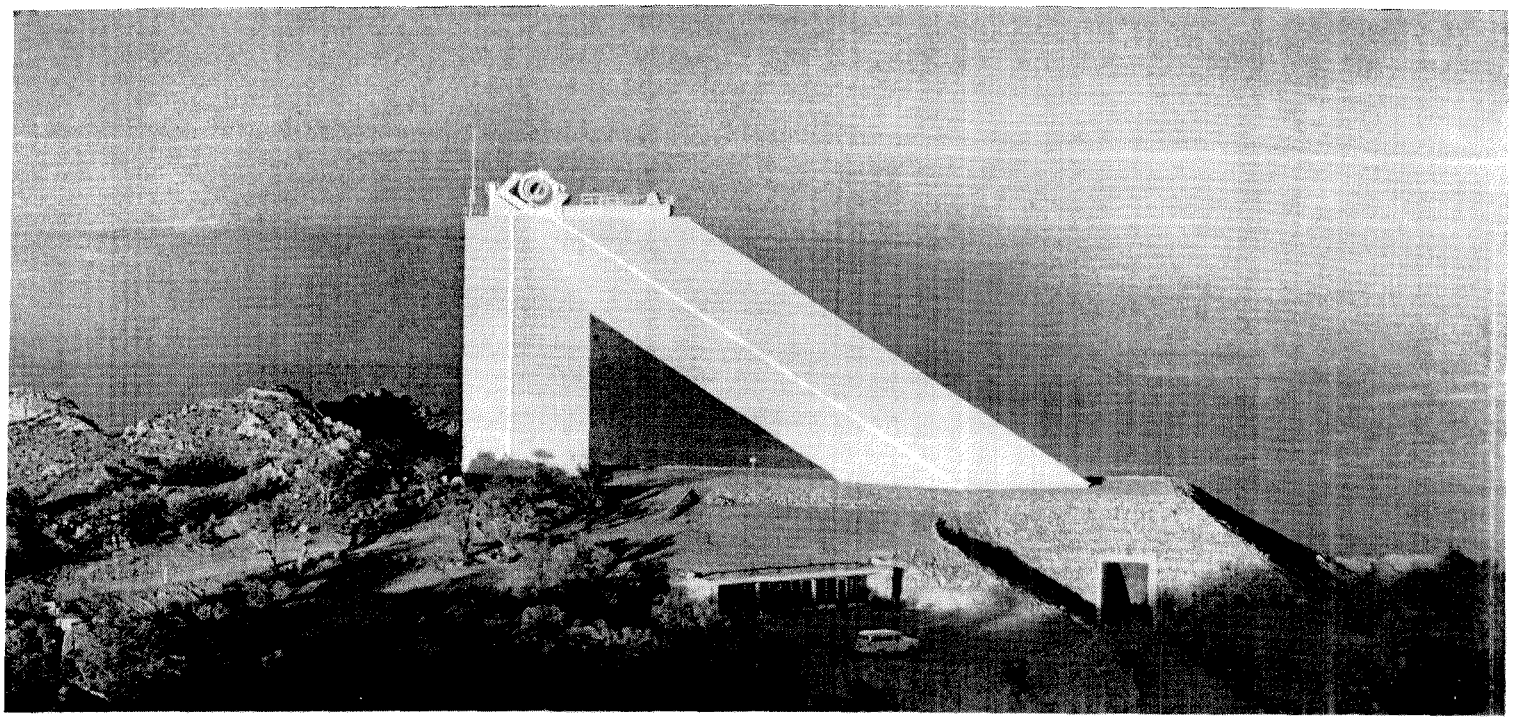
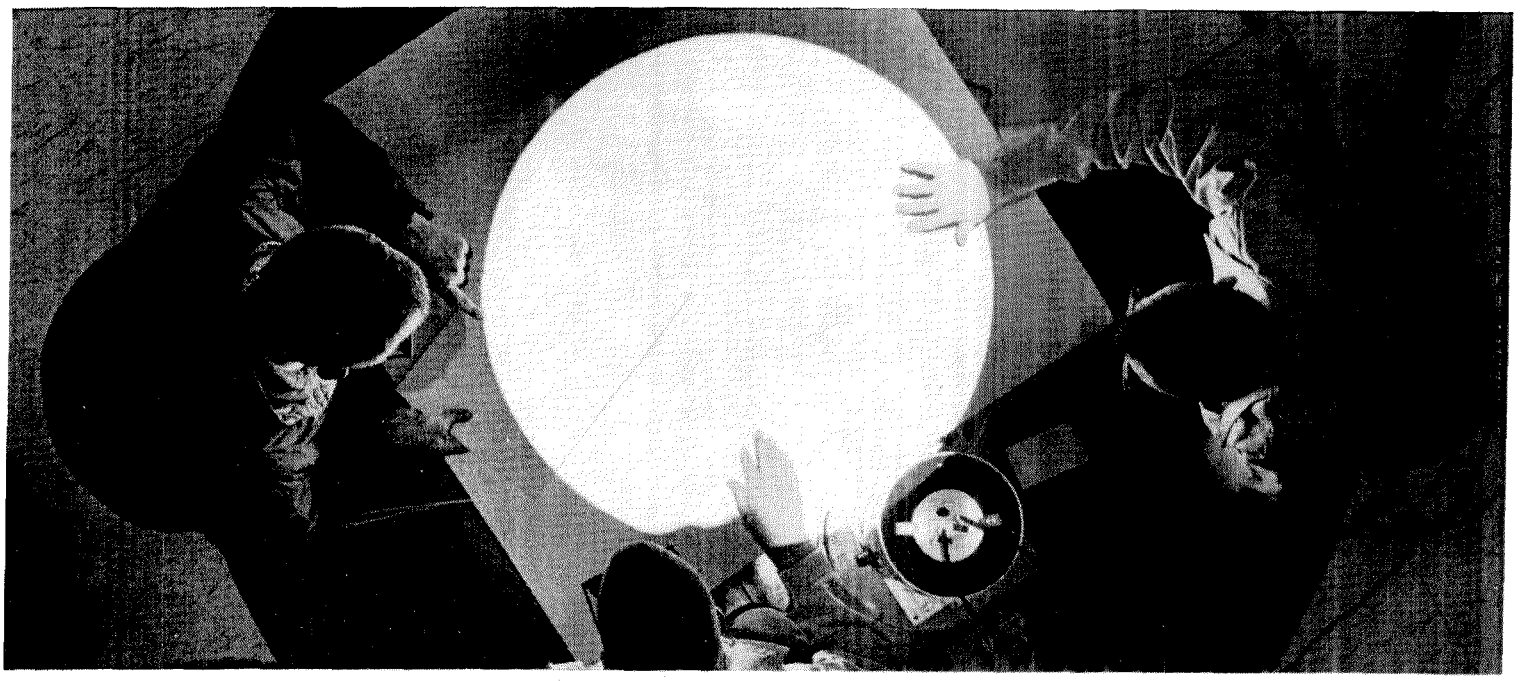
FEBRUARY 1965

ENGINEERING AND SCIENCE

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



On top of Kitt Peak, the world's largest solar telescope



gives scientists the largest image of the sun man has ever had

At the top of the gleaming white tower in the upper picture is a 60-inch quartz mirror which precisely tracks the sun all day in the clear, dry air above the Arizona desert.

It is cradled in a carriage called a heliostat, built by Westinghouse.

Part of this telescope is tunneled out of the flank of the mountain. Sunlight is reflected 480 feet down this tunnel and back up 280 feet into a dark viewing room by means of two other mirrors, also on Westinghouse mountings.

By studying the sun's image here, scientists hope to learn more about the sun's magnetic field and how sunspots affect our weather and communications.

The 60-ton heliostat at the Kitt Peak National Observatory is designed to track the daily motion of the sun to an accuracy of 1/1000 of an inch.

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General Motors hired its first woman designer more than 20 years ago. Originally color and fabric consultants, the young ladies advanced rapidly to full membership in a group effort which now involves the skills of hundreds of people in GM Styling. In the past two decades, the feminine influence has changed many concepts of automotive design.

Women designers have contributed to the development of interior convenience features, safety items and such innovations as color coordination of interiors with exteriors and particular fabrics to suit women's tastes. Many a man, too, is grateful for these and other feminine contributions.

The role of women in designing beauty, utility and quality into GM products is more important than ever before.

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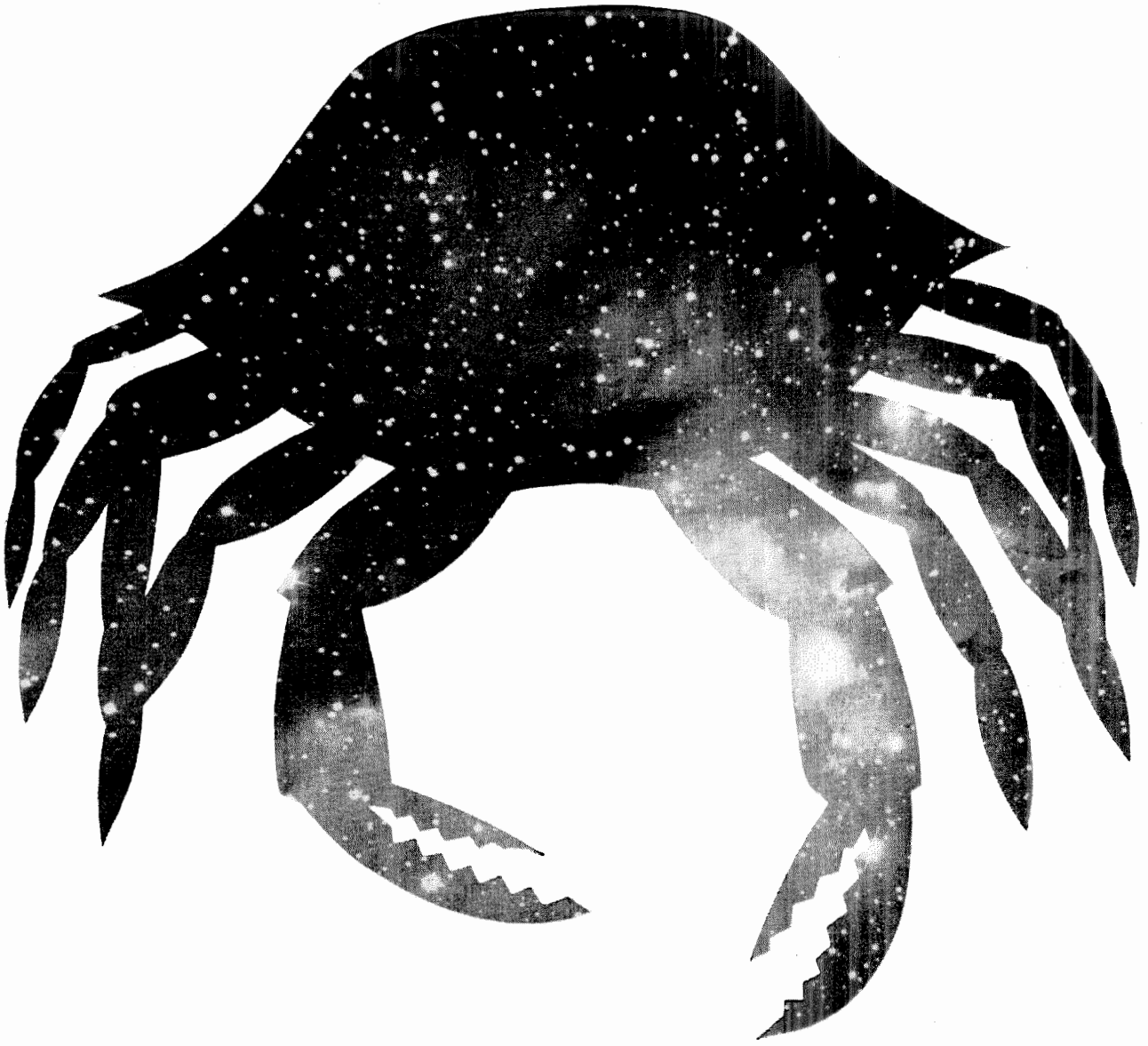

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ENGINEERING AND SCIENCE

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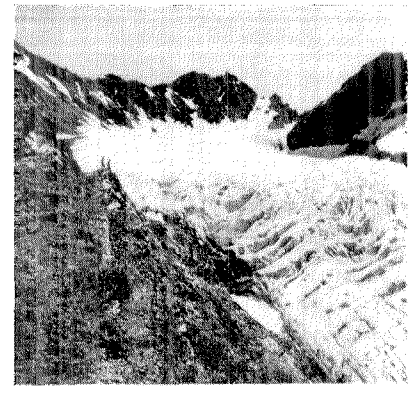

On Our Cover

Caltech geologists look over the Blue Glacier in northwestern Washington. Since 1957, when they began the study of this glacier as part of the IGY program, teams of faculty members and graduate students have been returning to Blue Glacier each summer to make further observations and measurements. On pages 16-19, some impressive pictures of some of last summer's activities on the glacier, taken by Clarence R. Allen, professor of geology and geophysics.

Air Pollution

On page 22 Dr. A. J. Haagen-Smit, professor of bio-organic chemistry, turns his attention, momentarily, from smog to another type of air pollution, in "Carbon Monoxide and the Freeway Commuter."

Alumni Survey

The series of five articles we ran in *E & S* (May 1964 - December 1964) on the recent Caltech Alumni Survey is now available as a single reprint. If you want a copy, just fill out the coupon on page 28 of this month's issue and send it in.

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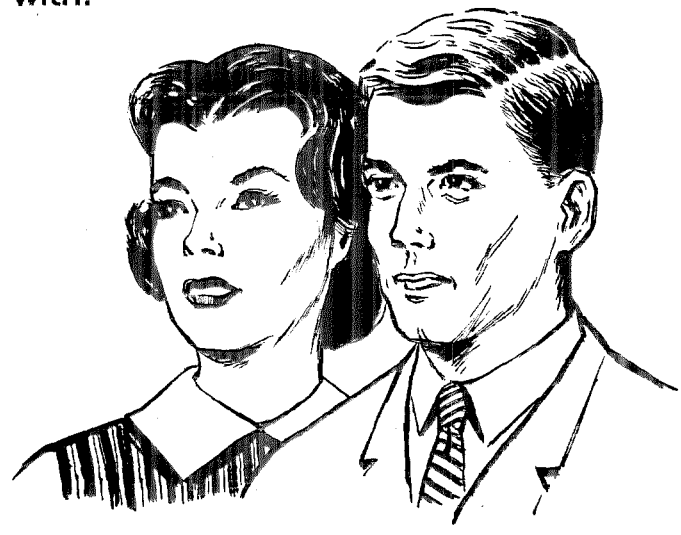

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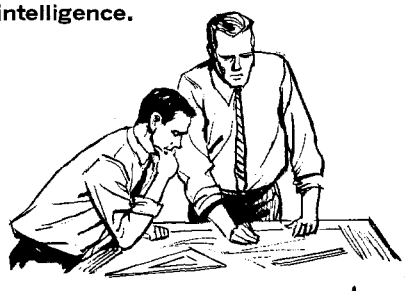

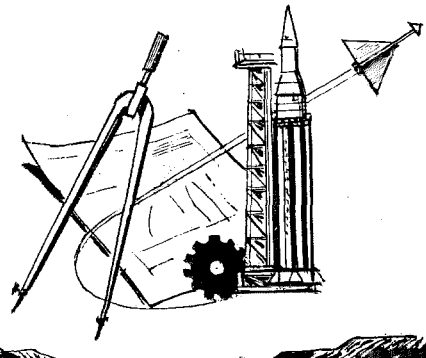

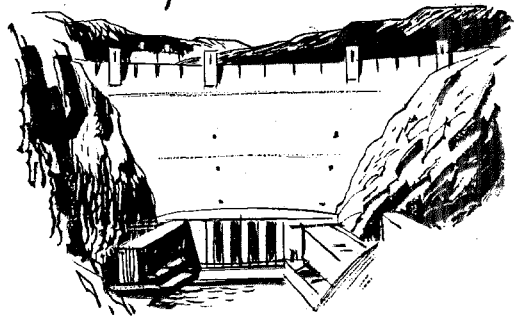

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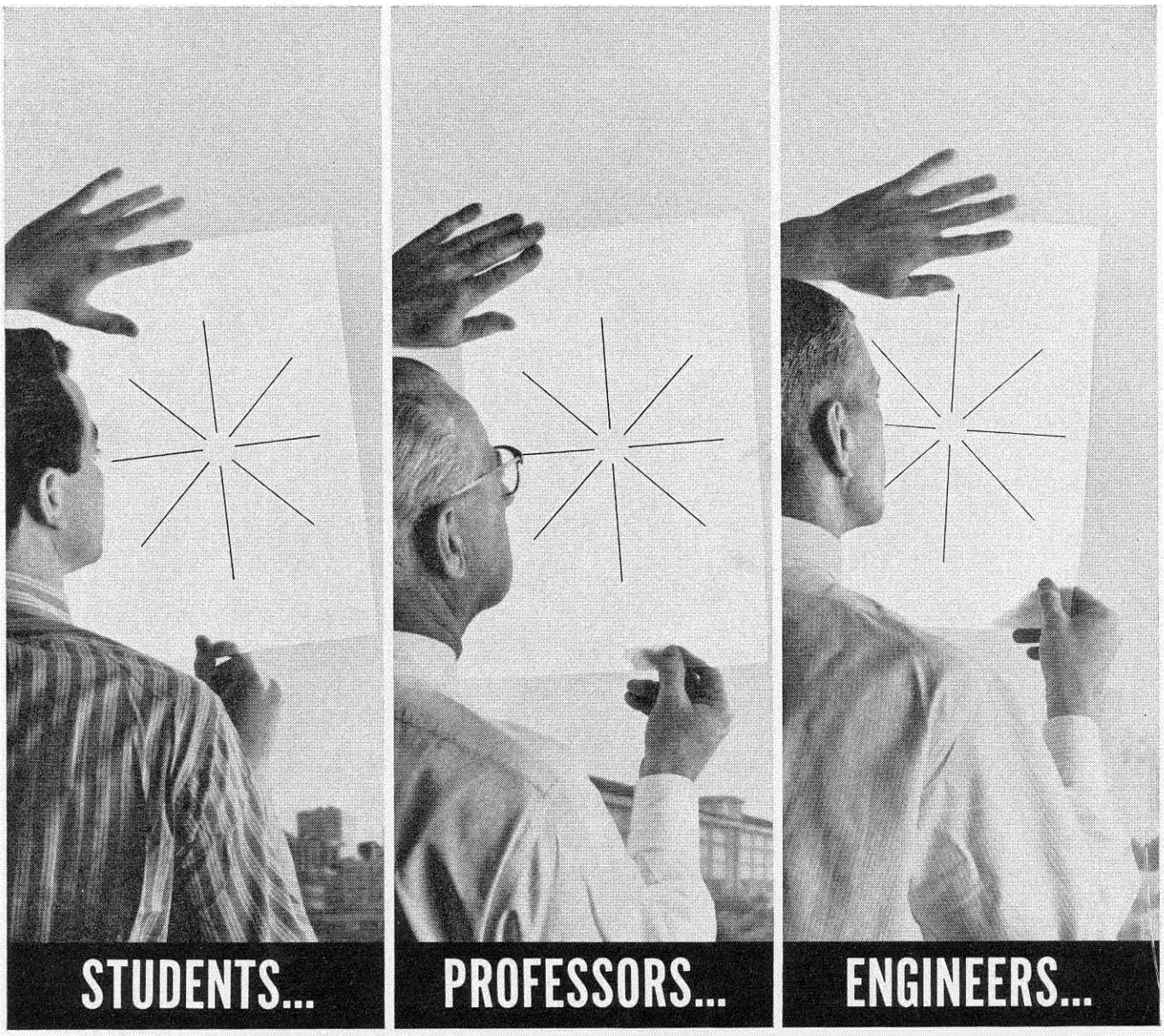

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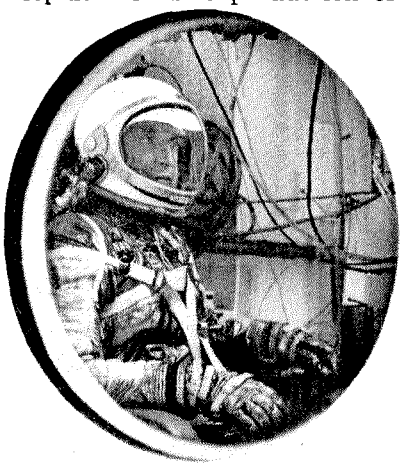

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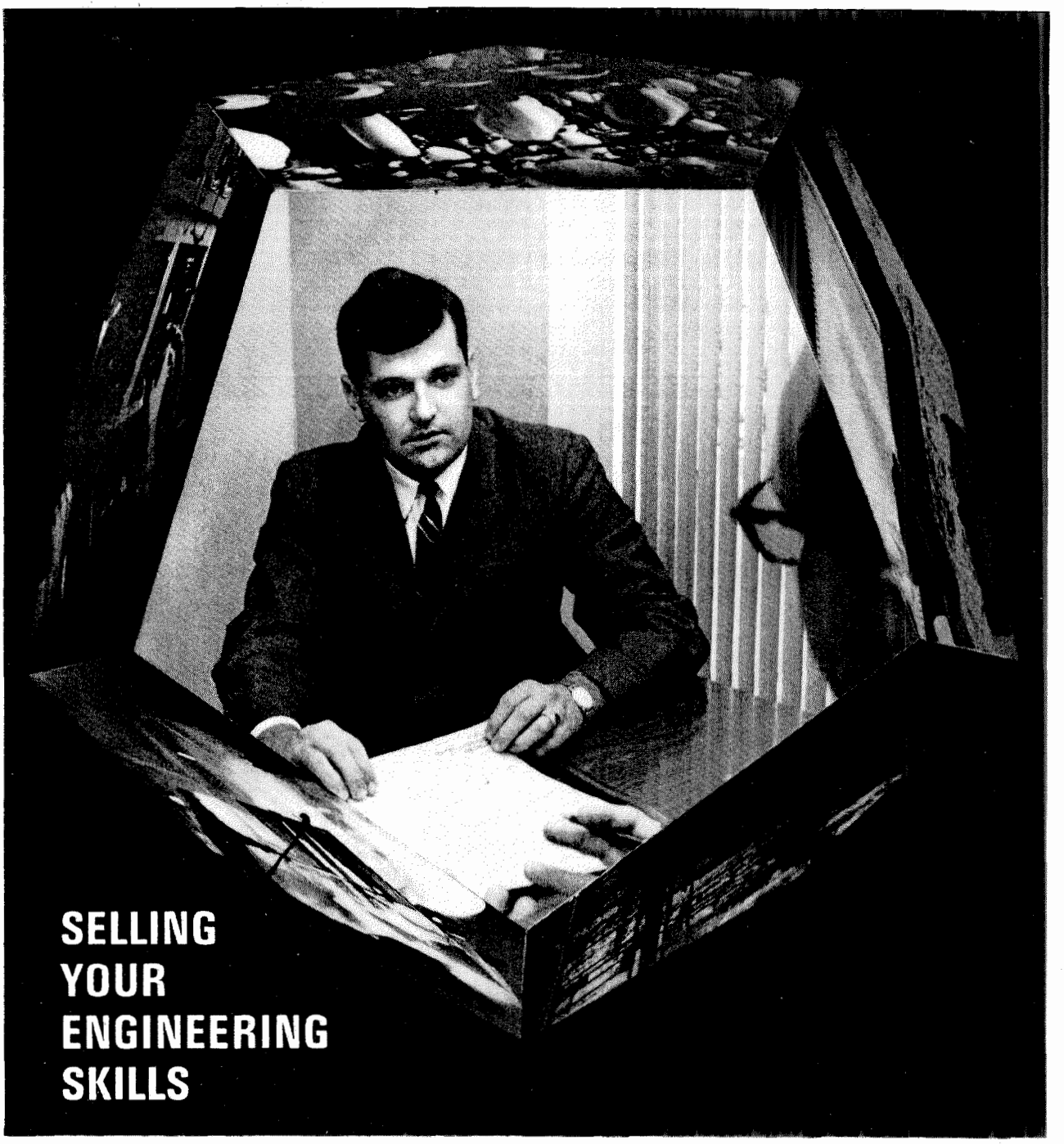

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ENGINEERING
AND SCIENCE
February 1965, Vol. XXVIII, No. 5

NEW DISHES FOR CALTECH'S RADIO OBSERVATORY

The Owens Valley Radio Observatory is on the way to becoming the world's most powerful and flexible system for the study of radio sources beyond our galaxy

A new 130-foot radio telescope for Caltech's Owens Valley Radio Observatory is now under construction, made possible by a $1,645,000 grant from the National Science Foundation. The new installation, scheduled for completion in mid-1966, is the first of several antennas planned to augment the twin 90-foot dishes which have been in operation at the observatory since 1958.

In a ten-year development program for ground-based astronomy in the United States, the Panel on Astronomical Facilities of the National Academy of Sciences recently recommended that a total of eight large antennas be built at the Owens Valley Radio Observatory.

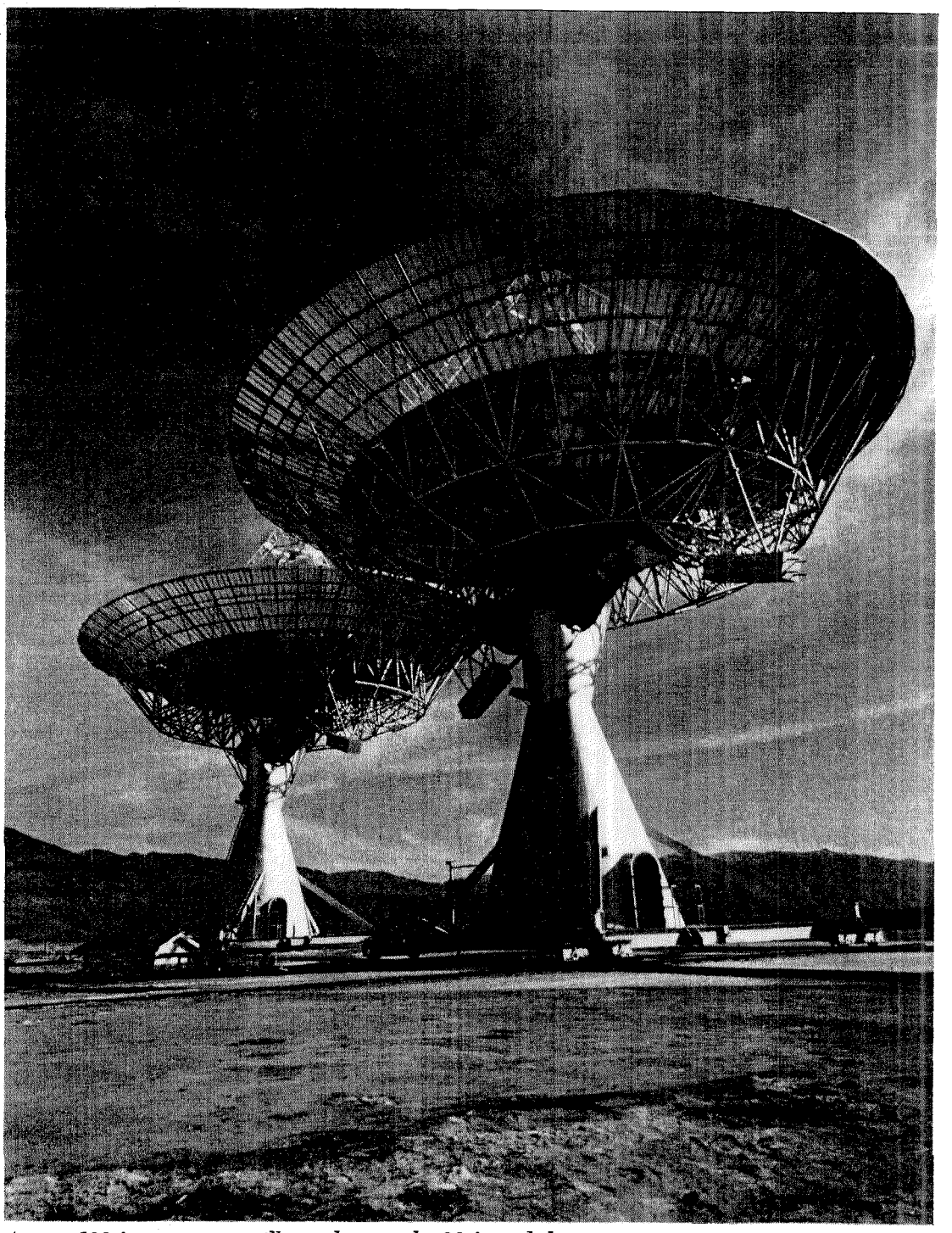
This will be the world's most powerful and flexible system for the study of objects beyond our galaxy that radiate energy in the radio frequencies. It will be 50 times as sensitive as the present system, capable of investigating a great range of problems, from the surfaces, atmospheres, and temperatures of planets, to the size and shape of the universe.

Westinghouse Electric Corporation will construct the new dish on a recently acquired 640-acre site adjoining the present 300-acre property located 250 miles north of Pasadena in the Owens Valley. Situated between the Sierra Nevada and White Mountain ranges, the observatory is ideally protected from man-made radio and television signals.

The additional land is needed for extension of the rail lines on which the radio telescopes, mounted on heavy wheeled pedestals, are moved. The two existing rail lines, on which the two 90-foot dishes move, form an "L" 1,600 feet long in a north-south direction and the same distance east and west. With the new dishes, the rail system will form an inverted "T" whose stem ultimately will extend for three miles north and south and whose east-west crosspiece will be 7,500 feet long.

On these rails the dishes may be moved into a variety of patterns. They can be used singly or ganged together as a phased array. Linked electronically as a single observing unit, the dishes become, through interferometry, the equivalent of a much larger dish than it would be possible to build.

"With the new dishes we can greatly expand our major research program," says Gordon J. Stanley, research associate in radio astronomy and director of the observatory. "We will be able to observe many more radio sources and to more accurately define their sizes and shapes, and to map more definitively the different intensities of emissions within a single source.

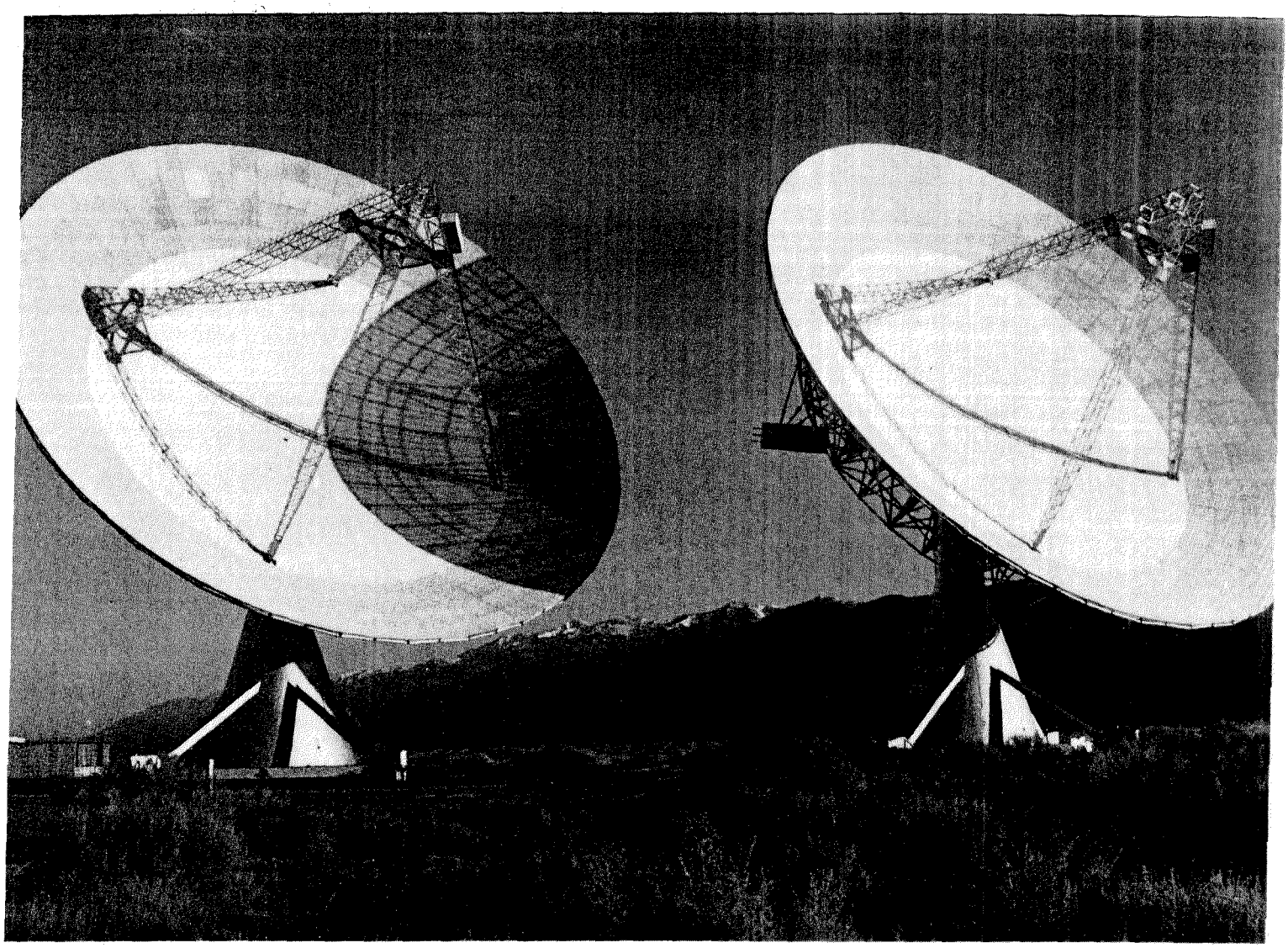


A new 130-foot antenna will supplement the 90-foot dishes now in operation at Owens Valley.

"We would like to be able to resolve several thousand radio sources and to study in greater detail more very distant ones. With our new ability to resolve and identify radio sources, it will be possible to tackle the cosmological problem of general relativity – that of the size and shape of the universe."

Bruce Rule, Caltech's chief engineer and a consultant for major radio and optical observatories throughout the world, is mainly responsible for the design of both the new and old antennas. The engineering problems that had to be overcome in designing the new antennas involved maintaining the accuracy of the 14,000 square feet of aluminum parabolic reflecting surface on each dish to within one-sixteenth to one-eighth of an inch under all conditions of gravity, motion, wind loading, and temperature extremes.

The shape of each dish will remain precise in



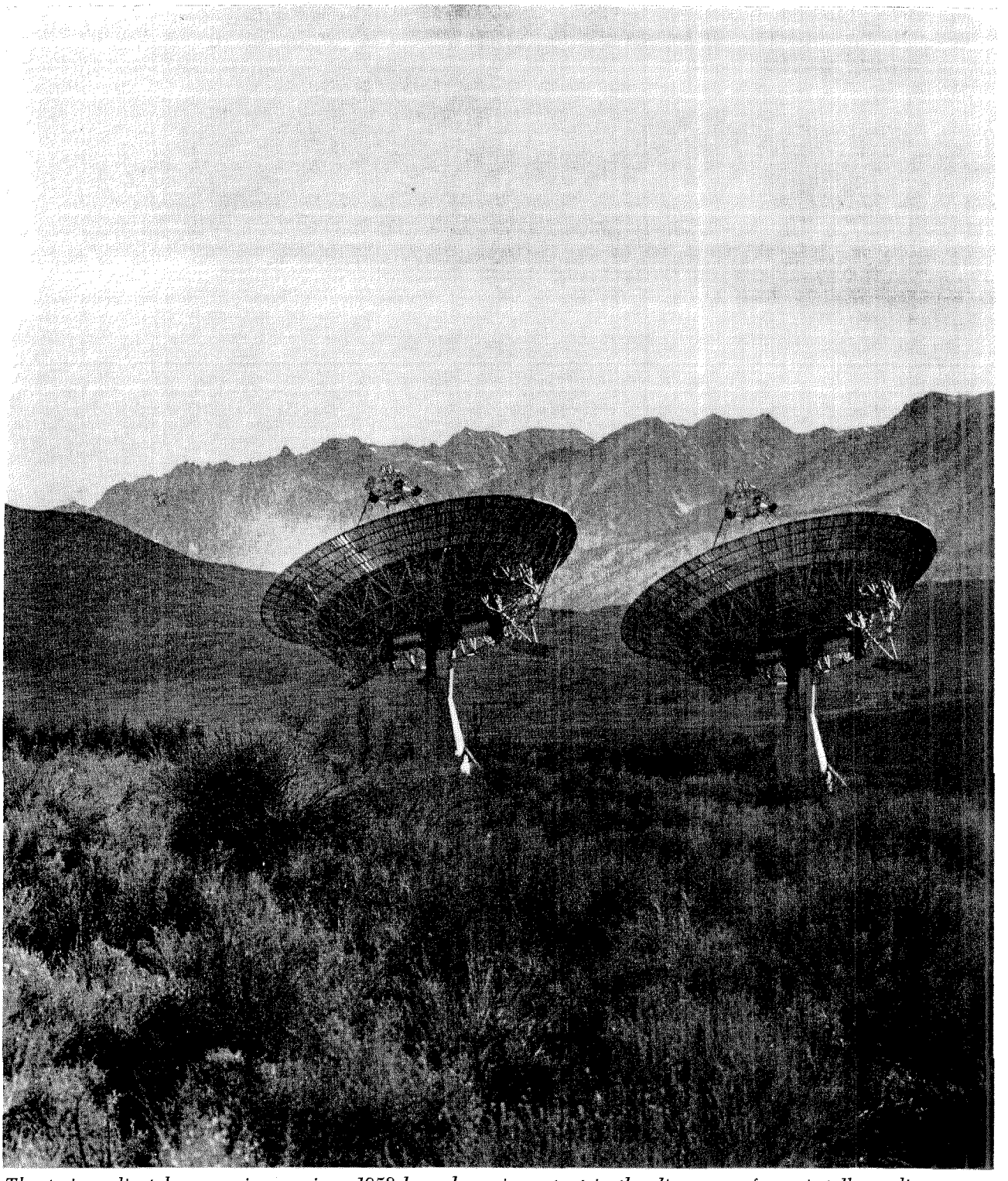
Radio waves from space are reflected from the surface of the dishes to receivers at the apex of 52-foot booms.

winds up to 20 miles an hour. In winds up to 35 miles an hour the shape will be less perfect, but will allow for some observations to be made. Each dish is designed to survive winds up to 90 miles an hour while locked, facing straight up.

The aluminum surfacing is in the form of panels which will have 936 adjustments per dish. The inner 60 percent of the surface will be solid aluminum sheets, while the outer 40 percent will be perforated to allow the wind to go through it. The parabolic surface of the dish will catch and reflect radio waves to a receiver mounted in front of the dish. The receiver will be at the apex of a quadripod of booms extending 65 feet from the surface. The recording equipment is in the pedestal, so that each dish may be used separately or linked electronically with the control and instrument building, where incoming signals are visually recorded.

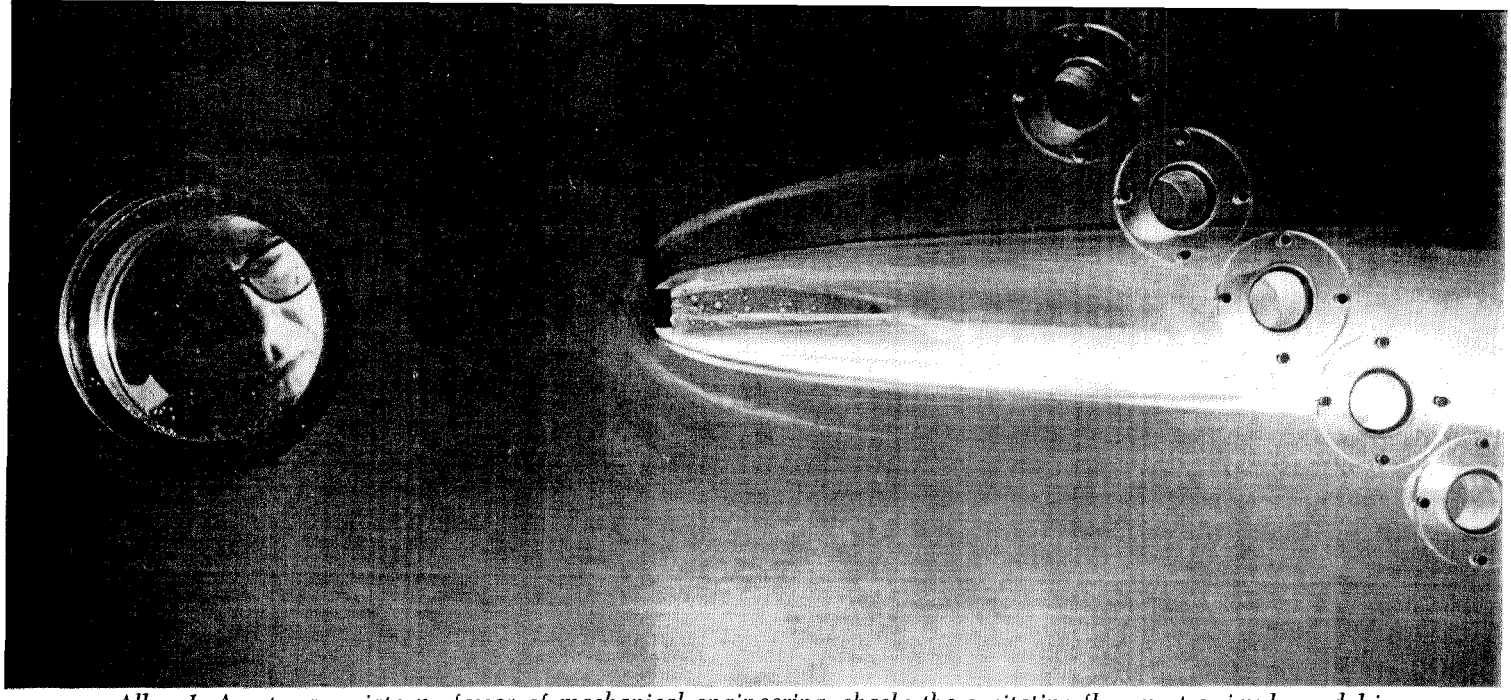
The work of the observatory's new 130-foot antenna will be a part of the continuing program in collaboration with the Hale 200-inch optical telescope on Palomar Mountain in identifying extremely distant objects, such as the quasi-stellar radio sources. This program has already increased the number of extragalactic radio sources identified with optical objects to about a hundred, and has made it possible to suggest the physical processes and energies involved in these radio sources.

"An additional dish area is needed," according to Stanley, "to obtain a more detailed picture of the hydrogen clouds within our galaxy and to make planetary observations. We want to learn whether or not the earth and Jupiter are the only planets with radiation belts and magnetic fields. We also will be able to extend our polarization work for detecting and mapping magnetic fields."



The twin radio telescopes in use since 1958 have been important in the discovery of quasi-stellar radio sources.

The operation of the Owens Valley Radio Observatory is sponsored by the Office of Naval Research. The observatory has already made many contributions to the young science of radio astronomy. It played a leading role in the discovery of quasi-stellar radio sources, and of radio sources beyond our galaxy. It determined that most radio sources outside our galaxy come in pairs, which led to the concept of their explosive nature. It has mapped the arms of our galaxy and determined its polarity and it has discovered Jupiter's Van Allen radiation belt.



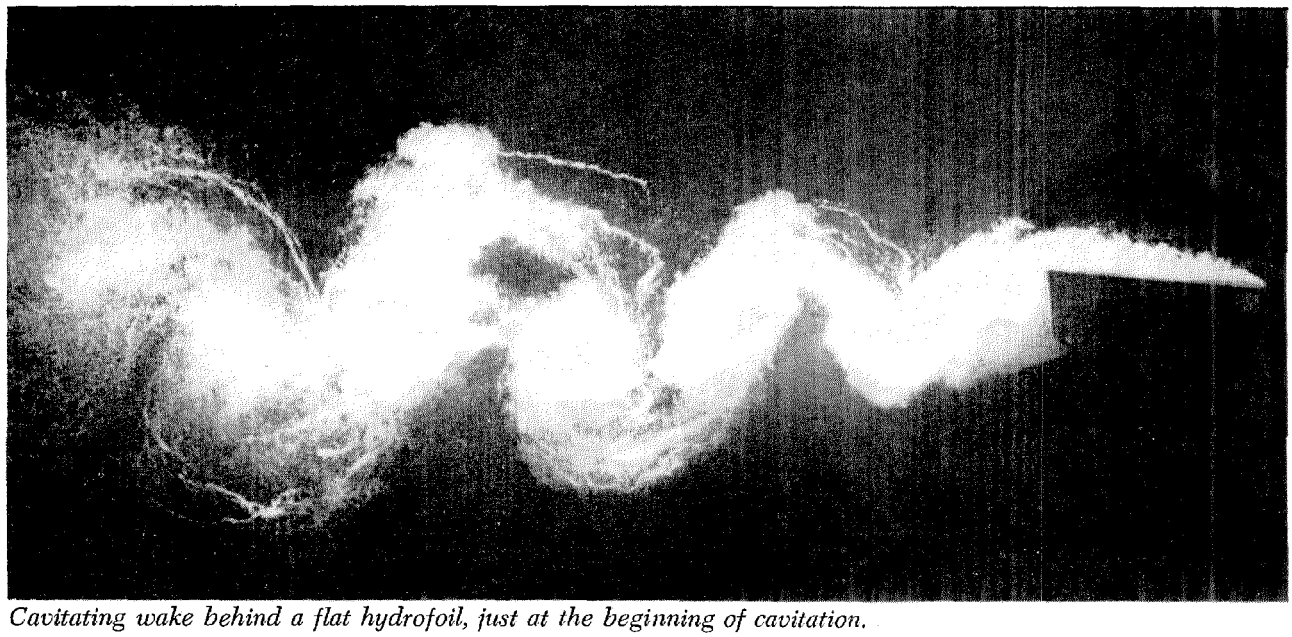
Allan J. Acosta, associate professor of mechanical engineering, checks the cavitating flow past a simple model in the new working section which is installed in the high speed water tunnel. The curved halo in front of the model is the result of cavitation caused by secondary motion of the boundary layer on the sides of the tunnel.

WATER TUNNEL

A unique new water tunnel in Caltech's Hydrodynamics Laboratory is furnishing new fundamental information on the behavior of water flows. At the same time, it is directly useful for applied problems arising from the hydrofoil boats now being developed by the U.S. Navy.

What makes the new tunnel unique is its size and shape. The four-ton test section, which is installed in the existing high speed water tunnel in the Hydro Lab, is 6 inches wide, 30 inches high, and 4 feet long. Though it is not the first two-dimensional (or rectangular) test section to be used in hydrodynamic research, it is the largest.

Designed specifically for hydrofoil testing, it permits flows which are flat, rather than round, and makes it possible to measure the flow around two-dimensional sections such as propellers or portions of hydrofoil wings. Previous studies have been made



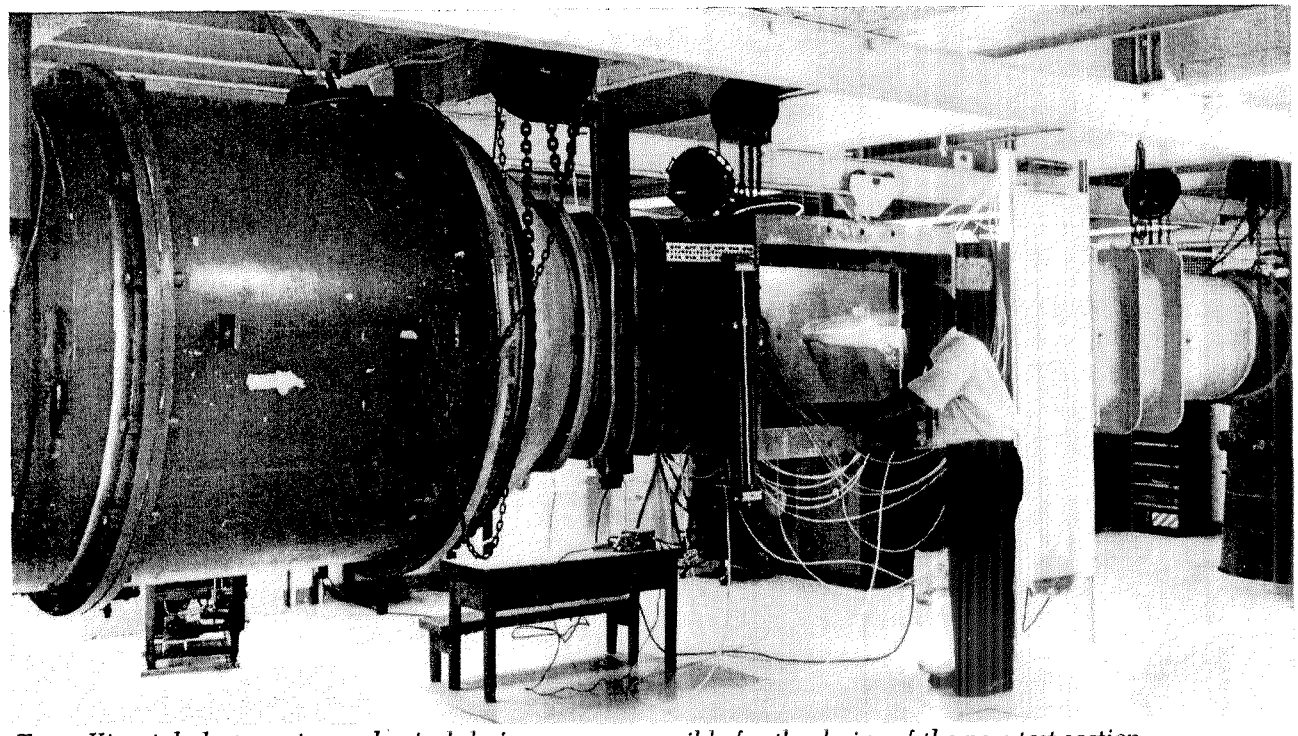
Cavitating wake behind a flat hydrofoil, just at the beginning of cavitation.

Ray DeLong, graduate research assistant, describes the flow to freshman Sam Logan, who is doing honors research.

at Caltech in a small temporary test section 3 inches wide and 14 inches high, which was inserted into the existing test section. The new section can accommodate larger and more complex bodies and makes it possible to probe and examine the flow in greater detail than ever before.

When a solid body moves rapidly through a liquid, cavitation — or vaporization — takes place. The vapor bubbles that are produced not only damage the toughest metals as they collapse violently, but change the entire flow field in important ways.

The new water tunnel is essential for studies of the development and structure of the cavitating wake behind various types of bodies. Current work includes a study of the optimum shape of a hydrofoil to give the least drag force for a given lift, and research on flapped hydrofoils to assist hydrofoil boats in taking off at low speeds. Studies are also under way on the non-steady motion of hydrofoils, and on a group of hydrofoils called a cascade, arranged like the slats in a venetian blind. These studies are important in the flow of water through pumps and propellers, as well as in certain hydrofoil lifting systems.



Taras Kiceniuk, lecturer in mechanical design, was responsible for the design of the new test section.

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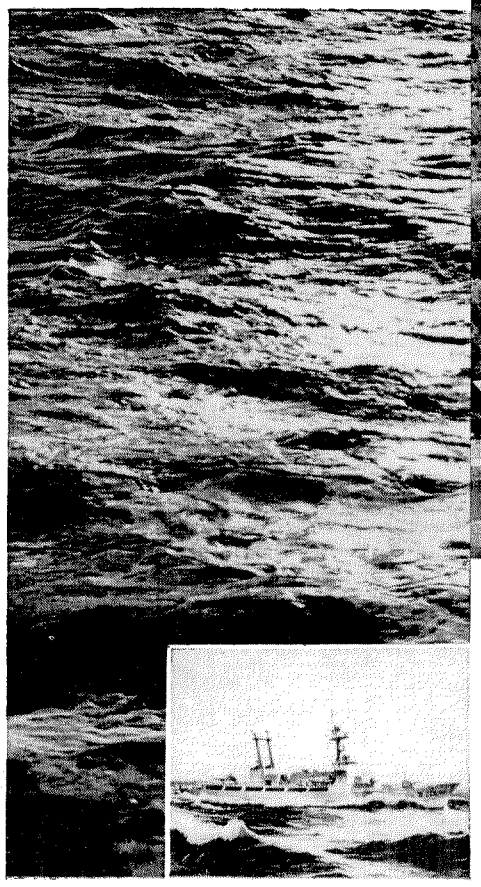

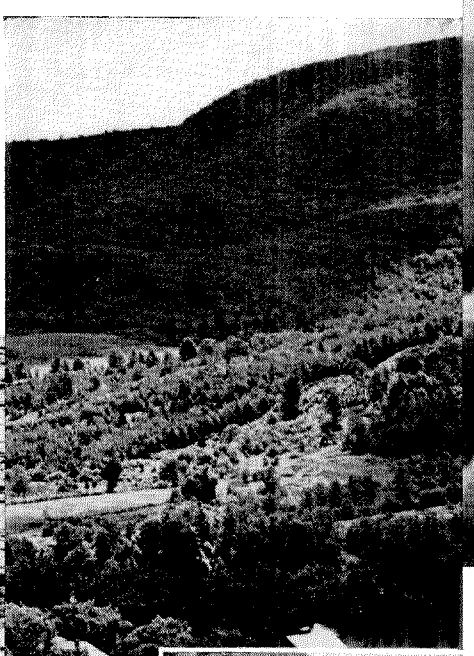

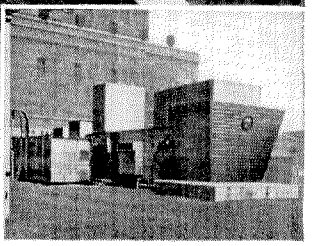

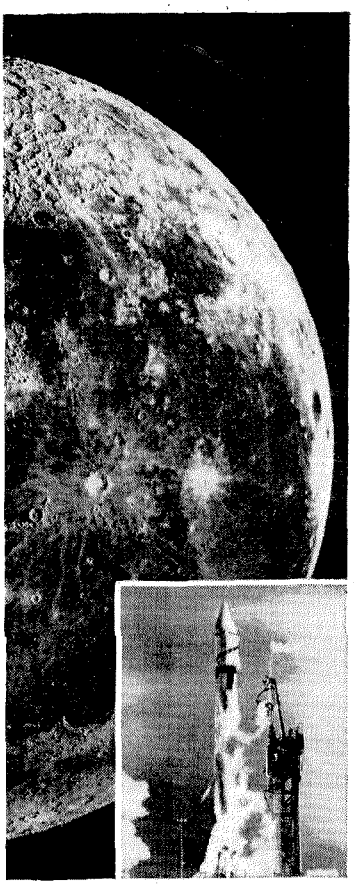

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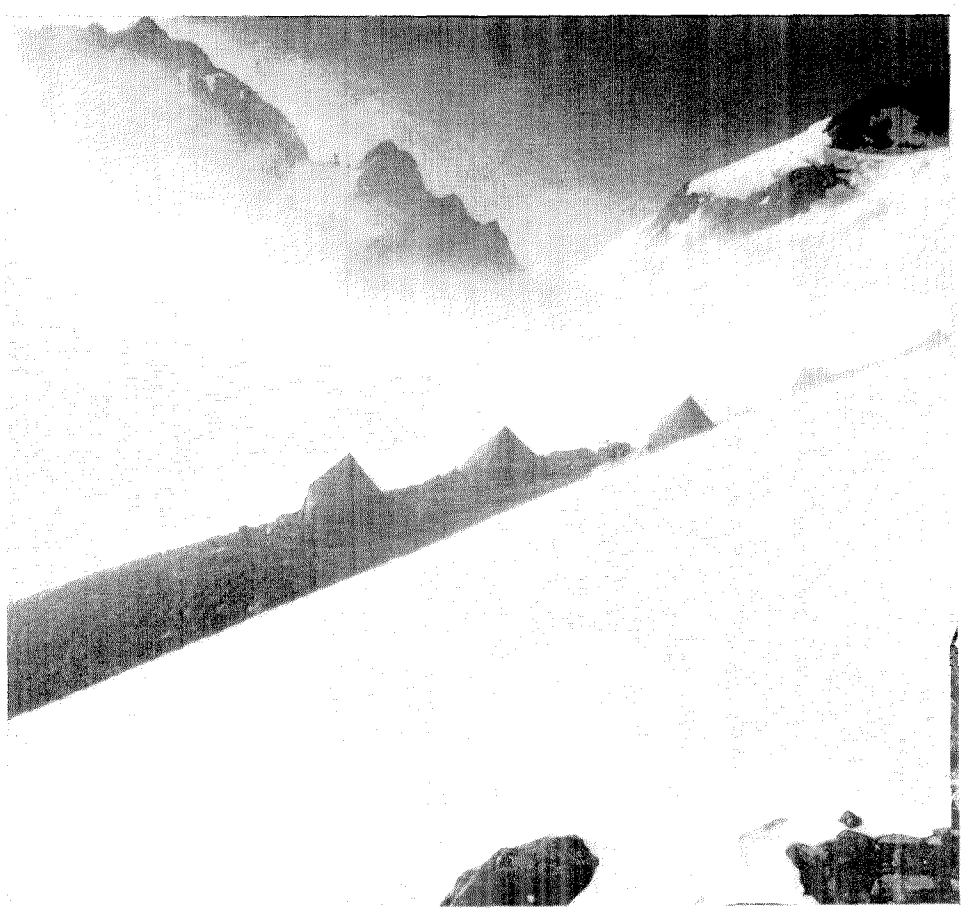
The position of the snout of Blue Glacier has remained remarkably constant for five years, although stakes placed in the ice, in a tunnel beneath the snout, move forward about 0.3 centimeters a day.

The Blue Glacier Project

Caltech geologists started the Blue Glacier Project on Mt. Olympus in northwestern Washington in the summer of 1957 as part of the IGY program, with the objective of gaining a better understanding of the flow processes in ice.

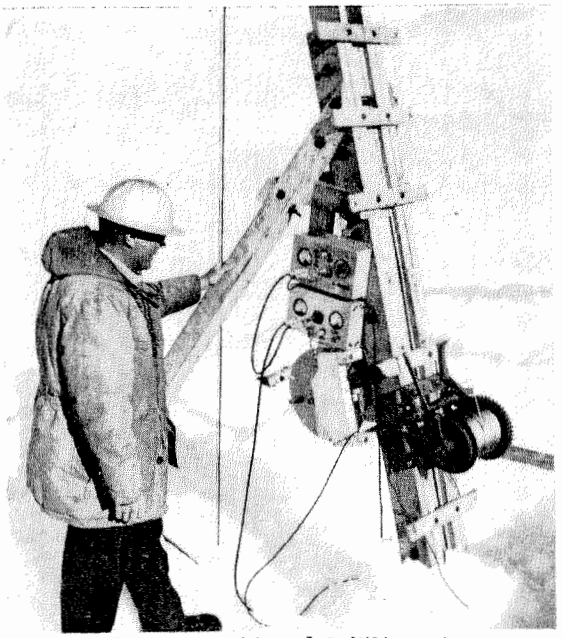
In the summer of each succeeding year, faculty members and graduate students have returned to the glacier to make further observations and measurements. During August 1964 the principal efforts — pictured on these pages — involved the coring of ice from within the glacier, and seismic measurements of the thickness of the ice.

Senior engineer Jim Westphal and graduate student Hugh Kieffer examine a seismic record. In the new technique under development here, reflected seismic waves at a frequency of about 1,000 cycles per second are recorded. This frequency is almost ten times as large as that conventionally used in seismic exploration. The equipment of the coring operation is visible near the base of the icefall. At upper right is the summit of Mt. Olympus.



The geologists' campsite is on a moraine near the edge of the glacier. In the background — Blizzard Pass.

In the coring operation a wood tripod supports electrical and other cables from which drilling or coring hotpoints are suspended. The thickness of the ice here is 110m and 45 cores were obtained in a profile from top to bottom, including the deepest meter of the ice.

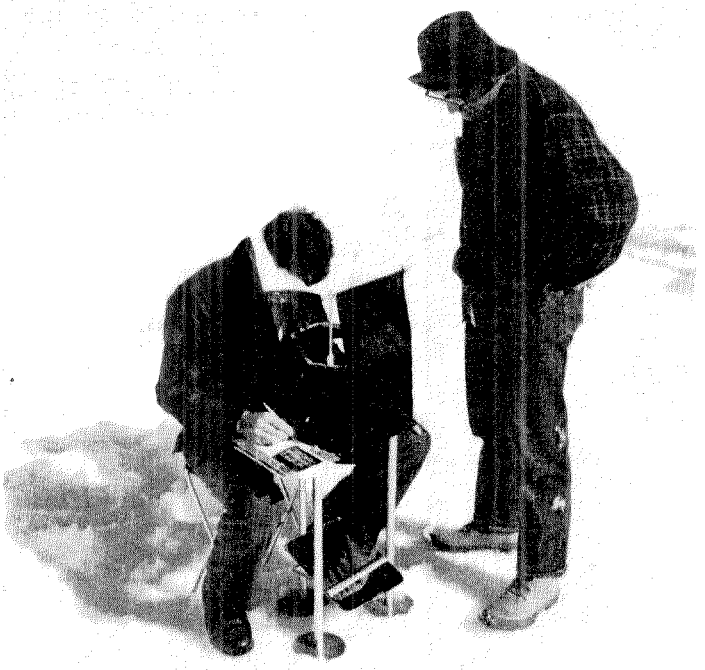


Ronald Shreve, (BS '52, PhD '59), assistant professor of geology and geophysics at UCLA, adjusts electrical and monitoring equipment. Shreve designed most of the equipment used in the coring and drilling work.

Barclay Kamb, professor of geology and geophysics, removes a 1-meter ice core from the coring hotpoint. The core is first examined visually, and internal structures are recorded and measured. An interesting feature observed is the formation of fine, perfectly planar cracks due to release of the confining pressure.

The core is flattened (using a gasoline iron). It is then sectioned to a thickness of 1 mm for optical examination.

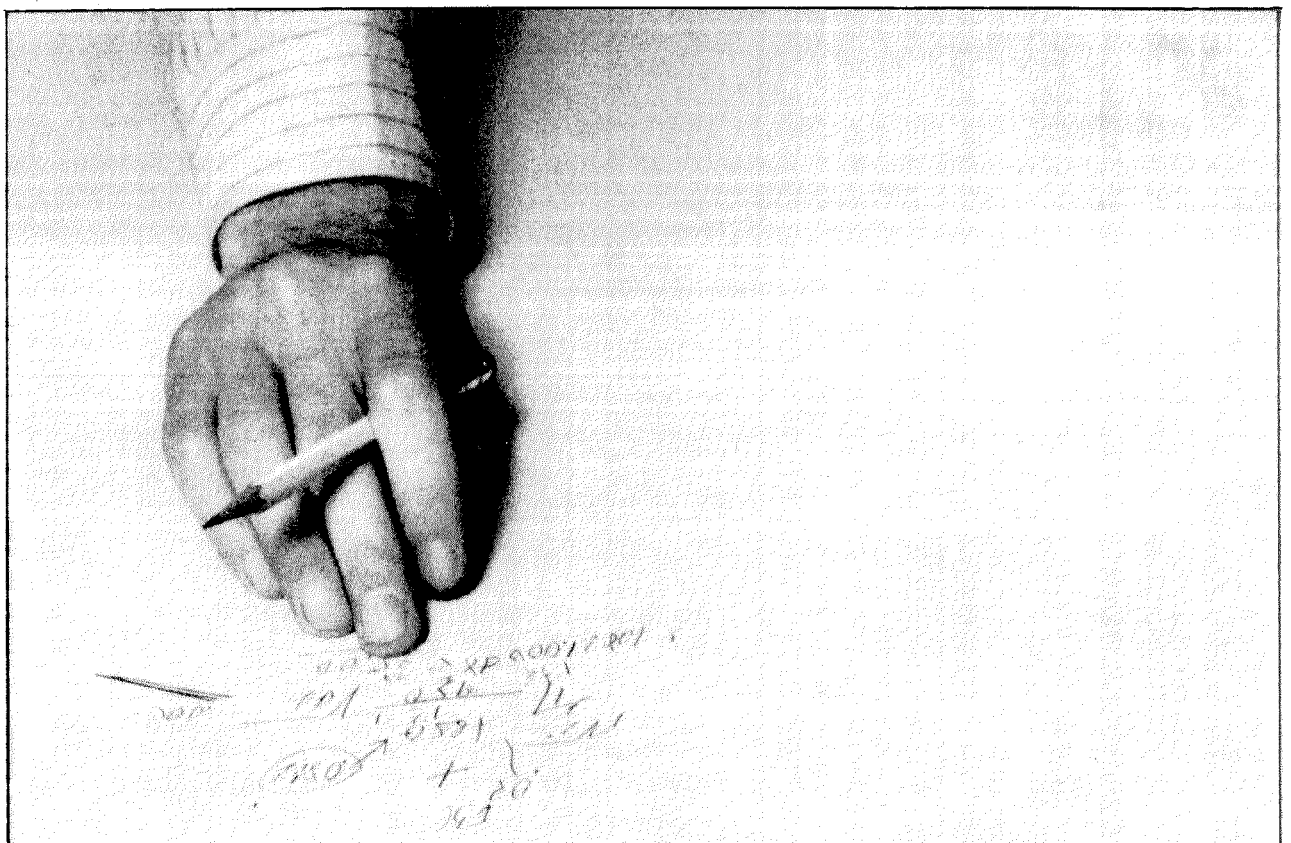
The core sections are examined by Dr. Kamb in a 15-cm-diameter universal stage, between crossed polaroid plates, to reveal the internal crystalline structure and to measure the orientation of the component crystals.



Sections of the ice core from a depth of 100 m, as seen in the universal stage. In spite of the irregular shapes of the individual ice crystals (areas of different shading), the axes of the crystals are arranged in a remarkably regular pattern of spatial orientation, caused by recrystallization of the ice in the process of flow. The axial orientations (not visible in the picture) are determined by optical measurements.

Research on Blue Glacier is usually conducted in August, since this is the driest month of the year there.

What is a chemical engineer doing at NCR?



Lots of things. With a BS, MS or Ph.D. in chemical engineering, he may be working with plastics, polymers, inks, paper, metals, foods or pharmaceuticals.

In NCR's Finishes Control Laboratory, his assignment might deal with new process design for electro or electroless plating. Or with new etching techniques for printed-thru-hole circuit boards.

In Chemical Development, he might be working with special paper products for business systems (such as carbonless transfer and thermocopy paper, punched cards, and tape). He might be developing new media storage by changing materials and coating techniques.

In the Plastics Laboratory, you may find him evaluating new materials, determining new methods of production, developing new processes or improving old ones.

Capsular Research and Product Development would involve him in NCR's unique microencapsulation process which locks up a material in a microscopic capsule for subsequent release. This has applications in such fields as pharmaceuticals, foods and adhesives.

In NCR's Materials Analysis group, he might assist our research organizations — qualifying production materials or developing new wet and dry test techniques.

If your interests fit into this broad picture of process development, product development and product application, we'd like to hear from you. Write to Thomas F. Wade, Technical Placement, NCR, Dayton, Ohio 45409. An equal opportunity employer.

NCR

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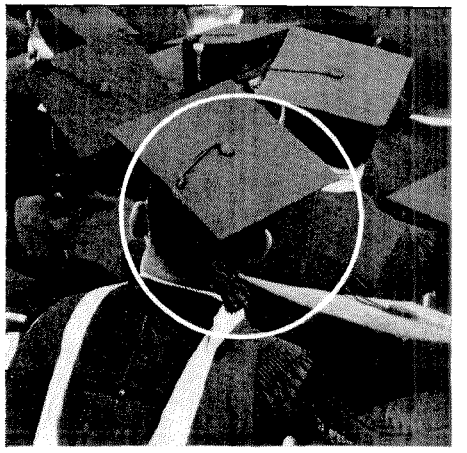
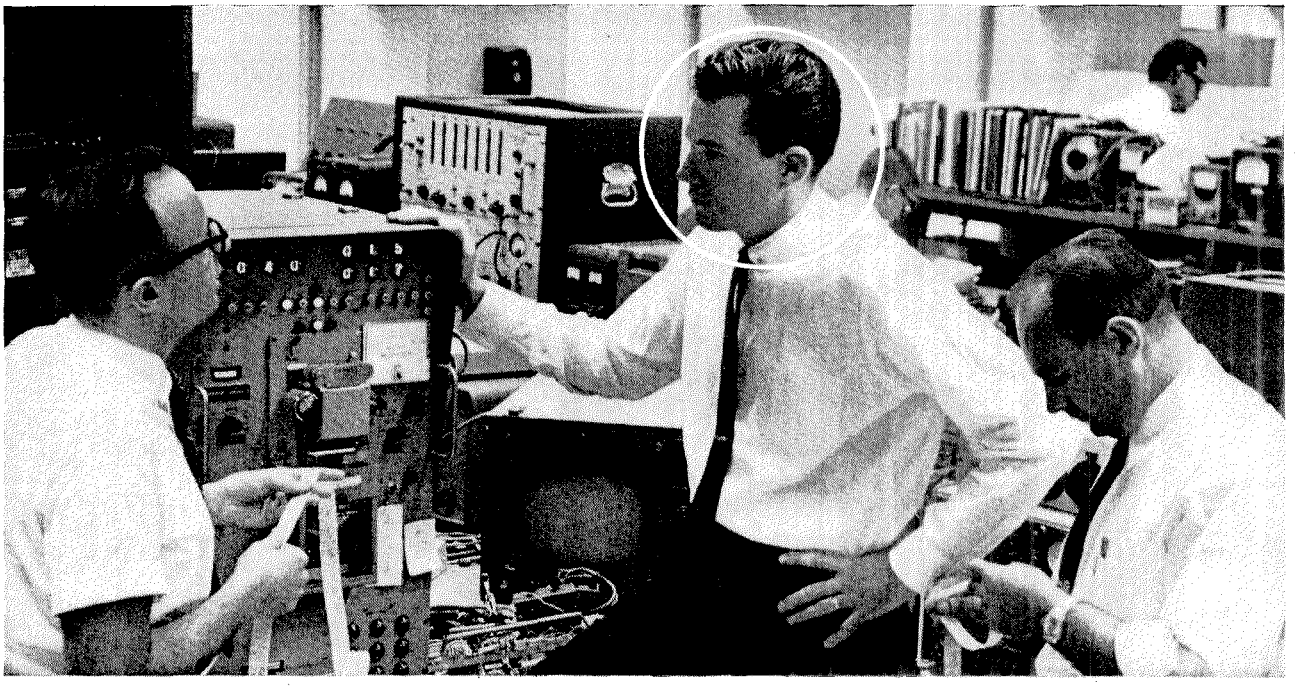


John Lauritzen wanted further knowledge



He's finding it at Western Electric

When the University of Nevada awarded John Lauritzen his B.S.E.E. in 1961, it was only the first big step in the learning program he envisions for himself. This led him to Western Electric. For WE agrees that ever-increasing knowledge is essential to the development of its engineers—and is helping John in furthering his education.

John attended one of Western Electric's three Graduate Engineering Training Centers and graduated with honors. Now, through the Company-paid Tuition Refund Plan, John is working toward his Master's in Industrial Management at Brooklyn Polytechnic Institute. He is currently a planning engineer developing test equipment for the Bell System's revolutionary electronic telephone switching system.

If you set high standards for yourself, educationally and professionally, let's talk. Western Electric's vast communications job as manufacturing unit of the Bell System provides many opportunities for fast-moving careers for electrical, mechanical and industrial engineers, as well as for physical science, liberal arts and business majors. Get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

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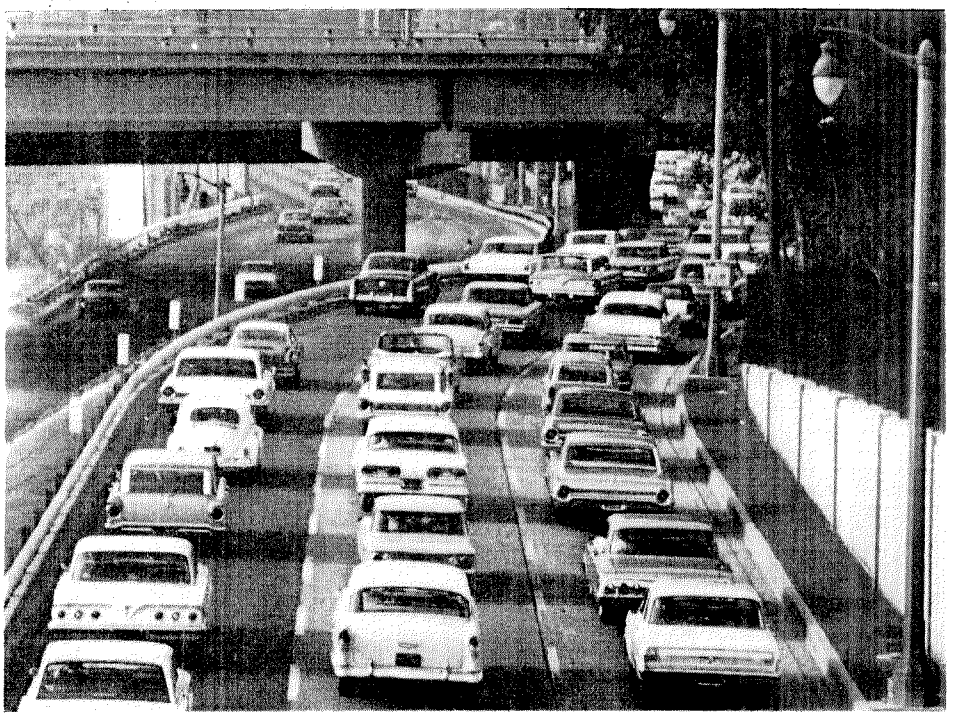


CARBON MONOXIDE AND THE FREEWAY COMMUTER

Carbon monoxide fumes inhaled by the daily freeway commuter can be of dangerous proportions. According to Arie J. Haagen-Smit, pioneer in smog research and professor of bio-organic chemistry at Caltech, "During rush hours, with heavy traffic, a buildup of slow-moving cars, and intermittent stopping, concentrations of carbon monoxide from exhausts can dull the alertness of drivers and could reach a more injurious level."

Data for this observation were obtained with a new carbon monoxide analyzer designed by Dr. Paul Hersch, senior scientist in the research department of Beckman Instruments, Inc. Prototypes of this instrument were installed on a sedan and a sports car which Dr. Haagen-Smit and a National Science Foundation student of his, Thomas W. Latham '64, drove in eight freeway trips, duplicating those taken by persons commuting between Pasadena and Los Angeles during peak traffic hours. The devices gave continuous records of the carbon monoxide levels of the drivers' environment.

Carbon monoxide is a poisonous gas produced by incomplete combustion of gasoline. Because red blood corpuscles prefer it to oxygen, high concentrations of carbon monoxide in the atmosphere cause oxygen starvation in the cells. This reduces the flow of blood, and bodily functions are slowed down, resulting in drowsiness, fatigue, and delayed physical reactions.

Prolonged exposure to carbon monoxide can cause loss of judgment, muscular incoordination, increased difficulty in breathing, and, eventually, death from asphyxiation.

While "country" air is completely free from carbon monoxide fumes, normal Los Angeles air contains from 10 to 12 parts carbon monoxide per million parts (ppm) of air. The State Health Department has determined that 30 ppm is an "adverse" level and that 30 ppm for eight hours, or 120 ppm for one hour, is a "serious level of pollution." In the test trips made by Dr. Haagen-Smit and Tom Latham, the over-all average level of carbon monoxide measured was 37 ppm of air. In heavy traffic, moving at less than 20 miles an hour, the level rose to an

average of 54 ppm, with peaks up to 120 ppm. A short distance from the freeways and heavily-traveled streets, levels dropped rapidly, except at stop signals, where traffic again accumulated.

"If a commuter spends two hours at the higher exposure level found in the study," says Dr. Haagen-Smit, "the carbon monoxide level of his hemoglobin would be approximately that cited by the 'State Health Department for the 'serious' level."

A concentration of 30 ppm of the gas will inactivate 5 percent of a person's hemoglobin and 60 ppm will inactivate 10 percent of it. If a person is smoking, another 5 percent of his hemoglobin is inactivated.

The trips made on the Pasadena Freeway by Dr. Haagen-Smit and Tom Latham were between Caltech and the vicinity of Exposition Park in Los Angeles. Half the trips were made in the morning and half in the afternoon. They averaged 71 minutes duration, with the quickest one being 40 minutes long and the slowest taking one hour and 55 minutes.

To establish the effect of poor ventilation on carbon monoxide levels *inside* a car, and to determine whether or not leaks in its own exhaust system might contaminate a car's interior, the concentration of the toxic gas was measured inside two test cars with the windows closed and the engine running. The readings were 10 ppm above that of the outside atmosphere. A third car, evidently in poor mechanical condition, showed an inside reading of between 100 to 200 ppm. And air-conditioning does not help, Dr. Haagen-Smit points out, because an air-conditioner does not filter out carbon monoxide.

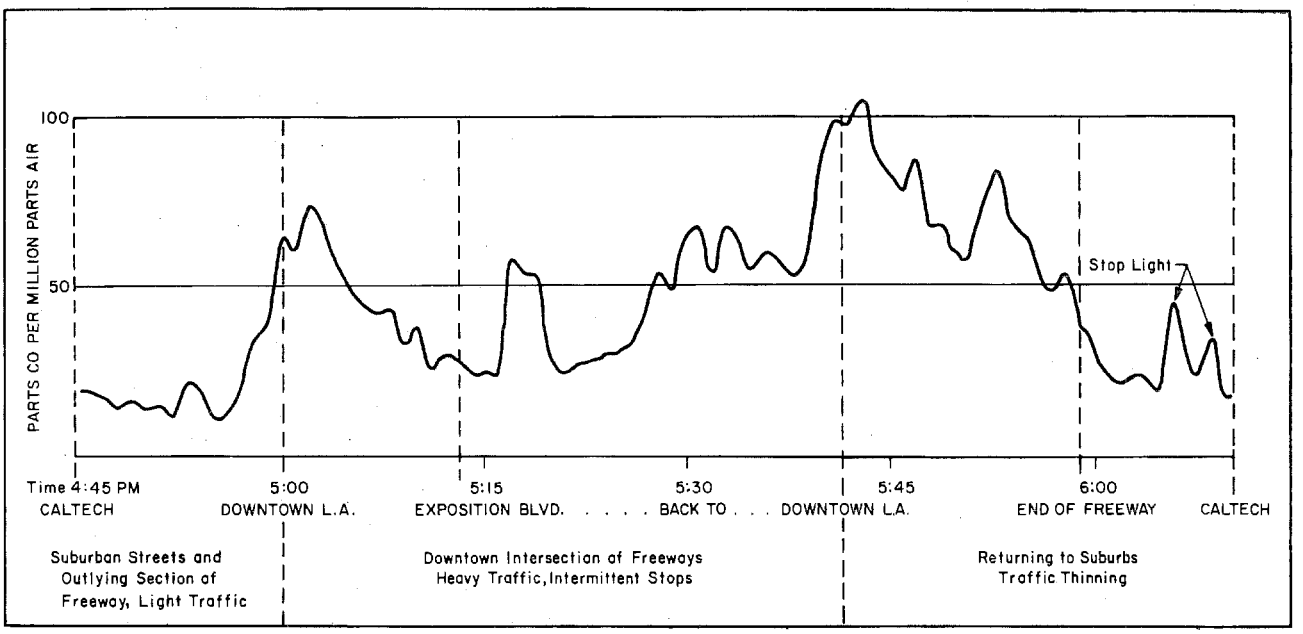
"Thorough study should be made of the effects of carbon monoxide levels on the alertness of motorists and on their ability to drive," Dr. Haagen-Smit recommends. "These investigations should include the respiratory cripples as well as the healthy drivers."

Dr. Haagen-Smit is a member of President Johnson's Environmental Pollution Panel and is a smog consultant for the state and Los Angeles County governments. He believes that automobile exhaust control is the answer not only for eye-irritating smog, but also for the reduction of the carbon monoxide level to which we are exposed.

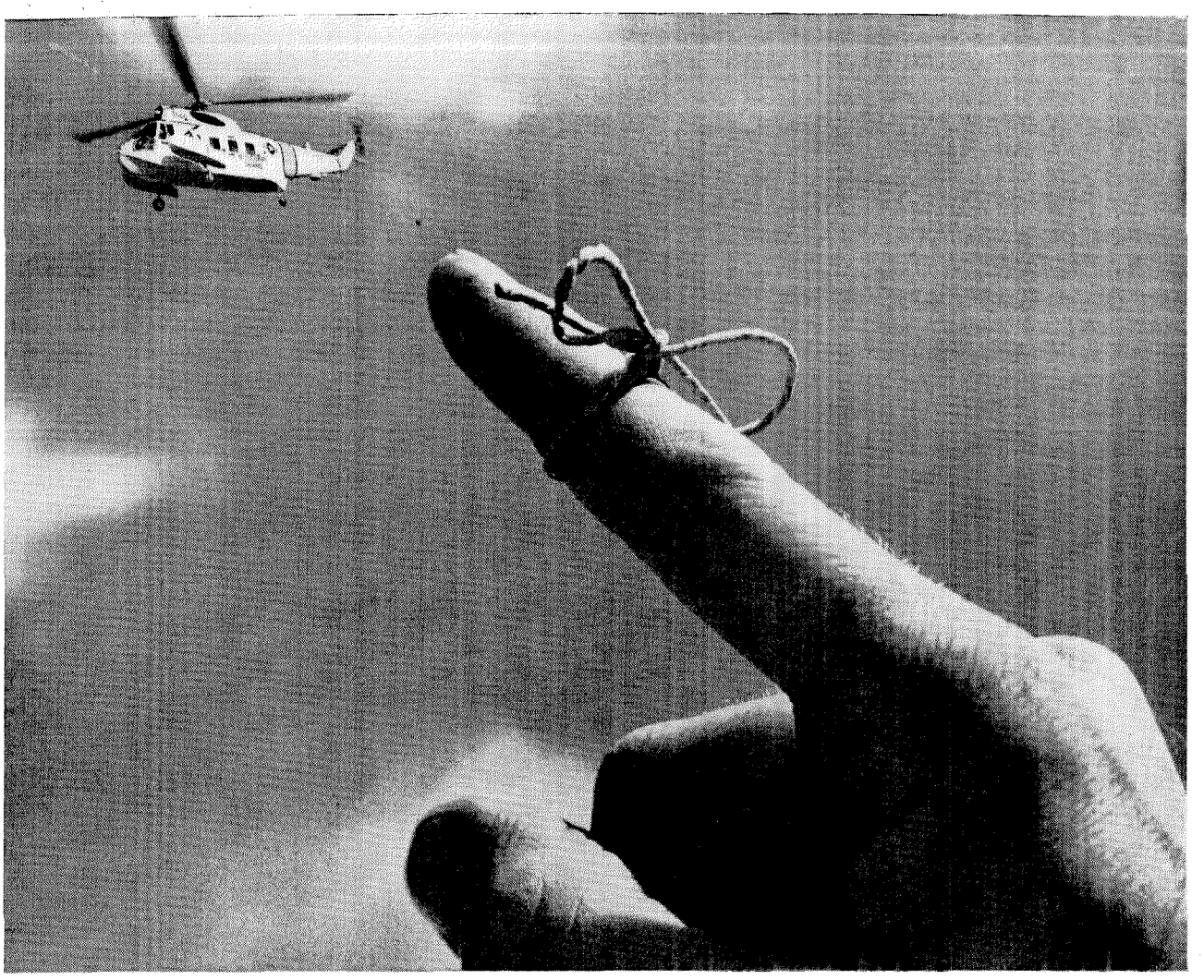
"Some people," he comments, "still seem to think that all the smog comes from industry. However, practically the only uncontrolled source of carbon monoxide is the incomplete combustion of gasoline, which throws 9,000 tons per day of this respiratory poison into the Los Angeles area atmosphere.

"Fortunately, the cars coming out next September will be equipped with exhaust devices that will reduce the carbon monoxide concentration to perhaps one-third of its former level. Those who oppose controlling auto emissions should think of the wholesome effect this will have on the carbon monoxide level of our atmosphere."

Carbon Monoxide Concentration in City and Freeway Driving Routes



Amounts of carbon monoxide measured by Dr. A. J. Haagen-Smit along a route from Caltech to downtown Los Angeles and return, via the freeway system, during the hours of heaviest traffic. The run was made on June 26, 1964, an "average" day during which a late afternoon west wind dispersed existing smog.



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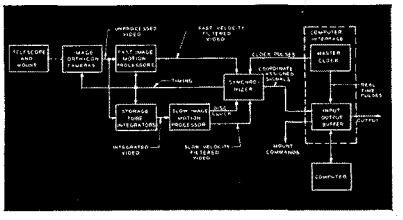
Engineering and Science at RCA

Ground Detection of Space Objects in the Night Sky

RCA has designed and installed for the Air Force a new optical satellite surveillance system that utilizes advanced techniques in several fields including physics, electronics, mathematics and astronomy. Starting in the laboratory with a bread-board experiment to prove the feasibility of using image orthicon tubes as detectors of moving targets among the



millions of stars in the night skies, a team of scientists and engineers carried the project through systems and design analysis, and produced the requisite equipment even to building an observatory on a mountain top in New Mexico. The system is now being evaluated under actual operating conditions. While performance data are security classified it can be said that the system is designed to detect, without a priori information, very dim satellites in real time, far beyond normal radar ranges.

Optical physics and engineering of the highest order were required to produce an eleven-ton, 27 inch f/1 telescope that uses 6 million optical fibers to present images to 12 orthicon cameras. Image motion processing necessary to find a tiny satellite moving slowly through a star field as dense as the Milky Way is accomplished by entirely automatic electronic signal integration, star cancellation and data association and reporting. The very latest techniques of electronic engineering have produced highly sophisticated equipment for control, data gathering and analysis of results.

System design, performance evaluation and computer programming have involved rigorous mathematical analyses applied to new combinations of scientific disciplines. Proof of the deductions are just beginning to emerge from the observatory, and much will be learned about applied astronomy as the system is used.

Reference—J. A. Hynek and J. R. Dunlap, "Image Orthicon Astronomy," Sky and Telescope, Vol. 28, No. 3, p. 130, Sept., 1964.

Color TV Receiver Automatic Degaussing

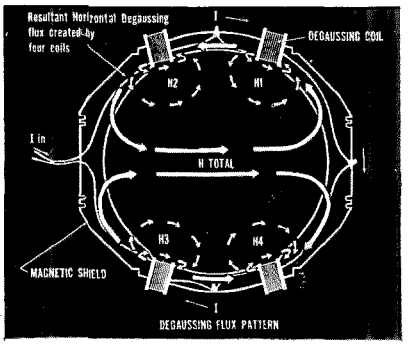
Even the comparatively small magnetic fields exhibited by the earth can cause visible errors in color television reception. To give picture tube output proper color alignment, while the TV receiver is in any desired location, an effective magnetic shield is required. But before a practical magnetic shield can perform its function, the shield must be degaussed in the specific magnetic field to be shielded.

Degaussing enables the metal in the shield to "forget" its previous magnetic orientation and to magnetically realign to counteract any new position. Degaussing affects the metal in the picture tube's shadow mask in the same manner.

Usually, a color television receiver is degaussed by driving a solenoid wound coil with 120 volt AC line voltage and moving the coil around the front of the tube . . . then slowly drawing the coil away. This operation usually is required every time the position of the color receiver, with respect to the earth's magnetic field, is changed.

Recently, RCA introduced *automatic degaussing*. This gives the color instrument freedom of movement, regardless of the earth's magnetic field. Automatic degaussing also protects the receiver from magnetic fields generated by nearby vacuum cleaners and other electrical appliances.

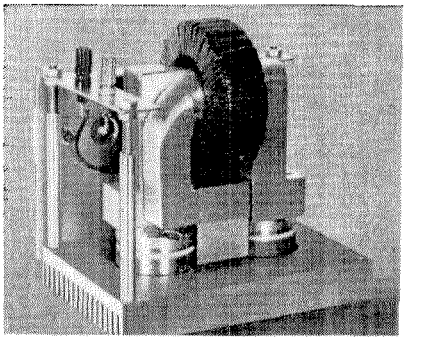
An RCA innovation, automatic degaussing is accomplished during initial warm-up—each time the color receiver is turned on from a cold start. The surge currents charging the electrolytic capacitors of the B+ supply start from a high value and decrease exponentially during the charging time. A thermistor in series with this charging current starts at approximately 110 ohms and decreases to 4 ohms as the current's heating effect changes the resistance.



A voltage-dependent resistor, in series with the degaussing coils (wound on the picture tube shield), acts as a switch to connect the coils across the thermistor only during the warm-up of the receiver. Thus, the slow drawing away of the coil in manual degaussing is simulated automatically.

Energy Conversion

One of the most attractive new methods for the direct conversion of heat to electricity is the thermionic generator. In many applications, however, the efficient use of a thermionic generator requires some form of low voltage DC to AC inversion. Such generators developed at RCA are capable of several hundred watts output at efficiencies of 20%. Because this power is generated at only 0.5 volts, techniques were needed to step up output to practical voltage levels. Under Navy and Air Force sponsorship, RCA has now developed a tunnel diode inverter system capable of inverting the output of thermionic generators and other low voltage power sources to any AC voltage desired, with efficiencies up to 80%. This is believed to be the first time that usable power has been developed from a thermionic generator.



The new system employs the use of gallium arsenide, a semiconductor material which provides larger bandgaps and hence higher efficiencies and temperature capabilities. The tunnel diode inverter system has the advantage over previous designs in the following areas:

Radiation resistance—operable at radiation levels of 10^{17} nvt with only small decreases in efficiency. *Temperature*—GaAs tunnel diodes have been operated successfully at 200°C. *Circuit simplicity*—An extremely simple circuit is required consisting of only one transformer and two tunnel diodes, while the more conventional type of transistor inverter requires several transformers, resistors, diodes and transistors. *Cost-Weight-Volume*—Due largely to their simplicity, these advantages are obvious over other circuits of comparable performance.

These advanced engineering achievements represent a real breakthrough in energy conversion that is extremely important to our defense and space efforts.

These recent achievements are indicative of the great range of activities in research, applied research, advanced development, design and development engineering at RCA. To learn more about the many scientific challenges awaiting bachelor and advanced degree candidates in Electrical or Mechanical Engineering, Physics, Chemistry or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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Personals

1932

C. J. BREITWIESER, MS, is executive vice president and general manager of the Cubic Corp. (which he founded) in San Diego. In addition to serving on the boards of directors of the GeoAstro Corp., the Dominion Dev. Corp., and the Montana Vista Corp., he has been taking an increasingly active part in community affairs and is a member of the San Diego mayor's committee on municipal finance.

1939

STEVEN E. BELSLEY, MS '40, has been appointed chief of the biotechnology division of NASA's Ames Research Center at Moffett Field, Mountain View, California. Formerly assistant chief of the division, Belsley has been at Ames since 1942.

1941

HUGH BRADNER, PhD, writes that he is now professor of aerospace and mechanical engineering science, and research physicist in the Institute of Geophysics and Planetary Physics at the University of California at San Diego. "About the only phase of all the above I'm an expert on," he says, "is the location of U. Cal, San Diego. It is in La Jolla." His geophysics activities include putting seismometers on the ocean bottom, and in that connection he has made several trips to Pasadena to "seek wisdom from Frank Press, Francis Lehner, Wayne Miller, and other kind people at the CIT seismological laboratory."

WALLACE D. HAYES, AE '43, PhD '47, professor of aerospace engineering at Princeton University, has received the American Institute of Aeronautics and Astronautics' fourth annual research award for his leading role in the development of supersonic and hypersonic flow theory. His basic research led to efficient aerodynamics shapes proposed for supersonic aircraft. The award is given annually by the Douglas Aircraft Company.

1942

JOHN H. RUBEL, vice president and director of technical planning of Litton Industries, Inc., in Beverly Hills, has been named a member of the National Council of the National Planning Association. A former assistant secretary of defense, research and engineering with the U.S. Government, he was awarded the Meritorious Civilian Service Award in 1961 and the Distinguished Civilian Service Medal in 1963.

1947

ROBERT K. BREECE, MS '48, died in Sacramento on January 18. He was assistant engineer of design with the California State Division of Highways. He is survived by his wife, two children, Janice and Gary, and his parents, Mr. and Mrs. G. E. Breece of Medford, Oregon.

TING-YI LI, PhD '50, will join the faculty of the department of aeronautical and astronautical engineering at Ohio State University in Columbus this month. He has been professor of aerospace engineering at the University of Cincinnati, and before joining that faculty taught for six years at the Rensselaer Polytechnic Institute in Troy, New York. He is the author of some 35 technical papers in the field of aerospace engineering and is currently consultant to the RAND Corporation.

1949

JOHN HEATH JR. returned to the Los Angeles area last month from San Francisco to be Pacific regional manager of The American Appraisal Company. His fourth child, Mary Ann, was born in September. She is sister to Sean, 13, Kathy, 8, and David, 4.

1950

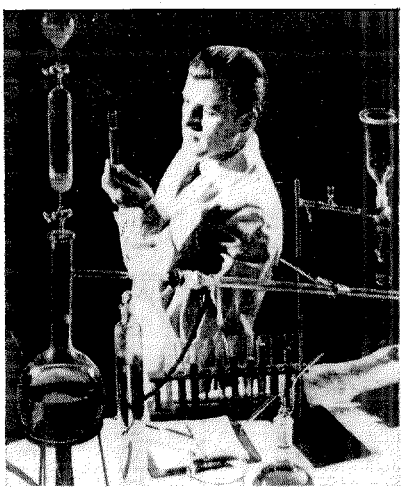
JOHN REEDS, MS '53, is newly appointed supervisor of applied research for the Mincom division of the Minnesota Mining and Manufacturing Company in Camarillo, California, and is building a new home in Thousand Oaks. He was, for 11 years, chief production engineer of Beckman Instruments.

1961

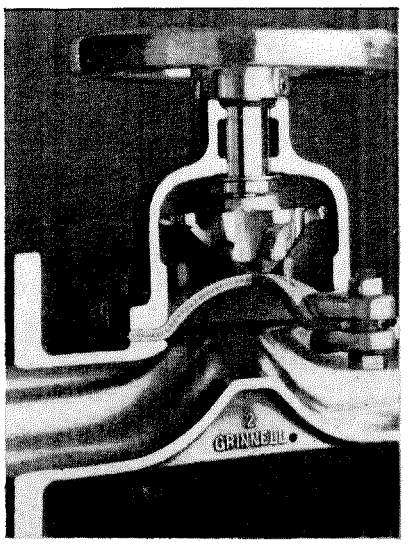
DOUGLAS SHAKEL, visiting the Caltech campus over the Christmas holidays, supplied the following news briefs about his contemporaries: THOMAS K. BJORKLUND, BS '60, was married last September and is now a geologist for the California Oil Company in Denver. MARTY KAPLAN, BS '60, is in San Francisco, married, and has two children. WENDELL W. MENDELL, BS '63, is at NASA's Manned Spacecraft Center in Houston, Texas. VINCENT HASCALL JR., BS '62, is doing research for the Rockefeller Institute in New York and recently spent some months in the back country of Colombia searching for rare orchids. JOHN L. LONG, BS '61, is a First Lieutenant in the U.S. Air Force in San Antonio, Texas, and has a year-old daughter.

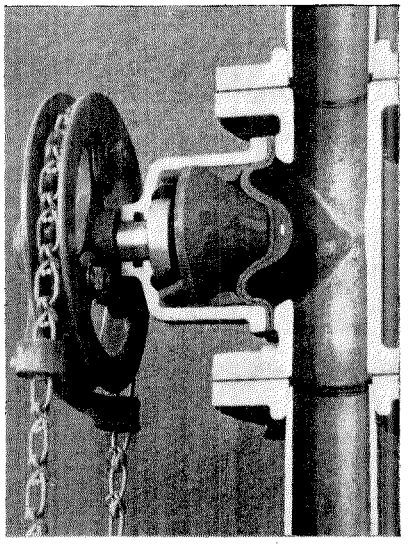
1964

GEORGE E. RADKE was recently commissioned a 2nd Lieutenant in the U.S. Air Force and is being assigned to an Air Force systems command unit at Kirtland AFB, New Mexico. His unit supports the AFSC mission of research, development, and testing of Air Force planes and missiles systems.



From acetaldehyde to zinc-sulfate . . .





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ALUMNI SURVEY

The results of the 1963 Alumni Survey have been published in five issues of *Engineering and Science* (May-December, 1964). However, *E&S* readers who want the reprint containing the complete collection of articles may obtain it by returning the coupon below to Alumni Survey, Caltech, Pasadena, California 91109.

Please send a copy of the Alumni Survey Reprint to:

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May 8

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Lawrence Radiation Lab., Univ. of Calif., Berkeley, Calif.

Meetings: 15th Floor, Engineers' Club, 206 Sansome St., San Francisco
Informal luncheons every Thursday at 11:45 A.M.
Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

SACRAMENTO CHAPTER

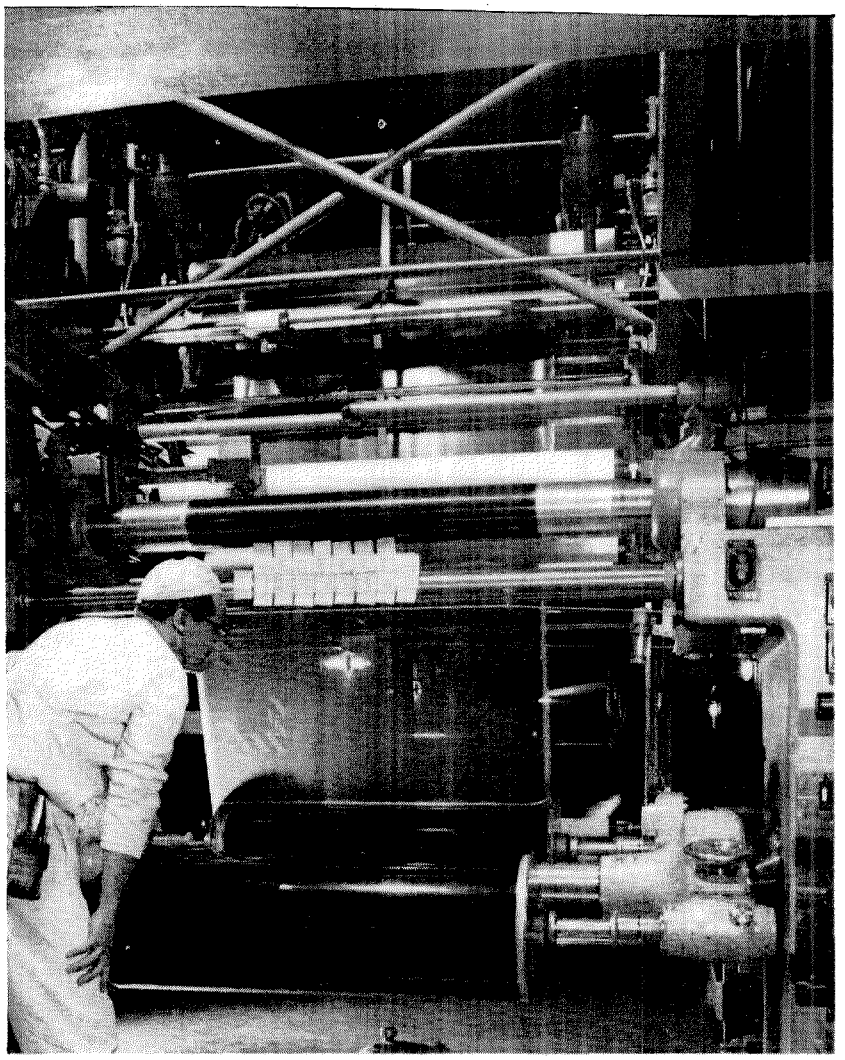
President — Dudley E. Bennett, '47
4535 Marble Way, Carmichael, Calif.

Vice-President — Harris K. Mauzy, '30
2551 Carson Way, Sacramento 21, Calif.

Secretary-Treasurer — William D. Pyle, '49
3920 Dunster Way, Sacramento, Calif. 95825

Meetings: University Club, 1319 "K" St.
Luncheon first Friday of each month at noon.
Visiting alumni cordially invited—no reservation.

Design a better one and call it chemical engineering



We understand as well as the next company the difference between, let us say, a chemical equipment design engineer and an electro-mechanical development engineer. To turn out the volume we intend of such a fantastically demanding cross-product of chemical and mechanical engineering as a KODAPAK Cartridge of KODACHROME-X Film, we have to interest fresh graduates answering to both these job descriptions and many, many others.

In talking to shoppers from the campus, we find it wise to be very specific about job descriptions. We would create the wrong impression at the interview by referring to the job available as "professional engineer."

The young man is winding up four or five years of building himself into a good all-around engineer. Now comes the time to get specific. He is smart enough to know that the demand by strong organizations for all-around engineers under 25 can be expected to remain slack. He is right. The projects awaiting engineers are terribly specific. But if he has picked the right employer, he will find that with each project brought off well the walls between the compartments of engineering get a little softer.

By the time he discovers he has been transformed into that vague "professional engineer," he is having too much fun fighting our competitors by the boldness of his concepts to care what specialty he promised to devote his career to.

On the chance that we might be the right employer, drop us a line.

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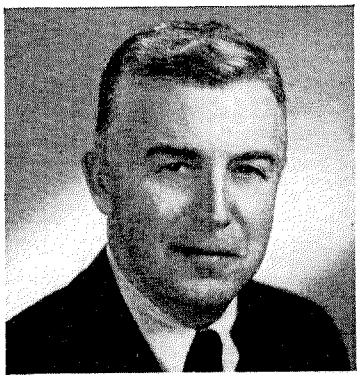
Should You Work for a Big Company?

An interview with General Electric's S. W. Corbin, Vice President and General Manager, Industrial Sales Division.



S. W. CORBIN

■ Wells Corbin heads what is probably the world's largest industrial sales organization, employing more than 8000 persons and selling hundreds of thousands of diverse products. He joined General Electric in 1930 as a student engineer after graduation from Union College with a BSEE. After moving through several assignments in industrial engineering and sales management, he assumed his present position in 1960. He was elected a General Electric vice president in 1963.

Q. Mr. Corbin, why should I work for a big company? Are there some special advantages?

A. Just for a minute, consider what the scope of product mix often found in a big company means to you. A broad range of products and services gives you a variety of starting places now. It widens tremendously your opportunity for growth. Engineers and scientists at General Electric research, design, manufacture and sell thousands of products from microminiature electronic components and computer-controlled steel-mill systems for industry; to the world's largest turbine-generators for utilities; to radios, TV sets and appliances for consumers; to satellites and other complex systems for aerospace and defense.

Q. How about attaining positions of responsibility?

A. How much responsibility do you want? If you'd like to contribute to the design of tomorrow's atomic reactors—or work on the installation of complex industrial systems—or take part in supervising the manufacture of exotic machine-tool controls—or design new hardware or software for G-E computers—or direct a million dollars in annual sales through distributors—you can do it, in a big company like General Electric, if you show you have the ability. There's no limit to responsibility . . . except your own talent and desire.

Q. Can big companies offer advantages in training and career development programs?

A. Yes. We employ large numbers of people each year so we can often set up specialized training programs that are hard to duplicate elsewhere. Our Technical Marketing Program, for example, has specialized assignments both for initial training and career development that vary depending on whether you want a future in sales, application engineering or installation and service engineering. In the Manufacturing Program, assignments are given in manufacturing engineering, factory supervision, quality control, materials management or plant engineering. Other specialized programs exist, like the Product Engineering Program for you prospective creative design engineers, and the highly selective Research Training Program.

Q. Doesn't that mean there will be more competition for the top jobs?

A. You'll always find competition for a good job, no matter where you go! But in a company like G.E. where there are 150 product operations, with broad research and sales organizations to back them up, you'll have less chance for your ambition to be stalemated. Why? Simply because there are more top jobs to compete for.

Q. How can a big company help me fight technological obsolescence?

A. Wherever you are in General Electric, you'll be helping create a rapid pace of product development to serve highly competitive markets. As a member of the G-E team, you'll be on the leading edge of the wave of advancement—by adapting new research findings to product designs, by keeping your customers informed of new product developments that can improve or even revolutionize their operations, and by developing new machines, processes and methods to manufacture these new products. And there will be classwork too. There's too much to be done to let you get out of date!

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-12, Schenectady, N. Y. 12305

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