SCIENCE

31 May 1963

Vol. 140, No. 3570

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MITOCHRONDRIAL STRUCTURE

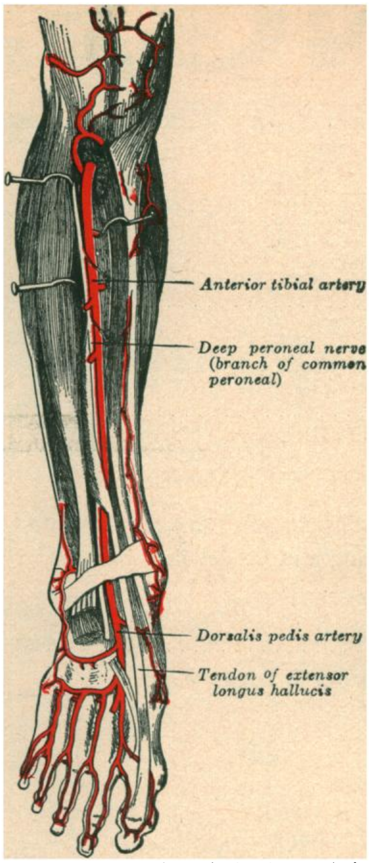

Figure 220. Arteries of the leg and foot, anterior. (After Gerrish.)

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By BARRY G. KING, Ph.D.; Accident Prevention Research, U.S. Public Health Service; Formerly Associate Professor of Physiology, Ohio State University School of Medicine; and MARY JANE SHOWERS, R.N., Ph.D.; Assistant Professor of Anatomy, University of Kentucky Medical School; Consultant Instructor in Biological Sciences. The Deaconess Hospital School of Nursing, Cincinnati. 469 pages, 6½" × 9¾", 322 illustrations, 55 in color. $6.00.

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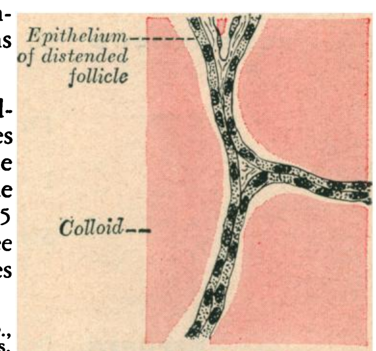

From Plate No. 11. Inactive follicles of the endocrine glands.

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31 May 1963
Vol. 140, No. 3570

SCIENCE

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COVER

Negatively stained mitochondrion from rat liver. The internal cristae and granules can be seen. A projection of the outer membrane shows small repeating subunits (about $\times$150,000). See page 985.

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Forthcoming programs include:

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13 "Meteorological Expedition." AMS

20 "Converting Waste Water to Tap Water." AICE

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Beginning June 13 "LASERS." AAAS (OSA*)

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Beginning June 17 "Artificial Intelligence: Present and Future." IEEE

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The "Television Journal" is presented under the auspices of 12 scientific and engineering societies and coordinated by the AAAS. The program is produced by JOHN K. MACKENZIE. Project Director is E. G. SHERBURNE, JR., of the AAAS.

*NBS—*National Bureau of Standards*
*NYAS—*New York Academy of Sciences*
*OSA—*Optical Society of America*

LETTERS

Space Program Skepticism

I was somewhat saddened to find D. S. Greenberg, whose writing I enjoy, fall for the current Republican line in News and Comment: "Space program skepticism" [*Science* **139**, 890 (8 March 1963)].

Greenberg is perfectly entitled to question the allocation of NASA installations (who hasn't?), including if he so believes the allocation of the proposed new NASA Electronics Research Center to Boston—although as a writer for a scientific journal he must know something of the university-electronics competency of the Boston area, especially as compared with the Houston or New Mexico areas.

Be that as it may. The main issue concerns the paragraphs . . . "but now NASA is proposing to build a $50 million electronics center in the Boston area, justifying the site on the grounds that Boston has a unique reservoir of trained manpower [evidently Massachusetts Institute of Technology and Harvard are ignored, or considered a labor statistic] to staff this facility. At last week's space hearings no one was so impolite as to ask NASA officials whether the selection of Boston had anything to do with Senator Edward Kennedy's campaign pledge that he 'can do more for Massachusetts,' but the suspicion was expressed privately." By the last phrase, Greenberg gives credence to the "suspicion."

Kennedy was elected to the Senate last November and only took office in January of this year. The announcement of NASA's proposed Boston Electronics Research Center was made 17 January 1963 in the President's budget message, which, as Greenberg should know better than I, was formulated months earlier.

The fact that Boston was to be the site of a proposed NASA center was known by key members of Congress before the election. Kennedy had not even begun to serve his senate term and in fact was resting up from his campaign fight. . . .

Boston and New England have been fighting for NASA recognition ever since they lost a futile battle for the manned space center which went to Houston. Representatives of the Chamber of Commerce, the universities, banks, and business and electronics firms were making official visits to Washington even before Edward Kennedy had received his party's nomination. But they have fought for recognition on the basis of their recognized capabilities, both academic and industrial, and have asked only for legitimate political support.

Not one of NASA's ten centers are in New England and as of last year Massachusetts, as compared with other states, received less than 1 percent of all NASA contracts. . . .

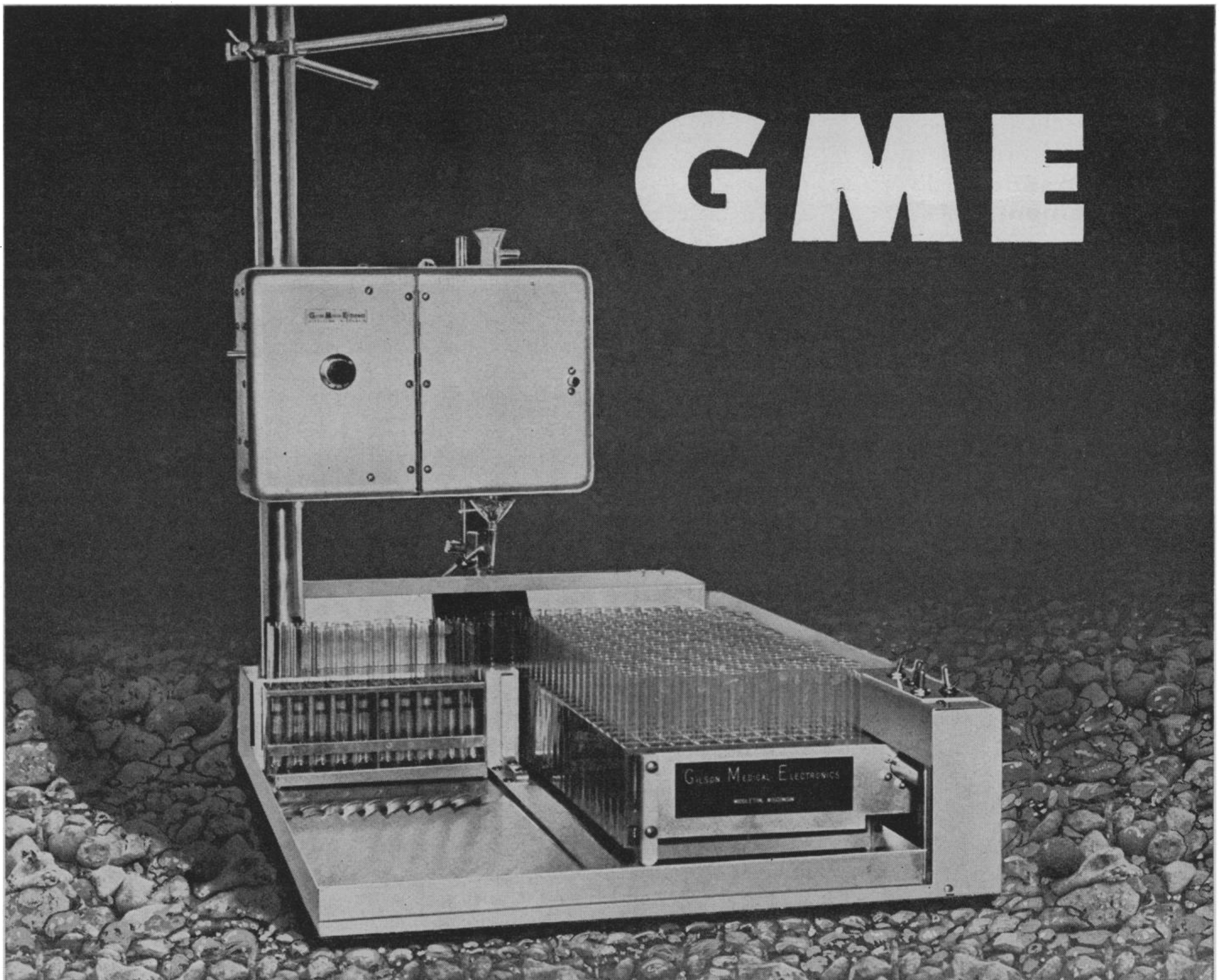
Further, Massachusetts, with only 2 percent of the nation's population, produces 12 percent of the 12,000 technician-engineers graduated annually; 5 percent of the engineers with B.S. degrees; 9 percent of those with M.S. degrees, and 12 percent with doctorates, a rather outstanding contribution to the nation.

I take no issue with the assumption that political pressure exists in the allocation of NASA centers—Boston and New England suspect this too—but to give credit to Senator Kennedy for the Boston decision is naive.

Further, I would hardly think one has to "justify" locating an electronics research center in Boston, alongside M.I.T. and Harvard, and in a state which, though small, has 80 4-year degree-granting colleges as well as numerous junior colleges and technical institutes.

IAN S. MENZIES
479 Main Street,
Hingham, Massachusetts

Fingerprints are notoriously lacking in site selection cases, and Menzies is therefore safe behind his view that virtue alone carried the day for Boston. Nevertheless, it is curious that NASA—as Menzies pointed out—managed to ignore the New England area until, coincidentally or not, the President's brother came along with his boast that he could "do more for Massachusetts." The decision was not announced until 17 January, but Senator Kennedy won office on 6 November and, after recuperating from the rigors of the campaign, impressed his admirers with his dedication to duty. An appropriate question is, if the site was known before the election outcome, as Menzies contends, why wasn't it announced at that time? Is it possible that the electronics center decision had something to do with the outcome of the election, or is that too cynical a view of how such things work?—D.S.G.


GME
Gilson Medical Electronics

31 May 1963, Volume 140, Number 3570

SCIENCE

Effective Use of Scientific Advice

The federal government is aware of the value of availing itself of the best possible counsel in scientific matters, and most scientists will accept appointments on Washington committees. Unfortunately, most such committees function ineffectively. In part, this is because they are appointed for inappropriate tasks or for inadequately delineated objectives. Thus committees may be asked to ponder the imponderable or to make decisions that timid administrators should have the courage to make. Even when the scope of the committee's functions is proper, a poor outcome may result if the agenda and procedures are badly chosen. Moreover, if a panel produces a wise result, the product is worthless unless it reaches and is acted on by those in authority.

At least two agencies in Washington use scientific advice effectively—the National Institutes of Health and the Atomic Energy Commission. Advisory groups of these agencies have important features in common: long tenure, chairmen not affiliated with the government, preparation of reports by members rather than by the agency secretariat, and free access to agency heads.

Evaluation of the relative merits of applications for grants involving more than a billion dollars a year is made by NIH study sections, which usually consist of about 12 experts who serve for 4 years and meet three times a year for 2 or 3 days. NIH personnel perform executive secretarial service, but the chairmen are outside scientists. Two members look deeply into each application and present their views to the full committee. After discussion, a vote is taken and a numerical priority is assigned by each member. The consensus of the discussion is written up by one of two members responsible for the close study and serves as a permanent record. These outputs have an important bearing on whether a grant is made. Top administrative personnel of NIH appear at the meetings. Morale is high. Members give devoted and thoughtful service and often spend extra hours on their tasks.

The General Advisory Committee of the AEC has different and broader functions, but its features are similar, and its activities have led to important advances in the field of atomic energy.

Illustrative of undesirable practices are the procedures of another large agency. This organization has successfully recruited as consultants most of the best talent in relevant fields, yet its committees have little influence on its programs. Appointments are for 1 year. The committee chairmen and secretaries are government employees. They are conscientious, but their scientific attainments and prestige do not match those of the visiting scientists. Agendas for the meetings are chosen without adequate consultation with members. Often the topics seem trivial in comparison with the topics, not discussed, that need full discussion. The minutes, if any, are fragmentary and are prepared by the secretariat and circulated long after the event. Repeatedly, key ideas are brought forth by consultants, but are lost. Urgent recommendations are made, but seem rarely to be put into effect. Either they do not appear in the minutes, they are not conveyed to those in authority, or they are otherwise neglected. The committee never sees the agency heads and cannot be sure its voice is heard.

In view of these contrasts, differences in the effectiveness and morale of the scientific advisory groups in the various agencies are not surprising. The basic features of the system used by NIH and AEC ought to be adopted by other agencies.—P.H.A.

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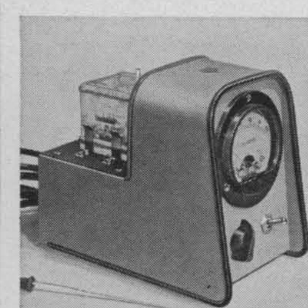

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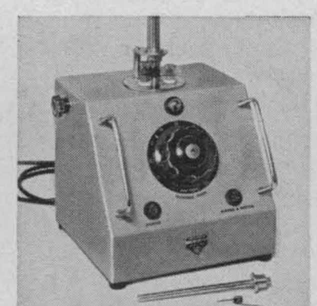

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As part of today's quickened effort to upgrade the quality and quantity of nuclear structure physics research, many program proposals are being made by colleges and universities both here and abroad. Mindful of the high degree of interest in these proposals, High Voltage Engineering Corporation is planning to publish excerpts from some of them in the hope you will find them both stimulating and informative.

Excerpts from the University of Pittsburgh proposal for the purchase of a three-stage Van de Graaff accelerator*

Introduction

"It is proposed that the National Science Foundation support the purchase, installation, and initial operation of a three-stage Van de Graaff accelerator to be installed in a new laboratory building to be provided by the University of Pittsburgh as part of its nuclear research program . . .

". . . The group in charge of developing the accelerator at the High Voltage Engineering Corporation is confident of achieving about 0.5 microamperes of protons or deuterons at 22 Mev. There is every reason to expect good beams of carbon and oxygen ions at about 60 Mev and 75 Mev respectively . . ."

Technical Motivation

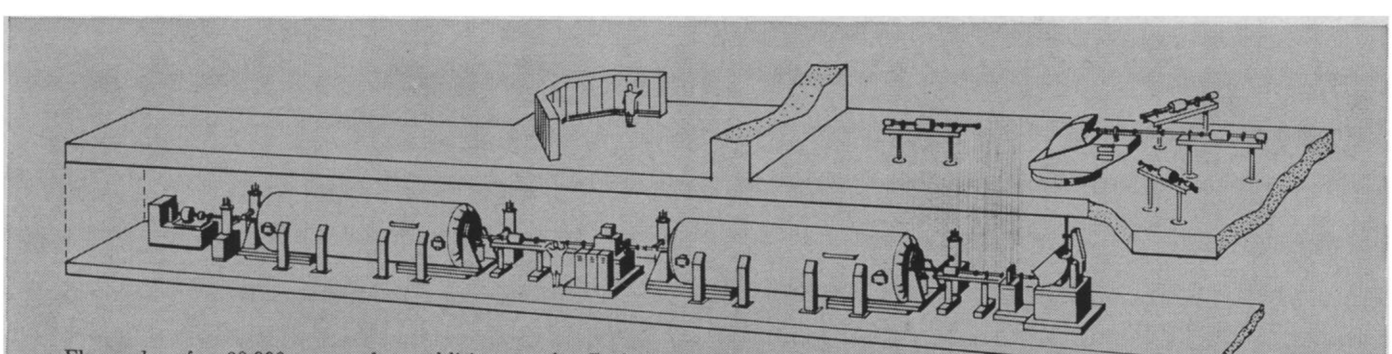
". . . The advantages of the high energy Van de Graaff accelerator over the present University of Pittsburgh Cyclotron are the following:

1. An order of magnitude smaller spread in beam energy and an order of magnitude better energy stability with time.
2. Non-pulsed beams, giving two orders of magnitude increase in efficiency for coincidence experiments, and one order of magnitude increase in allowable counting rate for all experiments where counting rates limit the rate of data accumulation.
3. Variable beam energy, which allows experiments to be done at different energies and as a function of energy.
4. Much higher maximum proton energy (21 Mev vs. 7.5 Mev) and higher maximum deuteron energy (21 Mev vs. 15 Mev).
5. Beams of high energy heavy ions such as C, O, etc., for studying heavy ion reactions.
6. Easily accessible ion source allowing possibility of polarized beams, controlled pulsing, etc.
7. Greatly improved beam quality which results in lower backgrounds, better defined geometry, more efficient beam handling, etc.
8. Easier and less expensive maintenance . . ."

Scientific Motivation

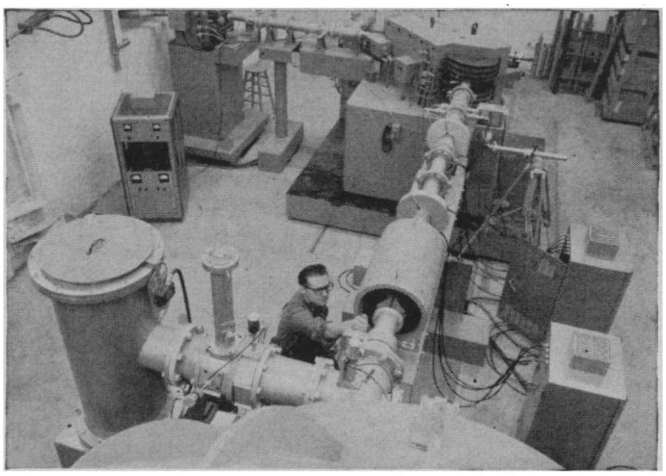
1. Nucleon-Nucleon Scattering

". . . Most of the data on proton-proton and neutron-proton scattering has been obtained at 100-300 Mev, where the reactions are very complicated and analyses tend to be ambiguous. There is elear need for experiments at much lower energies. Nevertheless, for a set of experiments to be useful it must include the measurement of all the polarization parameters of the system. Thus double and triple scattering experiments, and coincidence experiments, must be performed. It is significant both that a 3-stage Van de Graaff accelerator produces particles at just the most desirable energy for this problem, and that the one hundred per cent duty cycle of such a machine should make it entirely feasible to perform the very difficult coincidence and multiple scattering experiments."



Floor plan for 30,000 square-foot addition to the Radiation Laboratory at the University of Pittsburgh. Three-stage Tandem Accelerator occupies 7,000 square feet, three separately shielded beam rooms occupy 4,000 square feet and instrument, office and laboratory space occupy 7,000 square feet. Accelerator installation scheduled for early 1964.

*Published with the kind permission of the University of Pittsburgh.



High energy end of Tandem Accelerator showing quadrapole focusing lens. A 90° beam analyzing and switching magnet is shown in the background.

2. Nuclear Structure Studies

"... In the early experiments in light nuclei, the fairly crude resolution obtainable with scintillation or absorption techniques was satisfactory, as energy levels were generally well spaced. However, when the easiest problems had been solved and more specialized data were required for further progress, resolutions in the region of 100 KeV were found necessary . . ."

"... During this period, the light element region was studied thoroughly until essentially all useful information had been obtained; the heavy element region was largely ignored as it was thought to be far too complicated.

"However, in the middle 1950's, theoretical and experimental developments lead to great interest in the heavy element region. As studies in this area are progressing, it is becoming increasingly evident that, contrary to what had been expected, nuclear structure in this region is considerably simpler than in lighter nuclei . . ."

"... As a result of these developments, the center of interest in nuclear physics has shifted to the heavy element region . . . it is becoming increasingly evident that an order of magnitude increase in resolution is either highly desirable or vitally necessary in almost all cases. These can best be achieved with the high energy needed to surmount Coulomb barriers in heavy elements and very stable beams available from a high energy Van de Graaff accelerator.

"Heavy ion reactions have recently proven very successful in Colulomb excitation studies of high members of rotational bands ... with the high energy Van de Graaff accelerators these studies can be extended to emitted particles (including their angular distributions, and angular correlations with gamma rays)."

3. Nuclear Reaction Studies

"Even after ten years of intensive study, our understanding of medium energy nuclear reactions is still in a primitive state.... Even such basic questions as the relative amounts of compound nucleus and direct interaction, the energy at which nucleon-nucleon collisions becomes important, etc., are still completely unanswered. It seems apparent that these and other basic problems can only be solved by more complex experiments involving coincidence detection of emitted particles, all carried out as a function of bombarding energy. These experiments are difficult or impossible with cyclotrons and linear accelerators, but would be relatively easy with a high energy Van de Graaff accelerator.

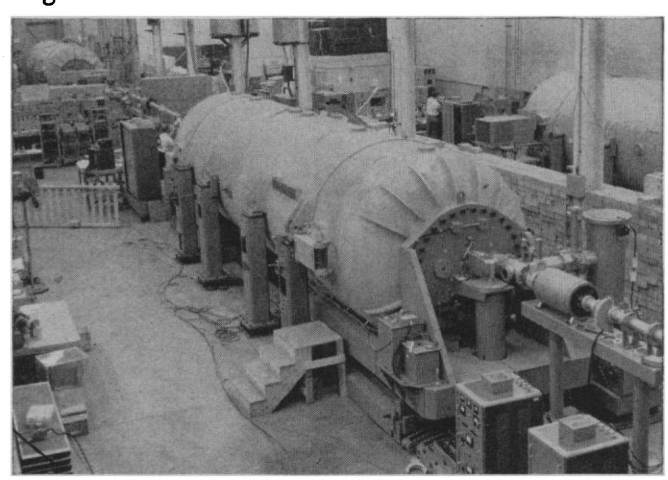
4. Radiative Capture Reactions

Immediately after the war . . . it became clear that earlier ideas about the interaction of nuclei with high energy gamma rays were altogether mistaken. The giant dipole resonance was discovered, and direct emission of high energy nucleons was found. Nevertheless, despite the success of such investigations it has never been possible to carry them through in the full detail which seems necessary ... In this circumstance much thought has been given to measurements of the inverse process, radiative capture.

"... To be useful for studies of the giant resonance, radiative capture experiments must be performed with a variable energy source and with good resolution. Cyclotrons cannot meet either of these conditions . . . A three-stage accelerator would seem to be the unique way to trace out all the features of the giant resonance."

5. Other Applications

"There are many possible applications of high energy Van de Graaff accelerators to fields other than nuclear physics. For example, heavy ion reactions have many well-known applications in nuclear chemistry. Very steady, high quality beams of 20-Mev protons are frequently useful in solid state radiation damage studies, as are heavy ion beams in the energy range close to that of fission fragments. Twenty Mev protons are well suited to radiation chemistry studies, and these as well as the neutrons could be used in a wide range of biological and medical studies. It should be noted in this connection that the proposed site for this machine is immediately adjacent to one of the world's largest and finest medical research centers.



In 1961, the principle of three-stage tandem acceleration of neutral-negative to positive ions was proved out in the Burlington, Massachusetts plant of High Voltage Engineering. Two tandem accelerators are shown in line for this critical test.

6. Summary

"It has been shown that a high energy Van de Graaff accelerator has very important applications in studies of nuclear structure, nuclear reactions, and many other fields. These applications are of pressing importance, and even a small fraction of them would justify the cost of this machine.

"However, in a larger sense, it should be realized that this is a very powerful and extremely flexible machine with many new and unique features. While it is difficult to predict in what directions nuclear science will develop, it seems completely certain that such a machine will be extremely useful."

High Voltage Engineering Corporation
Burlington, Massachusetts

MEETING REPORT

Arid Lands: Environmental Physiology and Psychology

The effect of environmental factors in arid zones on the functioning of man's body and mind was the main theme of a symposium sponsored by UNESCO and the Central Drug Research Institute of India, at Lucknow, 7–13 December 1962. Over 50 scientists from 13 countries participated.

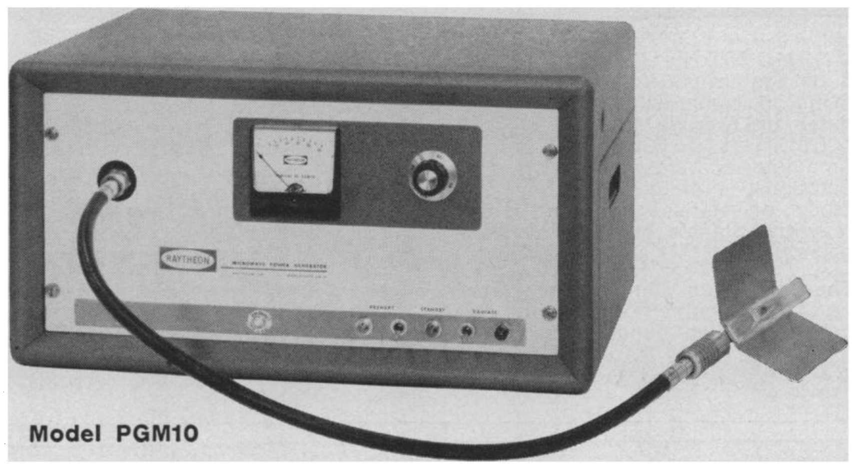
A session on the influence of environmental factors specifically considered only solar radiation, methods of measuring its incidence upon a man, and some ways for assessing the physiological significance of radiative heat exchange. The methods, however, are related to specific on-the-spot measurements, and do not indicate how meteorological data may be used to assess the radiative load and its significance for areas and periods of time in which special measurements are not possible. If we are to make valid generalizations, and that is at least one objective of science, we need methods for predicting the probable reaction of men to meteorological conditions as well as point data on the radiative environment. Whereas systematic observations of the incidence of solar radiation are still sparse, approximations can be made from astronomical data and records of cloud cover or hours of sunshine.

In spite of nearly 60 years of work since Haldane published his paper on Cornish tin miners, the subject of performance and comfort standards is in a very unsatisfactory state. In the range of conditions where "comfort" and "discomfort" still have meaning, there is very little in the way of physiological response to measure. French workers have found changes in the electroencephalogram, but unless these changes turn out to be more widespread, few quantitative measures other than correlations of subjects' responses to questions on sensations are available. Unfortunately, the technique of questioning and the conditions of questioning are far from standardized. Under great stress measurable responses do appear, but they constitute no more than partial glimpses of the fundamental strains developing in the subjects' tissues. Correlations of responses with environmental conditions have been largely limited to simple, stable laboratory conditions, and there is no satisfactory way of applying these correlations to the fluctuating and unstable environments of the field, or, for that matter, of using them with meteorological data. The equations of heat transfer used are extremely crude and take no account of even first-order variations, such as differences in curvature of different parts of the body, transient conditions, or change in physical parameters over a range of temperatures. There is little more than empiricism to guide us in selecting the duration and environmental conditions desirable for breaks in work under hot conditions.

It is now well established that the chloride loss in sweat is low in acclimatized persons and that chloride is replaced by a normally constituted diet, even though the rapidity of adjustment may be delayed by a high chloride diet. The role of aldosterone in the maintenance of the ratio of sodium to potassium and the water balance is becoming clearer, although some details remain unresolved. The role of the catechol amines in human sweat production is still somewhat uncertain. Although alkalosis can be produced readily in chamber experiments, its incidence and magnitude in free living are not certainly known. We do not know what factors govern the level of blood chloride concentration at which symptoms of hypochloremia appear; nor are we certain what the consequences to a normal individual will be of a continued unnecessary addition of salt to a normal diet.

Dehydration and starvation both invoke some compensatory reactions which mitigate, to some extent, the severity of effects upon bodily function. Dehydration increases nitrogen excretion in the urine and thus tends to increase the effects of any accompanying starvation. Starvation, on the other hand, by decreasing the water requirements for urinary excretion, may help to decrease the effects of dehydration. Much work remains to be done before satisfactory practical guides for the management of restricted food and water supplies can be given.

In neurophysiology, attention is now focused on the limbic and reticular systems, which participate in heat regulation. The introduction of cybernetic concepts has sharpened discussion on modes of control and the interplay of nervous loops, although the jargon at times obscures matters for the nonspecialist. It would seem that some of the energy spent in discussing whether



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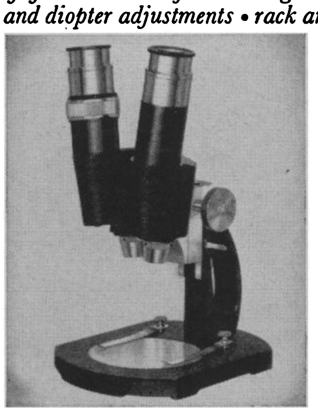

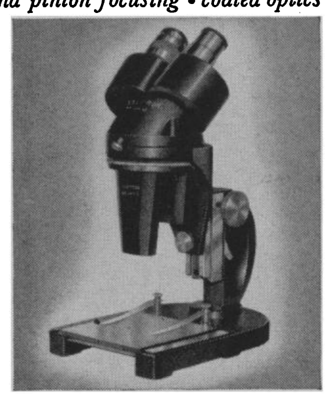

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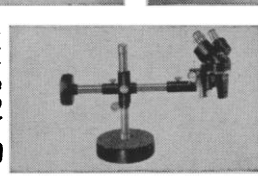

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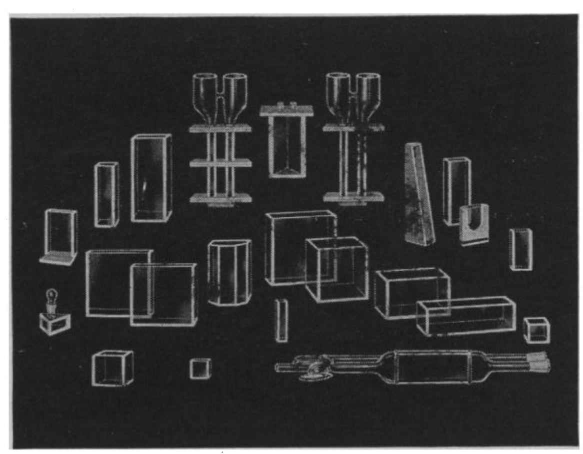

SCIENTIFIC APPARATUS

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central or peripheral thermoreceptors predominate would be better employed in determining the details of their interaction. It would be surprising indeed if the excellently placed peripheral receptors did not act as an early warning on external situations and if the internal receptors did not act as a warning system for changes in metabolic heat or in presenting after-the-fact information on regulatory inadequacies.

The exciting pioneer fringe of adaptation studies is in psychology. Available methods may still be inadequate, but it may be better to use less precise methods to study an obvious deficiency in knowledge than to refine a well known concept with precise tools. It is clear, even from preliminary results, that acculturation is a dominant factor in determining the psychological and psycho-motor responses of indigenous groups. Methods are being developed for the study of attitude and motivation in their relation to performance, and they should be applied to the problems of adaptation to stressful environments. It is time to set such studies up on a systematic basis, particularly with regard to the adaptation of primitive and isolated groups to desert environments. There is room for considerable improvement in measures of performance and in the standardization of conditions for their application. On the subject of neurasthenia, the adjective "tropical" may be added to the noun "neurasthena" if the intent is to indicate that a tropical environment provided the trigger factors; but it should not be taken to suggest that the resultant mental disturbance is of an essentially different kind.

It is becoming increasingly apparent that cultural and personal experience factors have an over-riding effect on adaptation of the individual, and that in the morphological realm the phenotypic is often more important than the genotypic character. The significance of surface area, as a determinant of heat loss, seems to have lost some of its appeal. Such differences in heat exchange possibilities as may be brought about by differences in surface area seem to be lost in the other and greater variables of heat balance. In the anthropological as in the psychological realm, and certainly to be coordinated with them, studies are urgently required on primitive and isolated groups exposed to stressful desert environments. In particular, those measurable characteristics which throw light on metabolic processes, such as blood protein fractions, blood enzymes, and cytological functions, should be carefully studied. Changes in the thermal efficiency of energy transfer may be just as important to adaptation as differences in the opportunities for heat loss.

The now common plea was reiterated that the distribution of disease in a particular type of environment, such as that of the arid zone, should be studied in full ecological detail, and not merely as an exercise in simple correlation with a few easily recognized climatic factors. Evidence was produced to support the contention, often ignored, that cessation of sweating may be a sufficient but is not a necessary prologue to heat stroke. Severe physical work may, under appropriate motivational conditions, push the body beyond its physiological limits. In such cases cessation of sweating may occur later as part of a runaway breakdown. A plea was made for distinguishing between true heat cramps following on a marked reduction of blood chloride concentration, and muscle cramps appearing as part of a circulatory failure in heat exhaustion.

While the gross physiological reactions of various species of animals are fairly well established, the variation within species and breeds has seldom been investigated. Any attempt to characterize the reactions of a group tends to be vitiated by nonstandardization of very influential factors, such as the nutrition of the animals examined. The full potentialities of an individual are unlikely to be revealed unless the animal is in full, including nutritional, health. Over-nutrition, on the other hand, may detract from heat tolerance. Argument from one species to another is fraught with danger. Not only in such directly influential factors as the presence and functional capacity of sweat glands, but also in such pervasive regulators as endocrine reactions, species vary extremely from one another. One study revealed that at least one species may lay down fat at the time that it is experiencing dehydration. This seems to present an interesting converse to the demonstration that, in response to dietary restriction, water may be stored as fat is removed. It is high time that studies of "heat tolerance" were carried out under strictly standardized conditions, with collateral studies investigating in each group the effect, within that group, of deviations from the standard conditions. Until this is done, knowledge will re-