ENGINEERING | AND | SCIENCE

JUNE/1957

Caltech and the IGY . . . Page 7

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Robert G. Thompson and William A. Knepper speak from experience when they say:

"At U. S. Steel, teamwork, companionship, mutual assistance and a healthy working atmosphere are traditional."

MR. KNEPPER MR. THOMPSON

Robert G. Thompson, Division Chief, and William A. Knepper, Research Technologist, Raw Materials Engineering, Applied Research Laboratory at Monroeville, Pa., are typical of the teamwork and working congeniality developed among the employees of United States Steel. Mr. Knepper is today Mr. Thompson's assistant. They work side by side, as do thousands of other engineers and scientists, in the development of their projects.

Mr. Thompson graduated with a B.S. degree in Chemical Engineering in 1941. He served in World War II for 4½ years as an officer in the U. S. Army in anti-aircraft artillery, attaining the rank of Major. Upon release from the Army, Mr. Thompson took a year of graduate work and acted as an instructor in chemical engineering for six months. In 1947, he was awarded an M.S. degree in Chemical Engineering.

In February, 1947, he entered the employ of U. S. Steel as technologist at the Applied Research Laboratory. In February, 1950, he was promoted to Supervising Technologist for a number of chemical engineering problems. In December, 1951, he was elevated to the position of Research Technologist, or Acting Assistant Division Chief of all chemical engineering research. In February, 1952, he was made Assistant Division Chief, and in January, 1954, he was promoted to his present post.

Mr. Knepper received his B.S. in Chemical Engineering in June, 1949. Prior to graduation, he spent thirty months as a pilot and flying instructor in the Army Air Corps, where he attained the rank of Second Lieutenant. During the summers of 1947 and 1948, he worked in analytical chemistry at the Applied Research Laboratory.

In September, 1949, he was employed as a Junior Technologist at this laboratory. Promoted four times during his last six years' employment here, he is now Assistant Division Chief.

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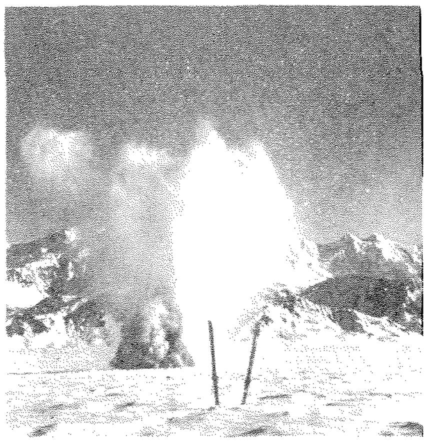
ENGINEERING AND SCIENCE

IN THIS ISSUE



ON OUR COVER this month—an explosion on the upper Seward Glacier in Alaska. This is a man-made explosion, set off by glaciological researchers from Caltech, who measure the thickness of the ice by recording the artificially-generated waves reflected from the rock floor beneath the glacier.

This summer, Caltech glaciologists will be making these studies in conjunction with scientists from all over the world, as part of the research program of the International Geophysical Year, which starts on July 1.

The U.S. program during the Geophysical Year will cover 13 fields of research. Work in each of these fields is being directed by Technical Panels. On these panels are five Caltech scientists who, on pages 8-17 of this issue, tell the story of Caltech's participation in the IGY program.

The five: Robert P. Sharp and Frank Press (Glaciology); William H. Pickering (Earth Satellite Program); Seth B. Nicholson (Solar Activity); and H. V. Neher (Cosmic Rays).

PICTURE CREDITS

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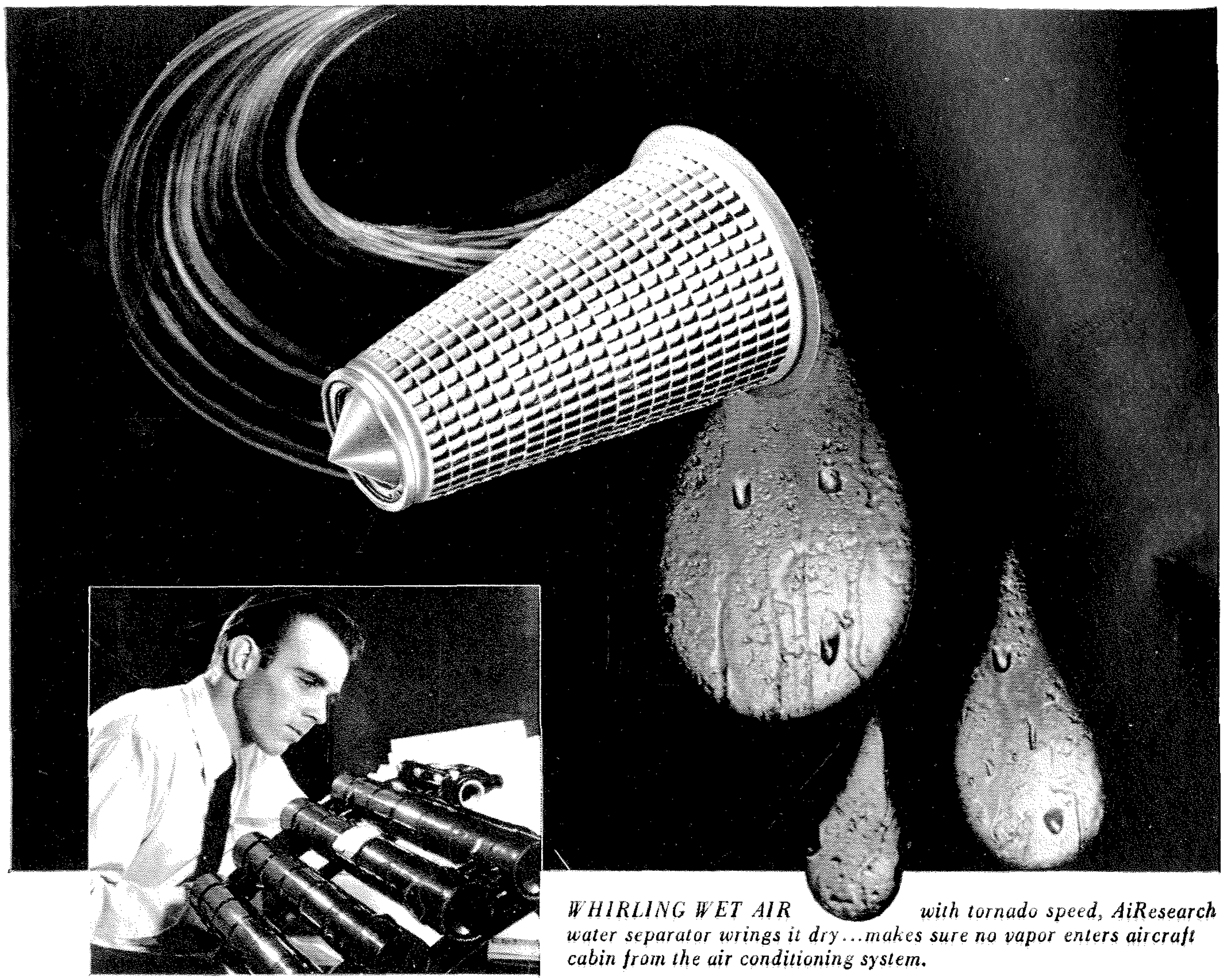
To the engineer with a bent for research...



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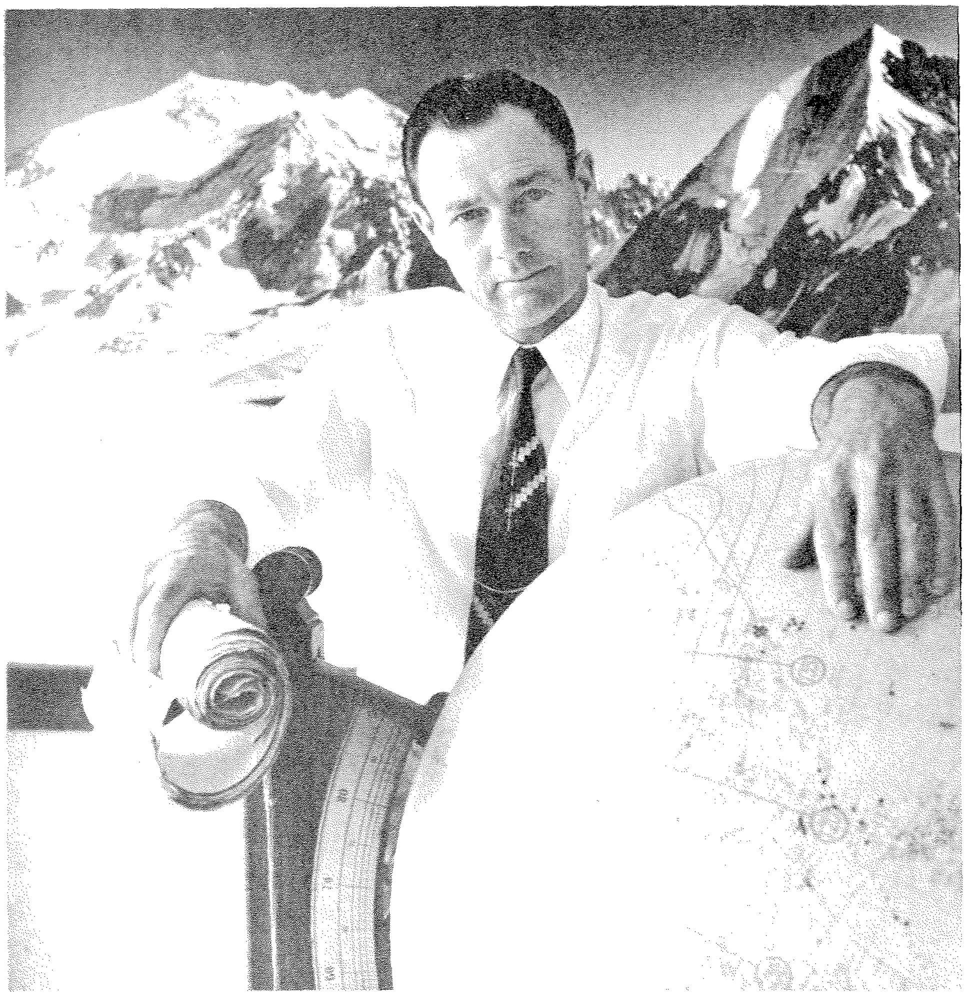
CALTECH AND THE IGY

The International Geophysical Year—the largest joint enterprise ever undertaken by scientists—gets under way on July 1, 1957. From then until December, 1958, over 5,000 scientists from more than 50 nations will carry out synchronized observations of the earth's crust and core, of its oceans and glaciers, and of the activities of the sun and the atmosphere. This concentrated 18-month examination of our planet is expected to produce the equivalent of 20 ordinary years of scientific research. In the United States, the IGY program covers 13 specific areas of research—each controlled by a Technical Panel of scientists, under the administration of the National Science Foundation. Each panel has representatives from almost every major university and research institute in the country. Caltech men are serving on the Technical Panels of Cosmic Rays, the Earth Satellite Program, Glaciology, Solar Activity, and Seismology and Gravity. On the following pages, five of these Caltech scientists, who are directing specific IGY research projects, describe the part the Institute will play in the International Geophysical Year.



Robert P. Sharp, professor of geology and chairman of the division of geological sciences, is a member of the IGY's Technical Panel on Glaciology.

by ROBERT P. SHARP

CALTECH AND THE IGY

GLACIOLOGICAL RESEARCH

By CIRCUMSTANCE and tradition, ice occupies a prominent place among subjects to be studied during the forthcoming International Geophysical Year. Twice before, various nations of the earth have joined in similar coordinated scientific efforts known as Polar Years which were devoted to investigations of ice-infested arctic regions. During the first Polar Year, 1881-1882, the U. S. Army sent a detachment of 24 men to northern Ellesmere Island for purposes of exploration and observation. Only 6 returned from this tragic expedition. In the second Polar Year, 1930-31, Alfred Wegener led a German scientific party to Greenland. At the cost of his own life, he established the German station *Eismitte* near the center of Greenland's ice sheet and produced the finest study made on that huge body up to the present decade.

Since much of the field activity of IGY focuses upon the Antarctic, it is natural that ice continues to be a subject of major interest. In truth, it can't be avoided. Fully 99 percent of the Antarctic continent is ice-covered. Some 85 percent by area and 90 percent by volume of the world's landborne ice lies on this south polar continent and contiguous islands. The surrounding seas support floating ice shelves and a heavy ice pack.

Now, a stevedore in Hong Kong, a tycoon on Wall Street, or a bather on the beach at Acapulco may all regard the Antarctic ice mass as too remote to be of much interest. Actually, they, and indeed much of the world's population, can be seriously affected by the behavior of this body. If it were all melted tomorrow, a worldwide sea-level rise conservatively estimated at 200 feet would occur. This would convert Florida to a few small islands and would solve the problems of congested traffic in New York City.

An objective of IGY Antarctic glaciological research is to place this estimate on a firmer basis by determining the volume of the Antarctic inland ice. Its area, already known to be something in excess of 5,000,000 square miles, will be more accurately determined by geographical explorations, air photography, and geodetic measurements. The great unknown is thickness. The Ross Ice Shelf has been sounded in a number of places, but since it is largely afloat, this is no help in the present problem. Measurements of depth have been made near the edge of the inland ice in only two small areas, and, though valuable, these data are wholly inadequate for volume calculations.

Previous estimates of mean and maximum thickness for the Antarctic ice sheet are judged to be much too low. These estimates have been unduly influenced by the predominance of observations in West Antarctica, an area of high rugged terrain and thinner-than-average glaciers. The bulk of Antarctic ice probably lies under the great East Antarctic dome, which is now known to attain an elevation of at least 13,000 feet. Owing to U.S. preoccupation with establishment of a South Pole station, the Russians have inherited the interior of East Antarctica. If they are successful in establishing their bases and in carrying out the proposed scientific programs, East Antarctica may yield some of the most significant results of the IGY operation.

Ice thickness

A guess is ventured that ice under the East Antarctic dome will prove to be in excess of 14,000 or 15,000 feet thick. It is also anticipated that IGY investigations by the 11 nations now proposing to occupy some 37 bases in Antarctica will establish a mean thickness for the entire ice sheet of more than 5,000 feet. This is a considerable boost over the 2,000 feet now commonly cited and used in calculations. Ice thickness will be measured by the usual commercial seismic exploration techniques, which involve the recording of artificially generated waves reflected from the rock floor beneath the ice. Earthquakes are to be recorded at a few Antarctic stations, and, if some of proper size and location occur during IGY, they may afford another means of arriving at a figure for average ice thickness. These methods are more fully explained by Frank Press in a companion article.

Now, the more important question facing our stevedore, tycoon, and bather is the possibility that enough Antarctic ice will melt to cause a significant sea-level rise within the near future. A one-foot rise would be embarrassing and a 10-foot rise catastrophic. Melting of 25 to 35 feet of ice from the entire surface of the Antarctic ice sheet would raise worldwide sea levels by one foot, and this amount of melting currently occurs on glaciers in other parts of the world in a few years. We have little basis for estimating the potential for such an occurrence in the Antarctic, but studies during IGY of accumulation, wastage, the micrometeorological factors affecting these processes, and the past history of fluctuations in ice volume will help immeasurably in evaluating the possibilities.

Wastage of Antarctic ice occurs at present by melting, evaporation, wind erosion, and calving in the form of icebergs. This last may be the most important, but it is not particularly sensitive to climatological change. Wind drifting of snow into the sea is relatively minor. Therefore, it looks as though melting and evaporation are the only wastage processes likely to be much influenced by climatological change. The Antarctic is so cold that a considerable warming of the environment could occur without notably increasing melting and evaporation. In fact, one currently popular theory holds that an increase of temperature in the Antarctic would produce an expansion of the ice rather than a shrinkage, owing to the increased snowfall resulting from greater water vapor content in the atmosphere. This is entirely possible, but it too remains a speculation until more is known about Antarctic accumulation, wastage and the controlling meteorological factors. Recent scare headlines concerning the possibility of a disastrous rise of sea level within the next few decades overlook the difficulties of increasing the wastage of Antarctic ice. A warming of the atmosphere may actually cause a fall of sea level.

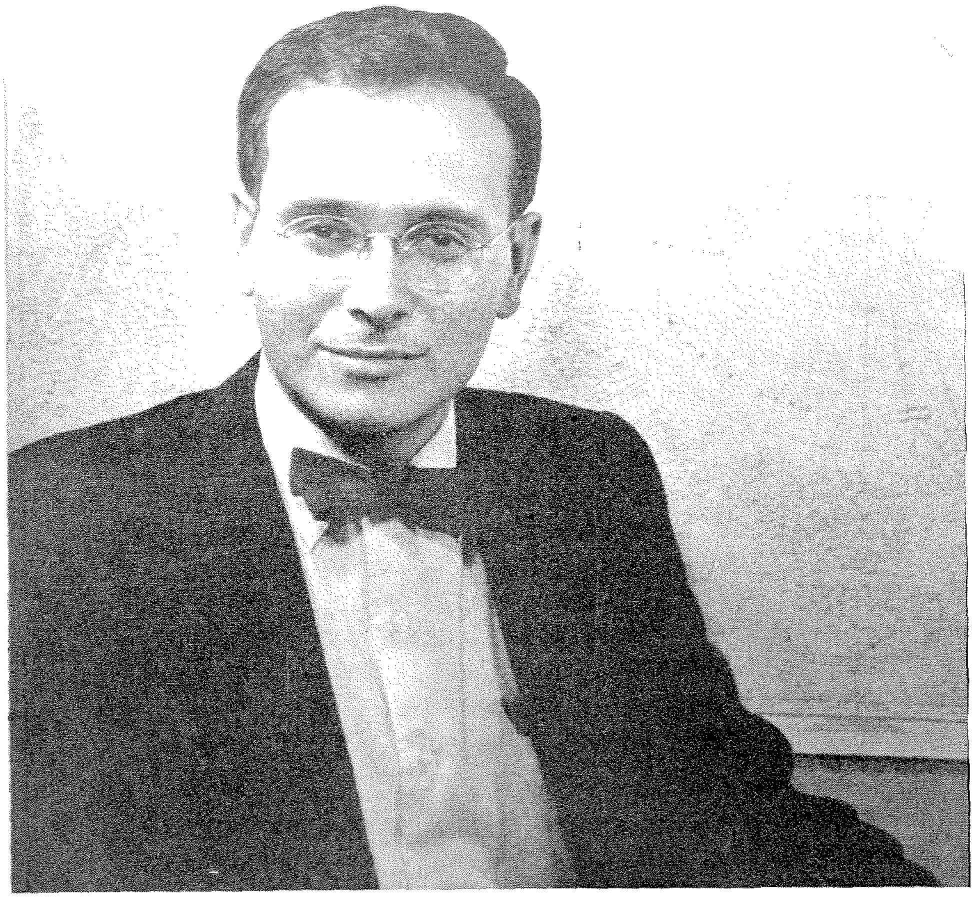
Evidence of former fluctuations in volume of the Antarctic ice sheet will be carefully studied with the aim of relating them to climatic fluctuations of identifiable type and magnitude. The history of the ice sheet for the past 500 to 1,000 years will be read in part from cores from deep drill holes. In this study the oxygen-isotope researches of Caltech's Sam Epstein will play a major role. Epstein, associate professor of geochemistry, and his colleagues, have shown that the annual layers of accumulation in snow and ice on glaciers can be identified by the differences of oxygen-isotope ratios (O^{18}/O^{16}) which reflect the temperature at which precipitation occurred. This relation, plus the fact that secular variations in relative temperature are indicated by these ratios, will show whether colder or warmer periods in Antarctic history have resulted in an increase or decrease of net accumulation.

Ice packs and glaciers

Many other phases of glaciological research will be pursued in the Antarctic and on other parts of the globe by the more than 50 nations participating in IGY. The Arctic will come in for its share of attention and considerable work is planned for the ice pack covering the north polar sea, both by the U.S. and Russia. The large islands of old thick ice within this pack will be of special interest, partly because of their possible strategic use. A Caltech crew will be engaged in detailed studies of the Blue Glacier in the Olympic Mountains, Washington, with the objective of determining the mechanical behavior and flow laws of that "plastic" rock, ice, as it exists in such natural bodies.

The IGY is designed primarily to yield coordinated studies of various geophysical phenomena, particularly those for which synchronous observations in a number of widely separated localities are especially valuable. The behavior of the earth's many ice bodies is related to worldwide conditions, and IGY glaciological research is designed to determine what these conditions and relations are.

Frank Press, professor of geophysics, is a member of the IGY Continental Committee (which is in charge of overall planning of all research projects on this continent), and is also vice-president of the Technical Panel on Glaciology.



CALTECH AND THE IGY

ANTARCTIC SEISMOLOGY

by FRANK PRESS

ONE INDEX of the tremendous activity in the geophysical sciences during the International Geophysical Year is the program in Antarctic seismology. During IGY there will be more first class seismograph stations in Antarctica than in all of South America. As many as five or six seismic field parties, using the best portable apparatus available from the petroleum industry, will be sounding the barren wastes of Antarctica, determining ice thickness and identifying the rocks beneath the ice.

The Antarctic seismology program has been organized with three specific problems in mind: Determination of (1) ice thickness, (2) the nature of the Antarctic continent and, (3) the seismic geography of the Southern Hemisphere, with particular attention to Antarctic regions.

Geophysicists are very much interested in the "water budget" of the earth, particularly in the partitions of water between the oceans and continental ice sheets. The proportion of water locked in ice sheets is a variable quantity which both reflects and affects worldwide climatic variations. Sea-level changes of the order of several hundred feet are associated with advances and retreats of continental ice sheets. It is not surprising that much effort will go into the determination of ice thickness in Antarctica so that reliable estimates of ice volume can be made.

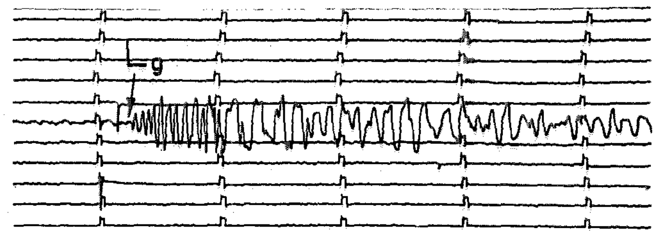
Field parties from the United States, Great Britain, the Soviet Union and France will make long traverses in tractor trains equipped with portable seismic equipment. Using techniques not unlike those employed in petroleum exploration, measurements of travel time of explosion-generated sound waves reflected from the ice-rock interface will be interpreted in terms of ice thickness. Three American parties under Albert P. Crary, chief glaciologist of the Antarctic expedition, will make traverses radiating from the Little America, South Pole and Byrd stations. A fourth airborne party will make spot measurements in areas inaccessible to the other teams.

Ice thickness

A novel approach to the ice thickness problem will also be attempted. The Antarctic ice sheet, bounded as it is by air and rock, forms an efficient elastic wave guide. Earthquake-generated elastic wave pulses are dispersed by propagation through the wave guide in a predictable manner, depending on the elasticity of the ice and rock and the ice thickness. Records from the half-dozen newly established Antarctic seismograph stations will furnish the basic dispersion data from which ice thickness can be obtained. An advantage of this method is that average ice thickness for the region between earthquake and seismograph station is obtained, in contrast to the point-by-point determinations of the field party. A serious defect in the method — and one which may render it useless — is its dependence on the occurrence of a suitably placed earthquake during IGY operations in Antarctica.

Information on the nature of the Antarctic continent is a major target of the Antarctic program. Some indications of the ice-buried topography will be revealed by the seismic field traverses. Of particular interest is the occurrence of buried mountain ranges, and indications of land elevations below sea level, as were found in Greenland. The underlying terrain will be examined by recording explosion-generated sound waves refracted through the materials of which it is composed. In this way, occurrences of unconsolidated rocks, sedimentary rocks, and igneous rocks beneath the ice will be charted.

The extent and continuity of the Antarctic continent will be examined, using recently discovered seismic waves guided by channels limited to the earth's continental crust. Channel waves have many features in common with "whispering gallery" sounds sometimes observed at the base of architectural domes. Known as *Lg* waves, these earthquake-induced vibrations reveal by their presence or absence whether or not the path between earthquake and seismograph station is continuous or interrupted. Thus, the unlikely possibility that Antarctica is composed of a number of islands, rather than a single continental mass, will be examined. The structure of the earth's crust in Antarctica will be compared with that of other continents. The manner of adjustment of the Antarctic crust to the ice load will be revealed by observations of gravitational acceleration together with land elevation and ice thickness.



The extent and continuity of the Antarctic continent will be examined, using these recently discovered seismic waves known as Lg waves.

Most of the world's seismograph stations are located in the Northern Hemisphere. The precision of earthquake determinations in the Southern Hemisphere suffers as a result of this distribution. Many basic questions remain unanswered and await the flow of data from the newly established Antarctic stations. The details of the closure of the southern portion of the circum-Pacific earthquake belt require more accurate epicenter determinations, especially for the smaller shocks. Suggested connections of the Pacific belt with Atlantic and Indian Ocean earthquake belts have yet to be verified. The fact that earthquakes mark submarine mountain chains raises the interesting possibility of discovering new mountain belts in the poorly charted southern oceans from the location of epicenters. The presence or absence of earthquakes in the Antarctic interior is diagnostic of the broad geological picture. It may well be that a new species of tremor associated with motions in the ice sheet will be recorded by the seismograph stations. It is not surprising that seismology will be a major effort of IGY operations in Antarctica.

Caltech and the Antarctic program

Staff members in Caltech's Division of Geological Sciences have been actively involved in the planning of the Antarctic scientific program. The Caltech Seismological Laboratory is responsible for the training of personnel and the design of equipment for the Knox Coast seismograph station in Antarctica. The seismographs have been especially designed to detect *Lg* waves, and ice-guided waves. The instruments are particularly sensitive in order to detect the numerous small earthquakes which might ordinarily pass unnoticed. This is necessary to ensure the recording of a sufficient number of earthquakes in the short time available for operations.

It is not an unusual role for earth scientists to participate in the opening of a new region for exploration and exploitation. Perhaps the IGY effort presages such an era for Antarctica.

PROJECT VANGUARD

— The Earth Satellite Program

by WILLIAM H. PICKERING

One of the most widely known projects in the International Geophysical Year is the Earth Satellite Program, "Project Vanguard." This project is a responsibility of the Naval Research Laboratory in Washington, D. C., but in view of the widespread scientific implications of the program it was almost inevitable that Caltech should have some association with the project.

Direction of the project falls naturally into two areas. The development of the rocket vehicle to put the satellite on its orbit is a responsibility of the Department of Defense and has been given to the Navy. The scientific program associated with the experiment is directed by the U.S. National Committee through its Technical Panel on the Earth Satellite Program.

The scientific program for the satellite experiment has evolved primarily around the experience of those groups which have been active in the upper atmosphere research program of the past ten years. In January, 1956, a symposium held at the University of Michigan resulted in some 30 papers proposing scientific experiments to be performed on a small satellite. During 1956 these proposals were studied by the panel, and, as a consequence, a set of experiments for the first six satellites has gradually evolved.

The first experiment is a measurement of the temperature of the orbiting vehicle. This will establish the environment in the vehicle and the extent to which it has been possible to control temperature fluctuations. Data for this experiment will also give information on the albedo or reflecting power of the earth.

A second experiment associated with the satellite environment is a measure of the effect of small meteoritic particles. It is proposed to make a portion of the satellite pressure-tight, and to observe whether this section develops a leak due to penetration by a meteorite. It is also proposed to place a resistive coating on the outer shell, to determine whether this coating is worn away by erosion from micro-meteorites.

Other experiments on the early satellite flights will include measurements of the Lyman-alpha radiation from the sun and the cosmic ray intensity above the atmosphere, as measured with a Geiger counter. An attempt will also be made to measure the magnetic field of the earth at satellite altitudes with the hope that some information may be obtained as to the presence of current sheets above these altitudes.

A satellite experiment has been proposed by Caltech. This involves contributions from the campus, the Mount Wilson Observatory and the Jet Propulsion Laboratory.

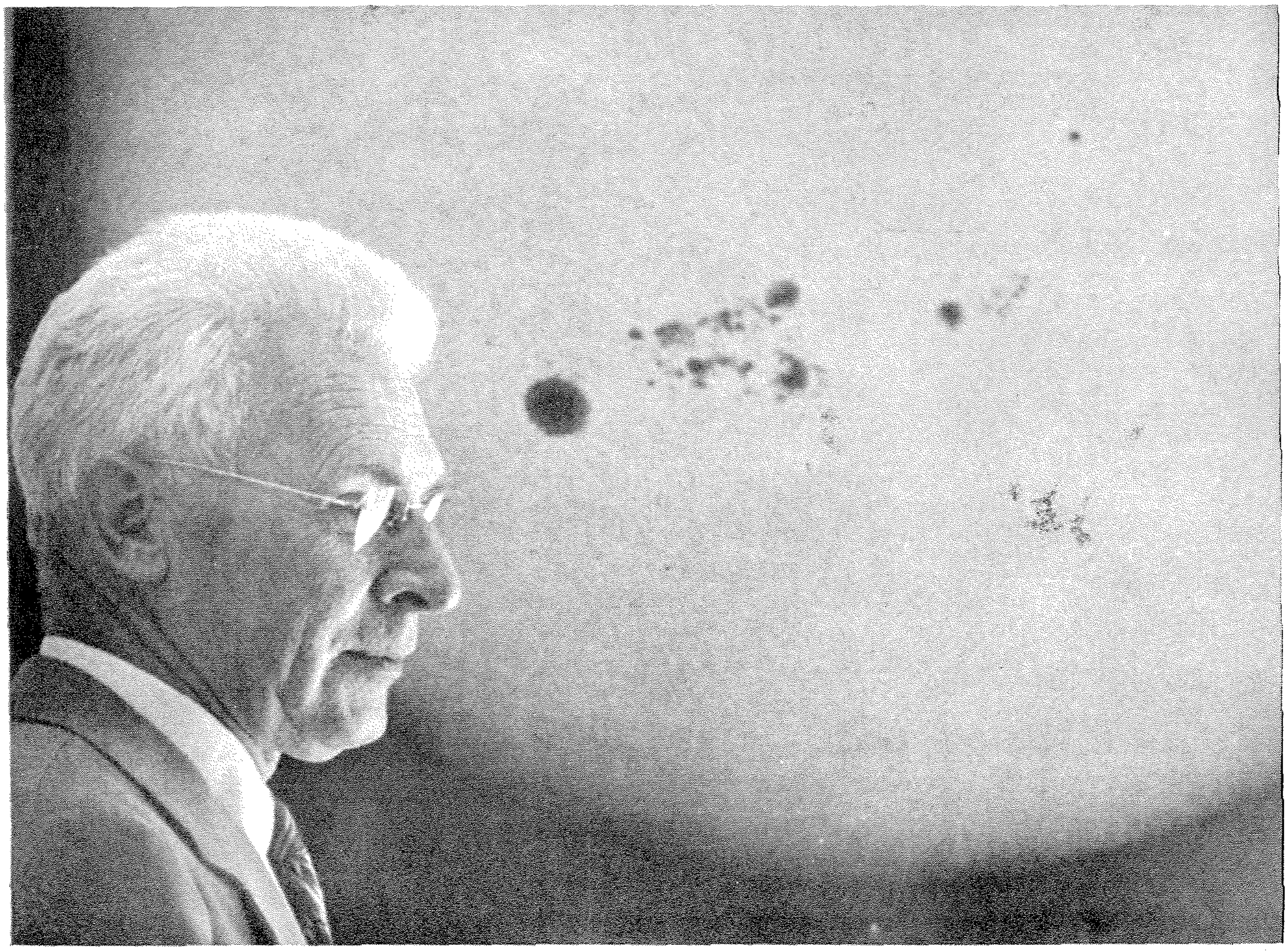
W. H. Pickering, director of the Jet Propulsion Laboratory, is on the Technical Panel of the Earth Satellite Program.

It would completely instrument one of the vehicles. The primary experiments would be, first, a measurement of the cosmic ray intensity with one of the cosmic ray ionization chambers developed by Dr. H. V. Neher, professor of physics; and second, a photometer experiment proposed by Dr. William Baum, staff member of the Mount Wilson and Palomar Observatories, which would measure the integrated light coming from different parts of the sky. A set of filters would allow the measurement to be made at different wave lengths. An analysis of the data may be of value in distinguishing between different cosmological models. For many years the astronomers have wanted to be able to mount a telescope on a satellite in order to view the sky from outside the earth's atmosphere. This experiment of Baum's is a first step in this direction, and is the only truly astronomical experiment proposed for the IGY satellite.

The instrumentation for these experiments will be provided by the Jet Propulsion Laboratory and will include JPL's Microlock communication system to transmit the data back to the earth. The Microlock system is an exceedingly sensitive phase-locked communication technique which allows the on-board satellite transmitter to be of very low power and low weight. With a radiated power of 30 milliwatts, there will be no difficulty in tracking the satellite and receiving the transmitted data over ranges of several thousand miles. The transmitter will weigh about two pounds, including its battery for a lifetime of two months. Because of the restrictions in weight of the satellite vehicle, it is very essential to miniaturize all of the satellite equipment as much as possible. Total weight of the Vanguard satellite is limited to 20 pounds.

The Jet Propulsion Laboratory has been interested in satellite problems for many years. Shortly after the war the Laboratory prepared a number of reports on satellite orbits and associated rocket problems. At the time when the IGY satellite was under consideration, each of the Services was invited to make a contribution to the project. The Army submitted a proposal in which the Laboratory played a very significant part. Microlock, which has proved to be exceedingly valuable in many applications, was essentially an outgrowth of this study.

The Caltech experiment is not at present scheduled for one of the early satellites, but it is hoped that there will be an opportunity to carry it out in the near future.



Seth B. Nicholson, staff member, Mount Wilson and Palomar Observatories, is on Technical Panel on Solar Activity.

CALTECH AND THE IGY

SOLAR OBSERVATIONS

by SETH B. NICHOLSON

DAILY SOLAR observations have been made at the Mount Wilson Observatory for the last 50 years. This daily record of activity on the sun has been improved as better instruments became available, and has been made more complete as it became evident what solar features were the important ones to watch.

The daily solar observations, which supplement specific research programs, constitute a volume of data about the sun that can often be used to check new theories without waiting for the accumulation of future data. These records consist of various kinds of solar photographs and visual observations of the intensity and polarity of the magnetic fields in sunspots.

The daily photographic program begins with photographs of the solar surface made with a 6½-inch image at the 60-foot focus of a tower telescope. The photographs, of very short exposure, are taken through yellow color filters to minimize the blurring of the image due to the unsteadiness of the earth's atmosphere.

In addition to the photograph made for ourselves, a second one is taken for the U.S. Naval Observatory to supplement the daily photographs made by them in Washington, D.C. Next, spectroheliograms using the red light of hydrogen are made of each sunspot group, with the 6½-inch image. These are made in the early morning, before heat waves from the earth cause blurring of the image. Later, spectroheliograms of the whole disk are made with a 2-inch image in the light of hydrogen and calcium. Three negatives of each kind are taken, one of them being exposed simultaneously with an image made by monochromatic light from the continuous spectrum near these lines. The 2-inch image of the sun is then blacked out by a metal disk and spectroheliograms are exposed long enough to record the high hydrogen clouds all around the sun.

Photographic flare patrol

When this program is completed, an automatic photographic flare patrol is begun. This consists of somewhat underexposed spectroheliograms taken every 80 seconds. These are just dense enough to outline the sun and the ordinary bright flocculi but they show the brighter flares conspicuously. The flare patrol uses a 1-inch solar image on 35-mm film.

While the flare patrol is operating, the magnetic fields in the sunspots are observed at the 150-foot focus of the other tower telescope. Here the solar image is 17 inches (430 mm) in diameter and even small spots can be observed individually on the slit of the spectrograph. To make certain the right data about sunspots is recorded, the observations are written on a drawing—the spots being traced directly from the solar image projected on white paper. The heliographic latitudes and longitudes of the spot groups are read from a card on which the projected meridians and parallels of latitude have been drawn, and are recorded on the drawing of the spot groups, along with the magnetic data.

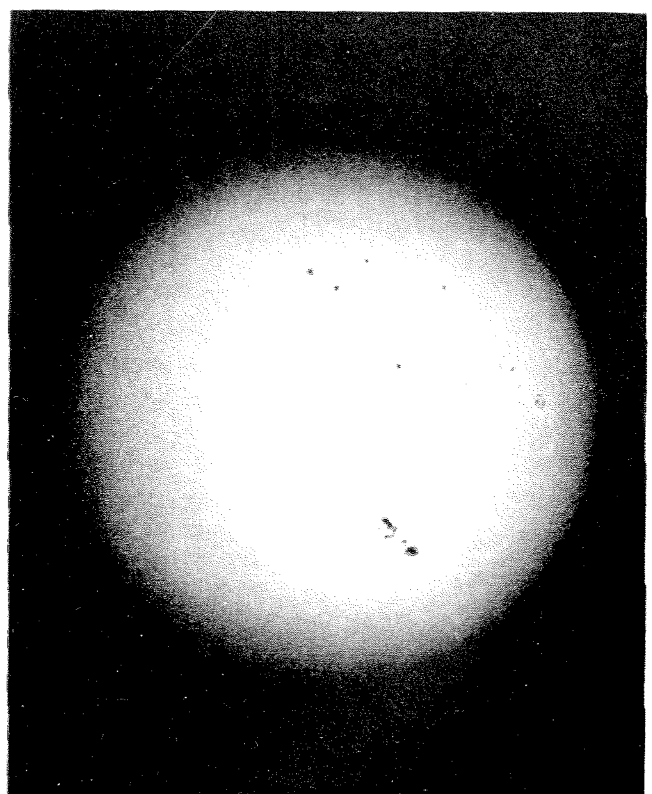
With remote controls, the mirrors at the top of the tower are turned to move the solar image so that each spot is centered in turn on the slit of the spectrograph. The observer notes the displacement and sign of the polarization of the components of a spectral line affected by the magnetic field in each spot and records the polarity and field strength of the sunspot on the drawing. Since this program was started, 12,000 such records have been made.

This observing program will be continued much as in the past during the International Geophysical Year, and will become a part of its intensified cooperative solar observing program. The routine program using the large solar images is now usually made just after sunrise, because that part of the day is most likely to have a good observing condition on Mount Wilson. During the IGY this program will be repeated in the late afternoon to check the continuity of changes in solar activity, and to supply data at a time of the day when solar observations are not possible at more eastern stations. The last photographs of the sun will be made here just as observing is starting in Japan, Australia, and India.

A new magnetograph is now installed in the 150-foot tower on Mount Wilson and will be in daily operation soon. This instrument will record the minute magnetic fields over the sun's surface, and around sunspots, that are too weak to be detected by the usual visual method. It is essentially a duplicate of the one that has been used by Drs. Harold and Horace Babcock at the Hale Observatory in Pasadena for the past four years. Many improvements have been incorporated in the new equipment on Mount Wilson and it will be ready for daily recording during the IGY. The results obtained with it will also be reported to the IGY communications centers.

Except for the emphasis on additional observing in the late afternoon, the program on Mount Wilson during the IGY will be changed very little. The principal change will be in the reporting of results. Now, except for a daily telegram to the Radio Warning Service of the National Bureau of Standards, the results are reported bi-monthly and quarterly in the standard publications. The film for the photographic flare patrol is now developed only after 100 feet has been completed. During the IGY this film will be processed daily, in short lengths, so that it can be scanned and the results from it reported daily. A spectrohelioscope is also available for visually detecting flares when a special spectrographic or photometric program for observing them is in progress.

The daily processing of the negatives and the preparation of more complete daily reports for the IGY will require the services of additional personnel. Arrangements are being made with the University of California at Berkeley to have one of their graduates, William Livingston, be in residence on Mount Wilson as a guest investigator to supply the additional help necessary to carry out the IGY program.



IGY comes at 11-year peak of solar activity, like that shown in this typical sunspot photograph taken March 28.

H. Victor Neher, professor of physics, is a member of the IGY's Technical Panel on Cosmic Rays.

CALTECH AND THE IGY

COSMIC RAYS

by H. V. NEHER

MANY OF THE gross aspects of cosmic rays have now been ferreted out—not only of the primary radiation itself, but of its numerous progeny as they filter down through the atmosphere. Few other fields of investigation have proven to be so puzzling—or so fruitful—in yielding new and exciting information as the field of cosmic rays. But much remains to be done, particularly in regard to the disposition of cosmic rays over the earth and the nature of the changes that take place from time to time.

The International Geophysical Year promises to add significantly to our store of knowledge. The cosmic-ray group at Caltech plans to make several series of balloon flights during the IGY. In the summer of 1957 we want to make six to eight balloon flights with ion chambers from Thule, Greenland. In 1958 we plan to establish a base station at Bismarck, North Dakota, and make simultaneous flights with balloons launched from a roving station, going by ship from the east coast of the United

States to Greenland. In late 1958 we plan to set up a base station in New Zealand and make simultaneous flights with a shipboard station leaving the United States and proceeding to the Antarctic.

By these experiments we hope to gain further information (1) on the geomagnetic effects on the incoming, electrically-charged cosmic-ray particles, and (2) on the nature of the fluctuations that take place.

Cosmic rays would be much less interesting if they remained constant. Knowledge once gained would be the same, year in and year out, and once we knew what the properties of cosmic rays were at any one time we would know it would be the same at all times.

The impression that cosmic rays remain constant in time came about with some justification because early measurements were made at or near sea level, and over short periods of time. Recently, Dr. Scott Forbush of the Carnegie Institution of Washington has analyzed measurements extending over about 18 years, and has shown that, at sea level, cosmic rays change about four percent during a solar cycle. Surprisingly, the relationship is inverse, so that when the sun is most active the intensity of cosmic rays is least, and vice versa. There is thus some justification for the idea that cosmic rays are nearly constant since this solar-cycle change is fairly small.

High altitudes and latitudes

However, as everyone now knows, cosmic rays themselves do not reach down to sea level—only their progeny do. We have to go to high altitudes and to high latitudes if we really want to find out what cosmic rays are up to. People are becoming somewhat less mundane in their thinking than was the case before rockets and space travel were talked of—just as we in the United States are becoming less provincial-minded as we become more aware of what is happening in the rest of the world.

Since cosmic rays appear to be really cosmic (i.e., they appear to come from space itself) when we speak about them in meaningful terms, what we are actually talking about is cosmic rays as they would be observed at some distance from the earth. The reason for getting away from the earth is that its magnetic field interferes with the low-energy part of the cosmic ray spectrum.

There are two locations on the earth where conditions are such that we are as good as out in space, provided we can get to the top of the atmosphere—namely, near the two geomagnetic poles. Here, charged particles of all energies can come to the earth, because the magnetic lines of force of the earth are vertical—or nearly so—and even the lowest energy particle can come spiraling in.

The requirement of reaching to the top of the atmosphere we cannot meet completely, but we can get 99 percent through the atmosphere with present-day balloons. This corresponds to a height of about 100,000 feet. Protons with energies as low as 150 million electron volts can penetrate down to this altitude. Indeed, on one flight in 1955, made from Thule, Greenland, our balloon reached an altitude where the pressure was only 0.40 percent of one atmosphere, and the particles found here were presumably protons and had energies down to 100 million electron volts.

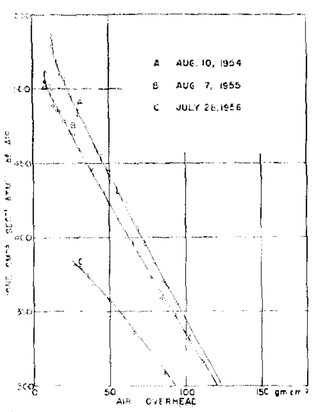
From work with various kinds of equipment sent to high altitudes with balloons, we know that a majority of cosmic-ray particles of higher energies are protons. In a series of balloon flights with ionization chambers at various latitudes in 1954 it was shown that the low-energy particles that can reach down to less than 10 percent through the atmosphere are also protons.

The curves at the left, below, show how large the changes at high altitudes can be with the passage of time. The abscissas are in terms of grams per cm^2 of air pressure ($1033\ g/cm^2 = 1$ atm); the ordinates are the ionization produced in an ionization chamber in terms of ion pairs/cm^3/sec/atm of air. (To convert to milliroentgens per year multiply by 15. To get the intensity in space multiply the ordinates by 2.) To account for the large differences between curves A and C, the numbers of incoming particles must have changed by a factor of 2.5 at least from 1954 to 1956.

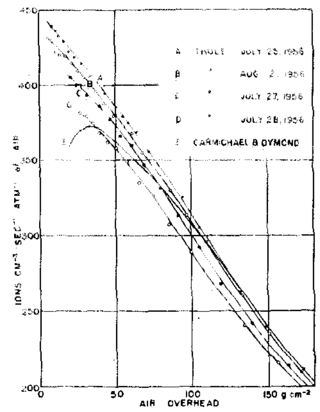
Since the low minimum of 1954, the sun has been increasing in activity and will presumably reach a maximum near the end of the IGY.

What 1957 and 1958 will bring, we, of course, dare not predict. We plan to return to Thule, Greenland, in both these years to learn what we can. In 1956 the ionization in the middle part of the atmosphere was less even than in 1937, when the sun was at a maximum of activity—although, at the lowest pressures, the intensity was higher in 1956 than in 1937, as shown at the right, below. The maximum of the curve of Carmichael and Dymond is due to the paucity of low-energy particles which do not multiply, compared with those of higher energy which create a number of secondaries as they strike the atmosphere.

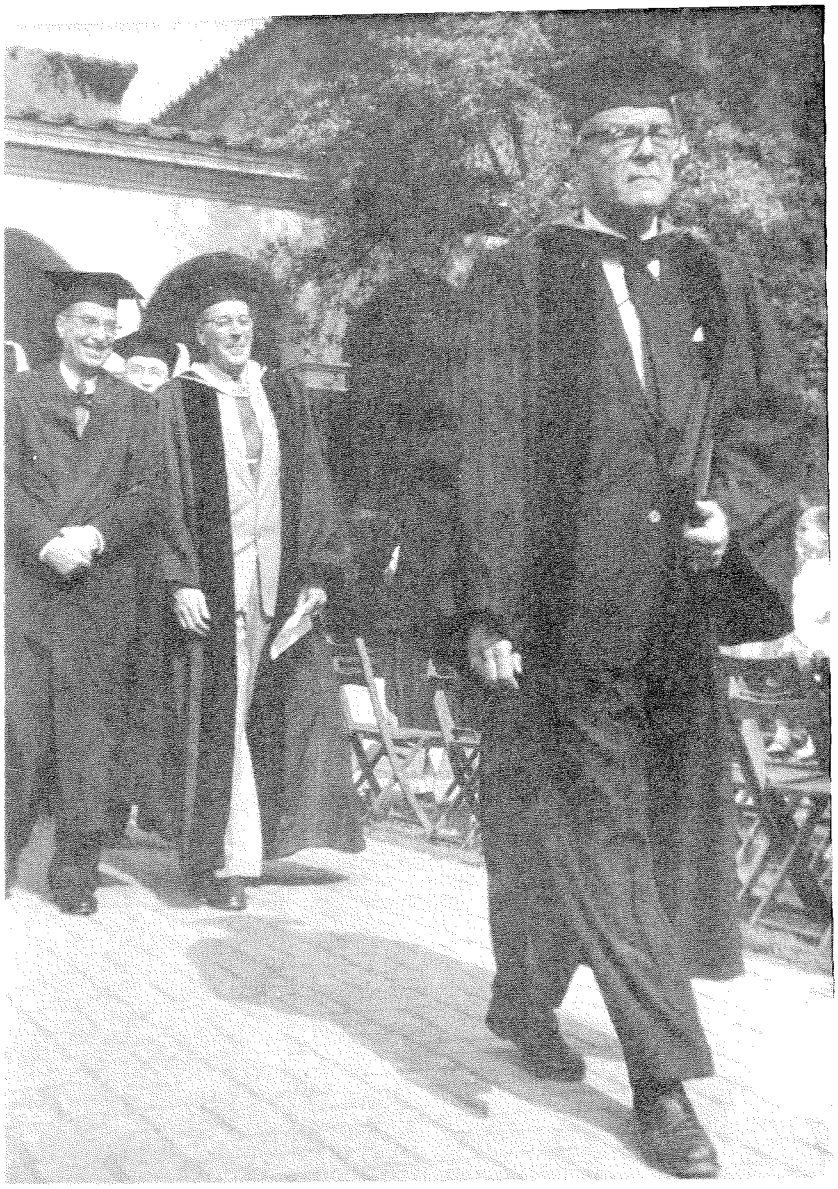
It is hoped that the data taken during the International Geophysical Year, by the several institutions planning balloon flights with various kinds of equipment at different latitudes, will add appreciably to our fund of knowledge concerning cosmic rays.



Intensity changes in cosmic rays from 1954 to 1956.



Cosmic ray intensity on different days in 1956 compared to 1937 (E).

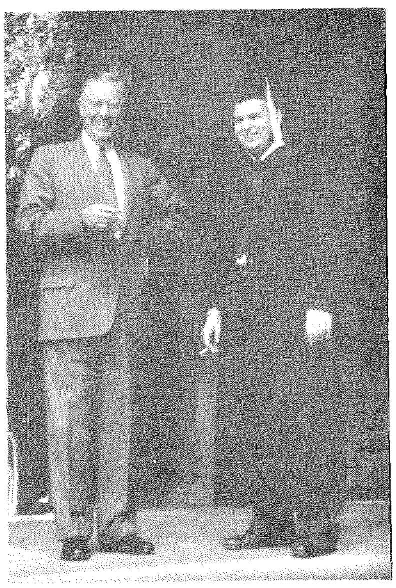


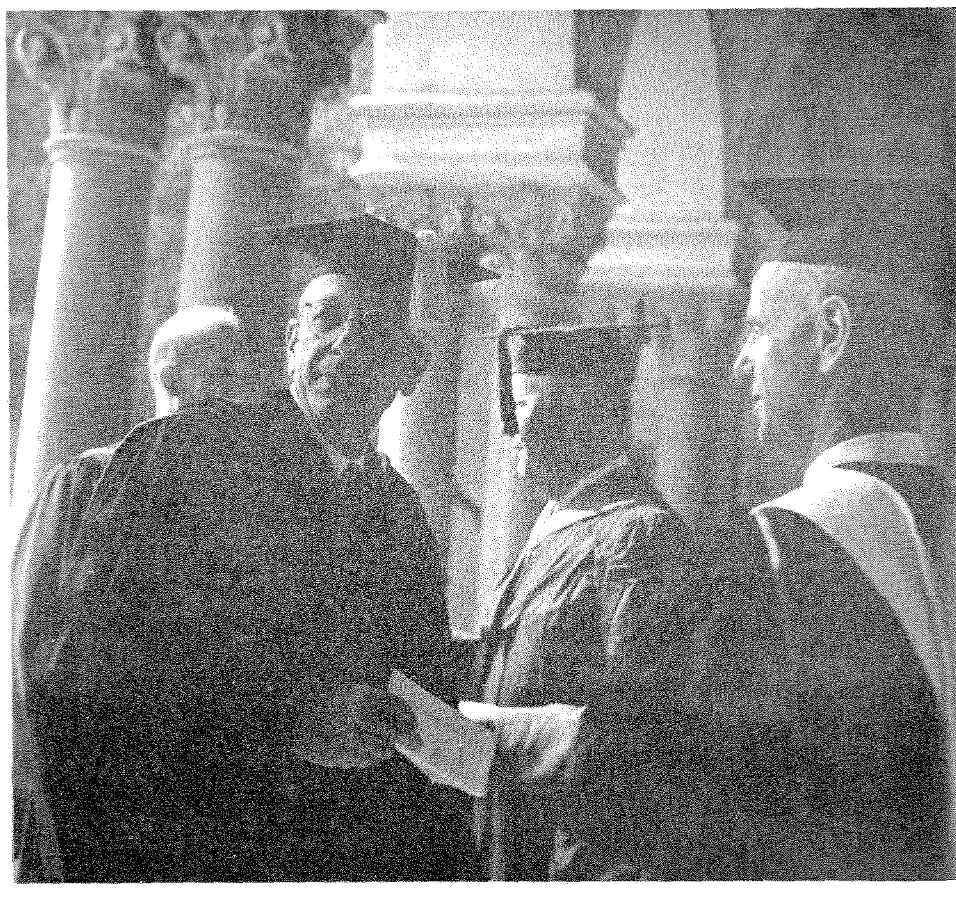
COMMENCEMENT 1957

AT CALTECH'S 63rd annual commencement on June 7, a total of 346 degrees were awarded—139 Bachelor's of Science, 138 Master's of Science, 11 Engineer's and 58 Doctor's of Philosophy.

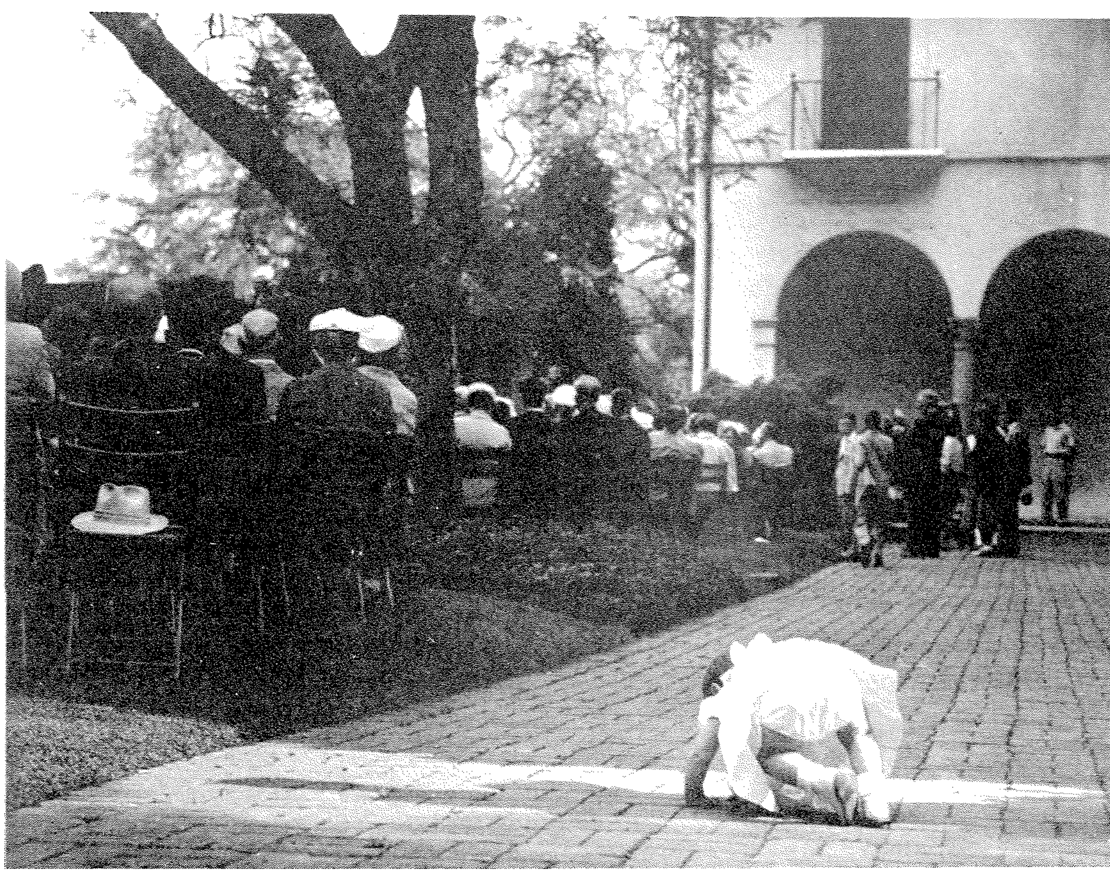
Of the 39 students who graduated with honor, 4 received both academic honor and student body honor keys: William McDonald, Herbert Rauch, Martin Tangora and James Workman. Honor keys were awarded to 17 men in all.

The Frederic W. Hinrichs, Jr., Memorial Award for the most outstanding senior this year went to Reuben B. Moulton, Jr. (at the left, below, with Paul C. Eaton, dean of students).





On the opposite page, some familiar faculty faces at the '57 commencement. Upper left, Harvey Eagleson, professor of English, leads the academic procession, followed by Foster Strong, dean of freshmen, and L. Winchester Jones, dean of admissions. Lower right, (p. 18) H. F. Bohnenblust, dean of graduate studies, and Peter Miller, assistant director of admissions. On this page, some graduates and some of the more—or less—interested spectators at the 1957 commencement.



THE NEXT HUNDRED YEARS . . . III

by HARRISON BROWN, JAMES BONNER AND JOHN WEIR

This article has been extracted from the book, The Next Hundred Years: Man's Natural and Technological Resources, *by Harrison Brown, James Bonner, and John Weir, published this month.* Dr. Brown is professor of geochemistry at Caltech; Dr. Bonner, professor of biology; Dr. Weir, professor of psychology.*

This extract, the last in a series of three, has been drawn largely from Dr. Weir's evaluation of our technical manpower sources.

IN OUR ANALYSIS thus far of the material, energy, and food resources of the world, from the purely technological point of view the future of mankind seems secure, if we exclude the possibility of a world catastrophe. There is an almost infinite supply of raw materials and of energy in the granite of the earth's crust, and we have sufficient knowledge of the technology of agriculture and of food production to support a world population of several times our present one. In principle, we may think of the problem of food and material resources in terms of energy. If we can produce sufficient quantities of energy and expend it properly in the production of food and materials, we can meet the demands we foresee for the future.

Our only remaining problem, then, is how to add this energy to the system. Obviously, someone must do it. But this is by no means a simple matter—much skill, knowledge, and equipment is required, and additional skill and knowledge are needed to build the equipment. So, in effect, we may be limited in the amount of energy we can expend, or in the rate at which we can expend it, by the availability of this knowledge and skill—that is, by the availability of technical brainpower, of trained scientists and engineers.

At the present time the United States is the most complex industrialized society in the world. Since it offers almost unlimited educational opportunities of many different kinds, as well as great freedom of educational and vocational choice, an analysis of technical brainpower resources in America will provide us with a good example of the problems of supply and demand for engineers and scientists in a free economy.

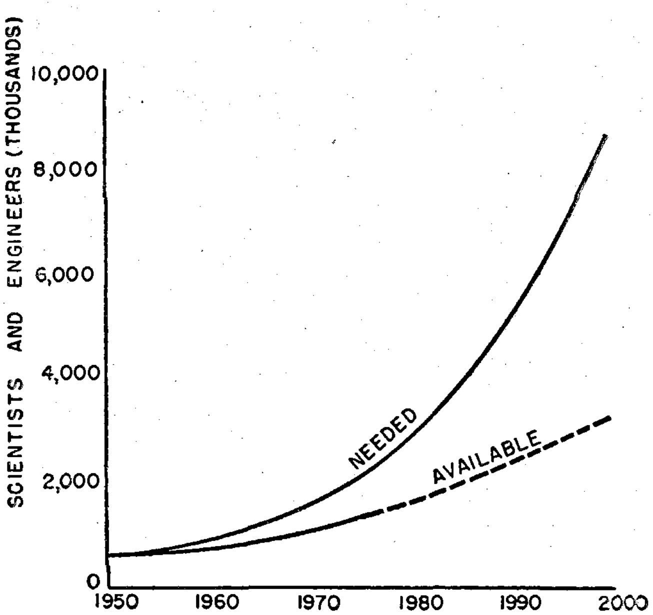
Scientists and engineers have been in short supply in the United States for several years—a shortage which is growing more acute and to which no immediate end is in sight. So critical has it become that industrial organizations are curtailing research and development activities because of a lack of available trained men. It takes many years to train an engineer and even more to develop a professional scientist. Even if we were to double enrollments in technical colleges immediately, it would be five to ten years before an appreciable effect would be felt in the field or in the research laboratory.

When we attempt to calculate the future supply of technical manpower, we are immediately faced with the problem of definition. What is a technician?

For our purposes, it will be satisfactory to confine our discussion to those scientists and engineers who have obtained bachelor's degrees in their respective fields. This group comprises the bulk of trained technical manpower in the United States; and a bachelor's degree in science or engineering provides a reasonably uniform criterion for professional competence.

In 1920 somewhat less than 3 percent of all 22-year-olds were college graduates. By 1930 this percentage doubled to almost 6 per cent. In 1940 it reached 8 percent, and by 1950, 11 percent. The rate of increase has slowed down in recent years, but it is predicted that by 1970 a plateau will be reached and that about 17 percent of all 22-year-olds in any one year will have earned college degrees.

For the past several decades the proportion of the graduates of any particular year that obtains degrees in engineering and science has remained around 18 to 22 percent. Within this group of technical graduates,



Projected technical manpower needs.

however, only about two-thirds of the engineers and one-third of the scientists continue in their respective fields.

On the basis of these varied figures, we obtain the curve above. It shows the total number of scientists and engineers with bachelor's degrees in the working population, and is adjusted for losses due to death and for retirement at 65. It gives us our expected available supply of working engineers and scientists of this level of competence from now to the year 2000, and it forecasts that we will have about 1,700,000 engineers and scientists in the working population by 1980—and about 3,300,000 by the year 2000.

We have, then, our estimate of future supply. What will be the future demand?

During the past half-century, the percentage of laborers and unskilled workers in the American labor force has been steadily decreasing while the percentage of semiskilled and professional workers has been steadily on the rise. The greater part of the increase in the proportion of professional workers is due primarily to increased numbers of scientists and engineers. At the beginning of the twentieth century there were about 1800 persons in the United States for each working scientist or engineer. By 1950, the ratio was about 300 to 1. By 1980, if these trends continue, we will need 1 scientist or engineer to every 90 persons; and by the year 2000, we will need 1 to every 40. When we compare this estimate of demand with the curve of supply, we may conclude that we will need over twice as many scientists and engineers as we will have available in the year 2000.

What are our ultimate potential resources of trained men? If we were able to change these past trends, could we increase the number of scientists and engineers produced each year? If so, by how many?

This is in part a question of the efficiency with which we can develop the potential engineers and scientists among our young people of school age. If we are efficient in this matter, then every American youth who possesses the abilities, traits, and characteristics required of successful scientists and engineers, and who wishes to enter these fields, will do so and will develop his potential abilities to their fullest extent.

As we are limiting our considerations here to engineers and scientists who have obtained bachelor's degrees from college or university, we can readily assess how well we are doing in the education of our young people by studying college enrollment and graduation figures.

For example, let us take a random sample of 100 American youths and follow them through their educational careers. All of them will enter the first grade, since in America everyone goes to school. Eighty will begin the ninth grade, 60 the eleventh grade, and 59 will graduate from high school. Twenty of them will go on to college, from which 13 will graduate—3 in engineering and science. (Only about one-third of our high school graduates go on to college. Of these, slightly more than one-half obtain their bachelor's degrees.)

These figures, which are typical of recent decades, give some indication of the attrition among American young people as they progress up through various levels of educational achievement. But they do not tell the whole story, for one may quite appropriately ask: Should *all* high school graduates go to college? Or, should *all* those who enter college obtain bachelor's degrees?

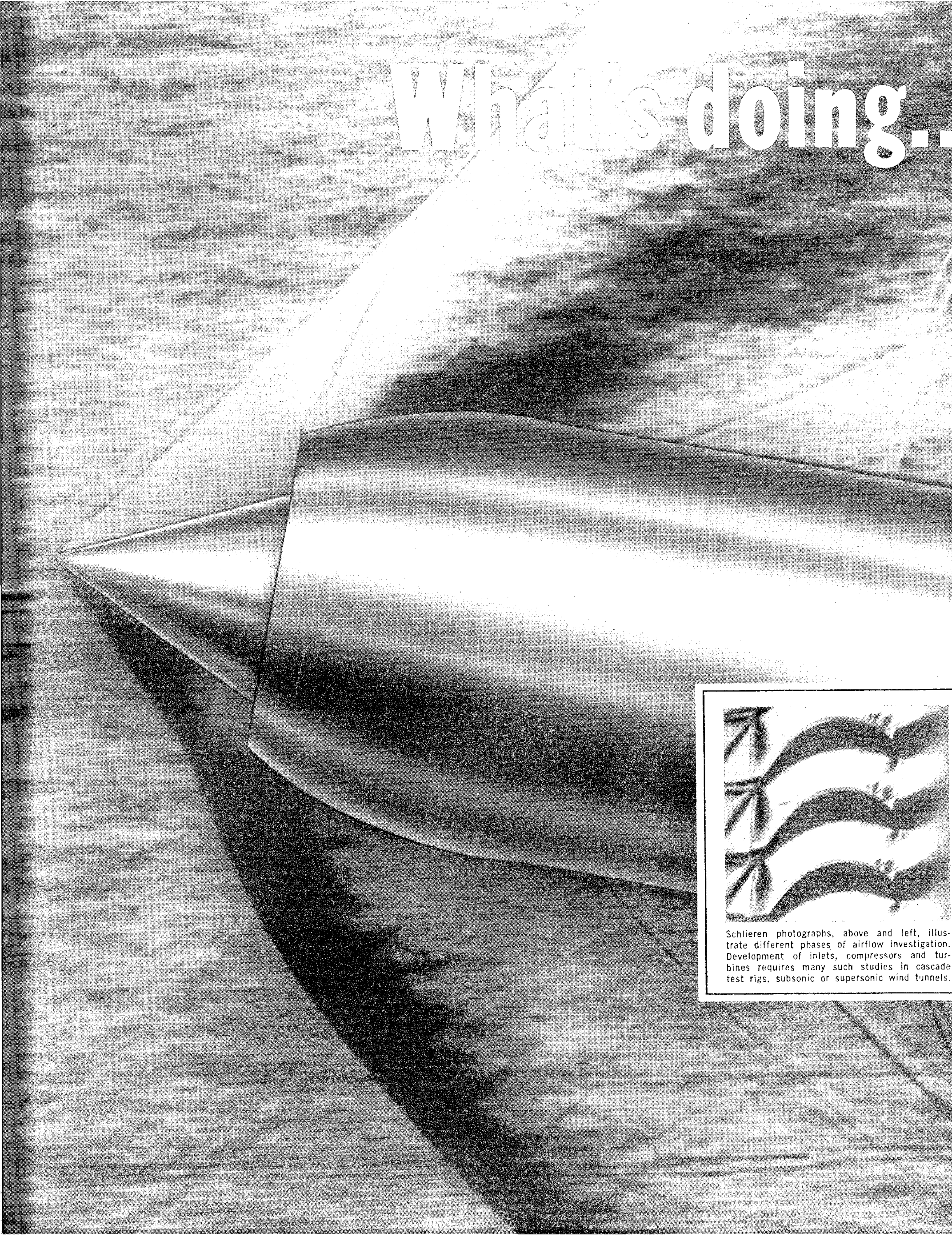
Intellectual manpower

The scholastic requirements set by our colleges and universities demand a minimum level of intellectual ability, so we must consider our output of intellectual manpower in terms of the available supply of potential graduates. We must concern ourselves with different levels of intellectual ability and judge how successful we are in helping each individual develop to his maximum potential.

The chart on page 24 shows the distribution of intellectual ability among certain groups of American young people. The numbers on the horizontal scale represent scores on the Army General Classification Test. These scores are measures of intellectual ability and are roughly equivalent to Intelligence Quotients. The height of the curve above any scale score represents the relative frequency of occurrence of individuals with that degree of intellectual capacity. The large curve represents the distribution of intellectual ability within an entire age group in the United States. The next smaller curve represents the distribution of intellectual ability in that portion of the total group that graduates from high school. Next is shown the distribution of ability of the portion that enters college, then of the portion that graduates from college, and finally, of graduates from college with degrees in engineering or science.

These curves show quite clearly the importance of higher levels of intellectual ability for higher educational achievement. While the average intellectual capacity for the entire group is 100, it is 110 for high

What's doing...



Schlieren photographs, above and left, illustrate different phases of airflow investigation. Development of inlets, compressors and turbines requires many such studies in cascade test rigs, subsonic or supersonic wind tunnels.

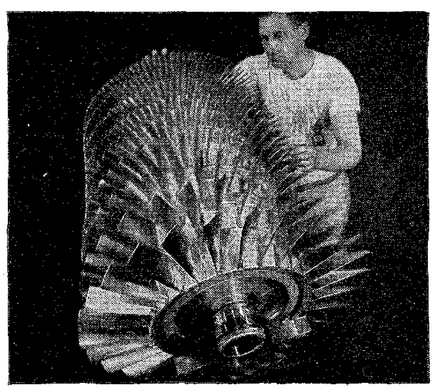
... at Pratt & Whitney Aircraft in the field of Aerodynamics

Although each successive chapter in the history of aircraft engines has assigned new and greater importance to the problems of aerodynamics, perhaps the most significant developments came with the dawn of the jet age. Today, aerodynamics is one of the primary factors influencing design and performance of an aircraft powerplant. It follows, then, that Pratt & Whitney Aircraft — world's foremost designer and builder of aircraft engines — is as *active in the broad field of aerodynamics* as any such company *could* be.

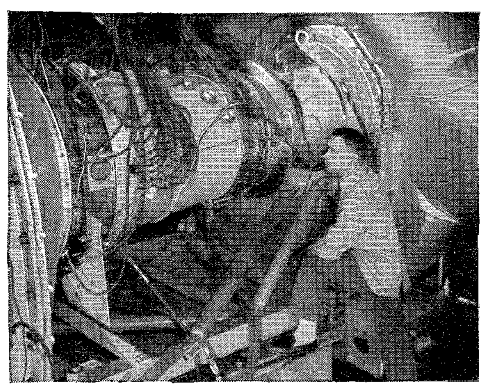
Although the work is demanding, by its very nature it offers virtually unlimited opportunity for the aerodynamicist at P & W A. He deals with airflow conditions in the engine inlet, compressor, burner, turbine and afterburner. From both the theoretical and applied viewpoints, he is engrossed in the problems of perfect, viscous and compressible flow. Problems concerning boundary layers, diffusion, transonic flow, shock waves, jet and wake phenomena, airfoil theory, flutter and stall propagation — all must be attacked through profound theoretical and detailed experimental processes. Adding further to the challenge and complexity of these assignments at P & W A is this fact: the engines developed must ultimately perform in varieties of aircraft ranging from supersonic fighters to intercontinental bombers and transports, functioning throughout a wide range of operational conditions for each type. Moreover, since every aircraft is literally designed around a powerplant, the aerodynamicist must continually project his thinking in such a way as to anticipate the timely application of tomorrow's engines to tomorrow's airframes. At his service are one of industry's foremost computing laboratories and the finest experimental facilities.

Aerodynamics, of course, is only one part of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of instrumentation, combustion, materials problems and mechanical design — spells out a gratifying future for many of today's engineering students.

Modern electronic computers accelerate both the analysis and the solution of aerodynamic problems. Some of these problems include studies of airplane performance which permit evaluation of engine-to-airframe applications.



Design of a multi-stage, axial-flow compressor involves some of the most complex problems in the entire field of aerodynamics. The work of aerodynamicists ultimately determines those aspects of blade and total rotor design that are crucial.



Mounting a compressor in a special high-altitude test chamber in P & W A's Willgoos Turbine Laboratory permits study of a variety of performance problems that may be encountered during later development stages.

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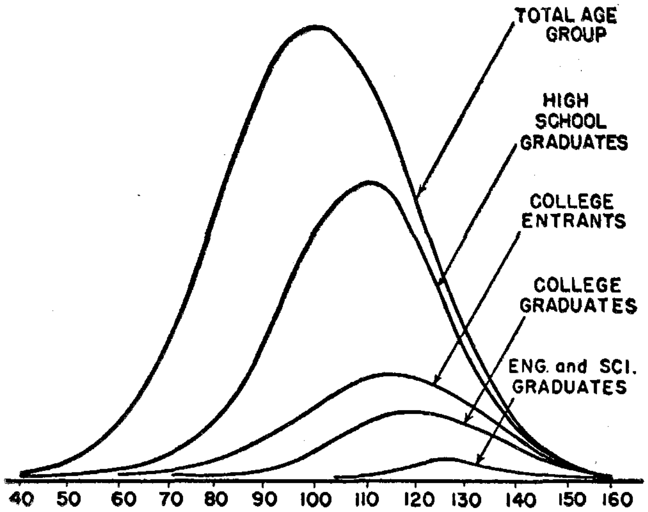


Distribution of intellectual ability.

school graduates, 115 for college entrants, and 120 for college graduates.

But these curves also indicate that there must be important factors in addition to intellectual ability that determine success or failure in college. For, on one hand, some young people scoring as low as 90 obtain college degrees, while on the other hand, at the extremely high-ability end of the curve (those with scale scores of 140 and above) we see that only two out of three obtain college degrees.

These curves indicate rather dramatically that we fall far short of developing to the fullest our intellectual resources within the United States. If we assume, for example, that a score of 110 represents a reasonable minimum of intellectual ability necessary for college-level work, then we can conclude that we lose two-thirds of our potential college graduates. We lose, by the mere fact that they don't go to college, one-half of the very capable, and one-third of the exceptionally talented.

Here, then, is one domain in which we might seek to increase our output of intellectual and technical manpower. If we could increase the efficiency of our educational procedures by eliminating this wasted potential brainpower, we could achieve an important reduction in our current technical-manpower shortage.

The more important influences which lead to success or failure in the making of a scientist or engineer fall readily into three groups—early identification, encouragement, and training.

Clearly, the earlier we can identify the embryo scientist or engineer the better, for we are then in a position to provide him with optimum intellectual and emotional opportunities and encouragement.

There are some indications at the present time that occupational choice within broad fields is determined to a very significant extent by psychological and cultural influences such as the parents' occupations, the socio-economic status of the family, positions of birth order among siblings, the attitudes of the parents toward intellectual knowledge, and the parents' own educational attainments.

We are just beginning to understand the manner in which these influences work. As we gain more understanding, we will be able to identify the embryo scientist or engineer at a much earlier age than is now possible.

The second group of problems centers around the encouragement of the budding scientist or engineer. Of importance here is his motivation for continued study and education. About half of the extremely high-ability students who fail to go on to college do so because they simply have no interest in higher education. Often the young student's rejection of intellectual achievement is a result of attitudes toward intellectual knowledge held by his parents and his peers. And certainly, with the great variety of social and cultural activities that are provided in American secondary schools today, distractions by competing interests and activities sorely test the student's motivation for intellectual work.

At both the elementary-school level and the high-school level, the manner in which science and mathematics are taught, and the enthusiasm and understanding of the teacher often have tremendous influences in awakening the spark of curiosity in young students. Too often, unfortunately, teaching procedures and course requirements deaden any interest the young student may have brought to the subject. In a recent study, the Educational Testing Service observed 60 mathematics teachers at the elementary-and secondary-school level. It was found that only 10 were competent to teach mathematics. The remaining 50 were judged to be confused, often dissatisfied, and unable to teach the subject except in a dull mechanical way.

Vocational counseling

Next, there is the matter of sound educational and vocational guidance and counseling. A student of high-school age is usually quite ignorant of the skills, abilities, interests, and personality traits which are necessary in order to be successful in a particular adult occupation. This is especially true for the professional occupations. Yet only rarely can a young student gain any first-hand experience as a scientist or engineer until very late in his college career. And so he must rely on the advice and guidance of others in making his vocational choice.

Often he must begin this reliance in the 10th or 11th grade in high school, at which time he must choose to study the mathematics and science courses that are required for admission to a technical school. He is much more likely to choose an occupation that will properly match his abilities, interests, and values if he has the opportunity to consider all possibilities in the course of discussions with trained counselors.

Still another influence that relates to the encouragement of potential scientists and engineers concerns financial support. In recent years about 40 percent of high school graduates who were clearly capable of doing college work did not go on to college because of lack of adequate finances. This is today recognized across the country as a loss of technical manpower that can be decreased by immediate and direct action. As a result, the funds available for scholarship purposes have recently been increasing rapidly, especially in technical schools. They have come from school funds, from industry, and from state and federal programs. The time is approaching when any qualified and deserving high school graduate who wishes to enter a technical field will not be blocked by lack of funds—whether he be merely capable, outstanding, or extremely gifted.

Teacher shortage

The third group of factors which affect losses in the production of engineers and scientists relates to training or education. We are faced also with the fact that high school science and mathematics teachers are in short supply. For example, we needed about 7900 new mathematics and science teachers in 1954-55. Only 3800 actually completed training in the same period. Of this number, only 2100 entered teaching in the fall—filling about one-fourth of the total need.

This attrition is easily explained. If the young teacher is well trained in his subject, he can begin his career in industry at an initial salary 25 to 50 percent greater than the initial school salary. After five years in industry, he can expect to earn as much as he might be getting after 14 years in teaching. A qualified scientist must indeed be a dedicated teacher to resist such an attraction.

Thus, the overall effect of these different influences on high school science and mathematics teaching is to lower the quality of teaching and to make instruction in science and mathematics less available just at the time when our industrial growth demands more scientists and engineers.

There is no serious shortage of teaching staff in higher education—at least up to the present time. Higher pay scales, greater prestige, and opportunity to pursue individual research interests have so far proved sufficient to attract qualified scientists and engineers into university teaching. We can, however, increase our efficiency in the production of scientists and engineers at the college level by critically evaluating our admissions procedures and course requirements.

One can certainly question whether it is really necessary to take 22 years to develop a scientist or engineer to the bachelor's-degree level. Might it be feasible to push back the age at which college-level teaching is begun from 18 to perhaps 16 or 15? Are 12 years of elementary and secondary education necessary before the student is qualified to begin what we now regard as a college career? There is strong evidence that the answer is no.

We also need to take a more critical look at our college course requirements. There have been almost no attempts to study the performance by college alumni in their productive careers and to find out how college performance and college course requirements prepare the student for later life. We have little validation of our college teaching procedures. There are probably many undergraduate courses currently required of all students that make no useful contribution to the students' skill or knowledge—either professionally, socially, or culturally.

We have discussed a few of the major factors which currently limit the production of scientists and engineers in the United States. Some of the problems are quite obvious, and solutions to them appear simple and straightforward, although difficult to achieve. For example, the shortage of science and mathematics teachers in the high schools would be eased if teacher pay scales were raised to the industrial level.

Solutions to other problems are not so clear. It will take years of intensive research before we will be able to enumerate all the important factors which contribute to the early identification of scientists and engineers, or before we understand thoroughly the nature of creative thought. It will take imagination, effort, and money to reduce these sources of waste to insignificance. However, if all these obstacles could be removed—and it seems theoretically possible to do so—then we would have a working force in which each individual would have achieved the highest educational level commensurate with his intellectual capacity.

Clearly, we would greatly increase the number of college graduates produced each year. As a matter of fact, we would have graduated about 75,000 scientists and engineers each year for the last two years, instead of the 45,000 we actually did produce.

Why not women?

We can also increase our production of scientists and engineers in quite another way. Among working college-graduate engineers and scientists in the United States, only 1 percent of the engineers and 11 percent of the scientists are women. Does this have to be? No student of human behavior has as yet convincingly isolated any difference between the sexes that would forever preclude women from becoming competent in these fields.

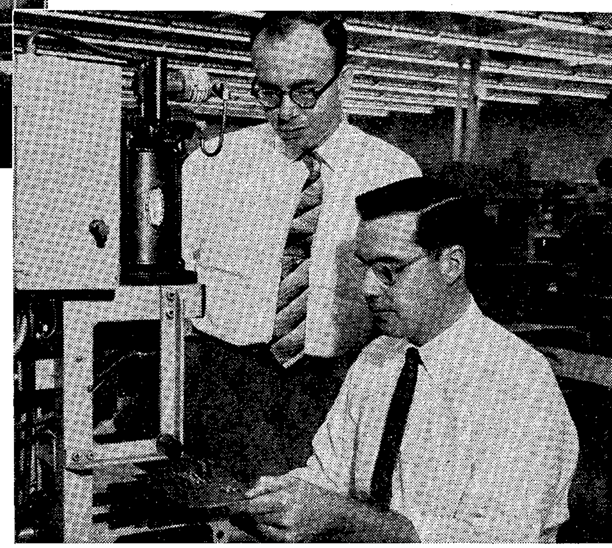
In Russia today, where 50 per cent of professional workers and at least 20 percent of engineers are women, we have a clear demonstration that women can successfully enter these fields. If technical occupations were to be made available and attractive to women, then we might almost double again the number of scientists and engineers produced in America each year.

Meet Bill Hancock

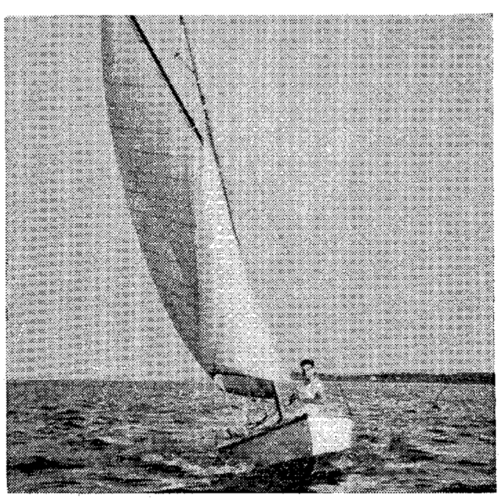
Western Electric development engineer

Bill Hancock is a graduate of Pennsylvania State University where he majored in industrial engineering. Bill joined Western Electric as a planning engineer in November, 1951, at the Kearny Works in New Jersey. Later, he was assigned to the new Merrimack Valley Works in North Andover, Massachusetts, as a development engineer. Here Bill is shown leaving his attractive New England home for his office while his wife, Barbara, and their daughter, Blair, watch.

Bill's present assignment at Western Electric: the development of methods and machinery for assembling one of today's most promising electronic developments — electronic "packages" involving printed wiring. At a product review conference Bill (standing) discusses his ideas on printed wiring assemblies with fellow engineers.



Bill and his supervisor, John Souter, test a machine they developed to insert components of different shapes and sizes into printed wiring boards. The small electronic packages prepared by this machine are being used in a new transistorized carrier system for rural telephone lines.



Sailing off the north shore of Massachusetts is one of Bill's favorite sports. He also enjoys the golf courses and ski runs within an easy drive from where he lives and works.

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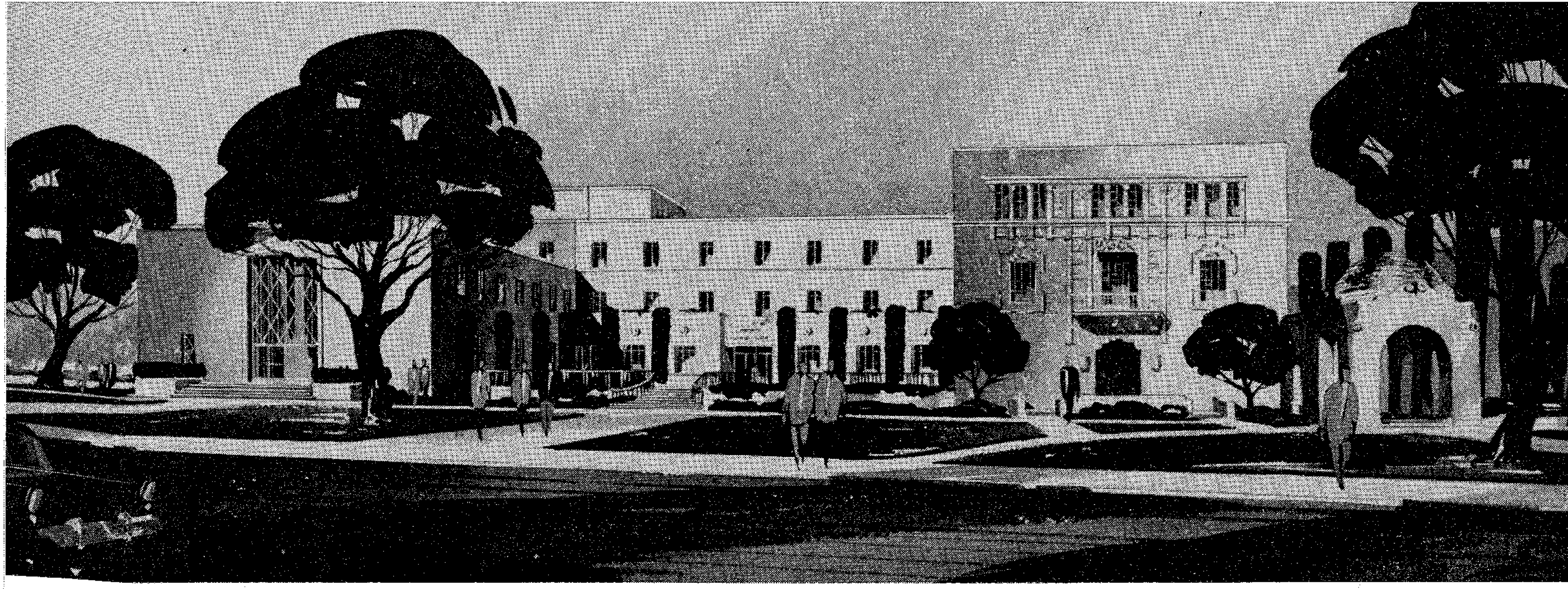


A New Biology Building

by GEORGE W. BEADLE
Chairman of the Division of Biology

WHAT, ANOTHER BIOLOGY BUILDING? They've just had one!

It isn't exactly *another* Biology building we are talking about. It is rather the completion of *the* Biology Unit—the fulfillment of a plan made almost 30 years ago.

In the area just outside the Kerckhoff Library of Biology there is a drawing made in 1931 by Architects Mayers, Murray and Phillip. It represents the plan for the "Biology Unit" as then visualized by George Ellery Hale, Arthur Amos Noyes, Robert Andrews Millikan, William G. Kerckhoff and Thomas Hunt Morgan. Professor Morgan had just got the new Biology Division well under way. It was Mr. Kerckhoff's hope—shared by all—that the building fund he and his wife had established would go a long way toward making the total plan a reality. But for the unforeseen rise in building costs, it would have.

Standing in Professor Tyson's driveway at 505 South Wilson Avenue, you will see that, with the addition of the Norman W. Church Laboratory for Chemical Biology, a large part of the 1931 plan has now been transformed into living laboratories. But one important section is missing. That is the wing connecting Kerckhoff and Church. The drawing reproduced here, which was prepared by the Physical Plant Department of the Institute, shows Kerckhoff and Church as they are today, and the proposed connecting wing pretty much as originally planned.

It is natural to wonder why more research space is needed in Biology so soon after the completion of Church. Here is the answer:

Animal virologists who now occupy Church were formerly housed in part in borrowed space at the Medical Research Institute of the Huntington Memorial Hospital. Kerckhoff rooms formerly used by bacterial virologists are being remodeled for Professor Robert Sinsheimer of Iowa State College, who joins the permanent faculty of the Institute in July. The rooms emptied in Kerckhoff by the moving of division offices to Church serve to relieve overcrowding of research workers in biochemistry and genetics. With the sale of the division's experimental farm, including a laboratory building, to the Temple City School District, plant genetics will have to have some space in Church or Kerckhoff. The entire east end of Church has served well to relieve former intolerable crowding in Chemistry. The second floor, west end, provides a home for a long homeless Department of Mathematics.

As a result, unless plans are made now for more space in the next couple of years, Institute biologists cannot hope to follow their share of the new and promising leads in such areas as psychobiology, animal physiology, embryology, immunology, biophysics, biochemistry, genetics, plant physiology, and virology. In many of these areas larger and more elaborate machines are constantly being needed. A new analytical ultracentrifuge has just arrived. Another will soon be needed in Chemistry. There may soon be need for another and more modern electron microscope. New methods of using radioactive tracers mean more counting equipment. All of these, and the people who use them, need space. To use these facilities intelligently requires thought—and thinkers need places in which to practice their art.

The Kerckhoff-Church connection is only one of sev-

eral needed Institute buildings, among the most important of which are additional Student Houses and a Central Library. The final section of the Biology Unit will tie together, at four levels, two laboratories now physically separated except for an inconvenient connection through the experimental animal quarters. In addition to providing for additional and superior facilities for work in important areas of Biology, it will make possible centralized stockroom facilities where equipment, glassware, chemicals and other necessary supplies can be received directly at loading-dock level. And it will add significantly to the architectural attractiveness of the campus. The present parking lot on the roof of the animal annex will become an appropriately landscaped tiled terrace—a part of the main entrance to the entire unit.

This year, for the first time, the United States Public Health Service was authorized by Congress to make construction grants for needed research laboratories committed to the study of problems related to human health. The Divisions of Biology and Chemistry of the Institute applied for such a grant—a part to be used to complete the installation of chemical benches, utilities, and other fixed equipment in the Chemistry section of Church Laboratory, and a part to construct the connecting wing. On recommendation of a special Public Health Service study group that visited the Institute, the entire grant of $477,000 was made.

Such grants are made on a 50-50 matching basis. Funds for the completion of Church—$86,000—have been matched and work is now under way. The remainder—$391,000—is available for construction of the connecting wing if an equal amount is obtained from separate sources. In fact, somewhat more than an equal amount is needed because Public Health Service grants are restricted to research facilities, and one floor of the new wing will be devoted to a stockroom, classrooms and offices.

In addition to this Public Health Service construction grant, which will provide for fixed equipment but not for movable equipment, a second five-year grant of $289,000 has been made to the Institute by the same agency for movable equipment, supplies and other expenses incurred in the course of research in experimental biology. A substantial portion of the equipment purchased on this grant will finally be housed in the new wing.

With such an encouraging beginning, hopes run high that the Biology Unit envisaged so many years ago will soon be complete.

ALUMNI NEWS

President's Report

THIS PAST YEAR has been a highly successful one as the result of the work of a good many of our alumni. Here is a quick review of the year's activities. We're sorry we cannot give credit to all who contributed their time.

The drive for funds to endow four four-year undergraduate scholarships is complete. In four years, our alumni contributed over $90,000. Three scholarships have been granted. The fourth will be awarded to a freshman starting in September this year.

Two directors, Bob Bungay and Ed Fleischer, headed the Fund drive this year. Some 1600 alumni contributed over $27,000 during the year.

The directors have selected as the next Fund goal, a part of the new student house—student union complex. We have agreed to raise about $150,000 as our contribution to this much-needed facility. You will be hearing more about this project soon.

By now, all of you have received your new Alumni Directory. Many alumni turned out to help catalog and proof all the data you sent in. The Secretary's office did their usual excellent job in typing and arranging the data. Director Dick Stenzel is responsible for a fine piece of work.

Our social program was particularly outstanding this year. Director John Fee and General Program Chairman Frank Bumb, with their committee of six, made all the arrangements. In order of occurrence were the sock hop with the undergraduates, the fall dinner meeting, the winter dinner meeting, the annual dance, the annual meeting, and—yet to come—the picnic.

The Seminar brought many alumni back to the campus for an interesting day. Director Chet Lindsay, General Chairman Fort Etter, and Program Chairman Manfred Eimer headed the group of some 16 alumni who worked behind the scenes.

Vice President and Senior Board Member Willis Donahue aided in the direction of both the Program and Seminar.

Directors Dick Jahns and Jack Osborn handled the membership drive. This year our membership reached 3573, an increase of 299 over last year. Sixty-three per cent of the men receiving BS degrees are members of the Alumni Association. This is one of the highest percentages in the country.

Retiring from the Board this year are Directors Bob Bungay, Dick Jahns and Dick Stenzel. On behalf of the alumni, I would like to thank them for their two years of work on the Board.

Four capable men join the Board this year. They are Frank Bumb, Fort Etter, John Fleming, and Nick Ugrin. All of these men are proven workers and will assure the continued success of the Association.

—*William F. Nash, Jr., President*

Alumni Picnic

HOLIDAYLAND, the area set aside for special groups by Disneyland, will be the locale for the annual alumni family picnic on June 29. The seven-acre picnic and play area features sheltered picnic tables, a baseball diamond, a children's playground and a refreshment stand. Caltech alumni are fortunate in being one of the first groups to have exclusive use of the area, which has a separate entrance and should permit them to see Disneyland in a more relaxed and leisurely manner than would otherwise be possible.

Disneyland holds many attractions, including two new ones—the Sleeping Beauty Palace and the New Utopia—so organize a group of alumni and guests to take advantage of this rare opportunity.

Save the date for Holidayland—June 29.

—*Frank Bumb, Program Chairman*

Chapter Note

THE SPRING DINNER DANCE of the San Francisco Chapter on May 11 at the Officers' Club, Hunter's Point Naval Shipyard, was enjoyed by 51 couples.

—*Jules Mayer, Secretary*

PERSONALS

1922

Edward G. Kemp, who has his own business as an insurance broker in Hermosa Beach, writes that "perhaps some bragging is excusable after 35 years; I now have 5 grandchildren—2 Californians and 3 Texans."

1925

John E. Maurer's 22-year-old daughter, Phyllis Ann, won the $1,000 Tom Treanor-Los Angeles Times Fellowship in Journalism last month. This provides for a year of study in the UCLA department of journalism. John is owner of the Tidi Products Manufacturing Company in Pomona.

1933

John C. Monning, assistant superintendent of the Los Angeles City Department of Building and Safety, was recently appointed a Reserve General of the U.S. Army Reserve. John has commanded the 409th Engineer Brigade for the past 15 months. This particular brigade was the only U.S. Army Reserve unit to be called to active duty as a unit, serving throughout the Korean War.

1936

Tyler Thompson is now professor of philosophy of religion at the Garrett Biblical Institute, the graduate theological school of the Methodist Church, on the campus of Northwestern University in Evanston, Illinois.

1937

Bernard Walley, Western district field engineering manager, in the tube division of RCA in Los Angeles, received an RCA Victor Award of Merit in Philadelphia recently. He's been with the company for 20 years, and has been manager of his department since 1955.

1938

Yuan C. Lee has been appointed as director of research and planning of the liquid engine division of the Aerojet-General Corporation in Azusa, California. He's been with the company since 1949.

1940

Robert C. Brumfield, MS '41, PhD '43, writes that "by virtue of being a founder and stockholder, I am now vice president and secretary treasurer of Automatic Fire Control, Inc., in El Monte, California. We manufacture and install automatic fire protection systems and automatic fire sprinklers.

"I have been hobbling around on crutches for a couple of months as a result of a skiing accident at Mammoth Mountain. Our two daughters—Corinne, 11, and Cynthia, 8—have been swimming and diving for several years with the Caltech Swim School under the able tutelage of Coach Warren Emery."

1941

Joseph F. Rominger, head of the geology section of International Petroleum, Ltd. (an affiliate of the Standard Oil Company) in Bogota, Colombia, writes that "after finishing graduate work with a PhD from Northwestern in 1948, I left the U.S. Geological Survey and began working for the Carter Research Laboratory at Tulsa, Oklahoma. The geologic section there does nearly all of the geological research for the parent company, the Standard Oil Company of New Jersey. During my five years there I spent six months in Venezuela, then worked all over the States. Four years ago we moved to Colombia, where I started work with International. The section has 85 people, including 35 North American geologists.

"I see by the 'we' in the above paragraph that I left out a very important event. In 1948 I married Betty Jordan of New York, who attended Northwestern when I did. We have a daughter, Kathryn Lynn, soon to be 5.

"I have met Tech men in various places since leaving school. *Clyde Wahrhaftig*, '41, *Henry W. Menard, Jr.*, '42, MS '47, and *Bob Greenwood*, '42, MS '43, were all at Harvard when I was there after the war. I saw them all again in Mexico City last August at the International Geological Congress.

"Probably the most unusual encounter was with *Norm Svendsen*, MS '42, and his wife on the streets of Copenhagen two years ago while we were vacationing in Europe. They were three-quarters of the way around the world, having gone west from Pasadena. Norm and I used to play on the tennis team together.

"I saw *Bill Chapin* at his home in Houston a couple of years ago. Then last year *Francis D. Bode*, '30, MS '31, PhD '34, was in Bogota on business and had dinner with us. He was my field geology professor at Caltech and is now with the Texas Petroleum Company in New York City, as some sort of coordinator of geological work for South America and Africa.

"I've also seen *John Maxson*, '27, MS '28, PhD '31 (another former geology teacher) and *Warren Beebe*, a geology grad student, on several occasions.

"I am going to attend Cornell's six-week executive development program starting June 16. After that we will go on our two-month foreign vacation ('foreign' means outside of Colombia). Part of that trip will include visiting my parents in

Personals . . . CONTINUED

Long Beach—and a trip to the Caltech campus, I hope."

1943

John W. Otvos, PhD, was appointed head of the chemical physics department of the Shell Development Company in Emeryville, Calif., this month. He has been with Shell since 1946.

1945

Robert F. Schmoker is now branch manager of the Sacramento office of American Blower, a division of the American Radiator and Sanitary Corporation. He was formerly sales engineer for the company, in Berkeley. The Schmokers and their three children—Linda, Nancey and Robert—now make their home in Sacramento.

1948

George S. Holditch is now superintendent of Procter & Gamble's Kansas City factory. He was formerly general production supervisor at the Chicago factory. George has been with the company since 1948.

Hugo D. Schwartz, MS, writes that "after I left Caltech, I journeyed to Chile, where I stayed for a short time, until the outbreak of the war of independence in Israel changed my plans. From the end of 1948, until 1951, I worked for the Israel ammunition plants, where I was in charge of planning the purchase of materials and machinery. In 1951 my brother and I opened a consultant engineers office, designing molds and planning production for plastic and metal factories.

"At the end of 1952 I founded the Israel Brake Lining Manufacturers, of which I am managing director. We are gradually making it a first class production unit—exporting to half the world, including the U.S.

"Lately I started a shipping enterprise and we are planning to build some tankers and ore carriers in Germany.

"My family has grown to three—my latest boy having been born last February. Besides business, I have been appointed Chili's Honorary Consul in Tel-Aviv."

1949

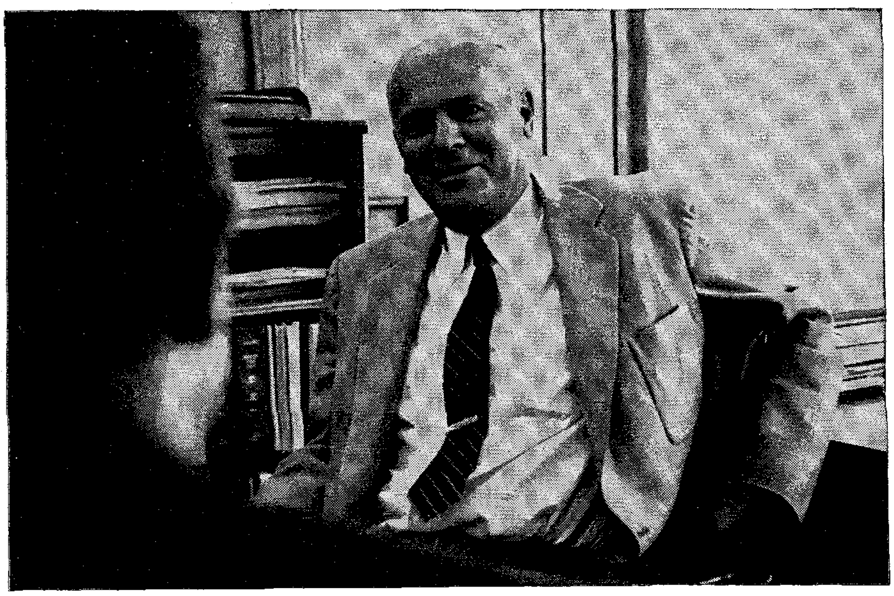
Gene D. Six, mathematics teacher at Pasadena High School, announces the arrival of the newest model Six—Laura Lynn, born on April 20—a companion to their 1955 model.

1950

David B. MacKenzie is now a research geologist at the Ohio Oil Company's research center near Denver, Colorado. He was formerly with American Overseas Petroleum, Ltd., in New York.

Richard H. Knipe has been working at the U.S. Naval Ordnance Test Station in China Lake, California, since his graduation from Caltech.

CAREERS WITH BECHTEL



JAMES F. DEL CURO, *Mechanical Engineer, Power Division*

MECHANICAL ENGINEERING

One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.

QUESTION: *As I understand it, Mr. Del Curo, the Power Division is concerned with the engineering phases of steam-electric generating plants?*

DEL CURO: That's true. Our own department is specifically concerned with the mechanical engineering phases of such plants.

QUESTION: *When the engineering graduate joins your department are his starting duties standard?*

DEL CURO: Yes. The routines are pretty well defined. We know a man learns best by actual doing, so he is put to work immediately on heat balances, line size calculations, specifications, miscellaneous and minor auxiliary equipment, instrument data sheets and information for plant data books.

QUESTION: *In other words, you sort of throw the man in and he has to learn to swim by himself?*

DEL CURO: No. He has plenty of help. He works under the direct supervision of a job engineer or the mechanical group supervisor.

QUESTION: *How long does this training phase last?*

DEL CURO: That will vary with the man, since aptitudes and desires to learn are different. The average is somewhere between a year and eighteen months.

QUESTION: *During this period he will gradually advance to more complicated equipment?*

DEL CURO: Yes. For example, after a while he will be doing original work on heat balances and system studies. He will be able to take an entire "piece" of a project and handle it on his own responsibility. He will become involved with bigger equipment and with the overall aspects of the power plant. Somewhere along the line he will likely be assigned to try his hand at piping materials, piping specifications and combined control specifications.

QUESTION: *What about the man who wants to specialize?*

DEL CURO: If, for example, a man shows a particular interest in steam turbines, instrumentation or control, and demonstrates a special aptitude for one of them, he will often be called on to work on that specialty, without being confined to it exclusively. Thus we encourage specialization, even during the training period, but also make sure that the young man gets overall experience through work in all phases of mechanical engineering.

QUESTION: *What about field experience?*

DEL CURO: That is, of course, highly desirable from his standpoint and ours. We make every effort to assign the young engineer to field work as soon as possible.

QUESTION: *What will he do in the field?*

DEL CURO: When we are building a power plant we try to get the young engineer on the job five or six months before the scheduled start up of the plant. He will actually help the chief start up engineer by writing up procedures, planning the hydraulic washing to steam lines, working on the start up of each piece of the equipment, checking out controls, etc.

He will also handle paper work such as filling out the data sheets that are later turned over to the plant operators to aid them in running the plant. By the time the turbine is rolled and the job ends, the young engineer has been able to see the end result of all the engineering work he and others have done back in the office.

QUESTION: *Are there any other types of field assignments?*

DEL CURO: If the young engineer desires such experience, he is sometimes used in the construction department if that group is shorthanded.

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Personals . . . CONTINUED

Dr. Peter T. Knoepfler is now a captain in the Medical Corps of the 3750th Technical Training Wing ATC at Sheppard Air Force Base in Wichita Falls, Texas. He had been working at the Bronx Municipal Hospital in Bronx, N.Y.

1951

Elmer F. Ward, president of Task Corporation, writes that the company has moved from Pasadena to Anaheim, California. The Wards have three children—two sons, 13 and 1, and a daughter, 9.

1952

Wilbur Barmore, mechanical engineer at the Wiancko Engineering Company in Pasadena, writes that he now has a third daughter. Bill adds that he's working with *William Rihn, Keith Winsor* and six other Techmen at Wiancko.

1953

John C. Behnke, Jr., writes that he'll receive his MD degree this month at UCLA, and will then begin his internship at the San Francisco City-County Hospital. The Behnkes have a seven-month-old son.

1954

Paul Concus, in his third year at the Harvard Graduate School of Arts and Sciences, has been awarded an Eastman Kodak Company Fellowship for 1957-58.

John L. Abbott graduated from the U.S. Navy's Officer Candidate School in Newport, Rhode Island, last March. He was formerly with the Calmec Manufacturing Company in Los Angeles.

1955

Dorothy A. Semenow, PhD, who has held a National Science Foundation postdoctoral fellowship this year at Pomona College, has been appointed assistant professor of chemistry there for 1957-58.

Hendrick H. Paalman, MS '56, who is studying for his PhD in chemical engineering at Stanford, announced his engagement to Nancy Creer of Pasadena last month.

1956

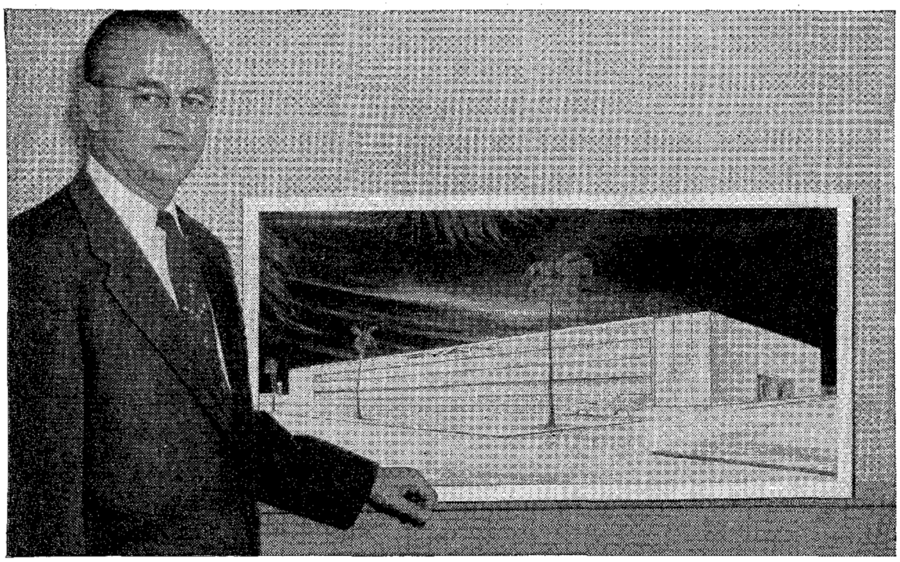
Frederick N. Benning, working in the control system division of the Ramo-Wooldridge Corporation in Los Angeles, will be married in August to Miss Sandy Hawkins, who graduates from UCLA this month. Fritz is studying for his MS in night school at UCLA.

William M. Chapple, who received his MS in geophysics at Caltech this month, will be studying at the University of Paris on a Fulbright grant for the 1957-1958 academic year.

1957

Don L. Bunker, PhD, is now a chemist at the University of California's Los Alamos Scientific Laboratory. Don is married and has one child.

New Engineering Opportunities Created as Ryan Projects Mushroom



FRANK W. FINK, RYAN VICE PRESIDENT AND CHIEF ENGINEER inspects architect's drawing of new Engineering and Research Center.

New Engineering and Research Center To Meet Ryan's Expansion

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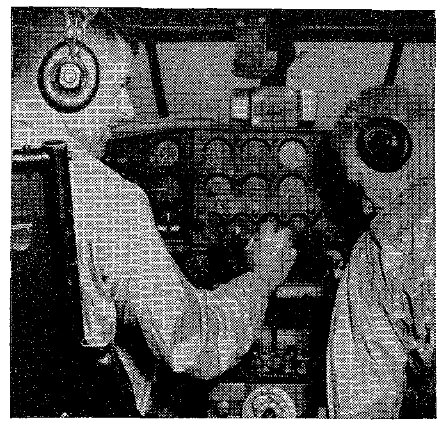
The system provides pilots and navigators with continuous information on longitude, ground speed, ground mileage, drift angle and ground track. It is accurate and instantaneous. Requires no computations, ground facilities or wind data.



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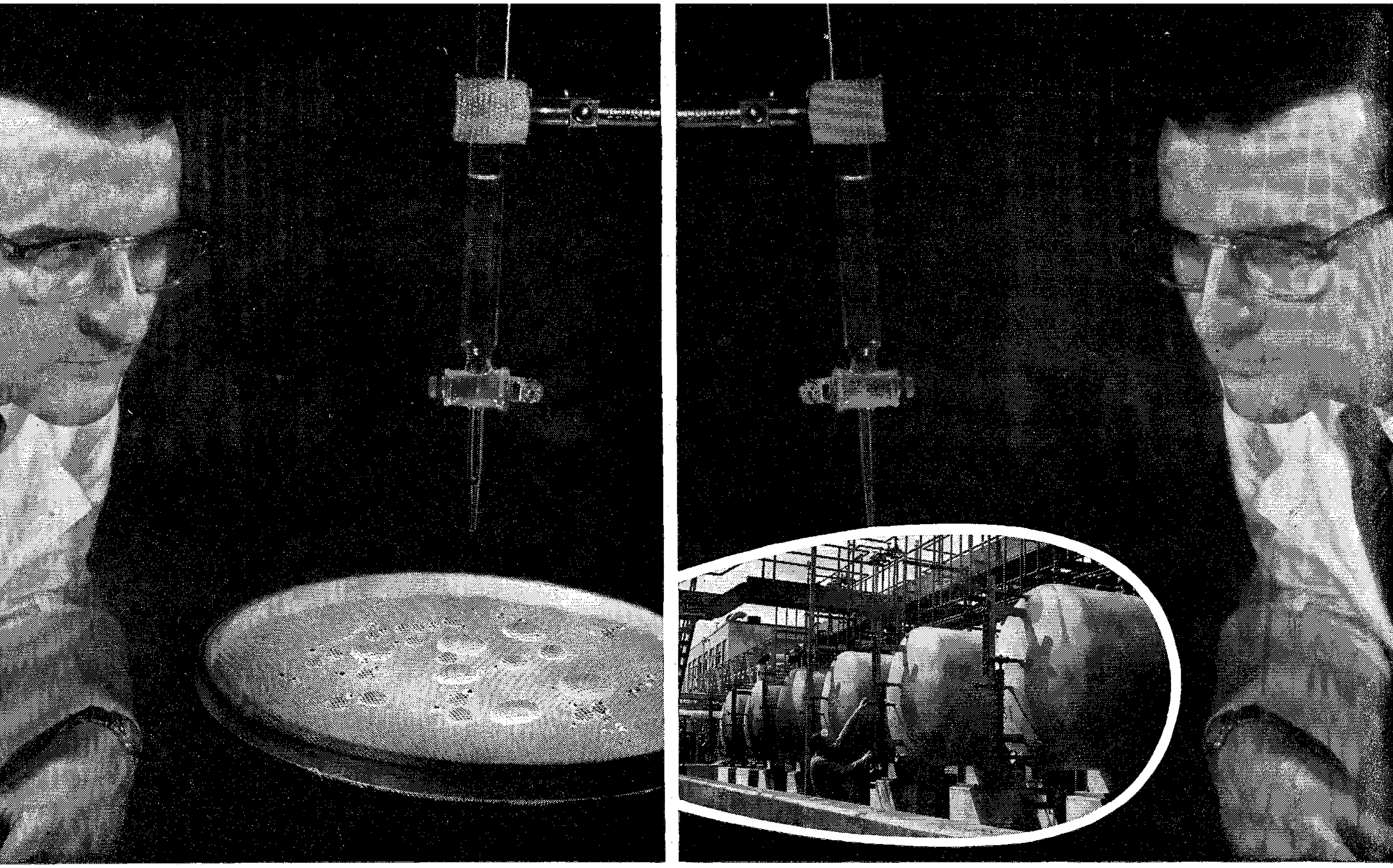

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