–4. International **Anesthesia Research** Soc., Bal Harbour, Fla. (A. W. Friend, 227 Wade Park Manor, Cleveland 6, Ohio)

28–4. **Aerial Triangulation**, symp., Urbana, Ill. (M. B. Scher, Intern. Soc. for photogrammetry, Commission 3, 9701 East Light Dr., Falls Church, Va.)

28–4. American **Crystallographic** Assoc., mtg., Univ. of Texas, Austin. (W. L. Kehl, Gulf Research and Development Co., P.O. Drawer 2038, Pittsburgh, Pa. 15230)

28–4. American Assoc. of **Junior Colleges**, 46th annual conv., St. Louis, Mo. (The Association, 1315 16th St., NW, Washington, D.C. 20036)

March

1–2. **Dairy Engineering**, natl. conf., Michigan State Univ., East Lansing. (C. W. Hall, Agricultural Engineering Dept., Michigan State Univ., East Lansing)

1–3. **Space Maintenance** and Extra-Vehicular Activities, natl. conf., Orlando, Fla. (M. B. Goldman, Mail No. 302, Martin Co., Baltimore, Md. 21203)

1–10. **Industrial Development** in the Arab Countries, regional sym., Kuwait. (Intern. Agency Liaison Branch, Office of the Director General, Food and Agriculture Organization, Via delle terme di Caracalla, Rome, Italy)

2–4. **Air Pollution** Medical Research, AMA conf., Los Angeles, Calif. (Dept. of Environmental Health, American Medical Assoc., 535 N. Dearborn St., Chicago, Ill.)

2–4. **Plasmadynamics**, conf., Monterey, Calif. (American Inst. of Aeronautics and Astronautics, 1290 Sixth Ave., New York 10019)

2–4. **Scintillation and Semiconductor Counters**, 10th symp., Washington, D.C. (W. A. Higinbotham, Brookhaven Natl. Laboratory, Upton, L.I., N.Y.)

3–4. Louisiana Soc. for **Electron Microscopy**, 3rd annual symp., New Orleans. (W. R. Goynes, Southern Regional Research Laboratory, Box 19687, New Orleans)

3–5. Central **Surgical** Assoc., Chicago, Ill. (C. E. Lischer, 457 N. Kingshighway, St. Louis 8, Mo.)

4–5. **Cineradiology**, 5th symp., Rochester, N.Y. (R. Gramiak, Div. of Diagnostic Radiology, Univ. of Rochester Medical Center, Rochester 14620)

4–6. American Assoc of **Pathologists and Bacteriologists**, 63rd annual mtg., Cleveland, Ohio. (P. Fitzgerald, Downstate Medical Center, 450 Clarkson Ave., Brooklyn 3, N.Y.)

5–7. Society for American **Archaeology**, 31st annual mtg., Univ. of Nevada, Reno. (D. D. Fowler, Dept. of Anthropology, Univ. of Nevada, Reno 89507)

5–10. International Acad. of **Proctology**, 18th annual conv., Miami Beach, Fla. (A. F. Cantor, 147-41 Sanford Ave., Flushing, N.Y. 11355)

6–11. American Soc. of **Photogrammetry**, Washington, D.C. (C. E. Palmer, 5917 Brookview Dr., Brookland Estates, Alexandria, Va.)

7–9. Fundamental **Cancer Research**, 20th annual symp., Univ. of Texas, Houston. (M. Mandel, Dept. of Biology, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 77025)

7–9. **Electric Propulsion**, 5th conf., American Inst. of Aeronautics and Astronautics, San Diego, Calif. (A. T. Forrester, Electro-Optical Systems, Inc., 300 N. Halstead St., Pasadena, Calif. 91107)

7–9. **Space**, 3rd congr., Cocoa Beach, Fla. (R. M. Barnes, PAA-Guided Missiles Range Div., Bldg. 423, MU 111, Patrick Air Force Base, Fla.)

7–11. American Soc. for **Metals**, western metal and tool exposition and conf., Los Angeles, Calif. (The Society, Metals Park, Ohio)

7–11. Society of **Plastics Engineers**, 22nd annual technical conf., Montreal, P.Q., Canada. (G. L. Bata, Union Carbide Canada, Ltd., P.O. Box 700, Pointe-aux-Trembles, P.Q.)