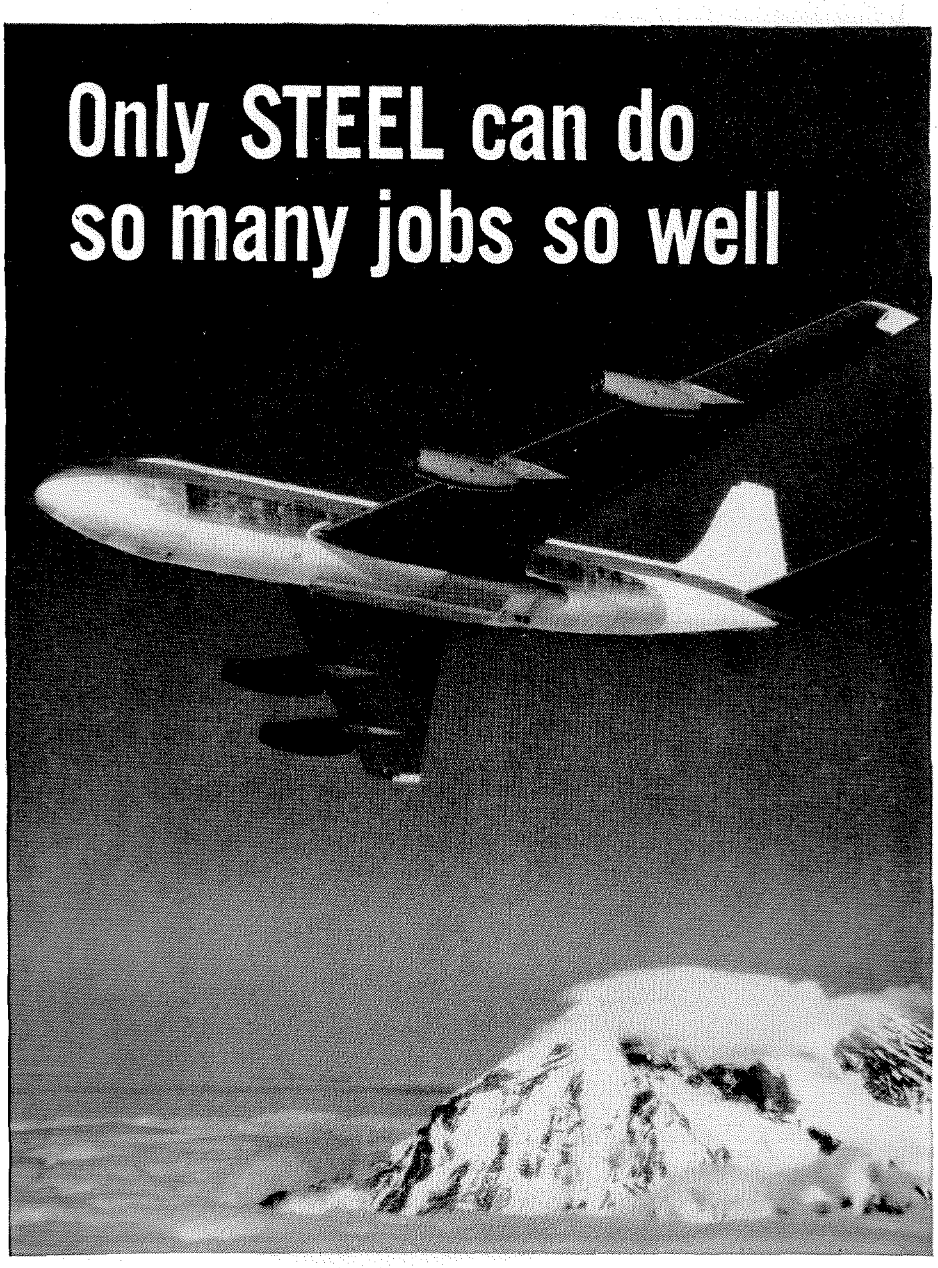
ENGINEERING | AND | SCIENCE

OCTOBER/1956

Freshman Camp . . . page 30

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



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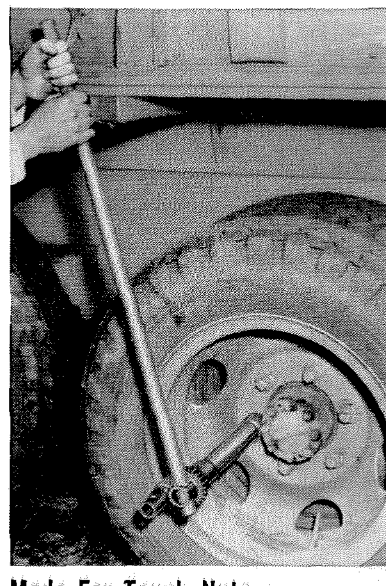

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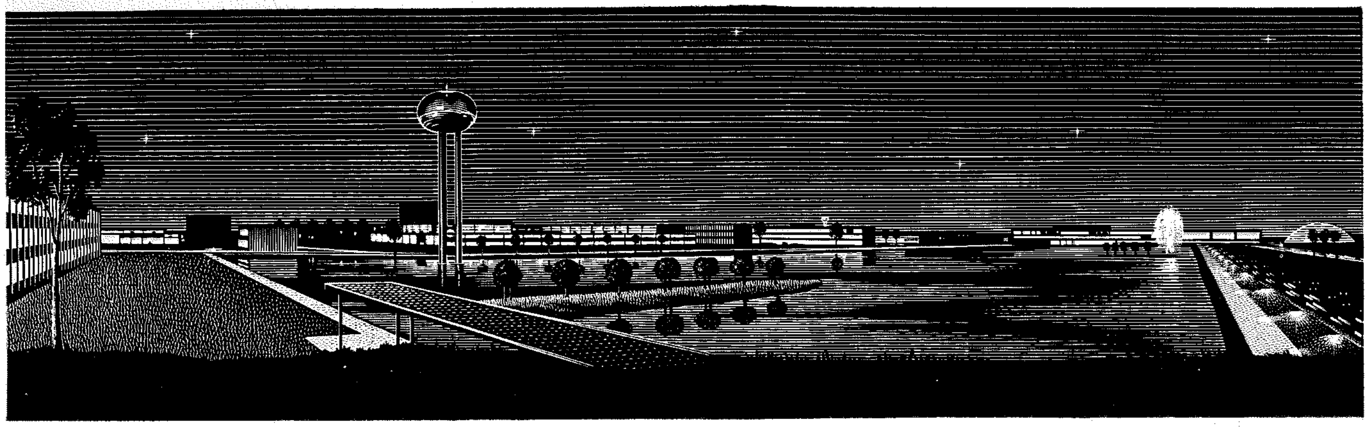

Left to right: Main Research Building, Service Building, Manufacturing Development Building (behind water tower), Engineering Building, Styling Building and Styling Auditorium Dome facing 22-acre lake, focal point of GM Technical Center.

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A FEW MONTHS AGO—after nearly 11 years in the planning and construction—General Motors officially opened its vast new Technical Center on the outskirts of Detroit.

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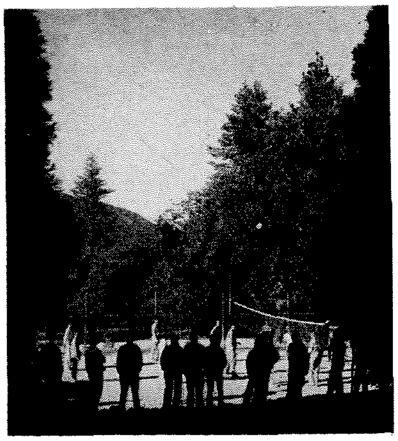
ENGINEERING AND SCIENCE

IN THIS ISSUE



On our cover this month—a picture of an early morning volleyball game at Freshman Camp, with a frieze of freshman spectators. Some of the other activities and personalities at this year's Camp are pictured on pages 30-32.

"Science—the Endless Adventure," on page 17, is a transcript of a talk given by President DuBridge at the 94th annual convention of the National Educations Association in Portland, Oregon, this summer. Even though this is the first time the full text of the talk has been printed, it has already gained considerable fame, and the President's office has been busily filling requests for transcripts all summer long. When you read it you'll see why.

It's been a long time since the last Caltech man went to the Olympics, but this fall Phil Conley '56 takes off for Australia to compete in the javelin throw. On page 44 Marty Tangora '57 explains how it all came about. . . . On page 40—more sports news. Doug Carmichael '59, who worked as a lifeguard at the Alumni Pool this summer, describes the colorful life around the pool after the school year ends.

On page 6, a letter inspired by Dr. Richard Feynman's June article, "The Relation of Science and Religion." On page 52, Dr. Feynman's reply to it.

PICTURE CREDITS

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p. 40, 41	Charles Mosher '57 Nolan Patterson

OCTOBER, 1956 VOLUME XX NUMBER 1

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

CONTENTS

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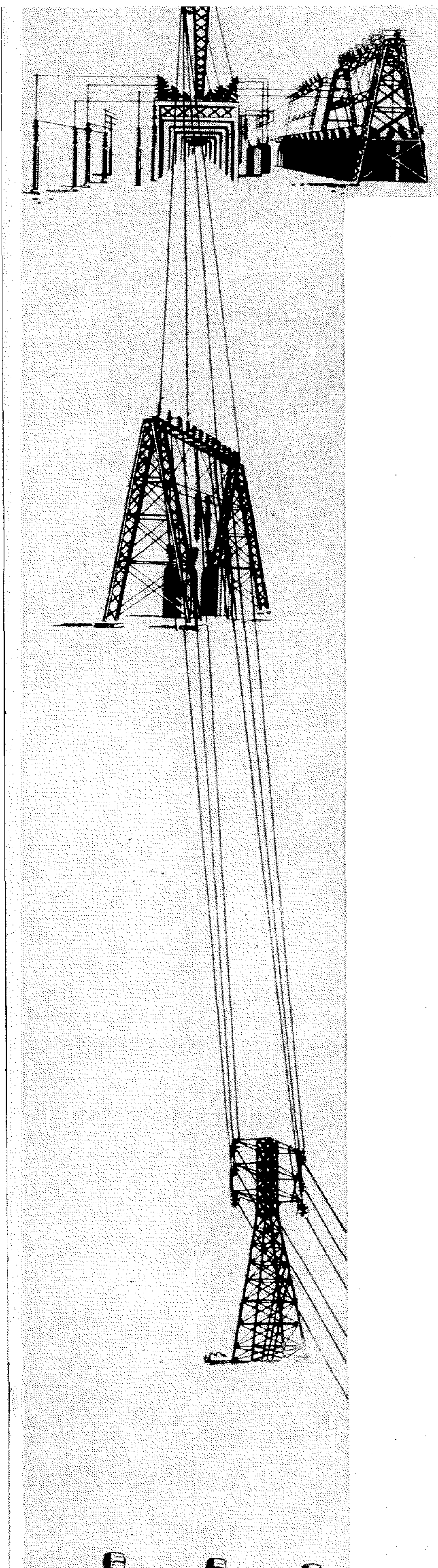
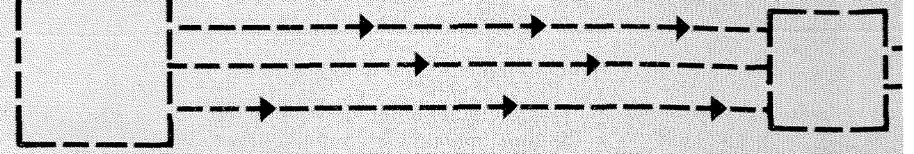
Douglas L. Carmichael '59

Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50 domestic, $4.50 foreign, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on Septmber 6, 1939, under act of March 3, 1879. Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.

Printed in Pasadena PP 6



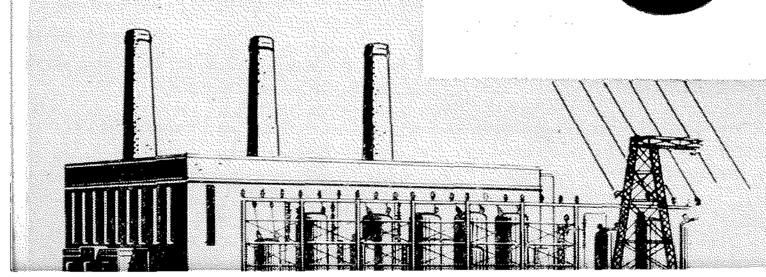


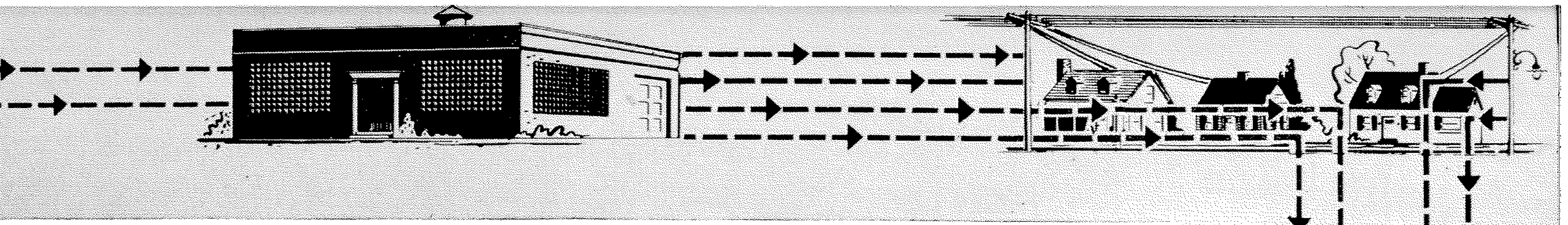
The importance of insulations fo

THE PURPOSE of electrical insulation is to offer resistance to the flow of electricity and thus to confine electrical potential to the conductor material throughout its length. An ideal insulating material would have infinite insulation resistance and voltage breakdown, a specific inductive capacity of 1 and zero power factor. In addition it would be flexible, physically strong and unaffected by abrading, cutting and impact forces, oxygen, ozone, acids, alkalies and water throughout a temperature range from minus 80 C. to the maximum operating temperature of copper. A conductor insulated with a thin wall of such a material would occupy minimum space and would operate indefinitely even at high voltages in the presence of any or all of the above destructive materials with no energy loss within the insulation. All available insulating materails fail to comply with the above ideal in practically every respect.

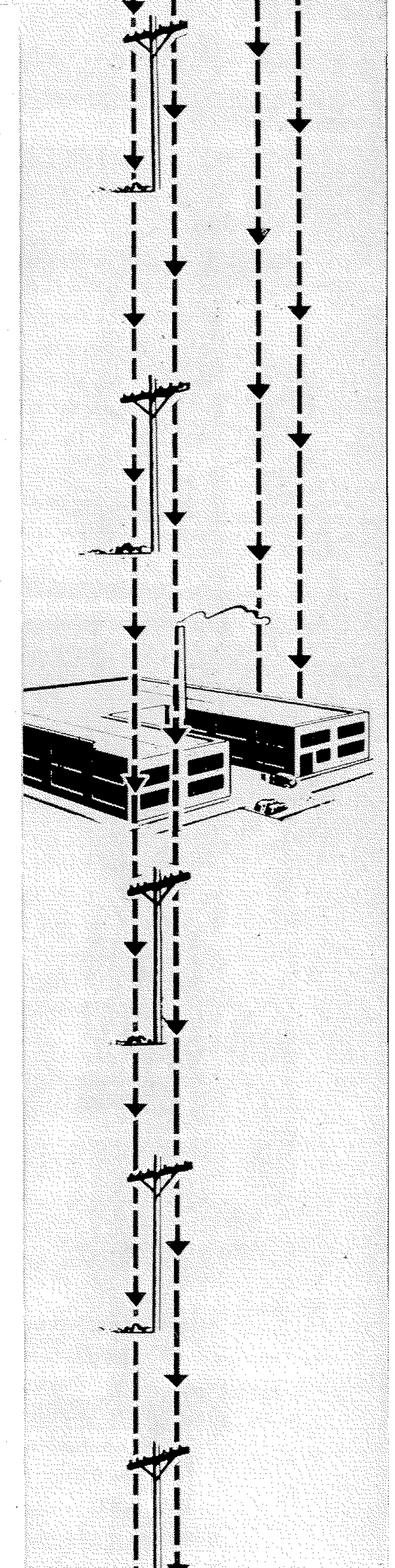
Insulations for use on electrical wires and cables which are subject to bending during manufacture, installation or use must have adequate flexibility. Flexible insulations for such uses are of two general classes, depending chiefly on the extent that they absorb or are affected by moisture. In one group are included the homogeneous rubber and rubber-like insulations, made from natural rubber or the synthetic rubbers, GR-S, butyl and silicone and thermoplastic insulations such as polyvinyl chloride compounds and polyethylene. Most of these are highly resistant to moisture. The other group consists of insulations built up of one or more layers of fibrous materials such as asbestos, cotton, varnished cambric, various synthetic fibers and paper. Even though these fibrous materials are impregnated with moisture-proofing materials such as paraffin, asphalts and oils, they readily absorb sufficient moisture in wet locations to completely lose their insulating properties. Such insulations must therefore be protected by a moisture-proof sheath such as lead when used in moist locations.

The insulations made from materials appearing in the first group fall into two general classes depending on whether or not they are vulcanized after application to the conductor, namely, (1) thermosetting insulations, those which are vulcanized and, (2) thermoplastic, those that are not vulcanized. Thermosetting insulations are those made from natural rubber, GR-S, butyl and silicone synthetic rubbers. Such insulations are applied to the conductor in a soft plastic condition and attain their ultimate physical properties as a result of a heat treatment (vulcanization) during which the sulfur or vulcanizing agents combine with the rubber. Thermoplastic insulations become plastic enough for application to the conductor simply by raising their temperature. They acquire their toughness again on cooling. From this it follows that thermosetting insulations are less subject to softening at elevated temperatures than





electrical wires and cables



thermoplastic insulations.

Natural rubber, including Laytex®, GR-S synthetic rubber and thermoplastic insulations are available in two classes, depending on whether they are designed for use in dry or wet locations. Standard insulations, Type R and Laytex Type RU (made from rubber) and Type T (made from thermoplastic) are for use in dry locations while moisture-resistant insulations Types RW, RUW, and TW are for use in wet locations. There are many installations, particularly in buildings, where the less costly standard compounds give entirely satisfactory service.

Natural rubber and GR-S synthetic rubber insulations are also available in two classes depending on the operating temperature for which they are designed, namely, Type R and RW for 60 C. operation and Type RH and RUH for 75 C. operation. Conductors insulated with RH insulation carry more current, that is, use the conductor more efficiently than those insulated with Type R insulation. There is also available a combination insulation capable of operating at 60 C. in wet locations and 75 C. in dry locations. Butyl rubber insulation is suitable for operation at 85 C. and silicone rubber for even higher temperatures.

The thermoplastic insulations described above are limited to 600 volts for general power distribution. The rubber and rubber-like insulations are limited to a maximum operating voltage of 5000. For operation at higher voltages where ozone is produced in quantity, resistance to ozone in the insulation must be provided.

Acceptable ozone resistance in rubber and GR-S synthetic rubber insulations is provided by incorporating in them relatively high percentages of an inert chemically saturated compound such as vulcanized vegetable oil. These are the so-called oil base compounds. Compounds made from butyl rubber are inherently ozone resistant. Oil base and butyl compounds are suitable for operation at a maximum voltage of about 28 KV, grounded neutral, when properly shielded.

Varnished cambric insulated cables are generally used in the same voltage range as ozone resistant rubber, that is, at a maximum of 28 KV, grounded neutral, and at a maximum conductor temperature of 85 C. For use in wet locations varnished cambric cables must be covered with a lead sheath.

Impregnated paper-insulated, lead-covered cables are suitable for operation at voltages up to 69 KV at a maximum temperature of 85 C. Gas or oil filled paper insulated cables are suitable for higher voltage services at somewhat reduced temperatures.

Insulation thicknesses for all insulations depend on the rated voltage, the conductor size and type of insulation. Minimum insulation resistance and test voltages have been established for all classifications.

For reprints of these pages write to address below.

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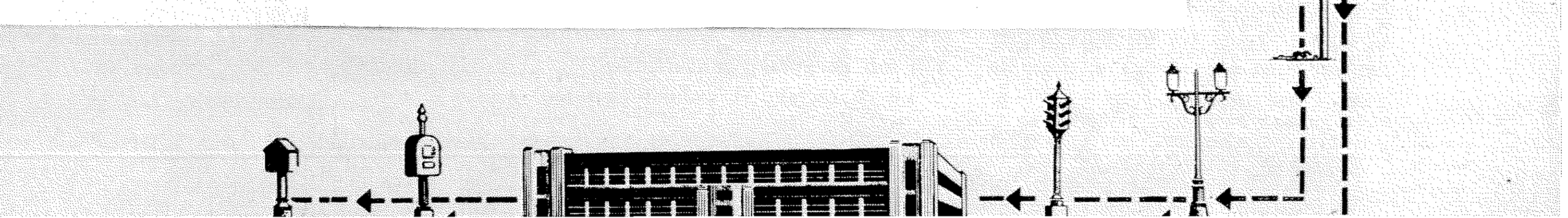

LETTERS

A "New Hypothesis" on Science and Religion.

San Jose, Calif.

Sir:

IN "The Relation of Science and Religion" (*E&S — June, 1956*), Richard Feynman defines his central question as "the problem of maintaining the real value of religion, as a source of strength and courage, while, at the same time, not requiring an absolute faith in the metaphysical aspects of religion." I cannot qualify as one of the experts requested by Dr. Feynman for his panel, but I ask to be heard as one of the hypothetical young men who has been exposed to both conventional religion and to science, and who is thereby personally confronted by this very problem.

Dr. Feynman's choice of the word "inadequate" for conventional religion is very apropos, and anyone with a sense of proportion must agree that this vast universe could hardly be a mere stage setting for "God" to observe man's struggles on a tiny speck such as the Earth. Anyone with a sense of justice must be dissatisfied with conventional religion's explanation of the suffering (especially in little children) which can be observed on all sides. How can such things be "God's will," when God is defined by conventional religion as "all-loving"? Finally, anyone with a sense of perspective must be acutely aware of Dr. Feynman's point that conventional religion's definitions of "What is God?" and "What is Man?" have had to be continually changed in light of new scientific discoveries.

It is possible that an expert on conventional religion can reconcile these problems to his own and some others' satisfaction, and I hope that this panel will have the opportunity to hear such a presentation. For my part, I ask that you (at least temporarily) set to one side all of conventional religion's concepts of "God" and "Man." You may wish to rush back to them as the lesser of two evils, but at least admit that they are unsatisfying in their present form, and be willing to open your mind to another hypothesis.

Dr. Feynman provided us with an excellent point of departure. He said: "Yet again, there are the atoms, of which all appears to be constructed, following immutable laws." Every day countless experiments reconfirm the fact that physical matter behaves in accordance with impartial rules or laws, and that any apparent departure from these laws is actually a measure of our lack of understanding of the laws. Science does not make up the laws; it can only attempt to gain a better understanding of the laws which already exist.

For example, science books have long maintained that "matter cannot be created or destroyed — only changed in form," and this ironclad "law" has been used to define the conservation of energy. Einstein and atomic energy have now shown the law to be an illustration of man's lack of understanding. It turns out that both matter and energy are merely different forms of the same "substance," and that one can be created from the destruction of the other. However, the principle of conservation still applies, for the net total "substance" or "force" remains constant, even though its form is changed from physical matter to energy, or vice versa. In a moment we will attempt an extrapolation of this knowledge.

Let us first take full cognizance of our limitations, typified by this not too imaginary conversation:

1st character: "I wonder how the universe got started?"

2nd character: "There must have been a God to create it—how else could it get started?"

1st character: "I don't know."

2nd character: "Well, if you don't know any other explanation, I must be right."

To the finite mind, there *must* be a beginning and an end. As long as finite objects are being discussed, the beginning and the end can be stretched very far apart, and it is still possible for the finite mind to encompass them. However, it just simply is not possible for the finite mind to comprehend infinity, any more than it is possible for the largest electronic brain to handle an infinite number. Let us be humble enough to admit that, to a finite, mortal human being, infinity (or "God") is literally unknowable. At most, we can only comprehend observable finite manifestations.

With this limitation in mind, I submit the following hypothesis: God is pure spiritual force, infinite in all dimensions, including time, and therefore unknowable to mortal man. All things, including physical matter, energy, and mentality are merely different forms of this universal life force, and all forms operate in accordance with universal and impartial laws. Each living human body is inhabited by an immortal unit of spiritual force called a soul, and all such units are subject to the same universal laws which apply to all other forms of the universal force. At such time as a soul becomes aware of all of these laws, and learns to live in harmony with same, it will literally become "one with God."

Let us take a deep breath and consider the personal implications of

CONTINUED ON PAGE 8

Letters . . . CONTINUED

the hypothesis. It implies that each individual soul is engaged in the process of learning the laws through experience, and that this experience is being currently accumulated through reincarnation into a series of physical bodies. (Bear with me—we will dispose of Bridey Murphy in a moment.)

I respectfully maintain that this concept at least disposes of the latter part of Dr. Feynman's central problem; it has no arbitrary metaphysical aspects, but throws open the entire field of observable phenomena to searching scientific investigation. In fact, this very search for wisdom is the personal challenge of every human being, because his increase of wisdom in any one lifetime is the measure of his soul's growth in that lifetime.

Back to Bridey Murphy

Before going further, let us go back and put Bridey Murphy in perspective. It would be tempting to enter into a detailed discussion of Mr. Morey Bernstein's lack of knowledge, and his poor experimental techniques. However, for the sake of brevity, I will gladly concede that his experiments did not prove the existence of reincarnation, if you will in turn concede that his sloppy handling of the material did not necessarily disprove such existence. Please remember that I am submitting a hypothesis—not trying to prove it.

Assuming that we are all still keeping an open mind, let us consider some other implications of the hypothesis stated above. We have accumulated massive amounts of experimental evidence of the existence of a law of cause and effect in the area of physical matter, and we have found that a similar law also operates in the area of energy. Modern psychiatry has discovered that the same law (in more subtle forms) is equally valid in the area of mentality. Our hypothesis implies that there is a similar parallellism of

CONTINUED ON PAGE 10

laws throughout the entire scale of manifestation, from the grossest physical matter right on up to the most refined forms of spiritual force, and further implies that full understanding of these laws awaits only the development of adequate experimental techniques for their true nature to be determined. Here is a real frontier for the scientist with the courage of a pioneer.

Reincarnation

Pending scientific determination of these laws, let us consider the probable nature of one of them. From our well-documented experiments with physical matter, we are well aware of the fact that we cannot extract more gasoline from a tank than we put in at the start. The same goes for energy in a storage battery. If our hypothesis is valid, a similar law should apply at the mental level and the spiritual level. Although it has never been measured, for lack of parameters, our own empirical experience has shown that any creative endeavor must necessarily be preceded by some comparable mental effort. And when we consider the spiritual level, we find that a very wise man has already stated the exact law for us: ". . . whatsoever a man soweth, that shall he also reap." When we combine this sound natural law with the concept of individual souls being reincarnated into a series of physical bodies, we find ourselves with a lap full of satisfactory explanations for many bothersome mysteries.

Immediately, we find that none of the suffering we see or experience results from the arbitrary and unpredictable will of some remote third-party "God." Any individual who suffers in this lifetime is merely reaping the results of suffering he imposed upon others in a previous lifetime. In a literal sense, each person "brings it on himself," through ignorance of this universal and impartial law. I suggest that there is a feeling of "rightness"

CONTINUED ON PAGE 12

about this concept that is bound to strike a responsive chord in any person who maintains that there should be individual responsibility for individual actions.

It is apparent from history, and from current events, that many individuals are piling up a peck of trouble for their souls in the future through their actions in this lifetime. It is high time that science got to work on the problem of checking out this law, in order that mankind may stop learning about it the hard way.

There is an excellent illustration of physical law which applies to this problem. Let us say that there are two men at the brink of a 1000-foot cliff, and we specify that one has full knowledge of the law of gravity, and that the other has no knowledge. Then, if both jump off the cliff, the man with no knowledge of the law will be just as dead at the bottom as the man with full knowledge. So, too, with the spiritual law of "as you sow." Ignorance of the law does not exempt anyone from its operation.

Learning the hard way

In the meantime, let us consider the impact of this concept on the first portion of Dr. Feynman's central problem—"maintaining the real value of religion as a source of strength and courage." I suggest that a personal code of conduct based on a literal acceptance of " . . . whatsoever a man soweth, that shall he also reap." will tower far above any code imposed on the individual through fear by an external organization. In fact, I think it likely that the curious tenacity of a general moral code, even in the atheist, is nothing more than the effect of the wisdom distilled the hard way by the atheist's soul through past reincarnations.

Furthermore, it is apparent that this same concept has a built-in automatic inspiration mechanism. The individual who accepts it has a compelling personal reason for carefully avoiding imposing his will upon that of another, for only by such avoidance will he save himself the pain of being on the other end of the stick in some future lifetime. At the same time, he has an equally compelling reason for taking positive action to use his talents for the benefit of his fellow man. The net result is a sound *selfish* motive for doing *only* unselfish things. This, too, feels "right." At this point, we find that the same wise man who stated the law of "as ye sow," some 2000 years ago, also made a neat summary of the very point we have been trying to make. He said, "For the Kingdom of God is within thyself. . . ."

Evaluating human actions

As more and more evidence pours in to reinforce the impression that this is in truth a "well-ordered universe," I find it personally comforting to have a hypothesis which provides a practical basis for evaluating the many human actions (including my own) which used to appear to be proof of a "disorderly" universe. Most of all, I appreciate the fact that it places no limitations on my ability to think. On the contrary, it provides the greatest possible stimulus to think for myself, for it would be folly indeed to blindly imitate those whose ignorance of the law is permitting them to sow weeds.

In conclusion, it is necessary that I qualify the term "new hypothesis" as applied to the concept described above. Of course, it is not new at all. Millions of people accept this concept today, and millions accepted it long before Jesus Christ was born. However, in one sense the term "new hypothesis" has been used correctly, for nearly all of these millions have had to accept a large overburden of metaphysical and social dogmas along with the essential truth. Our own conventional religions, as we have seen, suffer from the same burden; the truth of Christ's teaching is buried in an unpalatable jumble of dogma and metaphysical absurdities. Therefore, I suggest that science go to work on verifying the pure form of the universal laws suggested in this "new hypothesis," in order that all mankind may, in truth, "maintain the real value of religion as a source of strength and courage, while, at the same time, not requiring an absolute faith in the metaphysical aspects of religion."

A direct question

I yield the floor to another member of the panel, after this aside to Dr. Feynman: Have you ever been intrigued with the question of why you have always been interested in this apparent conflict between science and conventional religion? I suggest that you have had some experience with the reincarnation concept in a previous lifetime, and that it is this distilled wisdom in your soul which now prompts you to actively question something which just doesn't feel "right." You might even confirm this yourself, by carefully rereading your original article and noticing the numerous places in which the very phrasing of your questions contains indications of the answers from the standpoint of reincarnation. Also, it might be interesting for you to recall your feelings (*not* your intellectual evaluation) regarding the above article as you read it for the first time. If you had any feeling of "seems to me I have been here before," I think you could consider that at least a partial confirmation of the fact that you have indeed "been there before."

—*Stan Sohler, '41.*

Stan Sohler is owner of the Thoroughbred Business Service in San Jose, Calif. Before he went into business for himself he spent the five war years at North American Aviation, at Menasco in Burbank, and with the AAF at Wright Field.

For Richard Feynman's reply —see page 52

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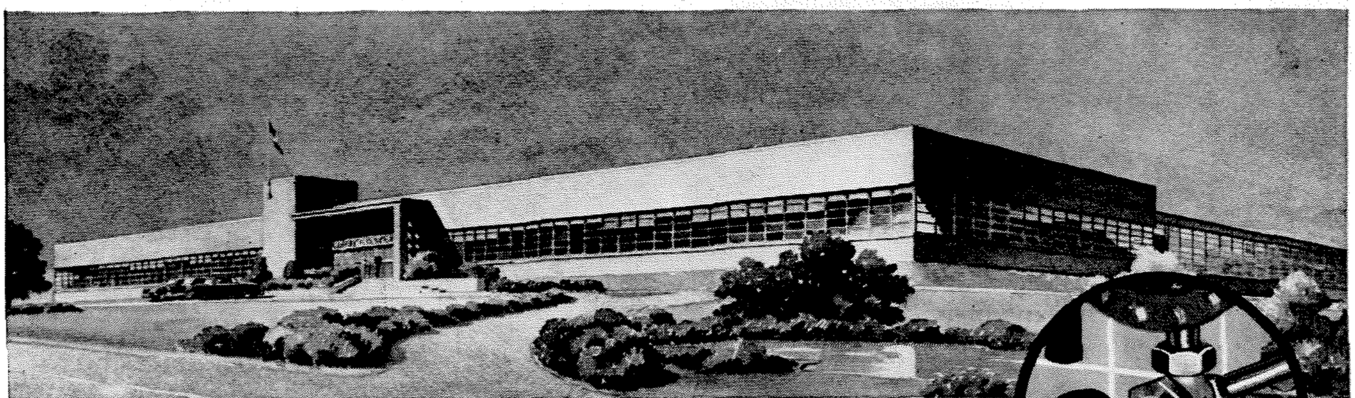

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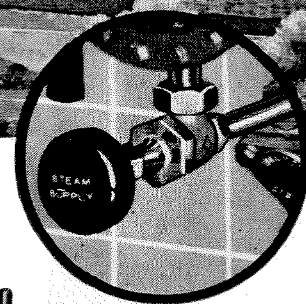

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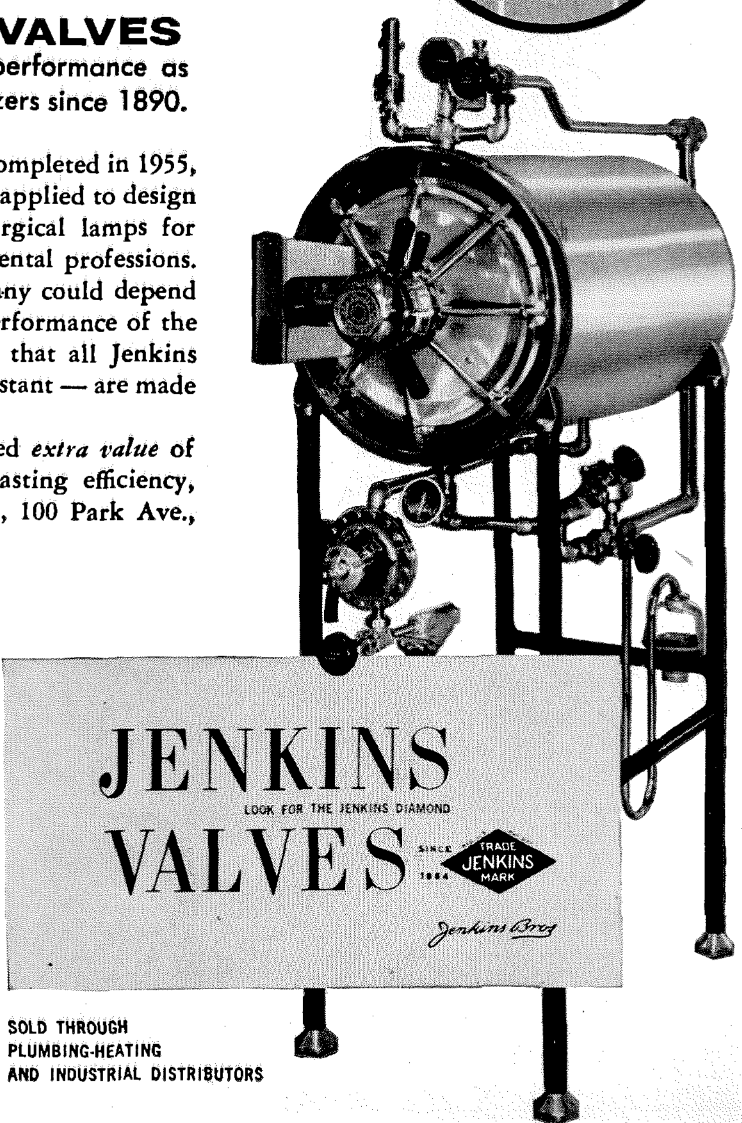

THE HOSPITAL LABORATORY AUTOCLAVE illustrated is one of the many types of Castle Sterilizers used in hospitals and laboratories, and shows typical use of Jenkins Valves on the steam, water supply, and drain lines. Valves are renewable composition disc type, and have special heat-resistant, non-staining Bakelite handles, with each valve's function moulded in the top. Jenkins Valves provide the sturdy construction, safety, and good appearance required. They also permit quick, easy maintenance, since the renewable discs, made also by Jenkins Bros., are available anywhere from Jenkins Distributors.

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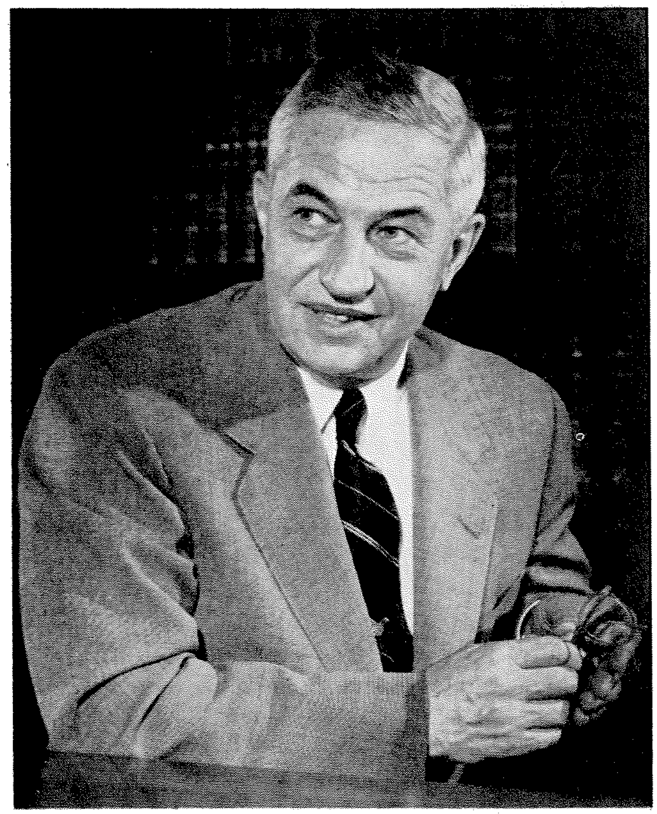
SCIENCE, THE ENDLESS ADVENTURE



By
L. A. DuBRIDGE

MUCH HAS BEEN written in recent years about science as the hope of man's future and also about science as the instrument of man's destruction. You have read of the possible glories of tomorrow's world of technology when people won't have to work—but only push buttons—and can spend endless hours of leisure speeding across the country in radar-guided, air-conditioned, pink Cadillacs at 120 miles an hour or more. And you have also read of the utter ruin which civilization would face in case of an all-out war using all the modern techniques of destruction.

You have heard of many such things which are probably true. Advancing technology is going to bring about great changes in our methods of living—changes in the next 50 years as great as those in the last 50. But it is also perfectly possible that an all-out nuclear catastrophe will intervene.

You have also read other things that are untrue or improbable. I think the imminence and practicality of space travel by humans (not to mention its desirability) have been grossly exaggerated. Cheap and abundant atomic energy is still a long way off—though in some parts of the world (not in America) it will soon be cheaper than other sources that are available. Still other promises you have heard violate basic laws of physics, or else they would be fantastically expensive.

Yes, the comic-strip artists, the science-fiction writers, as well as good solid scientists and engineers, can paint exciting pictures of the new devices, gadgets and machines that we will all have in 25 years. But these are not things I am going to discuss now.

Nor am I going to talk about whether these extraordinary things that technology is going to bring us are good or bad. In fact, no one can say—for *anything* can be *either* good or bad, depending on how it is used, whether it's a stick of wood or a stick of dynamite. *Things* aren't bad; only *people* are bad. And as to whether people are going to be bad or not there is no argument; some of them certainly will be. But whether they are or not, these new *things* are going to come anyway—*for no force on earth can stop men from thinking*, from inventing, from exploring.

But I am not going to discuss the things men will invent. I am going to talk about the things men are going to *think;* the ideas they are going to explore.

The things men invent will arise from new things they learn, from new understanding they acquire about the world. On the foundation of new ideas, men create great new technologies, new industries, new machines, new ways of doing things.

I propose to examine not the superstructure that men have erected on the foundation of knowledge, but the foundation itself. I am not going to explore the glittering

"Science—the Endless Adventure" is a transcript of a talk given at the 94th Annual Convention of the National Education Association in Portland, Oregon, on July 6, 1956.

upper rooms and towering pinnacles of technology—I propose to go to the basement and examine the foundations of science on which all technology is based.

And I propose to talk first about science not in the light of the new technology to which it may lead, but to talk about science for its own sake—science as a method of thinking, science as a method of acquiring new knowledge, science as the key to understanding, the road to comprehension of the physical world. I am going to speak of science, the endless adventure.

From the day that man first acquired consciousness he began to observe the things about him—the nature of fire, of water, of the winds, the sea, the stars. And as he observed, he remembered and reflected. He noted the regularities of nature. Fire could nearly always be produced in a certain way and extinguished in certain ways. The sun marched regularly across the sky—though more careful observation showed that its path changed almost imperceptibly from day to day, from week to week, and at the same time the weather became warmer, then cooler, then warmer again. When these invariable regularities of nature are reduced to their simplest form, we call them the "laws of nature."

At a very early time man must have been conscious of numbers—the number of his children, the number of his wives, how many animals he killed, how many enemies he had. Primitive men had words for only three numbers—one, two and *many*. Gradually the "many" became sorted out—3, 4, 5, 10. Curiously enough, it was a very long time before men discovered the number "zero" and learned to use it.

The importance of numbers

At this juncture I should like to pause a moment and reflect upon the importance of numbers—and upon the science of mathematics which has been built upon them. How many of us realize how utterly impossible our modern way of living would be without a number system and without our science of mathematics. Suppose we had not yet invented numbers above 10. Suppose even we had to add and multiply with Roman numerals. For example, how do you multiply XVI by MCMXL?

Suppose we were unable to deal with numbers higher than a million, or even a billion. That might have a salutary effect on government budgets, of course, but there are quite a few large corporations whose gross incomes are above one billion dollars too.

But, if we come to think of it, how many people *do* know what a billion really means—or even a million? Counting as fast as you can—say 3 per second—it would take you 3 days, 24 hours a day, to count to a million—over 8 years to count to a billion.

As an illustration, let me ask you how big a house would be if it were a million times as big as your house—assuming you occupy an average size dwelling. Would it be as big as the Empire State Building? As big as an Egyptian pyramid? As big as the Pacific Ocean? As the whole earth? As the solar system? You might amuse yourself by proving that a house with a million times the dimensions of yours would have a volume some 10 to 50 times the volume of the *earth*.

My point is that very few people really know what a factor of a million really means. Especially when we deal with a million *cubed* as we do in computing a volume.

Is it any wonder that we find it difficult to realize what it means when we say that a modern hydrogen bomb has an explosive energy 20 million times as great as a 1-ton TNT bomb? But we should not be misled the other way either. For the radius of destruction of a bomb depends on about the cube root of its explosive energy. And that means a 20-megaton bomb has a radius of damage only the cube root of 20 million—or 270 times as big as for a 1-ton bomb. That's still a damage radius of 10 miles or more. But a Los Angeles paper recently published a letter expressing fear that Los Angeles people might be hurt by the blast of the Bikini tests—5000 miles away! To do that would take the power of 125 million 20-megaton bombs.

Dealing in billions

Now I am not trying to confuse you or scare you. I am only giving some spectacular illustrations of the importance of numbers in the modern world—the importance of being able to think in quantitative terms. Why do we still teach arithmetic as though numbers bigger than 100 or 1000 were too complicated to grasp? A million is 10^6, a billion is 10^9, a million squared is 10^{12}, and 10^6 x 10^9 is 10^{15}. It's very simple! Even a little experience with exponents would give youngsters a lot of fun—and would make it possible for them, out of their own experience, to deal with millions and billions in a more meaningful way.

I noted the other day a curious example of this inability to deal with numbers larger than a billion. A science story in a weekly newsmagazine contained the statement that in a certain volume of air there were "billions of molecules." Now, of course, that is perfectly true but it is about as significant a statement as though we said that on the earth there live dozens of people. There are, of course, many dozens of people on the earth; in fact, there are about a quarter of a billion dozen. Similarly, there are many billions of molecules in a cubic centimeter of air; in fact, there are 30 billion *billion* molecules. We feel sorry for primitive men who were unable to distinguish numbers higher than 3 and referred to everything else as "many." Some day in the future, people will think of us 20th century humans as being rather primitive because we were unable to think in terms larger than a billion.

Our whole modern civilization is built on mathematics! Not a street can be laid, a foundation dug, or a building constructed, without the use of algebra, geometry and trigonometry. Not a machine can be designed, an engine's performance predicted, an electric power plant constructed without mathematics through calculus. The design of an airplane, a ship, a guided missile or an electronic computer requires a profound knowledge of higher mathematics, while the really interesting fields of nuclear physics and astronomy use group theory, matrix algebra and non-Euclidean geometry.

In other words, no one from a grocer's clerk to the nuclear physicist can do without mathematics—and the study of mathematics can be a great adventure in the methods of quantitative thinking which will provide to everyone a lifetime of better understanding of a technological world.

Journey to the sun

But let us turn now to adventures in the world of physical science rather than mathematics. I should like to start the adventure with a journey to the sun. Adventurers who climb Mt. Everest are pikers; we are going to explore (in our minds at least) what we would find at the center of the sun.

Now the first thing we notice about the sun is that it is hot. It is very hot, in fact. The surface temperature is about 11,000°F. That is higher than any temperature ever observed on earth except in the burst of an atomic bomb. That is far above the melting point of any material we are familiar with; it is far above the boiling point of most materials. Therefore, the sun is very much like a ball of hot gas.

But the surface of the sun is its coolest part. It is easy for an astrophysicist to prove that, because the sun is so massive and the gravitational forces are therefore so enormous, the sun would promptly collapse into a very much smaller object unless the central part of the sun is at a very high pressure and temperature. In fact, the central temperature is probably about 23,000,000°F. The pressure is so great that the central portion has a density 10 times the density of lead, though it is still a gas—in fact it is mostly hydrogen.

The age-old question about the sun, of course, is what keeps it so hot. We know that the earth has been at roughly its present temperature for 4 billion years or so. The sun must have been at about its present temperature equally long. Where does all that energy come from?

Up until just before World War II—very recently you see—not even the beginnings of a satisfactory answer had been found. We know now that the only source of energy possible is the transmutation of matter—specifically, in the case of the sun, the transformation of hydrogen into helium. The sun, in other words, is a big continuously-operating hydrogen bomb. It would, in fact, explode just like a bomb except that the gravitational forces are so enormous that it is all held together in a very nice balance.

Fortunately, there is a lot of hydrogen still left in the sun—enough to last for another few billion years in fact. Some day, however, it will be gone. What then? Will the sun collapse and cool off? No, it will collapse and get hotter! The gravitational energy developed in contracting generates still more heat, so the interior will get hotter as the sun gets smaller.

And then? Eventually the internal temperature will rise to about 200,000,000°F. at which point something new will happen. The helium which was formed by the conversion of hydrogen will now be at a temperature where it can begin to "burn." Three atoms of helium can join to make one atom of carbon; four atoms of helium can make one atom of oxygen. In both cases energy is again released so that this source of heat will maintain the internal temperature of the sun at 200,000,000°F. until the helium in turn is all used up. At this stage the sun will start to collapse again; the internal temperature will rise still higher until the point is reached at which the carbon and oxygen atoms will begin to combine to form still heavier atoms, building up eventually to elements in the neighborhood of iron. By this time, the temperature of the center may have reached several billion degrees F.

During these various processes, there are intervals of possible instability and the possibility of an explosion arises. We do not know precisely the conditions under which an explosion might take place, but explosions of distant stars have been observed in the heavens. They are known as supernovae. But at this point our knowledge gets very vague indeed. In fact, it is only in recent months that a detailed quantitative picture of the evolutionary history of the stars and of the process of atom building has been worked out by combining the knowledge of astronomy with knowledge recently acquired in the laboratories of nuclear physics. Again the problems and techniques of mathematics play an important role. Just recently Dr. Fred Hoyle of Cambridge has evolved a project for making detailed computations of the evolutionary history of the stars, a project which will require five years to complete on one of the fastest of modern computing machines. (Incidentally, those who wish to pursue this whole subject more thoroughly could do no better than read Dr. Fred Hoyle's very recent book, *Frontiers of Astronomy*, or the special issue of *Scientific American* for September, 1956).

A daring and intricate adventure

This, I claim, is one of the greatest of all adventures in science—the most daring, the most intricate. The sun is only one of a billion stars in our galaxy. And there are millions of other galaxies equally large scattered through space. The faintest that can be seen on the plates of the great 200-inch telescope at Palomar are 2 billion light years away. Yet we know that the same elements—the same kinds of atoms and molecules—occur in these distant stars as in our own sun. The same laws of physics apply—the same sources of energy must exist. No doubt there are some stars which are fairly young—are just beginning to "burn" their hydrogen. Others are probably old and hot. Some stars have gone through the explosive phase. Some supernovae are still glowing after many years; some appear to be "decaying" with a half-life of two months or so, like a radioactive element. Indeed there is evidence, recently noted by Fowler, Burbidge and Hoyle at Caltech, that possibly the great explosion did produce a vast quantity of radioactive material—just as does the explosion of a thermonuclear bomb.

This is one of the most exciting aspects of the great adventure of modern astronomy—the intimate way in which it brings the sciences of spectroscopy, of nuclear physics, of electronics, of cosmology, of quantum mechanics—each one helping to fit in some piece of the vast jigsaw puzzle.

Radio astronomy

There are other exciting developments in astronomy. Many years ago a radio physicist named Jansky was tracing down some of the sources of noise in a sensitive radio receiver. There were faint hissing sounds which he could not trace to electric motors, spark plugs, thunderstorms, or the other usual sources of "static." He eventually found that these flickering radio waves were coming from the sun! So began the science of radio astronomy.

It was not until 1946, however, that electronic techniques had been developed to allow radio observations to be made consistently and exactly. Today we know of hundreds of objects in the sky which are sources of radio waves. Some are stars like the sun; some are distant galaxies. Possibly the most interesting source is the great cloud of hydrogen gas which exists in the Milky Way galaxy and which gives off radio waves of a frequency of 1420 megacycles—a wave length of 21 centimeters, about 8 inches. In fact, there are parts of our Milky Way which are obscured by clouds of dust in space so that no light gets through. However, the radio waves from the hydrogen clouds do come through and so the only direct knowledge we have of the other side of our own galaxy beyond the dust clouds is supplied by radio waves. And from them we can learn something about the structure and velocity of that part of the galaxy.

Radio waves from the stars! Who would have thought it possible a few years ago? Or who would have thought that obscure studies at Columbia University on the energy levels in hydrogen could have led a couple of physicists — one in Holland and one at Harvard — to guess that hydrogen in space could emit 21-centimeter radio waves — then to look for such waves and find them? Today great radio antennas, radio telescopes—far larger than the 200-inch, but less expensive—are being built all over the world to explore further the nature of the stars as revealed by the radio waves which the racing electrons in their outer atmosphere emit. Since radio waves penetrate air, haze and clouds, a radio observatory does not have to be located in a clear climate, like southern California, or on a mountain top. In fact, the flat plains of Holland and the clouded moors of England and Australia have been primary locations for radio work.

They have there detected waves from sources which are so distant that for their waves to be detected here they must have been projected from a source as strong as a 50-kilowatt broadcasting station—multiplied a *million billion billion billion* times over! The power radiated is the inconceivably large figure of 10^{33} kilowatts. That's as much energy as the total energy from a hundred billion suns. It is lucky indeed that that source is so far away. If it were much closer, the earth would be so blanketed by radio "static" that radio and television broadcasting would be completely impossible. It is possible that radio telescopes may be detecting objects that are so far away that they cannot be seen or photographed, even with the Palomar telescope.

We see then that astronomy, though it is one of the oldest sciences, is being rejuvenated even today. New telescopes have made our distance measurements more accurate; new electronic techniques are extending the power of both optical and radio telescopes; new knowledge of nuclear physics is helping us understand how the energy of stars is produced, how all the different chemical elements are built up from primordial hydrogen, how the stars evolve, how some blow up, condense again and begin a new existence.

I am told that back in the 15th century so few people could read that millions of young people who were contemporaries of Columbus, Magellan and the other early explorers had never heard of their explorations—never knew that the new world had been discovered or that a ship had sailed clear 'round the earth.

The language of modern science

Today we run the danger that because our school children are unable to "read" the language of modern science, they too will miss knowing about the great explorations of this generation—the intellectual examination of the frontiers of space. It is true that some day people may travel out into space beyond the earth. But such excursions will be limited indeed. We could conceivably reach the moon in one day of travel at 10 times the speed of sound. We could reach Mars in 6 months. But to come into the vicinity of even the nearest star would require 100,000 years. Even at 100 times the speed of sound it would take 10,000 years. Hence, the only experience that human beings will have with the far reaches of space will be through the messages brought by light and radio waves. And even these, the fastest of all messengers, have been on the way for millions or billions of years.

So let us make it possible for our new generation to have the fun of understanding these marvelous adventure stories. Just a little familiarity with mathematics and science will help a lot.

The adventures of science are by no means confined to outer space. And the chief practical reason for learning the language of science may not be to understand about distant galaxies, but to understand what is going on right here on earth. There are adventures in each day's routine.

You arise in the morning to the ring of an alarm clock—an electric clock, no doubt, synchronized within seconds to millions of other clocks all over the country, all over the world. Synchronization is achieved by the miracle of alternating current in our power lines, connected in a network extending hundreds of miles, and connected by radio to other networks far away. Adventures? Just follow those alternating current impulses back along the wires to a transformer on a pole in the street, to higher voltage lines leading to a substation, to still higher voltage lines strung across the countryside to a power station by a dam in the mountains.

Or maybe the power station burns coal or oil—where man's most primitive discovery, fire, is producing his most modern carrier of energy, electricity. Think of the inventors, engineers, scientists—back through the generations, the centuries—who made that possible. Think of Michael Faraday in a little laboratory thrusting a magnet into a coil of wire and noting that a current was produced; pulling it out, the current was reversed—an alternating current!

A day's adventure

And so, even before we awake in the morning of each day, our adventure has begun. We get out of bed, put on nylon hose, a dacron shirt or an orlon sweater —fabrics made of coal and air and water. Shades of the alchemists who tried to make gold from lead! They would have been far better off if they had made nylon from air! And as you dress be glad you are not a silk producer of Japan or a wool grower of Australia whose very livelihood is being threatened by synthetic fibers made in America. Yes, adventures in science have their tragedies too.

Your breakfast is another kind of adventure—food brought to you from the far corners of the earth, prepared over a flame which burns gas piped from Texas. And as you eat you read of world events only a few hours old—long stories, and even pictures, which have been flashed with the speed of light from London, or Calcutta, or Cairo. Only a few years ago—less than 100—a famous British physicist, Lord Kelvin, slaved away years of his life supervising the laying of a cable across the Atlantic through which feeble electric impulses (dot-dash-dot) could be pushed—slowly, but thousands of times speedier than the fastest ship.

After breakfast you step then into a real miracle—your car. You seldom look under the hood to witness the bewildering array of examples of the laws of thermodynamics, of mechanics, of electricity, of metallurgy—of almost every science and technology. All we care is that this device converts a gallon of gasoline into many miles of travel—at speeds much faster than we ought to drive.

As your day passes, you will skirt the edge of many adventures: a jet plane will streak above you; you will read that Congress is arguing about guided missiles, about satellites which leave the earth, and you wonder if the Congressmen know what they are talking about.

You read that a group of scientists visited Russia—and that they found themselves in full agreement with the Russian physicists on the neutron capture cross-sections of nuclei and also on the best design of a synchrotron. You were not interested of course—but you should have been. It was another example of the fact that adventures in science are international. All countries agree on the laws of physics. We may fight over the writings of Karl Marx—but not over those of Isaac Newton or Albert Einstein. Not even in a dictatorship is it possible to suppress for long the findings of science. A fake genetics promulgated by a certain Lysenko was given official state sanction in Russia for a time. But Lysenkoism is now dead; politics cannot for long suppress the facts of nature. We have tried it here too. We thought that nuclear physics could be kept secret; we forgot that scientists in other countries can ask questions of nature too—and get the same answers that we do. We also learned that secrecy in science is very expensive, for secrecy impedes the advance of science and also the advance of technology.

But your day's adventures have only begun. You drive past a TB sanitorium that is being closed—for lack of business. You pass a hospital where once fatal illnesses are cured in a few days. You may see some youngsters getting polio shots and know that another dread disease is on its way to extinction.

Inside a living cell

If the adventures in the stars or the atomic nuclei do not interest you, what about adventures inside a living cell? In recent years giant strides have been made in unraveling the chemistry of living things. The structure of protein molecules has been worked out. And now it is found that viruses, too, are complex molecules built in the form of multiple helices. These virus molecules can be crystallized and kept on a shelf for years, like any other chemical. But when they are given a chance to enter a living cell, they begin the miraculous process of sorting out the substances in that cell and building up a new molecule just like themselves. These molecules can reproduce themselves; they possess one of the essential features of living things.

The properties and behaviors of viruses can be studied now with all the modern techniques of physics and chemistry—not solely by trial and error, but by systematic analytical methods. One by one the different harmful viruses will be isolated, bred and studied until methods of destroying or controlling them are evolved. Beneficial viruses—those that kill harmful bacteria—will also be studied and used in the control of other diseases. The days of bacterial and virus diseases are numbered. It may be years and there will be some exhausting struggles, but these elementary substances now can be understood and controlled.

These then are a few of the thrilling adventures of today's science: the understanding of genes and nuclei and stars; the unraveling of the laws of atomic physics and cosmology and chemical biology. There are also adventures in the application of this understanding to new things to make people healthier, more comfortable, and to improve their way of life.

These adventures are daily getting more exciting. And they are adventures that more and more people will eventually participate in. The fraction of the United States working force engaged professionally in scientific and engineering pursuits has multiplied by 5 in the past 50 years. It can't multiply by 5 again else it would be getting up to 100 percent. But it may well double. The need is great and the opportunities are endless. The great challenge of our school system is to help every child with potential talents to develop them to the utmost.

The enjoyment of science

But men and women without professional interests in science may still enjoy these adventures of science. The language of the atom can be learned. After all, people enjoy music who do not perform. People enjoy literature who do not write. People enjoy adventure stories who cannot walk. Lawyers and businessmen and English teachers have learned to enjoy science.

For the exciting adventures of science have a great immediacy. From morning alarm to evening TV program we are living in a world which has resulted from adventures in science. Just as the great adventure of Columbus opened a new continent, so the inspired adventures of many scientists—from Galileo to Einstein; from Newton to Bohr; from Faraday to Edison to the thousands of trained men and women working today in laboratories throughout the world—have created on this new continent a new kind of civilization. There are certain things about this civilization that we are not satisfied with. It is far from perfect. But the defects will be fixed by those who understand the nature of the world in which we live. The world will be made better by knowledge, not by ignorance.

But the adventures in science are not only fun; they are an essential part of our everyday intelligent living. I have referred to Congressmen who vote on vast technical projects which they cannot possibly understand. But men and women in everyday life, in business, in law, in politics, are experiencing and making decisions on things which they too cannot understand. We spent strenuous efforts in this country to reduce illiteracy, to make it possible for every man, woman and child to read and write. We succeeded—but we face a new type of illiteracy today in which citizens are unable to read and understand the things about which they must make decisions, all the way from spending billions on nuclear energy to investing a few thousand dollars in a new chemical company; decisions as to what to do about smog; about putting fluorine in drinking water; about paying higher salaries to teachers of science. The ability to understand the adventures in science has a real practical value in addition.

But there are certain illusions about science and mathematics that must be eliminated before the adventures of science can be appreciated and advanced more rapidly in America.

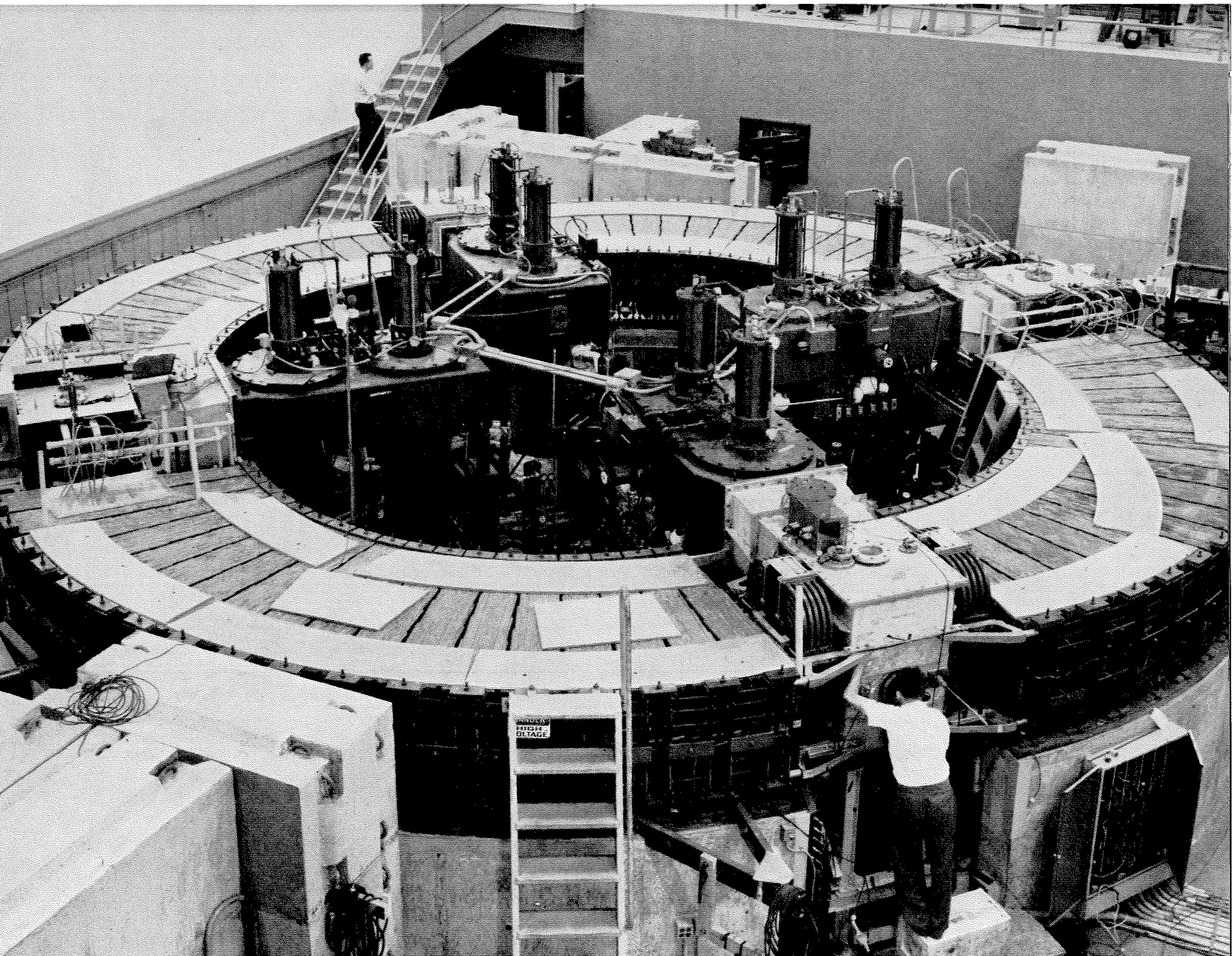
The first illusion is that mathematics is too hard for young minds to grasp. That is false. Properly presented and properly taught mathematics is an exciting adventure—especially for youngsters. What has made it seem hard is the endless procession of dull and useless problems which are normally taught—"How many square rods in 19½ acres?" or "If A has 3 apples and B has twice as many as A and C together . . . ?"—you know the kind. Why crush the glorious excitement of the great principles of algebra, geometry, trigonometry—yes, and calculus—with an avalanche of useless detail? I suggest that to prepare a really first-class series of 7th- to 12th-grade texts on mathematics that really arrest a youngster's imagination, challenge his curiosity, and develop his quantitative reasoning, would be the greatest project that a teachers' group could undertake.

The second illusion that must be eliminated is that mathematics can be taught by teachers who don't know any math—or are only a chapter ahead of the student. As long as teachers of math must take 16 hours of education and only 3 hours of math, mathematics will be badly taught. For it is a subject which becomes really alive only with years of study and can be conveyed in simple and exciting ways to students only by those who have themselves caught its true spirit. In this respect, it is like most other subjects of real intellectual content—it will certainly be taught badly by those who know nothing about it, no matter how much methodology they have learned.

A liberal education

A third illusion that needs crushing is that mathematics and science are narrow, technical or vocational subjects and that only humanities and social science are "liberal" and "broadening" and teach one how to get along with human beings. Nonsense! Mathematics and science are great intellectual adventures that have enlarged and broadened men's intellectual horizons, freed the human spirit from ignorance and fear, and elevated him above a primitive existence. They are a proper part of every liberal education. And if our country is to continue to make progress in evolving the material tools necessary to insure attaining the economic, political and moral goals which we seek, then we as a nation had better re-examine the adequacy of our school curricula in preparing young people to talk the language and understand the problems of *tomorrow*.

For if we are cheating our children of the opportunity of enjoying the adventures in science, we are also cheating our country of the benefits of profiting and prospering from the talents of its people.



MORE POWER TO THE SYNCHROTRON

Newly-modified Caltech synchrotron is now the most powerful machine of its type in existence

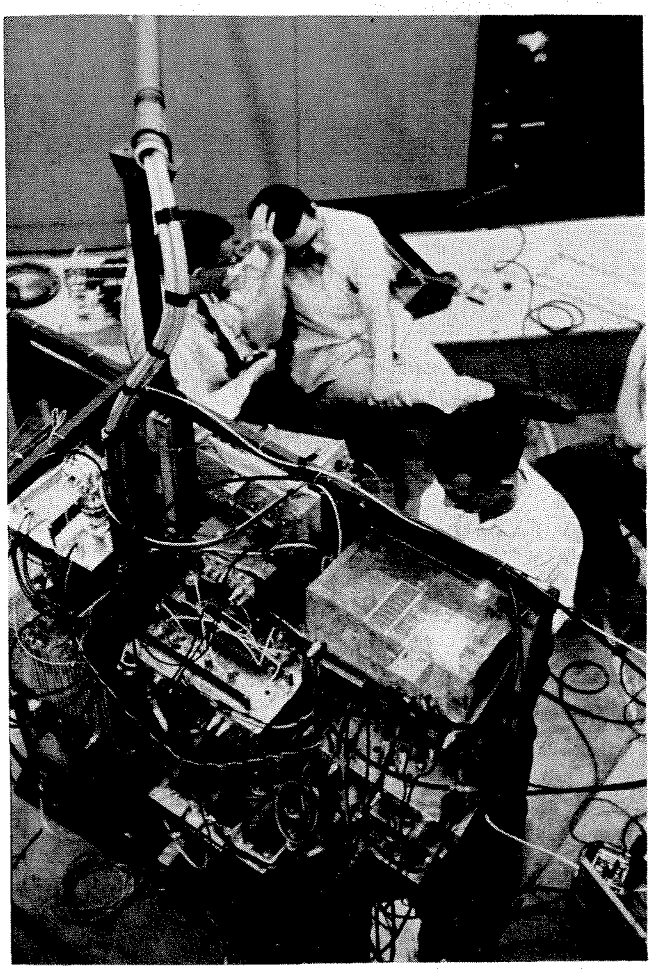
MODIFICATIONS in the Caltech synchrotron, made over a period of two years, have now brought the machine up to such high energy levels that researchers should be able to produce and examine some of the most fundamental particles in nature. The machine, which is now the most powerful of its type in existence, can accelerate electrons to energies of over a billion electron volts, and to speeds never before reached by any man-accelerated particles.

The original synchrotron principle was developed by two men, independently, in 1945—a Caltech alumnus and Nobel prizewinner, Edwin M. McMillan, now at the University of California in Berkeley; and a Russian physicist, V. Veksler. The Caltech synchrotron, installed in 1951, under contract with the Atomic Energy Commission, is of the "race-track" type first suggested by another Caltech alumnus, H. R. Crane of the University of Michigan.

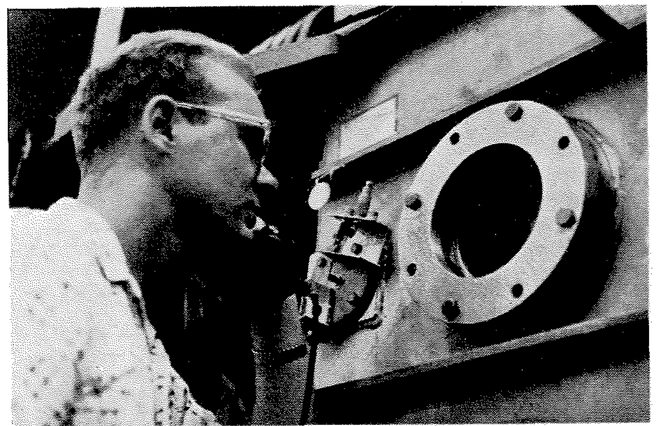
The synchrotron is essentially a machine for the production of X-ray beams of great energy. It does this by directing accelerated electrons against a metal plate or "radiator." The collision generates high-energy X-rays and these, in turn, are used to bombard the nuclei of atoms.

For many years it was believed that the structure of the atom was fairly simple—a nucleus composed of one or more protons and neutrons and, revolving around the nucleus, one or more electrons. But the exploration of atomic nuclei in the past two decades has revealed upwards of 20 other "strange particles" such as mesons, heavy mesons, hyperons, anti-protons and anti-neutrons. The nature of these sub-atomic complexes and of the tremendous forces locking them together presents one of the most formidable mysteries of modern physics.

During the first phase of its operation, over a period of three years, the Caltech synchrotron operated at an energy level of 500 million electron volts, and succeeded in producing relatively lightweight mesons from the bombardment of hydrogen and deuterium atoms. Careful measurements showed that the production of mesons was increased greatly as X-ray energies increased, but



Drs. Langmuir, Teem and Clegg tackle the problem of tuning up the radio frequency acceleration system.



Dr. Vincent Peterson watches electrons hit a fluorescent screen through a window in the machine.

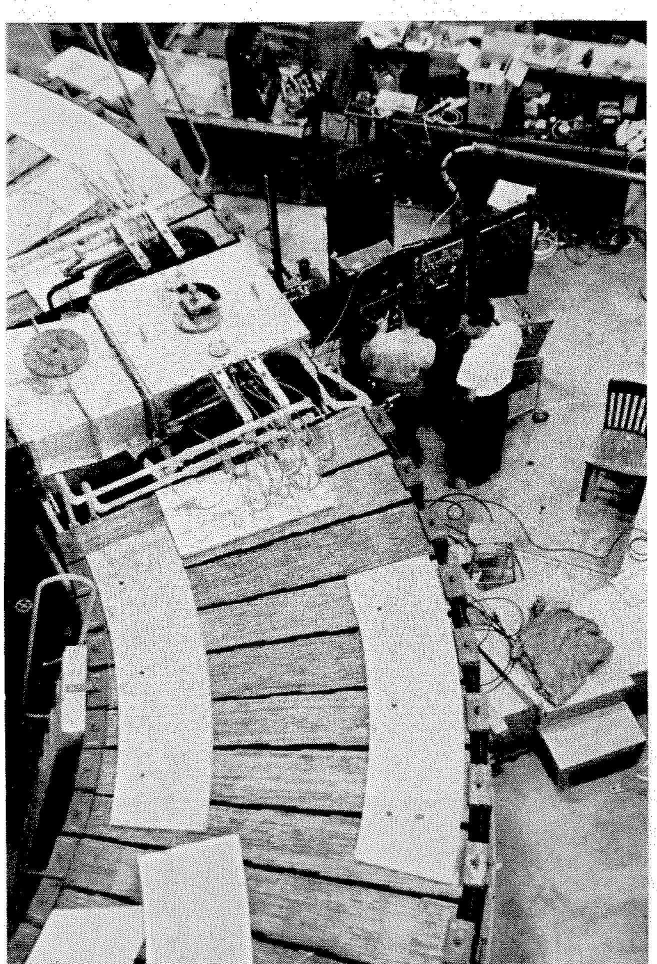
that beyond a certain energy level (about 300 million electron volts) the production of mesons fell off sharply. This enhanced response at a particular energy level is known as "resonance"—analogous to the resonant frequency of a piano string. It means that there is an excited state, or state of preferred energy, in which the proton-meson system exists. Investigation of the properties of this state gives physicists further insight into the nature of forces operating between protons and mesons and brings them a step closer to an understanding of the atomic nucleus.

Now, with much higher energies available, it will be interesting to see whether the synchrotron can produce other particles, such as heavy mesons and hyperons. They have been produced elsewhere as the by-products of proton-proton collisions, but it is not known whether high-energy X-rays can tear them out of the atomic core. If they can, it will be by a quite different production system. And it may be that the characteristics of this new system will shed more light on our understanding of nuclear forces.

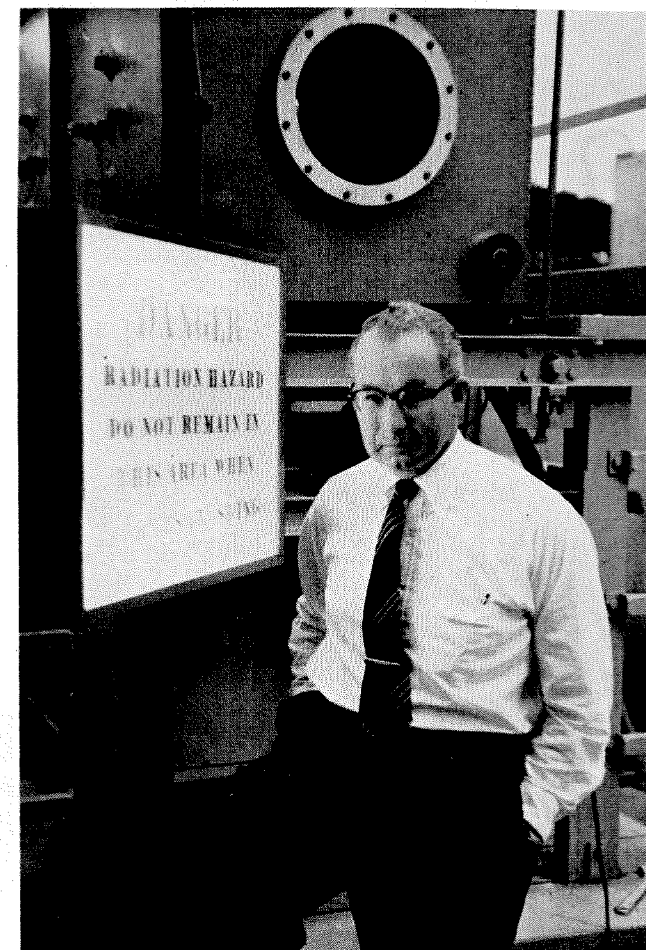
Research with the synchrotron begins when an "electron gun" driven by a million-volt pulse transformer shoots bursts of several billion electrons into a tube where they are accelerated to approximately 94 percent of the speed of light, then bent through 90 degrees to enter a tunnel-like vacuum chamber. This chamber, evacuated to within a few billionths of an atmosphere, runs around the inside of the 140-ton electromagnet which is the main body of the synchrotron. The chamber provides the path along which the electrons travel. The vacuum serves to minimize air resistance to them. The electromagnet holds them to their path.

The magnet is divided into four quadrants separated by five-foot straight sections. Each of these sections houses a unit of the vacuum pumping system, and two of them also house radio frequency cavities, or booster units.

Each time the electrons circle the chamber, they get a 600-volt kick from the first radio frequency cavity. As they are accelerated—and in accordance with Einstein's relativity principle—they gain mass, actually at a billion



View of magnet which bends particles into circular orbit. Radio frequency cavity is inside rectangular box.



Dr. Robert F. Bacher, chairman of the Physics Division, and director of the synchrotron project.

volts becoming heavier than protons. (Normally, the electron's mass is only 1/1840 that of the proton.) However, during acceleration, the electrons lose a certain amount of energy by radiating light. In order to make up for the lost energy, the electrons require greater energy boosts, and these, steadily increasing up to more than 50,000 volts per rotation, are provided by the second radio frequency cavity.

Meanwhile, to keep the electrons from flying out of their orbits, the strength of the magnetic force holding them must be steadily increased. This increasing force is produced by a current that rises from zero at the moment of electron injection to 3,000 amperes a quarter of a second later, and then falls back to zero in preparation for the next cycle. The power for the electromagnet is drawn from a large motor generator set, and when the synchrotron is in use, each burst of electrons is accompanied by a heavy pulsing sound occurring at almost exactly the same rate as that of the normal human heartbeat.

Before reaching their peak energy, the electrons travel around the vacuum chamber two million times, receiving a total of two million boosts and covering a distance of 37,000 miles. All this takes time—in fact, one-fifth of a second. At peak energy, the radio frequency cavity is turned off, the electrons leave their orbits and, at a "muzzle-velocity" within about one ten-millionth of the speed of light, strike a small piece of a heavy metal, tantalum. It is this collision that produces the 1.2 billion volt X-rays. The X-rays, directed at such targets as liquid hydrogen and liquid deuterium, produce sub-atomic particles such as mesons.

What happens during these secondary collisions is instantly registered either on photographic plates or on scintillation counters that produce electrical signals corresponding to the sizes, courses and decay modes of the particles.

In particular, researchers will try to find out what particles are created when nuclei are bombarded with the increased power of these very high energy X-rays.

Members of the synchrotron team are: Dr. Robert F. Bacher, chairman of Caltech's Physics Division; Dr. Arthur B. Clegg, research fellow in physics; Dr. Robert V. Langmuir, associate professor of electrical engineering; Dr. Vincent Z. Peterson, senior research fellow in physics; Bruce Rule, chief engineer; Dr. Matthew L. Sands, associate professor of physics; Dr. John G. Teasdale, senior research fellow in physics; Dr. John M. Teem, senior research fellow in physics; Dr. Alvin V. Tollestrup, assistant professor of physics; Dr. Robert L. Walker, associate professor of physics; and a number of graduate students.

Murray Gell-Mann, Caltech professor of theoretical physics, is—at 27—one of the country's outstanding young physicists. His special field is the theory of atomic nuclei.

AN AMERICAN PHYSICIST IN MOSCOW

I WAS ONE of a group of about a dozen Americans invited to a conference on high-energy physics held in Moscow last May. The field we discussed there is a branch of nuclear physics. In the last ten years there have been applications of nuclear physics to technology —the so-called peaceful uses of atomic energy—and there have been applications to war. But there remains a field of research which is pure nuclear physics—just the efforts of scientists all over the world to try to find out something about the structure of the atomic nucleus. And it is this field of physics that we discussed at the conference in Moscow.

Specifically, we discussed a particular part of nuclear physics which is not the study of nuclei at rest, but the study of what happens to nuclei and their constituents when they collide at very high energies, producing new particles which are never seen otherwise. After a small fraction of a second these particles decay into electrons and light and such things. Such transformation processes of nuclear particles are, for the most part, what we discussed under the name of high-energy nuclear physics.

The sort of nuclear physics that has been applied to the making of bombs and the making of piles for electric power is entirely low-energy nuclear physics. The

A Caltech physicist attends an international conference in Moscow, and brings back an informal—and surprising—report on Soviet scientists and how they work.

A transcript of an extemporaneous talk

by MURRAY GELL-MANN

high energy field is so far without practical application.

At the Geneva Conference last year, Western and Soviet scientists had already discussed the applications of nuclear physics to atomic energy. From the point of veiw of secrecy, our conference was very much in the nature of an anti-climax since we were talking about pure physics. From another point of view, though, our conference was more interesting because we were visiting the Russians at home. We were meeting their families and seeing how they lived—we were talking to them over long periods of time. And they must have felt much more at ease at home than they did when they were travelling abroad.

The sixty foreigners who came to the conference were from the West and the East. There was our delegation of about a dozen from the United States, including five from California. There were some five or six from England, a few from France, and a couple from Italy. There were two reasonably good physicists from China, and there was a very famous one from Poland. There were a number of people from other countries—one from Roumania, one from Hungary, a couple from the "Korean People's Democratic Republic" and so on.

At the beginning, the Soviets practiced segregation in housing us. The Westerners were put in the Moscow, an old hotel in the center of town, literally a stone's throw from the Kremlin. The People's Democrats went into one of the new skyscraper buildings on the outskirts of the city. There were so many complaints from both sides about the fact that we were segregated that, after a week or so, the People's Democrats were moved in with us. We got along very well, all of us; we talked about physics, and we talked about touchier subjects too.

The official sessions lasted about ten days and were held at the various institute and university buildings in and near Moscow. After the first one, I didn't go back very much to these sessions. The principal purpose of the conference was to present Soviet work to the Westerners, rather than the other way around. The speeches were given in Russian by Russian experimental physicists talking about their work, and simultaneous translations came to us through earphones. This system, so successful at the UN, was less so here, because the translators were not physicists, and, although the Russians were clearly talking about physics, the translators were not. You don't have to know very much about science to know that it would create some difficulty when the speaker said, "We then applied perturbation theory, neglecting terms of higher order;" and the translator said, "We made use of the method of disturbances, ignoring members of higher rank." So if you wanted to listen you had to perform second translations in your head, and that wasn't very convenient.

What I did most of the time was to try to engage in informal discussions with small groups of Soviet physicists, discussing various parts of the frontier of physics and comparing their work with ours in particular fields.

I expected to see a great many women scientists at the sessions, because I had been told that women comprised over half the medical profession, and I thought that in physics too, perhaps, something like that was the case. But there were only a few in the audience—about the same number that would be found in a corresponding meeting in America.

Another thing that I had expected was a great deal of formality—a sort of "Herr Professor" attitude among the Soviet physicists. But when the meeting began I realized that there really wasn't very much formality. Before five minutes had elapsed the Soviet scientists were on their feet, screaming at one another and arguing desperately. In general, there was a great deal of emotion and a great deal of heat generated as well as lots of light. So I find that the Soviet scientists are at least as informal as our American ones—perhaps more so.

Soviet research in physics is not run in any unified way. Although it is just about all financed by the National Academy of Science, which is a branch of the government, it is handled by many autonomous organizations and research institutes of the Academy. Aside from Moscow State University, the most important research is undertaken at these institutes. There are a great many of them, and, in or near Moscow, there must be about a dozen which are wholly or partially devoted to high-energy physics. These institutes cooperate with one another but they are also rivals, like the various universities in this country.

Soviet scientists are doing very good work. In almost all of the field of high-energy physics, their work was pretty much parallel to that going on in the United States and other countries. There is, however, one particular branch which we might call ultra-high-energy physics, or the physics of new unstable particles, in which there has been very little work in the Soviet Union. This is the physics of collisions at *extremely* high energies in which new kinds of particles—the so-called strange particles—are produced. These are investigated in one of two ways—by using cosmic radiation, which contains high-energy nuclear particles, or by generating high-energy nuclear particles in accelerating machines such as the Bevatron at Berkeley.

Bigger than the Bevatron

The Soviets have done very little with either of these methods. So this subject, which has been under investigation in the West for three to five years, is just in its infancy in the Soviet Union. However, they are now building a machine which will be bigger than the Berkeley Bevatron. It should be ready in about a year, and at that time they will presumably jump with all four feet into ultra-high-energy physics. They will, of course, be two or three years behind the Berkeley people, and they will have to start from scratch, but presumably after a little while they will be doing equally important work.

It is a little bit strange to find the Soviet Union, supposedly such a practical country, pouring so much money into a very abstract field. We asked one of their principal theoretical physicists how they got all this money from the government and he said, "Well, we just say to them, 'Look at the Americans'." It seems that, whereas we tell our government about the numbers of mathematicians and physicists and engineers that are being graduated by the Soviet universities—a figure which is in excess of the corresponding figure for the United States, possibly about double—they tell their government about our fundamental researches in pure science. And they apparently point out that scientists become discouraged if they can't do the most important frontier work in science, that they won't have the highest quality scientists if they can't train them by working on the most advanced and the most spectacular problems. And so they apparently get unlimited funds.

We took a trip to see the great new Russian accelerator that will be ready next year, and also their medium-energy accelerator which has been running for about seven years now. These are located in a new village, which was built for the purpose, about 70 miles from Moscow, on the Volga. The town is called Bolshaya Volga—the great Volga. The two laboratories there, each containing its gigantic accelerating machine, have just been donated by the Soviet Government to an international organization which consists of countries whose names you can guess—the Soviet Union, Poland, Bulgaria, Roumania, the "Korean People's Democratic Republic" and so forth. These are member countries. However, citizens from other countries will apparently be invited to come and visit and spend a year or more working at these laboratories. American physicists are to be invited too. Whether they will accept and whether the invitations will actually go through, no one can say at the moment.

The wrong side of the fence

It was an all-day trip that we took; we spent the morning looking at the existing accelerator, a large part of the afternoon (until most of us despaired of ever getting any lunch) looking over the other one. As we were walking around the grounds of the second accelerator, one of our physicists from Columbia was talking with Danysz, the Polish discoverer of the hyperfragments, and he said to Danysz, "Look, I see barbed wire over there and behind the barbed wire some people in fatigue clothes; don't you see them?" And Danysz looked over and said, "Yes, what about them?" And my friend said, "Well, they are digging trenches and throwing earth up into those trucks; who do you suppose they are—slave laborers?" Danysz looked at him for a little while, looked at the people, and looked at the fence. Then he said, "What you are faced with is a problem in topology; those people are *outside* the fence." Which was true. We were *inside*. The laboratories were enclosed in barbed wire and apparently had been top secret until just before our visit. We were the first Westerners to be shown them.

The contain, of course, the kind of equipment which, in the United States, has been pretty much open to the public ever since it was built. Physics of this sort—high-energy physics—has never been classified anywhere in the world except Russia. Some of the attitude of suspicion, naturally, still hangs over these installations. When I got tired walking around all the machines and looking at all the equipment and listening to the "Oohs" and "Ahs" of the American experimental physicists, I went out in back to look at birds. Bird-watching is a hobby of mine. After a minute I saw a woodpecker sitting on top of a pile of wood behind the Accelerator Building, and I was staring at it, fascinated, because I had never seen a wryneck before, when the driver of our bus came running up and said (in Russian, which I had difficulty understanding), "No, no, no, you mustn't stay out here; you mustn't look over in that direction; you must go back in there and look at that atomic machinery."

So I went back in, and I found our American physicists staring rather open-mouthed at the accelerators. They are, of course, very much like ours; they were invented almost simultaneously in Russia and the United States. But what our physicists marveled at was the lavishness of the accelerators. They had apparently been built without any regard for money at all. The equipment was the best that one could get, no matter how expensive or difficult the method of manufacture. Luis Alvarez of Berkeley said that it reminded him of Los Alamos during the war where the motto was, "Why use lead when gold will do?"

Princely salaries

These people not only have money for their equipment but they also have lots of money for themselves. The scientists are among the best paid people in the whole country. The ruble, in which they are paid, costs the tourist a quarter. However, it is not worth a quarter; from what we could tell, it is worth more like ten cents. A professor of physics will make several salaries. He will be a professor at one of the institutes of the Academy of Science where he does his research. That will net him 6,000 rubles per month. He will be, at the same time, half a professor at the university, which means that he will teach a course there perhaps for half a year. He will get half a salary for this too, which is 3,000 more. Besides that he is likely to be an Academician, a member of the National Academy, and that honor carries with it a salary of 5,000 rubles per month for life. Such a man, then, will make 14,000 rubles a month, or $1,400. That is, even by American standards, quite a decent salary. In the Soviet Union, although there isn't very much to buy, it is, of course, a princely salary. But the thing that strikes one particularly is the contrast with the salaries of other people. A maintenance employee—a janitor or gardener—at the same Institute may be making 400 rubles a month, a ratio of something like 30 to 1. In the United States, the ratio would be perhaps 3 to 1.

Political pressure

Although Soviet scientists live very well they have been subject, at least until the recent change of regimes, to a considerable amount of political pressure. One of their very greatest physicists was under house arrest for almost eight years as a result of a fight he had with Beria. He was released only about a year ago. He had managed to do some work at his country estate during his long confinement. His son, who was also a physicist, brought him out some equipment and some books and he was able to do a little work, but it was on some rather unusual things; for example, he worked on the "Kugelblitz." This is a phenomenon which may or may not exist—spherical lightning. These balls of lightning, which have been seen by various people—often peasants—are supposed to come rolling down the chimney and go spinning around on the hearth rug. It is uncertain whether they exist at all, of course; they are somewhat in the same category as flying saucers.

However, the physicist wrote an excellent scientific paper showing how, if these things *do* exist, they might be explained by certain physical principles. It was an extremely ingenious piece of work—but the great man could certainly have been better employed during these 7 or 8 years. He is the director of one of the biggest institutes near Moscow, and he is back in his office now. His salary is 32,000 rubles a month and he has a Zis limousine with a chauffeur who is supposed to be the best driver in Moscow, and he has a fine town house and a country estate, and so on.

Other physicists didn't receive promotions which were obviously due to them, because of the political and even racial prejudices which were prevalent under the Stalin regime. There were political arrests and there was a feeling of uneasiness among the scientists. A lot of this seems to be changed.

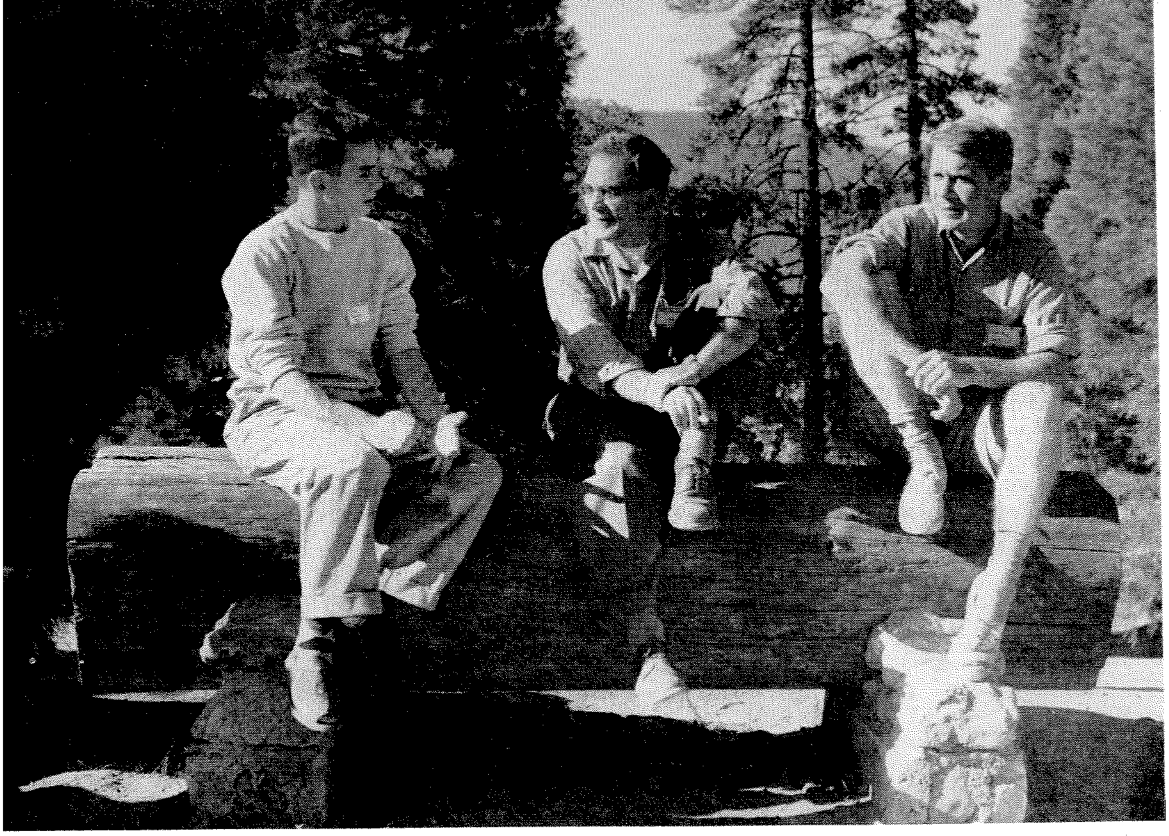
Laughing at Stalin

Many of the people we met expressed a considerable amount of relief at the change of government, and they seemed happy that they were now free to laugh a little at the Stalin myth. And they do laugh at it. For example, in the home of one scientist—in the bathroom, where, let's say in rural America one might expect to find a Sears Roebuck catalog, one finds the *Official Biography of Stalin* and one tears out pages.

Pure physics, which was strangely classified until two years ago, is now declassified and the Russians have published their results and are now free to communicate with foreign scientists. Whether all of Russia's principal physicists will be able to visit foreign countries in the near future is another matter. Some of them are allowed to travel, but many of the important ones have not been allowed to do so. It will be interesting to see whether—in the next year or so—they will be able to accept the invitations they have received from the United States.

I expect that if things continue the way they have been going in the last year or two, the Soviet scientist will become an ordinary member of the world community of scientists, producing results which will be on the same level as ours, discussing them with us freely, and making trips—we hope—to the West, just as we were permitted to visit them. We should be delighted to have them, for they are very good scientists and very fine people.

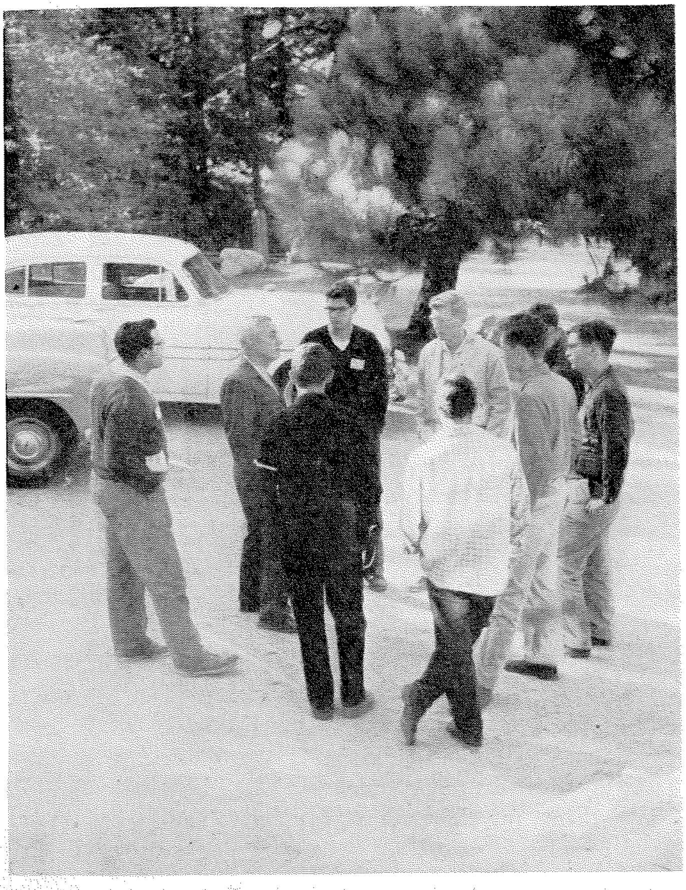
"An American Physicist in Moscow" is a transcript of a talk given at Town Hall in Los Angeles, on June 26, 1956



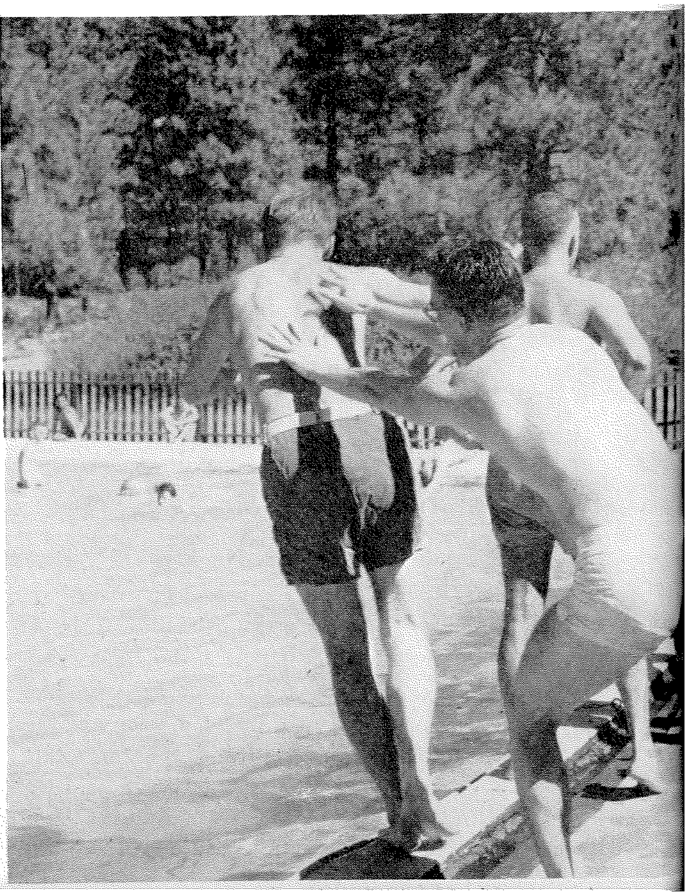
A freshman gets acquainted with Caltech's YMCA secretary Wes Hershey and history professor Peter Fay.

FRESHMAN CAMP

Caltech greets the class of 1960

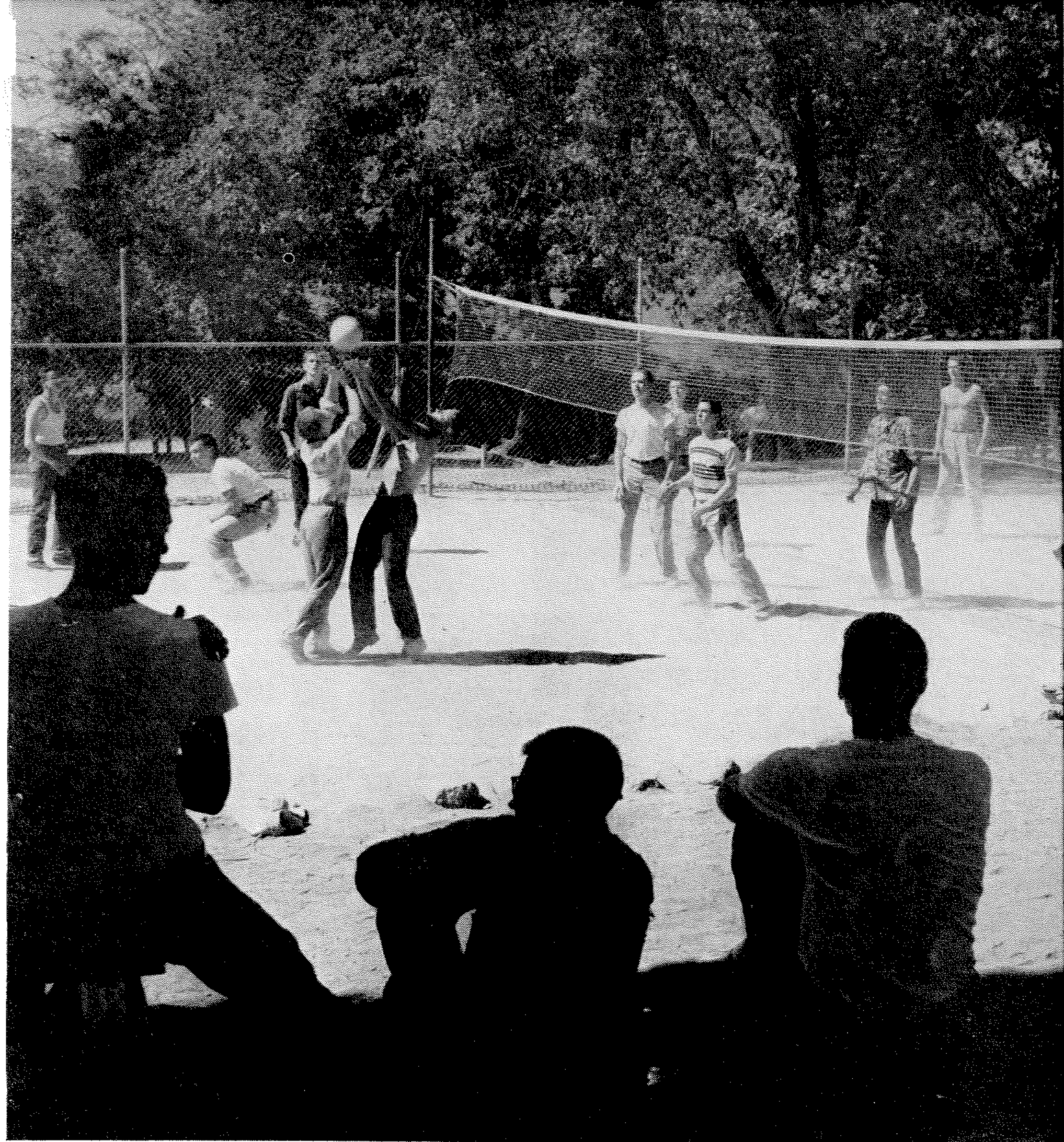


President DuBridge and questioning freshmen

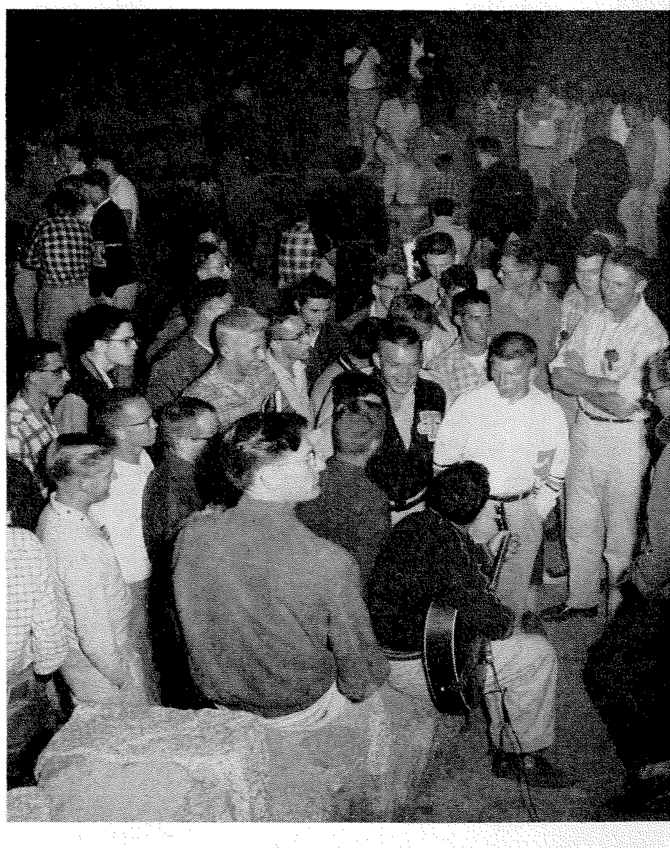


A timid camper takes the plunge

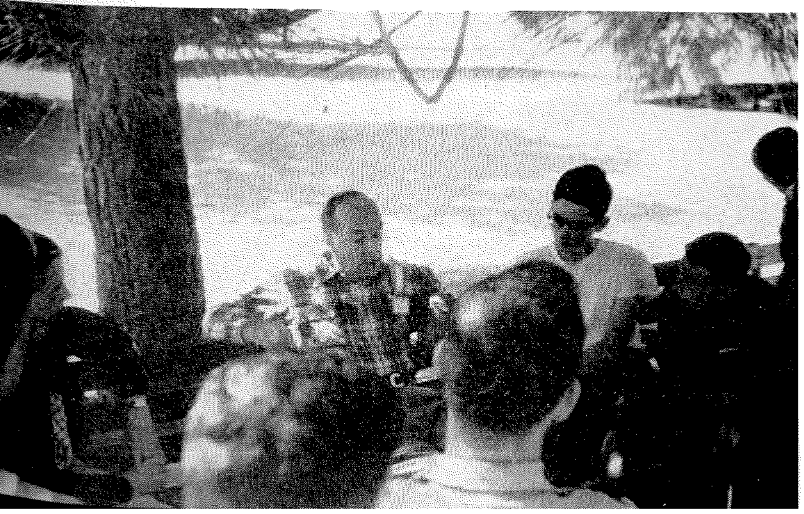
A vicious elimination tournament keeps the dust flying on the volleyball court from dawn to dark.



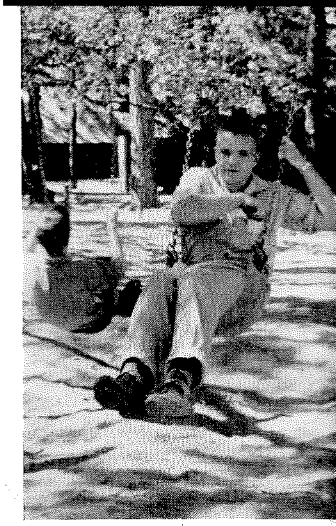
It's 11 p.m. and lights-out — but they know 23 more choruses.

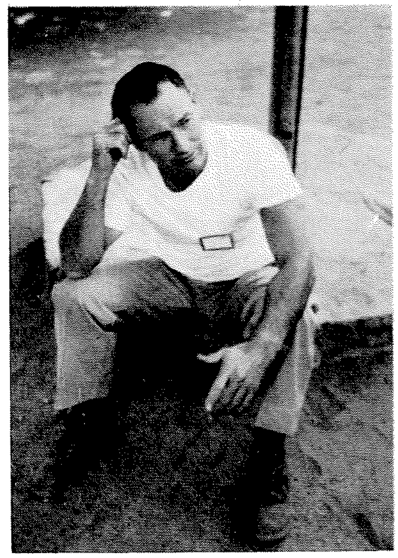


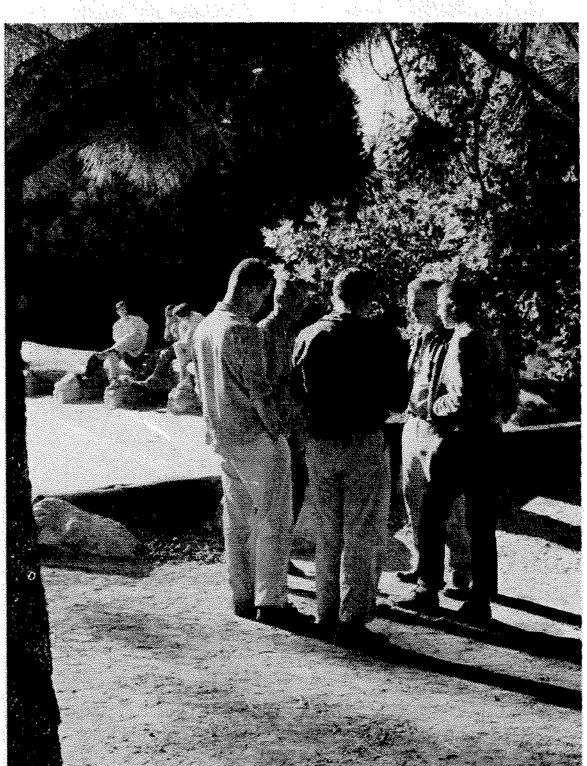
Foster Strong, Freshman Dean, dispenses advice.

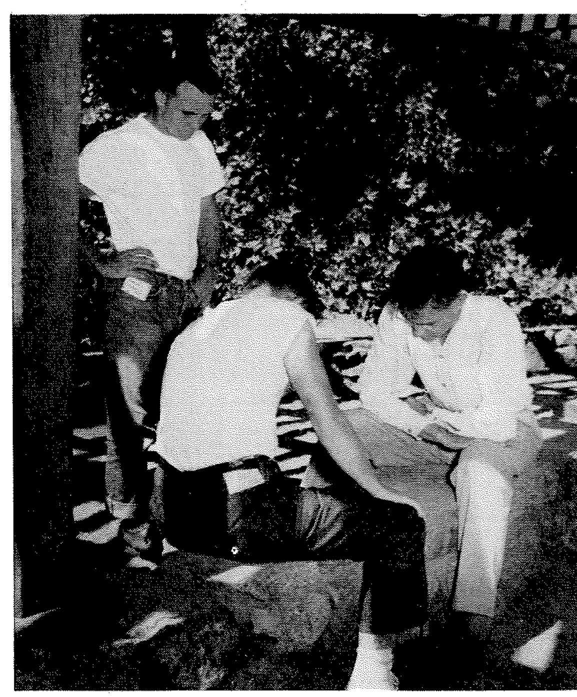


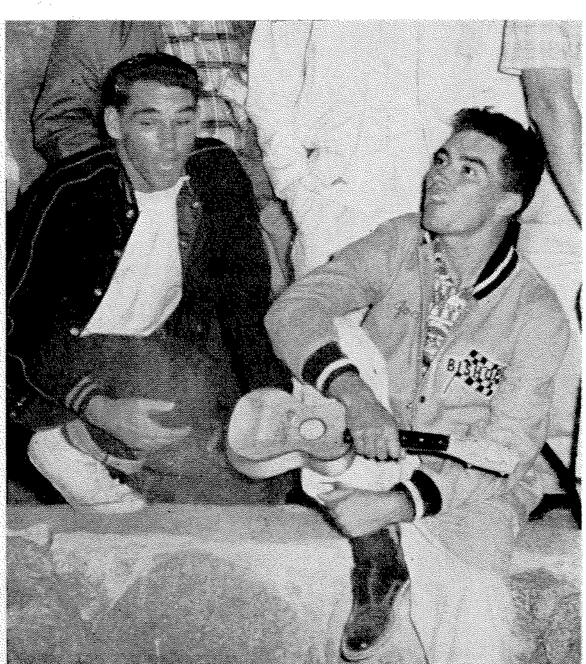
Random evidence that the camp has something for everybody

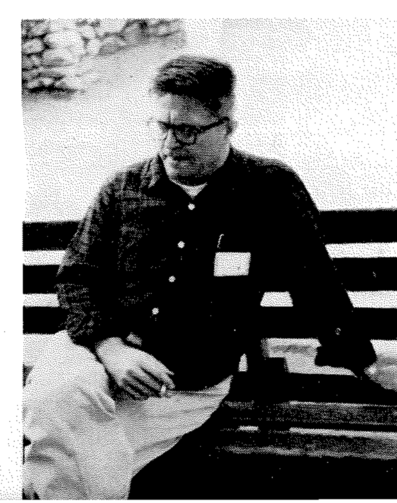


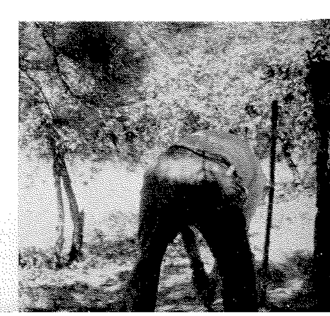












THE SUMMER AT CALTECH

Linus Pauling

Mental Disease

UNDER THE DIRECTION of Linus Pauling, chairman of the Division of Chemistry and Chemical Engineering, a team of scientists has now begun to explore the molecular chemistry of mental disease at the Institute. The research is being underwritten by a five-year $450,000 grant from the Ford Foundation.

The basis for the new program, according to Dr. Pauling, is "the probability that many cases of mental deficiency—perhaps most of them—are the result of gene-controlled mental abnormalities. We believe that significant progress can be made in the attack on mental disease by a program of fundamental research employing the most powerful techniques of modern chemistry in an effort to understand the causes and workings of certain abnormal molecules."

In 1949 Dr. Pauling and his associates traced the cause of the hereditary disease sickle-cell anemia back to its basic chemical cause—a defective molecule in the blood.

"Our major emphasis will be on basic research," says Dr. Pauling, "but we hope to develop ideas that will provide the basis of clinical research on the medical problem of mental retardation."

Richard Morgan, of the California State Department of Mental Hygiene, has pointed out that the cost of this research program would be repaid if it were to lead to discoveries that would reduce by only 50 the number of hospital beds (now about 200,000) that are used for mentally retarded patients in the United States.

Graduate Dean

WILLIAM N. LACEY, professor of chemical engineering, who has been dean of graduate studies at Caltech for the past ten years, asked to be relieved of his administrative post this summer in order to devote full time to teaching and research in chemical engineering.

H. F. Bohnenblust, professor of mathematics at Caltech for the past ten years, was therefore appointed new dean of graduate studies on July 1. Dr. Bohnenblust, a native of Switzerland, received his BS in 1928 at the Federal Institute of Technology in Zurich and his PhD at Princeton in 1931.

A graduate of Stanford University, Dr. Lacey joined the Caltech teaching staff in 1916 and became full professor of chemical engineering in 1931. He has won wide recognition for his investigations of the properties and behavior of hydrocarbons and has also exerted great influence on the teaching of chemical engineering, through an approach which emphasizes thorough grounding in physical chemistry and mathematics.

Faculty Changes

NEW MEMBERS of the Institute's staff of instruction and research for 1956-57 include:

Charles A. Barnes, senior research fellow in physics, from the University of British Columbia in Canada. He received his BA from McMaster University in 1943, his MA from the University of Toronto in 1944 and his PhD from Cambridge University in 1950.

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H. F. Bohnenblust, new dean of graduate studies

Arthur Code, associate professor of astronomy and staff member of the Mount Wilson and Palomar Observatories, from the University of Wisconsin, where he has been assistant professor of astronomy since 1953. Dr. Code received his MS in 1947 and his PhD in 1950 from the University of Chicago.

Captain Arthur S. Cooper, assistant professor of air science and tactics (ROTC), from the University of Southern California, where he received his BS in 1950. Captain Cooper has been assistant professor of air science at USC since 1953.

Howard M. Dintzis, assistant professor of chemistry, from the Cavendish Laboratory in England, where he has been on a National Science Foundation grant for the past year. Dr. Dintzis received his BS from UCLA in 1948 and his PhD from Harvard University in 1953.

Robert Finn, associate professor of mathematics, from USC, where he has been assistant professor of mathematics since 1954. Dr. Finn received his BS from Rensselaer Polytechnic Institute in 1943 and his PhD from Syracuse University in 1951.

Harold Fowler, visting professor of history, from William and Mary College, where he is a professor of history. Dr. Fowler received his AB from Dartmouth College in 1928, and his MA and PhD degrees from Harvard in 1930 and 1934 respectively.

Basil Gordon, instructor in mathematics, who received his PhD from Caltech in June.

Harold S. Johnston, associate professor of chemistry, from Stanford University, where he has been associate professor of chemistry since 1953. He received his PhD from Caltech in 1948.

Leite Lopes, senior research fellow in physics, from the University of Brazil, where he is professor of theoretical physics. Dr. Lopes, who is secretary for the International Conference for Peaceful Use of Atomic Energy, received his PhD at Princeton in 1946.

Harden N. McConnell, assistant professor of physics and chemistry, who received his PhD from Caltech in 1951. For the past four years he has been a chemist at the Shell Development Company in Emeryville, Calif.

Peter M. Miller, assistant director of admissions, from the Educational Testing Service in Princeton, New Jersey. Dr. Miller received his AB in 1934 and his PhD in 1939 from Princeton University.

Y. Miyake, visiting professor of geology, from the Meteorological Research Institute in Tokyo, where he has been chief of the geochemical laboratory since 1946. Dr. Miyake, who received his PhD from Tokyo University in 1940, is known for his extensive research on the effects of atomic explosions.

W. Barclay Ray, assistant professor of geology, who received his BS from Caltech in 1952 and his PhD this June. He began his new duties by taking charge of the summer geology camp in New Mexico.

The following promotions have been made in the Caltech faculty for 1956-57:

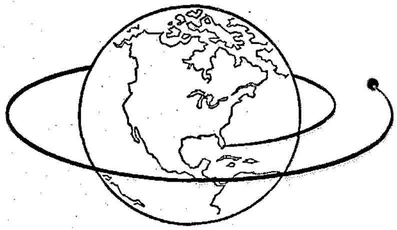
To Professor Emeritus:
Stuart J. Bates—Physical Chemistry
James E. Bell—Chemistry
Robert L. Daugherty—Mechanical Engineering
William W. Michael—Civil Engineering

To Professor:
Leverett Davis, Jr.—Theoretical Physics
Charles R. DePrima—Applied Mechanics
Murray Gell-Mann—Theoretical Physics
Edward B. Lewis—Biology
Jack E. McKee—Sanitary Engineering

To Research Associate:
Walter Schroeder—Chemistry
Jerome Vinograd—Chemistry

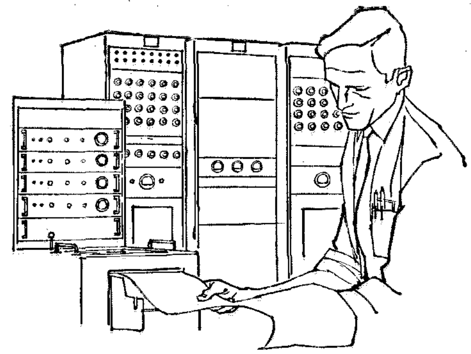
To Associate Professor:
Tom M. Apostol—Mathematics
F. S. Buffington—Mechanical Engineering
James C. Davies—Political Science
Paul Longwell—Chemical Engineering
Harold Lurie—Applied Mechanics
Henry Dan Piper—English

To Senior Research Fellow:
Harry Rubin—Biology
John M. Teem—Physics



Challenging new projects

The first man-made satellite to be launched by the U. S. in 1957 will be directed into its orbit by an ultrasensitive missile guidance system developed and manufactured by Honeywell. And that is just one of the exciting projects in progress at Honeywell. They include new instruments basic to automation, new firing control systems for national defense and new concepts in controls for heating and air conditioning offices, homes, buses, trains and ships.



The latest in scientific equipment

One of the largest installations of analog computers in private industry is an example of the kind of facilities and equipment available to Honeywell engineers. This installation has 250 computer amplifiers plus extensive nonlinear components and simulator tie-ins. Equipment like this enables our engineers to tackle confidently projects that are pushing back frontiers of physical science in fields that range from automation to the conquest of space.

Inside Honeywell

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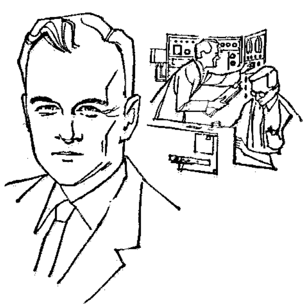

Outstanding associates

Dr. Finn Larsen, head of the Honeywell Research Center, directs an extremely capable staff of physical scientists in fundamental research projects dealing with semiconductors, solid state and magnetic and dielectric materials. Working with men like this in small groups at Honeywell gives you a tremendous backlog of experience to draw on for aid in developing your own ideas. It stimulates your own creativity, helps you realize your full potential.

Choice of location

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MINNEAPOLIS

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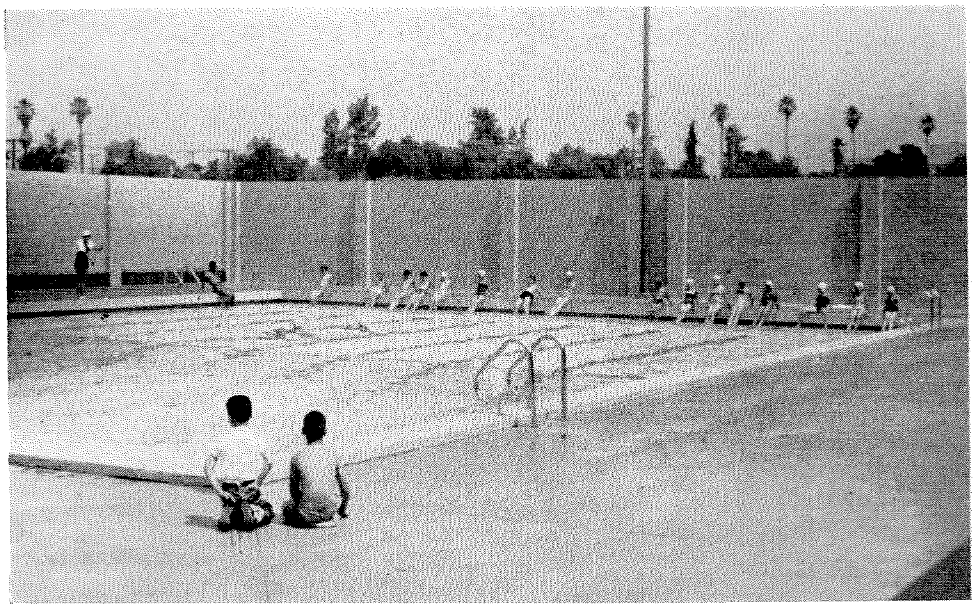
First in Controls



Summer swimming classes started at 9 every weekday morning; pupils started at about 2 years.

To Assistant Professor:

Donald E. Coles—Aeronautics
Roy W. Gould—Electrical Engineering
Frank L. Spitzer—Mathematics

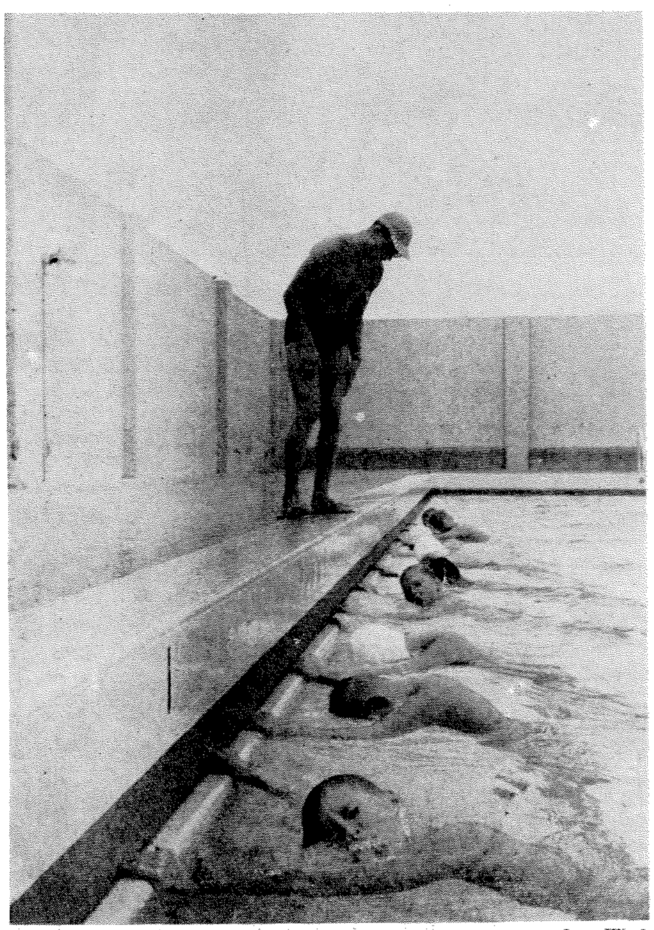
On Leave of Absence:

Julian D. Cole, associate professor of aeronautics and applied mechanics, in England for one year with the Office of Naval Research.

Norman Davidson, associate professor of chemistry, at Harvard University in Cambridge, Mass., as visiting professor of chemistry until June, 1957.

David Elliott, associate professor of history, for one year in England and on the continent, studying international relations on a Ford Foundation Fellowship.

Arthur Erdelyi, professor of mathematics, for one year as visiting professor of applied mathematics at the Hebrew University in Jerusalem.



Pool supervisor—and Caltech swimming coach—Web Emery worked with more than 250 dedicated summer pupils.

Summer in the Alumni Pool

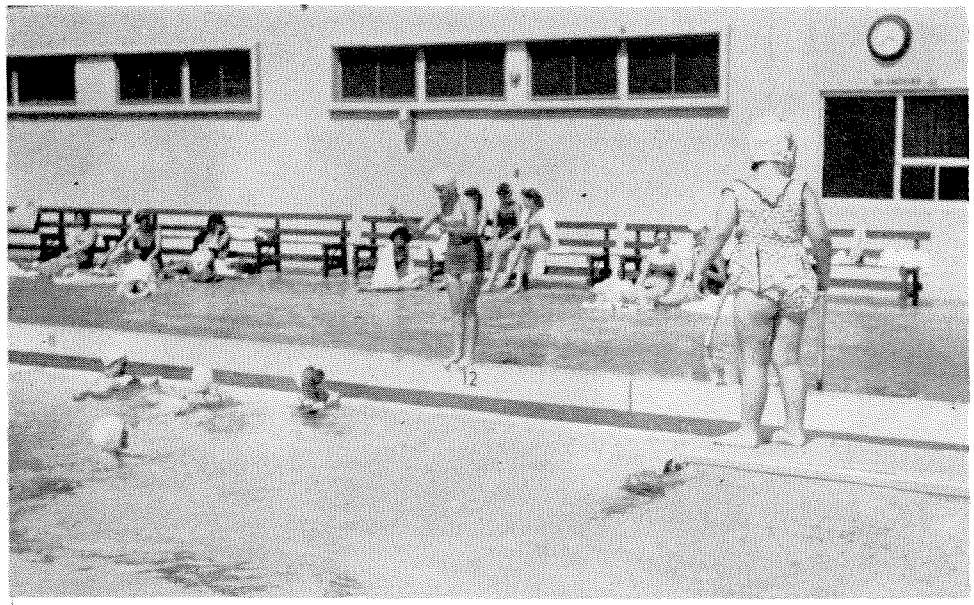
The Caltech campus used to be a pretty drowsy spot after the student body took off for the summer vacation, but since the opening of the Alumni Pool last year you'd hardly recognize the old place.

During the summer the pool is open to all employees of Caltech, the Jet Propulsion Lab and the Cooperative Wind Tunnel, and to all students and alumni. About 1,000 family admissions were sold this summer (at $30 for the season), and more than 22,000 single admissions were paid during the 12-week program.

The summer program starts about the time most kids are getting out of school. Instruction begins at 9 in the morning, when the competitive swimmers work out, and this summer there were about 15 in competition for the Caltech Swim Club, including a couple of boys about 16 and two girls who were only 6 and 7.

Regular classes get under way at 10—and there is an advanced, an intermediate and two beginners' groups. While the youngsters are in the water, special classes for mothers and synchronized swimming instruction for those who feel up to some exercise, are going on, too. Diving classes are held in the afternoon. During the week the pool is open for recreational swimming from

Mothers discovered that the pool was a great place to leave the youngsters while shopping.



1 p.m. to 9:30 at night; on weekends it's afternoons only.

This summer the pool staff consisted of two instructors and two lifeguards. Caltech's swimming coach, Warren (Web) Emery, from the University of Nebraska (which he left because it snows there), was pool supervisor and taught the kids. Mrs. Jamalea Corre taught the mothers. The two lifeguards were Tech students who found that sun-bathing pays better than soldering, drafting, surveying or whatever it is that Joe-Average-Techman does with his summer.

Twice during the summer, water shows were held to give the kids and their mothers a chance to show what they could do. There were races, exhibition and comedy diving, and, at the last show, two sets of sisters who did a synchronized swimming routine called "Waltzing Kittens."

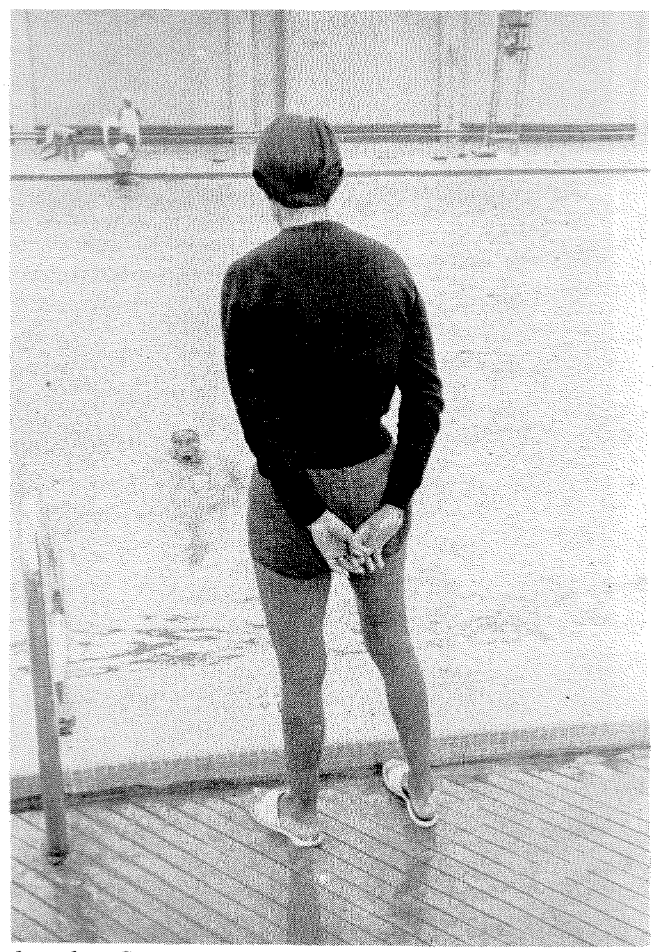
All in all, the summer was a howling success. Mothers found it was a good place to leave the kids while shopping—and even that it was a good place to give birthday parties. There were weekends when it looked like Coney Island around the pool, and a few foggy days when it was as desolate as a fog-bound island off the coast of Maine.

Only two things were really wrong with the pool this summer (speaking from a lifeguard's perch)—the lifeguard tower was too high for conversation with the customers—and there were far too few Caltech daughters between the ages of 18 to 21.

As further proof that the *whole* Caltech community is benefiting from the Alumni Pool—during its first complete season under the skillful coaching of Web Emery, the varsity swimming team took the conference championship; since the pool opened, every school record has been broken; and the Caltech team last year tied for the water polo championship, losing only to Oxy. What's more, one of our swimmers was in the Olympic trials.

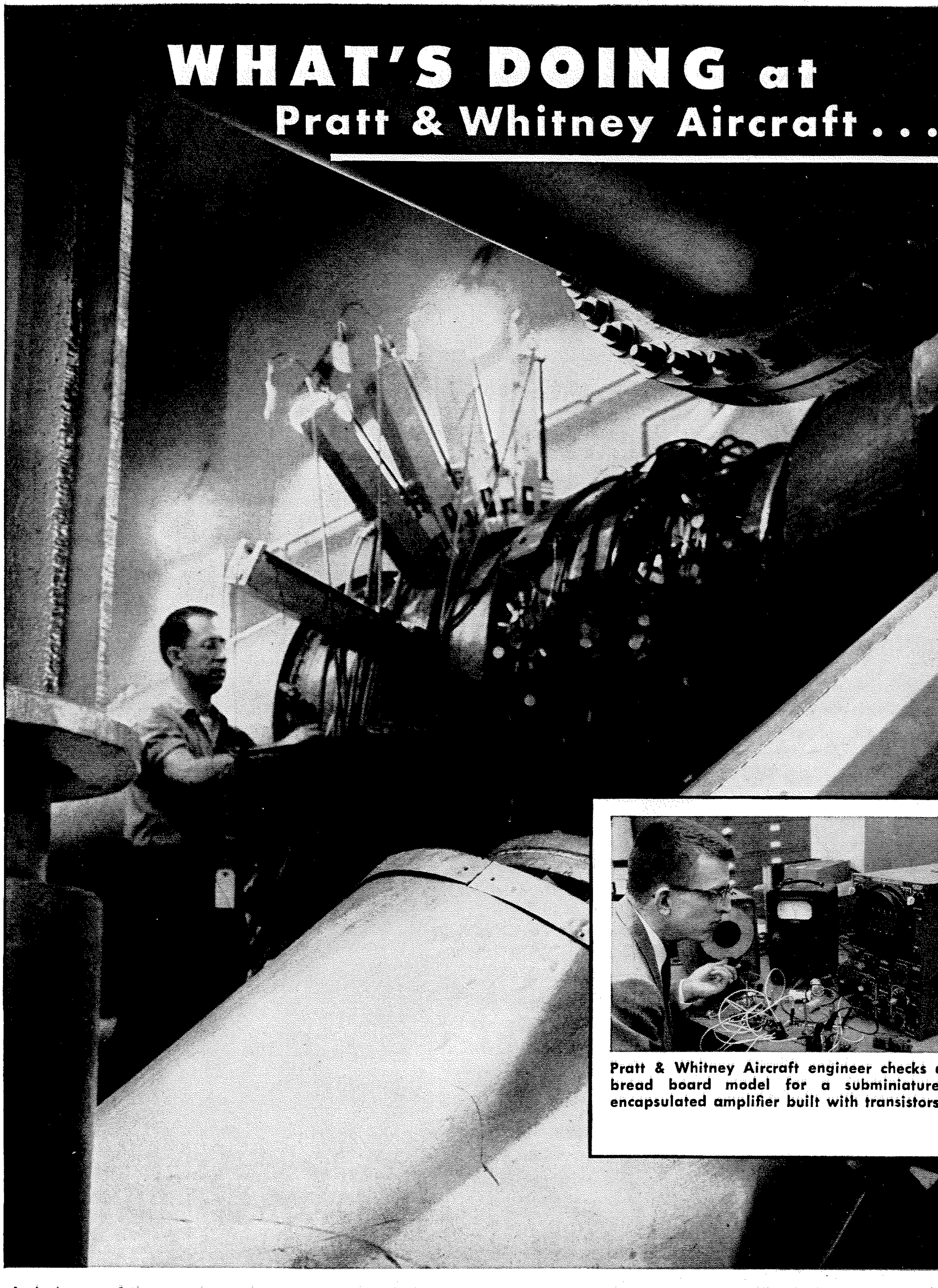
Starting the school year off this fall, the varsity water polo team beat the alumni in the last 30 seconds of play in a very close game, 8-7. This occurred on the day of another unrelated event—the Caltech football team beat Cal Baptist, 67-0.

—Doug Carmichael '59



Jamalea Corre taught synchronized swimming routines to mothers while youngsters took lessons from Coach Emery.

WHAT'S DOING at Pratt & Whitney Aircraft . . .



Pratt & Whitney Aircraft engineer checks a bread board model for a subminiature, encapsulated amplifier built with transistors.

A rig in one of the experimental test cells at P & W A 's Willgoos Laboratory. The six large finger-like devices are remotely controlled probe positioners used to obtain basic air flow measurements within a turbine. This is one of the techniques for obtaining scientific data vitally important to the design and development of the world's most powerful aircraft engines.

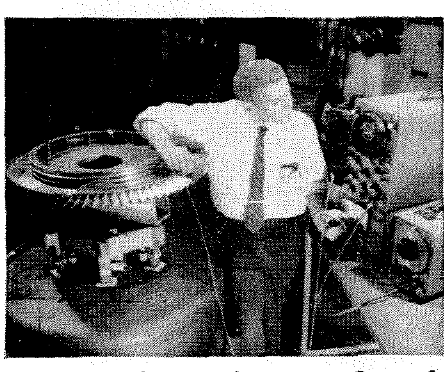
. . . in the field of INSTRUMENTATION

Among the many engineering problems relative to designing and developing today's tremendously powerful aircraft engines is the matter of accumulating data — much of it obtained from within the engines themselves — and recording it precisely. Such is the continuing assignment of those at Pratt & Whitney Aircraft who are working in the highly complex field of instrumentation.

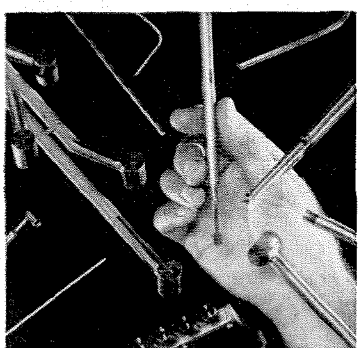
Pressure, temperature, air and fuel flow, vibration — these factors must be accurately measured at many significant points. In some cases, the measuring device employed must be associated with special data-recording equipment capable of converting readings to digital values which can, in turn, be stored on punch cards or magnetic tape for data processing.

Responsible for assembling this wealth of information so vital to the entire engineering team at Pratt & Whitney Aircraft is a special group of electronic, mechanical and aeronautical engineers and physicists. Projects embrace the entire field of instrumentation. Often involved is the need for providing unique measuring devices, transducers, recorders or data-handling equipment. Hot-wire anemometry plays an important role in the drama of instrumentation, as do various types of sonic orifice probes, high temperature strain gages, transistor amplifiers, and miniaturized tape recording equipment.

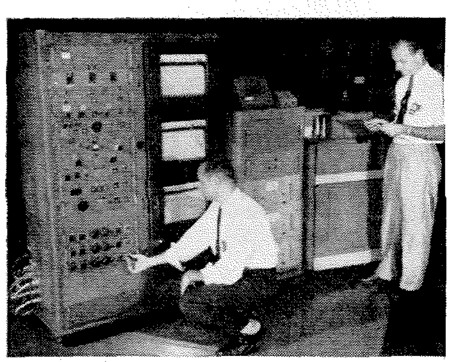
Instrumentation, of course, is only one part of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of combustion, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's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



Instrumentation engineer at Pratt & Whitney Aircraft is shown investigating modes of vibration in a blade of a single stage of a jet engine compressor.



Special-purpose probes designed and developed by P & W A engineers for sensing temperature, pressure and air flow direction at critical internal locations.



The "Plottomat", designed by P & W A instrumentation engineers, records pressure, temperature and air flow direction. It is typical of an expanding program in automatic data recording and handling.

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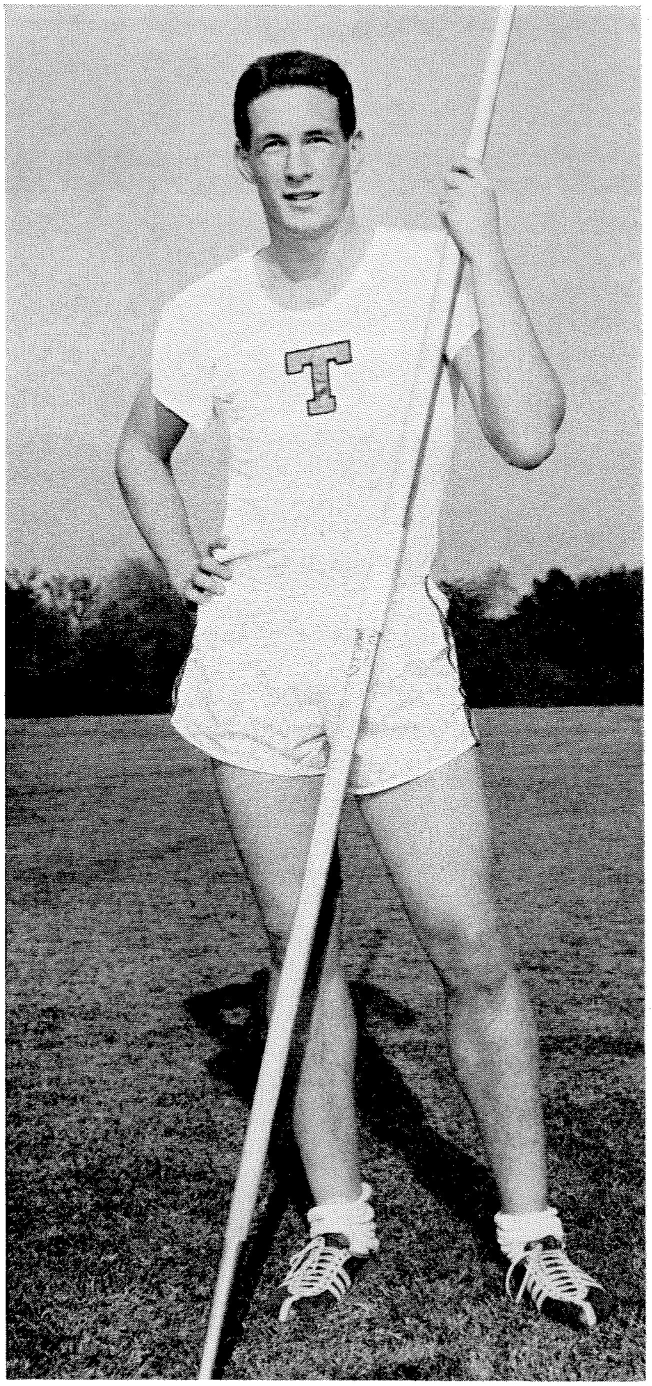


THE PHABULOUS PHIL CONLEY

by MARTY TANGORA

STUDENT-BODY president, three-year varsity football letterman and all-conference quarterback, three-year varsity basketball letterman and all-conference center (and high scorer), baseball letterman, red-headed, pleasant, honor grades.

Sounds like about how many guys?

Well, these are just a few of the *minor* virtues of Caltech's Phabulous Phil Conley. His real distinction is in track and field, and he does so well in his specialty—the javelin throw—that he is planning on a trip to Australia this fall for the 1956 Olympics.

Because it has been three blue moons and a month of Sundays since the last Caltech man went to the Olympics (Glenn Graham was second in the pole vault in 1924, and Folke Skoog ran the 1500 meters for Sweden in 1932), it is worthwhile investigating just how Phil got to be that way.

To clear up the last part, this "red-headed, pleasant, honor grades" bit was hung on Phil by *Sports Illustrated* after Phil took first place in the National Collegiate Athletic Association annual meet last June. Nobody questions the "pleasant," but there might be some doubt as to his being "red-headed." As for getting "honor grades," Phil himself asks, "3.51 is A-average, isn't it?" However, this was Phil's grade-point average in the third term of his senior year and should not be considered entirely typical.

Athletically, just how did this phenomenon come about?

Well, it all started back in Madera, California, on August 17, 1934. From there until Phil entered high school, historical facts are lost in a wealth of hazy legend sprinkled liberally across the countryside by his friends and his Fleming House brothers. The stories which these "friends" use to explain Phil's birth and childhood are generally facetious and probably do not have their place in a dignified magazine such as this.

When Phil entered Fresno High School in 1948 his promise was not unusually great. He played the piano but gave up lessons to go out for B football. He didn't make the team. Wiping the tears from his eyes, he proceeded to make a comeback, and by graduation from high school he had won A letters in basketball and tennis and B letters in football and track. (No javelin throwing.) In tennis he achieved significant stature; in his senior year he played first man on the varsity and was runner-up in the San Joaquin Valley in singles.

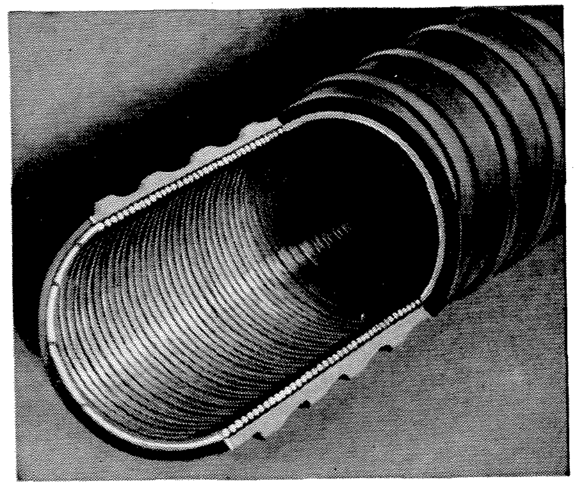
Besides this, he made grades which were so good that Caltech admitted him in spite of his being a four-sport letterman.

So he came to Pasadena and went out for football, basketball, baseball and track. This time he didn't miss any teams, standing out in his frosh year in all four sports. In the javelin throw, which Coach Bert LaBrucherie tried him in on one of those luckier hunches, he was good enough to break the school freshman record with a throw of 176′ 9½″.

CONTINUED ON PAGE 46

Communications Super-highways of the Future

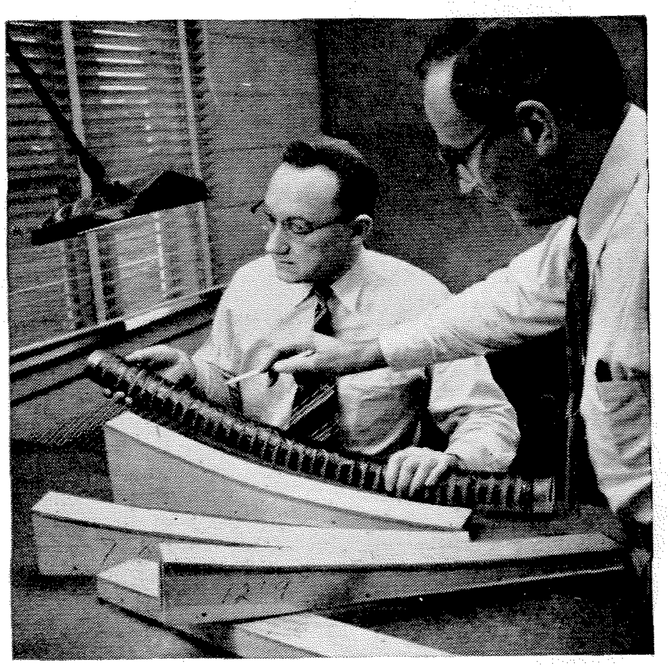
Another example of the pioneering opportunities at Bell Telephone Laboratories



Experimental waveguide, of tightly coiled copper wire in jacket, takes waves around bends. Solid wall pipe can be used for straight runs.

Careers with Bell Telephone Laboratories offer young engineers and scientists the chance to take part in pioneering exciting new developments in the field of communications—developments that look ahead to the needs of the future.

For example, the Bell System anticipates greatly increased demands for the transmission of telephone conversations and TV pictures. Communication links of giant capacity will be needed. Bell Labs scientists and engineers are experimenting with a new kind of long distance transmission medium which consists of round waveguides—empty pipes—and is theoretically capable of carrying hundreds of thousands of telephone conversations simultaneously with hundreds of television programs.



One type of guide, designed to be flexible, is bent on wooden forms to study effect of curvature on transmission. Left is A. C. Beck, Radio Research Engineer, E.E., Rensselaer Polytechnic Institute. Right is A. P. King, Radio Research Engineer, A.B. in Physics and Engineering, California Institute of Technology.

A crucial difference between this new waveguide system and present systems is that the *higher* the frequency of the waves transmitted, the *less* the attenuation. This is exactly the reverse of what is true for other forms of long distance transmission, such as the coaxial cable. To explore at frequencies higher than any now used, Laboratories scientists are devising new techniques and apparatus. Thus, they have developed a new reflex klystron tube able to generate a wide band of frequencies near 60,000 megacycles per second.

This new waveguide system is another result of the Bell System's unending effort to anticipate America's future communications needs. Projects like this are typical of the challenges that offer absorbing careers to able, imaginative young engineers and scientists. Your placement officer has more information about careers with Bell Telephone Laboratories, and also with Bell Telephone Companies, Western Electric and Sandia Corporation.

BELL TELEPHONE SYSTEM

Soph year he picked up varsity letters in all four sports, the first Techman to win four letters in one year since 1933. The javelin responded so well to practice and coaching that Phil broke the Southern California Conference record as a sophomore with a throw of 199′ 2½″.

Records and honors and assorted awards showered upon him in his junior and senior years, and Mr. Hal Musselman of the Caltech Athletic Department now needs five pages to give a detailed account of them. But being all-conference in three sports, team captain in the same three, and ASCIT President to boot sounds pretty impressive, doesn't it?

Phil's record in the javelin throw is the most impressive of all. In four years at Tech he was never defeated in a dual meet. In his senior year he was never beaten by another college man. He broke the varsity conference record over and over again. In February of this year his throw of 237′ 11½″ was the farthest ever recorded in a college dual meet. (It was Caltech's only first place in that meet with Occidental.) On June 15 his throw of 239′ 11″ in the NCAA meet made him official collegiate champion of the United States.

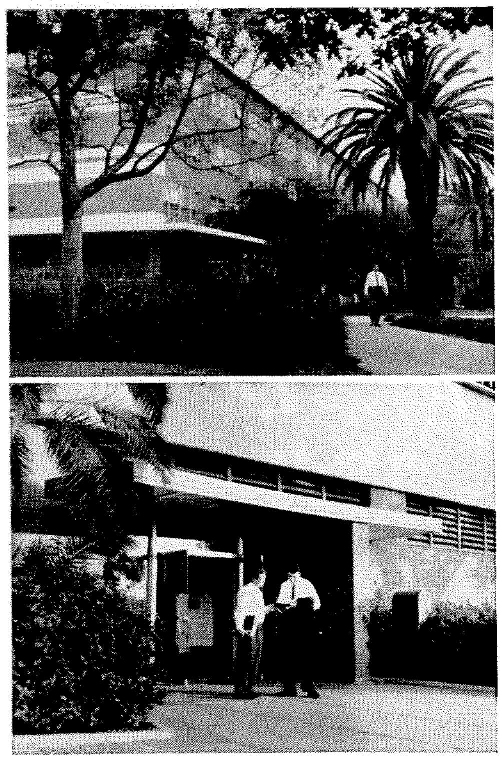
And finally, climatically, he threw 244′ 1″ in the U. S. Olympic Trials to win second berth on the javelin team for the Melbourne Games. Incidentally, that's about 30 feet better than anyone else in this conference has ever thought about.

It would be trite to say that "in spite of all this, Phil remains his true modest self." However, in spite of all this, Phil remains his true modest self. After all, you have to be neat to be President; and if Phil hadn't been "pleasant," *Sports Illustrated* could have used some other words, like "tall," or "bashful."

Seriously, Phil is as nice a guy as you'll ever hope to meet—which doesn't keep him from being ambitious about the Olympics, of course. His training schedule is well under way; and early in September he threw 251′ at a pre-Olympic meet in Eugene, Oregon, to give notice that he's ready for the big competition. Phil will get a ten-week leave of absence from Procter & Gamble, where he has been working since graduation, in order to finish training and ship out for the Games.

What's his goal? "I think I'll hit 255′ in the Olympics or before," Phil says. His practice throws have been encouraging.

Anybody wanna bet he can't?



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ALUMNI NEWS

Homecoming Dance

FOOTBALL SEASON is here again—and the Caltech Beavers meet the Pomona Sagehens in the Rose Bowl on October 13 for our annual Homecoming Game. After the game alumni and undergraduates, with their dates, will descend on the new Scott Brown Gymnasium for a Homecoming Dance. Dancing will be in socks (to preserve that beautiful polish on the gym floor). There will be coffee and doughnuts, and a chance to relax and catch up on what's happened to your old gang.

Caltech alumni and their families pose for an after-dinner picture at the San Francisco Chapter's picnic at Searsville Lake in the spring.

So save the day—Saturday, October 13.

Bring your enthusiasm and a matched pair of socks for an enjoyable evening.

—Bob Stanaway '52
Chairman, Homecoming Dance

Fall Dinner Meeting

CALTECH ALUMNI will hold their 1956 Fall Dinner Meeting on November 8 at Eaton's Santa Anita Restaurant at 1150 West Colorado Street in Pasadena.

Dr. Heinz Haber, chief science consultant at Walt Disney Productions, will speak on "Science Motion Pictures for the Future."

Dinner will be served at 7:15 p.m., preceded by a social-cocktail period at 6:30 p.m. All alumni and their guests are invited to attend.

—William W. Haefliger '50
Chairman, Fall Dinner Meeeting

San Francisco Chapter

THE MEMBERS of the San Francisco Chapter of the Alumni Association and their wives were the guests of Mr. and Mrs. Robert Bowman, '26, at a swimming party and barbecue held at their Concord home on Saturday, September 1. After the nominating committee's report, officers were elected for the following year.

—Jules F. Mayer, '40, MS '41
Secretary-Treasurer

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California Research & Development Company, Livermore, Calif.
Meetings: Informal luncheons every Thursday.
Fraternity Club, 345 Bush St., San Francisco

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Box 1499, Sacramento

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Secretary — Frank John Dore, Jr. '45
Consolidated Vultee Aircraft Corp., San Diego
Program Chairman — Herman S. Englander '39
U. S. Navy Electronics Laboratory

Letters . . . CONTINUED

Dr. Feynman replies to Mr. Sohler's "New Hypothesis."

MR. SOHLER presents us with another theory about why we should not make others suffer—namely, that if we do, our own soul will suffer in a later reincarnation. But that souls are reincarnated is not certain, and it seems to me that the idea would imply many metaphysical consequences.

Mr. Sohler also suggests that his hypotheses lead to verifiable consequences, for he says that it is high time science went to work to verify this "new hypothesis." So he wants to tell us what to find before we look, and it is this characteristic demand of religious theory which, I maintain, represents a conflict with the spirit of science.

Suppose that, after whatever scientific tests Mr. Sohler envisages are made, it turns out that his hypotheses are not verified. Suppose, let us say, they are even proved wrong. Would we then go out and make our neighbors suffer, being now released from the fear of retribution in a future reincarnation?

Everybody knows that somehow it is wrong to do that, but why is it necessary to get the strength to do good from a metaphysical theory of things which may eventually be in conflict with what is scientifically discovered?

That is the question I raised in my article. It is not answered by choosing a particular religion from West or East and claiming that its metaphysical consequences must be verified by future scientific research, while those of other religions are manifest absurdities. That is the old way.

What message would Mr. Sohler have for someone who doubts the reality of reincarnation? Our scientific experience teaches us that any definite theory of the world that we can formulate today is probably wrong. We ought to be able to live even better lives, knowing that.

PERSONALS

1915

Harold A. Black writes that he retired as a school teacher in June, 1955, after 36 years of industrial arts teaching—majoring in mechanical and architectural drawing. He's now a civil engineering draftsman for the City of El Cajon, Calif. Hal says that his college training paid off even 41 years after graduation for he made 83.2% on his civil service exam.

1922

Ralston E. Bear is now manager of distributor and contractor sales for the southern California area of the General Electric Company.

Russell J. Love is now in business for himself as a consulting engineer in San Francisco. He specializes in product and process design, cost reduction methods and industrial safety. He writes: "Since moving here I've been enjoying the weekly CIT luncheons and renewing old acquaintances."

Harold R. Harris is now president of Aviation Financial Services, Inc., in New York City. Hal was formerly president of Northwest Airlines in St. Paul, Minn.

Gordon Alles, MS '24, PhD '26, who operates his own chemical research labs in Pasadena, is now a pharmacology professor in residence at UCLA Medical School as well as a research associate in biology at Caltech. Gordon's yacht, *Cynjo*, was overall winner at the Ensenada race last spring.

1923

Donald H. Loughridge, PhD '27, formerly dean of the Technological Institute at Northwestern University in Evanston, Illinois, is now special executive assistant on the General Motors research staff at their new Technical Center in Detroit.

1926

Harold W. Lord, head of the Research Laboratory of the General Electric Company in Schenectady, N.Y., is celebrating his 30th year with the company. Hal has worked in many fields of electronics—from ballasts for fluorescent lamps to pulse transformers for radar.

1928

Albert E. Lombard, Jr., MS '29, PhD 39, was appointed director of research at the McDonnell Aircraft Corporation in St. Louis this summer. Al was formerly at the U. S. Air Force Headquarters where he served as scientific advisor in research and development.

W. Morton Jacobs vice president and assistant general manager of the Southern California Gas Company, will move this month from Arcadia to San Francisco where he will take over new duties as vice president of the firm's parent company, the Pacific Lighting Corporation.

1929

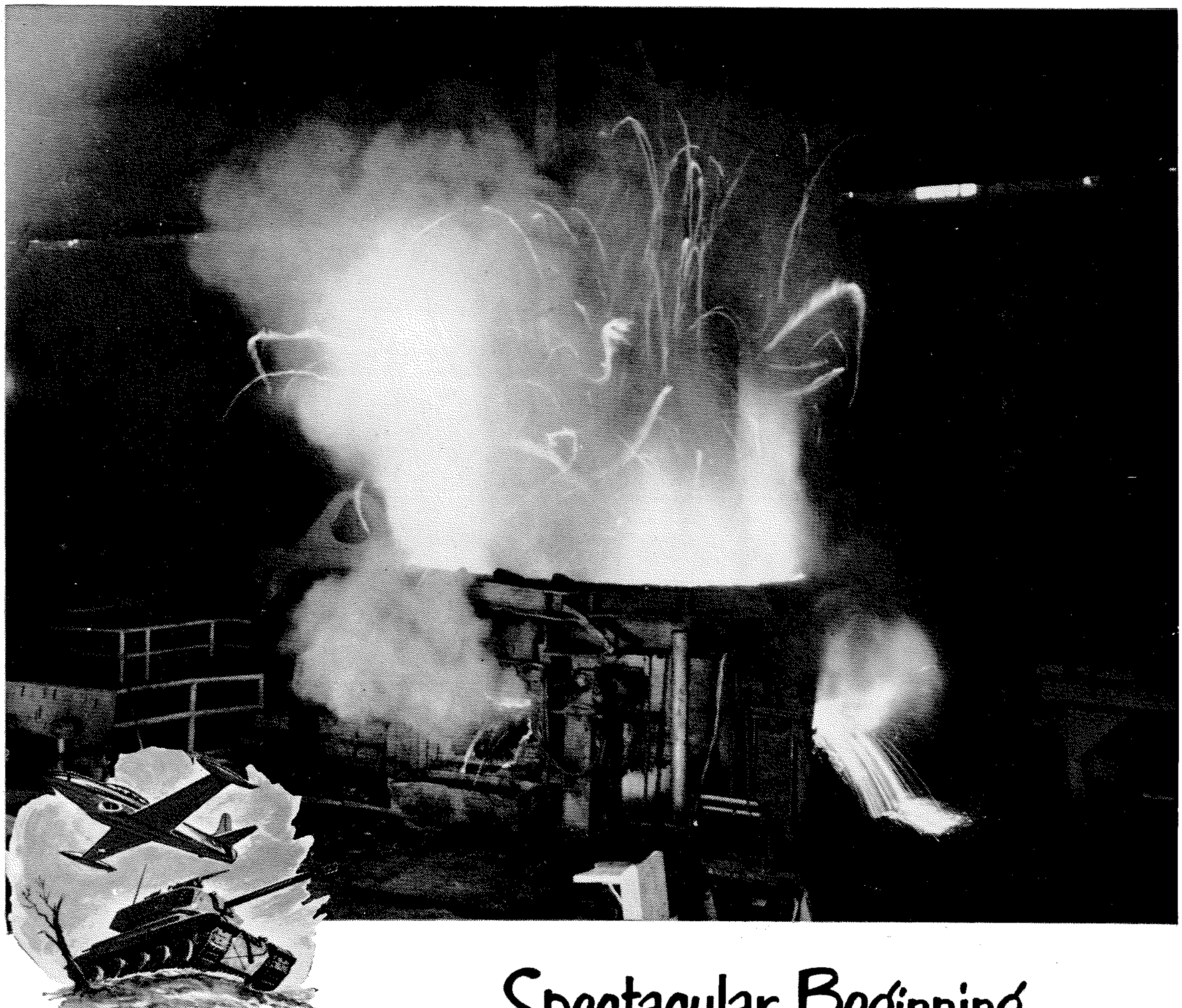
Knowlton R. Birge, electrical engineer with the Ralph M. Parsons Company, writes that he's been doing some field work this past year mostly in design or preliminary design for proposals or estimates at Richfield's Watson Refinery, and also at the Shell Chemical Company in Torrance.

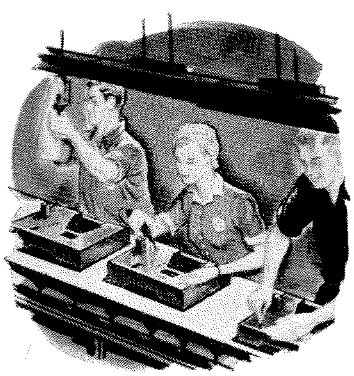
1930

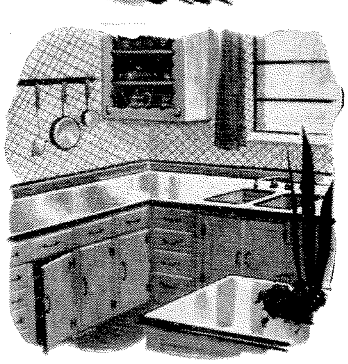
Austin W. Strong, MS '31, has been appointed vice president in charge of personnel at the Southern California Gas Company in Los Angeles. He was formerly assistant vice president of the General Standards Department.

1932

Thomas F. Anderson, PhD '36, just completed a year on a Fulbright Fellowship at







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the Institut Pasteur studying the mating of bacteria as seen in the electron microscope. Tom writes: "We are lucky enough to have a nice apartment on a hill overlooking Paris. Our children, Timmy, 14, and Jessie, 9, are going to French schools in which they are the only kids that speak English. They're learning French rapidly and have many friends." Tom writes that after a summer tour of Europe, he will work on a Guggenheim Fellowship until January when he and his family will return to Philadelphia where he is associate professor of biophysics at the University of Pennsylvania.

1934

William C. McFadden is now executive vice president of the Hycon Manufacturing Company in Pasadena. Bill has been with the company since 1949.

Curtis Cortelyou, manager of General Petroleum Corporation's Ferndale Refinery in Washington, had the interesting experience of starting up a new refinery with all its heartaches, headaches and satisfactions, he writes. The Cortelyous have four children—David, the eldest, is planning to go to the University of Washington next year; daughter Sandra, 15, is a high school sophomore; Sue, 10, has just finished sixth grade; and the youngest, Chuck, has just started in kindergarten.

1936

Tyler Thompson has just completed his fifth year in Philosophy of Religion at the Garrett Biblical Institute in Evanston, Illinois. He reports that *Robert Janes* '36, MS '44, lives nearby on the same street and their children (five in each family) frequently play together.

Peter W. H. Serrell, MS '39, partner in the firm of Sandberg-Serrell Corporation, writes from Pasadena that he and his wife, Kathleen (sister of *Kenneth Macleish* '39) have four daughters—Barbara, 15, Beverly, 13, Elaine, 10, and Elizabeth, 8. He says that in their spare time, he and his wife run a taxi service (strictly private), do Girl Scout work, swim, sail and watch the children grow. Pete sailed to Honolulu in the Transpacific race last spring.

1937

Foster C. Bennett, MS, chief of the Dow Chemical Company's metallurgical laboratory, received the annual Willard H. Dow Memorial Award in August. The award was given to Foster for outstanding research on magnesium die casting technology over a five-year period. He's been with the company since 1937 after three summers as a student employee.

1938

Newman A. Hall, PhD, who was assistant dean in charge of the graduate division at New York University's College of Engineering, is now at Yale University where he is chairman of the department of mechanical engineering.

1939

Mark Gardner Foster, PhD, was appointed in August as director of research for the Crosley Government Products Division of the Avco Manufacturing Corporation in Evendale, Ohio. He was formerly head of the development division of the Cornell Aeronautical Laboratory in Buffalo, New York. Mark, his wife and their three children, are now living in Cincinnati.

Warren E. Wilson, MS, formerly professor of engineering education at the Pennsylvania State University, is now dean of the school of engineering at Pratt Institute in Brooklyn, New York.

1940

Jack Tielrooy and *Robert S. Ray*, MS '41, were both elected vice presidents and members of the board of directors and executive committee of Brea Chemicals, Inc., in Los Angeles.

Jack has been with the company as manager of development since 1952 when it was formed. The Tielrooys have two children.

Bob joined the company in 1953 as manager of manufacturing. The Rays have four children.

Frank W. Dessel, Jr., MS '43, who is owner of the San Marino Pharmacy in San Marino, California, writes that he now has three sons—Frank III, 13, John, 9, and Tommy, 2. Frank is treasurer of the San Marino Post of the American Legion and president of the California Vending Corporation.

Darragh E. Nagle is now in the physics division of the University of California's Los Alamos Scientific Laboratory in New Mexico.

1941

Carl A. Carlson writes that after seven years of field construction as a field engineer and assistant superintendent for C. F. Braun and Company, he has now settled down in their home office in Alhambra. Carl was married in 1950 to Patricia Morse in Winnipeg, Canada. The Carlsons have a daughter, Judith Grace, who will be a year old in November.

Reuben P. Snodgrass, MS '42, was recently appointed director of flight research in the aeronautical equipment division of

we're in Milwaukee so we ought to know!

An AC* ENGINEER TELLS HIS STORY

Working at AC, THE ELECTRONICS DIVISION OF GENERAL MOTORS is exciting . . . challenges every inch of my engineering ingenuity, currently I am working on a phase of the Inertial Guidance System Program. A month or two ago I was equally absorbed in our Jet Engine Fuel Control Program. I am certainly growing ENGINEERING "KNOW-HOW-WISE" and my salary checks reflect it. I started at a good salary . . . have had regular increases in salary and position . . . gosh, I like it here.

AND, I enjoy AC's *MASTER'S DEGREE PROGRAM,* University of Wisconsin—Milwaukee. I attend evening classes and AC is paying my tuition *and* with no strings attached.

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P.S. AC's Permanent Expanding Electronic Program provides openings for more Mechanical, Electrical Engineers and Engineering Technicians. Even "square pegs" are provided "square holes" at AC.

Write today in strictest confidence to my friend, Mr. J. F. Heffinger, Supervisor of Salaried Personnel.

*AC THE ELECTRONICS DIVISION

GENERAL MOTORS CORPORATION

Milwaukee 2, Wisconsin • Flint 2, Michigan the Sperry Gyroscope Company in Long Island, New York. He's been with the company since 1948 when he worked for them as a test pilot.

Quentin Elliot, MS '42, recently joined the New Products Division of the Minnesota Mining and Manufacturing Company in St. Paul, Minnesota. He was formerly head of the propellants and explosives department at the U. S. Naval Ordnance Test Station at China Lake, California.

Keirn Zebb, MS '42, AeE '43, chief of the aerodynamics department at the Southern California Cooperative Wind Tunnel, was appointed staff executive engineer this summer. Keith started his career at GALCIT in 1937 as a part-time student employee and moved on to CWT in 1944. The Zebbs have three children—Roddy, 7, Ruth, 5, and Barbara, 5 months.

Paul Faust is now supervisor of manufacturing economics of the General Petroleum Corporation in Los Angeles. Paul, who was an economics engineer until his promotion, has been with the company since 1941.

1942

John K. Dixon is engineer-in-charge of the development section of Allis-Chalmers' steam turbine department. John has been with the company since 1942, first in connection with airplane supercharger work and later with marine and navy turbines.

George Holzman, PhD '48, who has spent the last two years in New York as a senior technologist in the Shell Oil Company's manufacturing research department, returned this year to the company's plant in Emeryville, California, as supervisor of the petroleum chemistry department.

Robert Greenwood writes from Houston, Texas, where he is assistant professor of geology at the University of Houston:

"After nearly four years as a geologist and roving factotum in Brazil, we came back to the U.S.A. via England in 1953, and taught temporarily at the Michigan School of Mines. We've been in Houston since 1954. This summer I'll be developing a uranium property in Montana for some Houston interests." The Greenwoods have two girls, 7 and 2, and a boy, 4.

Gershom R. Makepeace is president and general manager of the Sandshell Corporation in Santa Clara, California. Gerry and three engineering associates organized the company about a year ago. They manufacture shell molded precision castings in non-ferrous metals and provide specialized engineering services to Bay Region industry. Gerry was formerly head of the propellants and explosives department at the Naval Ordnance Test Station in China Lake, California.

1943

Charles P. Strickland writes that E&S (April) was not quite up-to-date on his recent activities. As well as daughter Anita, 9, the Stricklands have a son, Freddie, 2, and they have moved from Alhambra to Pasadena. Charles is industrial sales engineer with the York Corporation in Los Angeles.

1944

Gregory O. Young, MS '47, who has been an engineer at the Hughes Aircraft Company in Culver City, California, for the past nine years, passed his final oral examination for a PhD in electrical engineering last August at USC. He joins the USC faculty this fall as associate professor of electrical engineering. Greg has been a part-time instructor since 1952.

Wilbur M. Swanson, MS '48, ME '51, writes that after spending four years at Case Institute of Technology in Cleveland teaching aero and mechanical engineering while working for a PhD, he married the boss's secretary in 1954 and left the next year for a job with the DuPont experimental station in Wilmington, Delaware. Milt is doing fluid mechanics and process dynamics work in the chemical engineering section.

Donald A. Keating, manager of the transportation products division of Turco Products, Inc., in Los Angeles, has been with the company now for 10½ years. The Keatings have three children—Richard Alan, 5½, Russel Brian, 1½, and Pamela Gail, 3 months.

Francis Odell, who is president of his own company, Metal Surfaces, Inc., in Huntington Park, California, writes: "I married Mrs. Kay B. Smith in September 1955 and now have two fine sons, John and Craig, ages 4 and 5." The Odells live in South Pasadena.

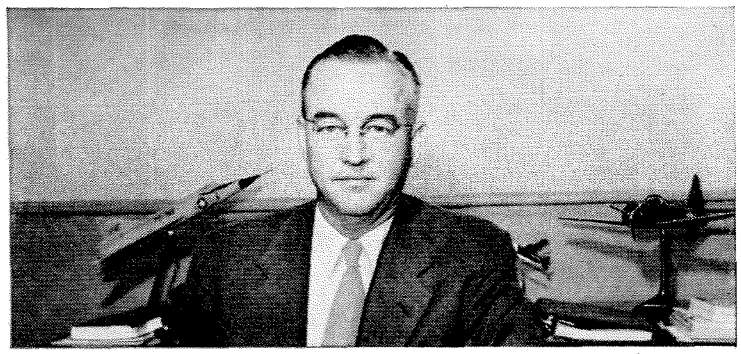
1945

John S. Jackson, Jr., MS '54, head of the science department at Campbellsville College in Kentucky, has a new appointment as assistant professor of electrical engineering at the University of Kentucky in Lexington. The Jacksons have a daughter, Jane Carolyn, born last March.

Edward R. Elko is head of the missile rocket project in the development department of the liquid engine division of the Aerojet-General Corporation in Azusa, California. The Elkos had a son in March which brings their family up to four (two boys and two girls).

Merritt A. Williamson, MS, manager of the research division of the Burroughs Corporation, and special lecturer on research administration at the University of Pennsylvania, was appointed this summer as dean of the college of engineering

"What do you need for a successful engineering career?"



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Your future is brighter at Ryan because of this *unique* combination of advantages:

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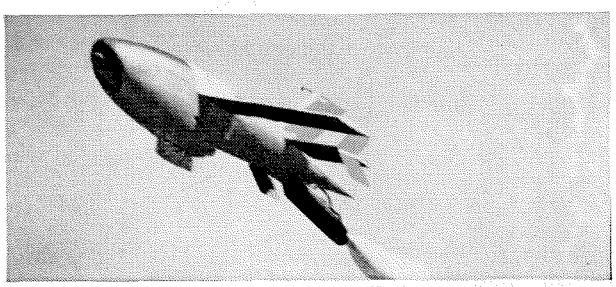
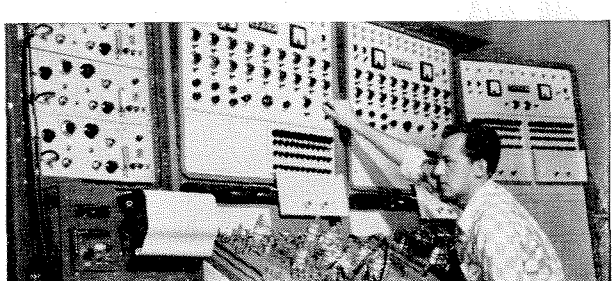
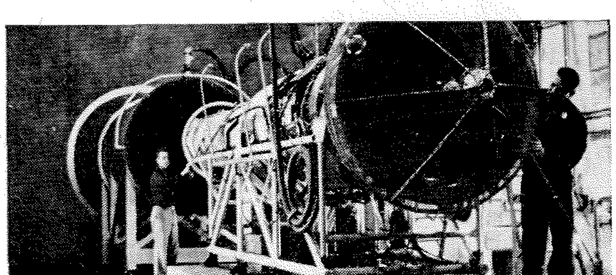


Jet Drone Missiles



Electronics Systems



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RYAN AERONAUTICAL COMPANY

and architecture at the Pennsylvania State University.

William R. Burns was recently appointed assistant manager of Farm Bureau Life, a section of the Farm Bureau Insurance Companies of Michigan. Bill had previously been planning supervisor of National Life of Vermont. The Burns have a son, 11, and a daughter, 9.

George Marvel Howe received his PhD from Clark University in Worcester, Massachusetts, last June.

1946

Edwin Pounder, MS '48, AE '51, is now chief of the aerodynamics department of the Southern California Cooperative Wind Tunnel. Ted has been assistant chief of the department since 1951 and at the present time is assistant director of the 10" tunnel at GALCIT as well. He also serves as vice president of the Caltech Management Club. The Pounders have four children—Susan, 7½, Bill, 6, Steven, 3, and Jeffrey, 2.

Ali Bulent Cambel, MS, received a full professorship effective September 1 at Northwestern University in Evanston, Illinois.

1947

Walter J. Hamming, MS '47, was recently appointed as assistant director of research of the Air Pollution Control District in Los Angeles.

Colonel Norman C. Appold, MS, is chief of the research and target systems division under the Deputy Commander for weapon systems at the Air Research and Development Command in Baltimore, Maryland. Norman has been in the service since 1941 and formerly was stationed at Wright-Patterson Air Force Base in Ohio as chief of the power plant laboratory. The Appolds are the parents of two daughters, Karen Louise, 8, and Linda Katherine, 6.

David A. Cooke, MS, welcomed his fourth child, Catherine, last February. Dave is supervising engineer for the control development section of the Westinghouse Electric Corporation in Kansas City.

1948

James E. Ash, MS, received an appointment last month as supervisor of the fluid mechanics and fluid power section of the Armour Research Foundation of the Illinois Institute of Technology in Chicago. Jim has been with the Foundation since 1951.

Paul MacCready, Jr., MS, PhD '52, who is a consultant in meteorology and aeronautics, won the world glider championship in the Soaring Olympics held in July at Saint-Yan, France. Paul gained enough points to win the title by placing second in the 186-mile triangle event.

1949

M. Kent Wilson, PhD, was recently elected professor of chemistry and chairman of the department at Tufts University in Medford, Mass. For the past eight years, he has been on the faculty of Harvard University.

Hugh C. Carter, senior mechanical estimator in the California State Division of Architecture, is instructing the University of Southern California's mechanical estimating course in the evening division this fall.

Arthur R. Marks, MS, writes that "after receiving the exalted rank of Pfc, I parted company with the Department of Defense on September 3, 1956." Art is now at Yale University as assistant professor of industrial administration.

David K. Hayward has worked for the Texas Company in various parts of California ever since he left Caltech. He's now district petroleum engineer of the Los Angeles Basin District for the Texas Company in Long Beach. Dave, his wife, Jeanne, and their two sons, Gary, 3, and Eric, 1½, live in Whittier.

1950

John K. Inman received his PhD in bio-chemistry from Harvard last June and the following month became a father upon the arrival of a daughter, Nancy Jeanne. John now has a position with the Michigan Department of Health—working in plasma protein research.

Vern A. Edwards reports the arrival of a daughter, Jeanne, on July 27, 1956. Vern's just completed his fourth year with Fibreboard Paper Products (formerly Pabco Products) and is now the process engineer of the Pabco Industrial Insulations Division in Emeryville, California. Working with Vern at the Emeryville site is *Robert Hallanger*, '35, who was recently made engineer manager of the new fibreboard company.

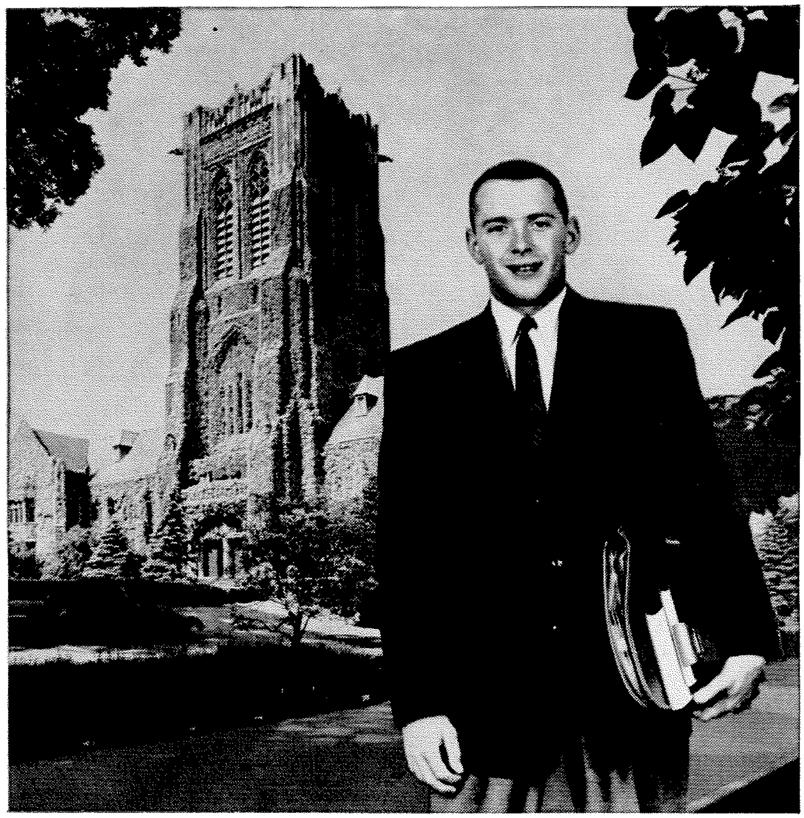
1951

Edwin A. Matzner writes that he is "at present working towards a PhD in organic chemistry at Yale University and suffering from the New Haven climate. I'm happily married and the possessor of a large cat, Ludwig." Ed invites any former associate who may read this to write to him.

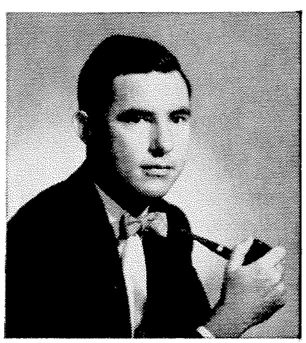
Eli Botkin, MS, is now with the Hughes Aircraft Company in Culver City on the

George Lincoln asks:

What do metallurgists do in a chemical company?



GEORGE M. LINCOLN, JR., expects to receive his B.S. in metallurgical engineering from Lehigh University in 1957. George was vice president of his junior class, is active in sports, and a participant in many other campus activities. He's starting his employment investigations early, for he feels that the selection of an employer is one of the most important decisions in a man's career.



CHARLES I. SMITH, JR., received his B.S. Ch.E. from V.P.I. in 1943, served in the Navy as an engineer officer, and joined Du Pont's Engineering Department in 1946. Since then, he has advanced steadily through a number of interesting assignments at various Du Pont plants. He was recently promoted to manager of the Technical Section of Du Pont's Pigments Department.

Charlie Smith answers:

They have an almost endless variety of interesting problems to face, George. As a student of metallurgy, you know that about two-thirds of all known chemical elements are metals. Many of them are revealing valuable new applications, when highly purified on a commercial scale. Du Pont is greatly interested in several metallic and semi-metallic elements.

My own experience at Du Pont ranges from work on titanium pigments, to metallic titanium production, and to the ultra-pure silicon used in transistors. You can appreciate some of our metallurgical problems when I point out that impurities in transistor silicon have to be below one part in 100 million. That's equivalent to one pound of impurities distributed through a train of ore cars twenty miles long!

Some of our metallurgists carry out fundamental research on new metals, and, in the development stage, they frequently operate pilot plants for producing them. Other metallurgists study problems relating to engineering materials used in construction, carry out research on intergranular corrosion, or investigate fatigue relationships encountered in dynamic, high-pressure operations.

You'll find many challenging opportunities in every phase of metallurgy at Du Pont, George.

Metallurgists and Metallurgical Engineers can find some of Charlie Smith's challenging new problems described in "Engineers at Du Pont." For a free copy of this booklet write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington 98, Delaware.

DU PONT

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Technical staff. He was formerly with the Naval Ordnance Test Station in Pasadena. The Botkins have two children—Dianne, 4, and Brad, 1.

Robert F. Connelly is west coast representative for the organic chemistry division of Emery Industries, Inc. in Cincinnati, Ohio. He's also secretary-treasurer of the Los Angeles section of the American Society of Lubrication Engineers for the year 1956-57. The Connellys expect to round out their basketball team next November—they've given up the idea of raising a baseball team.

1952

Paul D. Arthur, PhD, research scientist at the Marquardt Aircraft Company in Van Nuys, welcomed his first child, David John, last May 11.

Randolph G. Moore writes that after three years as a subsidized athlete, courtesy of the U. S. Navy, he's back to his chosen career as a professional student. He spent last year as the only junior in the graduate college of the University of Arizona but hopes for an MS in electrical engineering next spring.

Roland Dufour, MS, writes from Paris that he's working in the electronic field in charge of the computer and automation department of a French firm called Radio-Industrie. He's also studying business administration at the Chamber of Commerce of Paris. Roland adds that anyone from Caltech who wants information (business or pleasure) about Paris or needs help while there may contact him.

1953

J. Morgan Ogilvie resigned from the U. S. Coast and Geodetic Survey in September, 1955, and is now in the sales promotion department of the DuPont Company in Wilmington, Delaware.

Wilmer A. Jenkins II, PhD, is research chemist in the pigments department of the DuPont Company in Wilmington, Delaware. The Jenkins have two boys, ages 3 and 1.

Alfred H. Sturtevant finished his stint in the Army in September, 1955, and after a term at Caltech, left last January for Morococha, Peru, where he is assistant geologist at the Cerro de Pasco Corporation.

1954

George L. Johnston, a third-year law student at Harvard, has been appointed a proctor in Hollis Hall, one of the freshman dormitories.

Donald L. Hook received his MS in geology last June from the University of Arizona. Don's had a teaching fellowship there for the past two years and worked in the same office with *Charles St. Clair*, '54, and *Randy Moore* '52. Don says he's now working as petroleum geologist for the Continental Oil Company.

Roland S. Miller, MS '55, is serving with U. S. Naval Construction Battalion Nine at Subic Bay in the Philippine Islands.

Christian Dambrine, MS, a maritime engineer, was married on June 7, 1956 to Jacqueline Combet in Paris.

1955

George E. Madsen, sanitary engineer reserve officer with the Washington headquarters of the Public Health Service of the Department of Health, Education and Welfare, was assigned in June to the Arctic Health Research Center in Anchorage, Alaska.

Alain Brethes, MS, is back in France currently training to become a reserve officer in the French Air Force. He's working on electronic equipment for jet planes at a NATO air base in eastern France.

Alfred M. Goldman, Jr., MS '56, has been in the U. S. Air Force since leaving Caltech. He's stationed in the Air Defense Systems section at Air Research and Development Command Headquarters in Baltimore, Maryland, working with interceptor-type fighters and their armament.

Lt. George H. McDonald, Jr., MS '56, stationed at Wright-Patterson Air Force Base in Ohio, was married to Janet Ainsworth on June 2 in Moline, Illinois.

Lt. Richard F. Webber was assigned in June to Headquarters Air Research and Development Command in Baltimore, Maryland. Dick is assistant chief of the Technical Presentations branch of the Office of the Technical Secretariat.

Egil K. Bjornerud, PhD, writes from Norway that the day after Commencement, 1955, he became the father of a son. The whole family left in October for the old country and have since been enjoying some wonderful skiing. Egil has also been helping to build Norway's first power reactor. After touring Europe, he writes, the whole family will probably return to the "sunny shores" this fall.

1956

Richard A. Johnson was married on June 9 to Kathleen Nally of Alhambra, California. Dick is design engineer at the Sandberg-Serrell Corporation in Pasadena.

Garry L. Schott, PhD, is now a chemist at the Los Alamos Scientific Laboratory in New Mexico.

Specially-compounded coatings and housings enable IRC resistors to withstand a higher degree of impact, shock and vibration than any other resistors of their type.

The skillful combination of protective coatings and resistive elements assures superior moisture resistance and heat dissipation, as well as protection from severe humidity or temperature conditions.

Exactly how important are resistor insulations?

In a sense, a resistor is simply a mechanical device for packaging ohms. So it is easy to see why the materials making up the mechanical package greatly determine resistor performance. In fact, insulation is so important that more than one-third of the 200 technicians at IRC are engaged in developing custom-tailored insulating coatings and housings for IRC resistors. That's why every IRC resistor is better protected from damage and ambient conditions than any other of its type. And at no extra cost.

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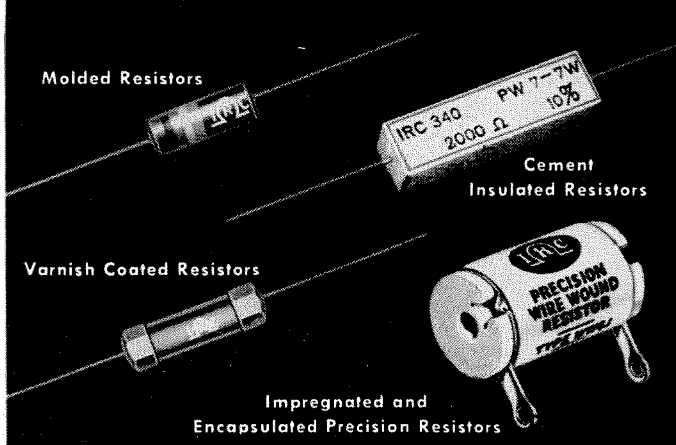

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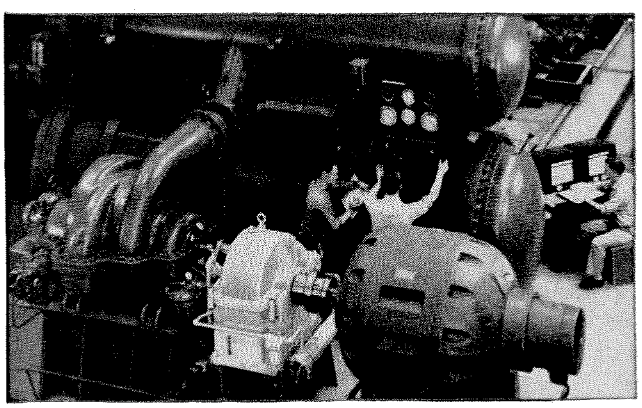
. . . the world's most versatile hydraulic proving ground



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That's why we built one of the world's largest hydraulic test stands at our plant in Harrison, New Jersey. Here, over a half-acre "lake," we can check the performance of anything from a fractional horsepower unit to pumps handling over 100,000 gallons a minute. When you realize there are thousands of sizes and types of centrifugal pumps alone, you get an idea of the versatility we had to build into our proving-ground.

Naturally, our new test equipment is a big help to our research engineers, as well as our customers. Now they get performance data on products quickly and accurately. Using it, we can save months, even years, in developing new Worthington fluid and air-handling devices — equipment for which this company has been famous for over a century. For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, N. J.

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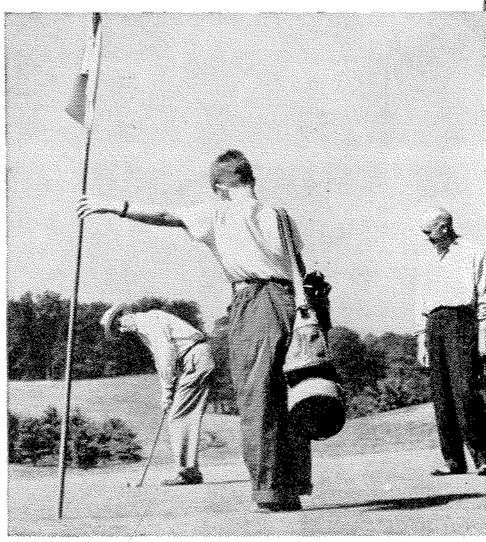
Will your income
and location allow
you to live in a
home like this...
spend your leisure
time like this?

A Douglas engineer lives here



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ALUMNI FUND

Report of the 9th Year — 1955 - 1956

ON MARCH 1, 1956, The Alumni Association established its third full-tuition four-year scholarship for undergraduates.

The Alumni Fund goal of four endowed scholarships can be achieved this coming year.

Alumni contributed $29,000 this year, making a total of $71,000 received towards the four-scholarship objective. A total of $90,000 is needed.

Earnings from this Fund will pay the full four-year tuition for an outstanding high school graduate selected to be a member of each new Freshman class starting at Tech. He wouldn't be at Tech except for your help. Let's finish our Fund goal this year, and get on with the next job.

Undergraduate contributions are tabulated below. The names of all contributors to the Alumni Fund for 1955-56 are listed on the following pages.

—William F. Nash, Jr.
—Robert H. Bungay
Directors in charge of the Alumni Fund 1955-56

NINTH YEAR—1955-56
(As of June 30, 1956)
Alumni Who Took Undergraduate Work at C.I.T.

CLASS	AMOUNT	NUMBER GIVING	AVERAGE GIFT	NUMBER ELIGIBLE	PERCENT OF ELIGIBLE GIVING
Prior 1915	$ 60.00	7	$ 8.57	24	29.2
1915	155.00	5	31.00	8	62.5
1916	20.00	3	6.67	7	42.9
1917	35.00	2	17.50	7	28.6
1918	521.53	7	74.50	30	23.3
1919	100.00	1	100.00	3	33.3
1920	764.00	7	109.14	26	26.9
1921	1,149.00	11	104.45	34	32.4
1922	2,630.00	23	114.35	59	39.0
1923	418.50	12	34.88	48	25.0
1924	740.00	13	56.92	73	17.8
1925	690.00	23	30.00	78	29.5
1926	1,200.00	17	70.59	98	17.3
1927	356.00	28	12.71	89	31.5
1928	257.50	17	15.15	59	28.8
1929	460.00	26	17.69	82	31.7
1930	786.52	26	30.25	101	25.7
1931	503.00	25	20.12	97	25.8
1932	1,436.15	23	62.44	93	24.7
1933	331.00	17	19.47	92	18.5
1934	532.00	30	17.73	103	29.1
1935	505.00	26	19.42	110	23.6
1936	1,521.00	29	52.45	113	25.7
1937	292.50	21	13.93	111	18.9
1938	500.00	33	15.15	125	26.4
1939	300.00	29	10.34	112	25.9
1940	493.50	41	12.04	140	29.3
1941	727.00	35	20.77	128	27.3
1942	458.50	47	9.76	149	31.5
1943	465.00	39	11.92	123	31.7
1944	646.00	52	12.42	207	25.1
1945	459.00	42	10.93	190	22.1
1946	265.00	23	11.52	163	14.1
1947	329.00	34	9.68	144	23.6
1948	556.25	65	8.56	190	34.2
1949	526.00	68	7.74	211	32.2
1950	488.50	45	10.86	183	24.6
1951	353.00	42	8.40	159	26.4
1952	205.50	29	7.09	126	23.0
1953	353.50	30	11.78	135	22.2
1954	125.00	19	6.58	104	18.3
1955	113.00	19	5.95	126	15.1
TOTAL	$22,827.45	1091	$ 20.92	4260	25.6

CONTRIBUTORS TO THE ALUMNI FUND, 1955-1956

1896
Haynes, D. M.

1906
Canterbury, H. H.

1911
Ward, R. V.

1912
Humphrey, N. E.

1913
Koch, L. J., Jr.

1914
Lavagnino, E.
Morse, V. F.

1915
Andrews, R. D.
Burt, E. A.
Holmes, W. M.
Holt, H. B.
Wilcox, C. H.

1916
Chamberlain, B.
DuMond, J. W. M.
Rich, K. W.

1917
Kensey, A.
Richards, R. T.

1918
Dowd, M. J.
Hainsworth, W. R.*
Heywood, G. B.
Hoge, E. R.
Karge, F. W.
Shade, N. R.
Smith, A. A.

1919
La Vene, C. C.

1920
Barton, P. D.
Crosby, P. N.
Ehrenfeld, D.*
Hounsell, E. V.
Hounsell, T. C.
Sawyer, M. A.
Smith, R. C.
Woodbury, R. E.

1921
Case, H. R.
Catlin, A., Jr.
Champion, E. L.
Honsaker, H. H.
Malaby, Z. T., Jr.
Mintie, E. H.
Mullin, W. B.
Raymond, A. L.
Scribner, H. I.
Simpson, C. F.
Stenzel, R. W.

1922
Alles, G. A.
Ames, P. R.
Biddle, C. J.
Bridgeford, F. R.
Clever, G. H.
Darnell, D. W.
Erb, L. H.
Essick, B.
Fleming, T. J.
Hall, A. D.
Hathaway, E. A.
Henny, G. C.*
Honsaker, J., Jr.
Hopper, F. L.
Jasper, W.
Keith, C. R.
Knight, A. W.
Kohtz, R. H.
Marsh, H. N.
Smith, G. K.
Vesper H. G.
Whistler, A. M.
Wilson, W. F.

1923
Baier, W. E.
Bangham, W. L.
Barnett, H. A.
Blakeley, L. E.
Dillon, L.
Fowler, L. D.
Gilbert, W. E.
Lewis, H. B.
Loughridge, D. H.
North, J. R.
Schonborn, R. J.
South, L. G.
Stromsoe, D. A.

1924
Anderson, K. B.
Clark, R. S.
Gandy, E. H.
Goodhue, H. W.
Irwin, E. M.
Jenkins, G. V.
Kalichevsky, V. A.
Layton, E. N.
Losey, T. C.
Maltby, C. W.
Wakeman, C. M.
Wilson, E. A.
Winegarden, H. M.

1925
Alderman, R. E.
Atherton, T. L.
Burmister, C. A.
Clayton, F. C. A.
Dalton, R. H.
Ferkel, A. J.
Freeman, H. R.
Fulwider, R. W.
Hart, E. W.
Heilbron, C. H., Jr.
Henderson, L. P.
Hertenstein, W.
Jones, H. J.
Miller, L. M.
Pauling, L. C.*
Prentice, L. B.
Rivinius, P. C.
Salsbury, M. E.
Schlegel, G. M.
Sellers, W. D.
Simpson, T. P.
Spurlin, C. D.
Stanton, R. J.
Stewart, E. D.

1926
Anderson, A. B.
Baker, J. C.
Ball, A. M.
Dinsmore, D. G.
Edwards, M. W.
Fahs, J. L.
Friauf, J. B.*
Graham, G.
Hastings, J. W.
Kiech, C.
Kinsey, J. E.
Kirkeby, E.
Kossiakoff, A.
Pompeo, D. J.
Schott, H. F.
Serrurier, M.
Van den Akker, J. A.
Wisegarver, B. B.
Wulf, O. R.*

1927
Aultman, W. W.
Bailly, F. H.
Baldwin, M. A.
Baxter, E. R.
Blankenburg, R. C.
Bower, M. M.
Capon, A. E.
Case, J. G.
Creveling, R.
Farrar, H. K.
Gardner, D. Z., Jr.
Gottier, T. L.
Heilbron, R. F.
Hoover, V. A.
Jaeger, V. P.
Loxley, B. R.
Mendenhall, H. E.*
Moore, G. E.
Moore, R. M.
Peterson, H. F.
Peterson, T. S.
Ralston, L. W.
Reynolds, R. W.
Schultz, M. N.
Southwick, T. S.
Stanton, W. L.
Starke, H. R.
Vaile, R. B., Jr.
Warner, A. H.*
Watson, R. M.

1928
Armstrong, R. C.
Beckman, A. O.*
Biddle, S. B., Jr.
Coulter, R. I.
Crosher, K. R.
Evans, R. D.
Gewertz, M. W.
Jacobs, W. M.
Joujon-Roche, J. E.
Kaneko, G. S.
Lash, C. C.
Lindvall, F. C.*
Lombard, A. E., Jr.
McFaddin, D. E.
Millikan, C. B.*
Nichols, D. S.
Noel, F.
Renz, C. F.*
Sechler, E. E.
Shaffer, C. C.
Tuttle, E. E.

1929
Atwater, E.
Baker, B.
Birge, K. R.
Clark, D. S.
Cline, F. R.
Corbin, H. A.
Cravitz, P.
Dunham, J. W.
Evans, T. H.
Exley, S. T.
Findlay, W. A.
Frendendall, B. F.
Grimes, W. B.
Haeff, A. V.*
Hincke, W. B.*
Hugg, E. B.
Huston, H. M.
Keeling, H. J.
Kingman, K. E.
Milliken, D. B.
Myers, A. E.
Niles, J. A.
Raitt, R. W.
Reed, H. C.
Roberts, B.
Rummelsburg, A.
Weismann, G. F.
Wheeler, F. A.

1930
Alderman, F. E.
Atkinson, R. B.*
Barnes, D. P.*
Bechtold, I. C.
Blohm, C. L.
Bode, F. D.
Bungay, R. H.
Butler, A.
Carberry, D. E.
Carlson, C. F.
Clark, J. D.
Crawford, F. G.
Giebler, C.
Hopper, R. E.
Johnson, J. J.
Johnston, N.*
Jones, H. R. E.
Kinney, E. E.*
Levine, E.
Myers, H. G.
Pleasants, J. G.*
Pritchett, J. D.
Ross, G. A.
Sawyer, H. G.
Sheffet, D.
Stirton, R. I.
Thayer, E. M.
Towler, J. W.
Wilkinson, W. D.
Zipser, S.

1931
Arndt, W. F.
Arnold, W. A.
Bolles, L. W.
Boothe, P. M.
Cogen, W. M.
Detweiler, J. S.
Eastman, S. C.
Gerschler, J. M.
Green, E. F.
Gregory, C. H.
Hill, E. S.*
Hoch, W. C.
Kinney, E. S.
Kircher, C. E., Jr.
Kuykendall, C. E.
Langsner, G.
Lehman, R. M.
Lewis, G. E.
McMillan, J. R.
Overhage, C. F. J.
Peer, E. S.
Peterson, R. A.
Pratt, L. D.
Sinnette, J. T., Jr.
Trostel, E. G.
Widess, R.
Wilmot, C. A.

1932
Arnerich, P. F.
Barton, M. V.
Bowden, F. W.
Bowler, G.E.
Bradburn, J. R.
Foss, R. E.
Freeman, R. B.
Graff, D. B.
Harsh, C. M.
Hibbs, F. J., Jr.
Hodge, M. S.
Kent, W. L.
Leermakers, J. A.*
Lyons, P. B.
Maass, R.
Parsons, P. G.
Pruden, W. F.
Roach, H.
Schuhart, M. A.
Sheffet, J.
Shockley, W.
Shull, G. O.
St. Clair, R. W.
White, M. P.
Wilson, C. E.

1933
Barlow, W. H.
Barton, R. C.*
Berkley, G. M.
Clifford, A. H.*
Edwards, E. C.*
Hayes, E. A.
Hofmann, O. D.
Keeley, K. V.
Kemmer, P. H.*
Lewis, W. H.
Libby, A. F.
Mathewson, A., Jr.
Mendenhall, J. D.
Poulson, D. F.
Prater, A. N.*
Randall, J. A.
Root, L. E.*
Scholtz, W.
Sparling, J. N.
Strauss, F. E.
Wattendorf, F. L.*
Wheeler, W. T.
Widess, M. B.
Wilking, A. P.

1934
Babcock, H. W.
Bollay, W.*
Charters, A.
Childers, M. C.
Cleveland, D. L.
Cogen, S.
Craig, C. C.
Donahue, W. R., Jr.
Escherich, R. H.
Felt, R. C.
Gordon, G.
Gulick, H. E.
Haskins, R. W.
Howard, E. R.
Judson, J.
McCann, G.
McFadden, W. C.
McRae, J. W.*
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Newton, C. V.
O'Neil, H. M.
Paxson, E. W.
Pearne, J. F.
Porter, A. F.*
Schaak, F. A., Jr.
Sharp, R. P.
Sherborne, J. E.
Shoemaker, O. H.
Sluder, D. H.
Smith, G. S.
Thompson, A. E.
Ugrin, N. T.
Weaver, G. W.

1935
Baldwin, L. W.
Davenport, H. W.
Davenport, L. B.
Davies, J. A.

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Dewees, N. B.
Etz, A. N.
Fussell, R. G.
Gluckman, H. P.
Halloran, J. J.
Higley, J. B.
Jahns, R. H.
Jennison, J. H.
Jones, R. G.
Ketchum, M. C.
Keyes, W. F., Jr.
Levy, H. A.
Lindsay C. W.
Nies, N. P.
Oliver, B. M.*
Parr, W. S.*
Ray, A. A.
Reynolds, E. H.
Roehm, J. M.*
Sheff, S. D.
Stick, J. C., Jr.
Stuppy, L. J.
Taylor, J. C.
Thomas, C. F.
Willits, V. W.

1936

Best, C. W.
Bolster, C. M.*
Boothe, R. H. F.
Bush, K. T.
Davis, F. W.
Dickinson, H. B.
Dilworth, R. P.
Graham, E. W.*
Hammond, P. H.
Harker, D.*
Heitz, R. G.
Jensen, R.
Johnson, F. L.
Jordan, C. B.
Klocksiem, J. P.
LaBoyteaux, E.
McIntyre, R. A.
McMahon, M. M.
Morse, C. A.
Muller, C. R.
Ostergren, R. H.*
Peugh, V. L.
Ramo, S.*
Schneider, P. J.
Serrell, P. V. H.
Spalding, L. P.
Stitt, F. B.*
Swanson, W. E.
Thompson, T.
Unholtz, K.
Vermeulen, T.
Veysey, V. V.
Watanabe, K.
Whipp, D. M.
Wooldridge, D. E.*

1937

Brice, R. T.*
Briggs, S. W.
Carrick, H. H., Jr.
Carroll, G. E.
Edwards, J. S., Jr.
Feuer, S. I.
Frost, H. H.
Harris, D. R.*
Johnson, C. B.
Kinley, J. C.
Levinton, H. L.*
Lipson, S. L.*
Lloyd, P. E.*
Lockwood, R. B.
Miller, H. H.
Miller, N. H.*
Miller, W. B.
Moore, W. L.
Nichols, D.
Poggi, M. J.
Ridgway, R. L.
Schaffner, P. C.
Strong, F.*
Sullwold, J. L.
Summerfield, M.*
Walley, B.
Webster, M. H.
Wiley, H. F.*
Wyckoff, P. H.*
Wylie, W. G.

1938

Althouse, W. S.
Baker, J. R.
Bertram, S.
Boller, H. B.
Bower, C. D.
Cardwell, W. T., Jr.
Clarke, C. W.
Davidson, D. D.
Davis, L.*
Davis, T. V.
Dixon, B. A., Jr.
DuFresne, A. F.
Ellis, H. B.
Farneman, J. D.
Farnham, D. W.*
Friend, C. F.
Henshaw, P. C.*
Hopkins, H. S.
Ives, P. T.*
Jack, S. S.*
Jewett, F. B., Jr.
Johnson, E. A., Jr.
Jurs, A. E., Jr.
Keller, S. H.
Koch, W. L.*
Milburn, W. E.
Nagamatsu, H. T.
Nash, W. F., Jr.
North, H. Q.
Nunan, J. K.*
Olds, R. H.
Osborn, E. F.*
Reamer, H. H.*
Robinson, C. F.*
Sherwood, D. M.
Van Horn, J. W.
Wald, G., Jr.
Warren, D. R.
Watson, S. E., Jr.
Weinberger, E. L.
Wilson, G. P.
Wood, H. J.

1939

Anderson, C. R.
Battle, J. A.
Beanfield, B. F.*
Beck, D. W.
Bishop, R. H.
Brown, P. H.
Cabeen, W. R.*
Carstarphen, C. F.
Carter, R. T.
Crozier, G. O.
Devirian, P. S.
Drescher, A. B.*
Fischer, R. A.
Goodell, J. H.
Green, W. M.
Hance, H. V.
Horowitz, N. H.*
Knoblock, F. D.*
Levet, M. N.
McKinlay, J. R.
Macleish, K. G.
Morikawa, G. K.
Pullen, K. A.
Radovich, F.
Roudebush, B. V.
Ruggiero, R. J.
Smith, M. F.*
Smith, P. L.
Smith, P. E.
Snyder, W. M.
Stones, J. E.
Stosick, A. J.*
Sullivan, E. F.
Tregidga, A. C.*
VanDusen, L. W.
Wilson, J. N.*
Winchell, R. W.
Zumwalt, L. R.*

1940

Barber, G. C.
Blackinton, R. J.
Brewer, A. F.
Brewer, L.
Brown, G. R.
Brunner, F. C.
Burton, C. C.
Crockett, H. C.*
Daams, G.
Dickerson, E. O.
Doolittle, R.*
Fox, S. W.*
Glassco, R. B.
Grigg, R. W.
Harper, J. C.
Helfer, R.*
Jongeneel, J. W.
Kohl, J.
Kupfer, D. H.
Larson, W. R.
Laue, E. G.
Lemm, W.
Loeffler, D. E.
Moore, R. S.
Nagle, D. E.
Palmer, C. S.
Phillips, R. A.
Quarles, M. W., Jr.
Reynolds, H. W., Jr.
Richards, R. G.
Russell, C. D.*
Samuel, H. D., Jr.
Sandiford, P. L., Jr.
Scarborough, W. B.
Smith, R.
Staatz, M. H.
Steinmetz, D. H., III
Stone, N. C.
Stone, W. W., Jr.
Stoner, W. A.
Sumner, H. C.*
Tielrooy, J.
Todd, G. J.
Weir, G. B.
White, H. J.
Whittlesey, D.
Wilts, C. H.
Wouk, V.*
Young, R. B.

1941

Acker, R. M.
Bersbach, A. J.
Bowles, R. R.
Bramhall, G. H.
Brandenberger, L. J.
Brooks, P. D.
Chapin, W. F.
Clarke, F. W.
Corcoran, W. H.
Davis, W. Z.
Dawson, D. E.
Dobbins, W. E.
Elliott, Q.
Eusey, M. V., Jr.
Gally, S. K.
Greenhalgh, F. M.
Hall, E. A.*
Harris, F. S., Jr.*
Ikawa, M.
Jones, G. A.
Jones, J. A.
Leighton, R. B.
Lewis, J. W.
Lockard, F. P.*
Partlow, J. G.
Richardson, J. M.
Rominger, J. F.
Rupnik, J. J.*
Silberstein, R. F.
Skalecky, F. H., Jr.
Sohler, S. E.
Spikes, J. D.
Stewart, W. A.
Truesdell, C. A.
Vey, E.
Wahrhaftig, A. L.*
Wahrhaftig, C. A.
Wallace, R.
Weight, R. H.*
Widdoes, L. C.
Wood, D. S.

1942

Albrecht, A. P.
Allan, J. R.
Almassy, G. W.
Andrews, R. A.
Atkinson, T. G.
Baird, H. A.
Bartlett, E. R., Jr.
Bauer, F. K.
Brown, C. M.
Brown, S. W.*
Church, S.*
Cox, R. H.
Crater, W. D.
Felberg, F. H.
Franzini, J. B.
Freeman, J. C., Jr.*
Fuller, W. P., Jr.*
Gold, S. K.
Goldin, R.*
Green, E. A.
Greenwood, R.
Grossberg, A. L.
Hall, R. N.
Hendrickson, W. J.
Holzman, G.
Howell, B. F., Jr.*
Hunt, C.
Irving J. H.
Kennedy, W. G.
Kirtley, T. L.*
Kumm, E. L.
Lutz, P. B.
McClain, J. F., Jr.
McCornack, R. W.
McKibben, P. S.
MacRostie, W.
Mader, P. M.
Miles, J. W.
Moore, R. L.
Nyborg, M. M.
Osborne, H. G.
Paul, A. D.
Pearson, C. W.
Rogers, W. L.
Rubel, J. H.
Savit, C. H.
Seegman, I. P.
Shapiro, H.
Skinner, M. J.
Smith, J. C.*
Smith, L. W.
Spurr, R. A.*
Tomlinson, E. P.*
Urbach, K.
Veronda, C. M.
Webster, P. W.
Weller, L. A.

1943

Bacon, J. W., Jr.
Bishop, A. S.
Brown, E. I.
Buchanan, J. W.
Carter, C. L.
Christianson, W. L.
Dazey, M. H.
Dubbs, C. A.
Elmer, D. A.
Farmer, H. W., Jr.
Flavell, E. W.
Fleischer, E. P.
Frost, R. C.
Garner, H. K.
Granicher, D. I.
Griffith, G. D.
Hodder, W. K.
Johnson, K. W.
Jones, W. L.
Kendall, G. A.
Lassen, H. A.
Lawrence, T. G.
Lee, T. S.
Lingle, H. C.
McGee, C. G.
Mattson, D. F.
Miller, H.
Morgan, S. P., Jr.
Neufeld, L. N.
Otvos, J. M.*
Powlesland, K. L.
Ridland, A. C.
Schamberg, R.
Sherwin, R. M.
Siu, R. G.*
Steinle, S. E.
Stirling, C. W.*
Strickland, C. P.
Sutton, R. A.
Tenney, F.
Terrell, O. D.
Warnken, J. P.*
Wheelock, W. S.

1944

Abrams, L. S.
Allingham, R. E.
Almquist, C. G., Jr.
Andrews, T. W.
Bair, W. P.
Barnes, F. A.
Beauchamp, E. E.*
Behrens, F. A., Jr.
Bond, W. H.
Buhler, R. D.*
Buller, J. S.
Carter, T. A., Jr.
Chadwick, J. H., Jr.
Dixon, H. H.*
Earl, J. B.
Fillippone, W. R.*
Furer, A. B.*
Green, L., Jr.
Greenwood, D. T.
Grimm, L. L.
Hall, E. S.
Hamilton, W. R.
Higgins, H. M.
Hughes, W. H.
Hunt, C. W., III
Johnson, R. S.
Jopson, R. C.
Kerr, J. G.
Kettler, J. R.
Klock, R. W.
Kott, W. O.
Kuhns, R. E.
Lester, R. W.
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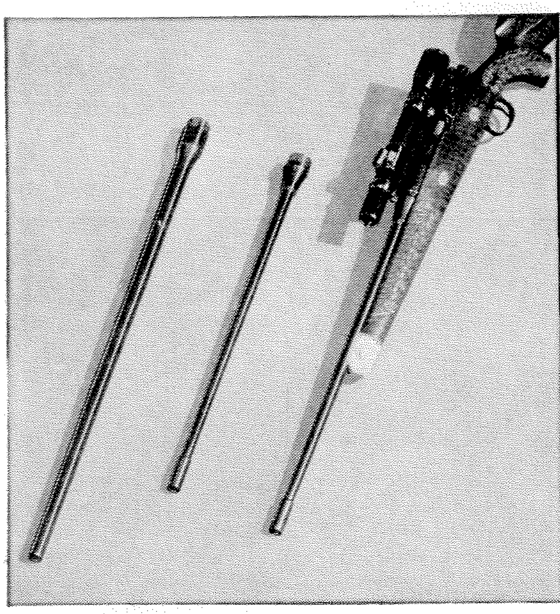
Another page for YOUR STEEL NOTEBOOK

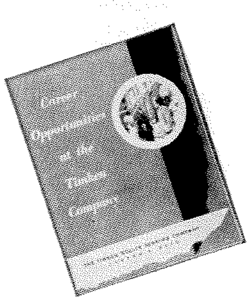
The rifle barrel steel that makes hunting more fun

A .30/06 rifle can get heavier toward nightfall! That's why a prominent gunsmith never gave up looking for a new steel—one that would be lighter, would machine readily, and yet would take the enormous firing stresses of even heavier calibers. Steels normally used for lightweight barrels gave all kinds of trouble to the gunsmith: distortion, poor finish, high tool costs, trouble with drilling, reaming, rifling. They took this problem to Timken Company metallurgists—and got the perfect solution.



This TIMKEN® rifle barrel steel is free from internal stresses

Developed by the Timken Company, this new steel (center barrel, in picture) made possible a rifle barrel 6″ shorter, 2 lbs. lighter than the previous barrel of the same caliber (left). It withstands the wear of thousands of rounds of firing. Machines to highest accuracy—and to high finish beauty. Machines without distortion. Drills, reams and rifles perfectly. Proof tests to 70,000 lbs. per sq. inch for safety in a .30/06. Has handled overloads up to 100,000 lbs. per sq. inch. Timken Company metallurgists are leading specialists in fine alloy steels . . . as this remarkable new steel will testify.



Want to learn more about steel or job opportunities?

Some of the engineering problems you'll face after graduation will involve steel. "The Story of Timken Alloy Steel Quality" will help you learn more about steel. And you might be interested, too, in the excellent job opportunities described in "Career Opportunities at the Timken Company". Drop us a card, ask for one or both booklets. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN *Fine Alloy* STEEL

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Mitchell, J. A.
Morris, F. W., Jr.
Nahas, R. T.
Nelson, J. B.
Parks, R. J.
Phelps, J. M.
Proctor, H. B.
Riffenburgh, R. S.
Sandell, W. R.
Schnacke, A. W.
Scott, W. R., Jr.
Shor, G. G., Jr.
Sigworth, H. W.
Smith, F. C., Jr.
Smith, G. F.
Soike, R. J.
Solomon, J.
Warren, J. C.
Winter, P. H.

1945

Austin, D. H.
Ball, H.
Bennett, R. R.
Brough, H. W.
Cardall, J. D., Jr.
Cutler, C. R.
Dandliker, W. B.*
Davis, C. M.
Davy, L. H.
Day, F. M.
Dodder, D. C.
Drake, J. H.
Francis, D. L.
Gardner, P. R., Jr.
Gerber, R. C., Jr.
Gerpheide, J. H.
Grossberg, T.
Hall, L. G.
Harrington, J. S.
Honey, R. C.
Hook, J. F.
Howe, R. M.
Jackson, C. T.
Kiechhefer, R. J., Jr.
Killian, R. G.
Levin, L. H.
MacDougall, D. D.
McDonell, W. C.
Marshall, W. M., III
Parker, W. H., Jr.
Parks, J. W.
Reed, R. J.
Schmoker, R. F.
Shauer, K. M.
Stefanoff, J. J.
Stern, J. L.
Stevenson, K. M.
Stone, C. R.
Tillman, D. C.
Tookey, R. C.
Traverse, D. K.
Vernier, B. R.
White, R. S.
Williamson, M. A.*
Wright, E. B.*

1946

Bates, S. R.
Benton, P. H.
Bongardt, W. G.
Calligeros, J. P.
Clapp, R. W.
Deodati, J. B.*
Essig, F. C.
Fleming, J. E.
Gephart, H. L.*
Greenfield, H. L.
Grube, R. H.
Hall, L. A. R.*
Haupt, L. O., Jr.
Horton, W. F.
Jessen, H. E.
Kuck, R. G.
Lamson-Scribner, F. H., Jr.
Lewis, C. H.*
McEwen, C. R.
Neale, E. G., Jr.
Nurre, V. W.
O'Reilly, J. D.*
Pounder, E.
Schuster, R. P., Jr.
Sease, J. W.*
Smith, R. A.*
Steele, H. M., Jr.
Strong, H. W., Jr.
Stuart, J. W., Jr.
Tingley, E. M., Jr.*
Weber, G. P.*
Wilburn, W. C.*

1947

Anthon, H. S.*
Austin, G. A. (In Memory of)
Bearson, R.
Beymer, E. H.
Biehl, A. T.*
Bolles, A. S.
Caldwell, D. O.
Comlossy, H., Jr.
Cowan, E. J.
Critchlow, A. J.
DeGroff, H. H., Jr.*
Demuth, O. J.
Deniston, J. J.
de Witte, L.*
Douglas, D. L.
Freebairn, D. L., Jr.
Haas, W. M. B.
Hardy, G. F.
Harris, R. B.*
Hawthorne, R. G.
Hedrick, L. C.
Hipsh, H. M.
Hodges, M. E.
Keck, H. C.*
Lewis, H. K.
Lund, L., Jr.
McCourt, A. W.*
MacNeal, R. H.*
Marschner, B. W.*
Meier, D. J.
Miller, C. N.
Moore, R. F.
Oswald, T. W.*
Parkin, B. R.
Pauw, A.*
Peterson, N. C.*
Rasmussen, C. F.
Riedel, J. C.
Roney, R. K.*
Rosener, J., Jr.
Roshko, A.*
Russell, W. T.*
Shaw, C. B., Jr.
Shoemaker, D. P.*
Six, L. D.
Smith, J. S.
Spaulding, C. P.*
Stevens, F., Jr.*
Thomas, D. W.*
Vadhanapanich, C.
Williams, M. L.*
Winters, E. B., Jr.
Yankauskas, P. C.*

1948

Bagley, A. S.
Barlow, G. C.
Baugh, H. W.
Bayley, R. M.
Beder, E.
Blenkish, P. G.*
Bloom, J. L.
Boutelle, G. W.
Brown, J. R.*
Brown, R. J. S.
Burt, F. B.
Butler, S. M., Jr.
Caprio, J. M.
Chope, H. R., Jr.*
Christopherson, W. A.
Clark, A. R.*
Cox, A. N.
Davis, W. K.
Deutsch, D. H.
Dickson, E. B.*
Dixon, W. J.
Ellis, H. M.*

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Fund Contributors . . . CONTINUED

Elms, J. C.
Ferguson, R. W.
Ferrell, R. A.
Fletcher, J. C.*
Fletcher, T. C.
Fullerton, P. W., Jr.
Garber, M.
Gleghorn, G. J., Jr.*
Glover, P. N.
Gray, R. A.*
Green, H. W.
Harrison, S. R.
Harrison, W. D.
Heppe, R. J.*
Hybertsen, H. M.
Kaplan, A.
Kaplun, S.
King, R. I.
Lang, T. G.
Lewis, H. B., Jr.
Lovelace, D. E.
McEuen, A. H.
MacMillan, R. S.
Markowitz, I. L.
Maurus, R. A., Jr.
Mitchell, G. H., Jr.
Moody, C. C. B.
Moore, H. J., Jr.
Mullen, J. K.
Murphy, C. G.
Paul, C. C.*
Phillips, E. V.*
Poindexter, R. W.
Reed, A. W.*
Rigsby, G. P.
Roberson, H. L.
Robinson, L. A.*
Roehm, R. M.
Rypinski, C. A., Jr.
Scheck, F. F.
Scott, G. R.
Sefton, W. E.
Silliker, D. L.
Spellmann, R. A.
Spooner, M. E., Jr.
Steenson, B. O.*
Stix, T. H.
Strain, D. C.
Susskind, C.
Talmadge, R. B.
Tang, K. K.
Tasker, R. B.
Thomas, J. W.*
Ure, R. W.*
Waters, A. E., II
Wechsler, J. W.
Wenzel, W. A.*
Wilkinson, D. P.
Williamson, W. J.
Wimpress, J. K.*
Worcester, B. A.
Zacharias, R.

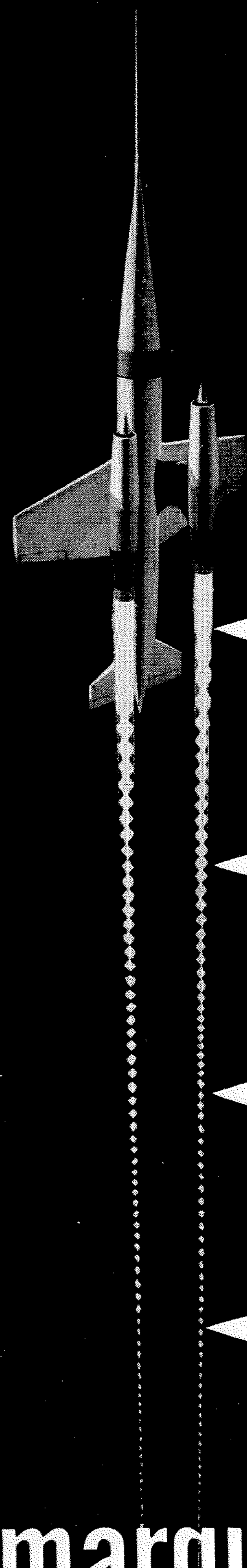
1949

Allinder, F. S., Jr.
Andres, J. M.
Archer, W. E.
Basham, W. L.
Berry, V. J., Jr.*
Beveridge, J. H.*
Brown, D. R.
Bryson, A. E., Jr.*
Cagle, B.*
Carter, H. C.
Carus, M. B.
Comstock, G. E., III*
Curray, J. R.
Danielson, W. E.
Darling, R. E.*
Dolan, E. J.
Doolin, W. A.
Drapes, A. G.
Dufort, E. C.
Englar, C.
Fisk, E. P.
Fletcher, A. N.
Forester, R. D.
Funk, R. B.
Gardiner, K. W.
Garrett, J.*
Gift, M. F., Jr.
Harris, P. B.
Harris, W. N.
Hayward, D. K.
Hayward, P.*
Herzig, W. M.
Hubay, P. W.
Iura, T.*
Karzas, W. J.
Kashiwabara, N.
Keinonen, F. W.
Kermeen, R. W.
Kidder, P. H.
Knight, C. H., Jr.
Kohnen, K. D.
Kostelac, J. F.
Lane, C. A.
Lawford, V. N.*
Liberman, D. A.
Love, J. R.
McIntosh, J. A.*
McKay, R. A.
McPhate, J. A.
Machetanz, F. A.
Mann, E.*
Mitchell, O. L.
Morgan, G. R.
Morrison, R.
Muehlberger, W. R.
Myers, R.
Paine, W. O., Jr.
Patterson, R. L.
Peterson, D. W.
Petrulas, T. G.
Pilling, R. R.
Powell, D. O.
Prevost, W. G.
Riise, H. N.*
Roesch, W. C.*
Rose, T. W.
Rosicky, F. G.*
Ryder, D. D.
Saltman, P. D.
Satre, L. H.
Schneider, F. C.
Shelton, F. H.
Shibata, H. H.*
Simons, W. H.
Six, G. D.
Smith, W. W., Jr.*
Stewart, R. M., Jr.
Sundsmo, A.
Terriere, R. T.
Terwilliger, K. M.
Vaughan, P. A.*
Vogel, M. C.
Vreeland, T., Jr.
Walquist, R. L.
Ward, W. W.*
White, J. L.
Wilts, J. R.*
Witkin, D. E.*
Woods, W. C. A.

1950

Baker, D. R.
Bartz, D. R.*
Bass, L. J.
Blom, C. J.
Brooks, M. C.*
Buck, R. P.
Burriss, W. L.
Calhoun, W. D.
Cockell, L. C., Jr.
Cox, W. P.
Dayman, B., Jr.
Erickson, R. A.
Fink, N. S.
Frick, L. F.*
Gage, B. M.
Greene, J. M.
Hakala, P. E.*
Hall, M. A.
Howell, P. A.
Humphrey, F. B.
Katz, L.
Kendall, D. V.
Kiceniuk, T.*
Knipe, R. H.
Korkegi, R. H.*
Lynn, S.
McCaldin, J. O.
McLellan, A. E.
McLellan, W. H.
MacAllister, R. V.*

* *graduate degree only*



Fund Contributors . . . CONTINUED

MacKenzie, D. B.
Markoff, D.
Marks, C.
Meghreblian, R. V.*
Mosich, J. T.
Pastan, H. L.*
Picciotto, R. A.
Pinckard, J. H.*
Proud, W. H.
Quandt, R. L.
Rains, D. A.
Reinceck, H. E.
Riesenfeld, W. B.
Robertson, G. D.*
Ross, M. N.
Rutherford, J. B.*
Schroeder, D. C.
Schuyler, A. H., Jr.
Solomon, G. E.*
Spencer, E.
Stillman, D. W.
Stone, R. J.
Stowe, B. B.
Strauss, B. S.*
Weeks, L. W.
Wikholm, W. A.
Wilmarth, W. W.*
Worrell, E. A.
Wright, R. B.
Zwick, S. A.

1951

Adler, R. G.
Ahlers, R. H.*
Baily, F. G.
Bible, R. E.
Bieler, B. H.
Blanchard, D. M.
Boblett, E. V.
Bookee, J. R.
Boyer, R. G.
Brown, E. A., Jr.*
Bunker, R. S.
Butler, T. J.
Caldwell, R. T.
Carter, J. M.*
Cavers, S. D.*
Clark, B. H.
Cleland, G. H.*
Cobb, R. E.
Connelly, R. F.
Denton, J. Q.
Edwards, W. G.
Elder, J. K.
Fee, J. R.
J. V. Hallstrom
J. Hermann*
Homewood, R. H.*
Hooper, F. L.
Ibers, J. A.
Ito, H.
Jaskowsky, W. F.*
Johnston, J. B.
Joyner, T. B.
Kamei, H.
Kendrick, J. B.*
Kinkel, J. F.
LeMay, D. B.
Madden, R. W.
Martin, H. F.
Merkel, G.
Merritt, R. G.*
Mickey, F. E.*
Narud, J. A.
Nuno, R. K.
Paigen, K.*
Pardee, R. S.
Paulson, C. T.
Pfeiffer, W. F.
Plapp, J. E.*
Ragon, R. B.
Rathje, D. S.
Sawyer, G. M.
Schmid, D. W.
Sharp, R. S.
Staples, D.*
Steese, C. M., Jr.
Sutcliffe, H.*
Walp, R. M.
Wylly, A.*

1952

Aagaard, P.
Abt, H. A.*
Arthur, P. A.*
Bader, M.
Baier, R. W.
Becker, J. L.*
Bettman, M.*
Blair, R.
Butler, S. E.
Callaghan, M.
Cook, S. P.
Cram, E. R.*
Cuff, L.
Davis, R. S.
Dickinson, R. R.
Ghauri, W. K.
Greene, M.
Groner, S.
Hanna, D. L.
Holm, R. J.*
Howell, J. L.
Irwin, W. W.
Israelsen, B. P.
Johnson, H. E.*
Karasawa, R. Y.
Kelly, P. M.*
Larson, C. V.
Lee, D. A.
Love, D. R.*
Perpall, R. C.
Phillips, R. M.
Preston, H. G.
Quon, P.*
Rogers, J. J. W.
Russell, T. L.
Schlipf, L. H.*
Serdengecti, S.*
Snider, A.
Staten, W. H.*
Stegall, G. E.*
Thayer, P. S.*
Von Herzen, R.
Webber, W.
Wise, W. L.
Y-T Wu, T.*

1953

Anderson, C. A., Jr.,
Asakawa, T.
Atkinson, J. H., Jr.*
Beale, W. T.*
Benjamin, C. E.
Borougbs, H. J.*
Cantrell, C. R., Jr.
Carpenter, H. J.*
Cosand, N. H.
Curran, D. C.*
Daw, E. H.
Delcamp, J. N.
Eager, W. J.
Gardner, W. D.
Gartner, G.
Gee, J. D.
Haire, A. M.
Haskell, R. A.*
Hendrickson, J. A.
Hunt, H. R.*
Ireland, R. O.
Jenkins, W. A., II*
King, K. R.
McCormick, W. D.
Mager, A.*
Marshall, D.
Moore, G. H.
Nicholson, K. F.
Ogawa, H.
Ogilvie, J. M.
Rambow, C. A.
Ross, G. H.
Shear, H.
Spencer, R. L.
Stevens, D. F.
Stockebrand, T. C.
Stofel, E. J.
Sutton, G. W.*
Taylor, T. T.*
Walker, J. D.
Wallcave, L.*
Warmanen, L. A.*
Willens, R. H.

1954

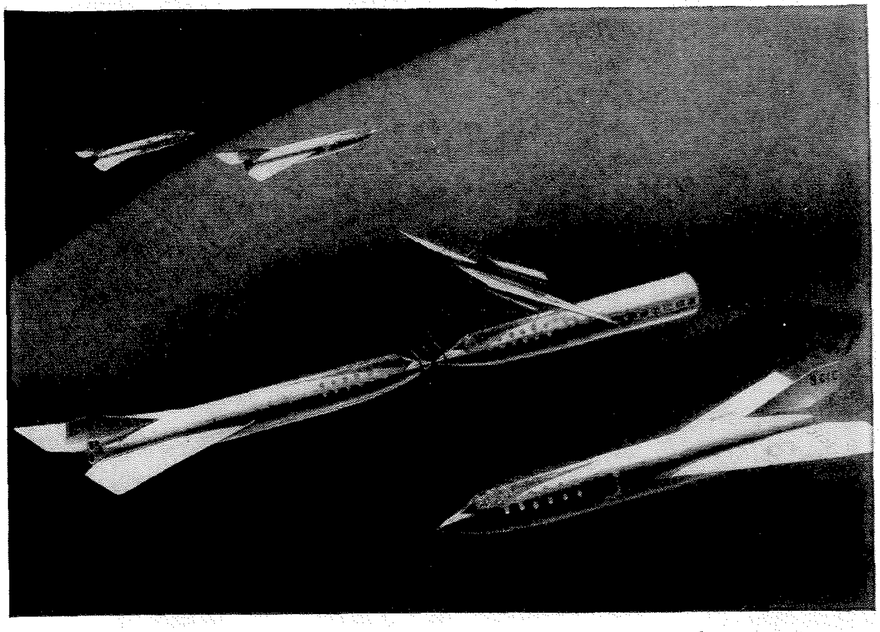
Abbott, J. L.
Anderson, W. F.*
Anson, F. C.
Autrey, S. W.
Boyd, G. D.
Cameron, S. A.
Caughey, T. K.*
Chamberlain, S. J., Jr.*
Concus, P.
Crosby, J. C.
Croswhite, H. L.
Dikkers, R. D.*
Dryden, F. D.
Dunn, C., III
Eklund, L. G.*
Evleth, E. M., Jr.
Gauss, E. J.
Gillespie, F. E.*
Johnson, H. E.
Kennedy, M.*
Kidder, J. N.
Lynam, R. W.
Miller, P. D.
Mitchell, J. C.
Murray, J. J., Jr.*
Peyton, J. J.
Potter, D. B.*
Richards, L. W.
Rowley, J. K.*
Void, R. C.*
Wallerstein, G.*

1955

Ames, J. E.
Barrios, A. A.
Biggers, W. D.
Cestari, V. M.
Cochran, R. R.
DeWiest, R. J. M.*
Furshpan, E. J.*
Graetch, J. E.
Howard, W. M.*
Jali, R. M.
James, G. T., Jr.*
Johnson, C. W.
Lewis, J. P.
Lindley, W. B.
Lombardi, O. W.
Manatt, S. L.
Mandell, J. D.*
Menetrey, W. R.
Miles, R. F., Jr.
Parkill, S. F.
Ragsac, R. V.*
Shumate, P.
St. Clair, C. S.
Stuart, J. L.*
Teague, A. J.
Welch, D. E.
Wilson, D. M.*
H-T Yang*

* *graduate degree only*

MARS outstanding design SERIES



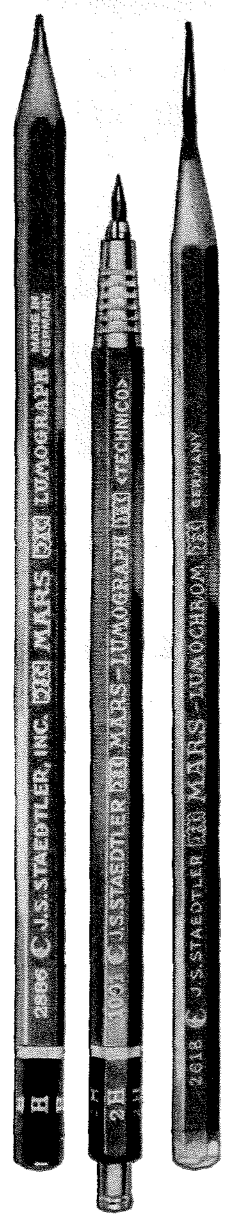
birth of a satellite

Most new ideas, like this inhabited satellite, start out as drawings on a sheet of paper. Here artist Russell Lehmann shows the first step in building the space station proposed by Darrell C. Romick, aerophysics engineer at Goodyear Aircraft.

Two ferry ships, one stripped of rocket units, are joined end to end. As others are added, this long tube forms temporary living quarters for crews. Eventually, outer shell will be built around core, making completed station 3,000 feet long, 1,500 feet in diameter.

No one can be sure which of today's bright ideas will become reality tomorrow. But it is certain that in the future, as today, it will be important to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars — from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

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Mars Outstanding Design Series—featured in the current advertising of J. S. Staedtler, Inc.—has attracted widespread attention among the users of fine drafting pencils. It has fulfilled our expectation that the men who appreciate the finest working tools are those with a lively creative interest in new designs, new projects, new ideas.

Concerned with unusual projects—*designs of the future*—Mars Outstanding Design Series provides a "showcase" for originality, for interesting work of engineers, architects, and students which so often lies buried. To stimulate you to send in *your* designs, Mars Pencils

will pay you $100

for any design accepted. This $100 is paid you simply for the right to reproduce your project in the Mars Outstanding Design Series. There are no strings attached. You will be given full credit. (See ad on this page—one of the ads in the current series.) All future rights to the design remain with you. You can reproduce it later wherever you like and sell or dispose of it as you wish.

The subject can be almost anything —aviation, space travel, autos, trains, buildings, engineering structures, household items, tools, machines, business equipment, etc. It should be a project that appeals to design-minded readers, be of broad interest, and be attractively presented. Do not submit a design that has been executed. As a matter of fact, the project does not need to have been planned for actual execution. It should, however, be something that is either feasible at present or a logical extension of current trends. It cannot be unrealistic or involve purely hypothetical alterations of natural laws.

There is no deadline for entries but the sooner you send yours in, the greater the probability of its use as one of the subjects in the 1957 Mars Outstanding Design Series.

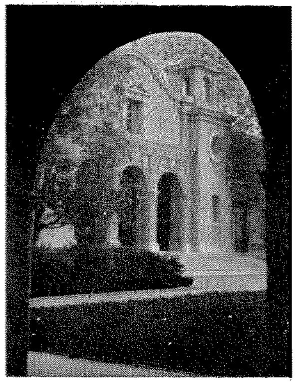
It Is Simple To Submit a Design For Mars Outstanding Design Series

Just mail in an inexpensive photostat or photocopy of the subject—one you can spare, since it cannot be returned.

If your entry is accepted, we will ask you to send in a sharp photograph of the design, or the design itself, so that we can make a sharp photograph suitable for reproduction—after which it will be returned to you promptly.

Send your entry to:

J.S. STAEDTLER, INC.
DICAROLIS COURT, HACKENSACK, NEW JERSEY



CALTECH CALENDAR

ALUMNI EVENTS

October 13	Homecoming Game and Dance
November 8	Fall Dinner Meeting
January 17	Winter Dinner Meeting
February 9	Dinner-Dance
April 6	Alumni Seminar
June 5	Annual Meeting
June 29	Annual Picnic

CALTECH ATHLETIC SCHEDULE

VARSITY FOOTBALL

October 6—
Redlands at Caltech (Rose Bowl)

October 13—
Pomona-Claremont at Caltech (Rose Bowl)

October 20—
Caltech at Barstow Marines

October 27—
Caltech at Whittier

November 3—
Cal Poly (SD) at Caltech

November 9—
Caltech at Occidental

November 17—
Caltech at La Verne

FROSH FOOTBALL

October 13—
Whittier at Caltech

October 20—
Occidental at Caltech

October 27—
Caltech at Pomona-Claremont

November 3—
No Game

November 10—
Caltech at Redlands

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 P.M.

October 19—
Element Synthesis in the Stars—
Dr. William A. Fowler

ALUMNI ASSOCIATION—CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California
BALANCE SHEET—As of June 30, 1956

ASSETS		
Cash in Bank		$ 291.81
Postage Deposit		148.47
Investments:		
Share in Consolidated Portfolio of C.I.T.		
6-30-56 Prior to current year capital gain	$38,246.86	
Share in Savings Account	12,014.74	
Total Investment		50,261.60
Furniture & Fixtures (at nominal amount)		1.00
Total Assets		$50,702.88
LIABILITIES		
Accounts Payable	$ 275.62	
1956-57 Membership Dues paid in advance	6,284.00	
Total Liabilities		$ 6,559.62
RESERVES		
Life Membership Reserves:		
Fully paid life memberships	$36,700.00	
Payments on life memberships under the installment plan	—0—	
Total Reserves		$36,700.00
SURPLUS		
Surplus June 30, 1956	$ 5,645.84	
Provisions for Directory June 30, 1956	1,797.42	
Total Surplus		$ 7,443.26
Total Liabilities, Life Membership Reserve, and Surplus		$50,702.88

STATEMENT OF INCOME—For the Year Ended June 30, 1956

INCOME		
Dues		$10,661.85
Less: Subscriptions to Engineering and Science Monthly for Association Members		8,170.50
Net Income from Dues		$ 2,491.35
Income from Consolidated Portfolio of C.I.T.	$ 1,827.45	
Investment Income and Interest Income	423.61	2,251.06
Program and Social Functions:		
Income	$ 3,460.75	
Expense	3,297.97	162.78
Annual Seminar:		
Income	$ 3,051.00	
Expense	2,730.74	320.26
Sundry Income		45.89
Net Receipts		$ 5,271.34
EXPENSES		
Administration:		
Directors' Expenses	$ 295.28	
Postage	733.29	
Printing & Supplies	737.81	
Total Administration	1,766.38	
Alumni Membership Solicitation	620.63	
Fund Solicitation	879.18	
Publications Committee	13.10	
Total Expense		3,279.29
Net Income		$ 1,992.05
Less: Directory Appropriation		1,050.00
Net Income to Surplus		$ 942.05

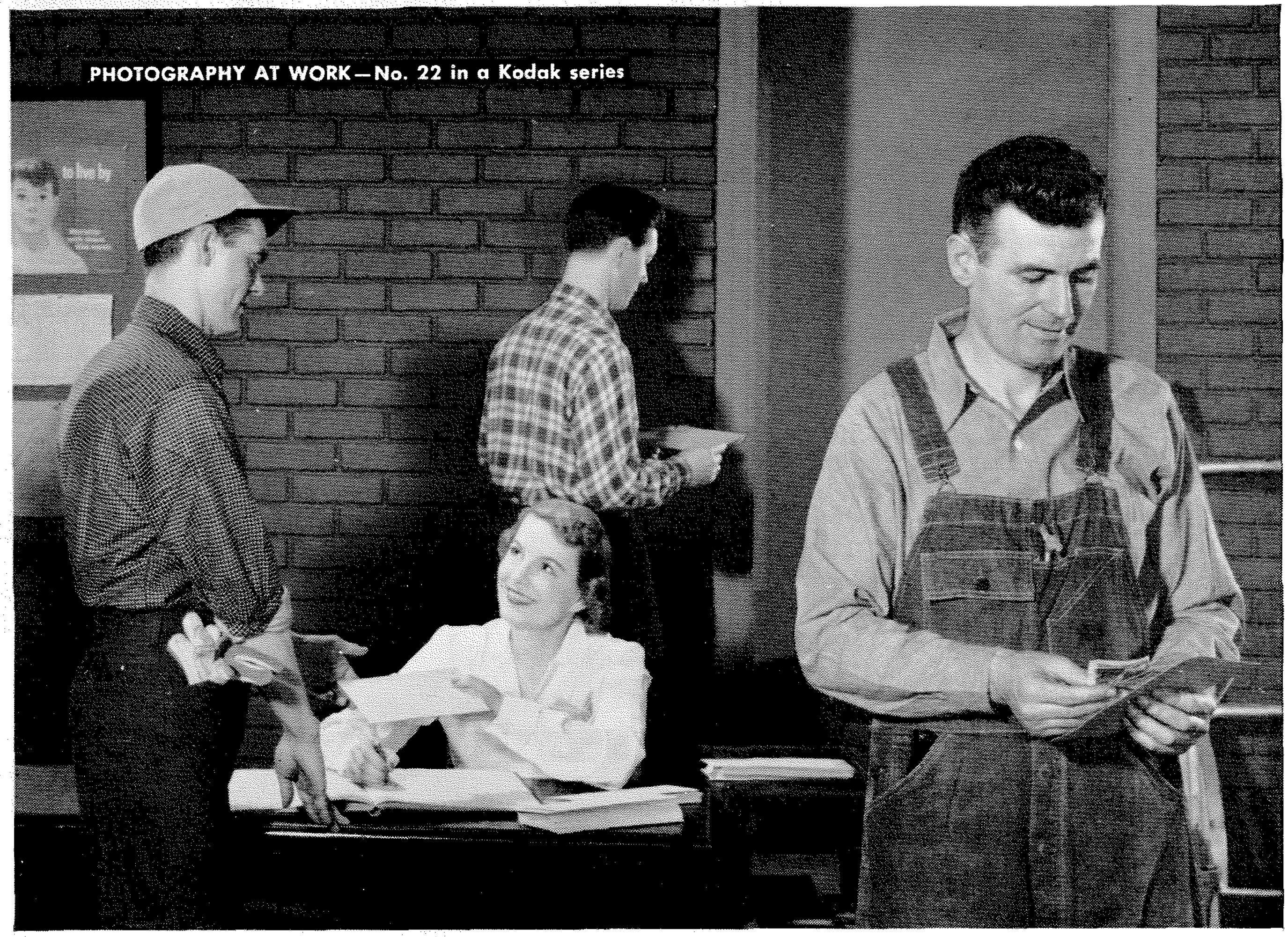
AUDITOR'S REPORT

Alumni Association—California Institute of Technology
Pasadena, California

I have examined the Balance Sheet of the Alumni Association, California Institute of Technology as of June 30, 1956, and the related Statement of Income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

In my opinion, the accompanying Balance Sheet and Statement of Income present fairly the financial position of the Alumni Association, California Institute of Technology at June 30, 1956, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

September 5, 1956 — DALE J. STEPHENS, Public Accountant, South Pasadena



Photography moved in, and...

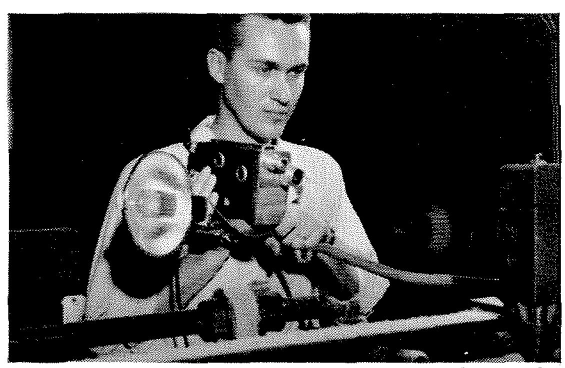
Out went the Doubts about Payroll Arithmetic

With some 2000 counters on their looms, the Fulton Bag and Cotton Mills faced the task of fast and accurate readings. Camera and film do the job in a fraction of former time and provide a conclusive record.

At Fulton Bag and Cotton Mills, employees are paid according to hand and pick "clocks" on their looms. It used to take 24 man-hours daily to read those meters. And there was always the chance of human error that could not be confirmed or denied at a later date.

So photography was put to work. Now the click of a camera shutter gets an accurate permanent record. No more doubts—no room for suspicion—everyone is happier. And "reading time" has dropped two-thirds. What's more, this has given Fulton a daily loom-by-loom check on the efficiency of its machines.

Building employee morale, checking efficiency, saving time and money are just samples of what photography is doing for business and industry.



A motion picture camera, adapted for single shots with "strobe" flash, snaps thousands of readings on a roll of film.

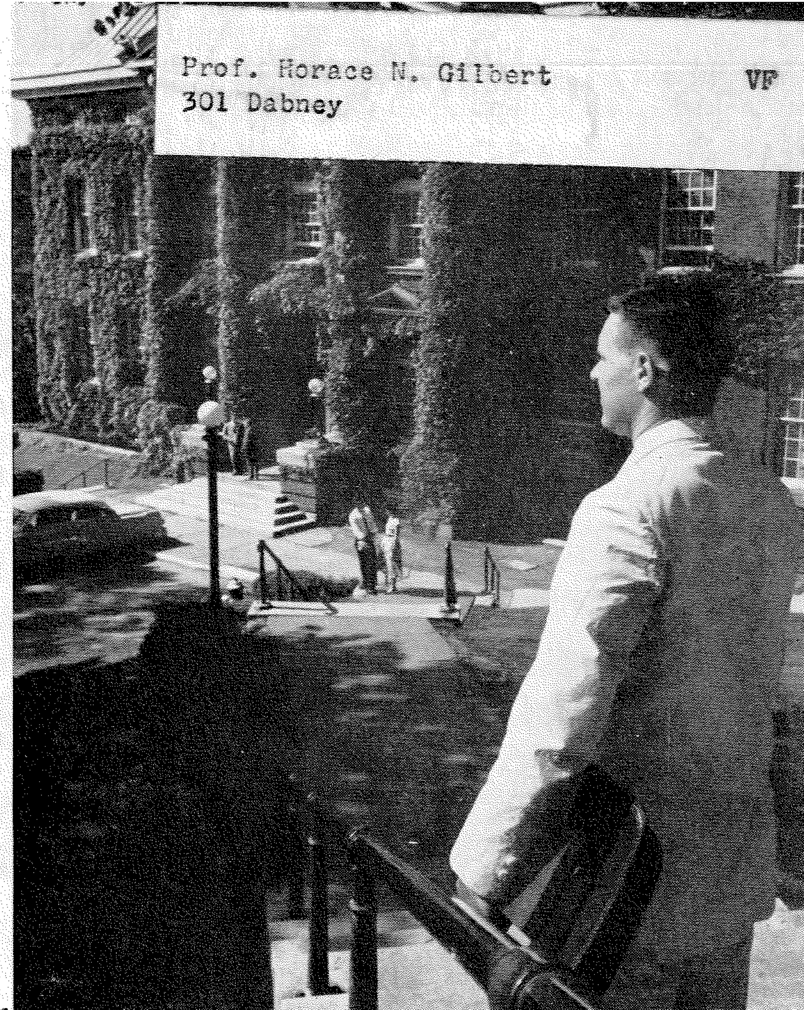
Behind the many photographic products becoming increasingly valuable today and those planned for tomorrow lie challenging opportunities at Kodak in research, design, production, and business.

If you are interested in these interesting opportunities—whether you are a recent graduate or a qualified returning serviceman, write to the Business and Technical Personnel Dept.

Eastman Kodak Company, Rochester 4, N. Y.

Kodak
TRADEMARK

ATOMIC RESEARCH at General Electric complements Paul Hess' Honors Program Studies.



MASTER'S STUDY at nearby college helps contribute to Hess' professional growth.

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To help outstanding engineers and scientists improve their technical competence in the face of industry's increasingly complex engineering problems, the General Electric Company has inaugurated a new Honors Program for Graduate Study. The Honors Program offers high calibre technical graduates the opportunity to complete the requirements for a Master's Degree in one and one-half years while working part-time on a G-E engineering assignment.

Here is what the program means to you, the technical graduate. If you qualify, you will attend one of several recognized universities located near General Electric plants throughout the nation. Carrying approximately one-half an academic load and doing your thesis work during the summer, you could obtain your Master's Degree in 18 months. General Electric pays for tuition, fees, books and other expenses related to your studies.

During the school term you will work 20 to 26 hours a week on a rewarding engineering assignment. Since your earnings are proportional to hours worked, you can attain up to 75% of a regular annual wage through full-time employment during summer vacations. You are also eligible for all employee benefits.

For more information on General Electric's Honors Program, which has been designed to help outstanding men develop to their fullest capabilities, consult your Placement Director or write W. S. Hill, Engineering Services, General Electric Co., Schenectady, N.Y.

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