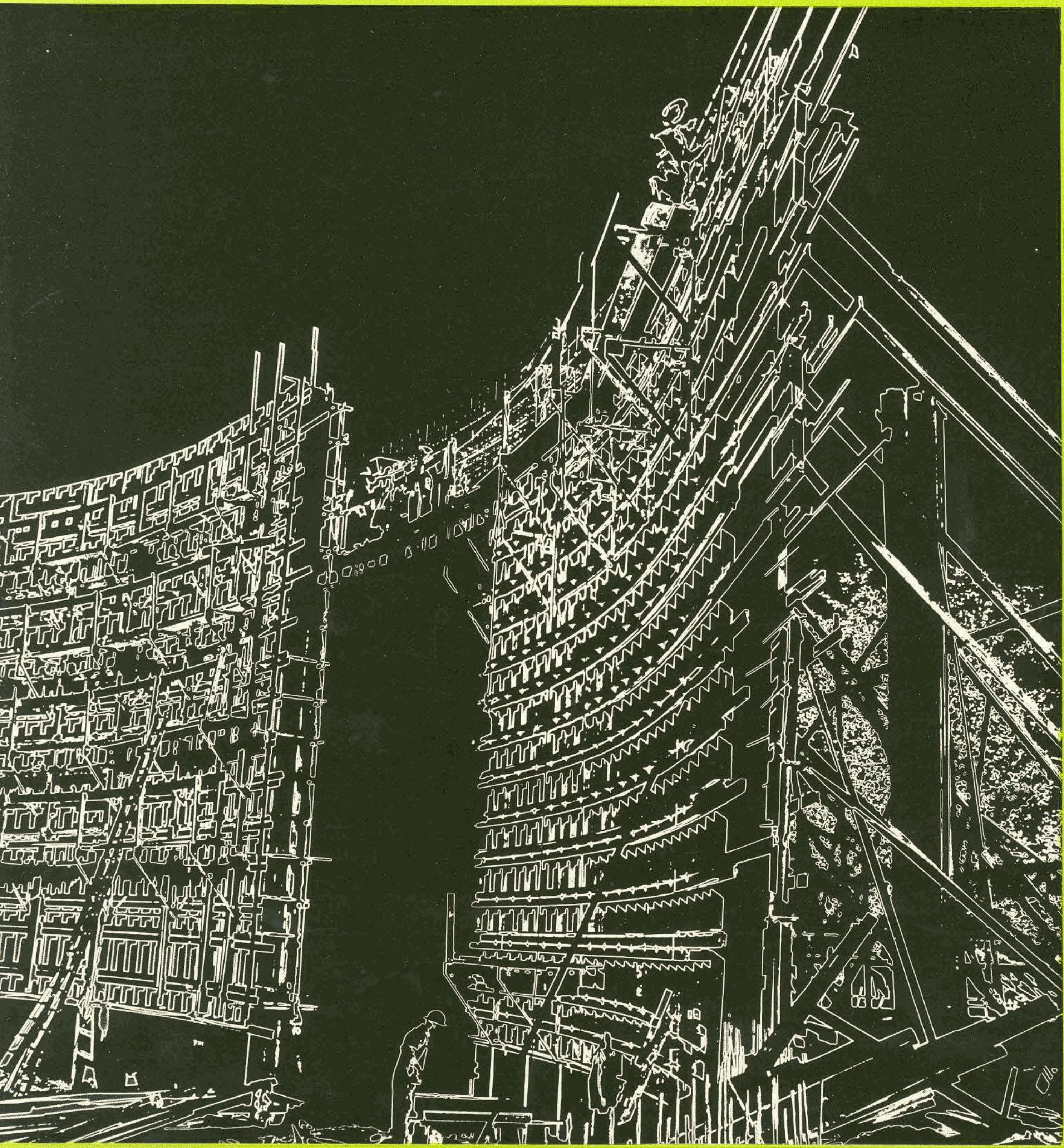
ENGINEERING | AND | SCIENCE

March 1963



Published at the California Institute of Technology

Things We Know About Tomorrow

EYES MADE FOR DARKNESS Westinghouse scientists expect that airplane pilots are going to be able to see the ground clearly on a cloudy, moonless night. Astronomers will be able to see vastly beyond the present range of their telescopes, perhaps to the final boundary of the universe, if there is one. Policemen will peer into dark alleys and see through special binoculars. Scientists at Westinghouse are working on the proposition that no matter how dark it looks to us, there is plenty of "light" everywhere: on a black night, in a coal mine, in a sealed room. We just have the wrong kind of eyes to see it all. So they have developed a device that "sees" infrared light which we can sense only as heat...another device that "sees" ultraviolet light, which we can detect only when it gives us sunburn...still another that picks up a single "packet" of light, the smallest amount that can exist, and multiplies it into a visible flash. You can be sure...if it's Westinghouse

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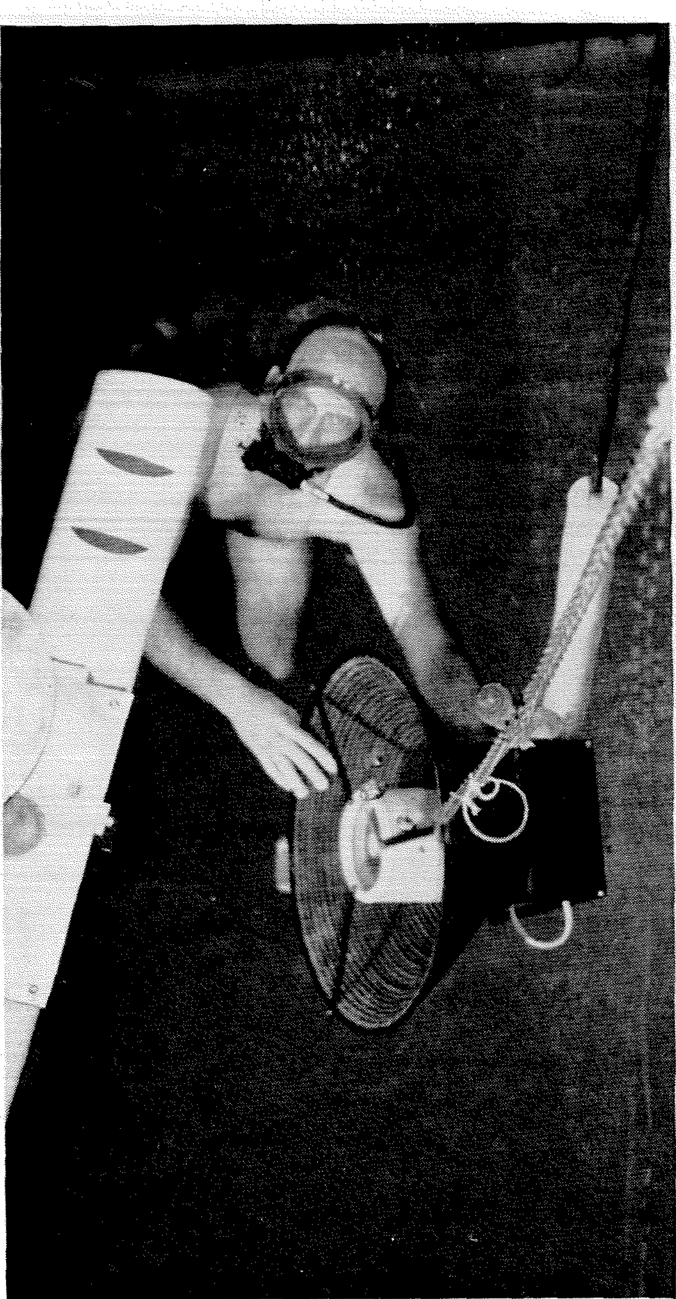 

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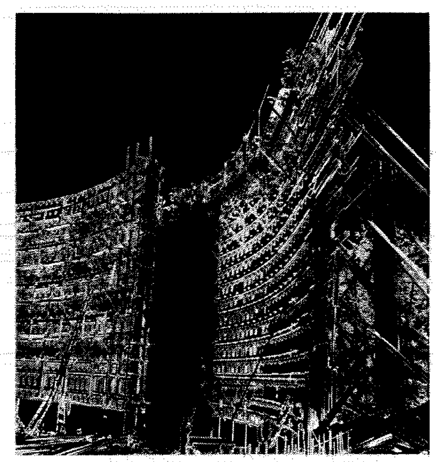
MARCH 1963 VOLUME XXVI NUMBER 6



On Our Cover:
is an unusual view of the construction work in progress on Caltech's new Arnold O. Beckman Auditorium. In fact, it's a view that can only be had through a camera lens and a well-equipped darkroom. Some more standard views of campus construction can be found on page 19.

Dean Acheson,
visited the campus on March 7 and 8 to lecture and discuss international affairs with members of the Caltech faculty and student body. The high point of his visit was probably his appearance on the Institute's Carnegie Program on Science and Government to discuss "The Obstacles to Partnership with Europe" in a public lecture. You'll find a large portion of the direct transcript of this talk on pages 11 - 15.

Mr. Acheson, who served as Secretary of State from 1949 to 1953 under President Truman, is now in private law practice in Washington, D.C. His most recent government assignment was as an emissary of President Kennedy last October, to inform De Gaulle and Adenauer of the proposed U. S. action in connection with the Cuban crisis.

Renato Dulbecco,
professor of biology, is the author of "Induction of Cancer by Viruses," which was originally given as a talk at a luncheon meeting of the Society of Sigma Xi on the Caltech campus on March 5.

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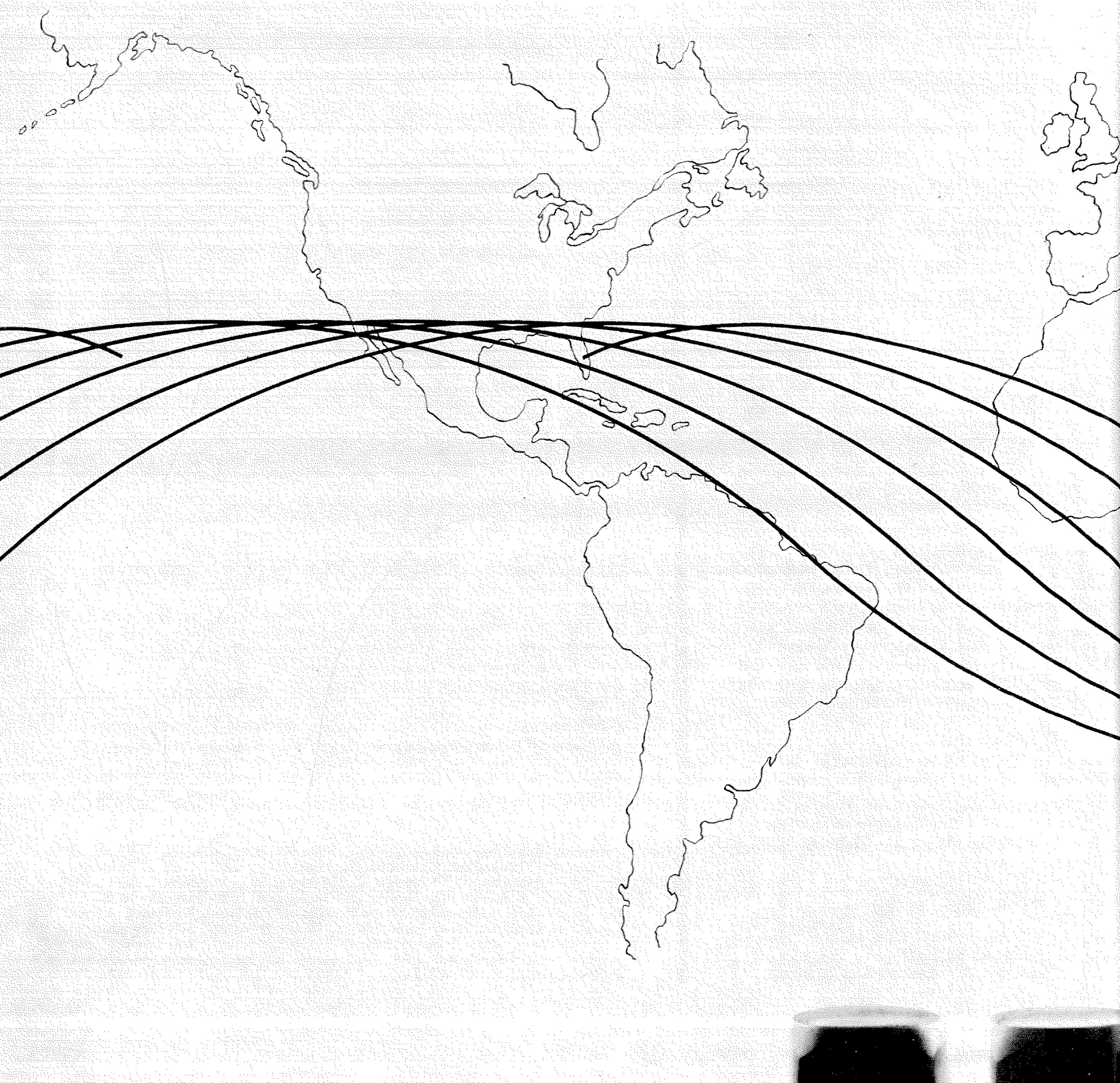
At IBM you design systems that bring space down to earth

In research and development at IBM, engineers and scientists are exploring new methods, materials, and ideas—a new world of data processing tools and techniques to extend the reach of man's mind. In space, IBM miniaturized computers will guide satellites into orbit, gather information from the stars, store data, and relay it on command back to earth. The IBM developments that make possible these systems for broadening man's grasp of the universe—and the new technologies that result from the application of data processing systems—form a firm basis for further progress in the development of information systems.

IBM is at work on applications of data processing concepts to meet the urgent need for effective information-handling systems for gathering vast quantities of data, assembling collected data, storage, and making vital information instantly accessible. For example, large-scale computer systems have been developed for coordinating the coast-to-coast network of airline flight reservations. Other computer systems handle research calculations for nuclear and thermonuclear energy. For automatic bank check processing, systems read characters imprinted on checks with magnetic ink.



Books

THE SCIENTIFIC LIFE

by Theodore Berland

Coward-McCann $5.75

The Scientific Life is a collection of profiles of nine assorted contemporary scientists, designed to give the layman a better understanding of what scientists and the scientific life are like. In a workmanlike manner, Mr. Berland gives a brief biography of each man, follows him step-by-step through a typical day, and – in extensive quotes which sometimes read too much like an unedited tape-recording – gives a more than generous sampling of each man's ideas and opinions.

Caltech is represented here by Murray Gell-Mann, professor of theoretical physics; Dean Wooldridge, PhD '36, research associate in engineering; and Charles Townes, PhD '38, who is now provost of MIT. The other men in the book are Willard Libby, James Van Allen, Albert Sabin, Chester Southam, Jeremiah Stamler, and Philip Hauser. Of the nine men, one is a chemist, three are physicists, three are medical researchers, one a demographer, and one an engineer. Their scientific lives are suitably varied. In fact, after reading *The Scientific Life*, it would seem that scientists have only these few things in common: they love their work, they work hard, and they don't need much sleep.

PHILOSOPHY OF HISTORY AND THE PROBLEM OF VALUES

by Alfred Stern

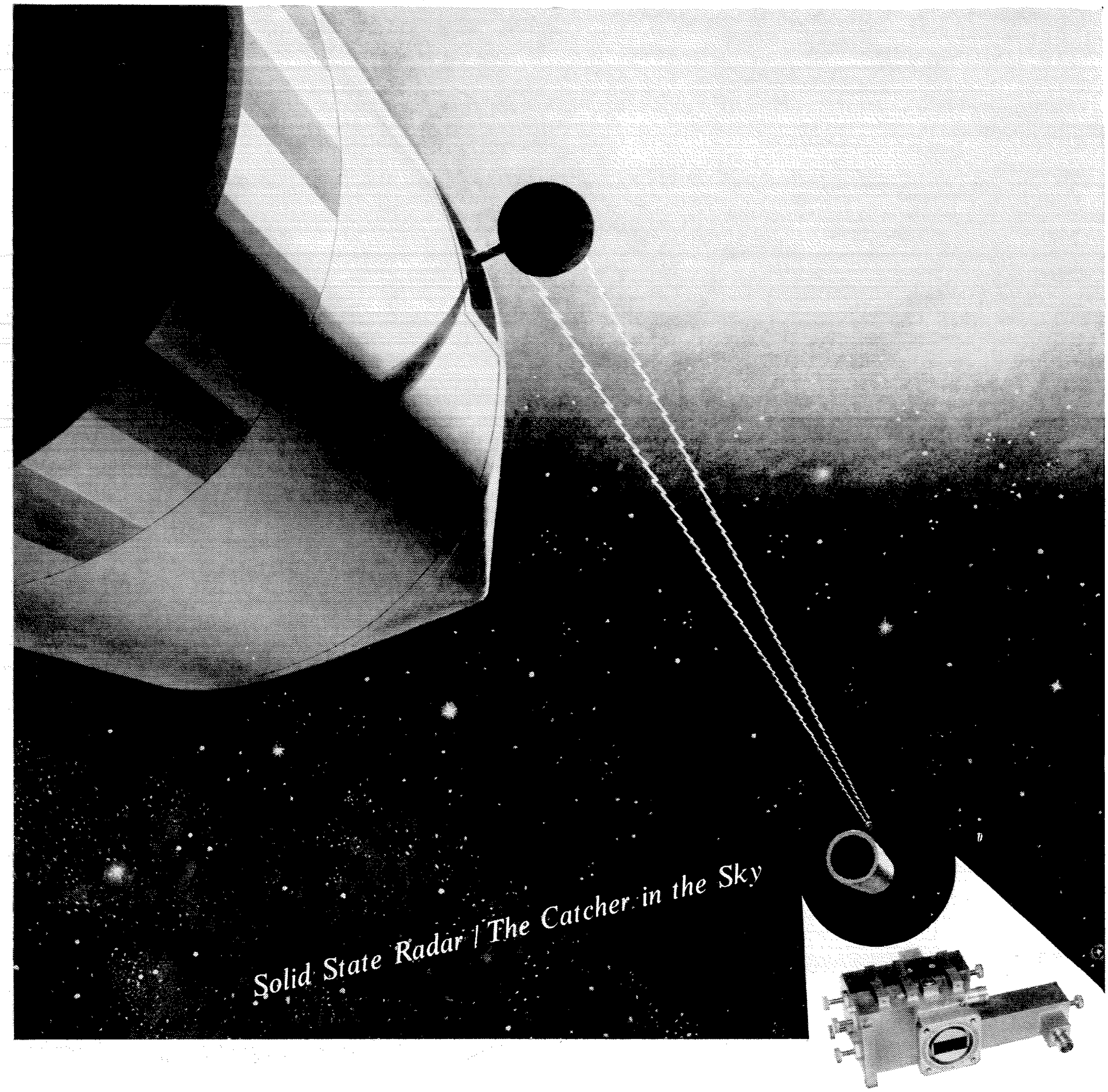
Mouton & Co., The Hague, The Netherlands .... *25 guilders*

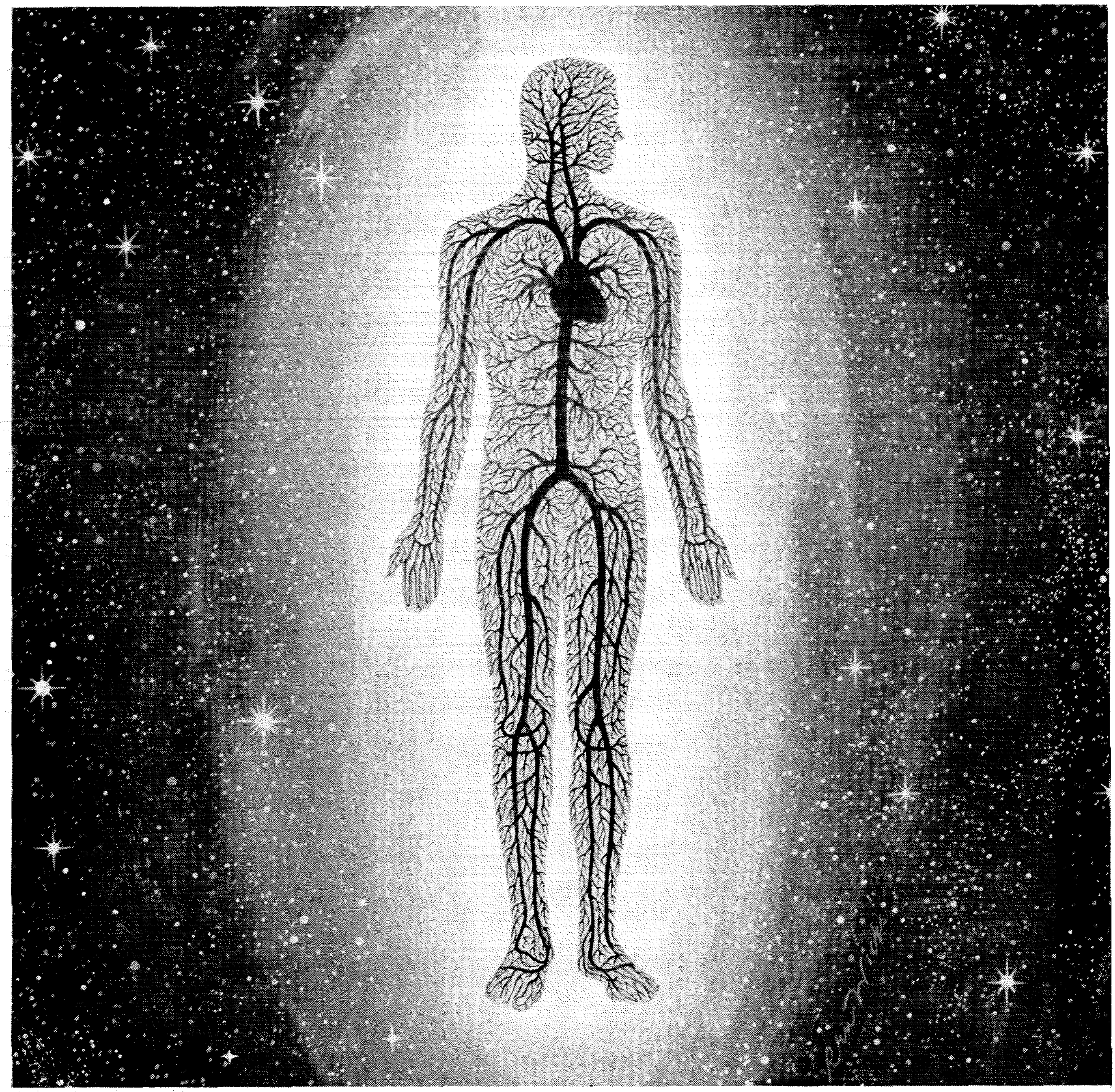
In his latest book Alfred Stern, professor of languages and philosophy at Caltech, studies the fields of history and of values in their interdependence, and offers some solutions to their disquieting problems.

"This book," Dr. Stern explains in his introduction, "tries to bring philosophy of history down to earth by showing that, in our epoch of gigantic ideological struggles and historical changes engaging the future of mankind, philosophy of history is everybody's concern. Our individual destinies depend to a large extent on the fate of the collectivity within which we live. Thus, philosophy of history becomes an essential part of our philosophy of life.

"The author is convinced that philosophy of history is intimately linked with the field of values. Even a superficial approach to the problems of present history reveals that a choice between the different ideologies struggling in our day for supremacy is a choice between different *sets of values*. The examination of the relationships between philosophy and history and philosophy of values has not yet been undertaken on a broad front. It will be attempted in this book."

The material in the book is based on a course of lectures given by Dr. Stern at the Sorbonne in Paris in 1957.


Solid State Radar / The Catcher in the Sky



ENGINEERING AND SCIENCE
March 1963, Volume XXVI, No. 6

THE OBSTACLES TO PARTNERSHIP WITH EUROPE

by Dean Acheson

I invite you to consider with me some of the obstacles which are in the way of that goal of American foreign policy which the President of the United States has called "partnership with Europe." First of all, however, I want to warn you against the words which I have just used. I think that we must put aside from this idea of partnership with Europe our conception of a human partnership—that is, some well-disposed and friendly people working toward mutual gain. That is not what we really are talking about here. What we are talking about is how 400 million people who are situated in non-communist Europe, and 200 million people who are situated on the North American continent can organize their worlds together so that they can counter the efforts of 200 million people who are situated in Soviet Russia, who are attempting to organize the world (not only *their* world, but *our* world) in ways which will be deeply disadvantageous to us.

What must we do if we are to be effective in organizing our part of this confrontation which is the inevitable confrontation of our time? I suggest to you that we have, first of all, to organize the wills of all these fifteen nations in this complex of western Europe and North America, so that they can act specifically and concretely —not that they shall have the same general ideals in common; not that they shall be inheritors of the same civlization; not that, broadly speaking, they wish to accomplish the same human goals, but that they are capable of acting in concrete and specific situations together.

And the second great problem is that they must bring together their production and expand their production so that they are able to take care of three vital needs which require them to act in some kind of harmony. These are the needs of education. They are the needs of transportation. They are the needs of recreation. They are all needs which look toward giving the people of these democracies the fuller life toward which they are looking.

Then we must have the kind of country which is worth living in, both here and in Europe. We are moving quite fast to destroy this foolishly and unnecessarily, by allowing cities to decay and by allowing populations to overflow into the countryside like lava coming from an urban Vesuvius.

All these things demand a withdrawal of productive capacity for domestic needs. Then there are the great military demands of defense, which become more and more costly.

And finally, upon this Western European-North American nexus, there is the great need for export capital for all the developing parts of the world—not because there is some evangelical demand for this; not because we are trying to bring about the Kingdom of Heaven upon Earth; not because we are engaged in "do-goodism"; but because we wish to organize the free part of the world in such a way that it is appealing for all people to join—not merely those who do well in it, but those who are developing. And they must be able to see in this free world area an oppor-

"The Obstacles to Partnership With Europe" is a direct transcript of a portion of the talk given by former Secretary of State Dean Acheson at Caltech on March 7.

tunity for development such as we saw in the early days of this country.

This means that capital should be made available to those parts of the world, those peoples, who are in a stage to receive it and are able to do two essential things. One is to preserve the necessary order so that work can be done, and the second is to work *in* that order. And if this can be done, these demands of the underdeveloped parts of the world for capital upon the more developed parts are legitimate demands. Therefore, there is this great need for the harmonization of economic and related financial policies in North America and Western Europe, so that we can produce for these purposes.

I want to talk about only two of the many difficulties which stand in the way of bringing about this harmonization of the political, economic, and other activities of these two great parts of the world. These matters, which are vitally important, require almost abstract analysis, because unless one understands the theory of these two matters, one gets simply bogged down in the operational side, by which I mean what you read in the newspapers: Is it possible to do this? Is it possible to do that? De Gaulle says this; Adenauer says something else. The important thing is to get the anatomy of these two difficulties and the way to meet them, and then we can deal with the flesh upon that anatomy.

Two obstacles

The two obstacles that I am talking about are, first, the great difficulty of agreeing, between Western Europe and North America, upon a method—a grand plan—for the defense of Western Europe. This does not exist. The other obstacle is to agree upon why we want a defense at all. Why is it necessary to have a defense? Who is threatening what? What is it that we stand for that other people are against? What is the issue all about? Why do we want a complicated and dangerous system of defense unless there is something to defend? On these two vital matters, there is at the present time, I am sorry to say, no common understanding whatever in the Western world.

Let us go into defense problems. First of all, we must understand that any strategic plan must be militarily sound before it is worth adopting. You all understand perfectly well that defense plans also have political aspects, and the political aspects are quite as important as the military aspect.

What sort of an attack, by whom, can be defended by what sort of a plan? And who is likely to do this? How will it come about? And how do we organize our political life so that if we are met with this threat, we are ready to put into effect the strategic plan which we have devised?

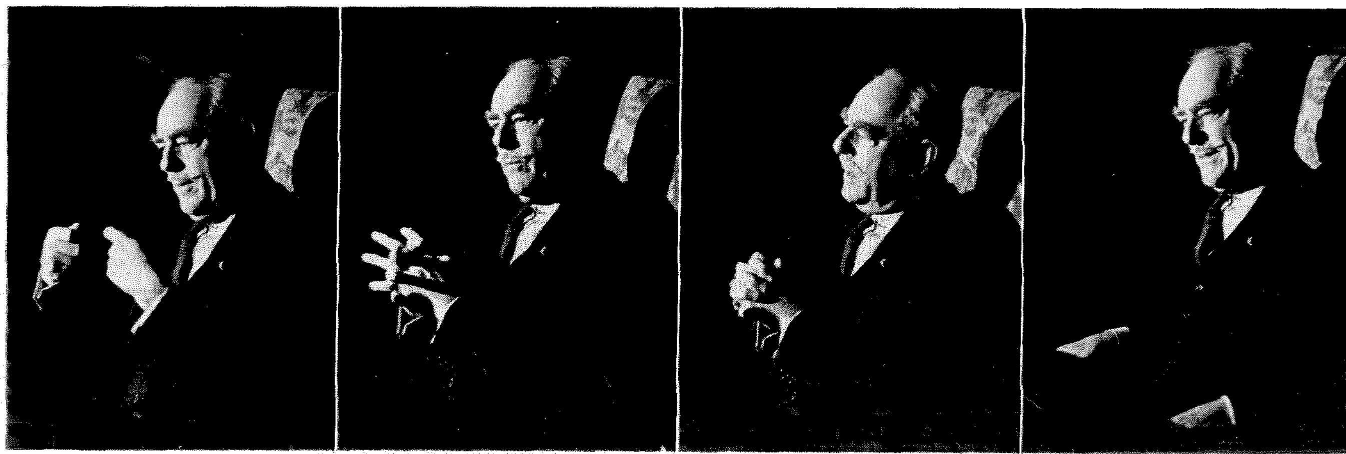
Let us go back a little while and see what plans we have had since the war, and what have been the strategic ideas of the NATO countries? First of all, I point out to you what I have said several times, that NATO has never put its mind on why it is doing what it is doing. It was faced in 1947-49 by the danger of an unprovoked, senseless movement of forces, the Russian troops in East Germany, who had no opposition and who might just start rolling westward and end up at Brest on the Atlantic coast. Therefore, we must devise a military plan. So we had a treaty which said "an attack on one will be regarded as an attack on all, and all will go to the help of one" — a very primitive sort of an idea, but a good enough one for that time. I think I can say that with proper criticism, since I wrote the words myself. But it still was a rather primitive idea.

A monopoly of nuclear weapons

From 1947 to 1950, our idea was that it wasn't necessary to do very much, because we had all the nuclear weapons there were. We had what was called a "monopoly" of the nuclear weapons, and that was regarded as deterrent enough. Then it began to dawn on other people besides ourselves that all it took to make a monopoly was one weapon — but one weapon wasn't necessarily a very powerful defense. Therefore, from 1950-53, we tried to organize in Europe a conventional military force with a united command, over which General Eisenhower became the commander, which would interpose some sort of a check in front of these Russian divisions which might start to roll.

This we attempted to do, with only mediocre success. It was very difficult. These nations were prostrate. The Marshall Plan was just an operation to try to bring them back to some sort of a prosperous condition, and we had very little success with it — but some. We had enough to change the pre-existing situation so that grave trouble would come from a military force just moving forward.

In 1953 a new idea occurred. The new idea was: This is all very expensive; we can do this much more cheaply by what was called "massive retaliation." (By this time we had a much larger



Former Secretary of State Dean Acheson at a press conference held during his Caltech visit this month.

nuclear stockpile than we had before. Before it was entirely atomic; now it began to have some nuclear weapons, and it became fairly formidable.) And so the government said, while cutting down the military budget, saving from 5 to 8 billion dollars a year, we would adopt a new theory. And this is, that if the Soviet Union does anything, anywhere in the world, which is hostile to our interests, we will deal with them by massive nuclear retaliation.

The only trouble with this idea was that it came just at the time when the monopoly was broken. This is the way human ideas often do develop. Therefore, we were saying: We will employ a weapon which is not any longer ours alone. We are now exposed to a retaliation from those upon whom we are going to retaliate. And it became more and more clear to us that this was an unprofitable venture.

Two ideas we sold to the world

Unhappily, we had sold to the rest of the world two ideas. One was that nuclear weapons were a status symbol. The great powers had them; if you didn't have them, you were a second-rate power. Secondly, if you had them, you could do anything. These were magical weapons; without all this business of soldiers going around and getting in everybody's way, and costing a lot of money, you could, by nuclear weapons, threaten people, and then they would stop doing these unattractive things which they planned to do.

Just as these ideas had come to be current, the Russians put up the Sputniks. Unfortunately, as they did this, we also got into trouble with our allies over Suez. So that in 1956 two things happened at once. Our allies said, "These Americans are capable of separate ideas, and this is very bad." And, as the Sputniks went up, they said, "The Russians are ahead of the Americans. Very dangerous to fool around with nuclear weapons." So we were left in a puzzling defensive posture which sometimes has been called "stalemate," but which really meant that, as it developed, each one of these great nuclear powers could so damage the other that neither would think it worth while to go forward except on a matter of very vital importance.

Reviewing defense policies

At this time also, as I said, we had made nuclear weapons a matter of status. Therefore, when we came to 1961, we had a review of defense policies in Washington, and the administration decided what seemed to me to have been clear for about the last ten years. At the beginning of the period between 1949 and 1961 the Russians had had a vast excess of conventional power. We had had nuclear power. In the meantime, the Russians had begun to in some way catch up with us on the nuclear side. We had done nothing on the conventional side. They could put pressure on Europe by their conventional forces. We could not resist that pressure in the same way. What we had to do was to say, "We will meet you with nuclear forces." But they could meet us with theirs — and therefore we were at a disadvantage.

Well, this sounds as though I were a boy who was playing with tin soldiers and didn't understand anything about the real forces of life, and hadn't read Chester Bowles, and many other things of this sort. This is not really so. I *have* read many of these things — not always with profit. But what occurs in international politics is what the Russians refer to quite wisely as the correlation of forces. If all the operating forces are forces which push in one direction, events are very likely to move in that direction. If, on the other hand, you can in some way balance these forces, or change the direction, or the push, you may get a different political development.

So, as we began to review policy in Washington in 1961, we discovered that our allies were quite immovable about doing what seemed to us a wise thing to do. The wise thing to do was to *increase* the conventional forces in Europe – to take away from the Russians their overwhelming superiority in this method of pressure. Our allies were very much opposed to this for several reasons – reasons, I thought, which stemmed from pride, from fear, and from ignorance: pride, because, as I have said, nuclear weapons became a status symbol; from fear, because they had expressed the worry from time to time, as a result of this or that or the other congressional speech, that we would withdraw from Europe and leave them alone, and since they had no nuclear capacity at all, they were at the mercy of the Russians; and from ignorance, which we had induced by the excessive secrecy which we had thrown around the whole idea of nuclear weapons.

That ignorance led them to overestimate the capacity for deterrence of a small nuclear force. This you will see if you read General de Gaulle's press conference of January 14th. He believes that a small force, a minute force, can threaten the Soviet Union with what he calls "the death of millions and millions of people." This is quite absurd.

Secrecy – and understanding

The reason that it is absurd is hidden from the Europeans because of *our* secrecy. They do not understand that these weapons cannot do what they think they can do – in the first place, because they won't be able to deliver the weapons; in the second place, because, if they begin to issue this threat, they themselves will probably be taken out before such weapons can ever be useful.

All these things the Europeans do not know, and this is indeed our fault. They think, therefore, that we are urging them to do something silly. "Why create this cannon fodder?" they say. "You want to send your power through the sky – ICBM's – while you want our soldiers to trudge through the mud."

But we are not asking anyone to do anything except what we are doing ourselves. There are 400,000 American soldiers in Europe. No other nation approaches that number, except the Germans, who are about 380,000 at the present time; and the Turks, who are somewhat over that.

Therefore, the debate between our European allies and ourselves has developed over the mystique of a weapon and not over either strategy or politics. Let us look for a moment at this basic element of strategy. What is the basic strategy of Europe since the end of the war? The USSR, the United States, and the European countries are all united in this appraisal – which is that the *decision as to the future of Europe lies in Central* Europe, and particularly in Germany. Is there going to be a United Germany which will fall within a United Western Europe – *within an* Atlantic Alliance – or is Germany going to be drawn into the Soviet orbit to get reunited in that way?

This is perfectly clear analysis by everybody. You remember that Stalin said, "I would rather have 20 million Germans on my side than 60 million Germans against me." This was his analysis. Therefore, the issue has been: Will Germany be divided at the Helmstadt Line, with Soviet control coming up to that point in Europe, and will the rest of Europe try to be viable west of Helmstadt?

Two schools of thought

This being a clear understanding of the central strategic issue in the world – the European world – following the war, there have been two schools of thought as to what we do. One of these schools has been popularized by George Kennan, and it now has the great authority of General de Gaulle behind it. That school is: Get the Americans out of Europe, and once they are out, Western Europe may be brought together in some kind of a balance against Eastern Europe, and Europe may find an equilibrium within itself.

The other school is the one on which NATO is founded, and the one with which I have been associated since 1947, which is that no equilibrium in free Europe is possible without the alliance of the United States. And therefore there must be a U. S.-Western European nexus before there can be a reuniting of Germany, a unification of Europe, and an Atlantic community.

Now these two ideas are diametrically opposed. They cannot be proved as you prove propositions in the physical sciences. All one can do is to amass the evidence and exercise a judgment. And it seems to me that the best way to do this is to assume that we have accomplished a result either way, and then make up our mind what is going to happen from that result.

What I would like to do here then is to ask you to assume that all the difficulties of persuading our allies to do these things have been overcome, that they have gotten over the difficulties about everybody wanting their own atomic independence. Then what we have arrived at is a European strategy, a European-American strategy and defense force, in which we have removed from the Soviet Union the overwhelming superiority on the Soviets' western front, so that they cannot look forward to putting the pressure of conventional arms on the West, and therefore giving us the election between giving in or returning the pressure with nuclear fire. We know that we have gotten out of that terrible dilemma, and we know that we have put them in the position where, if they wish to use force to achieve an object, the Russians themselves must face the use of nuclear force.

A changed Berlin

Suppose we have done that, and suppose, therefore, that Berlin is no longer a dangerous outpost, weakly held by the Western powers, in the center of a Communist-controlled Eastern Germany, but an area in which the Russians would hesitate very much indeed to put conventional pressure, because they would be faced with equal conventional pressure on the other side. This isn't too difficult to achieve. One doesn't have to have 175 divisions to do this; probably 30 or 35 divisions, plus the same number of reserves, would make it quite impossible for the Russians to exercise conventional pressure in Central Europe.

Suppose we have also, in the meantime, brought together a strong economic combination between an integrated Western Europe and a closely allied Atlantic community, by which all our economies have been moving ahead vigorously against a somewhat stagnant Soviet economy. Suppose this Western economy exercises a tremendous drawing power on East Germany and on the European satellites of Soviet Russia; what new coalition of forces might come about?

I don't intend to write the scenario. I don't intend to say who does what at what particular time. But what I do say is that if that result is brought about, it seems to me inevitable that the Russian forces will retire from Europe, back into their own country, that there will be a reunification of Germany, that there will be a larger measure of national independence and identity in the Eastern satellite countries, that there will be a real equilibrium of power between East and West which will then make it possible for the withdrawal of troops on both sides, and for some control of armaments which will really be sensible, and we will begin to have a period of real détente.

Assuring the other side

Now, assume for a moment the other side. Suppose that the De Gaulle view of Europe is the one which prevails. Suppose, at the request of Europe, the United States forces withdraw. Suppose Europe is much more united than it is now. What then does one look forward to? One looks forward, I suppose, to the fact that the disorganized will of even a De Gaulle Europe must face the vast, organized, concentrated power of the Soviet Union. And there the coalition of forces must inevitably lead, in my judgment, to a series of compromises and agreements on the part of Western Europe, and more and more Russian direction and control of economic life in Western Europe — not a march across the country, not a communization of all of Western Europe, but more and more and more control of the economic life of the countries of Western Europe until their own separate affairs become unmanageable. Now this seems to me to be what we are looking forward to.

And it seems to me that what I am proposing, and what I have consistently proposed for the last decade, is a combination of political analysis, political policy, and military analysis and policy which bring all these forces together in the direction of the most hopeful organization of democratic national powers that I know of.

True, it is extremely difficult. Many people say: This is Realpolitik; this is Machiavelli; there is no idealism in this. I really don't understand what they mean by the word "idealism" in this phrase. A policy which carries out the greatest conceptions of freedom that the Western world has ever conceived of, and gives us what to me seems to be a permanent place on this earth, I should suppose was the height of idealism. But apparently that isn't the way many people construe the word. Idealism now seems to be interchangeable with evangelicism. If one can hit the sawdust trail, if one can believe that by a succession of "Hallelujahs" all will come well, then one does not need to use one's brains. One does not need to use one's courage. One simply sails down a line of concessions to what seems to me to be the inevitable disaster. With these unprejudiced words, I leave the issue to you.

Theodore von Karman, Caltech professor of aeronautics, emeritus, receives America's top science honor from President Kennedy — with the full approval of General Bernard A. Schriever, Commander of the Air Force Systems Command; New York State Supreme Court Judge Victor Anfuso; General Curtis LeMay, Air Force Chief of Staff; and Caltech President DuBridge.

The Month at Caltech

National Medal of Science

Theodore von Karman, Caltech professor of aeronautics, emeritus, was awarded the first National Medal of Science on February 18 by President Kennedy "for leadership in the science and engineering basic to aeronautics, for distinguished counsel to armed services, and for promoting international cooperation in science and engineering."

Dr. von Karman, who served as director of the Guggenheim Aeronautical Laboratories at Caltech from 1930 to 1949, is chairman of the technical advisory board of Aerojet-General Corporation, which he helped to found in 1942, and chairman of the NATO advisory group for aeronautical research and development. He is a 1902 graduate of the Royal Technical University in Budapest and received his PhD from the University of Goettingen in Germany in 1908. He became an American citizen in 1936.

At a lunch honoring Dr. von Karman held at the National Academy of Sciences after the presentation, President DuBridge said: "Dr. von

Karman would be eminently eligible for either a medal of pure science or a medal of engineering, for he is one of those rare individuals who has made basic and important and numerous contributions to both of these areas of knowledge.

". . . Dr. von Karman's choice for this honor is on the basis of the *brilliance* of his many achievements, and not on their *massiveness*. Nevertheless, their massiveness alone is profoundly impressive.

"Take, for example, the description of his career. The list of the actual positions and appointments he has held contains 42 items. The list of his honorary degrees numbers 28. Of his decorations, orders and awards, there are 38. And he is a fellow, honorary fellow, honorary member, life member, charter member, or member of no less than 55 professional organizations throughout the world. His collected works, published in 1956, fill four sizable bound volumes. The first paper in Volume I is dated 1902, the year in which von Karman was 21 years of age . . . Surely, it would be hard to find anyone else in the history of science or technology who, after 61 years of continuous scientific productivity, is still going strong."

Satellite Corporation President

Joseph V. Charyk, Under Secretary of the Air Force, has resigned to accept the post of president and principal operating officer of the new Communications Satellite Corporation in Washington, D.C. The corporation is the first private enterprise corporation to be chartered to operate in space, and the first profit-making corporation ever set up by the United States for private financing.

Dr. Charyk received his MS in 1943 and his PhD in 1946 from Caltech. Canadian-born, he was graduated from the University of Alberta in 1942. In 1945-6 he served as a section chief at Caltech's Jet Propulsion Laboratory and instructor in aeronautics at Caltech. From 1946 to 1955 he taught aeronautics at Princeton University. In 1955, during the Eisenhower Administration, he went to Washington to be chief scientist of the Air Force. In June 1959 he was named Assistant Secretary of the Air Force for Research and Development, and less than a year later was appointed Under Secretary of the Air Force.

The Communications Satellite Corporation will probably be ready for business in about a year. The first job Mr. Charyk faces is the preparation of the public sales of stock in the new venture. Plans call for the transmission of messages, telephone calls, and inter-continental television and radio programs through such satellites as Telstar.

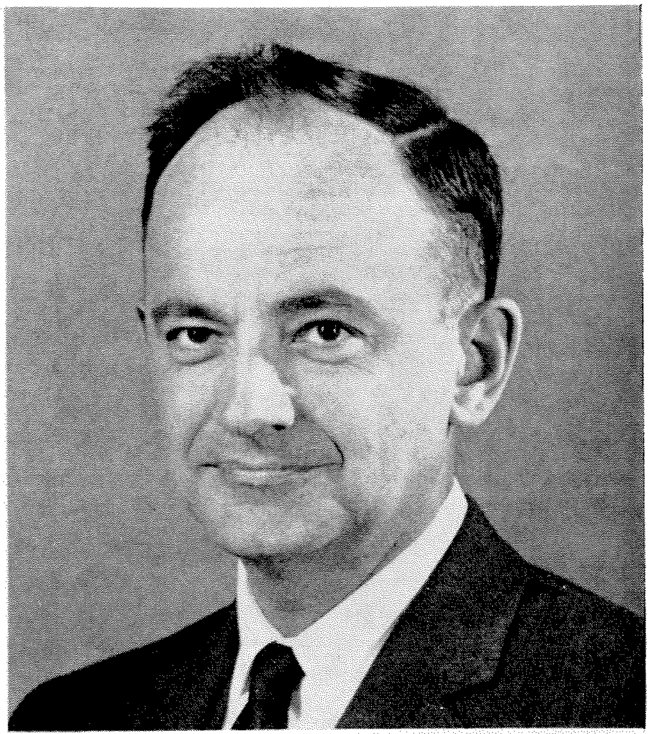
Honors and Awards

Dr. Lee A. DuBridge has been named by President Kennedy to serve on the Distinguished Civilian Service Awards Board which recommends outstanding persons to receive the Presidential Medal of Freedom.

The original Medal of Freedom was established during World War II and was given to those who "aided the U.S. in the prosecution of a war against an enemy." The award will now be conferred annually by President Kennedy. It will be given to "any person who has made an especially meritorious contribution to (1) the security or national interests of the United States, or (2) world peace, or (3) cultural or other significant public or private endeavors."

Richard P. Feynman, Richard Chace Tolman Professor of Theoretical Physics, was appointed this month to the State Curriculum Commission by the State Board of Education in Sacramento. The appointment is for a term of four years. Dr. Feynman succeeds C. C. Trillingham, Los Angeles County superintendent of schools.

William H. Pickering, director of Caltech's Jet Propulsion Laboratory, was named Engineer of



Joseph V. Charyk

William H. Pickering, Engineer of the Year and Time's *March 8 cover man.*

the Year and given the annual George Washington Award at a banquet meeting at the Beverly Hilton in observance of National Engineers' Week on February 20.

New Chemistry Chairman

John D. Roberts, professor of organic chemistry, has been named chairman of the division of chemistry and chemical engineering, succeeding Ernest H. Swift, who has been chairman since 1958.

Dr. Roberts received his BA in 1941 and his PhD in 1944 from UCLA. He taught and did research there, and at Pennsylvania State College, Harvard University, and the Massachusetts Institute of Technology. He came to Caltech in 1952 as a Guggenheim Foundation Fellow. The following year he went abroad to study the extent of organic and physical chemical research in European universities and laboratories. On his return he joined the Caltech faculty as professor of organic chemistry.

Dr. Roberts is known for his contributions to theoretical organic chemistry. His major research interests are in carbon-containing molecules, their synthesis, structures, and reactions, particularly rearrangement reactions. He has contributed to the understanding of the behavior of carbon atoms in many types of molecules.

Dr. Swift interrupted his outstanding investigations in the field of analytical chemistry to assume the chairmanship of the division on an interim basis in 1958. A member of the Caltech faculty for 44 years, he is the author of four standard books on analytical chemistry.

"The Institute is very fortunate in securing as the new leader of its chemistry and chemical engineering division so eminent a chemist as Professor Roberts," said President DuBridge. "He will carry on a distinguished tradition which began with the arrival of A. A. Noyes in 1917.

"We pay tribute also to the retiring chairman, Ernest Swift, whose leadership has been so outstanding in recent years. We accepted his resignation with reluctance, but appreciated his strong desire to devote full time again to his teaching and research."

Sloan Foundation Grants

Three Caltech scientists received unrestricted basic research grants from the Alfred P. Sloan Foundation this month: W. Barclay Kamb, professor of geology; Alan T. Moffet, research fellow in radio astronomy; and G. Wilse Robinson, professor of physical chemistry.

Dr. Kamb received a two-year grant in geochemistry and geophysics, and will do research into the nature of recrystallization phenomena in solids under stress, such as glacial ice and metals. He is interested in the flow of glaciers, the study of rock structure, and the atomic structure of rocks and crystals.

Dr. Moffet was awarded a two-year Sloan fellowship in radio astronomy to continue, with other astronomers, the mapping of brightness patterns of radio sources in space.

Dr. Robinson, recipient of a one-year grant, is doing research on the study of the transport and multiplication of energy quanta in molecular aggregates, with special reference to crystalline solids and photosynthetic systems such as plants and green algae. One purpose of the research is to try to determine the effectiveness of purely physical processes by which two low-energy quanta can be converted into a single quantum of high-energy excitation. Such a process might eventually prove to be one of the important steps in the conversion of sunlight into chemical energy in green plants.

Scientists do not apply for the Sloan Foundation grants but are nominated by those familiar with their work and potential.

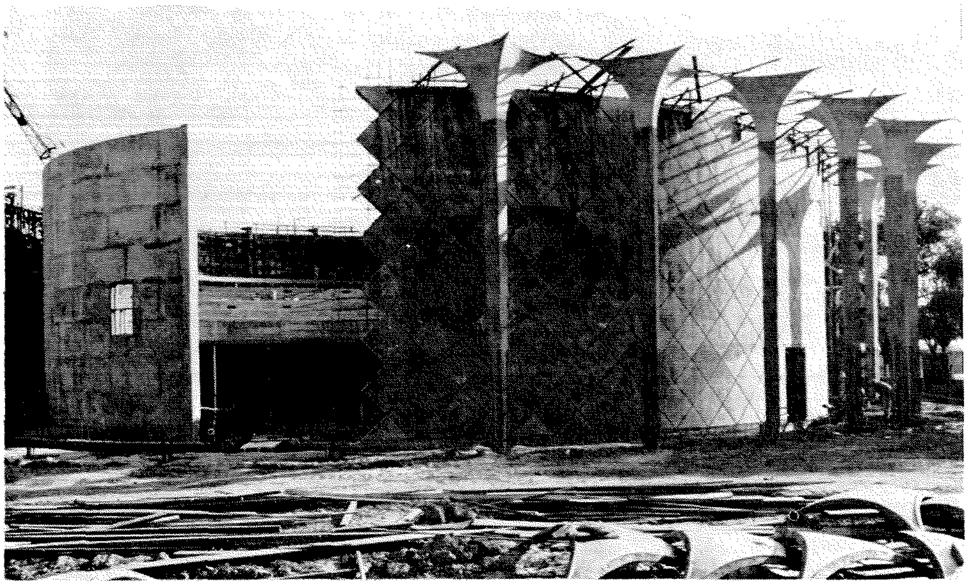
Two other Caltech scientists are already doing research under Sloan grants: Drs. John H. Richards, associate professor of organic chemistry, and Fredrik Zachariasen, associate professor of theoretical physics.

Putnam Winners

Caltech undergraduates came away with both team and individual honors in the 23rd annual William Lowell Putnam Mathematical Competition. There were 1,187 individual contestants and 157 teams from 187 colleges and universities in the United States and Canada in the contest, which consists of a six-hour written examination on problems covering general college mathematics.

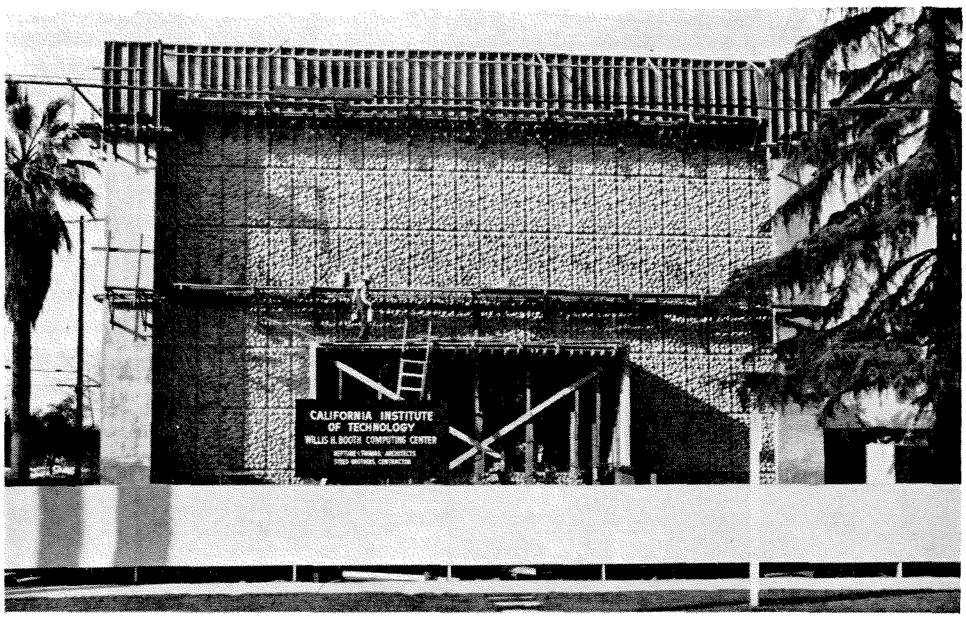
Caltech won the first prize of $500 in team competition. Members of the team are seniors Edward A. Bender and John H. Lindsey, and sophomore Kenneth Kunen. Bender and Lindsey also ranked among the five highest in individual scoring for the second consecutive year. They each received $75. Seniors Roger C. Hill and Kenneth B. Stolarsky ranked among the second five in individual scoring and received $35 each. Honorable mentions went to junior Alan Hindmarsh, senior Charles A. Ryavec, and Kenneth Kunen.

The $500 won by the prize-winning team goes toward a Caltech mathematics prize which is awarded at Commencement.



UNDER CONSTRUCTION

The circular Arnold O. Beckman Auditorium, located north of San Pasqual Street on South Michigan Avenue, is scheduled to be completed by the end of the year. It will seat 1200 people.



UNDER CONSTRUCTION

The Willis H. Booth Computing Center, on the northeast corner of Chester Avenue and San Pasqual Street, will house the IBM 7090 computer. The Center should be completed and occupied by late fall.

a
message
to
graduating
engineers
and
scientists

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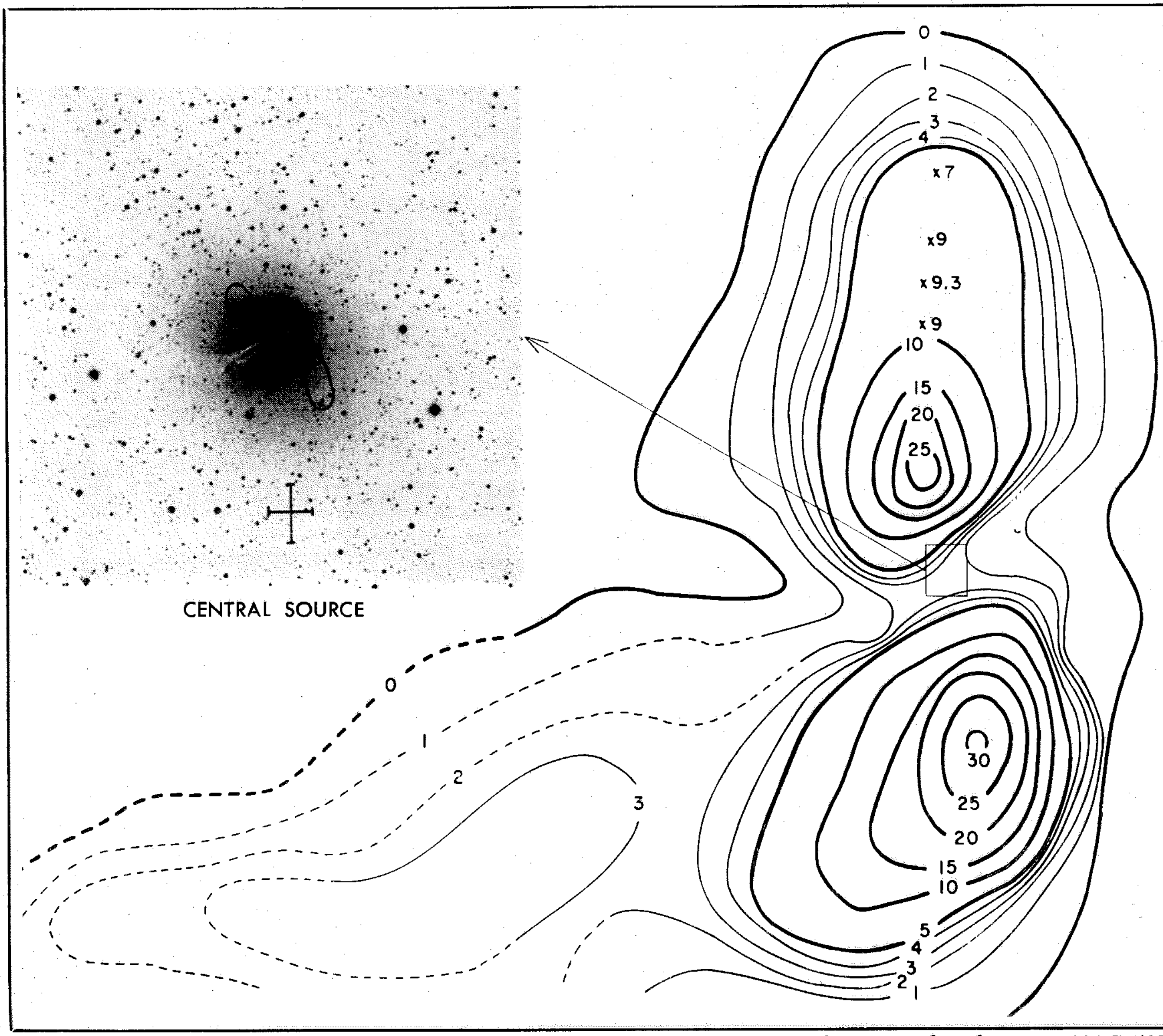


Radio astronomers receive signals from clouds of cosmic ray electrons ejected from such galaxies as NGC 5128 (left). Ellipses indicate position of the two inner components of the radio source. Crossbars show allowable margin for error in positioning the radio source. In outer radio structure (right), numbers give strength of radio emission.

Radio Galaxies

— the most powerful source of radio signals yet found in the universe

Caltech astronomers have found, in recent studies on 24 radio galaxies, that these invisible sources of radiation from space are the most powerful objects yet found in the universe. One of the strongest of these radio sources, Cygnus A, which is half a billion light years away, has an output of 40 billion billion billion billion watts—which is equivalent to the energy radiated by 20 billion suns.

Using the twin, 90-foot dishes at Caltech's Radio Observatory in Bishop, California, as an interferometer, astronomers found that, in most cases, radio emission comes from two immense, optically-invisible clouds of gas that are associated with an optically-visible galaxy. Usually the visible galaxy, an island of stars like our Milky Way Galaxy, is located *between* the two invisible clouds.

In their study of these objects, radio astronomers Per Maltby, Thomas A. Matthews and Alan T. Moffett first mapped the locations and outlines of the clouds. Then they superimposed the radio maps on photographs of the regions of the sky from which the radio emission was known to come. They found that usually one and occasionally two or more galaxies were located somewhere between each pair of clouds.

Spectrum studies by other astronomers, using the 200-inch Palomar telescope, indicated that the main optical galaxy was usually highly excited and displayed signs of a recent catastrophic disturbance.

Once these double sources of radio energy were associated with one or more galaxies, astronomers used the red shift of the galaxy to measure its distance from the earth. The farther a galaxy is from the earth, the greater the shift of its spectrum toward the red, or longer, wavelengths. Drs. Maarten Schmidt and Rudolf Minkowski (now retired) of the Mt. Wilson and Palomar Observatories determined most of the red shifts of the radio galaxies.

When their distances are known, the size of the radio clouds and the power of their radiation can be calculated.

The sizes of the clouds and the distances between them vary considerably. There may be as much as two million light years between the outside edges of a pair of clouds, and they may be many times larger than the visible galaxy. It seems that the farther apart the clouds are, the larger they are. This suggests a pattern which could be caused by enormous explosions.

Cosmologists Geoffrey Burbidge of the University of California in San Diego, Fred Hoyle of Cambridge University in England, and William A. Fowler of Caltech, are interested in how the enormous energies required for radio galaxies are generated. Dr. Burbidge believes that a chain reaction of thousands of exploding stars can cause it. Dr. Fowler and Dr. Hoyle suggest that a super star, millions of times more massive than the sun, may form and then explode in a galaxy's nucleus, ejecting vast amounts of matter beyond the galaxy which form the clouds.

Astronomers once thought that radio galaxies formed when two normal galaxies happened to collide accidentally. This theory has now been discarded because it appears that a galactic collision cannot possibly supply enough energy to make the observed radio clouds. Also, the fact that only one galaxy has been found in many of the radio sources cancels out the collision theory. Astronomers consider the radio galaxy to be a short-lived object which lasts probably a million years before it gradually fades away.

Induction of Cancer By Viruses

by Renato Dulbecco

The transformation of the normal cells of an animal into cancer cells is a process which can be induced experimentally by a variety of agents. A perplexing aspect of these experiments is the difficulty, or impossibility, of formulating a unitary mechanism for the various agents. For instance, cancer can be induced equally well by substances which have a strong action on the nucleic acids, or by hormones, or even by completely inert substances, such as sheets of plastic inserted under the skin. The lack of similarity in the properties of cancer-inducing agents has suggested that the similarity lies in the cellular mechanisms that they affect.

Among the agents that induce cancer are viruses. We look at viruses as interesting objects for an experimental study of cancer because we understand much more about the interaction of cells with viruses than with any other cancer-inducing agent. Furthermore, viruses are the only such agents that can induce cancers in dispersed cells cultivated *in vitro*. This result suggests that viruses induce cancer by direct action on the cells, whereas other carcinogens act indirectly and require the participation of mechanisms which operate at the level of the whole organism.

The nature of the changes caused by viruses in the transformation of normal cells into cancer cells can be well appreciated if one studies the properties of normal cells and of cancer cells *in vitro*. Cells are grown in dishes in contact with a solid substrate of glass or plastic, immersed in a liquid nutrient medium. Normal cells grow very rapidly as long as there is space between them; as soon as reciprocal contacts are established over a large part of the cell contour, growth stops. Therefore, these cells tend to constitute monolayers, cellular sheets which are one cell thick. Once the monolayer forms, growth stops.

This is not because the nutrients in the medium are exhausted, since the addition of more nutrients does not cause the growth to resume. Growth resumes if the cells are detached and transferred, more diluted, to a new dish, where they are not in reciprocal contact; or, simply, if part of the monolayer is mechanically removed. Therefore, cessation of growth is caused by regulatory mechanisms which are sensitive to the establishment of reciprocal contacts between cells.

The cellular surface appears to be the sensor that detects the contact. This is suggested by cinematographic observations of cultures of normal cells, which show that the normal undulating movement of the margin of moving cells is immediately arrested when the margin touches the surface of another cell. Similar mechanisms are probably responsible for maintaining the multiplication of the cells of the body under a strict control. The very existence of multicellular organisms depends on these regulatory mechanisms.

The behavior of cancer cells grown *in vitro* under the same conditions is totally different. These cells continue to grow after they have established a reciprocal contact and therefore are not confined to a monolayer. In effect, they form, in the dishes, very thick multilayered sheets, which stop growing when the food supply runs out or when toxic products of metabolism accumulate excessively. Regulation of cell multiplication is either absent or is ineffective in these cells. The absence of regulation of cancer cells is manifested, of course, in the organism, where these cells grow without any of the constraints which limit the multiplication of normal cells.

These characteristics of normal and of cancer cells are the basis for studying the effect of tumor-inducing viruses *in vitro*. In fact, when, in a monolayer of normal cells, one of the cells is

transformed into a cancer cell as a result of virus infection, it escapes the regulatory mechanisms and resumes growth. This cell gives rise to a colony of cells, a little cancer, which piles up on the background of the monolayer of normal cells. By taking advantage of this property, the tumor-forming potency of a virus suspension can be determined.

These observations raise two interesting and interconnected questions: How does the virus cause the escape of the cells from regulatory influences? And what can we infer about these regulatory influences, of which we know very little, from the fact that they can be made ineffective in a virus-infected cell? There is a certain duality in these questions, since the same problem affects not only the understanding of the mode of action of tumor-producing viruses, but also the operation of the regulatory mechanisms. A similar duality often connects these two areas of biological research.

Cancer viruses

There are two main groups of cancer viruses, each one fairly homogeneous. The viruses of one group contain RNA as the genetic material, and those of the other group contain DNA. The properties of cancers produced by viruses of different groups are markedly different; those of cancers produced by viruses of the same group are quite similar, with one notable exception.

The pertinent findings can be summarized as follows. The RNA-containing viruses, except the Rous sarcoma virus, produce differentiated tumors. The tumors are produced in a single step; that is, the cell which is infected becomes itself transformed into a cancer cell. The DNA-containing viruses produce *un*differentiated tumors. The cancer cells are not those first infected by the virus, but derivatives of them which are formed after a number of cell generations.

Differentiation

During the development of an organism from a single cell — the fertilized egg — to the completely developed multicellular organism, cells appear which have more and more specialized functions. We call this process differentiation. The specialized functions are caused by the synthesis in the cells of specific molecules, essentially proteins, which are made on specification of certain cellular genes. Thus, differentiation consists of the expression of the functionality of genes which were previously inactive.

The sudden expression of a gene function is the consequence of the operation of regulatory mechanisms, which have been studied very extensively in bacteria. The results obtained in bacteria have shown that the expression of gene functions is prevented by specific intracellular repressors, which are in turn made by other genes; and that the expression of the genes can be resumed when the repressors cease to be made. Production of the repressor or its discontinuation is under the control of *controller* substances, of small molecular weight and of many kinds, which come from the outside.

The pattern in animal cells

Regulation of gene function in animal cells is believed to follow the same general pattern; the expression of genes is regulated by specific intracellular repressors. However, an important deviation from the bacterial case may exist in the mechanism by which the control of repression takes place. There is little evidence in animal cells for a controlling action of substances of small molecular weight and great variety coming from the outside.

The known substances controlling cellular properties in animal cells, presumably through a control of gene expression, belong to a few classes and are fairly large molecules. Among these substances we find hormones, some of which are steroids, others proteins; we find specific growth factors for certain cells of the nervous system and for the skin epithelium, which are fairly large proteins; we find the protein antigens which are able to elicit a specific antibody response.

It is not known at all whether these controlling substances are taken *into* the cells; it is quite possible that they act on the cell surface. In fact, the cell surface is a very active and selective system, which is responsible for introducing essentially everything the cell takes from the outside. Molecules and ions penetrate the cell through the action of specific permeases, which have the duplex function of recognizing the molecules, with an incredible amount of specificity, and of pumping them in against a concentration gradient. Modification of the function of specific permeases may very well have specific effects on the functionality of cellular genes, by modifying the internal concentration of certain small molecules coming from the outside. The regulatory action

of cell-to-cell contacts may also occur through similar mechanisms.

Another important aspect of differentiation is that the controlling substances can induce a certain type of differentiation only by acting on cells which have already reached another, well-determined, stage of differentiation. Thus, differentiation is a sequential process, which develops according to instructions that are coded in the genetic material of the cells. The various stages are presumably locked in by the operation of feedback mechanisms.

The ability of certain viruses to produce differentiated cancers shows that these viruses alter the regulatory state of the cells without disrupting the complex instructions coded in the genetic material of the cells; thus, these viruses must act by causing a specific and functionally-well-circumscribed change of the cell. On the contrary, the production of undifferentiated cancers by other viruses can be attributed to more profound or less circumscribed disturbances.

Effects of viruses on cells

With these differences in mind we may now look a little more closely at the effects that the two types of viruses have on the cells they infect.

Let us look first at the RNA-containing viruses. Cells infected by viruses of this type, whether they produce tumors or not, synthesize a virus-specific protein which becomes incorporated in the cellular surface, as if it were a protein of the cells themselves. It is a very surprising observation that these cells, which contain a considerable proportion of viral protein in their surface, survive and in many cases multiply very actively.

In cancers produced by RNA-containing viruses the viral RNA is present in all cells all the time; therefore, the synthesis of viral protein occurs constantly in these cells. The incorporation of the viral protein in the cellular surface may cause the alteration of specific functions; so, on this basis, the loss of response to factors regulating cellular multiplication can be understood, as well as the differentiation of the cells.

The differentiation of the cancer cells follows the pattern which is normal for the cells at the stage at which they were infected. For instance, precursors of white blood cells produce, after infection, tumors of white blood cells, which are called leukemias; precursors of bone-forming cells produce bone tumors; embryonic remnants at a very early stage of differentiation give rise to cancers that contain cells in the various stages of differentiation which normally occur. Thus, the virus acts as the controller substance responsible for actuating the type of differentiation of which the cell is capable; the differentiation attained is characteristic more of the type of cell affected than of the virus type.

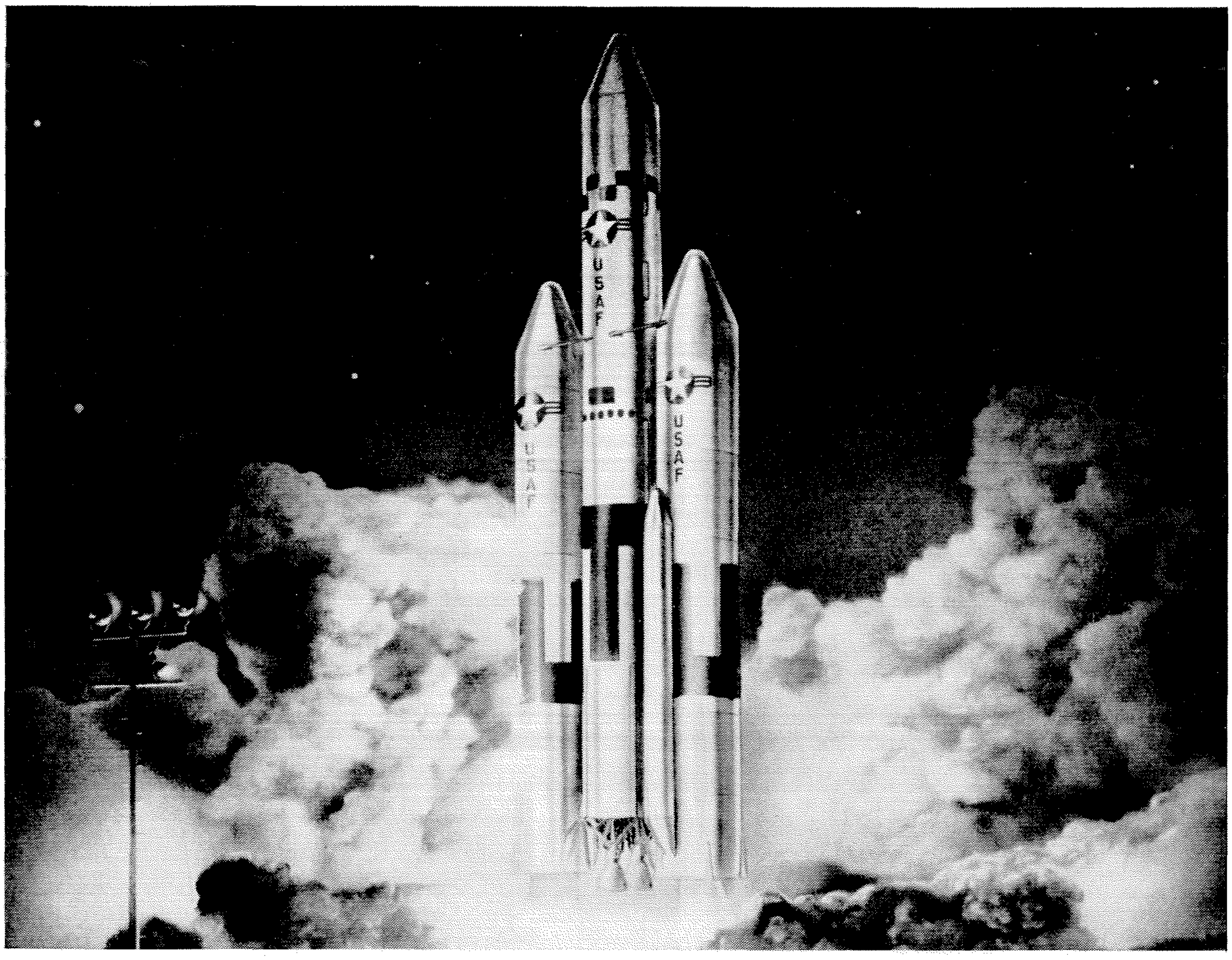
A possible interpretation of these events is that the cell, owing to the alteration of its surface caused by the incorporation of viral protein, recognizes, as specific controllers of differentiation, substances which normally do not have that function. It is interesting that a similar point of view can be entertained to explain certain puzzling observations of experimental embryology.

The Rous sarcoma virus

The only RNA-containing virus which causes undifferentiated tumors is the Rous sarcoma virus. This virus also has an important peculiarity: it is defective, in the sense that its RNA, although capable of self-replication, is unable to give rise to the production of complete infectious virus particles. The nature of the defect is unknown, and it is not therefore possible to determine whether the presence of the defect is responsible for the lack of differentiation of the tumor produced by this virus. It is, however, conceivable that the defect consists of an alteration of the structure of the viral protein that becomes incorporated in the cellular surface; the altered protein might then cause unusually large changes in the properties of the cell surface, and thus destroy the fine balance required for maintaining a state of differentiation.

The DNA-containing viruses of small size, to which the tumor-producing viruses belong, are synthesized in the nucleus of the cell. They do not cause any extensive incorporation of viral material in the cellular surface, although some of them can cause other characteristic surface alterations. During the multiplication of the virus the cellular DNA suffers damages, especially by enzymes, which in some cases are found to be formed as a consequence of virus infection.

In the cancer cells induced by these viruses the viral DNA is not recognizable by our present means; it is, however, likely that some part of the viral DNA persists in these cells, because they have two characteristic properties which are absent in normal cells. One property is a special surface configuration, detectable immunologically; the other is the occurrence of breaks in the cellu-



THIS IS TITAN III United Technology Center is now at work on development of the first or solid booster stage for the Air Force Titan III. UTC's huge segmented solid propellant rocket motors, each 120 inches in diameter and producing more than a million pounds of thrust, will blast the Standardized Space Launch Vehicle from its launch pad. Titan III, with all stages assembled, will stand more than 100 feet tall on the pad, and will be utilized to put multi-ton payloads into orbit. These payloads will include the X-20 Dyna-Soar.

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lar DNA for many generations after infection, perhaps caused by the activity of a new enzyme. Both surface configuration and hypothetical enzyme may be the expression of information contained in the viral DNA which persists in the cells.

The transformation of cells by DNA-containing viruses takes place in at least two steps. The first step occurs immediately after infection: it affects the regulation of cell multiplication but not the state of differentiation, which remains unchanged. These first changes are probably similar to those induced by RNA-containing viruses, and may also be caused by modifications of the cell surface. The cells in which this first step has occurred, however, are not cancer cells. From them the true cancer cells emerge after a number of cell generations, during which many breaks take place in the cellular DNA. These cancer cells appear to carry permanent and profound alterations of their DNA, which can be detected in some cases by studying their chromosomes.

The formation of cancer cells by DNA-containing viruses is therefore a process involving the cell nucleus and causing structural alterations of the cellular DNA. It is likely that these alterations produce a disarrangement of the coordination between the function of the cellular genes, causing the lack of differentiation that characterizes the cancer cells produced by these viruses.

A conclusion that one can derive from these considerations is that probably there are two distinct types of cancer cells. In one type, exemplified by cells transformed by RNA-containing viruses, the cellular alteration is functional. If the viral RNA could be removed from the cells, they should revert to a state of normality; the cancer state is potentially reversible. In the other type, exemplified by cells transformed by DNA-containing viruses, the cellular alteration is structural. Presumably the transformation would not revert even if the viral DNA were removed; the cancer state is irreversible.

These conclusions have stressed the significance of these investigations for the problem of the origin and nature of cancer. The point should, however, be made again that studies on the mechanism of cancer production by viruses have a much broader interest. In fact, they also offer experimental approaches for studying cellular regulation and differentiation, which are among the most outstanding unsolved problems of biology today.

Personals

1926

KENNETH C. McCARTER died at his home in Phoenix, Arizona, on February 13. He was 63. Kenneth, who retired from the National Park Service in 1948, helped with the geological survey for the Hoover Dam, and also served in the plans and designs branch of the Service. He worked with the Maricopa Planning and Zoning Board from 1953 to 1958.

ROBERT BOGEN died suddenly on January 10, of a heart attack, at his home on Lido Isle, Newport Beach. He was 59. He had been in semi-retirement since 1959. At the time of his death, he was sail fleet lieutenant of the Balboa Power Squadron, and instructor of the sail course sponsored by the Squadron. He was also a member of the Lido Isle Yacht Club.

1928

GEORGE T. HARNESS, PhD '33, professor of engineering and dean of professional studies at San Fernando Valley State College, is the first man to be named "Engineer of the Year" of San Fernando Valley by five of the country's top engineering societies – the American Institute of Plant Engineers, American Society of Metals, American Society of Tool and Manufacturing Engineers, California Society of Professional Engineers and the Institute of Electrical and Electronic Engineers.

Dr. Harness has headed the engineering division at San Fernando Valley State since 1959 and has been dean for a year. He has served on the faculties of College of the Pacific, Columbia University, and the University of Southern California.

1930

HARLAN R. E. JONES, safety engineer for the Pacific Indemnity Insurance Company of Houston, died of cancer on February 3 in a Houston hospital. He was 58. After graduation from Caltech, he worked as a safety engineer in Dallas, Houston, and San Antonio before joining the Royal Globe Insurance Company. In 1940 he was transferred to Hawaii by the company and lived there until his return to Houston in 1955. He had been with Pacific Indemnity since 1960.

1933

CHARLES D. PERRINE, JR., has been named executive vice president for General Dynamics/Pomona. He was formerly vice-president and has been with the company since 1950.

1935

D. J. LEHMICKE is now group leader for textiles and adhesives research at the Firestone Tire & Rubber Company's research laboratory in Akron, Ohio. He had been technical manager of the Firestone Synthetic Fibers Company plant at Hopewell, Va., since 1960. He joined Firestone in 1955.

1936

HUGH F. COLVIN, private manage-

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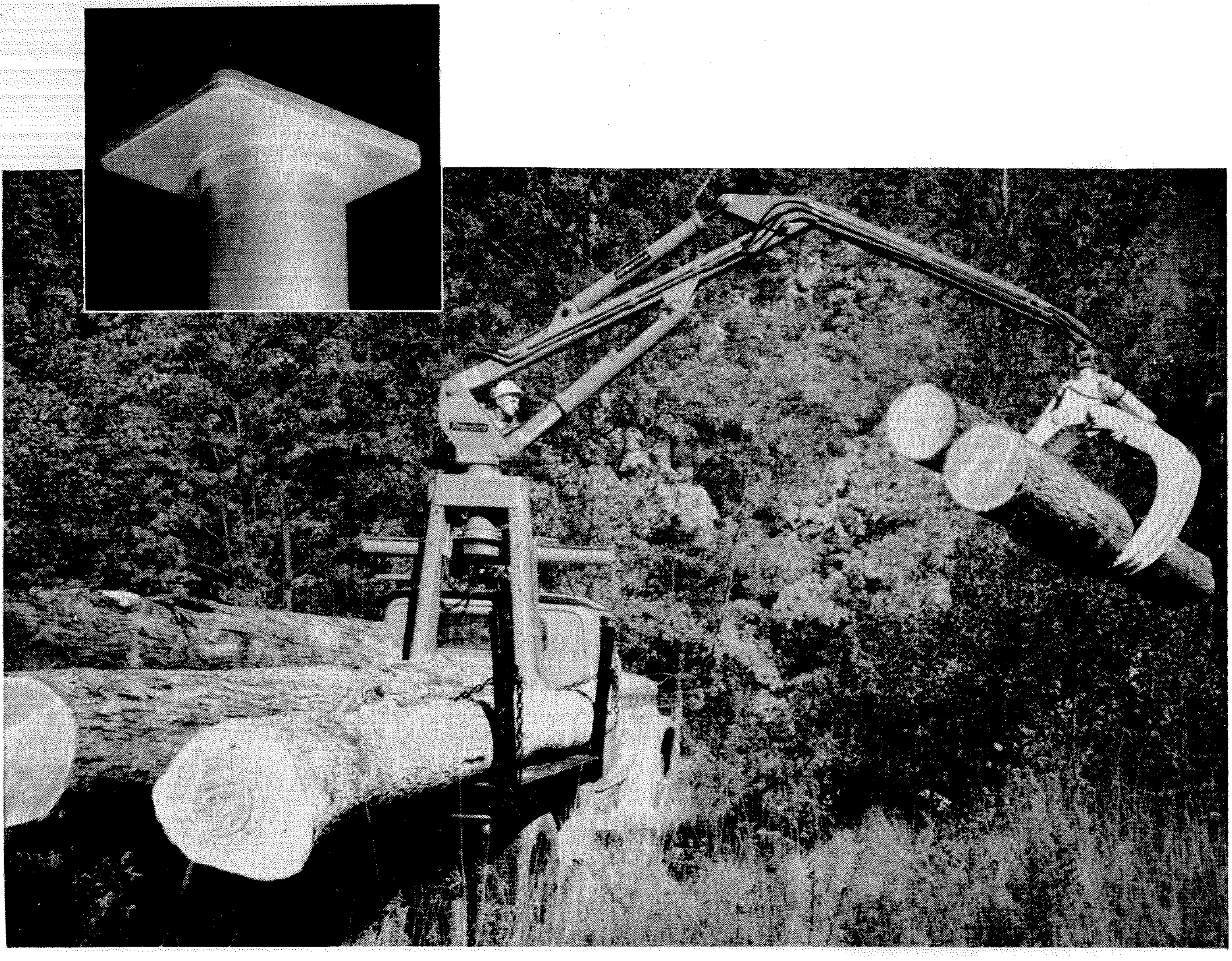


ment consultant, has been elected treasurer of the Western Personnel Institute, a non-profit cooperative research center for student personnel work. Mr. Colvin has served as a board member since 1959. He is a director of Reed and Reese, Inc., of Pasadena, the Unitek Corporation of Monrovia, and of WEMC Inc. of Hawthorne.

1937

BERNARD WALLEY has been appointed manager of the West Coast microwave engineering operation of RCA's Electron Tube Division in Los Angeles. He was previously manager of the Western district of RCA Industrial Tube Product Sales, and has been with RCA since 1937.

ROBERT P. BRYSON, MS, is now staff scientist for the lunar and planetary programs of the Office of Space Sciences, National Aeronautics and Space Administration, in Washington, D.C. He comes to the job after 25 years as geologist for the U.S. Geological Survey.

1939

CALVIN A. GONGWER, MS, is the new senior scientist and scientific advisor to the vice president of Aerojet-General in Azusa. He was formerly manager of the Oceanic division.

1946

ALI B. CAMBEL, MS, chairman of the mechanical engineering department of Northwestern University in Evanston, Ill., is the author of *Plasma Physics and Magnetofluidmechanics*, published this month by McGraw-Hill.

1947

NORMAN H. ENENSTEIN, MS, PhD '49, is manager of the systems division of Hughes Aircraft's ground systems group in Fullerton. He was formerly vice president and director of technical administration at Litton Systems, Inc. He is not a newcomer to Hughes for he was a pioneer in the company's work in radars and computers from 1949 to 1956.

1949

ROLF M. SINCLAIR announces the birth of his first child, a daughter, Elizabeth, on January 19. Rolf is on the research staff of the plasma physics laboratory at Princeton University. The Sinclairs live in Lawrenceville, N.J.

1950

JOHN W. BAXTER, MS, has been named manager of the thermodynamics division of Lockheed Missiles and Space Company in Sunnyvale. He has been with Lockheed since 1960 and worked for the Ryan Aeronautical Company for 10 years before that.

1953

THOMAS C. STOCKEBRAND has been working for the past seven years at MIT'S Lincoln Laboratory on input-output equipment for computers. Before that he spent two years with the Signal Corps working on field engineering of digital transmission equipment.

1956

RONALD O. STEARMAN, MS, is now associate analyst in the mathematics and physics division at the Midwest Research Institute in Kansas City, Mo. He was formerly a research fellow at Caltech.

KENNETH L. LAWS is now assistant professor of physics at Dickinson College in Carlisle, Pa. He received his master's degree at the University of Pennsylvania in 1958 and his PhD in physics at Bryn Mawr in June 1962. He has taught at Bryn Mawr, Swarthmore, and Hobart and William Smith colleges.

ROY A. WHITEKER, PhD., associate professor of chemistry at Harvey Mudd College, has been granted a Science Faculty Fellowship for 1963-4. He will spend a year at the Royal Institute of Technology in Stockholm working with Professor Lars G. Sillen, a pioneer in adapting computers to teaching and research in inorganic chemistry.

1958

CHARLES R. PENQUITE, MS '59, is doing research at the Monsanto Chemical Company's hydrocarbons division in St. Louis. He was formerly with the plastics division in Springfield.

1960

LIEUT. GERALD B. JOHNSTON is back at Homestead AFB in Florida after graduating from the U.S. Air Force training course for F-100 Sabre pilots at Luke AFB in Arizona. He is now qualified as "combat ready" in the supersonic jet fighter.

PAUL M. WEICHSEL, PhD, has been assistant professor of mathematics at the University of Illinois in Urbana since last fall. Before that, he had been doing research at the Mathematical Institute at Oxford in England.

1961

CHARLES SIEGEL received his pilot's wings last September at Williams AFB in Arizona, and then went to instructors' school at Randolph AFB in Texas. This month he is being assigned to Reese AFB in Lubbock, Texas, as a primary pilot training instructor.

Alumni News

Board Nominations

The Board of Directors of the Alumni Association met as a Nominating Committee on February 26, 1963, in accordance with Section 5.01 of the By-Laws. Five vacancies will occur on the Board at the end of the fiscal year (June 1963) – one vacancy to be filled from the present Board, and four members to be elected by the Association. The present members of the Board and their retirement years are:

William L. Holladay '24	1963	Charles P. Strickland '43	1963
William H. Saylor '32	1963	Robert Boykin '34	1964
Peter V. H. Serrell '36	1963	Patrick J. Fazio '53	1964
William H. Simons '49	1963	G. Russell Nance '36	1964
Richard W. Powell '40	1964		

The following nominations have been made:

President – Peter V. H. Serrell '36	(1 year)
Vice-President – Patrick J. Fazio '53	(1 year)
Secretary – Donald S. Clark '29	(1 year)
Treasurer – John R. Fee '51	(1 year)
Director – William H. Corcoran '40	(2 years)
Director – David L. Hanna '52	(2 years)
Director – Richard P. Schuster, Jr. '46	(2 years)
Director – Herbert M. Worcester '40	(2 years)

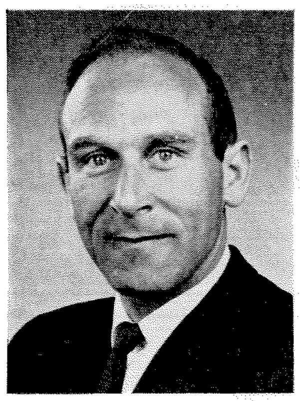
Section 5.01 of the By-Laws provides that the membership may make additional nominations for the four (4) Directors by petition signed by at least twenty-five (25) members in good standing, provided the petition is received by the Secretary not later than April 15. In accordance with Section 5.02 of the By-Laws, if further nominations are not received by April 15, the Secretary casts a unanimous ballot for the members nominated by the Board. Otherwise a letter ballot is required.

Statements about the nominees are presented below.

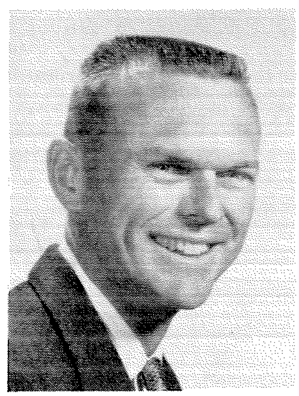
– *Donald S. Clark, Secretary*

WILLIAM H. CORCORAN received his BS in applied chemistry in 1941, his MS in chemical engineering in 1942, and his PhD in chemical engineering in 1948.. During World War II he worked on rocket ordnance at Caltech. From 1948 to 1952 he was director of technical development at the Cutter Laboratories in Berkeley. In 1952 he returned to Caltech as associate professor, and was appointed professor of chemical engineering in 1957. From 1957 to 1959 he had part-time duties as a member of the Caltech staff and was vice president and scientific director for Don Baxter, Inc., in Glendale.

DAVID L. HANNA received his BS in mechanical engineering in 1952. While at Caltech he played varsity football and golf and served as athletic manager and president of the student body. From 1952 to 1957 he worked for the Anaconda Wire and Cable Company, first as a technical salesman and then as a project engineer. He then spent two years in military service in Korea. Four years ago, after receiving an MBA degree from Stanford's School of Business, he joined the management consulting firm of Booz, Allen & Hamilton, which he now serves as western administrative manager.



RICHARD P. SCHUSTER, JR., received his BS in electrical engineering in 1946. After a year with the U.S. Navy, he returned to Caltech for an additional two years and another BS degree, this time in applied chemistry. He received an Honor Key for extracurricular activities during this period. For two years he served as a production foreman at the Procter and Gamble Manufacturing Company in Long Beach. Pursuing a career in chemical engineering, he spent the next ten years as plant manager of the Bray Chemical Company in Los Angeles. In June 1962 he joined JPL as a staff engineer, working in the newly created Arms Control Study Group. He is on the Board of Directors of the Caltech YMCA and is currently treasurer of that organization.



HERBERT M. WORCESTER received his BS in mechanical engineering in 1940. While at Caltech he was active in track, basketball and swimming. From 1940 to 1962 he was chief engineer and manager of the specialty products division of the Pacific Wire Rope Company in Los Angeles. In January 1962 he became manager of manufacturing at Boller & Chivens Inc., designers and builders of custom scientific instruments. An avid sailor, he was a crew member of the *Staghound*, the overall winner of the Trans-Pacific Yacht Race to Honolulu in 1955.

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	APPLIED RESEARCH LABORATORY Waltham, Massachusetts Central Research Facility for Entire Division	EASTERN OPERATION Laboratories at Waltham, Massachusetts and Needham, Massachusetts	CENTRAL OPERATION Williamsville, New York Advanced Communications Systems Laboratories	WESTERN OPERATION Mountain View, California Electronic Defense Lab; Reconnaissance Systems Lab
Advanced Systems Planning	●	●		
Advanced Phased Array Antenna Systems		●	●	
Aerospace Systems Research & Development	●	●	●	●
Airborne Instrumentation	●		●	●
Antenna Research & Development		●	●	●
Command & Control Systems	●	●		
Communication Techniques Research & Systems Development	●	●	●	
Data Processing & Display Systems R&D	●	●		●
ECM & ECCM Techniques	●		●	●
Electronic Tactical Warfare Systems				●
Information Handling Systems	●	●		
Intelligence & Reconnaissance Systems			●	●
IR Sensor Techniques	●	●		●
Microwave Research & Development	●	●		
Microelectronics Research		●	●	
Navigation Techniques	●		●	●
Operations Research	●	●		●
Optical Data Sensing Systems		●		●
Radio & Radar Research	●	●	●	
Reliability		●	●	●
Speech & Character Recognition Research	●			
Solid State Devices	●		●	
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Systems Integration Techniques	●	●		
UHF-VHF Circuit & Component Design		●	●	●

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"Hello? . . . Oh – Hi, George! How's tricks? Heh, Heh. What's on your mind? . . . An apology? . . . For me? . . . Why?

"I don't believe it. You mean you're sorry that you've been asking me to give to the ol' 'lumni Fund? Why? . . . Caltech doesn't *need* any more money? Alright, I'll bite. *Why* doesn't Caltech need any more money?

"No foolin! An unlimited supply, huh? Boy, you people will have to build a shed to stack it in. Can't have all those bills floatin' around in Throop ya know. Millions, huh? Maybe billions? Boy, I'm impressed.

"Those Development people are really doin' a great job. It must bring the tears to their eyes just thinkin' about a donor like that . . . Yeah."

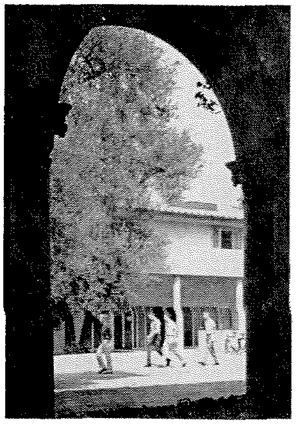
"Tell me, George. Who *is* the donor? . . . Oh, c'mon, George; I cross my heart and swear to go on the wag—. No, uh, on second thought I better just hope to die. Now *tell* me . . .

"Uncle WHO? . . . Oh, you're kiddin', George. You must be. Why Tech's a *private* school. Needs private support. You can't do that, George. Tech's got friends—lots of friends . . .

"Wait a minute, wait *a minute*. O.K. . . . O.K., no need to beat me over the head. Think you're smart I'll bet. Well you're not smart enough for me. C'mon over. *I'll* write you a check—one that'll make Saylor and Nance sit up and take notice—maybe even in *three* figures . . . Bye.

"(Three figures. Let's see, that's like nine dollars and sixty-five cents!)"

Your Alumni Fund Council
Will Be Dee-lighted



CALTECH CALENDAR

ALUMNI EVENTS

May 4 Annual Alumni Seminar

ATHLETIC SCHEDULE

Baseball

March 30
Claremont-H. Mudd at Caltech
April 3
Redlands at Redlands
April 13
Chapman at Chapman

Swimming

March 29
Claremont-H. Mudd at Claremont-H. Mudd

Track

March 30
Claremont Relays at Claremont
April 13
LaVerne at Caltech

Tennis

March 30
Claremont-H. Mudd at C-HM

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

April 5
The Electron Microscope in Geology
—Kenneth M. Towe

April 12
The Fortunate Pilgrims—Americans in Italy in the 19th Century
—Paul R. Baker

April 19
Hypersonic Wakes
—Lester Lees

April 26
Tumor-Producing Viruses in Mice and Men
—Roger Weil

Save the date
of May 4
for the

ANNUAL
ALUMNI SEMINAR

Outstanding Program beginning
at 8:30 a.m. on the
Caltech Campus

Dinner at 6:30 p.m. at the
Huntington-Sheraton Hotel

Complete program to appear in
the April issue

Announcements to be mailed
early in April —

WATCH FOR THEM!

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An Interview with G.E.'s H. B. Miller, Vice President, Manufacturing Services

Halbert B. Miller has managerial responsibility for General Electric's Manufacturing Services. This responsibility includes performing services work for the Company in the areas of manufacturing engineering; manufacturing operations and organization; quality control; personnel development; education, training and communications; materials management; purchasing and systems as well as the Real Estate and Construction Operation. Mr. Miller holds a degree in mechanical engineering and began his General Electric career as a student engineer on the Company's Test Course

For complete information about General Electric's Manufacturing Training Program and for a copy of G.E.'s Annual Report, write to: Personalized Career Planning, General Electric Company, Section 699-06, Schenectady 5, New York.

Manufacturing Careers Offer Diversity, Challenge and Opportunity

Q. Mr. Miller, what do engineers do in manufacturing?

A. Engineers design, build, equip, and operate our General Electric plants throughout the world. In General Electric, this is manufacturing work, and it sub-divides into categories, such as quality control engineering, materials management, shop management, manufacturing engineering, and plant engineering. All of these jobs require technical men for many reasons. First, the complexity of our products is on the increase. Today's devices—involving mechanical, electrical, hydraulic, electronic, chemical, and even atomic components—call for a high degree of technical knowhow. Then there's the progressive trend toward mechanization and automation that demands engineering skills. And finally, the rapid development of new tools and techniques has opened new doors of technical opportunity—electronic data processing, computers, numerically programmed machine tools, automatic processing, feedback control, and a host of others. In short, the requirements of complex products of more exacting quality, of advanced processes and techniques of manufacture, and of industry's need for higher productivity add up to an opportunity and a challenge in which the role of engineers is vital.

Q. How do opportunities for technical graduates in manufacturing stack up with other areas?

A. Manufacturing holds great promise for the creative technical man with leadership ability. Over 60 percent of the 250,000 men and women in General Electric are in manufacturing. You, as an engineer, will become part of the small technical core that leads this large force, and your opportunity for growth, therefore, is unexcelled. Technical graduates in manufacturing are teamed with those in marketing who assess customer needs; those in research and development who conceive new products; and those in engineering who create new product designs. I sincerely believe that the role of technical graduates of high competence in the manufacturing function is one of the major opportunities for progress in industry.

Q. What technical disciplines are best suited to a career in manufacturing?

A. We need men with Doctor's, Master's, and Bachelor's degrees in *all* the technical disciplines, including engineering, mathematics, chemistry and physics. We need M.B.A.'s also. General Electric's broad diversification plus the demands of modern manufacturing call for a wide range of first-class technical talent. For one example: outside of the Federal Government, we're the largest user of computers in the United States. Just think of the challenge to mathematicians and business-systems men.

Q. My school work has emphasized fundamentals. Will General Electric train me in the specifics I need to be effective?

A. Yes, the Manufacturing Training Program is designed to do just that. Seminars which cover the sub-functions of manufacturing will expose you to both the theoretical and practical approaches to operating problems. Each of the succeeding jobs you have will train you further in the important work areas of manufacturing.

Q. After the Program—what?

A. From that point, your ability and initiative will determine your direction. Graduates of the Manufacturing Training Program have Company-wide opportunities and they continue to advance to positions of greater responsibility.

Progress Is Our Most Important Product

GENERAL ELECTRIC