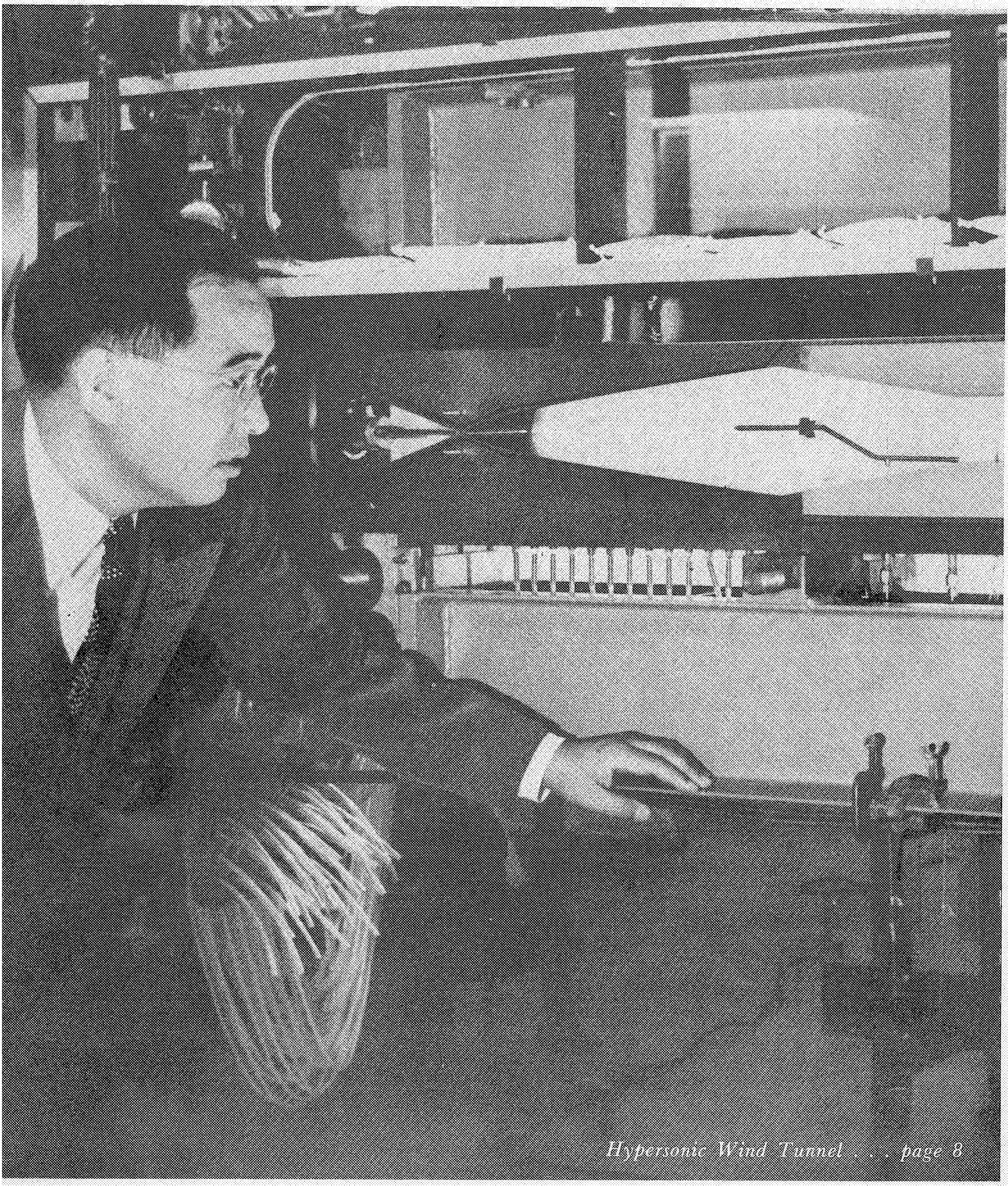
ENGINEERING AND SCIENCE

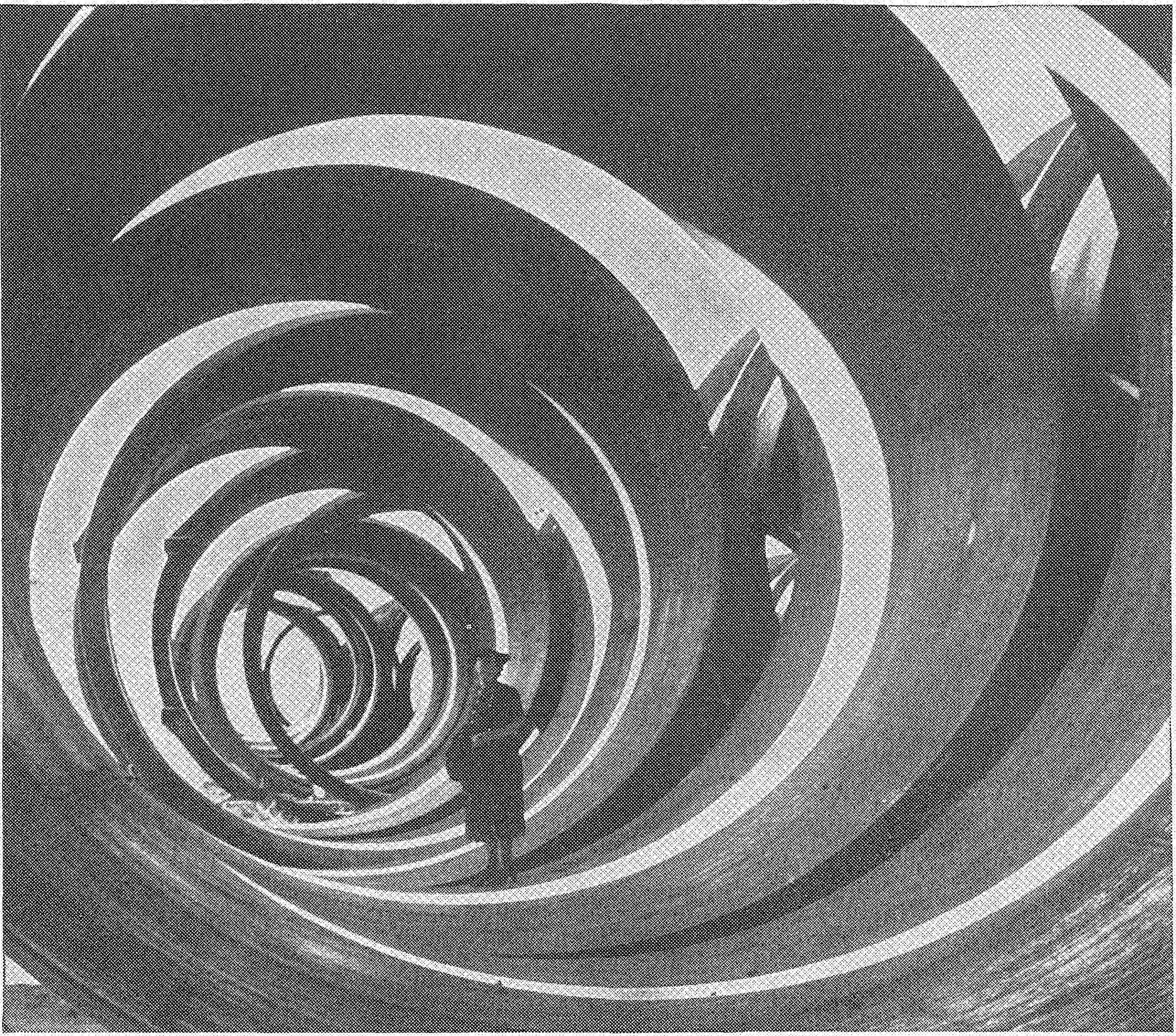
November, 1949



Hypersonic Wind Tunnel . . . page 8

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Want to make a river run uphill?



Steel pipe ready for installation at Grand Coulee Dam, Washington

EVERY DAY, America's engineers are performing miracles with water . . . creating vast, crystal lakes where valleys were before . . . transporting entire rivers across mountains in steel pipe. But there's still a big job to be done. For 108 million Americans still lack adequate water supplies, and 17 million acres could be made into fertile farms with proper irrigation.

The jobs at hand and the jobs ahead will require steel in tremendous quantities . . . for pipe of large diameter and small . . . to reinforce massive concrete dams . . . for bridges that carry pipe across broad streams . . . for cables that suspend it across yawning chasms.

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ENGINEERING AND SCIENCE MONTHLY

VOL. XIII CONTENTS FOR NOVEMBER NO. 2

ENGINEERING AND SCIENCE MONTHLY
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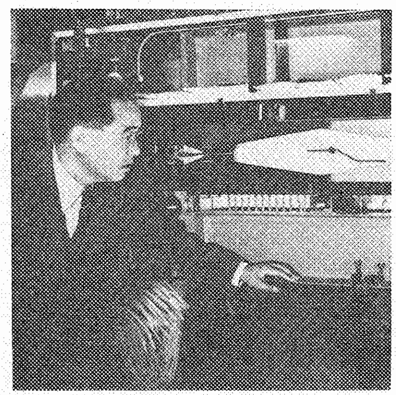

In this issue

On the cover is Dr. Henry T. Nagamatsu, aero-dynamicist and director of the new California Institute of Technology-Army Ordnance Hypersonic Wind Tunnel, examining the test section of the recently-completed tunnel. The hypersonic tunnel—which has already been operated at the unprecedented speed of more than ten times the speed of sound—is the fastest in the world. Even more important, however, is the fact that it opens up a whole new range of air speeds to the designers of rockets, planes and projectiles. The story's on page 8.

Bacher on Atomic Energy

Dr. Robert F. Bacher came to Caltech this fall as Chairman of the Division of Physics, Mathematics and Astronomy. One of the country's leading physicists, Dr. Bacher was Professor of Physics at Cornell University before the war. In 1941 he joined the Radiation Laboratory at M.I.T., headed by Dr. L. A. DuBridge. In 1943 he became Chairman of the Bomb Physics Division on the Los Alamos Laboratory Atomic Bomb Project. At the end of the war he returned to Cornell as Director of the Laboratory of Nuclear Studies until he was called to serve on the Atomic Energy Commission in 1946. From 1947 until he resigned last summer to come to Caltech he was the only scientist on the five-man commission.

Dr. Bacher's article on page 3 of this issue, "Our Progress in Atomic Energy," is adapted from a talk given on October 3, 1949 at Town Hall in Los Angeles.

Free World Agent

In his article on page 10 Fritz Zwicky, Professor of Astrophysics at the In-

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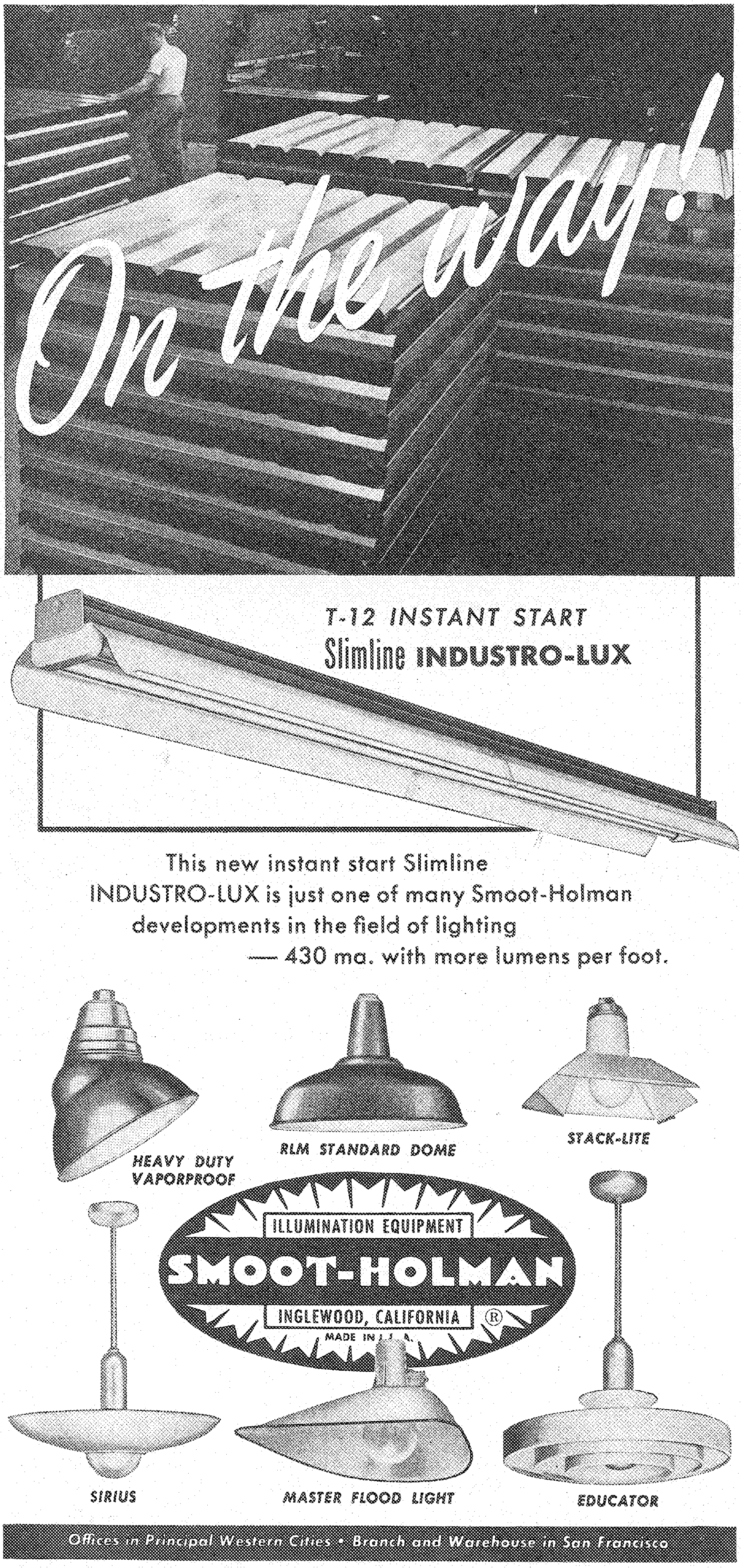


In this issue CONT'D.

Bacher

stitute, deserts the field of astrophysics—as he often does—for that of philosophy. "Free World Agents of Democracy" is adapted from a talk which Dr. Zwicky delivered at an Alumni Association dinner early this year. As an address it proved to be provocative, challenging, rousing, infuriating and interesting. As an article it is all these things and more.

Dr. Zwicky has been at Caltech since 1927, when he came here as Assistant Professor of Theoretical Physics. Born in Bulgaria, he was educated in his native Switzerland, and received his B.S. and Ph.D. at the Federal Institute of Technology in Zurich. Since 1943, in addition to his Institute duties, he has been Director of Research for the Aerojet Engineering Corporation in Azusa. This year he became a member of Aerojet's Technical Advisory Board.

During the war he served as Technical Representative of the Air Force in Germany in 1944-45, as Consultant of the Air Force Scientific Advisory Board in 1945-46, and as a Member of the Board from 1946-48.

This fall (Sept. 21) on order of President Truman, Dr. Zwicky was awarded the Medal of Freedom, in recognition of his services in Germany in 1945, when he interrogated German scientists and technicians who had been engaged in the development and manufacture of German rocket-powered weapons such as the V-2.

Zwicky

VOL. XIII, NO. 2 ENGINEERING AND SCIENCE MONTHLY NOVEMBER 1949

Atomic bomb test at Eniwetok Atoll in 1948—"very encouraging."

Our Progress in Atomic Energy

by ROBERT F. BACHER

A leading physicist—and former member of the Atomic Energy Commission— answers some pertinent questions concerning the future of atomic energy.

IT IS NOW nearly seven years since the first controlled chain reactor started operation. It is over four years since the first atomic bomb was exploded. Perhaps more important—it is just a little more than a month since the President announced that an atomic explosion had taken place in Asia. You may ask: "How are we getting ahead with the development of atomic energy? Where do we stand today in the development of weapons and atomic power? Are we going to get a new source of electrical energy soon? What are other countries doing about atomic energy?"

These are some of the questions that are often asked, and I shall try to give some answers to them.

During the war the atomic energy enterprise was aimed solely at the development and production of atomic weapons to use in the war. This enterprise, as you may recall, was based upon the fundamental scientific discovery of fission of the nucleus of the uranium atom in 1938, and upon a number of later discoveries that showed how this fission took place and what happened when the uranium nucleus did divide.

By the end of 1941 a considerable amount of scientific work related to fission was going on in this country. By the end of 1942 the first controlled chain reactor had been put into operation. During 1943 tremendous plants were constructed for the separation of the vital component, Uranium 235, from ordinary uranium and for the production in reactors of a new element hitherto unknown in nature—plutonium. These elements were destined to become the critical materials of the atomic bomb. Also during 1943 a laboratory was built, staffed, and put into operation in a remote region of New Mexico for the development of the bomb itself. All of this happened in a little more than four years.

In the development of the atomic bomb everything was sacrificed for speed. The whole enterprise was undertaken on a wartime basis. Industrial companies were pressed into the development work, and into the construction program and production operation, with promises that they would be relieved at the end of the war. Personnel for technical and scientific work was borrowed from many different types of organizations. A large fraction of the experienced personnel was obtained on a loan basis for the duration of the war.

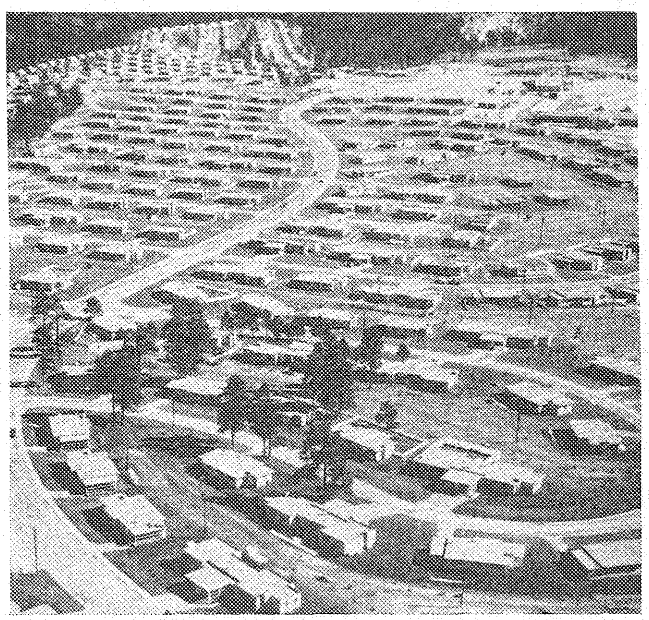
As a wartime project this worked and resulted in the development in 1945 of a successful atomic weapon. But at the end of the war the whole project started to fall apart. This was more or less inevitable from the way it had been set up. Industrial companies wanted to be relieved of their responsibilities; scientists wanted to go back to their peacetime work; technical experts from various industries and research laboratories were called home. In addition, there was great uncertainty as to what would happen to the atomic energy project, and this was being debated vigorously in Washington.

The discussions in Washington led to the passage of the McMahon Act or Atomic Energy Act, in the summer of 1946, establishing an Atomic Energy Commission. This commission, appointed by the President, took office in November, 1946, and assumed control of the atomic energy project at the beginning of 1947. During 1946, amid all these uncertainties, the atomic energy project continued to disintegrate.

When the Commission took over, on January 1, 1947, it was indeed a sad situation that we found. Although I had had a rather close connection with the atomic energy project during the war years, I was deeply shocked to find what our position was on weapon development and production. Our development work was going slowly, hampered by many difficulties; our stock of bombs and production rate were frighteningly low.

In the production of Uranium 235 the situation, while by no means excellent, was in very much better shape. But in the production of plutonium there was another emergency. According to the experts, the big reactors or atomic furnaces which had been built to produce plutonium at Hanford, Washington, on the Columbia River, were in bad shape and getting worse fast. No one was optimistic about how long they would last. It was essential to find ways of stopping this deterioration, and to ensure that the country would not be left without means of producing plutonium.

In research in the various sciences associated with atomic energy, the end of the war brought temporary confusion and a great deal of readjustment. The research and development work needed strong encouragement, but efforts in this direction had to await the solution of the emergency problems in weapons and production. Although we had available to us many of the necessary ingredients for producing new types of nuclear reactors, this development work had to take second priority.



Workers' homes at Los Alamos atomic weapons plant.

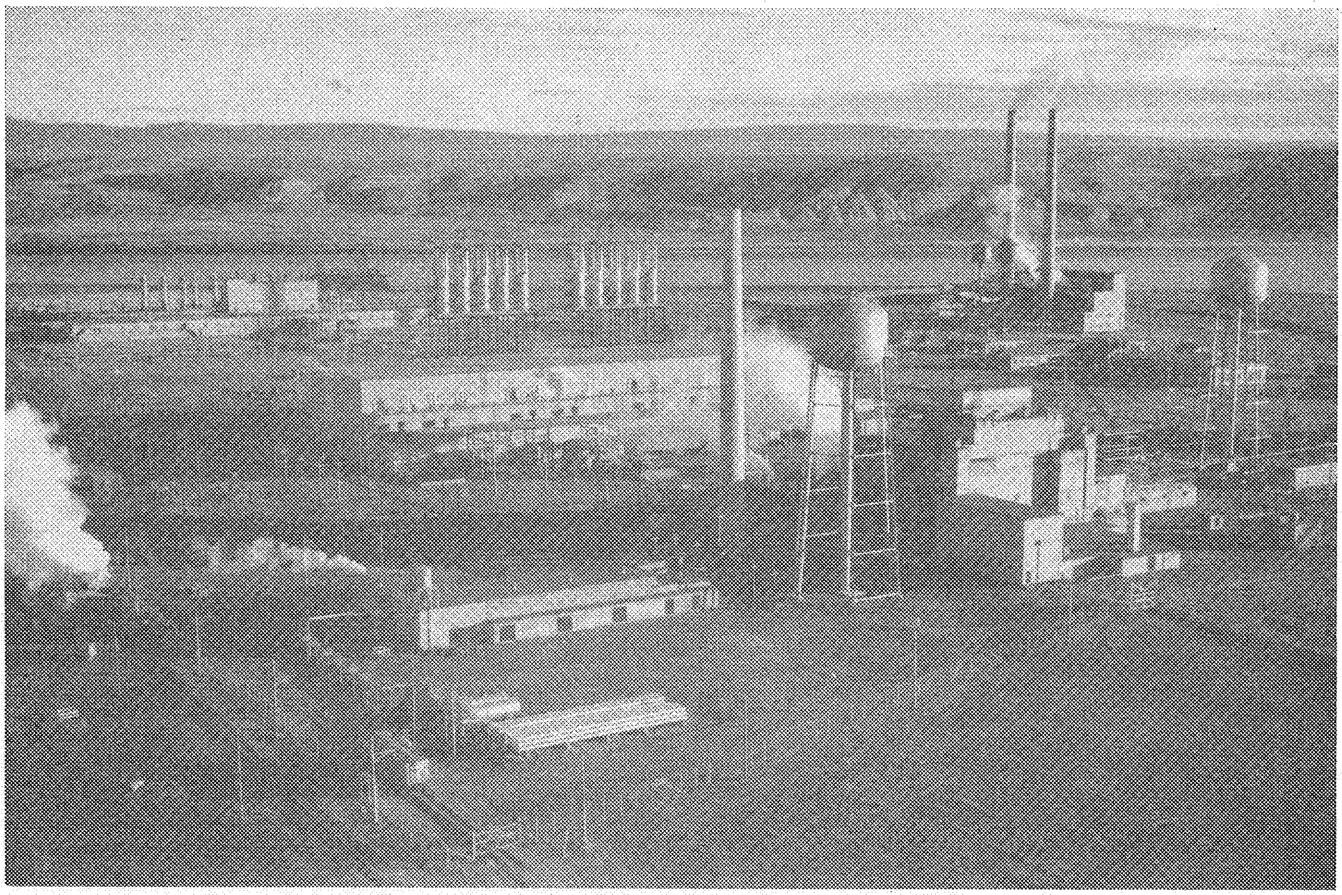
Where do we stand today?

You may well ask, "How was this situation met—and where do we stand today?" During 1947 the main effort of the Atomic Energy Commission was directed toward correcting the situation in atomic weapons—toward increasing weapon production and toward development of new types of weapons. This work was pushed and encouraged by the Commission in every way that it knew. The members of the Los Alamos laboratory, who are mainly responsible for the weapons work, deserve a great deal of credit for their efforts to bring the laboratory back to a satisfactory state. The recovery was encouraging, leading, in the spring of 1948, to a series of atomic bomb tests at Eniwetok Atoll in the Pacific. The 1946 tests at Bikini had been made to determine the effects upon various types of ships of the same type of weapon used in the war. At Eniwetok new types of atomic weapons were tested and examined in action. These tests were very encouraging. They showed that the laboratory developments were good, and they gave us a much better understanding of how an atomic bomb works than we ever had before. It was a terrific boost to this enterprise.

During 1947 new reactors were started at the Hanford works to replace those already in operation, should they go bad. During 1948 considerable success was achieved in the correction of the deterioration which was taking place in the units already constructed, and today the prospect for those units seems much better than it once did. It now seems quite unlikely that the country will be left without facilities for the production of plutonium.

During the past year there has been increased effort on the development of new kinds of nuclear reactors. The present production reactors are structures of graphite and uranium which produce large quantities of energy. This energy is removed by water from the Columbia River and it is wasted. One of the aims of reactor development is to make some good use of the energy which a reactor can produce. Some of the present work is aimed at the construction of a mobile reactor which might be used as a source of energy to drive a ship or submarine. Such a vessel would be able to have an extraordinarily large cruising range.

Other work is aimed at the development of a nuclear reactor called a breeder. A nuclear reactor burns nuclear fuel but the process of burning generates nuclear particles called neutrons which, if properly utilized,



One of the large manufacturing areas at the AEC's Hanford, Washington, plutonium production plant.

can be made to produce new nuclear fuel. There is the possibility, not yet proved, that a reactor may be built which will burn nuclear fuel, produce electrical energy, and generate more nuclear fuel than is burned. Whether it is possible to make such a breeder remains to be seen. Whether it is practical is a still further question. And whether it can be run economically—even if possible—nobody knows today. But since this astounding process *may* be possible, it needs a vigorous study.

For static reactors one question is, "Will atomic energy provide us a cheaper way of producing electrical energy?" Nobody knows how to answer this today. Present estimates indicate that it would be somewhat more expensive to produce electrical energy from a nuclear reactor in a place like New York City than to produce the same electrical energy from coal—even if all the technical problems now confronting us were solved. But the atomic energy enterprise is new, and many short-cuts may be found. New developments may lead to lower production costs, but whether atomic energy can compete with coal will probably not be decided for some years.

In any event, even if it turns out to be economically feasible to produce electrical energy from nuclear reactors, it seems quite unlikely, because of the magnitude of the undertaking, that any appreciable fraction of our electrical energy will be produced from nuclear reactors within the next twenty years. It is much more likely that the development of nuclear reactors may provide cheaper power for remote and inaccessible regions of our country, and thus stimulate their growth and productivity. The successful development of atomic energy as a source of electrical energy will have a stupendous effect upon our country, even if it does not entirely replace other sources of electrical energy.

It has sometimes been stated that there just isn't enough uranium in the world to furnish the raw material for a big production of energy from nuclear reactors. Unfortunately, there are no reliable estimates of how much uranium there is in the world. The Russians seem to have obtained enough to support their atomic project without having access to many of the known sources. We do know that rich deposits of uranium are very rare, but we also know that there are large deposits in very low concentration, and until quite recently, little effort has been made toward recovering this material. A few years ago, uranium was a drug on the market. Its main use was for the extraction of radium, and after the radium had been extracted there was practically no use for the uranium itself. Also there has been little prospecting for uranium, and many new discoveries will probably be made as the attention of prospectors turns in this direction. Up to the present time more uranium has been taken out of the earth than some people said, ten years ago, would ever be available.

One difficulty is that we are not using the raw material as efficiently as we should. We must try to produce more fissionable material from a given amount of raw material. Some steps in this direction have already been made, and further progress seems assured. A tremendous step forward could be made if thorium, as well as a larger fraction of natural uranium, could become available to us as a source of fissionable material through the development of the breeding process.

The recent announcement by the President of the evidence of an atomic explosion in Asia has made it clear that the Russians have been engaged in an all-out effort in atomic energy. To have arrived at this state, they must have been successful in their scientific and technical work as well as in large-scale industrial development. Ever since the war scientists have warned that the atomic bomb could, and probably would, be developed by other nations. The main secret of the bomb was the fact that it could be exploded, and this became known to everyone more than four years ago. There are, to be sure, many other secrets about its design and construction which have been very closely held. But the fact that an atomic bomb can be made must have greatly simplified the Russian problems. Many of the difficulties of the construction of the first bomb never needed to be encountered by anyone who knew it could be done.

At this time it would be interesting to speculate on the objectives of the Russian atomic energy program. The Russians are most certainly interested in bomb development and production. They are probably engaged in an all-out effort to make better bombs and more bombs, realizing that it is the possession of a large stock pile of bombs that determines their military effectiveness. But it seems to me most unlikely that this is the only aim of their program. I surmise that they recognize in atomic energy a new field, the successful development of which, on a broad front, would allow them to achieve in one jump a position of more equal industrial development with the rest of the world. They would, under such an incentive, be willing to devote strenuous efforts to this accomplishment. Success would mean a stronger country both in industry and in military potential. New developments in atomic energy can be expected to contribute both to peacetime and wartime strength without possibility of sharp distinction.

In other countries

The uncertainties of the future have by no means discouraged other nations in this work. Many of them are pushing ahead just as hard as they can with the development of atomic energy. Britain has two experimental reactors in operation at the present time, one of which is of sufficient power to produce all the radioisotopes that are needed. In addition, the British have under construction larger units which should be able to produce fissionable material in considerable quantity. Canada has in operation, at the Chalk River Laboratory in Ontario, a nuclear reactor which probably gives a more intense neutron bombardment to samples inserted in it than any other reactor now in operation. This is primarily an experimental machine, and it has served to train many people, both Canadian and British, in the fundamentals of atomic energy.

France is in the midst of an atomic energy program and has already constructed and put into operation its first reactor. The French have said that the purpose of their program is the development of the peacetime uses of atomic energy. Sweden, Norway, India, and a host of other countries have set up atomic energy commissions to foster nuclear research and promote the development of atomic energy. Most of these are at present engaged in the scientific and technical development stage of the work and are not yet involved in production facilities.

The announcement of the recent atomic explosion means that the Russians have moved a long way in the development of atomic energy. Since this announcement was made we have heard many suggestions about what this country should do, now that we know roughly what the Russian state of development is. Fortunately, during the past three years the main effort of the United States atomic energy project has gone into the development and production of bombs and the production of fissionable material. This year somewhat more effort has gone into the development of nuclear reactors, either to breed new fissionable material, to provide mobile power sources, or to test materials. This work is now an important part of our atomic project and may be expected to furnish the technical developments for new accomplishments.

Do we now abandon our development work and put all effort into exploiting our present knowledge? Such a policy might lead to a somewhat greater strength in the very near future. But for a longer pull I do not believe that this policy would be wise, and it might be disastrous. The secret of our national strength is progress and we must take care to provide every encouragement for that progress.

In order to achieve sustained progress in atomic energy it is essential to push ahead on a broad front. We need new technical developments and we need fundamental research from which still further technical developments will spring. We can say emphatically that the technical progress of the future depends upon the fundamental research of today. Unless we have scientific progress now there will come a time when our technical progress will bog down

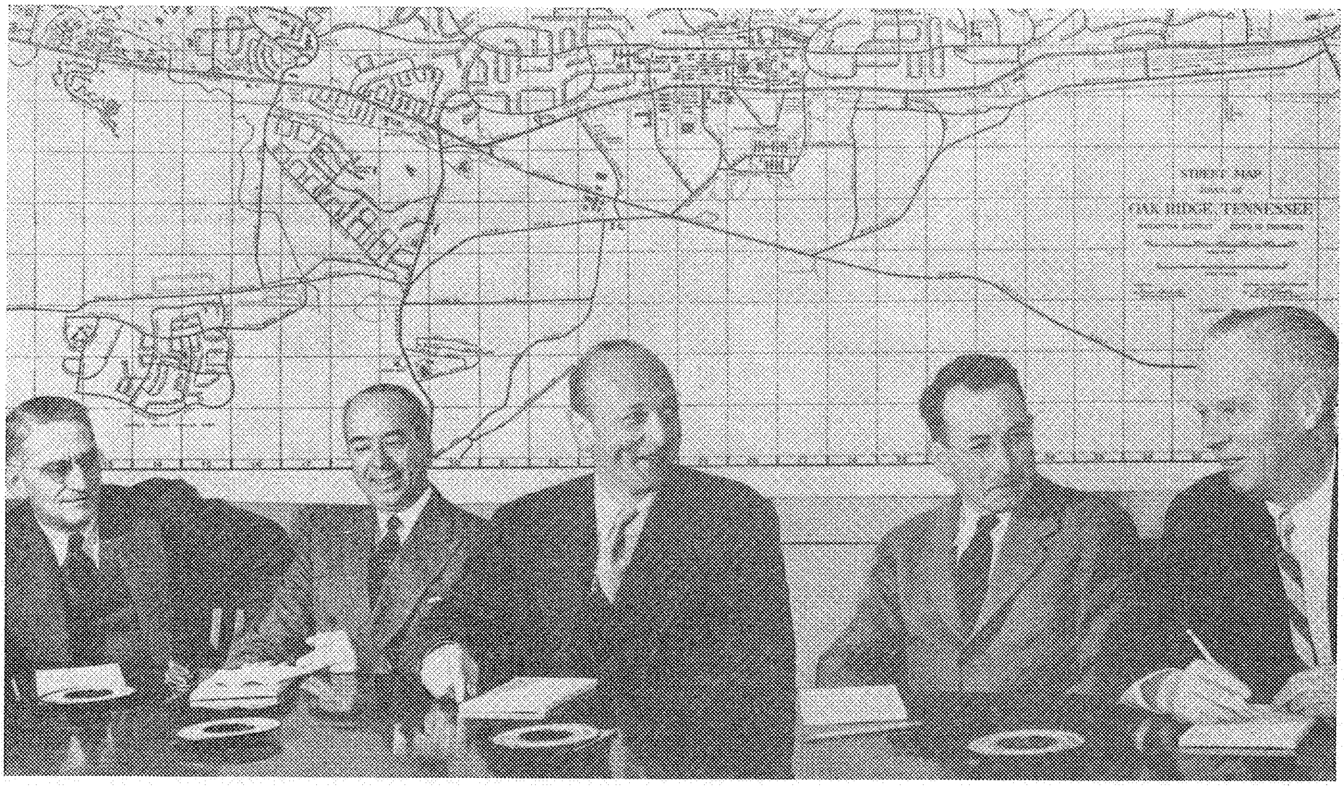
Both scientific and technical progress have been adversely affected during the current year by the time-consuming congressional investigation into the atomic energy project. This investigation has shown that the sensational charges which precipitated the investigation were quite unjustified. The right of congressional investigation is an important part of our democratic system, but abuse may not only weaken our democratic structure; in the case of atomic energy it may hold back our technical and industrial progress.

The extent of secrecy in atomic energy work has been the cause of many serious problems. A good many of the developments in atomic energy have been shrouded in a veil of secrecy. Information about the design and production of weapons and the production of fissionable material has been very closely held. But the veil of secrecy has a tendency to spread like a fog and cover all sorts of other subjects as well. No one wants to be responsible for making information generally available which someone might claim should remain a secret. As a result, many developments are kept secret which might have led to major advances elsewhere in American industry. Secrecy does not contribute to our own progress; it holds it back.

Of course, we must be prepared to accept some disadvantages if we are to keep secret the development of new weapons, and this is undoubtedly sensible. But it is not sensible to keep information only remotely related to weapons unavailable to our own scientific laboratories and industries. Now, with the knowledge that there has been an atomic explosion elsewhere in the world, we should stop impeding our own progress with excessive secrecy.

One of our present great difficulties is that too many things about atomic energy are called secret to keep them *all* under wraps. If we persist in this direction it is inevitable that, sooner or later, we are going to lose some real secrets. A little more hard-headed thinking would show us that we are not only holding up our own development by our present policy of blanket security, but also jeopardizing some information that we would really like to keep secret.

When the Atomic Energy Act was passed in 1946 the wartime cooperation with the British and Canadians was abruptly halted in accordance with the provisions of that Act. Our agreements about raw material pro-



Original members of the AEC—William W. Waymack, Lewis L. Strauss, Chairman David Lilienthal, Robert F. Bacher, Sumner T. Pike. Waymack and Bacher have now been replaced by Gordon E. Dean and Henry T. Smyth.

curement did continue, and in addition for the past year and a half there has been a limited exchange of information in a few areas. Such limited exchange is a long way from full cooperation. We are at present using a joint stock of raw materials to pursue independently-conceived programs in atomic energy. We are exchanging information on such a limited front that it is almost certain that the same problems are being studied in the United States, Britain and Canada. If the aim is mutual progress, such a policy makes little sense. Especially now that the Russian position in the development of atomic energy is somewhat clarified it is probably most unwise not to cooperate with our friends. Because of their wartime collaboration in the development of the atomic bomb they are generally well informed about work in this field up to 1946. Closer relations in the development of atomic energy with Britain and Canada will contribute to our mutual strength.

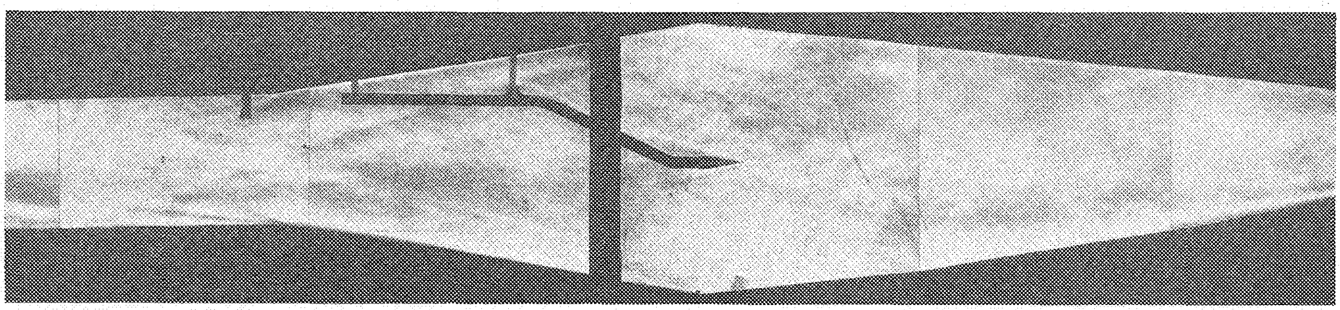
Speeding Up

Today our atomic energy project is moving ahead rapidly. Our weapons production and development are in much better shape than they were three years ago. Our production of fissionable materials has shown major strides forward and we are today getting more fissionable material produced from a given amount of raw uranium. The development of nuclear reactors, while greatly impeded by the fact that the high priority on effort had to be given to production of fissionable material and weapons, is now moving ahead at an accelerated pace, and I believe that we can expect outstanding accomplishments in this direction in the coming years.

The basic research on which these developments are founded is by no means in such good shape. During the war our development of atomic energy was largely based on scientific discoveries which had been made some time before. There were, of course, some new discoveries and quite a number of technical developments. At the end of 1945 scientists started again to pursue the fundamental research that had been abandoned in the wartime emergency. While progress in basic science is faster today than it was during the war, it certainly has not kept pace with technical developments. With all the stupendous effort in atomic energy, we have no better understanding today of the forces which hold the atomic nucleus together than we had twenty years ago. It is quite unsound to base our atomic energy program upon such flimsy foundations of knowledge as we now have. This is but one example of our lack of knowledge in basic science. Our knowledge of the solid state is very fragmentary and it has hampered us in understanding the behavior of materials that are put in nuclear reactors. There are many other examples.

Progress in science depends primarily upon the availability of competent scientists and suitable equipment. The number of scientists in this country today is far too small, and we must take steps to produce more and better-trained research workers. On the side of available equipment, basic research in the physical sciences is today almost entirely dependent upon grants from the federal government. This is a dangerous situation, but the work in basic science would be going much more slowly were it not for the government's help.

No one would argue today that our national security is not closely tied to our present position in atomic energy. But it is vital to realize that our security and continuing national strength are tied to the future development of atomic energy. In order to make the best progress in this work we should remove unnecessary road blocks set up by excessive secrecy; we should cooperate with Britain and Canada, making the most of their work as well as our own; and we must advance not only in the solution of our immediate technical problems but on the broad front of scientific research.



Schlieren picture of a rocket model in the tunnel—which is operating at ten times the speed of sound. Shock waves from the nose of the model are hard to see because of the low density of the air in the tunnel test section.

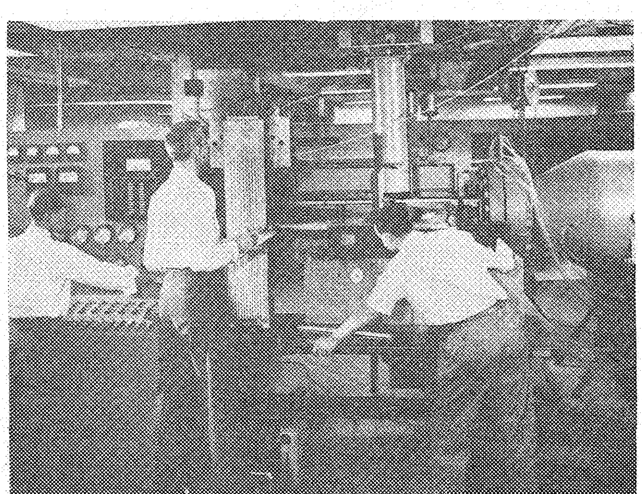
The Hypersonic Wind Tunnel

In this new Caltech-Army Ordnance tunnel men can study the inevitable intercontinental missiles of the future.

A NEW "HYPERSONIC" wind tunnel which has just been completed in the Guggenheim Laboratory of Aeronautics has already attained a speed of more than ten times the speed of sound. This not only surpasses all other highspeed wind tunnels now in operation; it opens up a whole new, unexplored range of air speeds to the designers of rockets, planes, and projectiles. For the first time now man has an apparatus that will allow him to make tests at speeds well above those of our most advanced rockets and missiles.

The top speed for a rocket officially reported to date (E & S—March '49) is 5,200 miles an hour, or a little more than seven times the speed of sound. This record was established by the two-stage rocket—a WAC Corporal launched from the nose of a German V-2 in flight—fired by the Ordnance Department at White Sands, New Mexico, on February 24, 1949.

A guided missile designed with the aid of the new hypersonic tunnel should be able to travel at speeds above 7,500 miles an hour. It could take off from San Francisco and land in Sydney, Australia (7,600 miles) in about an hour. Or it could span the Atlantic, from New York to London, in less than half an hour.



The tunnel requires intricate instrumentation and three men to operate and record data when it is running.

The new tunnel was built for the Army Ordnance Department, whose ballistic experts foresaw the need for tunnels capable of extremely high speeds in which to study the inevitable intercontinental missiles of the future. It will be operated under Ordnance Department contract and, as the pioneer tunnel in the hypersonic range, it will be used to obtain basic information about the design, performance, and instrumentation of hypersonic tunnels. Basic experimental data will also be obtained on shock waves, boundary layers, and the flow past models at hypersonic speeds—along with other information essential to the design and construction of future rockets and missiles.

In all wind tunnels a uniform stream of air is blown through a test chamber in which a scale model of an airplane, rocket or projectile is mounted. The test section of the hypersonic tunnel is only five inches high by five inches wide, though the entire working section stretches to an overall length of four feet. The air enters this working section through a slot, or throat, only a few thousandths of an inch high (the exact height depending on the air speed desired). Thus, at Mach 10*,

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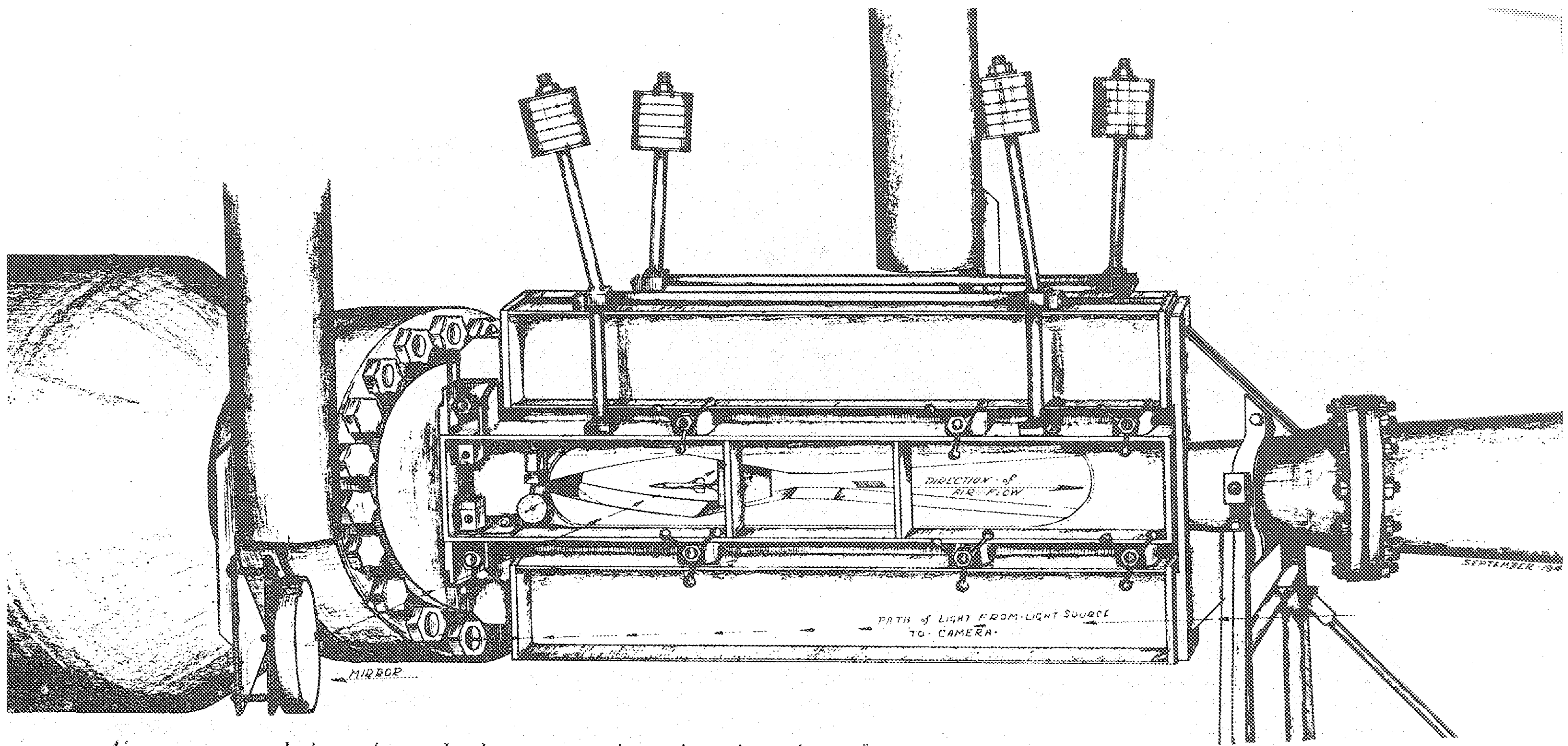
* A "Mach number" expresses the ratio of the speed of a moving body to the speed of sound.

When a body moves through the air at a very low speed the disturbance it makes is propagated to all parts of the air so rapidly—as far as the body is concerned—that the air is effectively incompressible. However, as the speed of the body becomes higher, relative to the speed of sound, the rate at which the disturbance is sent through the air may affect the appearance of the flow pattern around the body. Thus the important criterion of speed is the ratio of the speed of the body to the speed of sound (750 mph at sea level and normal atmospheric temperature).

This ratio is known as the "Mach number"—after the Austrian scientist who made some fundamental investigations in gas dynamics in the 19th century. When the Mach number is less than 1, the flow is said to be subsonic; greater than 1, supersonic; in the region of 1, transonic. Aerodynamicists now say little about actual speed in miles per hour, but talk only of Mach number.



Air enters tunnel through nozzle throat, goes through region of acceleration into test section, then to diffuser section.

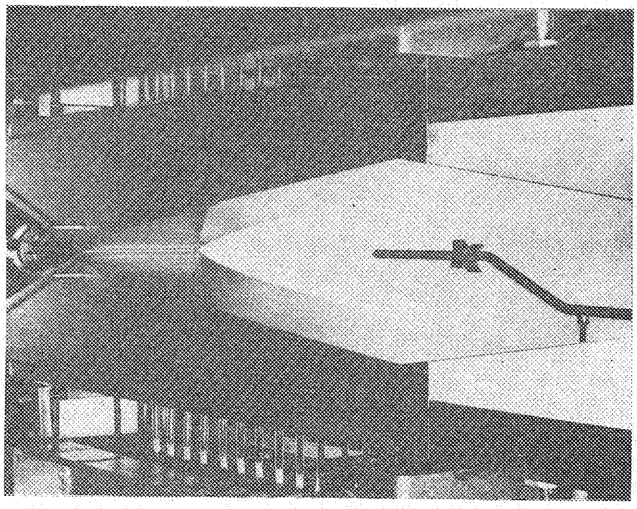
which means ten times the speed of sound, air at tremendous pressure blasts through the tiny slot.

As the air expands into the test section, the temperature drops to about 430 degrees below zero Fahrenheit. Stationary air at this temperature would turn to liquid, but here the air apparently moves so fast through the cold zone that it hasn't time to freeze.

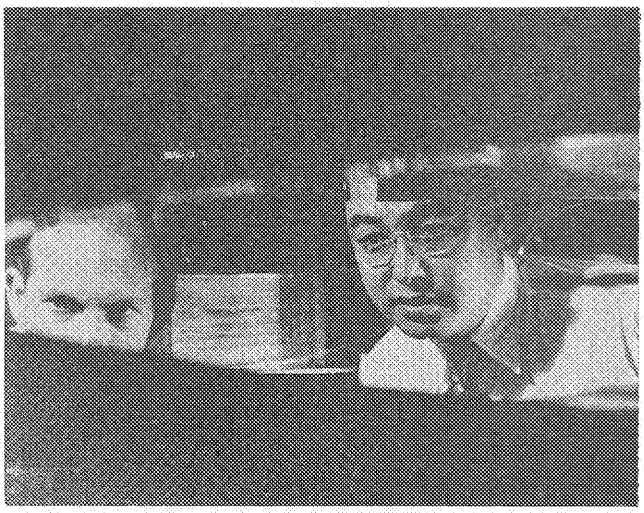
Along with the drop in temperature the pressure in the test section drops to about one millimeter of mercury, or 1/1,000 of normal atmospheric pressure. Consequently, the air is so thin—like that of the atmosphere dozens of miles above the earth—that it is extremely difficult to observe its flow patterns. A schlieren optical system is used to photograph these patterns, made by the fast-moving air as it speeds past the models in the test section. Shock waves in the air stream act as miniature lenses to disturb a parallel light beam, and the disturbance is recorded by a specially-designed camera. The camera can photograph an eight-inch circular area at a time, and the whole system can be moved along the tunnel on an overhead track to get a complete picture of what happens ahead of, and behind, the model.

The tunnel is housed in a building specially designed for it in the Guggenheim Laboratory. The building has two basements, one for the tunnel proper, the other—under it—for the enormous power plant which is needed to operate the tunnel. It takes no less than 15 compressors to supply air for the tunnel. And this air flows first into a large supply reservoir tank, 12 feet long, 3 feet in diameter, and weighing approximately six tons.

From the standpoint of the speed ranges it explores the hypersonic tunnel is "the fastest in the world." It has already been operated at higher than Mach 10. The fastest speed ever reported in any tunnel before is approximately Mach 7, and that could be maintained for only a few seconds in an intermittent-type tunnel. The hypersonic tunnel operates continuously and air velocities of Mach 10 can be maintained for any length of time. In raising the Mach number to 10, the new tunnel makes it possible for the aerodynamicists to move on to the design of rockets, planes and missiles with speeds far greater than any yet attempted.



Test section of tunnel, where models are placed, measures 5" x 5"—but it takes 15 compressors to force air in.



Robert M. James, Project Engineer, and Dr. Henry T. Nagamatsu, Director of the tunnel, check test chamber.

Free World Agents of Democracy

A free man is the world's best agent of democracy. But where — and who — are the free men today? A provocative analysis of our chances of achieving "true democracy."

by FRITZ ZWICKY

ONE OF THE MOST puzzling aspects of human society is the continuing occurrence of wars among nations, of internal bloody conflicts within nations, and of the periodic enslavement of whole peoples by ruthless dictators. Many reasons have been given for these unfortunate phenomena and just as many cures have been proposed. Since no lasting beneficial results have as yet been achieved, we must conclude that all of the efforts made so far to understand and to overcome war and enslavement must somehow have been fundamentally at fault.

For instance, it has been said that economic strife leads to war, especially when one nation is depriving another of necessary resources in raw materials or is strangling its industries or agriculture by competition, excessive tariffs or the like. There are, however, two obvious illustrations of why even the most serious economic conditions may not necessarily cause war.

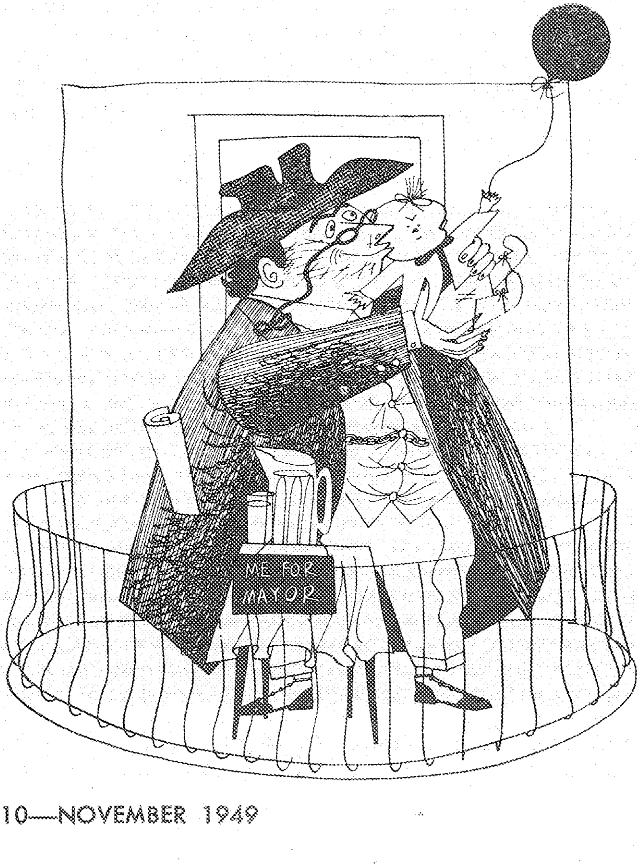
In the first place, a country like Switzerland may have hardly any natural resources and still become, per capita, the richest country on earth. This has happened in spite of the fact that many of the Swiss industries, such as those engaged in the manufacture of watches, embroideries, instruments, and heavy engines, time and again have suffered financial losses and have encountered very great obstacles, because of the confiscation of their assets in dictatorship nations like Nazi Germany and Russia and its satellites. To a lesser degree these industries have often suffered from tariffs, such as the Smoot-Hawley tariff in the United States. Nevertheless, Switzerland has remained friendly with everybody; it has not been embroiled in a war for over 150 years; it has prospered; and it has helped many other countries whose natural resources are far superior to its own.

The second refutation of the theory that economic stresses lead to war is that very few nations have profited from fighting another nation. And if any nation ever did get richer that way, it is in every case obvious that the victor would have done better still if he had used his strength and gone to work in peace to improve his country's and his people's over-all potential.

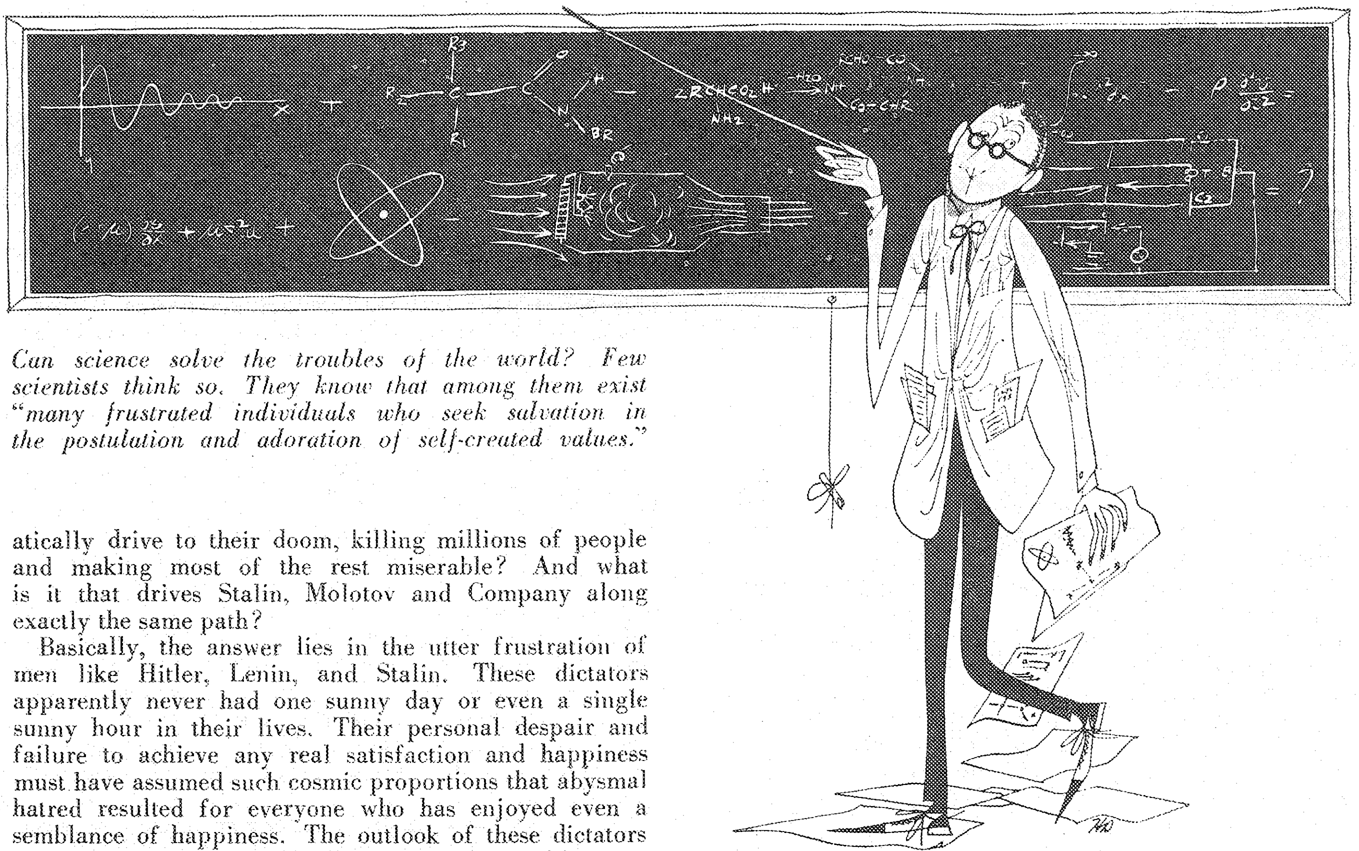
Germany, of course, is the classic example of how a nation may utterly ruin itself. All the claims of German leaders over the past fifty years that Germany was being strangled economically and not being given "Lebensraum" appear now as sheer nonsense. In all major activities Germany was advancing faster than any other large nation. In science, in industry, in national commerce and world trade, in social institutions and in material improvements within the country, Germany, excluding some of the small countries like Sweden and Switzerland, was advancing the fastest and was well on the way to becoming—in the respects mentioned—the most powerful nation on earth, without resorting to bloody conquests.

A similar situation holds true today for Russia, which, without the enslavement of its people by the Politbureau, and the Cominform's intrusion into other people's affairs, would stand an excellent chance of becoming the richest country on earth.

What is it then that made Hitler and Mussolini system-



How can we expect real leadership from "governments made up of politicians who are . . . primarily concerned with keeping their jobs by pleasing their constituents"?



Can science solve the troubles of the world? Few scientists think so. They know that among them exist "many frustrated individuals who seek salvation in the postulation and adoration of self-created values."

atically drive to their doom, killing millions of people and making most of the rest miserable? And what is it that drives Stalin, Molotov and Company along exactly the same path?

Basically, the answer lies in the utter frustration of men like Hitler, Lenin, and Stalin. These dictators apparently never had one sunny day or even a single sunny hour in their lives. Their personal despair and failure to achieve any real satisfaction and happiness must have assumed such cosmic proportions that abysmal hatred resulted for everyone who has enjoyed even a semblance of happiness. The outlook of these dictators on life was and is pure, never-ending gray, and because of their own misery they must take revenge on everybody. It is now obvious that Hitler had no love for his own people. For Lenin and Stalin the same may be said.

If we take the case of Stalin as an illustration, it is a dangerous illusion to assume that his actions are determined by his chances of winning a war, or of advancing the cause of the Russian people. Not at all. What ultimately sways his decisions is his fanatical desire to mess up the world, to keep it in nervous suspense, and in the end to take satanic revenge on as many happy people as possible, enslaving them and killing them—even if this leads to his own doom and to the doom of Russia. All other considerations and manipulations are only a cloak covering and hiding the real instincts that drive a cosmically unhappy and frustrated man. These auxiliary manipulations serve to maintain the suspense, to conduct a war of nerves, and to lead up to the final revenge in a sadistic orgy of "incidents."

Holding actions are necessary

What specifically causes the gray, hopeless mood of dictators is of course most difficult to know, and any hope to unravel this mystery and in this way to arrive at a cure of the ills of the world appears futile. Generally speaking, one may say that frustrations have their origin in the failure to develop one's genius and in the subsequent vulnerability of one's mind to all sorts of slights and mental injuries. In any event curative measures appear extremely difficult. Before they can be understood and practically applied, *holding actions* will be necessary to prevent the unhappy and frustrated dictators and their satraps from wrecking the world.

Such holding actions obviously can not be effectively devised by governments made up of politicians who are committed to wishful thinking, to the evasion of real difficulties, and to the dissemination of false optimism because they are primarily concerned with keeping their jobs by pleasing their constituents. Real leadership demands sacrifice on the part of the leader and of those he attempts to lead, and is therefore hardly to be found among men in governments or in political, scientific, social, or religious organizations whose very existence depends on gaining popular support rather than on unbiased truth. It seems hardly necessary to point to specific examples which, during the course of human history, have accumulated like the sands of the sea. Two illustrations, nevertheless, may be given, because their real significance, which I consider very great, is hardly yet appreciated.

Real leadership?

The first example has to do with Mr. Truman's antics in the issue of Palestine. His frantic meanderings and reversals of policy before the United Nations can only be interpreted in one way. Neither the human destiny of the Jews nor that of the Arabs was the motivating factor. The two principal counterpoles considered must have been the question of political votes in the United States on the one hand, and of Arab oil and geographical military potential on the other. No doubt equally objectionable reasons motivated the Soviet attitude. The unfortunate upshot of the whole affair is a tremendous moral weakening of the United Nations, which let its original plans for Palestine be drastically modified by the force of arms, which let its mediator, Count Bernadotte, be assassinated by chauvinistic Israeli hoodlums who are still at large, and which complacently views the final result of many hundreds of thousands of Arab refugees being made homeless and perishing. It is a sad commentary on our ethics indeed, that so many among those who rightly abhorred or pretended to abhor the actions of the Nazis now act in no way

Henri Dunant, founder of the International Red Cross, at the time he won the first Nobel Peace Prize in 1901.

differently. Whenever it suits their purposes they too put might before right.

The only agents who acted humanely and objectively on the issue of the Jewish problem were some small nations and some individuals whom we may call *free world agents* and who, in the writer's opinion, represent the hope of the future. As Einstein stated in his address at the Fifth Annual Nobel Anniversary Dinner on December 17, 1945: "We shall never forget the heroic efforts of the small countries, of the Scandinavian, the Dutch, the Swiss nations and of individuals in the occupied parts of Europe who did all in their power to protect Jewish lives." Men like Roosevelt and Truman, in spite of floods of noble words, never rose to similar actions. Therein lies a typical attitude of hypocrisy which has done the democratic nations no end of harm and which is largely responsible for tragedies like the present advances of communism in Asia and Europe. Therein also lies a lesson for the future. In the future, as in the past, *we must look to the free world citizens and to the small nations to point the way in truly human affairs.*

Science to the rescue?

The second example has to do with the hopes of some unrealistic optimists who imagine that if no other institution can be of help in solving the troubles of the world, there is still science which might come to the rescue. I think that relatively few of the scientists themselves harbor any such illusions. They know that among them exist a great many frustrated individuals who seek salvation in the postulation and adoration of self-created values which are fundamentally worthless.

Again, to give just one example of the hypocrisy of the scientific community, the recent actions of the "American Association of Scientific Workers" headed by Professor A. H. Compton and including H. C. Urey, J. R. Oppenheimer, and others may be mentioned. This Association in the fall of 1940 issued a manifesto or "Peace Resolution" advising its brother scientists against putting their knowledge in the service of military preparedness. This was at a time when England and Greece stood alone against the Nazis, and isolationism in the United States seemed the proper attitude to please the American public. Later, when America became involved and the all-out offensive was the slogan of the day, most of the men of the Scientific Workers joined the band wagon of the scientific war effort. This band wagon, with its cargo of nuclear energy, jet propulsion, and radar, was rolling at a good clip at that time, thanks to those other scientists who also believe in the value of peace but who, in addition, are determined to fight for it at all times with all means at their disposal—including their special and particular scientific knowledge.

The irony and hypocrisy of the whole setup became evident in the decision to drop atomic bombs on Hiroshima and Nagasaki. This decision put the final and ultimate stamp of approval on the use of *any weapon* by anybody who thinks he is right. It was supported most strongly by the same men who before Pearl Harbor made the greatest noise about the perversion of scientists who put their knowledge in the service of the defense of the democratic way of life. To those who have studied the record, and who are not fooled by the glamorous pretenses of the scientific mutual admiration society, the value of science as such for the advancement of the genius of man thus appears highly problematical.

The unattached man

The principal conclusion to be derived from the study of all of these sad aspects of life we have been discussing is that *no* organization, whether it be political, scientific, or religious, may be trusted to act objectively upon the fate of man. History shows that organizations inevitably have cramped the style of life, if not the judgment and the elementary morals, of their members. Any hope to resolve the predicament of the world rests squarely on those *individuals who are unattached and free in every respect, materially and spiritually*. Only these *free agents* are capable of seeing things as they are. Only they are free to act regardless of the consequences.

To the free man all problems become simple because he is happy. To the ideologically attached and restricted man even the simplest problem is difficult to solve because he is frustrated. We shall not discuss here why, under such attractive circumstances, there are so few free men. Suffice it to state that those who are free are the world's best agents of true democracy. They seek to promote the realization of the genius of every individual and of every nation and thus to eliminate the frustrations and unhappiness brought upon the world by the sadism of gray thinkers.

The world has known many free agents—some successful, some not. Paracelsus and Goethe come to mind, Pestalozzi, and Dufour and Dunant, the founders of the International Red Cross. Within our own lifetime Fridtjof Nansen perhaps rates before all others.

The common bond

The free world agent is not only free materially and spiritually, he is bound by no nationalistic ideologies. He is the friend of all whose actions further the realization of the genius of man. And he is the only truly effective adversary of those gray thinkers who in their frustration have become murderers, killing either openly or under the guise of hypocritical doctrines which claim to have the good of the world at heart. The free world agent is not fooled by words, doctrines, or creeds. These to him are immaterial. It is the *actions* of men that count. These are the actions, on the one hand, of actual and potential murders; on the other hand, of those for whom living means the preservation and enrichment of the lives of all men. Still, in spite of these common aims, there is *no greater diversity than that of the types of men who are free world agents.*

Paracelsus, in the 16th century, was a man much maligned and ridiculed. He was perhaps the first of modern scientists to break through the stalemate imposed on scholars and laymen alike by Aristotle's misunderstood philosophy. He was the first to do basic work in experimental chemistry, pharmacology and medicine. And he had at heart first and last the physical and mental health of humans of every race and creed. He traveled far and wide, helping and teaching. He stood aloof from and above the doctrines both of the Catholic church and of the Reformation, and he visualized clearly the bloody conflicts which were bound to result from the clash of these doctrines.

Pestalozzi, the greatest son of Switzerland a century and a half ago, became the advocate of general education, the founder of the public school system. His theoretical and practical approach towards education is still a hundred years ahead of our time. Kings and czars paid tribute to him for his work with the orphans of the Napoleonic wars. His memory in recent years has been effectively, and in a most appropriate manner, honored and perpetuated by the founders, Mr. and Mrs. H. C. Honegger of New York, and members of the International and the various national Pestalozzi Foundations. And in Pestalozzi villages today—in Rimini, Italy; Trogen, Switzerland; Five-Lille, France; Waldwies, Germany; and others—children from all nations, left orphans by the recent world war, are being raised in a spirit beyond nationalism of any kind.

Dufour, Dunant and Nansen

Any discussion of free world agents must include that long list of courageous, extranational fighting men of the International Red Cross, with the co-founders, Henri Dunant and General Dufour, marching in front. For one hundred years these men have done their job to alleviate the misery of all combatants, working quietly and effectively in a realm which is beyond the praise or blame of any nation, race, or creed.

Dunant, banker and philanthropist, fought his whole life against enormous odds to have the plan of action of the International Red Cross approved by all nations. Dufour lent Dunant his effective support. A great civil engineer, the first modern cartographer, and a truly democratic military figure, Dufour won a war by superior strategy—without killing anybody. And before his power Bismarck had to back down for the one and only time in his career.

Perhaps the most successful of the free agents is Fridtjof Nansen. A polar explorer and a scientist, he served as peacemaker among the Scandinavian countries in the critical years of the 1890's, worked ceaselessly for the millions of refugees of World War I and created the Nansen passes, formed a huge rescue mission to famine-stricken Russia in 1919, served as mediator in the Balkans and Asia Minor following the war of 1921-22 between Turkey and Greece, and received the Nobel Peace Prize in 1922.

The fact that no good biography of Nansen exists in English must be regarded as an abysmal shortcoming of the Anglo-Saxon "Lebenskreis." He had a deeply human outlook and, before all, the will to transform his convictions and words into action. And what is most important, he had the scientific and technical knowledge to streamline his actions effectively and meet the objections of the ever-better-knowing multitude of scientists and technologists who do not see the forest for the trees.

Goethe wrote of his journey to Switzerland and Italy, "I made the acquaintance of happy people, who are happy because they are whole. . . That quality I too will and must attain." These people, we should say, had realized their genius and therefore were happy. However, to make a successful free world agent more is needed. Our materialistic society adores specialists. These have made most people believe that scientific and technical proficiency and material success are the most important things in life. They have succeeded in perverting all human values. Real values will be difficult to establish unless the indirect sabotage by scientific and technical doctrinaires can be counteracted. The doctrinaires must be met and over-matched in their own fields.


Fridjtof Nansen, Norwegian polar explorer, scientist, peacemaker, and winner of the 1922 Nobel Peace Prize.

This, of course, is a large order which can only be filled if ways are developed, more powerful than any hitherto known, to allow man to gain universality and depth of technical knowledge much more easily and more quickly than is possible through conventional education. One such new way is available through the use of the *morphological method of thinking, analysis, and construction.* This method permits man to forge his way into a special field of knowledge, arrive at any point in this field he chooses, and confidently confront any so-called expert in this field. The method, some of whose elements have been used by many thinkers of the past, has been systematized (see box p. 14) only recently and has proved a most powerful tool in opening up vast new fields for human activity. Briefly, it involves the analysis of the totality of all solutions of any given problem, and the construction, regardless of obstacles—such as political, racial, religious, scientific, and personal prejudices and doctrines—of these solutions which, seen in the light of the striving after the realization of the genius of man, seem the most appropriate.

A free world agent then must not only have realized his genius and be a happy man; his genius must happen to lie along the lines of universality and versatility. As Goethe has also said, however, universality is not totality and versatility is not wholeness. Totality and wholeness involve integration. This may be considerably aided by morphological thought.

Morphological thought

For centuries men possessing the attributes of totality and wholeness just happened. They had neither predecessors nor pupils and they only accidentally knew of one another as kindred spirits through the ages. These men were single events whose influence gradually died. Their efforts, unlike the efforts in science and technology, did not bear accumulating fruit. Twenty years after his death Nansen—at least in the Anglo-Saxon world—is essentially forgotten, in spite of his tremendous achievements. Except perhaps for men like Bernadotte, Nansen had no successors, and only pitifully few know the full scope of his character and achievements.

Evidently the crucial element which would make for the accumulation rather than the dispersion of the efforts of free world agents has been lacking in the past.

Fortunately this element is now slowly but steadily gaining in momentum. It is contained in the idea of *morphological thought and action.*

Morphological thought has already been applied to a number of scientific and technical problems. In addition to this method's providing a fascinating game of systematized invention, the successes gained have served to impress on many specialists, whether they are narrow-minded doctrinaires or not, the surprising fact that the morphological method in the hand of rank outsiders can serve to outmatch the specialists in whatever field this may be. Thus morphologists, without being professionals on jet engines and propulsive power plants in general, on the chemistry and metachemistry of propellants, on astronomy and on the science of war, have produced results during the past decade which no specialist in these fields even dreamed of. As morphologists get into their stride and multiply in numbers, more startling successes may be expected to justify their efforts. They, as a group of men who understand one another and who do not need to be organized, are then destined to play a decisive role in the realization rather than the destruction of the genius of man.

While Paracelsus, Goethe, Pestalozzi, Dufour, Dunant, Nansen, and many of the great men of the past were morphologists by birth and native genius, they were not aware of the fact that morphological thought and action can to a great extent be systematized and taught to all those of good will and inclination. This then is the first step which we visualize, the *teaching and application of morphological thought.* We thus predict the emergence of university courses on the subject, and of morphological planners in governments and national and international enterprises. Since morphological thought and action are intrinsically the *prerogative of free men,* their development and spread will clearly advance men towards the goals which the democratic peoples and individuals have been attempting to achieve in a more or less muddled way, and therefore with only limited success.

THE MORPHOLOGICAL METHOD

A Brief Summary

The morphological method is nothing more than an orderly way of looking at things. Its aim is to achieve a schematic perspective over all of the possible solutions of a given large-scale problem.

The method was perhaps consciously applied for the first time during the recent war when it became apparent that not even the richest nation could afford to experiment along all the lines of technical development which presented themselves. In the field of propulsive power plants the method was particularly successful. Because of the forceful incentives provided by the war emergency, not only was the morphological analysis of jet engines carried out theoretically, but also all the means were made available to carry out the results of this analysis in practice. This lucky circumstance contributed largely to the successes achieved, which are embodied in a whole series of remarkable jet engines as well as in the integrated and extended knowledge which was acquired on the whole problem of propulsive power.

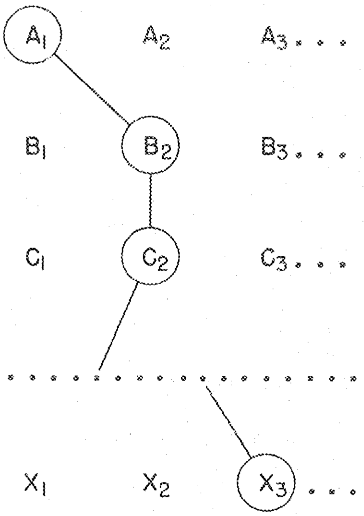
How the method works:

1. A specific problem is formulated. For example, the problem may be to invent, design, and construct a telescope which will make possible certain observations. Instead of asking for a particular telescope, the morphologist attempts to achieve a perspective over all possible telescopes and their performance characteristics.

2. A schematic representation is attempted of the totality of the possible things (telescopes) falling within the category under discussion. This representation is advantageously arranged in terms of significant qualitative and quantitative parameters which are relevant to the problem.

In the case of a telescope, one significant parameter would be the ratio of the energy entering the aperture to the energy absorbed in the recording instrument. Since the entering energy will either be equal to, greater than, or less than the absorbed energy, this first parameter is a matrix of three elements (A_1, A_2, A_3). The second parameter may qualify all the available recording instruments (photographic plates, ionization chambers, photocells, etc.). The third parameter might describe the interaction of the light with the optical parts of the telescope.

Continuing in this fashion, the array of parameters, represented by their matrices, becomes



By circling one element in each matrix and connecting the circles one arrives at a schematic representation of a special type telescope. The end result is a morphological box, or file cabinet, in which each chain of circles either represents one, and only one, telescope or must be ruled out.

3. A performance analysis of all these telescopes is made. Here the morphological method strives toward an evaluation of all telescopes on the basis of very general theorems rather than individual evaluation.

4. Steps are taken to construct and operate all the solutions contained in the morphological box. Limitations of time, means, and manpower obviously demand some choice. This choice, however, can now be made wisely, taking into account the specific problems whose solutions appear most desirable.

THE BEAVER

Some Notes on Student Life

THE first weeks of the fall term always had a special and very pleasant flavor for the Beaver. They were warm days, and the joyful feeling of vacation freedom still lingered unshakably in the air. It wasn't like the weeks later in the year, when everyone seemed bowed down by too many problems and too little sleep.

Most of all, each new autumn presented a new group of frosh, first to be fawned over and rushed, then to be initiated. There was the interest in new faces combined with the ego-warming opportunity to display yourself as a knowing upperclassman—as a wise big brother whose broad experience at Tech and life in general would be devoured word for word by eager new freshmen. A very pleasant situation, the Beaver decided expansively.

During frosh rotation period, everyone proselyted. You personally brought the frosh in to dinner, slyly insinuated into the conversation the perfectly obvious advantages of your particular house, got them dates, bought them beer, and in short treated them as favored equals. This was a painful concession for upperclassmen, and particularly for sophomores, who have all gained untold years in maturity since they were frosh.

Rude-Awakening

■ Past the Beaver's room shuffled a very wet frosh, leaving a soggy trail of water from his squishing shoes to the alley shower. The Beaver put his head out into the corridor to observe several more clothed and squirming frosh headed for the showers. He went out to help.

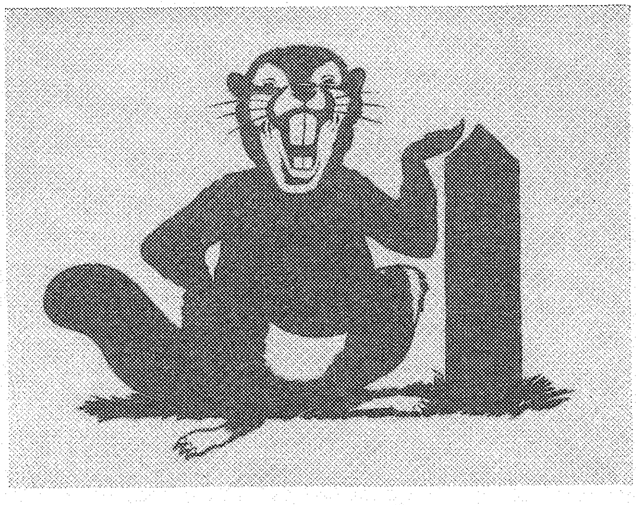
It comes as a stout shock to suddenly become frosh again directly after the settling of house assignments. Initiation commences then with a suddenness that serves to salve the wounded dignity of the sophs after the equality and fraternization of rotation period.

Turning Worms

■ The Beaver had seen a good many wise and spirited freshmen though, and he was inwardly amused when their Fleming component staged an insurrection. The glorious portrait of Prince Eugene, of whom frosh must humbly beg permission to enter or leave the lounge, disappeared the night before initiation. Rising in noble authority, Pledgemaster Sonny Crump informed the frosh they would eat with only their bare left hands until the defiled icon was returned. But, behold, at dinner that evening the entire dining room was mysteriously devoid of any silverware.

The Beaver was broadly pleased. This sort of spirited revolt was secretly desired and admired by upperclassmen. Why not? he pondered, missing his transom with a carelessly tossed cigarette butt; the frosh are still outnumbered three to one—no real danger.

The Beaver slipped on old clothes and went out into the patio, stepping carefully through the slick of water on the stone walk. A dozen frosh were half-heartedly singing "Cool Clear Water" in the center, at the loud insistence of pledgemasters—and were getting the commodity they sang for in great wastebasket gulps from the surrounding second-story windows. Everywhere on campus the Beaver saw frosh with green hats or enormous red bow ties, with nipple-capped root beer bottles hung from their necks, carrying books in suitcases, or determining pi to ten decimal places by counting the number of revolutions of a golf ball rolled down a brick sidewalk.



At every meal the Beaver enjoyed entertainment provided by frosh who stood on their chairs and sang, or ercited or reported—and were "floated" when they sat down again. Every noon water fights broke out between houses, patios were flooded, stirrup pumps going at grim speed. Initiation was, above all, a magnificent way to get acquainted. The Beaver deeply regretted that the grave and gray-haired powers of law and order had forbidden the uproarious tradition of measuring the length of a block of street in downtown Pasadena in unit mackerel-lengths. Traffic used to pile up like neglected homework when the frosh set up a blockade and studiously flopped their dead mackerel down the PE car tracks to measure the standard length of the city block.

Still, here on campus, enough went on to lighten the academic intensity of physics and math. The final initiation ceremonies left the stains and smells of molasses, flour, and eggs on all four houses, but with these the Beaver also noted a distinct atmosphere of righteous satisfaction.

Expanding Universe

■ It was a great adjustment for the freshman. He had been an academic wonder in his home-town high school. He had risen to the top of the high school hierarchy as a senior—maybe a wheel. Now he was suddenly inverted, at the bottom looking up again. And now he competed against a whole class who had graduated last June with top honors. He was swamped with work, staggered with initiation, and learning to live in a dorm with a new and somewhat more mature group of men. He lay in bed at night and wondered in the dark how he would stack up in the competition, how he would adjust himself to the nebulous four years that confronted him.

But the Beaver watched them pass their initial crises: Foster Strong's first formidable physics quiz; the first time they were floated in their dining room seats; the first night they were forced to leave a piece of homework unfinished. The Beaver knew these things built character, and that most of the frosh would pull through with little more damage than to high school egos. After all, the Beaver noted with satisfaction—didn't I? To prove which he pushed away the problems he was doing and wandered down the corridor in the direction of a phonograph playing hot jazz. He was thinking, somebody here must have some beer he'd be eager to share.

—*Jim Hendrickson '50*

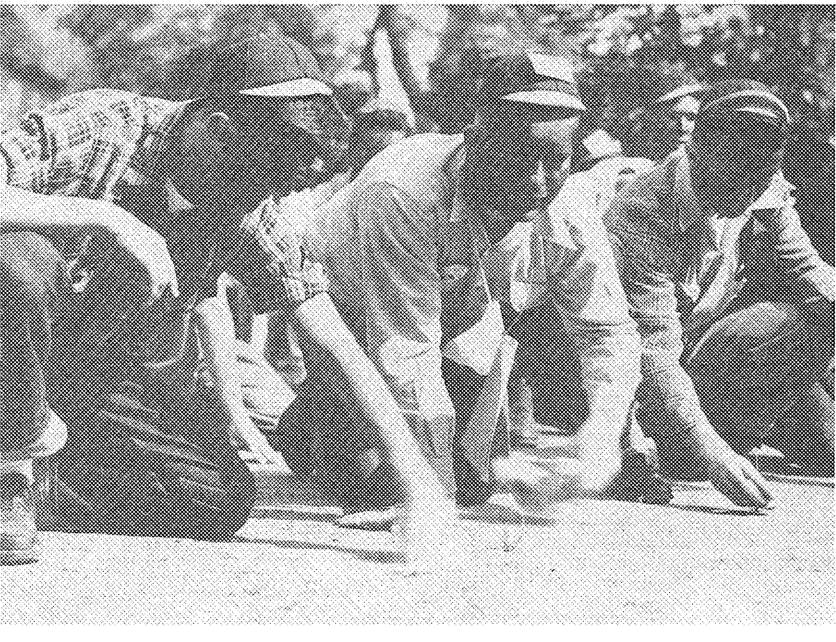
Blacker frosh get a quick shampoo before dinner, consisting of soda, flour, cornmeal and oil — the shampoo, that is.

IT HAPPENS EVERY FALL

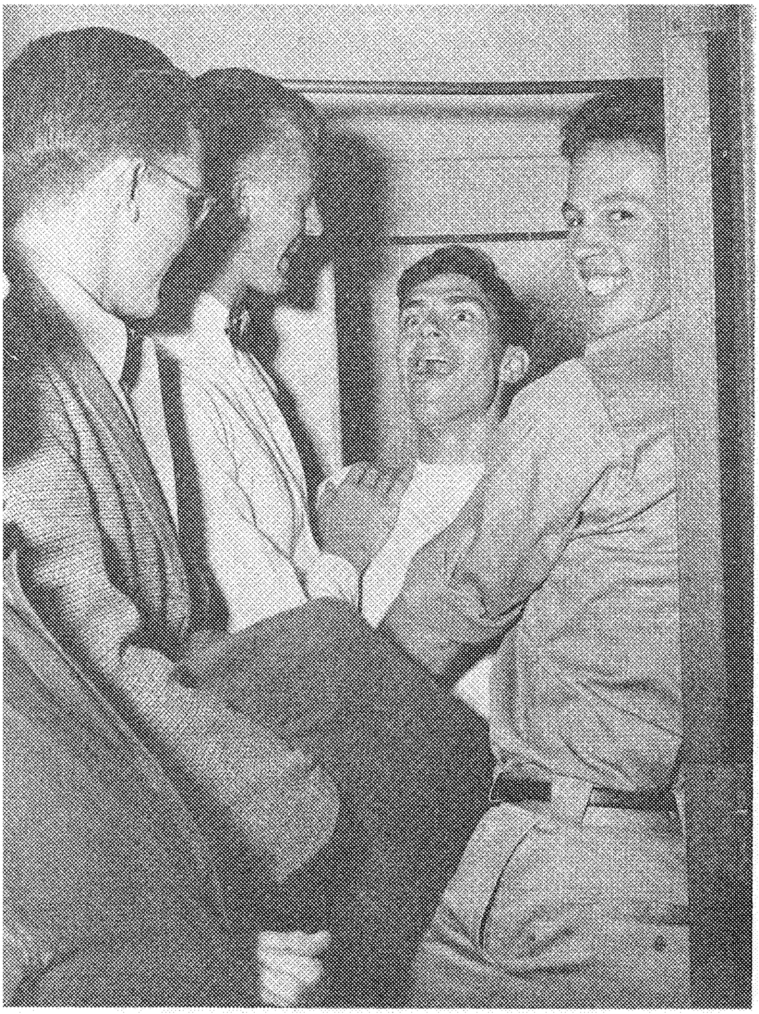
The pause in the term's occupation known as freshman initiation came as violently as ever this year, as the pictures on these pages prove. After six days of rotation, during which the freshmen had a taste of the life in each of the four student houses, final assignments were made, and the intensive five-day initiation period set in.

The tortures devised by this year's pledgemasters were, as always, a little more ingenious than those of a year ago. The four freshmen administering the shampoos in the picture above, for instance, found out when they were through that the sheets covering their victims were their very own. For four days the shoe-shine boy below had to carry a cardboard clock on his back, and keep it constantly correct—on Bolivian sub-standard time.

Throop court gets a dusting — with paper towels.



Available on demand, shoe-shines are free and often.

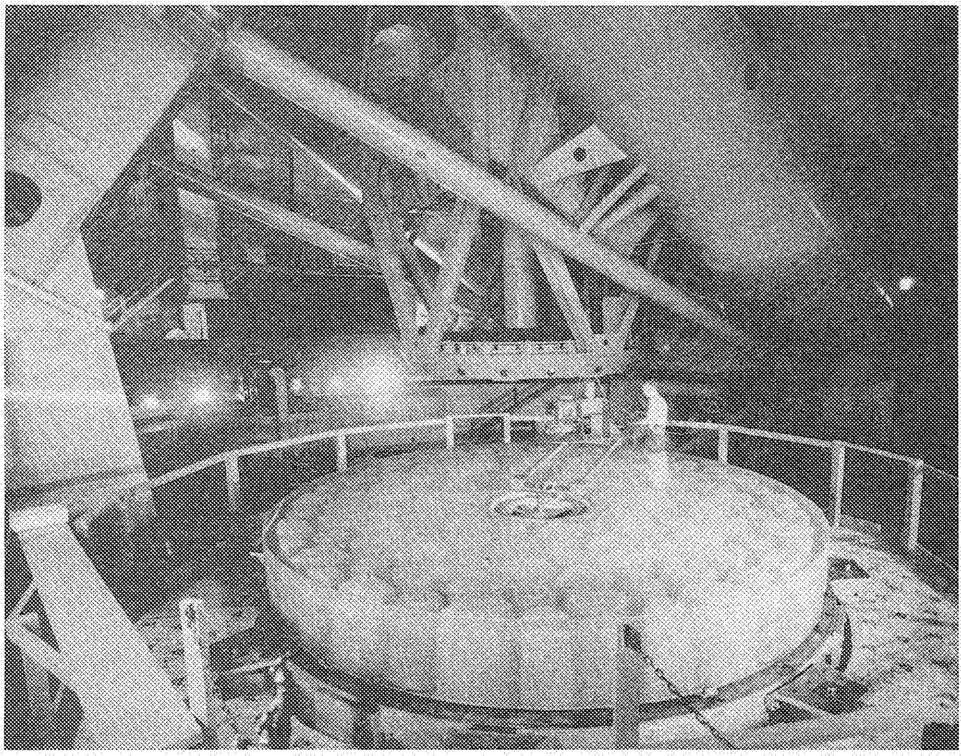


The virtue of cleanliness is instilled in all freshmen.

Leader of frosh rebel movement pays terrible price.

Early-bird freshmen from Ricketts and Blacker thoughtfully dismantle Dabney's lounge at 6:30 in the morning.

THE MONTH AT CALTECH



Polishing the 200-inch telescope mirror to remove 20 millionths of an inch of glass.

Progress Report

■ The 200-inch telescope should be back at work by the end of the year. It's been out of action since last May, when the big mirror was removed for additional polishing. Now the polishing has been completed. As soon as the mirror gets a new aluminum coating it will go back into the telescope tube and the 200-inch will get on with its job.

The mirror was removed for further polishing last spring when more than a year of testing revealed that the outer 18 inches of its surface were just about 20-millionths of an inch too high. "It had been deliberately left high," said Dr. Ira S. Bowen, Director of the Mount Wilson and Palomar Observatories, "because we had anticipated some sag when it was placed in the telescope. When this sag did not develop to the extent we had anticipated, and tests under actual operating conditions revealed that we were not getting the accuracy we desired from this portion of the mirror, we decided to do some additional work on it.

"Although we believe we have now obtained as nearly perfect a surface as possible, we cannot be absolutely certain until the telescope has been tested further under actual operating conditions. If, after a year or so, we believe we can still further improve the mirror by additional polishing, we will undoubtedly remove it again and do such additional work as we deem advisable."

Though it took five months to complete the additional polishing, only seven hours was spent in actual work on the surface of the mirror. Most of the time was taken up in exhaustive test runs, in removing and replacing the mirror in the telescope for each short polishing run, and in determining from studies of test photographs where and how much additional glass had to be removed. Weather accounted for a good deal of the time too. Since the light from distant stars was used in the testing, Dr. Bowen and his staff had to wait for the best seeing conditions and long periods of uniform temperature.

The polishing job was done by Don O. Hendrix, Mount Wilson Observatory optician who did the mirrors for the 48-inch Schmidt camera. Using polishing tools as small as 1 x 1¼ inches and as large as 12 inches in diameter, Hendrix began cautiously removing more glass from the mirror last June. The smallest tools, which were made of cork, were used by hand to remove as little as five-or six-millionths of an inch of glass in small localized areas. For larger areas, where as much as 20 millionths of an inch of glass had to be taken off, work was done by machine.

Extreme care had to be taken to avoid removing too much glass. When polishing was in progress no one except those working on the mirror had access to the observatory floor. Before each polishing run the mirror had to be thoroughly cleaned to avoid the possibility of foreign matter getting on it and scratching its surface.

"The efficiency of the mirror has been improved considerably by the additional polishing," says Dr. Bowen. "Under average seeing conditions it was good enough before we did this extra work. Now it is good enough to take full advantage of those exceptionally good seeing nights that occasionally occur. It is on these nights that the 200-inch will get in its best work and we are now in a position to take full advantage of them."

The Palomar astronomers, who first obtained pictures of stellar systems a billion light years from the earth last January, believe that the repolishing of the mirror will make it possible to photograph stars 20 percent fainter than those recorded on the first test plates. There is good reason to believe that the Hale telescope will now be able to record objects more than four million times fainter than the faintest stars you can see with the naked eye.

ACS Honors

■ At the annual fall meeting of the American Chemical Society in Atlantic City, Dr. Bruce H. Sage received the $1,000 Precision Award (E & S—Oct. '49). At the same meeting it was announced that two other members of the

Caltech faculty would be similarly honored when the Society meets again in the Spring.

Dr. A. J. Haagen-Smit, Professor of Bio-Organic Chemistry, is to receive the $1,000 Fritzche Award for "outstanding achievement in analysis, research, and new applications of essensial oils." Specifically, Dr. Haagen-Smit will be honored for his studies of the chemical composition of the gum turpentines of various species of pine, which he has been making in conjunction with the U. S. Forestry Service.

Dr. Verner Schomaker, Associate Professor of Chemistry, will receive the American Chemical Society Award in Pure Chemistry for his contribution to structural chemistry and, particularly, his determination of molecular structure in the vapor phase by electron diffraction techniques. This award, which also amounts to $1,000, was established in 1931 to "recognize and encourage fundamental research in pure chemistry carried out in North America by young men and women." First winner of the award was Linus Pauling, now head of the Division of Chemistry at Caltech and President of the American Chemical Society.

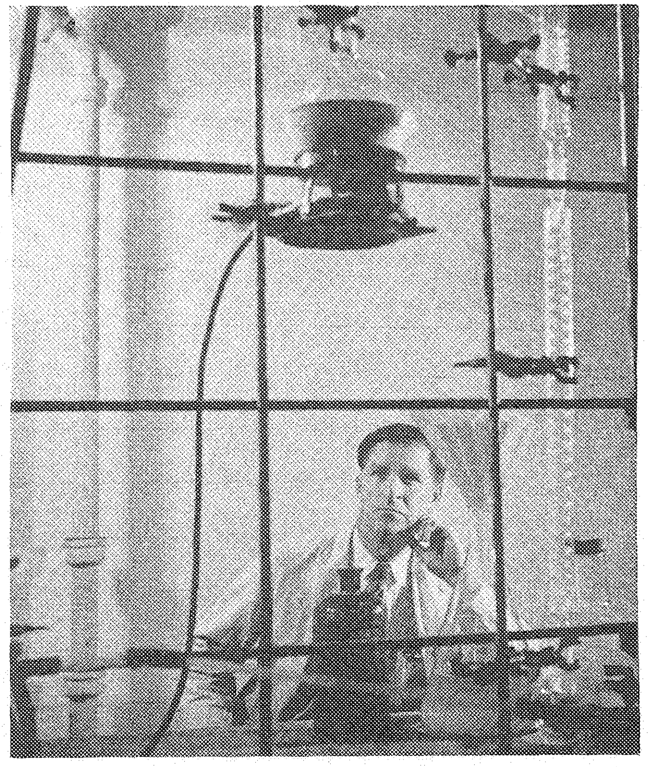
Gilbert to Germany

■ Horace N. Gilbert, Professor of Business Economics, has taken a year's leave of absence from the Institute to serve on the staff of the U. S. High Commissioner of Germany. Under Commissioner John J. McCloy—who succeeded Gen. Lucius Clay in the change from military to civil administration—Prof. Gilbert will work in the Office of Economic Affairs, supervising imports, exports and monetary payments made by the new Republic of Germany.

This is Prof. Gilbert's second postwar visit to Germany. In 1945 he went there as a member of the U. S. Strategic Bombing Survey appointed by President Truman. A longtime student of German affairs, Gilbert was also in that country in 1931 when the German banks closed, in 1934 when Hitler succeeded von Hindenburg as head of the State, and in 1936 when Hitler's mobilization of the nation for war was well under way.

Horace Gilbert has been at Caltech since 1929. He has served as an industrial consultant to a number of companies and as a special consultant to the U. S. Air Forces on Industrial Preparedness. During the war he was principal production supervisor for the Air Forces at Wright Field and in Los Angeles. In his new post he is stationed at Frankfurt, where Mrs. Gilbert and their three children will join him around the first of next year.

Verner Schomaker wins ACS Award in Pure Chemistry



A. J. Haagen-Smit receives the 1950 ACS Fritzche Award.

DuBridge Sidelines

■ Dr. L. A. DuBridge has been elected temporary chairman of a University Presidents Committee, set up recently to advise the Los Angeles County Board of Supervisors on rapid transit problems. The committee includes the presidents and the heads of the engineering departments of U.C., Stanford, U.S.C., U.C.L.A., and Caltech. The committee's job is to advise the Board of Supervisors on the selection of a firm of engineers to study the county's transit problem and draw up plans for a solution. An initial appropriation of $300,000 has been made to cover the costs of this engineering study.

With three other prominent civilian educators, Dr. DuBridge was also recently appointed to the Board of Visitors for the Air University at Montgomery, Alabama, by General Hoyt S. Vandenberg, Air Force Chief of Staff. The board was formed in 1946 to advise the commanding general of the school, and to report on the character, quality, and management of the Air Force educational system for officers.

Vital Statistics

■ There are 1,140 students registered at the Institute for the 1949-50 school year—443 graduates and 697 undergraduates. Of the undergraduates 197 are seniors, 168 juniors, 161 sophomores, and 171 freshmen. The freshmen this year come from 18 states and 7 foreign countries—the Argentine, Canada, Ecuador, England, Egypt, Hawaii, and the Philippines.

ALUMNI NEWS

Dinner Meeting

■ The November Dinner Meeting of the Alumni Association will be held on November 16 at the Pasadena Athletic Club. Speaker of the evening is to be Henry Duque, President of the Los Angeles Police Commission. His talk on "Police, Public Enemies, and the Public," will give the police commission side of the recent investigation of the Los Angeles police department.

Dinner is at seven; the bar will open at six.

Life in Japan

Tomizo Suzuki received his B.S. in Engineering at Caltech in 1928. After graduation he worked for several years for the American Bridge Company in Pittsburgh, Pennsylvania, then returned to his native Japan to go with the Hazama-Gumu Company, one of the largest contracting concerns in structural work. During the war he was in Japanese Intelligence. His family was living in Hiroshima when the atomic bomb was released, but they were not immediately affected because their home was in a canyon on the outskirts of the city.

Since the war Suzuki has served as liaison officer for the American Occupation Forces. In the letters below—written to Loren Blakely '23—Suzuki not only brings us up to date on his own activities, but manages to convey pretty graphically what it's like for anybody to live in Japan today.

May 19, 1949

My dear Mr. & Mrs. Blakeley:

For unduly long time I failed to write you, but am certain that all of you are well and prosperous. I was transferred to Eta Jima, an island off Jure (naval base), where Japanese Naval Academy was situated until the end of the Pacific War. We are doing construction and maintenance work here.

My family still lives at No. 708 Kozaki-cho, Sekimachi, Suzuko Gun, Mie Ken. They are fairly well except Toshiaki, my eldest son 13 years of age, who attends a Junior High School, has some trouble with his lungs and is absent from school since January of this year. He has improved considerably, but still has slight fever occasionally. We have tried to give him foods containing proteins, fats, and vitamins, which are not easily secured in these days when inflation is prevalent, as far as circumstances permit.

Recently, I was asked to present my record of schooling and occupations (employment) to the main office in Tokyo. They in turn presented it to G.H.Q. If they approve, I am entitled to go to the States for one month and inspect various engineering works there. (It is said that U.S.A. will pay our transportation and hotel expenses.) I wish I can go to America and see things there and meet old acquaintances, friends, and relatives.

August 5, 1949

How are you all in these days when it is unbearably hot? We in Seki are comparatively well in spite of intense heat and high humidity. I came back from Eta Jima to Seki on July 19. We had a typhoon on July 28-29 which passed through Mie Prefecture and caused damage aggregating to Yen 150,000,000.00 in this prefecture alone. I suffered from sunstroke for several days, but am now fairly well. Toshiaki has improved much; he attended school starting with the latter part of May—increasing school hours by degrees. He made fairly good marks for the term before summer vacation, which started on about 15th of July. But the Doctor says that he must take as much nutrients as possible (proteins, fats and vitamins). Yoko, our daughter 15 years of age, seemingly has similar tendency as Toshiaki due probably to insufficiency in nutrious foods.

Well, the package through CARE has reached us. It contained the following articles:

1 sack Domino cane sugar
2 pkg. Uncle Ben's Rice
2 pkg. Converted rice
6 cakes Toilet soap
2 cans Bonita (Lima, Peru)
2 cans Plymouth Rock beef
1 can Swanson Dried and whole egg
1 can Swift's Brookfield powdered whole milk
1 sack Omar flour
1 box Sterling salt
1 can Capitano soya bean oil
4 cans Phillip's Delicious corned beef loaf
1 can Fruit drop
1 can Marusho shoyu (sauce)
1 can Richmond coffee (1 lb.)
1 Towel

They all are precious to us and are hard for us to secure by ordinary means. We all are glad to receive them, and will try to give them to our weak children. I wish to thank you immensely for your kindness thousand times.

September 29, 1949

The long, sultry summer has almost gone, and it is rather cool at times at night and in the morning. I have been in Atsugi for more than 40 days; we have urgent work here so I do not go out of the Camp very often. We work every day in the week, plus all night when we are asked to complete certain jobs in time.

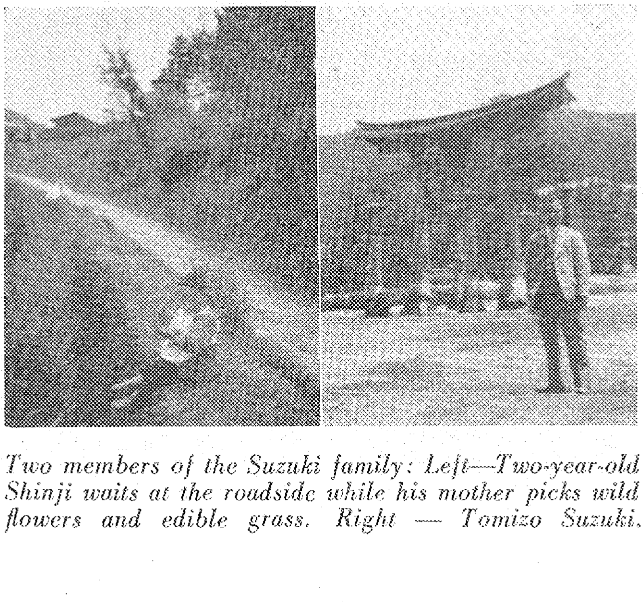
Probably in a month or so, I may be able to return to Tokyo Main Office to stay there for sometime. Our activities will be concentrated on the construction of dams, harbors and highways in future. Maybe we rely upon American Capital more than ever before.

I am suffering from lack of proper dormitory to stay in since I moved here. As I expect to stay in Tokyo-Yokohama Area for a number of years, I wish to find a house for my family. However, housing shortage is so acute here that it is almost impossible for me to locate a suitable house in or near Tokyo. Only means to solve this problem seems to be to construct a house of our own. A small, standard house costs us about 300,000 or 400,000 yen, which is about $1,000 in U. S. money. In spite of the inflation, our income is so low that most of us do not make so much money in these days. The trouble is that I neglected to build a house prior to the Pacific War when we could build a house 36' x 24' at about 2,000 yen, which corresponded to about $700 at that time. Somehow, however, I must find a house so that the family may live together as it should.

Although we had typhoons and heavy rains our crops of rice and other cereals may be above average. Already pears, apples, chestnuts and other fruits of the season are displayed in fruit stands, and persimmons and mandarin oranges will come out soon. It is becoming to be good hiking season; hills and mountains will be covered with gorgeous hues of scarlet and gold leaves amidst evergreen trees. Before long, hunters will be busy in chasing wild hogs, deer and duck. In the meantime, our struggles continue forever!

We hear that the Russians now possess A-bombs. But our desire will be "NO MORE HIROSHIMAS" for centuries to come.

Sincerely yours,
Tomizo Suzuki



Two members of the Suzuki family: Left—Two-year-old Shinji waits at the roadside while his mother picks wild flowers and edible grass. Right — Tomizo Suzuki.

PERSONALS

1918

We have received word that *William R. Hainsworth* was a member of the party of four which reached the top of Mt. Vancouver. This was the first time Vancouver—the highest mountain in the North American continent—had ever been scaled. Dr. Hainsworth is vice-president of the Arctic Institute of North America, whose members made the climb with him.

1925

Earl D. Stewart, who has been Director of Research for the Schwarz Laboratories of New York City since 1943, has been promoted to Chief Chemist.

1926

Ted Coleman has left the Standard Oil Co. of California to join Hill Richards & Co., California investment banking firm, as resident manager of the Pasadena office.

1927

George Kaye has given up the life of an engineer and has started making his one-time hobby his business. He and his wife have moved to Portland and, together, have started a firm to "make things which people want." George does the wood-working; his wife does the art work.

1928

Richard D. Westphal, Ex. '28, after a year in Nashville, Tenn., has moved to Philadelphia as District Manager for the General Electric X-Ray Corp.

Since July *Frank Noel* has been Assistant District Maintenance Engineer in the Division of Highways in Redding.

1929

Harry J. Keeling, M.S. '30, is a Mechanical Engineer with the Southern Counties Gas Co. in Los Angeles. In addition to this job, for the past year he has served as Chairman of the Western Division of the National Association of Corrosion Engineers.

Beverly Fredendall has been given the job of President of the Dutchess County (N.Y.) Chapter of Professional Engineers. He writes "I am enthusiastically in favor of the 'PE' trend because it helps all engineers. My only regret is that I have not yet met a chemical engineer who is a professional engineer—are they asleep?"

1930

Frank Alderman has opened a consulting engineering office in South Pasadena.

1931

Charles Buffum, M.S. '32, formerly construction and technical service section supervisor for the Stanolind Oil and Gas Co. in Tulsa, has been promoted to the post of research group supervisor.

Frank H. Ford is now co-owner of the Los Angeles Commander Engineering and Supply Co., jobbers in pipe, valves, fittings, copper tubing and engineering specialties.

L. D. Huff, Ph.D., is Head of the Department of Physics at Clemson College, South Carolina. He was married in June to Rose Shanklin of Pendleton, S.C.

1932

Charles Breitwieser, M.S., chief of electronics and engineering laboratories for the San Diego Division of Consolidated Vultee Aircraft Corp., was awarded an honorary Doctor of Science degree last June by the University of North Dakota, where he delivered the commencement address. He and his wife have a daughter, Diane Louise, who will be two in April

Charles Coryell, Ph.D. '35, is completing the editing of a 1,500-page book on wartime work on fission products with Prof. Nathan Sugarman of the Univ. of Chicago. The book, containing 336 declassified research papers, is entitled *Radiochemical Studies: The Fission Products*, and is part of the McGraw-Hill National Nuclear Energy Series.

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The San Francisco Chapter meets for lunch at the Fraternity Club, 345 Bush Street, every Thursday.

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PRESIDENT Donald H. Loughridge '23
Department of the Army
Office of the Assistant Secretary, Pentagon Bldg.

SECRETARY-TREASURER Charles E. Fitch '23
9214 Long Branch Pkwy., Silver Spring, Md.

A. J. Tickner is now with Northrop Aircraft as a Research Engineer on their Guided Missile project.

1933

L. J. Laslett is Associate Professor of Physics at Iowa State College.

1934

Glen Woodward and his wife announce the birth of a son, Donald, on August 24. Glen is a petroleum engineer with DeGolyer and MacNaughton in Dallas, Texas.

1935

James L. Carrico, Ph.D., is a member of the chemistry teaching staff at North Texas State College in Denton.

1936

Bruce L. Hicks, M.S. '37, Ph.D. '39, is Chief of the Combustion Branch, Interior Ballistic Laboratory, in the Ballistic Research Laboratories at Aberdeen Proving Ground, Md.

1937

David Pressman, M.S. '38, Ph.D. '40, is an associate member of the Sloan-Kettering Institute for Cancer Research. He is co-author with Howard Lucas, Professor of Organic Chemistry here at Caltech, of a new book, *Principles and Practice in Organic Chemistry*.

1938

Henry K. Evans has been appointed to the staff of the Chamber of Commerce of the United States, as highway-transportation specialist in the Transportation and Communications Department. He will deal with matters of interstate and local highway transportation, which will include studies of transport economics and highway planning, solutions of truck-loading and automobile parking problems, and studies of local transit.

Until recently, he was the San Francisco resident manager for DeLeuw-Cather Co., national transportation consulting firm.

John A. Bonnell, Jr., M.S. '38, has been appointed Assistant Professor of Civil Engineering at the University of Nevada. He was formerly structural designer for Quinton Engineer, Ltd., of Los Angeles.

Newman Hall, Ph.D., is Professor of Mechanical Engineering at the University of Minnesota.

L. H. Tejada-Flores, M.S. '43, Ph.D. '48, has been appointed Assistant Professor of Electrical Engineering at USC.

Joseph Westheimer, Ex. -'38, was married last year to Katherine Zelinsky of San Francisco. He is working at the Eagle-Lion Studios in Hollywood in charge of the Editorial Department (film cutting).

1939

J. J. Browne has been working for General Petroleum in Wilmington, Calif., since graduation—except for three years in the Navy. He is married and has two boys, one 3, and the other 7 months old.

Michael E. Hiehle writes that he is still at G.E. working on TV antennas—currently on the largest ever designed. He has three children, age 6, 4½, and 2½. He is on the air regularly with amateur radio, call W2SO.

Bertram Roudebush, M.S. '41, was married in New York on August 20 to Mary E. Madsen of Plainfield, N.J.

1940

Arthur M. Compton, Jr., was married on August 21, in Houston, Texas, to Nancy Fleming Eidson. He is a mechanical engineer in Kansas City.

1941

Francis M. Greenhalgh is now working for Southern Counties Gas Co. and living in Whittier. He returned to California a year ago from Peoria, Ill., where he was employed by the Caterpillar Tractor Co. He has a son Richard, now 16 months old.

1942

William R. Turner, M.S. '49, has been appointed to the Research Department of the Naval Ordnance Laboratory in Silver Spring, Md.

1943

Stanley Dunn writes that since leaving the Navy in 1946 he has been working toward a Ph. D. in Chemistry at Johns Hopkins. He has held a DuPont Fellowship for the past two years and has worked for that company for the past two summers—experimental station and cellophane research respectively at Wilmington, Del., and Buffalo, N.Y. He has a son, Mark Randolph, 2½, and another child is expected in January.

Donald I. Granicher, M.S. '48, now a process engineer with the Stearns-Roger Manufacturing Co. in Denver, is engaged to Frances Elizabeth Marker, who is on the nursing staff of the Denver Children's Hospital.

Philip E. Wilcox now holds an AEC Post-doctoral Fellowship and is engaged in studies of proteins in the laboratory of Prof. E. J. Cohn at the Harvard Medical School.

1944

James G. Kerr has accepted a position as Metallurgist at Los Alamos Scientific Laboratories, New Mexico.

Philip Smith, *William Collings*, and *Paul Winters* all became fathers on July 9. In fact, all three were in the same waiting room at the same hospital at the same time. It was a second child for Phil—a son, Bradford Hoyt.

Leon Trilling, after working at Inyokern from 1944-46 came back to Tech and got his Ph.D. in 1948. He is now instructor here in Applied Mechanics, and also doing research in Hydrodynamics. He was married in 1946, is the father of an 11-month-old son, and lives in North Hollywood.

1945

George S. Budney received his M.S. in Mechanical Engineering last June from Columbia University—"another institution with an excellent M.E. department." He majored in Heat-Power and is now associated with the Steam Division of the Foster Wheeler Corporation in New York.

Walter F. Hiltner, Ph.D., writes that he has little *news* and then goes on to add that he's been working for two years at a new job, with the Boeing Airplane Co.; living for a year in a new home, at Mercer Island, Washington; and has had two daughters since we last heard from him—Nancy Louise, 2, and Carol Ann, four months old.

Roland Hummel, M.S., was married to Bea Frie of Pottsville, Pa. on Sept. 3. He is now head of the department of civil engineering at Robert College in Istanbul, Turkey.

Mark M. Macomber, when we heard from him last summer, had just returned to the States aboard his LST which was undergoing inactivation processing at Puget Sound Naval Shipyard in Bremerton, Wash. As a member of the Pacific Reserve Fleet, Mark had just finished participating in the largest evacuation project by an LST in the China Area.

"According to official count," he wrote, "we carried 668 persons, but as they were debarking after the 43-hour trip from Tsingtao to Shanghai we counted 671 and a dog. Of this number only one was an American; the largest percentage were stateless persons—formerly Russians.

"Here were people fleeing from the advancing Communists. They were leaving behind everything they held dear—or so we were led to believe. Unfortunately, the displaced persons were not so informed. The largest single item carried was a piano. One lady was very put out when she was told to leave a case of whisky behind.

"The worst part of the trip was the feeding. The messing compartments accomodated 66 at a time. The Good Book says it takes 17 minutes to eat, but when you add the roll of a ship, and put in a mob of people to fight your way through it takes considerably longer. We could squeeze in only two meals a day for the passengers.

"With better than 450 women aboard segregation of the sexes was almost impossible. One couple felt that, as long as they both slept on the tank deck, it was automatically their bedroom—and conducted themselves accordingly, despite about 250 watchful eyes."

John Stern received his M.B.A. from Stanford in 1948, then worked as a real estate appraiser for the Winter Mortgage Co. in Los Angeles for about eight months. He is now a real estate broker with the Walter H. Leimert Co., and teaches an evening course in Real Estate Principles and Practices at USC. He expects to have his B-1 Contractor's License soon. He was married last year to a Stanford girl, and is expecting an addition to the family next March.

1946

Richard Allison Fayram, M.S., and his

wife announce the arrival of David Fisher Fayram on August 27.

Major Harry L. Gephart, M.S., is now instructing in the Air R.O.T.C. program at the New Mexico State College of Agricultural and Mechanical Arts in Las Cruces, N.M. This is a regular U.S.A.F. assignment, probably of three year's duration, and carries with it the imposing title of "Professor of Air Science and Tactics."

Edward S. Ida reports that he is still a Service Representative for Otis Elevator in Los Angeles. A second addition to the Ida family is expected this month; the order's in for a boy this time.

1947

Albert H. J. Mueller is enrolled in the Graduate School of Business Administration at Stanford. He reports that *Dick Roehm* '48 is also in the Business School, while *Burt Crumly* '47 and *Roy Gould* '49 are in Stanford's graduate Electrical Engineering Department.

Charles B. Shaw, Jr., now a Ph.D. candidate in theoretical physics at the University of Chicago, writes that "*Joe Green* '49 and I have a nice little cave—complete with Caltech pennant, Dabney steins, and the cut for the frontispiece of the 1947 Big T—near the University. We await the snows with some foreboding."

1948

Patrick Norman Glover, now completing his training as an Exploitation Engineer with the Shell Oil Co. in Bakersfield, was married last June to Betty Dunn, an English girl.

Lewis O. Grant, M.S., now employed by the American Institute of Aerological Research in Pasadena, was married on July 23 to Patricia Martin, Caltech's erstwhile Humanities Librarian.

1949

Bill Muehlberger was married in September to Sally Provine (Scripps '49). They're living in South Pasadena while Bill is back at Tech, as a graduate assistant, working for a Ph.D.

BOOKS

THE CONQUEST OF SPACE

Paintings by Chesley Bonestell
Text by Willy Ley
Viking Press, N.Y., 160 pp. $3.95

Reviewed by Robert S. Richardson
Research Associate in Astronomy

The Conquest of Space takes you on a superbly illustrated tour of the solar system via space ship. Some of the paintings probably look better than if they were actual photographs of the real thing.

There have been other books on descriptive astronomy of this general type, but always before the rocket has been merely a convenient literary device for easing the reader from one chapter to the next. Here the approach is much more realistic. The book opens with a dramatic account of the launching of a V-2 from the White Sands Proving Grounds, followed by an elementary discussion of the principles of rocket flight and planetary motion in general. Although the authors feel confident that inter-planetary travel will be realized, they tell the reader frankly that he will have to wait a while until the day arrives. But when and if it does come, here are some of the sights we will see.

There is so much general interest in rocket flight, and the habitability of the planets, that anyone rumored to have a special knowledge of these subjects often finds himself the target for some rather awkward questions. The trouble is that two fields formerly quite distinct have suddenly been merged. Few astronomers feel competent to answer queries on the intricacies of high-speed propulsion; and I presume that rocket experts feel the same way when it comes to discussing surface conditions on the planets. The easiest way out of such a situation is always to refer to some good book. In this event, you could not do better than to recommend *The Conquest of Space*.

The distinguishing feature of this book is Chesley Bonestell's illustrations. In full color, they're real "stoppers," as the magazine editors would say. Mr. Bonestell's training, first as an architect, and later in the special camera effects department of a motion picture studio, enables him to depict a lunar landscape or Saturn viewed from one of its satellites, with such startling realism that the effect is photographic. And there is imagination, too, in the peculiar dream-like quality that he imparts to many of his scenes.

The informative passages are lightened by numerous amusing and interesting historical anecdotes, so that the exposition never becomes burdensome. Readers may differ with the text on certain points that are matters of opinion: thus they may object that the question of the origin of the lunar craters is not nearly so well settled as the remarks on pages 68 and 69 would imply, or that the fins on the rockets are too big, etc. Although these criticisms may be valid, they are trivial when compared with the fine quality of

The Main Line

The picture above doesn't begin to do justice to our fanciest piece of new equipment.

It was taken aboard the *Cascade Club*, swank kitchen-dining car-lounge, now in nightly service on the *Cascade* between Portland and San Francisco. But you really have to see it first hand to appreciate it.

In railroad parlance, it's a three-car articulated unit. All that means is that it is three cars long over all, and the dining and lounge sections provide an unbroken vista 135 feet long. The kitchen adjoins.

S•P Exclusive

These *Club* units are an S.P. exclusive. No other railroad has anything like them. Built to our specifications by Pullman Standard Car Mfg. Co., the two needed for nightly service on the *Cascades* cost $750,000. Together with their sister *Lark Clubs*, they provide the world's finest dining-lounges-on-wheels all the way from Los Angeles to Portland. They can make your next overnight trip along the Coast a truly memorable one.

Number Please . . .

Speaking of the *Lark Club*, incidenally, there'll be a telephone aboard soon. It works by radio, while the train is in full flight. And it will handle both incoming and outgoing calls. Aside from legitimate business and personal calls, we expect it to get a heavy play from folks who know people with the right name to whom they can call at odd hours to say, "Mr. Watson, come here, I want you."

Cactus Fever?

Like the desert in the wintertime? If you do, chances are you'll like it even better in early season. It isn't too soon to be thinking of spots like Palm Springs, Phoenix, Tucson and the rest of the resort and guest ranch country.

For one thing, if you go soon, the resorts won't be crowded, and the weather will be at its best. Then, too, lots of places have special reduced rates for Indian Summer vacationers.

And remember, in making your plans, Southern Pacific has the only main line trains direct to Palm Springs, Phoenix and Tucson. We know our way around that country pretty well, and have a couple of generously illustrated folders to prove it. One of them is entitled simply "Palm Springs," and the other is "Your Vacation in Arizona and the Southwest."

If you'd like one or both to help plan your trip, just mail a card to Mr. Geo. B. Hanson, 610 South Main, Room 406, Los Angeles 14. He'll send them to you right away.

Ski Heil

The world's longest ski lift (8000 feet long, 2000-foot lift) is almost finished at Squaw Valley, not far from Truckee on our Overland Route. Opens next month.

S•P The friendly Southern Pacific

the book as a whole.

Perhaps the biggest question left unanswered is how the Viking Press managed to put a book on the market containing 16 illustrations in full color for only $3.95.

LIVE WITH LIGHTNING

by Mitchell Wilson

Little, Brown & Co., Boston
404 pp. $3.00

Live With Lightning is science fiction in the purest sense of that battered term. It doesn't involve any space ships or men from other worlds; it's a sober, earnest account of the making of a modern physicist.

Erik Gorin, at 21, gets an appointment as an assistant in the physics department at Columbia University. "What makes you want to be a physicist?" the head of the department asks him.

"It just never occured to me to think of anything else," Erik answers. "After all, what else is there?"

In the course of the book, which covers the next 15 years of Erik Gorin's life, he finds out why he gave that answer, and why—for him—it was the right one.

After a couple of years of teaching at a midwestern university, Gorin gets a bellyfull of faculty politics and turns to industrial research. There isn't much satisfaction in it, but there's money, and Erik is a family man by now. When he tries to move in on the big money his work entitles him to, however, he is neatly outwitted by the business men who are old hands at this game.

After a wartime hitch at Los Alamos Erik is about to accept a top job in the atomic energy setup in Washington when he discovers what the politicians are doing to exploit atomic power. Finally he heads back to pure research at Columbia.

Surprisingly, *Live With Lightning* is a selection of the Literary Guild. It makes very few concessions to popular taste. The only flashy thing about it is its title. Above all, it is an honest book—with some of the dullness and doggedness that often accompany honesty. Erik Gorin doesn't win a Nobel prize or invent the atomic bomb. He's no hero. He's not even a colorful individual. He's the kind of man, and this is the kind of book, a physicist couldn't sneer at. In a sense, that's a high compliment.

—*E.H.*

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