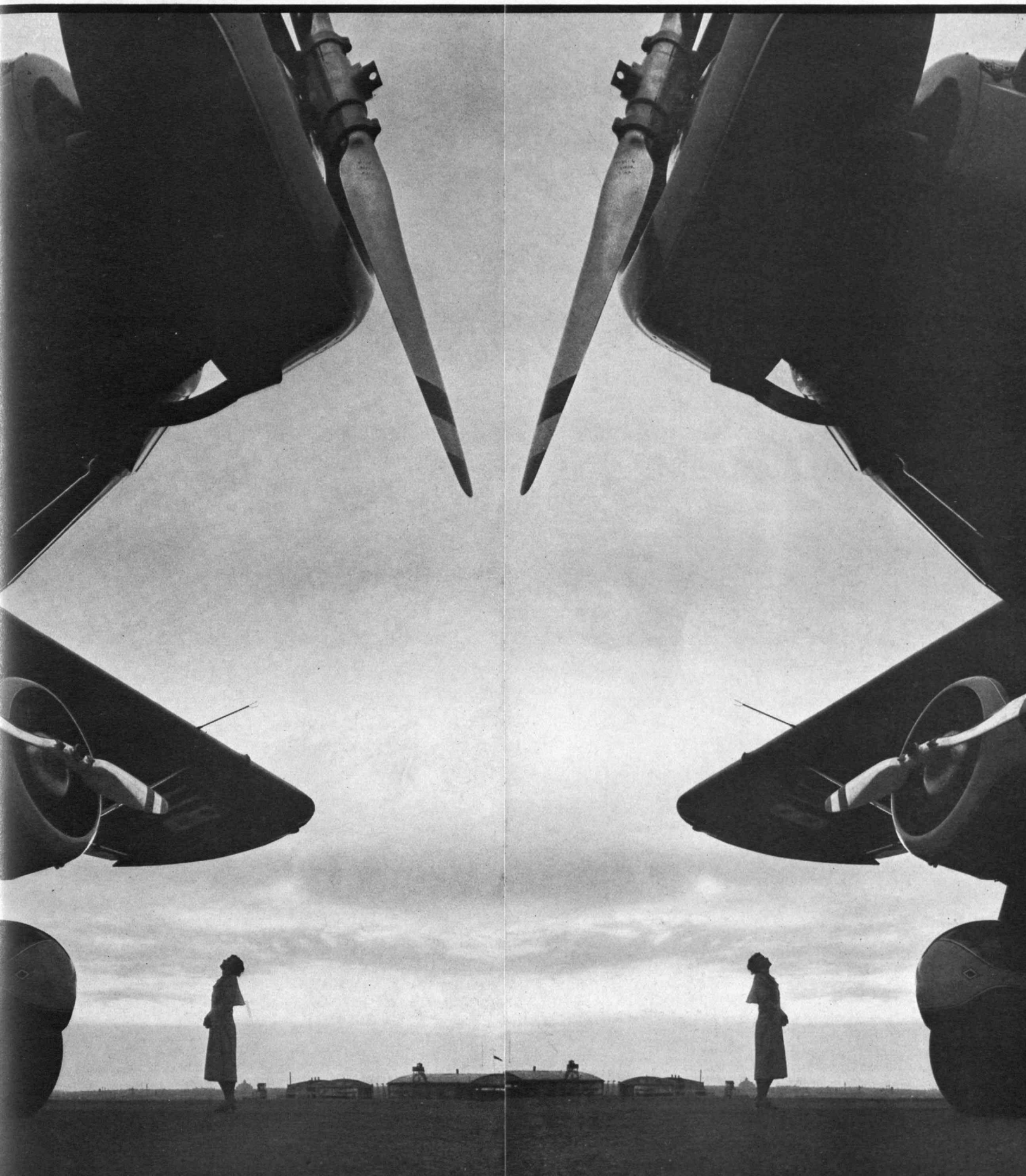
July 1933

TECHNOLOGY REVIEW



THE TECHNOLOGY REVIEW, July, 1933. Vol. XXXV, No. 9. Published monthly from October to May inclusive and in July at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

THE TABULAR VIEW

WHAT better proof than cosmic rays of John Owen's remark, "Nature never proclaims her secrets aloud, but always whispers them"? ARTHUR H. COMPTON, Nobel Laureate and Professor of Physics at the University of Chicago, describes how Nature's reticence is being circumvented in an effort to discover the solution of the cosmic ray charade. His article (page 327) is based on a brilliant lecture given by him at M. I. T. during the dedication of the George Eastman Research Laboratories of Physics and Chemistry. ¶ As he retires from the Presidency of Harvard University, A. LAWRENCE LOWELL is the recipient of felicitations from the entire educational world on his distinguished service to that institution. It is a pleasure for The Review to present the oration he delivered at Technology's graduation exercises on June 6. ¶ So frequently is the question asked "How is American engineering organized?" that the Review Staff found it expedient to attempt a complete answer. If the tables, charts, and text presented in this issue are not complete and adequate, the Editors would appreciate emendations. So far as we can discover, no such study of engineering organizations of this country has ever been made before, and we hope that this one will fill the gap. ¶ HAROLD L. HAZEN, '24, is an Assistant Professor of Electrical Engineering and has participated in the development of the integraphs and analyzers built by his department. He has contributed two major articles to The Review: "Miniature Power Systems," published in July, 1931, and "Working Mathematics by Machinery," in May, 1932.

WITH compelling, though we hope pardonable, enthusiasm, we record the pleasing intelligence that The Review, too, in this season of bays and laurels, has received what a contemporary painfully calls "kudos." In a contest conducted by the American Alumni Council, The Review was designated as (1) having published the best article, and (2) having presented the best page layout among all the graduate and alumni magazines published during the year in the United States. Recalling that once before The Review was awarded the palm for having the most handsome cover, we are naturally experiencing a modest glow of pride now that our inner worth is recognized equally with our outer form.

THE Review is not published during the summer months following July. This issue concludes Volume 35. Number 1 of Volume 36 will be published on September 27, and dated October. Readers who bind their copies of The Review are reminded that if they possess nine numbers of Volume 35, their files are complete. An index to Volume 35 will be ready on September 15, and will be supplied post free on request. While Volume 35 ends with the July issue, The Review will not celebrate its Thirty-Fifth, or Coral, Anniversary until January, 1934, the first issue of The Review having appeared under date of January, 1899.

SOME CALL IT "FRATERNITY ROW"

Have you heard about those corking rooms that we have just set aside for you fellows who come to New York for a week-end—or for a few days' run around the old village? They are as trim and as smart as a Star Class sailboat. And getting to be so popular with university men that some call this part of our hotel "Fraternity Row." (They are specially priced for college men and we have only a limited number of them.) Perhaps it would be a good idea for you to write us a line asking us to reserve one for you a few days in advance of your next New York visit.

THE ROOSEVELT

Edward C. Fogg, Managing Director

MADISON AVENUE AT 45th STREET, NEW YORK CITY

A MONUMENTAL TASK FOR HOSE—and the G. T. M.

ON the huge granite brow of Mount Rushmore in South Dakota, the vast sculpture conceived by Gutzon Borglum is emerging from the living rock to a symphony of power drills and powder blasts.

Completed, it will be an enduring memorial to four great sculptors of the American nation—Washington, Jefferson, Lincoln and Theodore Roosevelt. Its inscription was written by Calvin Coolidge.

It is being hewn from the everlasting rock by workmen suspended from belts and cables anchored on the mountain top, their hands steadying the throbbing drills and hammers fed by pressure lines of Goodyear Hose.

Heroic in concept, Herculean in labor, what a task this is for man and tools and hose! It fittingly demands the stamina built into such a hose as this specified by the G.T.M. — Goodyear Technical Man.

Stout-bodied to hold the pulsating pressures, specially compounded of tube to withstand the action of oil working through the line, tough-covered to withstand dragging across sharp jagged rock and timbers, yet flexible and easily handled, this Goodyear Style M Air Drill Hose stands up to any duty requiring super hose.

Goodyear Style M Air Drill Hose is one of the complete line of Goodyear industrial hose, a representative G. T. M.-specified and Goodyear-built quality product for better work, at lower final cost. For detailed information about any of these superior mechanical rubber goods, or to get in touch with the G.T.M., write to Goodyear, Akron, O., or Los Angeles, Calif., or call on your nearest Goodyear Mechanical Rubber Goods Distributor.

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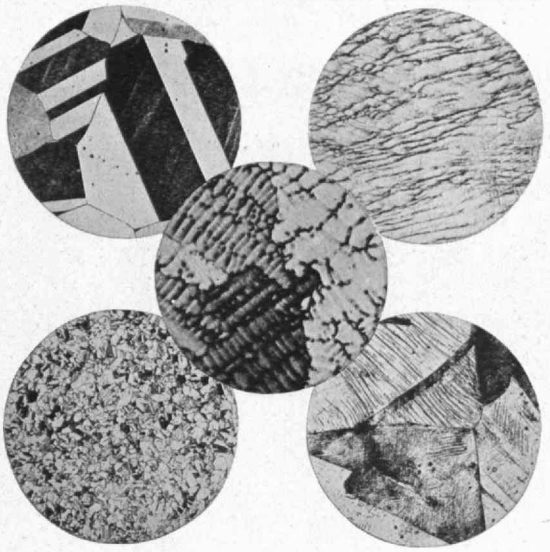


Metallographical photographs of brass. The brass is the same in each picture but each specimen photographed has been differently cast, worked, or annealed, with resultant changes in crystal structure

THE TECHNOLOGY REVIEW

A NATIONAL JOURNAL DEVOTED TO SCIENCE, ENGINEERING, AND THE PRACTICAL ARTS

Edited at the Massachusetts Institute of Technology

VOLUME 35 NUMBER 9

Contents for July, 1933

PUBLISHED monthly on the twenty-seventh of the month preceding the date of issue at 50 cents a copy. Annual subscription $3.50; Canadian and foreign subscription $4.00. Published for the Alumni Association of the M. I. T. Redfield Proctor, President; Harrison P. Eddy, Jr., Edward L. Moreland, Vice-Presidents; Charles E. Locke, Secretary; J. Rhyne Killian, Jr., Treasurer.

Published at the Rumford Press, 10 Ferry Street, Concord, N. H. Editorial Office, Room 11–203, Massachusetts Institute of Technology, Cambridge A, Mass. Entered as Second-Class Mail Matter at the Post Office at Concord, N. H.

Three weeks must be allowed to effect changes of address. Both old and new addresses should be given.

M.I.T. Photo

Reading from left to right: Vannevar Bush, '16, Vice-President and Dean of Engineering, M. I. T.; Arthur C. Hardy, '18, Associate Professor of Optics and Photography; Karl T. Compton, President; Samuel C. Prescott, '94, Dean of Science; and Harry M. Goodwin, '90, Dean of the Graduate School

NEW COLOR ANALYZER

This instrument, developed by Professor Hardy for the Color Measurements Laboratory of M. I. T.'s Department of Physics, is designed primarily for measuring the color of opaque materials, such as paper, textile fabrics, ceramic products, and surfaces coated with paint, ink, or lacquer. By a slight modification of the optical system, it will measure the color of solutions or transparent substances also. The instrument employs a photo-electric cell and is entirely automatic in its operation. The sample whose color is to be measured is placed against one of the holes in a small integrating sphere and the instrument draws a curve indicating the amount of light reflected or transmitted by the specimen at each wave length. By means of an integrating attachment, which is still under construction, the color sensation evoked in the brain of a normal observer can be computed, thus enabling a color to be described by three numbers instead of by descriptive terms whose meaning is necessarily ambiguous

THE
TECHNOLOGY
REVIEW

Vol. 35, No. 9 July, 1933

Cosmic Ray Clues

Further Light on the Nature of Earth's Incognito Visitors

By Arthur H. Compton

THREE major methods of observing cosmic rays have been developed. By means of an ionization chamber filled with a gas such as argon under high pressure the cosmic rays can be measured in terms of the conductivity or ionization they produce in the gas. Thus it is found that at high altitudes in a balloon or on a mountain a much greater ionization is observed than at sea level, while inside a deep tunnel, if the gas is shielded from gamma rays, ionization is almost completely absent.

The cloud expansion chamber, invented by C. T. R. Wilson, makes visible the paths of the ionizing particles associated with the cosmic rays, as they break into ions some of the air molecules through which they pass. Some of these particles seem to be the cosmic rays themselves, whereas others are secondary particles produced by the cosmic rays. Highly sensitive ion chambers, connected through amplifying tubes to electrical recorders, serve to count the cosmic rays as they pass through the chambers. These are known as "counting tubes." By arranging these tubes in pairs, so connected that they will record only when both are excited simultaneously, it is possible to study the direction from which the cosmic rays are coming.

With the help of such devices it has been found that a kind of ray exists which comes from high above the earth and is strongly but not completely absorbed as it passes through the earth's atmosphere. Believing that these rays have originated in the remote parts of space, they have been called cosmic rays. The heat that they bring to the earth is less than that of starlight. But they are the most penetrating known rays.

Cosmic Rays as Tools for Investigating the Structure of the Atom. The Energy of One Ray

Two types of theories have been suggested to account for the origin of these rays. The first type assumes the cosmic rays to be photons, or electromagnetic waves, like light or x-rays, or the gamma rays from radium, but of much shorter wave-length. If the rays are of this type, their observed penetrating power corresponds to the energy of rays that might be emitted by sub-atomic processes, such as the formation of hydrogen out of helium or the annihilation of hydrogen atoms. Dr. Robert A. Millikan has strongly defended the view that cosmic rays are emitted at the formation of heavy atomic nuclei from groups of lighter nuclei, and has made this a stage in the life cycle of matter in a continuous universe. Sir James Jeans has proposed the annihilation of hydrogen atoms as a source of the most penetrating cosmic rays, and sees this as one way in which the universe is running down.

The second class of theories supposes that cosmic rays are not photons, but electrically charged particles entering the earth's atmosphere from outer space. Dauvillier imagines that these particles are shot out from the sun by intense local electric fields. Swann suggests that they come from the changing magnetic field of sunspots on the hotter stars. But by far the most

romantic and by no means the least plausible theory is that of Abbé Georges H. Lemaitre. He attributes them to a primeval explosion of the universe some thousands of millions of years ago, since which time the universe has been expanding, and certain atoms and pieces of atoms that have been flying about in space ever since constitute the cosmic rays which we now observe.

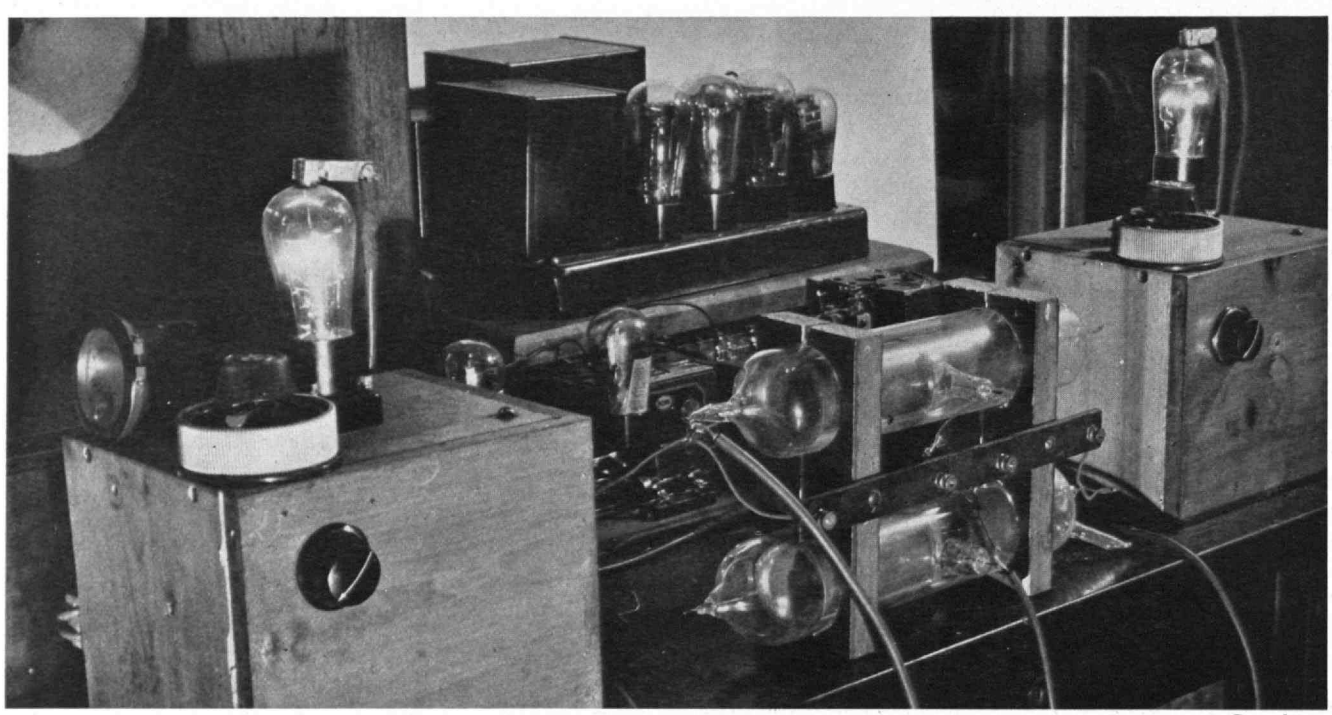
In order that a choice may be made among these theories, it is important that the nature of the cosmic rays be learned. Five methods of approaching this problem may be mentioned:

1. Observations with the cloud expansion chamber described above show that the ionization observed in air is due directly to high speed particles. When a strong magnet is present these particles curve in both directions, indicating that some are positively and some negatively charged. Some of these particles are certainly secondary rays produced by more energetic primary rays, though certain ones have energies sufficient to carry them through the earth's atmosphere. These experiments thus do not tell us whether the primary cosmic ray is a photon or an electrified particle.

2. Experiments with the coincidence counters described above, performed by Bothe and Kölhorster in Germany and Rossi in Italy, have shown that these coincidences are due to ionizing particles which are absorbed at substantially the same rate as the cosmic rays themselves. These experiments have been supplemented by recent ones by Johnson and Street which show that the pairs of ionizing particles that are frequently observed are produced by rays which are themselves ionizing particles. Since the only ionizing particles with which we are acquainted are electrically charged, these experiments point strongly toward the cosmic rays as electrically charged particles rather than photons.

3. Opposed to this conclusion are some early experiments by Millikan and his collaborators which seemed to show no variation of the intensity of the cosmic rays with the position in the earth's magnetic field. Theories, due to Störmer and recently much more completely developed by Lemaitre and Manuel S. Vallarta at the Massachusetts Institute of Technology, have shown that unless they have energies much greater than is supposed, any electrified particles should have their paths bent by the earth's magnetic field, resulting in a diminished intensity near the equator as compared with that near the poles. During the past year a group of our associated expeditions have made measurements at stations widely distributed over the earth. Their combined data show precisely the kind of variation in intensity with latitude predicted by the theory, only the energy of the electrified particles is somewhat greater than had been supposed. More recent experiments by Clay and by Millikan's collaborators have confirmed this result. This indicates definitely that at least a part of the cosmic rays consists of electrified particles.

4. At those latitudes where the deflection by the earth's magnetic field is sufficient to prevent part of the incoming electrified particles from reaching the earth, there should be a difference between the rays from the east and from the west. If the rays are positively charged, they should come mostly from the west; if negatively, mostly from the east. At these latitudes, numerous experiments have failed to show any appreciable difference. Our geographical distribution curves however indicated that as far south as Mexico such differences should appear. Accordingly Alvarez from the University of Chicago and Johnson from the Bartol Institute have been working independently in Mexico City during the past month, and have both reported a definite predominance of the cosmic rays (*Continued on page 346*)



Germeshausen

In experiments in Mexico, described above, to determine the direction from which cosmic rays come, double Geiger counters are used like those in the picture above, designed by Professor Ralph D. Bennett, of Technology's Department of Electrical Engineering