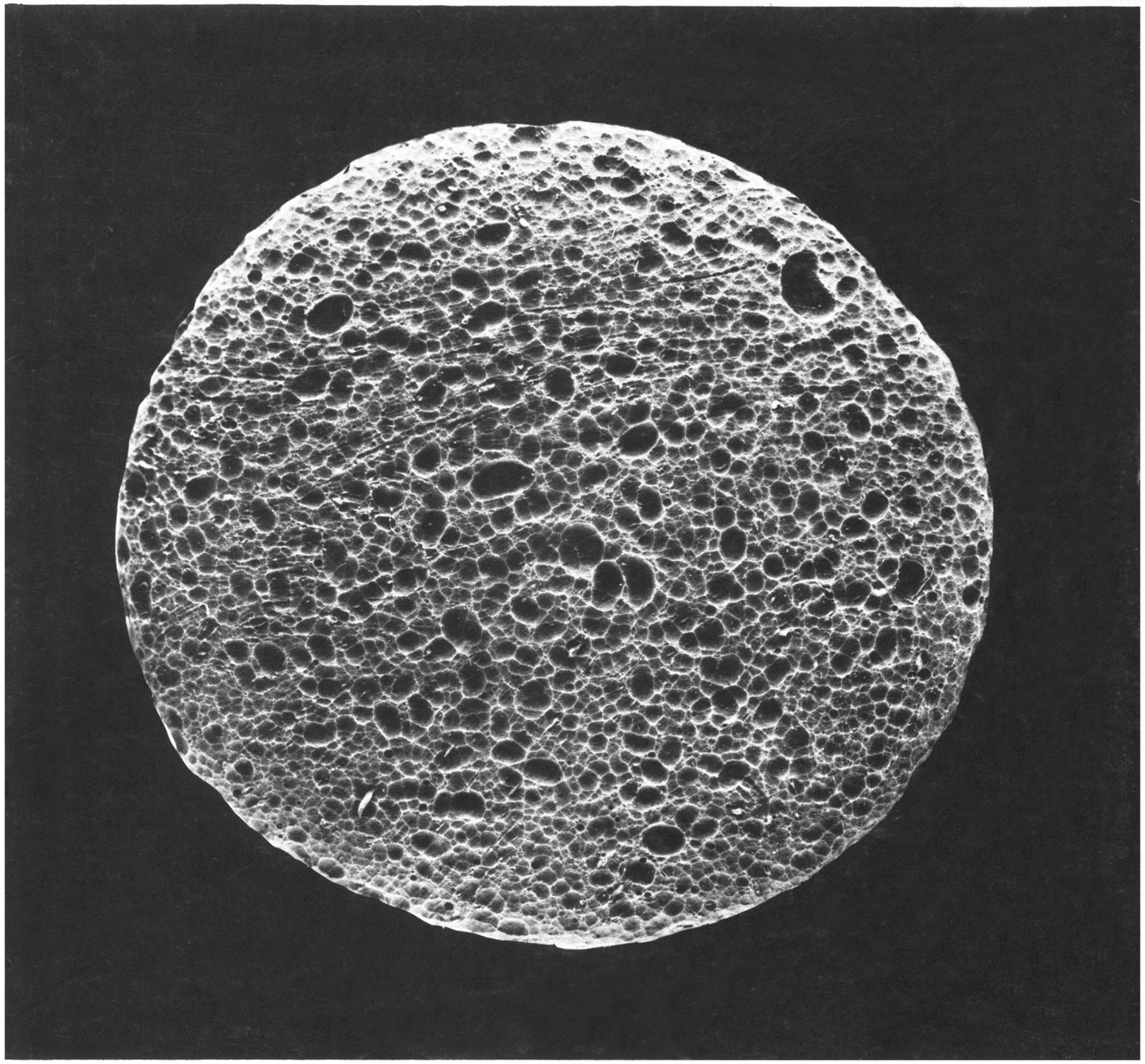
SCIENCE

24 February 1961

Vol. 133, No. 3452

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

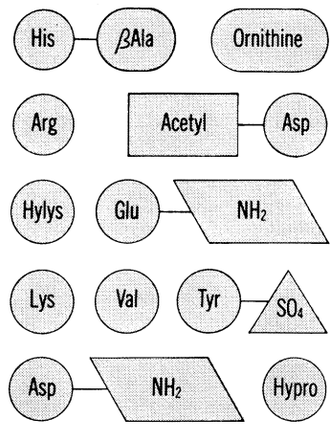


Amino acid analysis

... quantitative analysis in 24 hours for the twenty amino acids in protein hydrolyzates ... in 50 hours for the free amino acids and related compounds in physiological fluids.

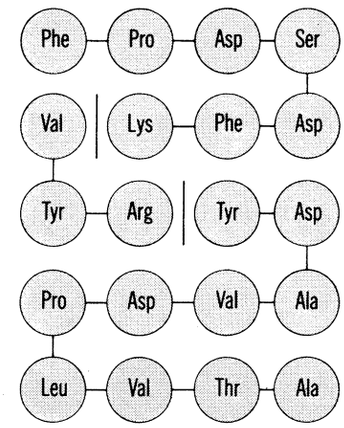
Amino acid isolation

... separation, collection, and identification of amino acids and related compounds in physiological fluids and tissue and plant extracts on both analytical and preparative scale.



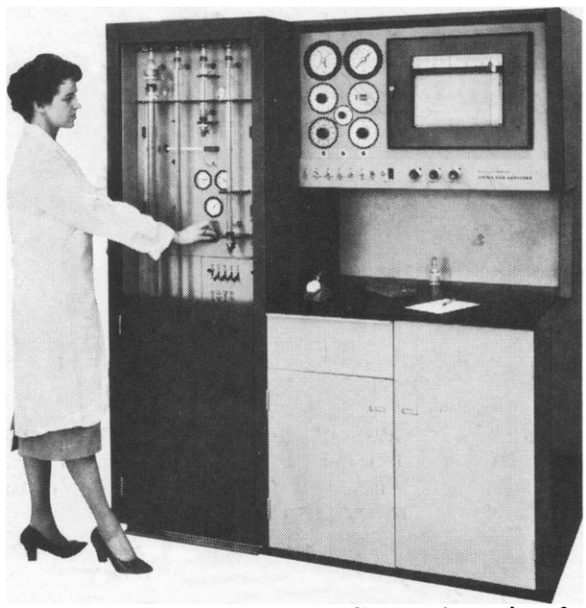
Peptide isolation

... separation, collection, and identification of peptides on both analytical and preparative scale.



MODEL 120 AMINO ACID ANALYZER DOES ALL THREE...

automatically!



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With the addition of new accessories, the 120 Analyzer has become an even more valuable time-saving tool for the biochemist. Large-bore columns allow preparative runs on mixtures of peptides or amino acids. A versatile new valving system and an accessory stream divider pump permit part of the column effluent to be analyzed colorimetrically, while diverting the main flow either to an external fraction collector, through a scintillation counter, or both.

Whether your work involves analyzing protein hydrolyzates, physiological fluids, tissue extracts, foods, culture media, or pharmaceuticals, this versatile instrument can take over much of the routine of repetitive peptide and amino acid analyses.

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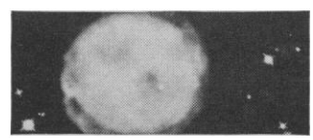
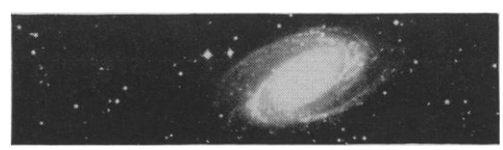
WE'RE REACHING INTO SPACE



Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



A strange combination of Nature's forces at Bell Laboratories foreshadows the day when world-wide phone calls may be relayed via man-made satellites orbiting the earth. It is a union of synthetic rubies and extreme cold, making it possible to amplify microwave signals from these satellites clearly.

Synthetic rubies possess an extraordinary property when deeply chilled and subjected to a magnetic field. They can be excited to store energy at the frequencies of microwave signals. As a signal passes through an excited ruby, it releases this energy and is thus amplified a thousandfold.

Bell Laboratories scientists chose a ruby amplifier because it's uniquely free of "noises" that interfere with radio signals. For example, it doesn't have the hot cathodes or hurtling electrons that generate noise in conventional amplifiers. It is so quiet that only the noise made by matter itself in heat vibrations remains. But at a temperature close to absolute zero, this also is silenced. Even very faint signals from satellites can be clearly amplified and studied for their possibilities.

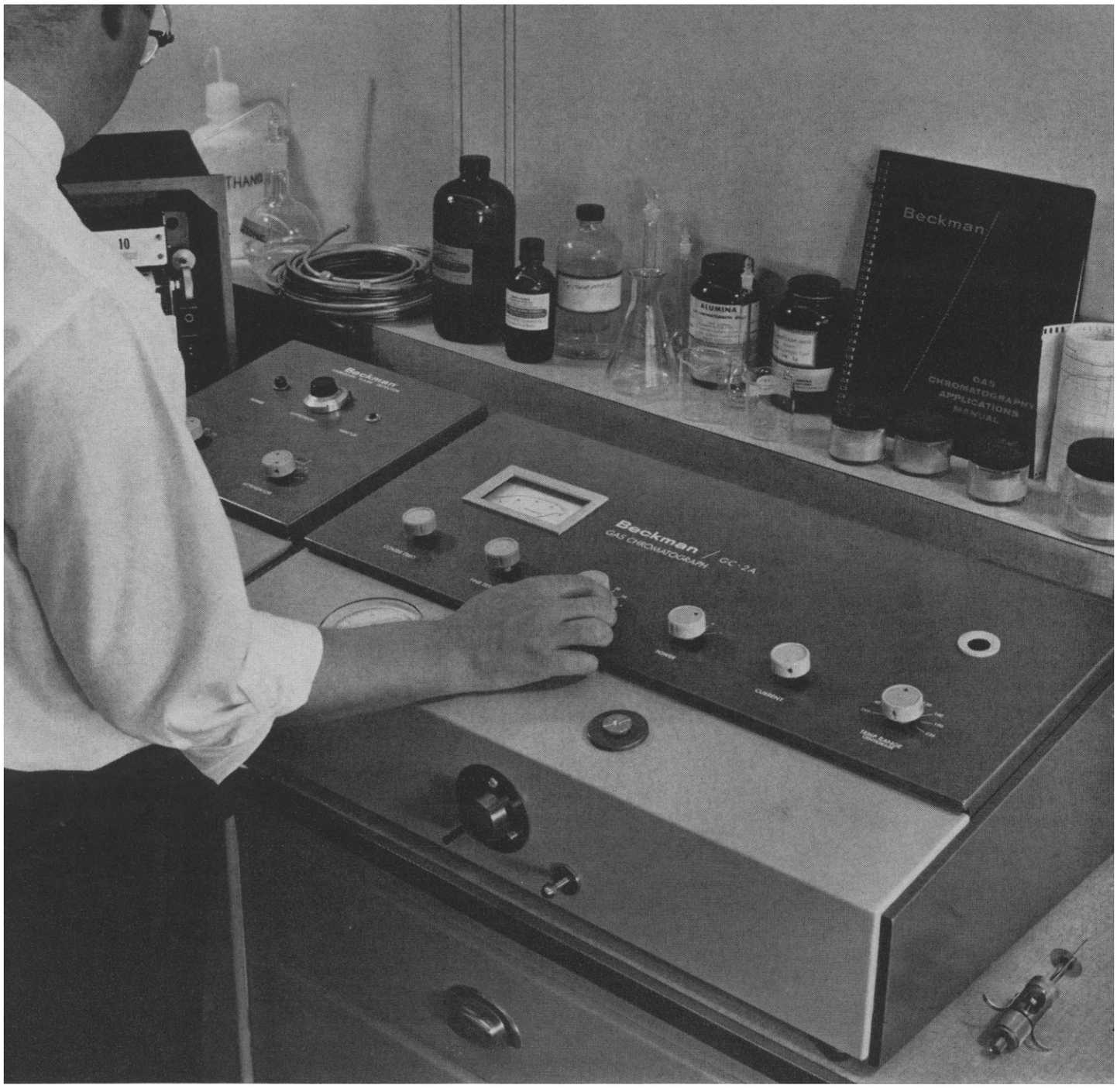
Bell Laboratories scientists were first to discover that matter itself generates electrical noise. They also discovered that stars send radio waves, and thus helped found radio astronomy. It is particularly fitting that the same scientists, in their endless research on noise, should now battle this number-one enemy of telephony in the dramatic new field of communication via satellites. The ultimate goal, as always, is the improvement of your Bell System communications services.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

24 February 1961, Volume 133, Number 3452 **SCIENCE**

Cover Tektite found in 1955 about 3 miles southwest of Osierfield, Ga., now in the Museum of the Georgia Geological Survey, Atlanta. The specimen, which measures 4.7 by 4.4 by 0.6 centimeters and weighs 17.8 grams, was smoked with ammonium chloride to bring out surface details. See page 562. [U.S. National Musueum, Washington, D.C.]



Highest sensitivity laboratory chromatograph...the New Beckman GC-2A.

The GC-2A employs the most sensitive thermal conductivity detector to be found in any commercially available laboratory gas chromatograph. Extremely stable, full-proportional temperature control over a wide range is combined with a precise carrier gas flow control system to provide exceptionally reproducible retention volumes and peak heights. The 2A functions economically and efficiently in a broad range of applications from routine qualitative analyses to the detection of low, 0.5 ppm. concentrations encountered in trace analyses, and in high efficiency, fast analysis techniques that use small samples. ⌑ An ultra-sensitive Hydrogen Flame Detector, shown above, the new Beckman Stream Splitter for optimizing column efficiency, micro liquid sampling apparatus for highly reproducible samples, and over 100 different standard ¼″, and ⅛″ packed columns...make this the most versatile of any commercial laboratory gas chromatograph. Consult your Beckman laboratory apparatus dealer. Or write for Data File 38-8-04.

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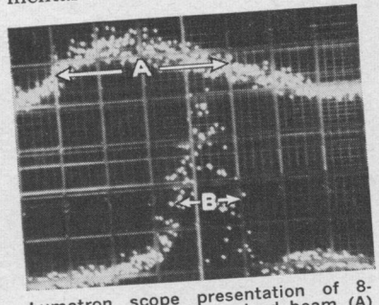
High Voltage Engineering Corporation . . .

"CHARGED PARTICLES"

Nanosecond Pulsing

The timing of nuclear events and the discrimination between them continues to be a major hurdle for the experimental physicist.

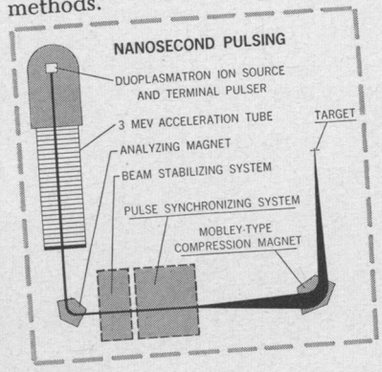
We don't need a market research program to reveal the need for apparatus which will assist the experimenter to do accurate neutron time-of-flight work or to determine excited state lifetimes in the milli-u-sec. region. Ultra-short high-intensity pulses of charged particles, and the resulting neutron bursts, provide one of the most promising techniques in these experimental areas.



Lumatron scope presentation of 8-nanosecond terminal-pulsed beam (A) and compression to 2-nanosecond post acceleration pulse (B).

We have completed the development of a system for producing and measuring *pulsed proton beams with an intensity of several milliamperes and a pulse duration of less than one nanosecond (10⁻⁹ seconds).* The first research results from this apparatus are soon to be reported.[1]

The beam is accelerated to 3-Mev by a Van de Graaff fitted with a terminal pulser of the deflection type, delivering ion pulses of 10 ns duration every 1000 ns at the input end of the acceleration tube. After acceleration, the pulse is compressed by a 90° double-focusing Mobley[2] magnet whose radius of curvature is 30 inches. The deflection electrodes at the entrance of the magnet are driven by a 10 Mc sinusoidal voltage which is synchronized with the pulse from the accelerator. Observations were made with a time-to-pulse-height-conversion measurement system checked by nuclear methods.



Isotopes of Rare Purity

The need for pure isotopes in work concerned with nuclear structure and particle reactions has led us to develop a new, broad-range electromagnetic isotope separator that is faster, simpler to use and provides purer samples than any comparable equipment we've seen.

This instrument is designed to produce up to 10 microamperes of individual particle beams — *with a mass resolving power better than 400.* Separation is achieved in a 5000-gauss, 160 cm radius magnetic field. Time for recovery of samples after collection is less than two minutes. Those who have had their decay schemes disappear before their eyes will appreciate this bit of engineering in working with short-lived isotopes.

The instrument can also be used to produce nuclear targets for studies of energy level, scattering, neutron cross-section or other phenomena, as well as pure radioactive tracers. Two of these instruments are now being built for U.S. atomic energy program. Specifications for the machine are presented herewith.

160 CM ELECTROMAGNETIC ISOTOPE SEPARATOR

Range:	Atomic mass 1 to 400
Current:	10μa of most abundant isotope (100 μ achievable with some loss in resolving power)
Voltage:	80 kv
Magnetic Field:	5000 gauss
Field Stability:	Better than .01 per cent
Ion Sources:	Modified Arc
Operation:	Time for removal of collector after full operation — 2 minutes
Vacuum System:	All metal bakeable gasketing

Accelerator Conference

The 2nd Accelerator Conference held recently in Amsterdam was a rewarding occasion for High Voltage and its Dutch affiliate, High Voltage Engineering (Europa) N.V. Three hundred participants from 24 countries joined in this exchange of information on accelerators and experimental techniques. There was some healthy give and take between the "ideal" machine described by physicists and the "present state of the art," reported by our engineers. If there were no gap between what is wanted and what is commercially available, most of us could pack up and go home.

As things stand, High Voltage continues to push its development to the limit and is glad to share a challenge with its insatiable customers in research.

The Conference Proceedings were published in a January special issue of *Nuclear Instruments and Methods.* Check with your librarian, or write us for a complimentary copy.

HIGH VOLTAGE ENGINEERING CORPORATION

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APPLIED RADIATION CORPORATION

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1 *L. Cranberg, et. al., to be presented at Am. Phys. Soc. Meeting, New York (February 1961)*

2 *R. C. Mobley, Phys. Rev. 88, 360 (1952)*

24 February 1961, Volume 133, Number 3452

SCIENCE

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"Neither snow nor rain nor . . ."

Since 1940 the Bureau of Customs and the Post Office have been impounding mail deemed to be foreign political propaganda. During World War II millions of pieces of mail were impounded and destroyed without notification to those to whom it was addressed. In 1946 the program virtually lapsed, only to be resumed in 1950 when propaganda began to increase with the onset of the Korean War. During the early '50's the policy of not notifying addressees was continued; propaganda was so loosely defined that even works on art, philosophy, and religion, some 19th-century literature, and some scientific and scholarly journals were destroyed. Research libraries, bookstores, and individuals often did not receive books that they had ordered or journals that they had subscribed to.

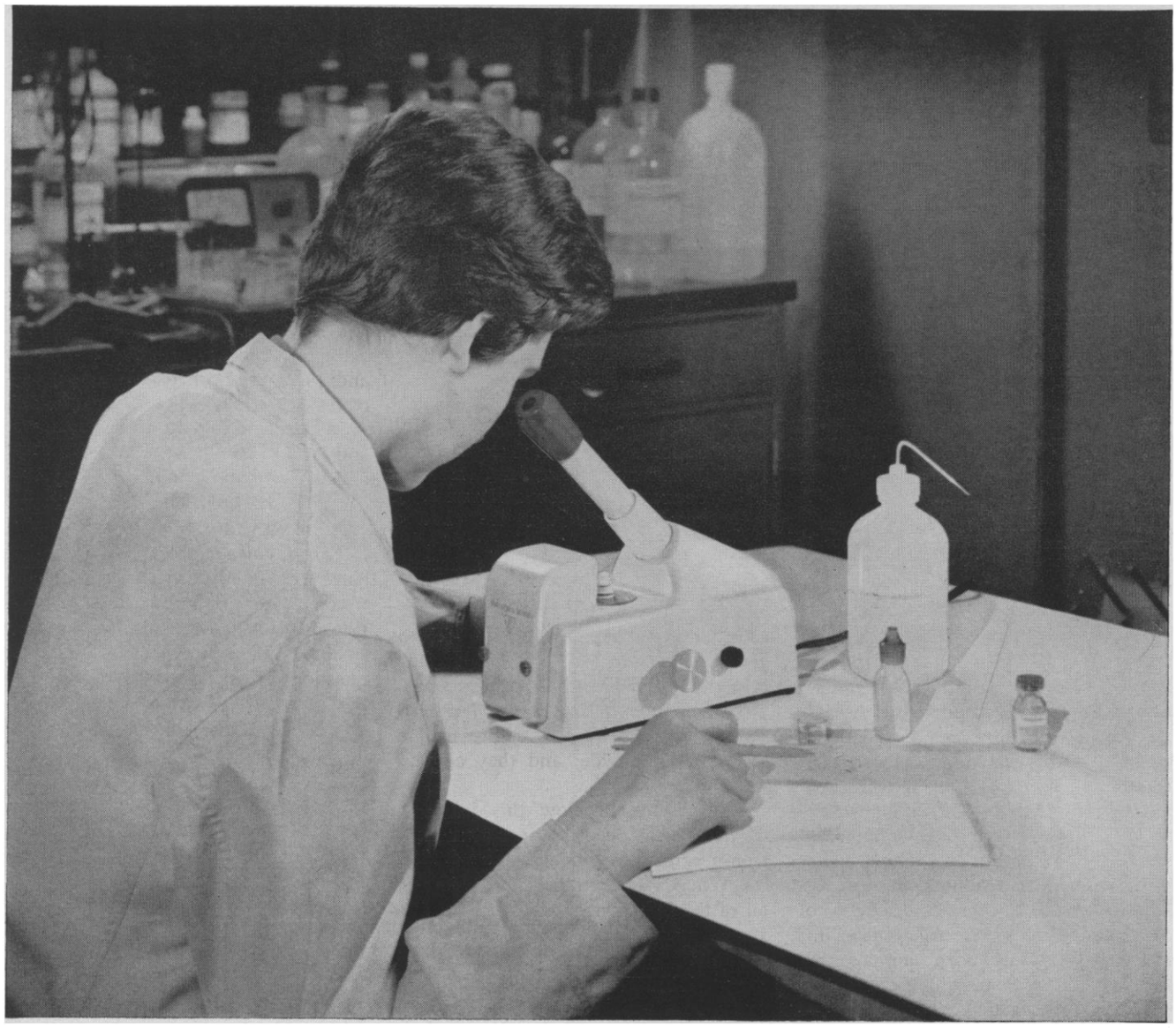
By 1955, research libraries, universities, and specialists in Asiatic studies had applied enough pressure to persuade administrators in Customs and the Post Office that they had a scholarly need for the materials that were being delayed or destroyed. Accordingly, a "white list" of those eligible to receive such mail was prepared. Material addressed to a professor at his university address would be delivered; that addressed to his home, impounded.

In 1958 the Post Office adopted the policy (still in effect) of notifying all addressees that it was holding mail containing foreign political propaganda—material which, though ordinarily nonmailable, would be delivered to the addressee provided it "has been ordered, subscribed to, or desired, and is not for dissemination." To receive the material the addressee must sign a statement that he has ordered, subscribed to, or desires the publications listed. And what is meant by "dissemination"? Read by two people? Available in a library? Referred to in an article? No one knows.

Still more remarkable, the entire program, from its inception, has had no statutory basis. Congress has passed no law giving the Bureau of Customs or the Post Office the right to impound, destroy, or delay delivery of mail. The legal basis is a 1940 ruling by the Attorney General that depends upon a strained interpretation of two statutes. A *nonregistered* foreign agent resident in the U.S. would violate the Foreign Agents Registration Act of 1938. He would thus also be violating the provision of the Espionage Act of 1917 that makes it a criminal offense for anyone "in aid of any foreign government" to have or control papers to be used in violating any penal statute. Such papers are nonmailable under the Espionage Act. The Attorney General then ruled that foreigners in foreign countries who used our mails for transmitting propaganda became *unregistered foreign agents here*, and that their papers were therefore unmailable. If taken literally, this means that the clerk who mails an issue of the London *Times* that contains an editorial distasteful to a U.S. customs or postal official could be regarded as an unregistered foreign agent and the issue could be impounded.

During the two decades in which this legal fiction has been used to justify censorship, numerous efforts have been made to get a court test, but the challenges have so far been successfully evaded. In general, threat of a suit has been sufficient to bring about delivery of the material. But three suits are now pending in the District of Columbia, and it is encouraging that the Department of Justice has asked for an extension of time to permit it to review the entire question.

Regardless of the outcome in these cases, we hope that Congress will review the program and come up with some legislation that will protect the traditional freedom of a citizen in a democracy to decide for himself what to read without having to sign a document, and that will not put him in jeopardy if he "disseminates" what he has read.—G.DuS.



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design of pattern-recognizing devices. One theoretical device is able to distinguish patterns, regardless of their rotation or translation in the visual field, by differences in the frequency with which the lines of the pattern were intersected by a line segment, of fixed length, repeatedly placed in random orientation and position on the visual image (a "randomly tossed" curve).

Visual Systems

J. R. Singer of the University of California described a visual system which, by means of radial scanning, can recognize a two-dimensional object regardless of the visual angle it subtends or of its rotation in the visual field. However, this system requires that the object be centered in the visual field, so it is unlikely that the visual systems of living organisms, at least of vertebrates, use the same principle.

A different type of artificial visual system, designed by L. D. Harmon of Bell Telephone Laboratories, can recognize the convexity of a moving target. It consists of seven similar photocells, six tightly packed around the central one. The output of the central photocell produces inhibition at an artificial neuron; the output of the others, excitation. The neuron responds only to the passage of targets with radii within a particular size-range, according to the threshold setting. This system may correspond to the convexity detectors in the frog's eye, previously reported by Lettvin, Maturana, McCulloch, and Pitts.

E. E. Loebner demonstrated an artificial visual system consisting of a matrix of photoconductors, each connected in series with an electric energy source and an electroluminor. When light hits a photoconductor, this permits current to flow through the luminor and causes the luminor to emit light. By appropriate connections and interconnections of these elements it is possible to reproduce many of the functions of the vertebrate retina, including all four detection functions found in the frog retina by Lettvin *et al.* It is possible that some of the circuits used in the model may be recognized in the living retina.

A machine capable of distinguishing among the spoken names of the digits ("one," "two," and so on) was described by W. C. Dersch of International Business Machines Corporation. At least one of the principles on which it operates is known not to be used in the human auditory system. L. A. de Rosa of International Telephone and Telegraph Corporation presented a theory of the operation of the auditory system, explaining that its frequency discrimination is produced by an autocorrelation process rather than by mechanical filters. W. A. van Bergeijk of Bell Telephone Laboratories has built an artificial neuron network which he considers analogous to the spiral innervation of the cochlea and has measured signal loss as a function of simultaneous firing of several branches of the neuron. No similar measurements have been made on the actual nerve for comparison. He has also built an analog of a branching sensory nerve of the skin and has found that the analog and such nerves have comparable recruitment functions.

Artificial Neurons

The highlight of the symposium was a group of talks by W. S. McCulloch and other mathematicians from his laboratory at the Massachusetts Institute of Technology and by K. K. Maitra of RCA Research Laboratories, on the general problem, "How simple can a neuron be and still, by proper interconnection . . . perform all the known functions of the brain?" They started with the very simple McCulloch-Pitt neuron, which consists of a device that has many inputs which can carry either excitation or inhibition. It possesses a polar threshold such that the output is in one or the other of two states, depending on whether the algebraic sum of the inputs does or does not exceed the threshold value.

M. Blum considered the general question of what logical functions could be performed by simple networks of such neurons. He showed that if the number of inputs (such as signals from different sense organs) to a neural net is large, the number of logical functions which the net can perform approaches one-quarter of the totality of logical functions. This should certainly be enough to perform the limited number of logical functions which are known to be carried out by the brain.

A. N. Verbeek showed how to produce reliable computation with a "noisy," unstable neuron having four sources of trouble: variations in the signal strength of the inputs, faulty connections, variations in internal threshold, and inability to propagate its output signal. He used triplet networks made up of three of the simple neurons, all the inputs to the triplet going in parallel to two of the neurons and their outputs going to the third neuron, whose output was the output of the triplet. Signals from each input were connected in parallel to each of many triplets. Each of these performs the logical operation, and the output of all the triplets goes to a neuron which acts as a majority decider, taking the outputs, comparing them, and deciding which is correct according to the output signals of the

majority. If each neuron is capable of producing an error 5 percent of the time, the upper limit of the probable error of such a net can be made less than one in 1 million by a combination of just 30 such redundant triplets. This work is of great significance, since up to now the only theoretical method of increasing reliability has been to put many elements in parallel wherever one element has been used in the original net. Von Neumann has shown that to achieve a reliability of one error in a million by this older method with neurons which produce an error 5 percent of the time would require a net of about 20,000 neurons.

Cowan presented the mathematical logic he has developed for dealing with the behavior of nets of neurons carrying on logical computations in the presence of noise. He was able to represent a general noisy computation scheme and to calculate the amount of signal that came through.

K. K. Maitra presented an extension of the work of Verbeek in the design of nets which reliably perform logical operations even though the neurons and connections of the net may be unreliable. He developed a simplified mathematical symbolism for describing the manipulations of each triplet network. He was able to show that where a certain logical function is desired from the triplet, this function can be achieved with the greatest reliability by making the triplet from a combination of neurons each having a particular logical function, determined by a process he could specify. In a similar way he was able to show that if triplets are combined into triplet networks and these in turn into larger triplets, and so on, a minimum probability of error is found in networks made by three or four orders of such tripletting. When instead of tripletting the triplets he duplexed them, this gave increasing reliability with increasing order of duplexing up to any arbitrary level of reliability. Thus, it is possible in theory to design networks with unreliable neurons which will give any desired reliability of performance.

In a delightful summarizing talk, H. von Foerster of the University of Illinois pointed out the importance of this work on reliability. It permits the achievement of increased reliability in a system not by increasing the reliability of the components and connections but, more economically, by multiplexing unreliable components.

At the end of the symposium a final question was presented to McCulloch. He was asked, in effect, whether the people working on information processing would not some day, like the nuclear physicists today, have cause to regret the social consequences of their

work. McCulloch replied that he was convinced that it was in man's nature to develop both the socially good and the socially bad consequences of any invention. He fully expects that the world will be booby-trapped by the use of these and other sciences, but it is his firm hope that by making available information-handling devices of great capacity man will prevent the detonation of that booby trap through misinformation.

LEO E. LIPETZ
Institute for Research in Vision, Ohio State University, Columbus

Forthcoming Events

March

19–25. Caribbean Region, American Soc. for Horticultural Science, 9th annual, Miami, Fla. (E. H. Casseres, Londres 40, Mexico 6, D.F., or W. H. Krome, Box 596, Homestead, Fla.)

20–22. American Physical Soc., Monterey, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4)

20–23. Institute of Radio Engineers, 1961 intern. convention, New York, N.Y. (E. K. Gannett, IRE, 1 E. 79 St., New York 21)

20–24. American Surgical Assoc., Boca Raton, Fla. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati 29, Ohio)

20–24. National Health Council, forum and annual meeting, New York, N.Y. (NHC, 1790 Broadway, New York 19)

20–24. Western Metal Cong. and Exposition, 12th, Los Angeles, Calif. (A. R. Putnam, American Soc. for Metals, Metals Park, Ohio)

21–23. American Meteorological Soc., general meeting, Chicago, Ill. (E. P. McClain, Dept. of Meteorology, Univ. of Chicago, Chicago 37)

21–23. American Physical Soc., Division of High-Polymer Physics, 21st, Monterey, Calif. (D. W. McCall, Bell Telephone Laboratories, Murray Hill, N.J.)

21–23. American Power Conf., 23rd annual, Chicago, Ill. (W. C. Astley, Philadelphia Electric Co., 900 Sansom St., Philadelphia 5, Pa.)

21–24. American Assoc. of Anatomists, 74th annual, Chicago, Ill. (O. P. Jones, Dept. of Anatomy, Univ. of Buffalo, Buffalo 14, N.Y.)

21–30. American Chemical Soc., 139th, St. Louis, Mo. (A. T. Winstead, ACS, 1155 16th St., NW, Washington 6)

23–25. American Orthopsychiatric Assoc., 38th annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19)

23–25. Quantum Electronics, 2nd intern. conf., Berkeley, Calif. (J. R. Singer, Dept. of Electrical Engineering, Univ. of California, Berkeley 4)

23–26. International Assoc. for Dental Research, 39th annual, Boston, Mass. (D. Burrill, IADR, 311 E. Chicago Ave., Chicago 11)

24–29. National Science Teachers Assoc., Chicago, Ill. (R. H. Carleton, NSTA, 1201 16th St., NW, Washington 6)

26–29. American Assoc. of Dental

Schools, annual, Boston, Mass. (R. H. Sullens, 840 N. Lake Shore Dr., Chicago 11, Ill.)

27–31. Temperature—Its Measurement and Control in Science and Industry, natl. symp., Columbus, Ohio. (C. M. Herzfeld, National Bureau of Standards, Washington 25, D.C.)

30–1. Southern Soc. for Philosophy and Psychology, Atlanta, Ga. (D. R. Kenshalo, Dept. of Psychology, Florida State Univ., Tallahassee)

April

3–6. Massachusetts Institute of Technology, centennial celebration, Cambridge. (Office of Public Relations, M.I.T., Cambridge 39)

3–15. Medical Conference, 11th, Nassau, Bahamas. (Bahamas Conferences, P.O. Box 1454, Nassau)

4–6. Electromagnetics and Fluid Dynamics of Gaseous Plasma, intern. symp., New York, N.Y. (J. Fox, Microwave Research Inst., Brooklyn 1, N.Y.)

4–7. Society of Automotive Engineers, natl. aeronautic meeting, New York, N.Y. (E. W. Conlon and G. W. Periman, 485 Lexington Ave., New York 17)

4–8. National Council of Teachers of Mathematics, 39th annual, Chicago, Ill. (F. A. Janacek, J. S. Morton High School, Cicero 50, Ill.)

5–8. Water Relations of Plants, British Ecological Soc., symp., London. (F. H. Whitehead, Botany Department, Imperial College, Prince Consort Road, London, S.W.7)

6–7. Council on Medical Television, annual, Bethesda, Md. (Institute for Advancement of Medical Communication, 33 E. 68 St., New York 21)

7–8. Eastern Psychological Association, Philadelphia, Pa. (C. H. Rush, P.O. Box 252, Glenbrook, Conn.)

7–9. American Assoc. for Cancer Research, 52nd annual, Atlantic City, N.J. (H. J. Creech, Secretary-Treasurer, Inst. for Cancer Research, Fox Chase, Philadelphia 11, Pa.)

7–9. Fleming's Lysozyme, 2nd intern. symp., Milan, Italy. (R. Ferrari, Organizing Committee, Via Modica 6, Milan)

8–9. Histochemical Soc., 12th annual, Atlantic City, N.J. (H. W. Deane, Albert Einstein College of Medicine, Bronx 61, N.Y.)

9–13. American Assoc. of Cereal Chemists, annual, Dallas, Tex. (J. W. Pence, Western Utilization Research & Development Division, 800 Buchanan St., Albany 10, Calif.)

9–13. American Industrial Hygiene Assoc., Detroit, Mich. (W. S. Johnson, Bethlehem Steel Co., Bethlehem, Pa.)

9–15. American Institute of Nutrition, Atlantic City, N.J. (A. E. Schaefer, ICNND, Bldg. 16A, National Institutes of Health, Bethesda 14, Md.)

10–14. American Soc. of Civil Engineers, Phoenix, Ariz. (W. H. Wisely, 33 W. 39 St., New York 18)

10–14. Detection and Use of Tritium in the Physical and Biological Sciences, intern. symp., Vienna, Austria. (Office of Special Projects, U.S. Atomic Energy Commission, Washington 25, D.C.)

(See issue of 17 February for comprehensive list)

Letters

Drug Industry and Government

With reference to your recent "Science in the news" article [*Science* **132**, 1536 (1960)] commenting about government intervention in the drug industry, could it be that the author displayed just a little cynicism (which is perhaps too common these days) in saying: "There is the danger not of cordiality between the regulators and the regulated, which is useful, but of the regulators' coming to forget that, despite the room for a great deal of useful cooperation, the regulators and regulated do, or should, after all, represent opposing interests and opposing points of view"?

It does not seem to me that a really objective observer could conclude that the interests of the Food and Drug Administration and of the pharmaceutical industry are opposed. Rather, our interests are really identical: to provide the best medicine for those in need of it, or, putting it another way, to protect patients from bad medicine.

If the views of the industry and the government differ from time to time, I think such differences are largely confined to the question of how we attain our common objective. This may be a fine point, but it is one that is useful in the interests of clarity.

AUSTIN SMITH
Pharmaceutical Manufacturers Association, Washington, D.C.

DNA's and RNA's

In the realm of biochemistry, names (of substances) are used to designate products in which substantially all the molecules in a sample are the same, or at least potentially the same, through tautomerism. To speak of a *mixture* of structurally different molecules, as though they were all the same, causes misleading muddlement. The same principle holds for alphabetical abbreviations such as ATP, ADP, AMP, TPP, FAD, and TPN. For example, AMP stands for adenosine-5′-phosphate. If it were used indiscriminately to designate the 5′- compound, the 3′- compound, the 2′- compound, or the 2′, 3′- phosphate, this could only cause confusion.

A widespread violation of this principle, which can only result in confused thinking, particularly on the part of unsuspecting biology students, is the use of the designations DNA and RNA as though they, too, represent single species of molecules. This is particularly objectionable because there must be a multitude of DNA's and RNA's and

their biological functioning depends specifically upon the existence of a great diversity of molecules. To speak of *a* DNA or *the* DNA's is proper, but to refer simply to "DNA" as though it designated a chemical substance is unfortunate and leads to mixed-up thinking on the part of those who may not be fully initiated.

ROGER J. WILLIAMS
Clayton Foundation Biochemical Institute, University of Texas, Austin

Stimulus Generalization Gradients

In a recent report [*Science* **132**, 1769 (1960)] Eliot Hearst compares the stimulus generalization gradients obtained in the case of each of a concurrent pair of responses, one response being maintained by an appetitive reward, the other by aversive reinforcement. From his results he concludes that aversive reinforcement produces greater generalization (flatter gradient) than an appetitive reward. This conclusion is not warranted from the data presented because there is not even an attempt to equate the drive level corresponding to the two responses.

Since the earliest Pavlovian work it has been known that increased hunger (deprivation) flattens the generalization gradient of an alimentary conditioned reflex. Hearst could have readily manipulated the flatness of his appetitive gradient in this fashion. In the case of the aversively maintained response, the relevant drive variables are the intensity of the electric shock, the number of shocks received, and the time since the delivery of the last shock. Of these, the first is particularly significant. By decreasing the shock intensity in conditioning the avoidance response, a sharper gradient would have been obtained.

The equating of drive between positively and aversively reinforced habits is certainly unattainable in practice, and probably even in principle. Thus, Hearst's conclusions would in any case be questionable. The report would have had some factual value, however, if the deprivation schedule of the food-reinforced response and the electric shock parameters had been clearly described in the text. The absence of this information means that the data are not even reproducible by the noninitiated reader.

MICHAEL F. HALASZ
Department of Psychology, University of Chicago, Chicago, Illinois

I am glad to have the opportunity to make some additional comments on our stimulus generalization data and to answer several points raised by Michael Halasz.

1) Since appetitive and aversive

drives have quite different properties, any attempt to equate them would be very dubious. In my opinion this "obstacle" does not render futile or questionable all comparisons of appetitive and aversive behavior. A more positive approach to the problem might initially involve the design of a model situation in which both generalization gradients can be obtained, and then an analysis of the effects of various factors on the relative slopes of the two gradients. In our laboratories my co-workers and I are currently investigating such variables as type of avoidance and reward schedule, kind of response measured, visual versus auditory cues, method of testing, and amount of food deprivation to determine whether the reported results can be generalized to a wider variety of experimental conditions.

2) Extremely flat gradients of the sort reported for avoidance have rarely, if ever, been noted in prior investigations of appetitive drives, even with extremely high hunger motivation [for example, with subjects at 60 percent of normal body weight (*1*)]. In support of our avoidance findings, Sidman (*2*) has recently presented data which also indicate a very flat gradient for the type of avoidance behavior we studied; Sidman's results were obtained for an auditory dimension, and the two subjects were trained under different levels of shock.

3) It is not likely that shock parameters are extremely influential variables here. The monkey subjects rarely received more than one or two shocks per 2-hour session, and such factors as shock level, number of shocks, and time since preceding shock probably are important only in a situation where a meaningful number of shocks are received. In any case, it was noted in the report that no rewards or shocks were possible during generalization testing. Thus these factors could not have had a direct effect during the generalization tests sessions.

4) Halasz's assertion that decreases in shock intensity would have resulted in sharper avoidance gradients is rather premature, since there are very few experimental data bearing on this problem. As a matter of fact, Sidman (*2*) has recently shown that threefold changes in shock duration, though affecting response rate, have no effect on generalization. Additional experimental work is needed on this interesting problem, however.

5) The specific parametric values of the reported experiment are typical of those used in many current comparative studies of appetitive and aversive behavior—for example, in several productive investigations of differential drug effects on reward-motivated and fear-motivated behavior. Limitations of space made it impossible for me to include several details of the experimental method in the published report. The monkeys were maintained during the experiment on a daily diet of 60 to 70 Foringer D & G whole diet pellets, and each monkey was given one orange immediately after the session; the subjects had thus been food-deprived for approximately 22 hours at the beginning of each experimental session. Water was continuously available in their home cages. The shock level was set at an intensity of approximately 5 ma (0.6-sec duration), and shocks were delivered through a Foringer shock power supply and grid scrambler, which randomly reversed the polarity of the voltage on the grids. According to the animal's particular posture and movements at the time of punishment, the shock might vary by as much as 0.5 to 1.0 ma from the predetermined value.

ELIOT HEARST
Clinical Neuropharmacology Research Center, Saint Elizabeths Hospital, Washington, D.C.

References

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