ENGINEERING AND SCIENCE

DECEMBER
1948

Comet 1948 l
How it looks to an astronomer-- page 6

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The Main Line

DECEMBER, 1948

Probably you don't need us to remind you that there are precious few shopping days left before Christmas.

Maybe, though, in the mad scramble to buy gifts for Aunt Mary and Uncle Joe, you've overlooked a worthy case . . . *yourself!*

If you have, and if you're all worn out (or expect to be soon) from bucking the line at the gift wrapping counter, we know just the man you should see. (No, he isn't Santa Claus, but he's the next best thing.)

He's your nearest Southern Pacific ticket agent—and he can dispel any doubts you may have about the merits of a midwinter vacation in Southern Arizona or Palm Springs. Why not take one as your Christmas present to you?

Get in the Sun

Along about this time of year, when the weather most other places is a little brisk, the desert is the place to be. You'll find all the sunshine you can stand around Tucson, Phoenix, Palm Springs and the rest of the southwest sun country (which includes San Diego, Imperial Valley and runs east as far as El Paso).

Your S.P. agent has colorful, picture-crammed booklets called "Your Vacation in Arizona" and "Palm Springs" that will put the finishing touches to your sales resistance—if you aren't already convinced. He has a complete list of ranches, resorts, and rates, too, that is yours for the asking.

(If you prefer, drop a card to Mr. F. Q. Tredway, Room 735, Southern Pacific, 65 Market Street, San Francisco 5. He'll mail the booklets and list to you right away.)

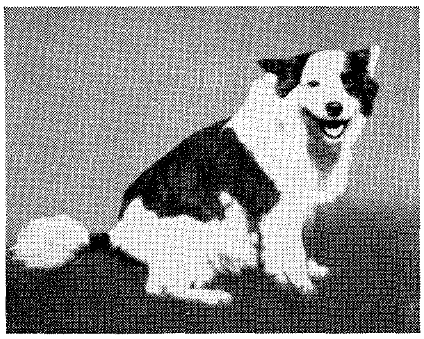
We have fine train service to Southern California and Southern Arizona. Our new *Golden State* streamliner and *Sunset Limited*, for example, offer a wide choice of accommodations. Take your pick from luxurious Pullman rooms and sections or lush but low-cost chair cars.

Now is the time to make your plans and reservations. There are lots of new hotel and resort accommodations in the Southwest, but even so they get pretty full after January 1.

Incidentally, if you're already in the desert, we have a suggestion for you, too. Come on up and go Christmas caroling in San Francisco.

"Something for everybody" is our motto.

Have you seen Mike?



We are currently engaged in the biggest "dog hunt" we've ever seen.

Several months ago, somewhere between Phoenix and El Paso, a black-and-white shepherd dog named Mike disappeared from the baggage car of our eastbound *Imperial*. He belonged to the children of Mrs. Pauline Ward, and was being shipped from the family's former home in Arizona to St. Paul.

We don't know how he escaped from his crate or got out of the car—but we're awfully anxious to find him. We've been running big newspaper ads with his picture, offering a $50 reward, all over the Southwest. As we go to press, we haven't heard any news, but we're still hoping.

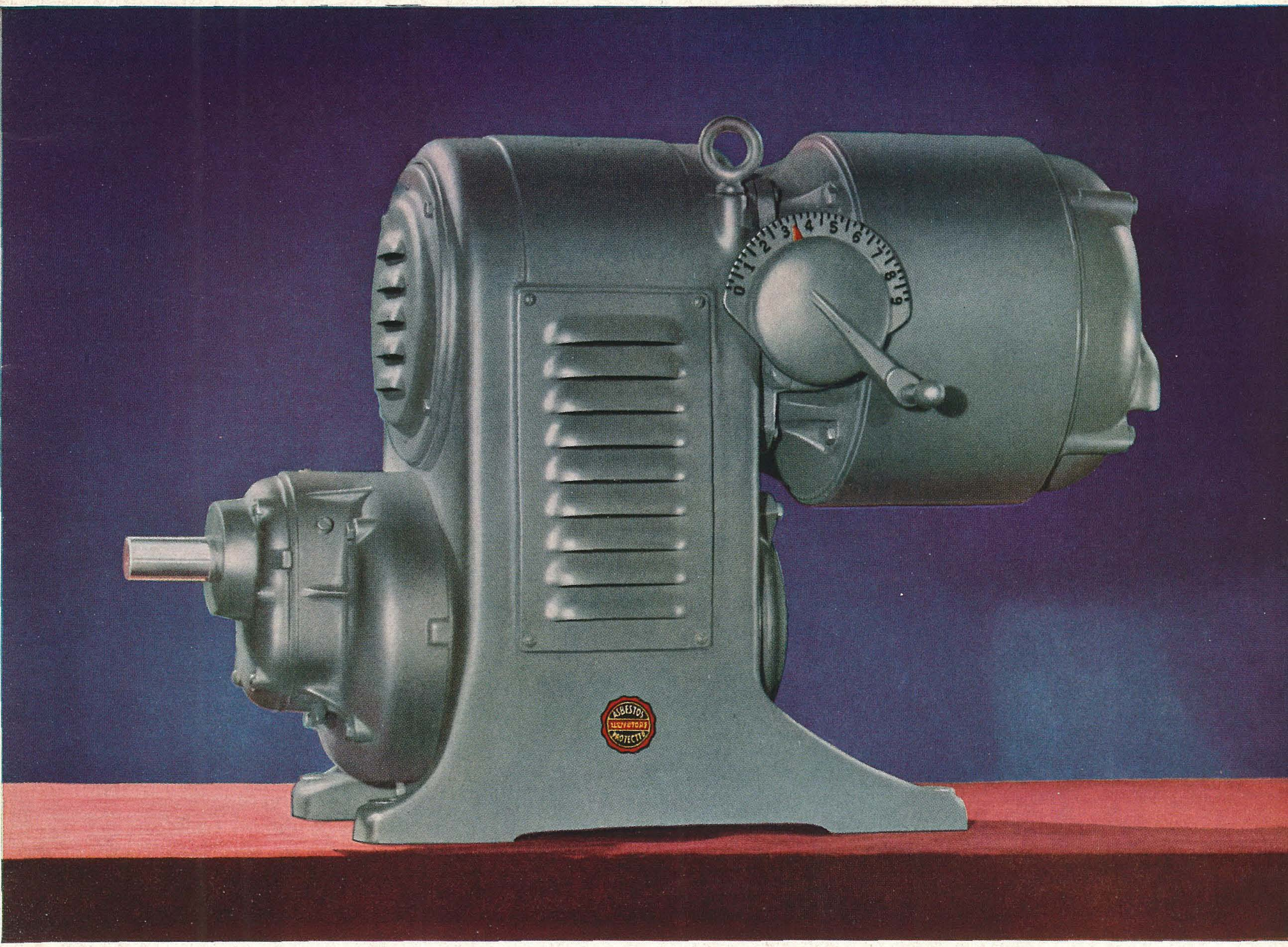
Mike is just ordinary dog. But a family of children love him and are disconsolate at his loss. That makes him just about the most valuable dog in the world. We hope Mike will be home for Christmas—and if you have any information as to his whereabouts, will you please tell any Southern Pacific agent?

90,000 Christmas Greetings

Along our 15,000 miles of line, there are 90,000 Southern Pacific men and women who wish you and yours a merry, merry Christmas and a happy and prosperous New Year.

—R. G. BEAUMONT

S•P The friendly Southern Pacific



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U. S. VARIDRIVE MOTOR

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MICROSPEED CONTROL. Accurate, non-fluctuating speeds over a wide range are instantly available. Greater production can be obtained by adjusting to changing needs without stopping machine.

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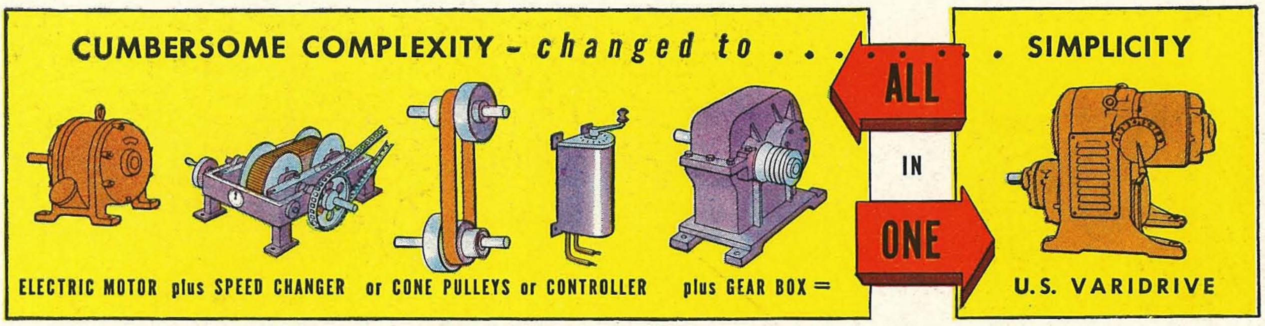
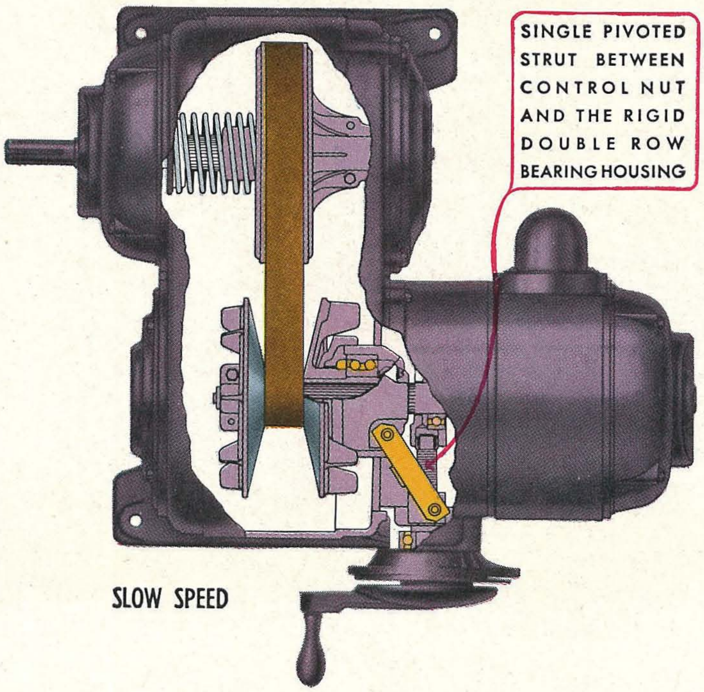
IF IT ISN'T A U.S. MOTOR IT ISN'T A VARIDRIVE

See next page



U. S. VARIDRIVE MOTOR



PROVED PERFORMANCE

Dependable operation is assured when you install a *U.S. Varidrive.* Its design has been perfected and proved over a period of more than 15 years. During this time U.S. engineers have gained actual field experience with a multitude of industrial applications of variable speed power. The present day Varidrive motor is the result of practical improvement of a sound fundamental principle.

NEW, IMPROVED TYPES —WITH MICRO-SPEED CONTROL

The improved *U.S. Varidrive* motor is quickly and easily adjusted to give any required speed over a wide range *while operating.* No stopping, or declutching of load, is necessary. Simply turn the control handle until the desired speed is obtained. An *infinite* number of speeds are available. For example, a quarter-turn of the control handle will result in a one per cent change of speed for a typical condition. Even closer adjustment is readily made. Speed can be increased as much as 700 per cent within a few moments. Once set, any given speed is maintained, regardless of load fluctuations. U.S. engineers have applied the years-tested principles of Varidrive to a completely redesigned series, now ready for delivery. These advanced designs are the greatest contribution to motor flexibility in the last three decades of motor progress. The restyled control handle is more conveniently located, with choice of positions. The sliding spline drive with Autotaut belt tensioner appreciably increases life of mechanical parts and belt. Synthetic cords in the specially designed belt give longer wearing qualities and add resistance to heat and oil. Belt changing is made easy. Greater visibility is given to the speed indicator.

A TIP TO THE VERY WISE—BUY VARIDRIVES

Write for descriptive Varidrive Bulletin

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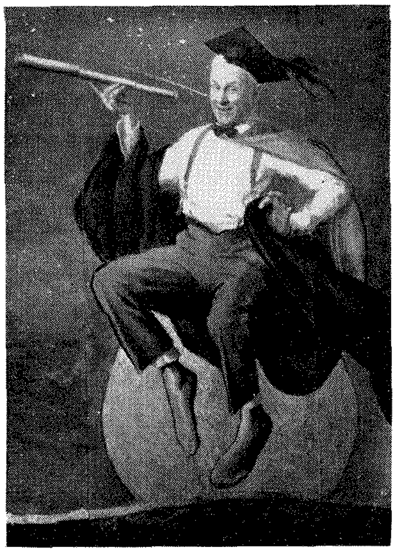
IN THIS ISSUE



Readers of this magazine are all familiar with the "official" portraits of Robert A. Millikan—whose recent speech before the National Association of Manufacturers, "What Research Has Done for You" is reprinted on page 3 of this issue. But not everyone knows the more informal pose shown above—even though it's now 12 years old. The original, a colored crayon drawing about 12′ x 15′, hangs in the basement of the Athenaeum.

In 1936, when Dr. Millikan was president of the Sunset Club in Los Angeles, Arthur Cahill, a well-known portrait painter and a fellow Sunsetter, did the drawing for the Club's annual Christmas party. At its unveiling, a presentation speech was made by the late Dr. Richard Tolman.

Admitting failure in his scholarly attempt to find any scientific explanation for the cosmic position occupied by Dr. Millikan in the mural, Dr. Tolman concluded:

" . . . we must turn to a new problem, that of Millikan's position in the world of human values. And here, gentlemen, being myself nothing but a physicist, I can no longer be your guide. I recommend the problem to your consideration, however; and even with my own poor powers, I can see that the final solution will contain such descriptive terms as kind and affectionate father, generous and trustworthy friend, wise and able administrator, profound and industrious scientist, and in every way a hell of a fine fellow."

(Continued on page 2)

ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

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ENGINEERING AND SCIENCE MONTHLY

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IN THIS ISSUE--cont.

The picture on this month's cover is actually two pictures. One was taken on November 10, the other on November 11—both by Dr. Roscoe F. Sanford, of the Mt. Wilson Observatory, and Research Associate in Astronomy at Caltech.

Just before dawn on November 10, Dr. Sanford finished his regular stint with the 100-inch telescope at Mt. Wilson. He was about to go home when he noticed that the spectacular southern comet, which made its appearance early in November, was especially bright and clear. He took one of the fast cameras used in the spectrograph of the 100-inch telescope, set it out on the balcony of the Observatory, and, using it as a hand camera, took the comet's picture.

The picture was made on red sensitive film, with an F3 lens of 10 inches focal length and a one-minute exposure. Though the camera's speed was perfect for this kind of photography, the available field was narrow and the camera was extremely difficult to aim. When Sanford checked his negative, in fact, he found that he had a beautiful shot of Pomona, and a fine view of the comet's sweeping tail —but the head hadn't got into the picture.

He caught the head the next morning, on November 11, and spliced the pictures together, with the result you see on our cover.

On Page 6, Dr. Edison Pettit also of the Mt. Wilson Observatory, tells the story of Comet 1948 l—that's its official name. Dr. Pettit doesn't give Comet 1948 l much of a niche in the Comet Hall of Fame. Despite its astronomical insignificance, however, 1948 l proved to be one of the most photogenic comets in history—as Dr. Sanford's cover shot clearly proves.

Dr. Henry Borsook's article on page 7, "We Could Feed the World," is adapted from a speech delivered last month before the Institute of Food Technologists in Los Angeles.

Professor of Biochemistry at Caltech, Dr. Borsook was born in London, and received his B.A. at the University of Toronto in 1921. He went on to graduate work in biochemistry, and received his M.A. in 1922, his Ph.D. in 1924, and his M.B. in 1927—all from the University of Toronto. In 1941 he received his M.D. from the same university.

Dr. Borsook came to Caltech in 1929 as Assistant Professor of Biochemistry. He has been a full professor since 1935. Best known for his work on nutrition, he is the author of a book on "Vitamins—What They Are and How They Can Benefit You" (1940). During the war he conducted valuable experiments with defense workers at Lockheed Aircraft plants on the benefit of scientific consumption of vitamins. And, as his article describes, he is responsible for the development of Multi-Purpose Food, which is now being distributed by the non-profit Meals for Millions Foundation, in Los Angeles, to Alaska Eskimos, American Indians, needy families in Tennessee. MPF has also been used by more than 30 relief agencies throughout the world.

ENGINEERING AND SCIENCE
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WHAT RESEARCH HAS DONE FOR YOU

An address delivered before the Congress of the National Association of Manufacturers in New York City, December 3.

by ROBERT A. MILLIKAN

IT IS WITHIN THE MEMORY of every man of sixty that in the great Empire State of New York —and in the most intelligent of her communities, too, —the question could be seriously debated as to whether Archbishop Usher's chronology, computed by adding Adam's 930 years to Enoch's 365 years to Methuselah's 696 years, etc., gave the correct date of the creation. Today we know from radioactive measurements that the age of the earth is not less than two billion years. That is something "research has done for you."

But what has this to do with "Science and Industry?" Everything! For mankind's fundamental beliefs about the nature of the world and his place in it are, in the last analysis, the great moving forces behind all his activities. Hence the enormous **practical** importance of correct understanding as a guide to all actions.

It is man's beliefs about the nature of his world that determine whether in Africa he spends his time and his energies in beating tomtoms to drive away the evil spirits; or in Phoenicia in building a great "burning fiery furnace" to Moloch into which to throw his children as a sacrifice to his God; or in Attica in making war on his fellow Greeks because the Delphic Oracle, or the flight of birds, or the appearance of an animal's entrails bids him do so; or in medieval Europe in preparing for the millennium to the neglect of all his normal activities and duties; or in burning heretics in Flanders, or drowning witches in Salem, or making perpetual motion machines in Philadelphia, or magnetic belts in Los Angeles, or soothing syrups in New England.

The invention of the airplane and the radio are looked upon by everyone as wonderful and preeminently useful achievements, and so they are—perhaps one-tenth as useful as some of the discoveries in pure science about which I wish to speak.

Look, for a moment, at the historic background out of which these modern marvels, the airplane and the radio, have sprung. Neither of them would have been at all possible without 200 years of work in fundamental science before any bread and butter applications were dreamed of. This work started in the seventeenth century with Copernicus and Kepler and then Galileo, whose discoveries for the first time began to cause mankind to glimpse a nature and a nature's God, not of caprice and whim—as had been all the Gods of the ancient world—but instead a God who rules through law, a nature which can be counted upon, and hence is worth knowing and worth carefully studying.

This discovery, which began to be made about 1600 A. D., I call the supremely useful discovery of all the ages, for before any so-called practical application was ever dreamed of, it began to change the whole philosophical and religious outlook of the race; it began to effect a spiritual and an intellectual revolution.

The material revolution came later. The Reformation preceded the machine age. This new knowledge was what began at that early time to banish the monastic ideal which had led thousands, perhaps millions of men, to withdraw themselves from useful lives. It was this new knowledge that began to change man's conception of his duty—which is the essence of religion—to inspire man to know his universe so as to be able to live in it more rationally.

As a result of that inspiration there followed 200 years (1600-1800) of pure science involved in the development of the mathematics and of the celestial mechanics necessary merely to understand the movements of the heavenly bodies. Though this seemed useless knowledge to the unthinking, it constituted an indispensable foundation for the development of the terrestrial mechanics, the power machines, and the industrial civilization which actually followed in the nineteenth century; for the very laws of force and motion essential to the design of all power machines were completely unknown up to the time of Galileo and Newton.

Do you practical men fully realize that the airplane was only made possible by the development of the internal combustion engine—and that this in its turn was only made possible by the development of the laws governing all heat engines, the laws of thermodynamics, through the use for the hundred preceding years of the steam engine (1780-1880)—and that this was only made possible by the preceding 200 years of work in celestial mechanics—and this again was due to the discovery by Galileo and by Newton, in the first half of the seventeenth century, of the laws of force and motion, which have to be utilized in every one of the subsequent developments?

That states the relationship of pure science to industry. **The one is the child of the other.** You may apply any blood test you wish and you will at once establish the relationship. **Science begat modern industry, and the son now owes a great debt to its parent.**

In the case of the radio art, the commerical values of which now amount up to the billions of dollars, the parentage is still easier to trace. For if one's vision does not enable him to look back 300 years, even the shortest-sighted of men can scarcely fail to see back as much as forty years. For the whole structure of the radio art has been built since 1910, definitely and unquestionably upon researches carried on in the pure science laboratories for twenty years before any one dreamed that there were immediate commercial applications of these electronic discharges in high vacua.

It is precisely the same story everywhere, in all branches of human progress.

So far I have merely traced the historical steps and the researches through which the heat engine and the dynamo—which now do practically the whole of the world's physical work—came into being. Now, let me trace similarly the transition from nineteenth to twentieth century physics.

This transition was probably made as dramatically in my case as in that of anyone in the world, for I was in the fortunate position of having entered the field just three years before the end of the complete dominance of nineteenth-century modes of thought. In those three years, 1893-1896, I had the privilege of personally meeting and hearing lectures by the most outstanding creators of nineteenth-century physics—the giants Kelvin, Helmholtz, Boltzmann, Poincaré, Rayleigh, Van't Hoff, Michelson, Ostwald and Lorentz. In one of these lectures I listened with rapt attention to the expression of a point of view which was undoubtedly held by most of them—indeed by practically all physicists of that epoch.

The speaker had reviewed, first, the establishment and definite proof of the principles of mechanics during the seventeenth and eighteenth centuries, culminating in Laplace's great "Mecanique Celeste" (Celestial Mechanics). Then he had turned to the wonderfully complete verification of the wave theory of light by Young, Fresnel, and others between 1800 and 1850—experiments which laid secure foundations for the later structure known as "the physics of the ether," one of the most beautiful products of nineteenth century thinking and experimenting. Then he had traced the development, in the middle of the century, of the greatest and most fundamental generalization of all science—the principle of the conservation of energy. Finally he covered the development by Maxwell (1867-83) of the electromagnetic theory, and its experimental verification by Hertz in 1888—only six years earlier than the date (1894) of the lecture in question. This theory abolished, in all particulars except wave length, the distinction between light, radiant heat, and long electromagnetic waves—all these phenomena being included under the general head of the physics of the ether, or the physics of radiant energy.

Then, summarizing this wonderfully complete, well-verified, and apparently all-inclusive set of laws and principles—into which it seemed that all physical phenomena must forever fit—the speaker concluded that it was probable that all the great discoveries in physics had already been made. Future progress was to be looked for, not in bringing to light qualitatively new phenomena, but rather in making more exact quantitative measurements upon old phenomena.

Just a little more than one year later, and before I had ceased pondering over the aforementioned lecture, I was present in Berlin on January 4, 1896, when Roentgen presented to the German Physical Society his first X-ray photographs. These clearly demonstrated that he had found some strange new rays which had the amazing property of penetrating as opaque an object as the human body, and revealing on a photographic plate the skeleton of a living person.

Here was a completely new phenomenon—a qualitatively new discovery, and one having nothing to do with the principles of exact measurement. As I listened, and as the world listened, we all began to see that the nineteenth century physicists had taken themselves a little too seriously, that we had not come quite as near sounding the depths of the universe, even in the matter of fundamental physical principles, as we thought we had.

This was the dramatic introduction, from the standpoint of one of the very young stage assistants in the play, to the new period in physics. Nobody at that time dreamed, however, what an amazing number of completely new phenomena would come to light within the next ten years.

The discovery of X-rays in December, 1895, had revealed a whole new domain of ether physics—phenomena that travel with the speed of light. The discovery of **radio-activity**—discovery No. 2— which came in 1896, now revealed an entirely **new property of matter,** and quite as important a property—so far as its influence upon our conceptions of our world are concerned—as any which had ever been discovered. For it forced us, for the first time, to begin to think in terms of **a universe which is changing, living, growing, even in its atomic elements**—a dynamic instead of a static universe, such as the nineteenth century had assumed. It has exerted the most profound influence not only upon physics, which gave it birth, but also upon chemistry, upon geology, upon biology, upon philosophy and religion, changing our ideas in all of them. For radioactivity not only revealed for the first time a world changing, transforming itself continually even in its chemical elements, but it also began to show the futility of the gross mechanical pictures upon which we had set such store in the nineteenth century.

Again, one had to wait only another year for the appearance of another stupendous discovery—discovery No. 3. Roentgen's discovery furnished an instrument and a technique which made possible the rapid development of the **electron theory of matter** by J. J. Thomson of England in 1897. This was one of the grandest, because the simplest, of all the great physical generalizations. It pictured the electron not only as a constituent of all the atoms of matter, but also as the binding element that held the atoms together. What that discovery has done for industry is immeasurable. Radio, radar, motion pictures—there is scarcely an industry that does not use that electronic discovery. One now asks, what hasn't **that** "research done for you?"

But, further, these three great discoveries were soon followed by Planck's even more fundamental one—discovery No. 4—**the discovery of discontinuous, jump-like, or "quantum" energy and momentum changes.** The reason this discovery had not been made earlier is that man was here entering an almost completely unexplored domain—namely, the domain of subatomic or microscopic, as distinguished from ordinary or macroscopic, energy and momentum exchanges. This field is most simply entered through photo-electric research, already found industrially very useful, especially in television. These last three discoveries, 2) radioactivity, 3) electronics, 4) quanta, actually determined the direction of my own study and research for the next fifty years.

But the greatest discovery of all—discovery No. 5—came in 1905. It may have been something of a blow to the nineteenth century to learn of the general transmutability of the elements, but how much more of a shock to find that **the principle of the conservation of matter itself is definitely invalid.**

Beginning in 1901, the mass of an electron was shown by direct experiment to grow measurably larger and larger as its speed is pushed closer and closer to the speed of light, i.e., energy is here being transformed into mass, or inertia. But of much greater interest than that is the reverse process found through the fact that Einstein worked out of the relativity formula a general relation between the two quantities, energy and mass, of the form $mc^2 = E$. Here, m means mass in grams, c^2 is the velocity of light squared, or the enormous number 9×10^{20}, and E is energy in ergs.

This equation seems now to have the best of experimental credentials. The atomic bomb at least has convinced the world of that. If it is a correct one, it means that matter itself in the Newtonian sense, the quantitative measure of which is mass or inertia, has entirely disappeared as a distinct and separate entity, i.e., as an invariant property of any system. In other words, **matter may be annihilated, the equivalent radiant energy appearing in its place.** And in view of the enormous value of the factor 9×10^{20}, a very small number of grams of matter may transform themselves into a stupendous number of ergs of energy. Thus, according to Einstein's equation, one gram of mass transferring itself into heat or radiant energy per second means the development of 90 billion kilowatts of power.

It is well known with what joy the astronomers have seized upon this fact to enable them to explain why the sun, for example, can not possibly have been pouring out heat as long as it is now known to have been doing if it is merely a hot body cooling off. Or again, if it were pure carbon and oxygen in their proper combining ratio, the sun would burn itself out in only 2,500 years. If, however, it has the capacity at the tremendous temperatures existing in its interior — say 40,000,000° C.—of transforming its very mass into radiant energy, then the great mystery of its enormous lifetime is solved.

Further, we now think we know the process by which this transformation takes place. It is the process of the building up of the heavier elements out of the lightest primordial element, hydrogen, which still constitutes a considerable part of the sun's mass. We now estimate that 80 per cent of the sun's atoms are hydrogen atoms. Here is the key to the evolution of heat by the sun. Accurate measurement actually shows that the four uncombined hydrogen atoms weigh more in the uncombined state than in the combined state. The difference—called the "packing fraction energy"—is what feeds the furnaces of the sun, which generously sends our share down to earth for storage in coal or oil, or for direct use in wind-mills, solar heaters and the like. Mother Earth has stored away in coal alone enough solar atomic energy to keep us going for 4,000 years, at the present rate of use of heat and power.

According to my calculations, there may be 1 per cent as much packing fraction energy available to us through the fission of uranium as through the burning of coal. Therefore, if I am right, those of you who are in the power industry don't need to fear ever being put out of business by fission energy. This has already shown great biological usefulness, but uranium's practical utility is limited by its rarity, by its commercial availability—and if man has got any intelligence at all he will conserve his uranium and not burn it up in heat or power plants. **There is no atomic packing energy to be got out of the common abundant elements.** That, again, is something that "research has done for you."

Now, let me close by telling you what I think industry should do in its own interests and at the same time—though only incidentally—to pay back a little bit of the debt it owes to both fundamental and applied research. (I treat them here as one since all research that increases our knowledge of nature, or our control over her processes, is useful research, as I have attempted through the foregoing history to show.) What such research, then—whether you call it pure or applied—has done in the past for you, it can assuredly do even more fully in the future, if you act with wisdom and intelligence. The key to the whole problem lies in the careful selection and training of young research men.

Within the last forty years, the United States has helped mightily to save world civilization twice when it was threatened by the spirit of the wild beast. What is happening now in international affairs shows clearly that that spirit is not yet dead, and that therefore we must provide the most effective defense against it of which we are capable.

I think that the most obvious teaching of the last two wars in both England and America is that the most effective defense consists in having an adequate supply of able, well trained scientific men.

But that is not only the key to our **defense. It is also the key to all our future progress as a nation.** The Rockefeller Foundation saw this thirty years ago, and in collaboration with some of us officers of the National Research Council set up the National Research Council Fellowship Board to meet that need. I can give you statistical evidence that since the date at which this step was taken the United States has risen from a place well down the line among the nations in productivity, in both pure and applied science (certainly in physics, chemistry, biology and medicine) to a place of world leadership in all these fields.

I attribute that change largely to the National Research Fellowship plan. Not only that, but those National Research Council fellows also were found in key positions in World War II. They certainly did their full share in the winning of that war. Though specifically trained in so-called fundamental science, they actually came strikingly into leadership in the practical problems of the war—that is, in radar, in rockets and other phases of jet propulsion, in atomic energy developments, in meteorology, etc.—problems which the exigencies of war brought forth.

This well-tested National Research Council Fellowship plan could be and should be greatly expanded **now**, and without essential change. It is a highly competitive plan of proved effectiveness for picking and training the ablest research material among the nation's coming leadership in science and its applications. In my judgment, this is a responsibility that should be assumed by **industry** in the interests of its own progress, but the results would be available for national defense as well, as was the case in World War II.

If the foregoing move is made in a large way by industry—in the interests of picking and training its most effective personnel for its own use—the movement will be entirely removed from the corrupting influence of politics, and from all the trends toward totalitarianism or stateism, in which lies the greatest menace to the future of a free America. The need is great and the time is critical—no less critical than when the immortal Lincoln raised the question whether this nation or any nation conceived in liberty and so dedicated could long endure. Never in our history have the forces tending to destroy the free American way of life bequeathed to us by the founding fathers, been so strong the world over as at this moment. Here is, I think, one of the most effective ways of preserving our freedom.

COMET 1948 l

by EDISON PETTIT

COMET l (l for the twelfth letter of the alphabet; this being the twelfth comet seen this year) is reported to have been first seen and photographed in Africa during the solar eclipse of November 1. It was first reported by Dr. Harley Wood in Australia on November 6, and by Dr. John Paraskevopoulos in Africa on the 7th. It was then south and somewhat east of the star Spica (Alpha Virginis), rising just before the sun. When first seen in the northern hemisphere in the morning of November 9 it was 12° south of Spica and 12° east of Corvus. The head was of about the brightness of the pole star, 2nd magnitude, with a tail extending westward some 20°.

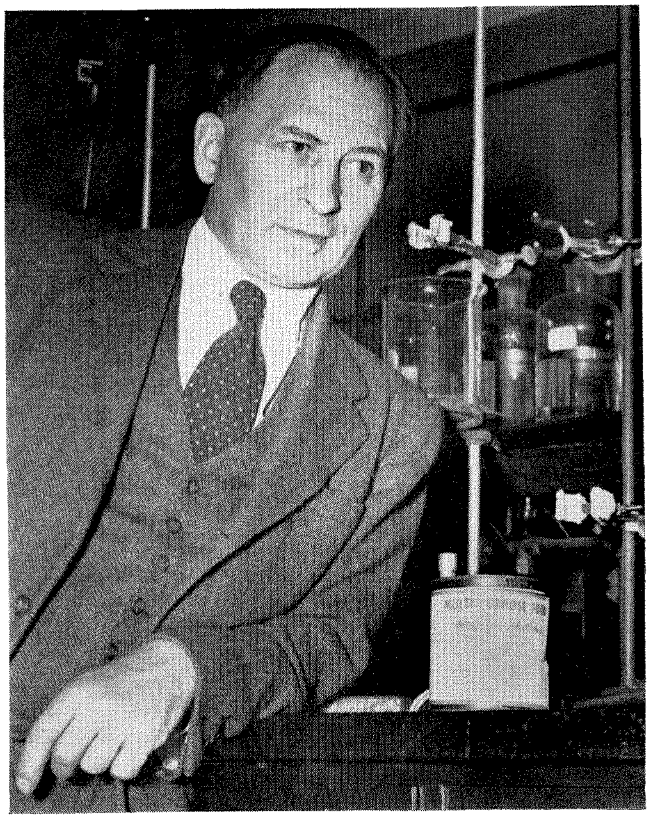
The orbit of this comet passes the sun within one eighth the earth's distance, or 12 million miles. The comet reached this nearest solar distance (perihelion) on October 27, coming toward the earth from behind the sun, so that its approach could not be observed. In fact, it has been inside the earth's orbit since the last days of September, but the sun has always been in the way. By the end of November it was leaving the earth's orbit and, already faded to magnitude 5, with a tail only 6° long, would soon become a telescopic object.

Whether a comet is a remarkable object depends on (1) the amount of matter in it, (2) the closeness of its approach to the sun, (3) the position of the orbit with relation to the earth's, and (4) the relative places of the earth and comet during its appearance.

Brilliant comets with long tails streaming across the sky are rather rare. One of the finest comets of the last century was that of 1882, discovered in broad daylight on September 3. It was one of the "Sun Grazers" and actually passed through the solar corona. Seen in the autumn sky, this comet exhibited a brilliant tail and sheath at the head extending toward the sun.

In the present century the comet of 1907, visible in the morning sky, was a bright object—much better situated and brighter than the present comet. Comet 1910 a, in the winter evening sky, had a tail more than 30°long, and Halley's comet of that year was a wonderful sight. No comet can be compared with Halley's. It passed through all the phases of comet formation, from a faint fuzzy spot to its appearance on that spring morning when the earth actually passed through its tail—which could be seen streaming from horizon to horizon. The great comet of 1914, which passed over the northern sky, was the last of the great brilliant comets which everyone in the northern hemisphere could see. Compared with these, the present comet is second rate, and about the same as comet 1947 n, another southern comet.

Comets are probably a dense cluster of small meteorites mixed with gaseous material, which is driven away by the action of the sun—we suppose, by light pressure—to form the tail. The sheath of the head in great comets cannot be explained by light pressure. The light of the tail and head consists of reflected sunlight and light emitted by the gases **per se.** This emitted light consists largely of the hydro-carbon and cyanogin bands. A study of the intensities in the spectral lines of these bands by Dr. Pol Swings has shown that this light is emitted by a process of fluorescence. The nuclei of the heads of great comets sometimes also show light emitted by sodium and other metals near the time of perihelion passage.



WE COULD FEED THE WORLD

by HENRY BORSOOK

WE HAVE THE TOOLS and the technology to feed everyone in the world with our present resources. And yet it's been estimated that 80 per cent of the world population normally suffers from under-nutrition or malnutrition.

One hears any number of explanations for this ironic situation—but at the bottom of them all is the simple fact that we still think of food in terms of the nineteenth century.

As long as we persist in thinking of food in terms of bushels of wheat, we'll never have enough to go around. As soon as we learn to consider food as a conveyor of essential nutrients—and look for the cheapest and best way to get these nutrients—we'll find we have enough for all.

According to the standard definition, only natural, or unprocessed, food deserves the name. Processed foods, generally considered to be the opposite of unprocessed, are by the same token "unnatural." Processing foods is "tampering with nature"—an odd objection when you consider how willingly we accept such "tampering" in every other branch of science.

There is a general impression, even in nutrition circles, that processed and unprocessed foods are competitors. But I know of no case where this is really true, if the circumstances under which the different foods are intended to be used are taken into account.

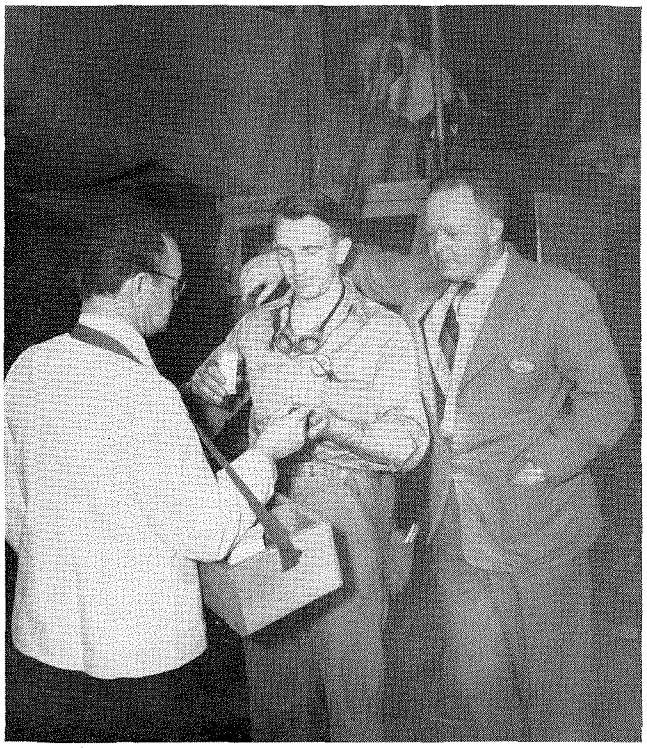
The novelty in the present situation is that, thanks to great advances in nutritional science and food technology, many more foods can now be improved. There is good reason to process a number of foods which we are accustomed (erroneously) to think of as natural foods—that is, unprocessed foods. No one raises an eyebrow any longer at dehydrated vegetables and fruits. Iodized salt and Vitamin D milk are an old story. So is margarine, now that manufacturers and nutritionists have begun to add Vitamin A to it.

During the war, flour in this country was enriched by the use of vitamins, and in some cases iron and calcium. Opponents of the idea of improving natural foods either forget or like to pass over the fact that during the war, in Britain, the dark flour which they had to use was enriched with calcium—to neutralize the deleterious effects of phytic acid in the bran of the high-extraction flour.

During the war, in this country, orange juice concentrated for export was fortified with synthetic Vitamin C, in order to give it a reasonable Vitamin C content. Recently there has been talk of including a certain amount of Vitamin C in canned tomato juice, for the same reason. If any such measure is finally decided upon, it will be necessary to add synthetic Vitamin C to nearly all of the tomato juice canned in the United States—except possibly California and Arizona.

Surely this is evidence enough that the processing of foods is an old story—and that it is a natural and reasonable application of scientific progress to extend this kind of processing to foods wherever they can be improved nutritionally without significantly increasing the price.

My interest is in the nutritional aspect of processing foods. From a *nutritional* point of view, I repeat, a food is only a conveyor of certain essential nutrients. I am aware that there are other important considerations, such as taste and eye-appeal, which are of great practical importance; but they, I think, look after themselves pretty well. The great discoveries in nutrition in this century have enabled us to define the nutritional value of foods in quantitative terms. One important item among these great advances was the discovery and proof that, as far as the physiology of the body is concerned, the source of an essential nutrient is immaterial. It doesn't matter whether it is grown or synthesized in the factory. The economic and social implications of this finding are enormous. In fact, no one can see how the present world shortage of essential nutrients can be solved without taking



Borsook's experiments with defense workers at Lockheed Aircraft showed benefits of scientific consumption of vitamins.

advantage of this great scientific advance, and the great modern technology to which it gave rise.

The essential nutrients are, briefly, **calories,** which may be obtained from proteins, fats and carbohydrates, and from nitrogen in the form of protein (as far as human beings are concerned). Here the content of the ten indispensable **amino acids,** determines whether the protein mixture is adequate or not, for these substances provide all the material from which proteins are built. For nearly all practical purposes, the only **mineral** about which we need to be concerned is calcium. As far as the **vitamin** content of human food is concerned, at least in this country, we need take into account only Vitamins A, B_1, B_2, Niacin, C, and D.

Let me review briefly some of the things we need to take into account in the use of processed and synthetic foods, with regard to the provision of the different essential nutrients.

Where there is a food shortage, we must never forget the need of calories. We learned during the war that a deficiency in calories is what is felt first and most acutely. This, no doubt, applies today in semi-famine areas. A low caloric requirement for sedentary work is 2,000 calories a day. Taking an average value for a mixture of protein, fat, and carbohydrate as five calories per gram, this requirement will call for 400 grams (dry weight) of these food materials; in other words about nine tenths of a pound.

This disposes at once of the notion one meets every once in a while that it may be possible some day to supply all the food requirements in a few pills. It is simply impossible to squeeze nine tenths of a pound into a few pills. The fundamental laws relating matter and energy exclude the possibility of our providing our caloric needs with less than this amount of food.

The minimum protein requirement of an adult is in the neighborhood of 50 grams a day, or shall we say roughly two ounces (dry weight). So little protein, if it is to maintain nitrogen balance, must all be first-class. In other words it must contain adequate amounts of the ten amino acids which the body cannot synthesize from others; hence their designation "indispensable." In most cases, where the protein eaten daily is so low, it is for economic reasons; and hence vegetable proteins are used rather than animal proteins. In general, vegetable proteins tend to be low in two of the indispensable amino acids, lysine and methionine. But by mixing some vegetable proteins, proteins relatively rich in these amino acids would (though they may be low in others) convert the whole mixture into a first class protein. Flour, which is deficient in lysine, is relatively high in methionine. Among the vegetable proteins, those in legumes are on the whole of the best quality. But they are low in methionine. This deficiency could be met easily by the use of bread.

As far as calcium is concerned, the experimental nutritionist Henry Clay Sherman showed many years ago that the calcium in such salts as Calcium Carbonate (chalk) or Calcium Sulfate (plaster of paris) is used as effectively as the calcium in milk. The British, during the war, added Calcium Carbonate to flour.

With regard to the vitamins, I need only say that it doesn't matter whether we use vitamin concentrates from natural sources or synthetic vitamins. They are in every respect identical with those in the foods as they come from the field.

Vitamins have two characteristics which set them apart from the other substances the body uses—the small amount necessary to preserve health, and the complete inability of the human body to make them itself. They are formed for the most part by green plants on land, and by algae and other smaller organisms in the sea. Until recently we had to get the necessary vitamins directly from plants, or indirectly from animals. Now of course the synthesis of vitamins has progressed to the point where 11 of the 13 known vitamins are being produced commercially. The naturally occuring vitamins will for a long time be the main source of vitamins for us human animals. But synthesized ones are invaluable in treating vitamin-deficiency diseases, and in supplementing diets with inadequate supplies of them. And it's cheaper to manufacture many of them than to grow the plants that provide them.

Present technological knowledge and production facilities can, I would guess, supply all the vitamins and minerals needed for optimal nutrition of all the people in the world, including the billon very poor of Asia. But there can be no question that more calories and protein need to be produced.

As for calories, modern technology cannot compete with the sunlight of the tropics and semi-tropics. The photosynthesis of carbohydrates is still the cheapest and best method of obtaining sugar, and thence calories. What the 1,000 million poor people of the world need is money to get it. That takes us out of the field of food and nutrition into economics; and on that subject I have nothing to say.

One thousand million people of the world need more and better proteins. We cannot yet manufacture or synthesize protein. As far as we can see, for a long time to come it will have to be grown, whether as animal or vegetable protein. The production of animal protein is costly and inefficient. Animal protein is a luxury, which is fine if you can afford it. Most of the people of the world cannot afford much of it. Vegetables, with a few exceptions, such as the legumes, are not rich sources of protein. And vegetable protein as a class is not first-class protein.

The prospect is not hopeless. I can see two things which can be done, which would help a great deal. First we should use far more of the protein now grown for human consumption. Today most of it is used as animal feed or is simply thrown away. During the war we threw away large amounts of the soybean protein. We are not doing that now; but too little is going to human consumption. There are large amounts of protein in oil cake and residues in the fermentation industries. We should and could use more of it.

A large fraction of fish protein goes to fertilizer or animal feed. Fish protein is first-class animal protein; it is cheaper than terrestrial animal protein; and I know it can be processed so as to be palatable. One of the necessary measures in the solution of the world protein problem is, then, less waste, and the diversion of more protein to human consumption.

The other necessary step is education. Processors and consumers need to be taught to so blend incomplete proteins that they will cover each other's deficiencies in essential amino acids. This can be supplemented in a few instances by the enrichment with synthetic amino acids.

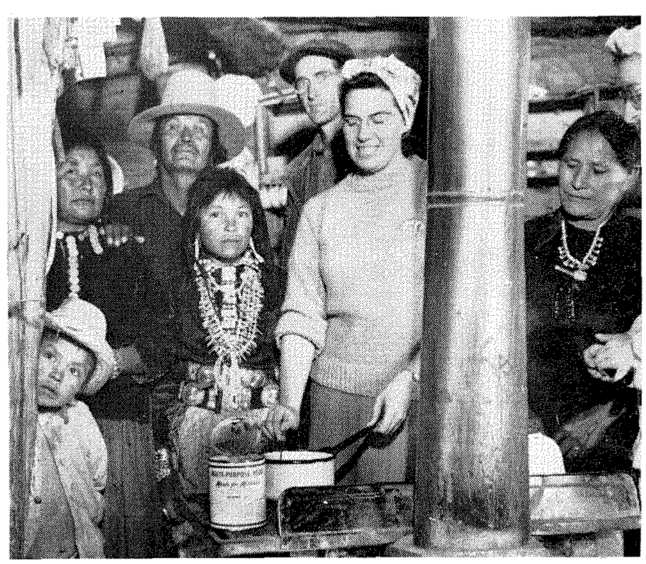
As an example, and only as an example, of the kind of thing I have in mind, I will tell you briefly about a food I had a hand in developing. It has received considerable publicity, and you may know it by the name of Multi-Purpose Food. The specifications which were given me in the devising of this food ran somewhat as follows: Three servings were to supply the Recommended Daily Allowances of protein, minerals, Vitamins A, B_1, B_2, and Niacin. The food was to be palatable, to blend readily with other foods when other foods were available, to be eaten by itself when they were not. The meal had to be quickly cooked, in not more than 10 minutes, and require only the most rudimentary cooking equipment. It had to keep from six months to a year, packaged in a dry state. It was to cost not more than three cents a meal. It could not offend the religious principles of any people. It had to be transported easily. It could not draw on those foods which Americans eat to a large extent.

The major ingredient chosen finally was soy grits, with a low fat content. The soy protein was chosen because it was the best cheap protein from a nutritional point of view. It is cheap because it is a by-product. Soy was grown chiefly for its oil, which has a variety of uses, including the manufacture of paints and lacquers. Why did I choose the soy grits? The mistake that had been made and may still be made with regard to the use of soy protein for human consumption was that it was used as a flour and invited comparison with flour. It is not a good substance for flour. It doesn't cook or bake as flour does. The grits, however, have a good texture, and this quality at once determines their use in a different way than flour. One need add only water to make a good soup. If only a little water is added, it is stew. It can be used as a meat extender. To the grits were added Vitamins A, B_1, B_2, and Niacin, so that one serving of $2\frac{1}{4}$ oz. would supply one-third of the Recommended Daily Allowances of protein and these vitamins. Vitamin C was not added because it is largely destroyed in the cooking. Certain spices were added. These are of such a character that the food blends readily with any other food. For example, if it is used with a little fish, it takes on the character of shall we say fish-balls; with cabbage, of a cabbage dish. As it stands, it is low in methionine and in calories. The deficiency of these two essential nutrients is met by bread. It is cheap compared with any other protein food used for human consumption.

The Multi-Purpose Food is only an example, I reiterate. I refer to it here as a very simple example of what can be done by the application of the science of nutrition and modern food technology. A food such as Multi-Purpose Food, is, of course, not intended to replace the habitual American diet wherever people can afford it. All of us would prefer a steak at any time.

The use of foods of this character should be considered in two extreme situations or conditions. One is semi-starvation, in which even the objection of monotony is removed; the other and more common occurrence is where people have some food, but for budgetary reasons cannot afford enough first-class animal protein. They need vitamins and minerals in an enriched protein food because fruits and vegetables are dear too. The objection that a processed food cannot supply all of the yet unidentified vitamins and the trace elements is again not valid, because these people will be getting them from the rest of their diet. The common objections to food such as the Multi-Purpose Food is that people would not want to eat it alone every day, three times a day. They are not expected to.

It is this example I have in mind when I say that we have in our hands the scientific tools and the technology to prepare foods to meet almost any situation. The use of industrial and agricultural by-products insures their low cost; vitamin concentrates, synthetic vitamins, and commercial minerals will make them as nutritious as an expensive diet scientifically selected from natural fresh foods. In no other way can the needs of such countries as China, India, and even portions of Europe today be met. It isn't necessary to force people to eat brown bread if they prefer white. It isn't necessary for people to get scurvy, if the good food sources of Vitamin C—citrus fruits, tomatoes, cabbage, potatoes, and a few green leafy vegetables—are not available or are too costly. Freedom to eat what we like and still be well-nourished is one of the new freedoms which science and the technology of foods offer to the world if it will only take it. That offer has not yet been accepted.



Multi-Purpose Food has proved a boon to Navajo Indians—though this demonstration isn't stirring up much interest.

THE MONTH AT CALTECH

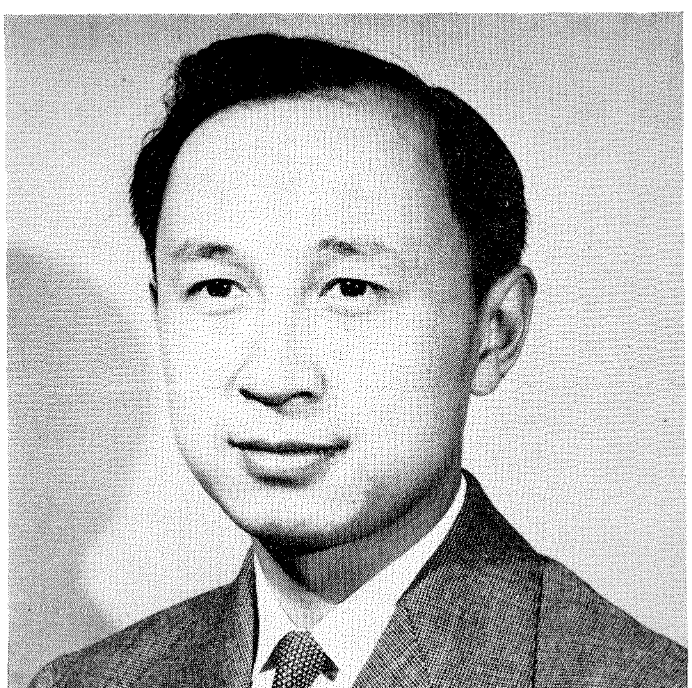
JET PROPULSION CENTER

A NATIONAL CENTER of rocket and jet propulsion study and research, to be known as the Daniel and Florence Guggenheim Jet Propulsion Center, will be established at Caltech. This is one of two such centers in the country; the other is being set up at Princeton University. The Guggenheim Foundation has appropriated $500,000 to support the centers for a seven year period, which means that the Caltech center will operate on a budget of approximately $30,000 a year.

Says Dr. DuBridge:

"Establishment of this center on the Caltech campus will not necessitate new buildings or new laboratories. The work of the Center will be primarily analytical, theoretical and educational, and will concern the basic problems in jet and rocket work. There will be no making and firing of experimental jet or rocket motors on the campus in connection with this activity. The analytical and theoretical research to be done on the campus will be complementary to experimental work carried out at the Jet Propulsion Laboratory in Arroyo Seco."

In announcing the establishment of the Jet Propulsion Centers, Mr. Guggenheim said: "The California Institute of Technology was chosen for this vital research work in the west because it was a center of rocket development prior to and throughout the war, and is the site of the Jet Propulsion Laboratory, at which it is carrying a major research load in connection with the Armed Forces' guided missile and jet propulsion program.



Dr. Hsue-Shen Tsien, Goddard Professor

"Jet propulsion has opened a new era in engineering and in human thought, and will affect the future of the world more profoundly than any one can foresee today.

"The Daniel Guggenheim Fund for the Promotion of Aeronautics contributed after the first World War to commercial aviation development in the United States. It was this commercial aviation development that was the basis for our supremacy in the air in World War II.

"In establishing these Jet Propulsion Centers, the Daniel and Florence Guggenheim Foundation is endeavoring to contribute in a similar way to the development of the peacetime applications of jet propulsion and the rocket."

The object of the centers is three-fold:

"They will serve as training centers for leaders of the future in the field of rocket technology. They will serve as centers of research and advanced thinking on rocket and jet propulsion problems. And they will be centers of leadership in the development of peace-time commercial and scientific uses of rockets and jet propulsion."

The principal post in each center will be a professorship, named in honor of the American rocket pioneer, Dr. Robert H. Goddard. A number of post-graduate fellowships will be associated with each Goddard Professorship, and at least three of these will be granted each year by the Foundation. They will be known as the Daniel and Florence Guggenheim Jet Propulsion Fellowships. They will carry stipends of up to $2,000 a year each, and will be granted for two-year study leading to a Doctor's degree. They will be awarded to unusually promising graduate students in jet propulsion, following an annual nation-wide search for the best available candidates.

The Goddard Professorship at Caltech is to go to Dr. Hsue-Shen Tsien. Now a professor of aerodynamics at the Massachusetts Institute of Technology, Dr. Tsien received his Ph.D. in aeronautics, **magna cum laude,** from Caltech in 1939. He remained at the Institute as research fellow, assistant professor, and finally associate professor, until he left to accept a professorship at M.I.T. in 1947.

Dr. Tsien was born in Shanghai, China, in 1910, received his B.S. in Mechanical Engineering at Chiao-Tung University in Shanghai in 1934. As an outstanding student he qualified with his government for additional education in the United States, and in 1935 entered M.I.T. for graduate study. He received his M.S. in Aeronautical Engineering in 1936.

Under the guidance of Dr. Theodore von Karman, Director of Caltech's Guggenheim Laboratory of Aeronautics, Dr. Tsien contributed much in both theory and research to the problems of supersonic flight and jet propulsion. He served with Dr. von Karman during and after the war as a member of the Scientific Advisory Board of the Air Forces.

He returns to Caltech next summer.

TUITION UP

THE INSTITUTE Board of Trustees this month announced an increase in tuition, from $500 to $600 a year, for all students, effective September, 1949.

The action of the board was taken after a long study of the problem of seeking additional income to meet rising costs in all categories of education, research and maintenance. Even though this increase in tuition fees will bring an estimated $120,000 in additional funds, it will provide only a little over one-third of the estimated $400,000 deficit for next year.

The increase is in line with that of other privately endowed colleges and universities, which have been forced to make similar or even larger tuition increases. M.I.T., the nearest comparable institution to Caltech, has had a $700 tuition fee in recent years, and is raising it to $800 this year.

"The type of education offered at the California Institute of Technology is unusually costly," said President DuBridge. "A tuition fee that would cover costs of providing a highly personalized education for a small group of carefully selected students by our staff of leading scholars in science, engineering and the humanities would have to be so high that it would be prohibitive for all but a very few. The policy of the Institute is opposed to charging a fee of this nature. The present costs of operating the Institute are almost three times as great as before the war and tuition rates have not gone up in this proportion. Only the generosity of individuals and foundations in making gifts for current operations or endowment has made it possible to maintain and improve the education and research program.

"The Institute is not unaware of the hardship that the $100 increase in tuition rate will cause many students and their families. Every effort, however, will be made to provide scholarship or loan funds for the most needy and worthy cases. On the other hand, during these times of rapidly rising national income there are certainly many families which can afford this increased cost and we are confident that those families will be quite willing to have the tuition rate adjusted to cover more nearly actual educational costs at the Institute."

At the same time an energetic attempt to increase the Institute endowment and to secure gifts for annual expenses is being undertaken in order to avoid further tuition increases. Funds are also being sought to provide additional buildings now urgently needed for educational, recreational and health purposes. Even with the tuition increase, additional endowment of at least $5,000,000 is required to provide the income necessary to cover the deficit anticipated for the current year's operations.

PRESIDENT STERLING

DR. J. E. WALLACE STERLING, director of the Huntington Library in San Marino, and professor of history at Caltech until last July, has been elected president of Stanford University. He will be Stanford's fifth and youngest (42) president.

Dr. Sterling came to Caltech in 1937 as a history instructor, and became a full professor in 1942. He served as chairman of the faculty, as well as a member of the executive committee, and he was occupying the Edward S. Harkness chair of history when he was appointed director of the Huntington Library in July, 1948.

Dr. Sterling was born in Linwood, Ontario, Canada, received his B.A. at the University of Toronto in 1927, and his M.A. at the University of Alberta in 1930. He played football and basketball as an undergraduate, and doubled as athletic coach and history lecturer at Regina College in Saskatchewan from 1928 to 1930. From 1932 to 1937, at Stanford, he doubled as research assistant in the Hoover Library on War, Revolution and Peace, and as instructor in history. He received his Ph.D. at Stanford in 1938.

Dr. Sterling was on leave from Caltech in 1939-40 as a Fellow of the Social Science Research Council, and again in the autumn of 1947 as a member of the resident civilian faculty of the National War College in Washington. A popular lecturer, he has also been a radio news analyst, and covered the United Nations Conference in San Francisco for CBS. Co-author of a history textbook published in 1939, Dr. Sterling is now preparing two books for publication — one on Canada and the refugee problem, another on British foreign policy since 1783.

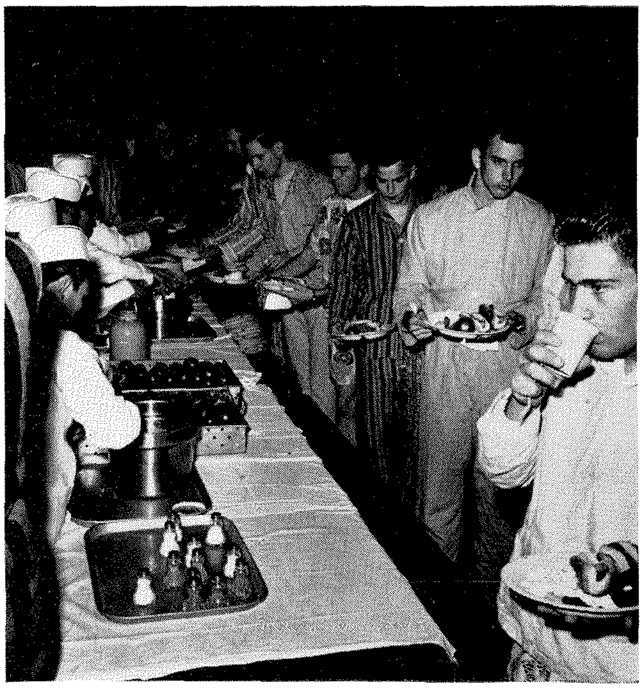
He takes over his new post on July 1.

IN SHORT

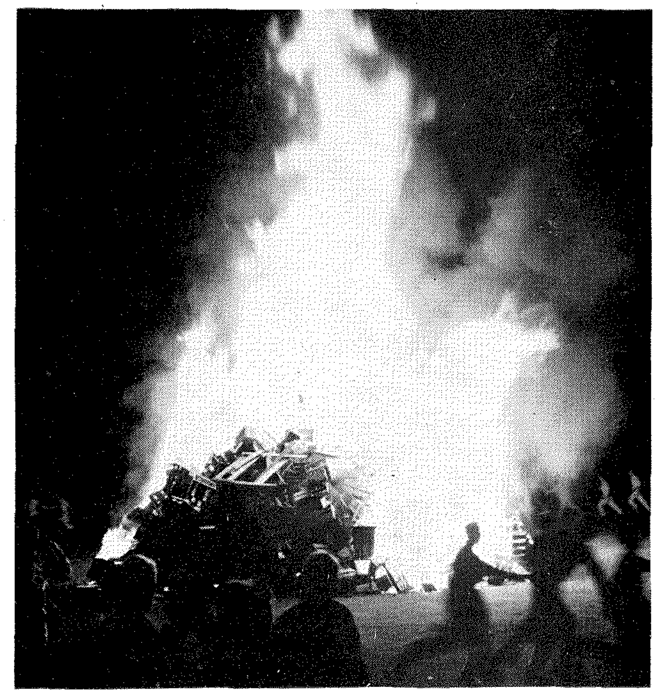
DR. LINUS PAULING, Chairman of the Division of Chemistry and Chemical Engineering, flew to France this month to receive an Honorary Doctor's Degree from the University of Paris.

Dr. Edwin Powell Hubble, Astronomer and Research Associate, was selected "Man of the Year" by the Kappa Sigma Fraternity, and received a plaque memorializing the award at a banquet at the Hotel Huntington on Dec. 10.

Dr. J. E. Wallace Sterling, Stanford's President



PAJAMERINO, Caltech's annual pre-Oxy game rally, gets under way with an al fresco pickup dinner in Tournament Park.



HIGHLIGHT of the rally is always a blazing bonfire, fed by frosh-foraged lumber, crates, and an occasional outhouse.

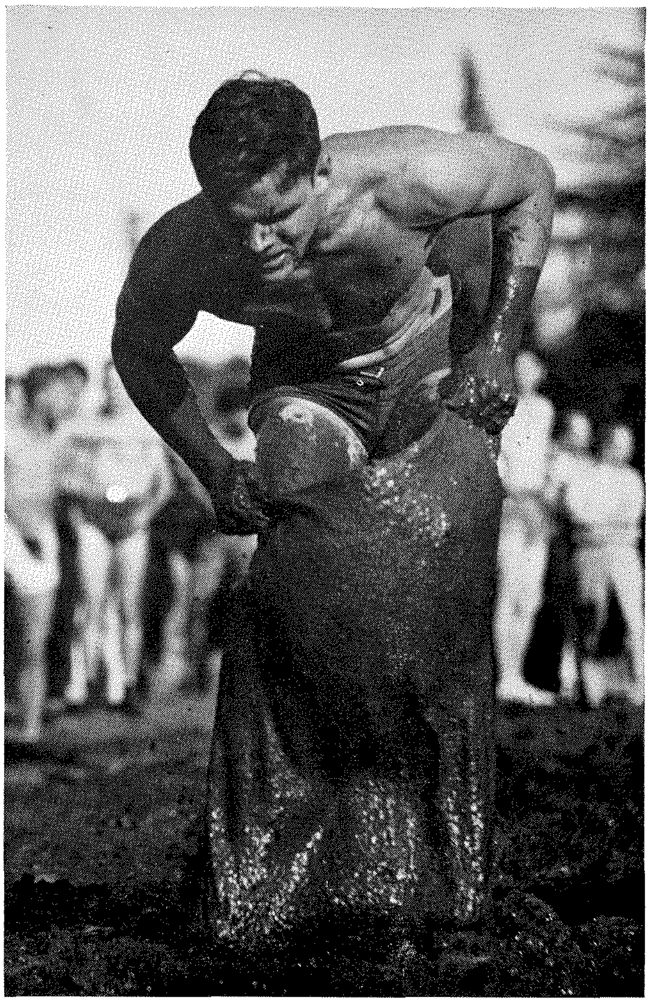
ALL WORK?

Some pictorial highlights of the brighter side of student life in the first term

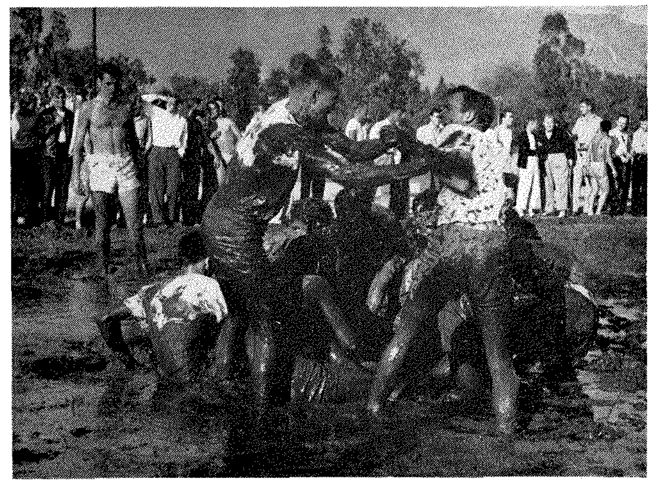
Pictures by Hugh Stoddart

STUDY IN CORN, this collegiate scene, set up by newsmen, was recorded as well by our shocked student photographer.

WHAT THEY'RE WEARING on campus this year gets an airing as students leave Tournament Park for parade through town.



MUDEO, freshman-sophomore free-for-all, was won by sophs. This sad sack-racer displays the determination that did it.



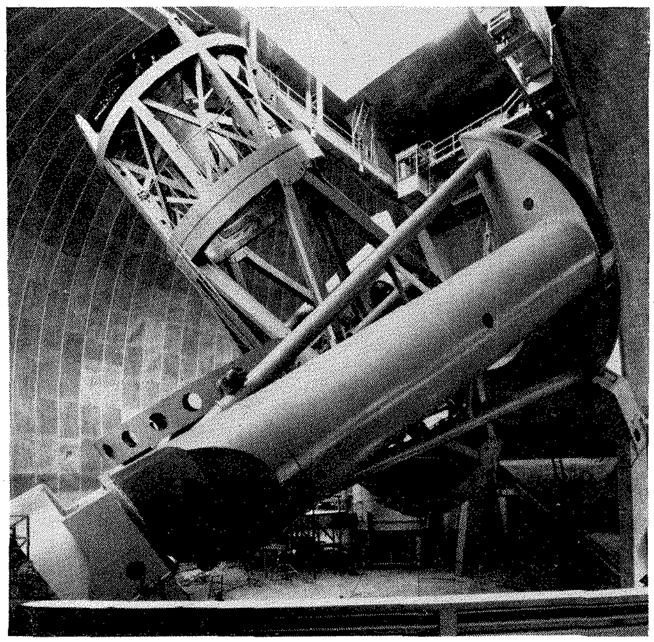
SOPHS won all events, including tire spree (above) and horse-and-rider contest (below). The victory was strictly Pyrrhic.

INTERHOUSE DANCE found Dabney turned into a post-atom-bomb cave. Dignity went out the door as guests came in.

FLEMING HOUSE, where theme was "Mutiny in the Monastery," featured a handsome, inefficient still (background).

The Palomar Story

A Progress Report



The Hartman screen — in place at the end of the 200-inch, above — makes it possible to measure the shape of all parts of the mirror with an accuracy of a millionth of an inch.

BECAUSE THE 200-INCH telescope is now in the public domain, the Observatory Committee this month made a public announcement of the private problems it has to solve before the 200-inch can get to work as advertised. Complete down to the last twist of a screwdriver and thoroughly frank, the announcement ought to go a long way toward explaining to an impatient public why nescient newsmen can't yet get the answers to their favorite questions ("How about those canals on Mars? . . . What's new with that expanding universe? . . . When's that big eye gonna *see* something?")

According to the committee, the 200-inch may not be in operation until next fall.

Since December, 1947, when the first test photographs were made with the 200-inch—barely a month after the big mirror went into the telescope—Dr. Ira S. Bowen, Observatory Director, and his staff have been locating "bugs" in the instrument, finding out why they appeared and what could be done about them.

"Mostly," Dr. Bowen said, "our major difficulties have concerned the mirror and its supporting mechanism, although at one time a chatter developed in the right ascension mechanism which gave us a lot of grief." This had to be overcome before accurate tests of the mirror could be made.

Tests taken with a Hartman screen over the end of the telescope—this screen makes it possible to measure the shape of all parts of the mirror with an accuracy of one or two millionths of an inch—revealed that the mirror was not holding its form as it should. A long series of adjustments and tests of the 36 support mechanisms which were designed to maintain the mirror's correct figure in all positions, showed that they were not all working properly. There was too much friction in these mechanisms to allow the free balance that was necessary. Last summer, following dedication of the observatory, each of the 36 support levers was modified. Subsequent tests revealed that the friction had been reduced sufficiently to remove this trouble.

When the final tests of the mirror were made in the Optical Shop at the Institute, it was found that the outer edge was too high by about 20 millionths of an inch. However, there was reason to believe that when the mirror was placed in the telescope in a horizontal position the edge would probably sag by about this amount. Consequently the decision was made to accept the mirror without further correction, since if the edge were over-corrected it would be much more serious than the present under-correction.

Although every test known to science was used in figuring the mirror in the Optical Shop, a true picture of how it would behave under actual operating conditions could not be determined until it was in the telescope. When the Optical Shop was built, this problem was given very careful study. To do in the Shop what could be done in a telescope would have required adding a 125-foot tower to the building, at a pre-war cost of more than $100,000. The tower would have had to be solid and completely insulated. It was decided that this would not be necessary. "I think we would still make the same decision today," Dr. Bowen says.

Under actual operating conditions, the astronomers discovered that the mirror was not sagging at the edge as much as had been expected. When it was found that the support system had to be modified, there was reason to believe that this might also serve to control what had now become a "turned-up" instead of a "turned-down" edge. Subsequent tests revealed that this condition was corrected to some extent but not enough to assure the accuracy sought.

Additional tests of both the mirror and its support system were made. A new factor showed up. The mirror was not adjusting uniformly to temperature changes; the outside edge was adjusting more rapidly than the center. As a result, the edge was turned up by different amounts, depending upon the temperature to which the mirror had been exposed during the preceding 24 hours. Here the "bugs" problem now stands.

What can be done about it? Several things, the astronomers say. One solution, and the one that will be attempted first, will be to devise a means of equalizing the air temperature beneath the mirror and inside the mounting point sockets with air about the outside edge. A system of small fans may be installed inside the cell which holds the mirror so as to circulate inside air enough to get equalized change.

There is also a possibility of insulating the outside edge. Though previous attempts at this sort of thing with other telescope mirrors have not proved too satisfactory, it will probably be tried.

If, however, air circulation or insulation—or a combination of the two—does not provide the solution, it will probably be necessary to remove some of the glass from a portion of the mirror about 18 inches wide around the outer edge. This area represents about 30 per cent of the total mirror surface. The mirror would have to be removed from the telescope for this additional polishing.

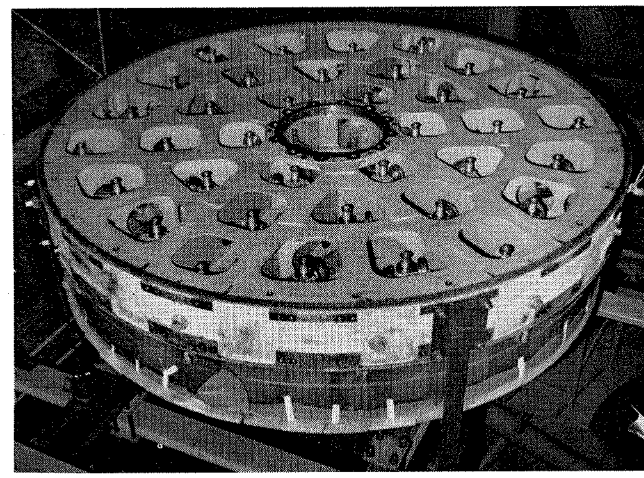
If such polishing is required it will be done at the observatory. It would take a minimum of six months and would involve frequent tests of the mirror in the telescope to avoid any possibility of removing too much of the glass. Actually the maximum amount to be removed will not be more than a few millionths of an inch. This polishing cannot be done until spring at the earliest, since it is considered inadvisable to polish in the observatory at this time of the year.

Designing and installing a system to control the bottom and inside temperature of the mirror will require a minimum of two more months. If this proves successful and no additional polishing is necessary, things may move faster than the astronomers will venture to estimate now—providing no other problems turn up.

"We have always known there would be problems which we could not anticipate," Bowen said. "Obviously we couldn't tell ahead of time what all our troubles would be, but we knew some would show up. They always do in any new piece of equipment, and the more intricate and complicated the instrument the more "bugs" you can expect. The Hale Telescope is, by the very nature of the job it is designed to do, an intricate instrument. With the mirror we have had to deal with tolerances in millionths of inches—not just thousandths or tens of thousandths—over four times as great an area as ever before attempted. We have hesitated to say anything about our problems until we understood them. We haven't yet encountered any for which there isn't a definite remedy, but overcoming them has been, and will continue to be, a time consuming job. First you must know why the problem exists and then what to do about it. We now know this.

"I might point out that it was a year and a half after the 100-inch mirror went up to Mt. Wilson before the telescope was put into operation and it was nearly ten years before that mirror was thoroughly satisfactory at all times. We are trying to do an even more difficult job at Palomar.

"It is this accuracy we are going to get with the 200-inch mirror that will make the Hale Telescope 'pay off' for it is on nights of 'good seeing' that it will do its best work. It is then that we will be able to get out to the billion light-years for which it was designed. There may be no more than twenty such 'good seeing' nights in a year. When they occur we expect to be ready to take advantage of them. We are shooting at a maximum, not just a 'good enough' accuracy. We have better than that already."



The 36 support mechanisms, designed to maintain the mirror's correct figure in all positions, has already been modified.

ALUMNI NEWS

WASHINGTON CHAPTER

ON NOVEMBER 16 the Board of Directors of the Alumni Association established a Washington, D. C. Chapter. Request for the establishment of the chapter came from a group of alumni in the area—Robert D. Fletcher '33, Richard W. Seed '44, Calvin B. Frye '31, Frederick T. Sadler '44, Donald Campbell '41, F. G. Casserly '41, Charles R. Cutler '45, Clarence A. Burmister '25, John W. Jackson '40, C. Lewis Gazin '27, Charles E. Fitch '23, and Donald H. Loughridge '23.

While there were only these twelve signatures on the petition for establishment of the chapter, there are more than 35 alumni in the area. Donald H. Loughridge has been elected president of the new chapter, and Charles Fitch is secretary-treasurer.

SAN FRANCISCO CHAPTER REPORT

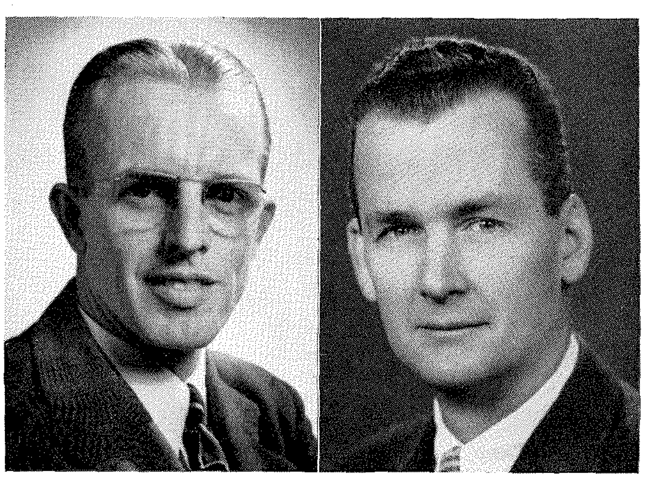
ON NOVEMBER 17 the San Francisco Chapter of the Alumni Association held a dinner meeting at the El Curtola Restaurant. There were about 75 wives, members, and guests on hand to meet the really all-star line-up of special guests—Dr. and Mrs. DuBridge, Dr. R. A. Millikan, Dr. and Mrs. Chester Stock, and Dr. Beno Gutenberg.

Dr. Stock gave a very interesting talk covering recent geological operations of his department, and Dr. Gutenberg outlined the 20-year history of the Seismological Laboratory.

Dr. DuBridge then took us on a verbal tour of the campus, pointing out that the Institute now has eight separate campuses (the number the University of California mentions so often in connection with its size). He went into detail as to the activities of each campus—the one at Pasadena, the Jet Propulsion Laboratory at the Arroyo Seco, the Hydraulics Structures Laboratory at Azusa, the Experimental Farm at Arcadia, the Marine Laboratory at Corona del Mar, Palomar Observatory, the Seismological Laboratory and the Orlando Greenhouse in Pasadena. All of us were fascinated by the growth of the Institute's research activities.

Jim Halloran acted as President and Chairman in Bob Jones' absence. All in all, the meeting was a very impressive and successful one, and I want those at Tech to know how much we appreciated having so many and such prominent people here.

—L. Dean Fowler



Moving up—Bob Freeman '32 and John G. Pleasants, M.S. '30.

V. P. PLEASANTS

YOU DON'T HAVE TO WAIT until you're old and gray to become a top executive in industry these days. Not if you've got what it takes—which John Gibson Pleasants obviously has. And not if you work for Procter & Gamble—which Pleasants has been doing since 1933.

John Pleasants, who will be 40 on December 27, has just been made a vice-president of Procter & Gamble. A graduate of the University of Southern California, he received his M.S. in Electrical Engineering from Caltech in 1930, his Ph.D. in 1933. He went right to work for Procter & Gamble, in the company's oil processing plant at Long Beach. Five years later he was plant superintendent at Port Ivory, New York. Then he stepped up successively as superintendent of the Baltimore plant in 1939, head of the Western Division in 1940, technical division manager in 1946, manufacturing director in 1947, and now vice-president in charge of manufacture.

Along with the announcement of Pleasants' promotion, Procter & Gamble reported the election of two other P & G career men to vice-presidencies—average age of the three new vice-presidents being 39, average term of service with P & G 15 years, eight months. P & G's new president, Neil H. McElroy, elected at the same time, is an old party of 44.

CHIEF FREEMAN

THE COLUMBIA STEEL Company, far Western subsidiary of the United States Steel Corporation, recently announced the appointment of Dr. Robert B. Freeman as Chief Metallurgist.

Bob got three degrees from Caltech—a B.S. in Mechanical Engineering in 1932, an M.S. in Metallurgy the following year, and a Ph.D. in 1936. Starting as a Metallurgist at the Torrance Works of Columbia Steel in that same year, he was transferred to the San Francisco headquarters office in 1938 where he worked under the Chief Metallurgist. He became a Metallurgist at the Pittsburg, California, Works in 1941, and was made Works Metallurgist in 1943.

As an undergraduate Bob was president of the YMCA, a member of the Varsity Club—and, in his senior year, its president. In his junior year he served as a Representative-at-Large and a member of the Board of Control. As a senior he was vice-president of the Student Body and chairman of the Board of Control. He was active in track, received a letter for each of the four years, and was captain of the track team in his senior year.

PROFESSOR WAYLAND

J. HAROLD WAYLAND, M.S. '35, Ph.D. '36, has been appointed Associate Professor of Applied Mechanics at the Institute, to succeed Ralph E. Byrne, Jr., who died on September 17.

Wayland, who received his B.S. degree in Physics in 1931 from the University of Idaho, comes to his new post at Caltech from the Naval Ordnance Training Station at Inyokern, where he has been serving as Supervisor and Research Director of the Underwater Ordnance Section.

After receiving his Ph.D. from Caltech in 1936, Wayland became Assistant Professor of Physics and Engineering at the University of Redlands. In 1941 he joined the Naval Ordnance Laboratory in Washington, D. C. Here he was put in charge of a group of about 50 men doing research and testing in degaussing. In 1942 he served with the 11th Naval District in San Pedro, as Senior Physicist in degaussing and other underwater problems. In 1944 Wayland became a War Research Fellow at Caltech, and in 1945 went to Inyokern. He takes on his new duties at the Institute on January 1.

ATOM-SMASHER

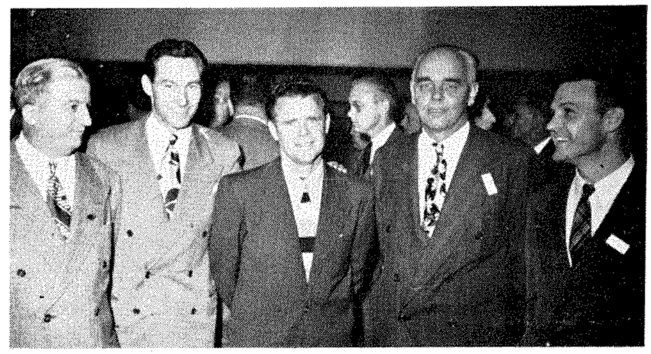
CAROL G. MONTGOMERY, B.S. '27, M.S. '28, Ph.D. '30, and now a member of the Physics Department at Yale University, has collaborated with three other members of his department to turn out a new atom-smasher.

Known as a proton accelerator, the machine produces gamma rays, or high-energy X-rays, in large numbers. In other words, it can fire more atomic bullets per second than other atom-smashing machines; so, more of them are likely to hit their targets.

Another advantage claimed for the machine is that it can speed up any type of charged particle, and produce more of them. Other atom-smashers like the cyclotron, betatron, and synchrotron are limited in the kind of atomic particles that can be used in them.

The Yale machine operates on pulses of direct current. These are transformed into rapid, radio-frequency oscillations. Then, in a cavity resonator, this voltage produces high-energy protons from hydrogen gas. These are shot out in powerful bursts at a target of lithium. As the atoms of lithium are broken down, they liberate gamma rays with an energy of 17 million electron volts. The gamma rays, in turn, are then fired at the test atoms to smash them.

Since no heavy steel magnets are needed, as in the cyclotron, the proton accelerator is cheaper to build and operate, according to the Yale physicists. It costs between $10,000 and $15,000, compared with $50,000 for the cheapest cyclotron. Collaborating with Dr. Montgomery in designing and building the machine were Dr. George A. Kolstad, Dr. Howard L. Schultz, and Dr. Richard B. Setlow.



Warm-up session before the Alumni Association dinner at the Pasadena Athletic Club, November 8. Speakers of the evening —Ernst Schreiber and Robert Simpson of Pacific Tel & Tel, and Caltech's football coach, Mason Anderson—with Alumni President Howard Lewis, and Director Wendell Miller.

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101 Arroyo Way, San José
General Electric Co., San José

The San Francisco Chapter meets weekly for lunch at the Fraternity Club, 345 Bush Street, on Thursdays.

Washington, D. C., Chapter:

PRESIDENT — Donald H. Loughridge
Department of the Army
Office of the Assistant Secretary, Pentagon Bldg.
SECRETARY-TREASURER — Charles E. Fitch
9214 Long Branch Pkwy., Silver Spring, Md.

Personals

1917

Archie R. Kemp, B.S. '17, M.S. '18, has retired from the Bell Telephone Laboratories with which he has been associated since 1918. During most of this time, he had been concerned with organic research on rubber and other insulating materials. Since his retirement he has been living in Temple City, Calif.

1921

Robert Craig, on a trip around the world for the National Supply Co., is now visiting India, Iraq, Iran, Arabia and other countries where petroleum exploration is being conducted.

Dr. Emil D. Ries, M.S., is the new general manager of the Du Pont Company's Ammonia Department. With Du Pont since 1930, he has been assistant general manager since July, 1946.

1927

Dr. Murray N. Schultz, who received his D.D.S. degree from the University of Southern California in 1946, is now practicing dentistry at 723 So. Catalina Ave., Redondo Beach.

Dr. H. E. Mendenhall, Ph.D., represented the California Institute of Technology at the inauguration of President Jess H. Davis of Clarkson College in Potsdam, New York, on October 8. Dr. Mendenhall is with the Bell Telephone Laboratories, and lives in Summit, New Jersey.

1929

Frank W. Thompson, who has been with the California Public Utilities Commission for 12 years, has been named Director of Utilities for the Michigan Public Service Commission in Lansing. He will direct all engineering and accounting work of the commission, and will coordinate activities which have heretofore been referred to the three members of the commission.

1931

S. Frederick Ravitz, Ph.D., is now senior metallurgist in the Metallurgical Division of the Salt Lake City branch of the U. S. Bureau of Mines. He is in charge of work on pyro-, hydro-, and electrometallurgy at the Intermountain Experiment Station, 1600 E. First South St., Salt Lake City.

1932

Howard W. Finney, Certified Public Accountant, has opened offices for the general practice of Public Accounting in Los Angeles. He was formerly Supervising Accountant with Lybrand, Ross Bros. & Montgomery, of Los Angeles.

K. H. Swart, B.S. '32, M.S. '33, who has been with Security Engineering Co., Inc. for the past 13 years, has been elected vice-president of the firm. Along with his new responsibilities Ken will retain his present position as chief engineer.

William Shockley was a visitor to the Caltech campus last month. On November 18 Dr. Shockley and Dr. John Bardeen, both of the Bell Telephone Laboratories in Murray Hill, N. J., gave a lecture-demonstration in 201 Bridge on "The Electronic Theory of the Transistor." Shockley and Bardeen share the credit for the discovery and development of this miniature device which threatens to replace the vacuum tube, and maybe even open up some brand new applications for electronics.

C. Philip Schoeller was here for a visit on November 30. He has just returned from Afghanistan where he has been doing work for the Morrison-Knudsen Co. of New York.

1933

Ted Mitchell has been appointed Division Engineer of the Shell Oil Company, at Long Beach. He also served as chairman of the Petroleum Division's meeting of the American Institute of Mining Engineers in Los Angeles in October.

Sidney F. Bamberger, B.S. '33, M.S. '36, died unexpectedly and without any previous warning of heart trouble, of a heart attack, on September 18, following an operation from which he was fully recovered.

1934

James Gregory has been appointed Superintendent of the Long Beach Division of the Shell Oil Company.

John Sherborne has been promoted to Chief Production Engineer of the Union Oil Company, at Whittier, Calif.

1935

Joseph A. Ashworth died in Bernardsville, N. J., on November 3. At the time of his death he was a physicist on the technical staff of the Bell Telephone Laboratories. A specialist in the study of magnetic materials, he had helped in the development of magnetic mines and mine detectors during the War.

Jack M. Roehm has resigned from Buehler and Co. to accept a position as Assistant to the Director of the Research and Development Department of the Pullman Standard Car Manufacturing Co. in Hammond, Ind.

Victor W. Willits has returned to the Long Beach plant after working for Procter & Gamble in Cincinnati (1940-41) and Dallas (1941-1948).

1936

Jim Watts is now Assistant Superintendent of Production for the Southern Division of General Petroleum Corporation.

1937

Warren Fenzi has been steadily moving up in the organization of the Phelps-Dodge Co. at Morenci, Ariz. He was recently promoted from the position of Mine Superintendent to that of General Superintendent—in charge of the mine, mill, and smelter.

Peter H. Wyckoff's new business address: Chief Experimental Physics Laboratory, Cambridge Field Station, 230 Albany St., Cambridge, Mass.

Holloway H. Frost who has been with the Socony-Vacuum Oil Co. in Cairo, Egypt, is now back in this country at Corpus Christi, Texas.

1938

Forrest Nelson Daggett, ex-'38, Foreign Service Officer, has been transferred to Ottawa as Second Secretary and Vice Consul. He had been Second Secretary to the American Legation at Wellington, New Zealand. Since he entered the Foreign Service in 1942 he has served in Rio de Janeiro, Para, Manaos, Sydney and Wellington.

Robert S. Custer, now doing process design work for the Bechtel Corp. in San Francisco, has moved into a new house at 508 Pope St., North Palo Alto.

Ralph D. Baker, Ph.D., is professor of Aeronautical Engineering at the University of Utah.

1940

Don Kupper is back at Yale doing graduate work in Geology. His address: Box 2721, Yale Station, New Haven, Conn.

Forrest Hall and his wife announce the arrival of a son on October 12. Hall is an Associate Professor at the University of Idaho, teaching structural engineering.

1941

William L. Ingersoll is now in Venezuela as a construction engineer for Standard Oil Co. of California.

1942

Joseph B. Franzini and Mrs. Franzini announce the arrival of a second son, Robert, on September 2. Their first son, Joe, is now 16 months old.

Ventakachalam Cadambe, M.S., is now Assistant Director to the Head of the Department of Applied Mechanics and Materials at the National Physical Laboratory of India. He resigned his position as Technical Officer of Tata Aircraft Ltd., India.

1943

Robert L. Bennett, a transportation supervisor for Pacific Tel & Tel, is building a new home in Chapman Woods, Pasadena.

Edward I. Brown is now an aerodynamicist for Northrup-Hendy. He and his wife have a 1½-year-old daughter, Linda.

Richard A. Sutton writes from Venezuela: "Since starting to work for the Creole Petroleum Corporation a year ago I've learned some interesting facts. Creole, whose operations are confined to Venezuela, is the world's largest producer of crude oil, two-thirds of which comes from the Lake Maracaibo region. The company, a subsidiary of Standard Oil of New Jersey, pioneered deep water drilling.

"All lake well foundations are of either concrete piles or specially constructed caissons. The concrete piles (21″ square and up to 133′ long) are some of the largest in the world, and the caissons are up to 165 feet long. To drive these, two of the world's largest pile drivers are used. The caissons are sunk using four 50-ton concrete blocks. The wells are drilled using special drilling barges which are towed from location to location.

"I remember graduating as an M.E., but here my work has been everything but that of an M.E. (My first job was to raise a sunken barge.) At present I'm a pile-driving foreman, doing some work on the waterfront development. The work has been varied and interesting.

"I've had to wait one year to be assigned a company house so my wife can come down here. This may be one reason I've neither seen nor heard of any Tech men on the eastern shore of Lake Maracaibo."

Wayne H. Brown is a design engineer for Northrup Aircraft. He and his wife have two sons—Steven, 4, and David, 1½.

William Hovanitz, Ph.D., has been appointed Assistant Professor of Biology at Wayne University.

1944

Wesley Sandell has been selected a George F. Baker Scholar at Harvard University's Graduate School of Business Administration. This honor goes each year to the top five per cent of the second year students at the Graduate Business School.

Neville S. Long was married to the former Miss Anne Elizabeth Armstrong of Beverly Hills, last June. He is working now for the McNary Dam Contractors in Plymouth, Washington.

Wilfred R. Barnard, ex-'44, was married on September 25 to Miss Antoinette Rudolph in Tucson, Arizona. He is now superintendent of a Nevada ranch

Jurg Waser, Ph.D., was recently appointed Assistant Professor of Chemistry at Rice Institute, Houston, Texas.

1945

William H. Cook was married to Miss Mary Jeanne Toner of Atherton, Calif., on September 18. He received his M.B.A. at the Stanford Graduate School of Business last June, and is now on the staff of the Stanford Research Institute as Coordinating Engineer on the Long Beach Subsidence Study.

Yung-Huai Kuo, Ph.D., is Assistant Professor of Aeronautical Engineering at Cornell University, Ithaca, New York.

Roland Hummel, M.S., who was an Assistant Professor at Swarthmore College in Pennsylvania, is now teaching at Roberts College in Istanbul, Turkey.

1946

L. Clyde Werts is now Regent and Acting Dean of the College of Engineering at Loyola University.

David Arthur Cooke and his wife announce the arrival of a daughter, Vivian Irma, born in Sharon, Pa., on September 26.

1947

Paul C. Yankauskas, Jr., Prof. degree, and his wife have a second son, David Alan, born July 4. The Yankauskas' are also in a new home at 4508 Blackthorne Ave., Lakewood Village, Calif.

Eugene M. Shoemaker is now a geologist with the U. S. Geological Survey, with headquarters in Grand Junction, Colo.

J. C. Fletcher, Ph.D., reports that he is now working for Hughes Aircraft.

1948

Robert D. Dalton, Jr. was married to Antonia Lima in San Francisco on September 12. Bob is back at Caltech for his master's degree in Civil Engineering.

Robert P. Barraclough is an Engineer in training with Allis-Chalmers Co., in West Allis, Wisconsin.

Index to Advertisers

Books

NO PLACE TO HIDE

by David Bradley

Little, Brown & Co., Boston   182 pp. $2

by A. L. Klein
Associate Professor of Aeronautics

DR. DAVID BRADLEY kept a journal during his service with the Radiological Safety Section at the Able and Baker atomic bomb tests. **No Place to Hide** is the result—the impressions and experiences of a typical member of the Radiological Safety Section (RADSAF) during this period.

I was forced to leave Bikini approximately a month after the Baker Day explosion. Dr. Bradley, being a member of the armed forces group, was enabled to stay on for a longer period, and had a far more varied experience than those of us who returned earlier. He gives a graphic account of our psychological problems —the difficulties we had in adjusting ourselves, and in getting the working fleet, and other participants in these epoch-making experiments, to believe that radioactive dangers were real.

Early in the test, the fleet's attitude was that nothing unusual occurred as a consequence of the bomb's explosion. This attitude continued even after Able Day, because of the rapid disappearance of the radioactive effects in the air test. After Baker Day the same reaction occurred at first. But when the most vigorous efforts to decontaminate the ships failed—as described so vividly by Dr. Bradley—there was a tendency for the Navy personnel to go overboard in the opposite direction. If anything, Bradley tones down the psychological oscillation in RADSAF and in the fleet, before, during, and after these tests.

After Baker Day the contamination of the fleet by the radioactive rain from the well-known mushroom-head cloud caused fantastic effects on practically all the target vessels. For some time, the importance of these effects was overlooked. But when the contamination of the "Live" Fleet started to occur, and we began to realize that even the vessels that had not been in the radioactive rain were becoming potential radioactive hazards, the full magnitude of this danger revealed itself to us. These problems which were so new and unforeseen brought on a whole new set of psychological effects. Bradley records several instances of

these, and the methods used to protect the working fleet against them.

I was one of a small group (four in all) responsible for the safety of the drinking water on the Live Fleet. We had great trouble in getting people to believe that clean, tasteless water may still be extremely poisonous —and that no known chemical treatment would make it any less so. Fortunately for us, the evaporators used by the Navy to manufacture drinking water happened to be effective in eliminating radioactive contamination.

Dr. Bradley's experiences were somewhat different from mine, in that he was an air monitor, while I served with the Lagoon Patrol in the comparatively plebian duty of inspecting the target fleet. He had the very exciting job of flying over the target fleet, directly after the bomb burst, in the first inhabited aircraft— to determine the hazards for us on the surface. When safety was reasonably assured, we were to enter the target area.

Dr. Bradley's book is well written and should be informative to anyone even remotely interested in the subject. The book contains an appendix entitled "A Layman's Guide to the Dangers of Radioactivity," describing the physiological effects of radiation. I recommend that this portion of the book—at least— be familiar to everyone living in our day and age.

POSTMASTER: Return postage guaranteed.