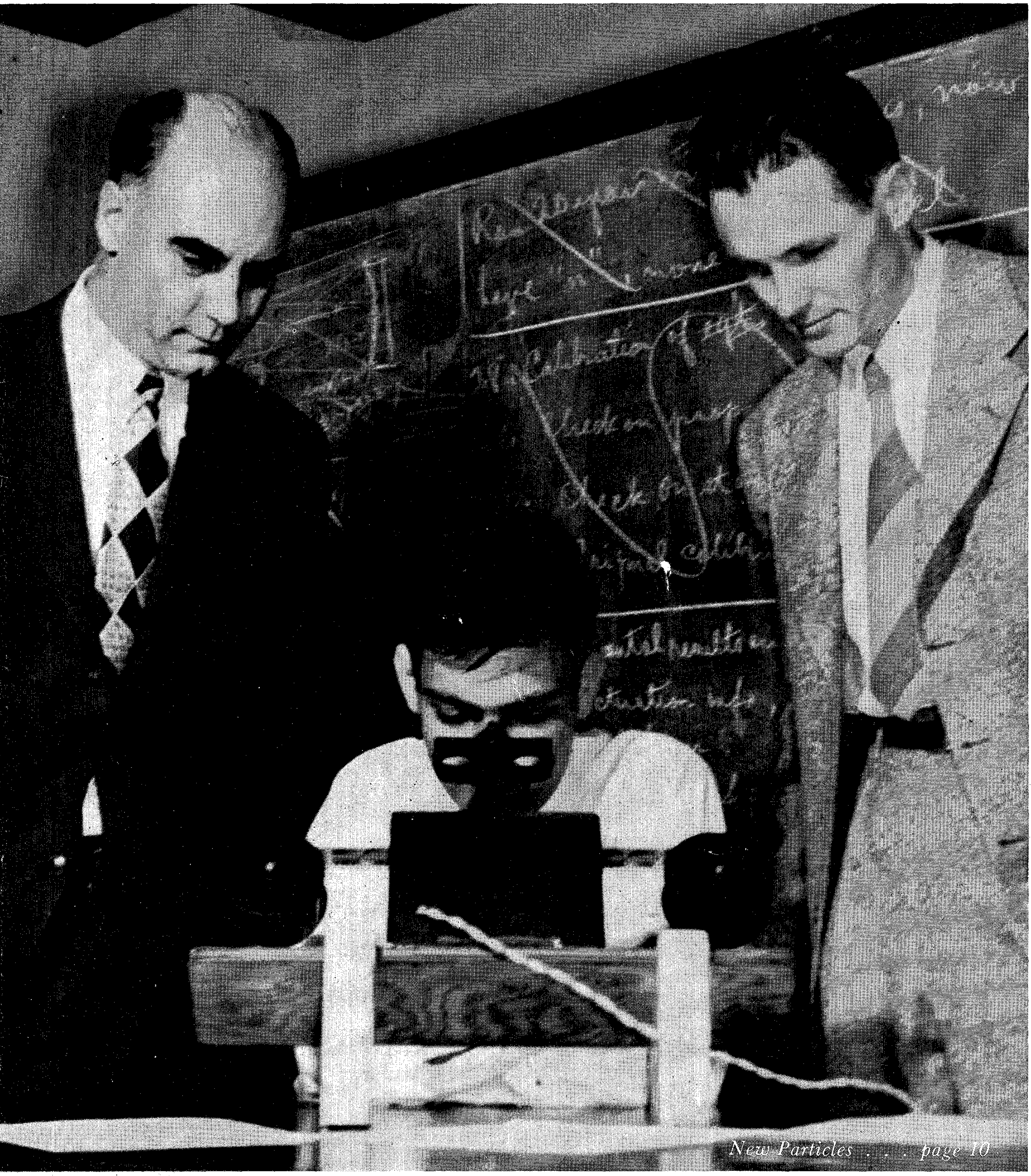
ENGINEERING AND SCIENCE

May 1950



New Particles . . . page 10

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

6,250,000 in 1949—*another new record*

THE automobile industry smashed records again in 1949 as it produced 6,250,000 new passenger cars and trucks —more than in any other year in history. This terrific output of the finest cars ever made climaxed a phenomenal rise in production that began at the war's end.

These new cars by the millions are a tribute to the American way of life. Their production is the result of the demands of people working under the American system of free enterprise, which has produced the highest living standard the world has ever known.

Millions of tons of steel of almost every type and form helped America's auto makers boost their production so amazingly high . . . helped the quality of today's automobiles keep pace with the quantity. In fact, many new steels have been developed just to meet the exacting requirements of present-day production.

In spite of record-breaking production, the automobile industry's job is far from finished—the average age of the cars on America's highways today is 8.4 years.

Continuing demands for vast quantities of steel from the automobile industry and from countless other sources mean a big job for the steel industry in coming years . . . mean a promising future for men who make steel their career. To assure itself management men of the highest caliber, United States Steel maintains a continuous training program that prepares young men with suitable backgrounds for places in this great industry.

College engineering courses lay the foundation . . . United States Steel builds a practical knowledge of steelmaking on this foundation.

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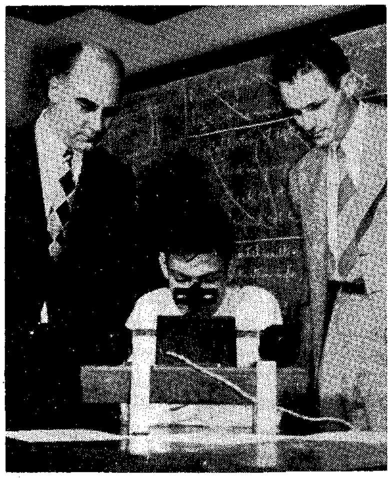
USS

UNITED STATES STEEL



In this issue

On the cover this month Caltech Physicists Carl Anderson, Aaron Seriff and Bob Leighton are gathered around a viewer, checking cloud chamber photographs — a procedure which has occupied a good deal of their time in the last year, while searching for evidence of two new elementary particles of matter. In fact, they took 11,000 cloud chamber photographs — and found evidence of the new particles in exactly 34 of them. You'll find the story of these new particles on page 10 of this issue.

The Bomb

Robert F. Bacher delivered a speech on the hydrogen bomb before the Town Hall Club in Los Angeles on March 27. Unlike most speeches, it's still going strong. Besides appearing in this issue of *E & S*, it's in the May issue of *Scientific American*, is due to appear in the July issue of *Reader's Digest* — and is still stirring up editorial comment in the newspapers and other magazines.

Dr. Bacher, head of Caltech's Division of Physics, is a former Atomic Energy Commissioner. On these grounds his speech is naturally *deserving* of attention. But it's *getting* attention on its own merits. It breaks through the iron curtain of secrecy that surrounds the hydrogen bomb these days and produces the kind of vital information on the subject that ought to be — but isn't — available anywhere else.

PICTURE CREDITS

Cover—Ralph Lovberg '50
p. 11—Official Photograph—U. S. Navy
p. 14—Mount Wilson and Palomar Observatories (right)
p. 16—Ross Madden-Black Star (top) Ralph Lovberg '50
p. 17—Ralph Lovberg '50
p. 18—Bob Madden '51

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Editor and Business Manager........Edward Hutchings Jr.
Student News........James Hendrickson '50
Staff Photographer........Ralph Lovberg '50
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PUBLICATIONS COMMITTEE

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BOOKS

WORLDS IN COLLISION
by Immanuel Velikowsky
Macmillan, N.Y., 401 pp., $4.50

Reviewed by H. P. Robertson
Professor of Mathematical Physics

THE CENTRAL THESIS of this incredible book is that the planet Venus broke away from Jupiter, as a comet suffered near collisions with the Earth during the fifteenth century before the Christian era, continued to cruise in a cometary orbit for some eight hundred years, and after a collision with Mars lost its tail and settled down into its present orbit!

The scientific pretensions of this jejune essay at cosmology are too ludicrous to merit serious rebuttal. Support for the thesis is sought in the accounts of catastrophe in the chronicles of civilizations of the past, and in a spate of legend, folklore and superstition. As examples of the method of "historical cosmology" fathered by Velikowsky, it should suffice to mention a few of the effects attributed to the initial contacts of the comet Venus with the Earth. The collision caused a "stasis" of the Earth, thus accounting for the stopping of the Sun and the Moon as recorded in the Scriptures (Joshua 10:12-13); the gravitational perturbations caused the parting of the waters of the Sea of Passage (Exodus 14:21-22); the gases composing the tail of the comet produced, on interaction with the oxygen of the atmosphere, variously naptha (Numbers 16:35) and manna (Exodus 16:14-15)—and on top of this brought to the earth a swarm of flies (Exodus 8:24)!

But let us turn from the inanities of the book itself to the truly remarkable manner in which it has been promoted by one of the most reputable publishing houses in America. Well in advance of publication a little band of literary apostles spread its message over the pages of *Harper's*, *Collier's*, *Reader's Digest*, and the Sunday supplement *This Week;* none among them is a scientist—only one, a science writer, is listed in the standard reference work *American Men of Science*, which includes some 50,000 names. As a result of their efforts, and the sensational nature of the book, *Worlds in Collision* has hit the nonfiction best-seller lists in various parts of the country.

And more is yet to come. The author proposes to continue his excursions into historical cosmology in further volumes, the first of which is to establish a synchronical scale for the sesquimillennium immediately preceding our era, under the catchword *Ages in Chaos*. It is sincerely to be hoped that the prospective publisher of these volumes will seek competent editorial advice, which will enable him realistically to weigh the value of his firm's reputation against the monetary rewards to be reaped by catering to those with a taste for sleasy pseudoscience.

PHENOMENA, ATOMS, AND MOLECULES
by Irving Langmuir
Philosophical Library, N.Y., $10

Reviewed by Robert V. Langmuir
Senior Research Fellow in Physics

THIS IS A COLLECTION of twenty papers by Irving Langmuir, ranging over various subjects from surface chemistry and molecular physics to world control of atomic energy and impressions of a trip to Russia in 1946. The book is of considerable scientific value, for it covers subjects not normally touched on in college textbooks. Surface phenomena are on the borderline between chemistry and physics, and knowledge of the fundamentals of this important field is not widespread among physicists. This collection of important papers by a leader in the field will do much to change this unfortunate situation.

Langmuir has worked in many fields of science, including the early theory of valence in chemistry, thoriated tungsten filaments for radio tubes, high vacuum technique, meteorology, surface chemistry and radio. This wide range of interests is more akin to that of the English "natural philosophers" of the last century, such as Kelvin and Lord Rutherford, than that of the modern specialists who stick closely to one restricted field such as cosmic rays or nuclear magnetic movements. Typical of Langmuir's versatility is his recent work in meteorology, not mentioned in this book. He entered this field as a logical extension of some work he was doing on the problem of reducing snow static in airplane radios. An amateur in the field, he made meteorology an experimental science as well as an observational and theoretical science. The effects of this recent work in weather may well be as important as his early work on gas filled lamps.

The production of the book itself is an extremely poor job. Several graphs are printed upside down or sideways, and at least two equations are printed upside down. There is no reference to the dates or the original place of publication of the various papers reprinted, although there is a good bibliography of Langmuir's papers in various fields. It is not clear at all that the publishers have contributed anything to the production of this book. Under these circumstances it seems to be almost highway robbery to charge $10 for it.

THE INTERPRETATION OF DREAMS
by Sigmund Freud
The Modern Library, N.Y., $1.25

Reviewed by Hunter Mead
Professor of Philosophy and Psychology

FIRST PUBLISHED in 1900 (English translation 1913), this book has always been crucial in psychoanalytic theory. It has also been highly controversial. Freud himself regarded his "discovery" of dream interpretation as his most important contribution to psychology, and his followers have usually concurred in this evaluation. The non-Freudians, however, have been less impressed; while it is no longer smart to refer to the book scornfully as "Dr. Freud's Dream Book," there remain many psychologists who regard some of his interpretations as arbitrary or twisted to fit into his general theory of pansexuality.

The reader who approaches the book with an open mind will probably feel that the seven chapters are uneven, both as to general interest and controversiality. For example, the chapter on "Dreams as Wish-Fulfilment" now seems straightforward and almost obvious—thanks to a half-century of Freud's influence. On the other hand, the chapter on "The Dream Work," in which he attempts to show how dreams are worked over or processed by the subconscious before they enter consciousness, will probably impress the unbiased reader as arbitrary and far-fetched.

But such criticisms are largely irrelevant. What must impress any

CONTINUED ON PAGE 4

The Main Line

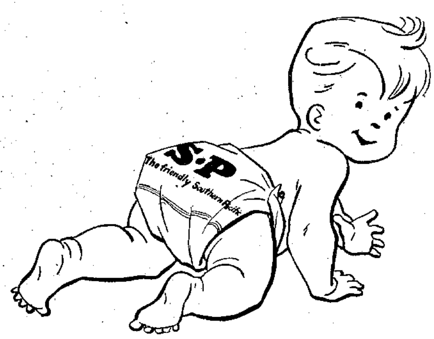
MAY, 1950

In the midst of a welter of correspondence about our "Why Don't Trains Fly?" booklet (and, believe me, we've *loved* hearing from you) we also received a mash note for one of our *Shasta Daylight* porters. It's too long to reproduce entirely, but we think you'll enjoy a few excerpts.

Beyond Call of Duty

"A woman got on the train with her two little boys, one not quite two years old and the other just a baby . . . her luggage evidently had not been put aboard and she was almost in tears. What to do about two babies who already needed to be changed!

"Your porter was equal to the emergency. First he begged a few clean dish towels from the dining car steward for her. After that he warmed the babies' bottles and saw that they were fed. At lunch and dinner he did the same thing and brought sandwiches for the mother and older boy.



"By the time evening came, the dish towels had been used up and there was the emergency again. This time the porter asked the conductor if he might have some towels and the answer was yes, because when the train arrived in Oakland, the baby was proudly borne out to meet his relatives with the most conspicuous part of him adorned with a blue-striped diaper with the initials S.P."

This strikes us as a novel solution to the eternal triangle problem. And while we're sorry our passengers' luggage got left in Portland, we're proud of the resourcefulness of *Shasta Daylight* porter John Barnes.

Looks Like August

These being uncertain times, we don't want to make any unqualified predictions, but it now looks as if the new *Sunset Limited* will be in service in August.

If you've been aboard our *Daylights*, *Lark*, *City of San Francisco* or new *Golden State*, you've seen some pretty fancy streamliners. But until you see the new *Sunset Limited*, you haven't seen anything yet.

Woosh—In 42 Hours

The new *Sunset Limited* will flash between Los Angeles and New Orleans in just 42 hours, clipping five hours from the present schedule. It will give you an eye-level, close-up of the spectacular Louisiana bayou country by day in both directions.

The new streamliner is being built by Budd Company to our own specifications. That means lots of special features you won't find in any other train. Watch this space for details.

Cheap Seats

Sometimes, when a thing ceases to be news to us, we assume that everybody must know all about it. It always comes as something of a shock when we discover they don't. That's the way it is with the low fares in chair cars on some of our finest trains. Few people realize how inexpensive they are.

For example, going back to our lady in distress on the *Shasta Daylight*, her ticket cost just $12 from Portland to San Francisco ($21.60 roundtrip) and her two youngsters rode free. For her $12 she got a reserved seat for herself, as well as one for each of the children.

The same good deal applies on the California *Daylights*—just $7.50 one way, $13.50 roundtrip between San Francisco and Los Angeles. (Federal tax, of course, is extra, as it is on all transportation.)

Similar low rates are available to you for trips east. You can ride fine trains like the *City of San Francisco*, *Overland* and *Golden State*. So if you want to s-t-r-e-t-c-h your vacation budget, ask us about those low-fare, luxury chair car seats.

Books CONTINUED FROM PAGE 2

person interested in the history of ideas is the fact that here is a popular, low-priced edition of a work originally written as a technical treatise for professionals, and mostly a few sympathetic professionals. In the half century since its publication, its author has risen from a virtual unknown to the rank of one of the most influential thinkers of modern times. There may still be a few die-hard sceptics who still wonder if Freud is here to stay, but the present book is one more evidence that he is very decidedly here at the moment, and probably will be for some time to come.

SCHOLARSHIPS, FELLOWSHIPS AND LOANS
by S. Norman Feingold
Bellman Publishing Co., Inc., Boston
249 pp. $6.00

Reviewed by Charles Newton
Assistant to President DuBridge

THIS BOOK LISTS scholarships, fellowships and loans available in the United States today. These are indexed according to granting agency, and cross-indexed according to field of interest; so that it is easy for, say, a biology student to find what is attractive in his line at different universities in the country. The importance of the book lies in the fact that it is the first of its kind ever published. Customarily, information on scholarships is handled the following way: universities spend large sums printing bulletins and posters (Caltech appropriates $250 a year); these are sent out to be heaped on overloaded college bulletin-boards; most students overlook them; a few draw mustaches on them; some few read them. The distributing center of scholarship information is thus the college janitor. Hundreds of good scholarships and fellowships go begging, hundreds of men miss what might have been just right.

The present book doesn't wholly correct the situation. It is incomplete. Under "Biological Sciences," for example, it lists three fellowships and one scholarship as available in the country. Caltech alone now has at least nine fellowships and two scholarships operating in Biology, and seven of the fellowships are nationally available. It will be a tremendous job to gather all the information that is needed to make such a guide complete. If *Scholarships, Fellowships and Loans* succeeds at the job, it will bring order and economy into a situation that is now irrational, wasteful and chaotic.

THE HYDROGEN BOMB

Can it be made? Will it add to our national security? How effective will it be as a military weapon? How much more effective than the atomic bomb? Will the Russians be able to make it? Here are the answers to some of the questions most people ask about the H-Bomb

by ROBERT F. BACHER

THERE HAVE BEEN MANY conflicting statements about hydrogen bombs and what we should do about them. Some of these statements have become distorted in repetition. Others, while clearly stating physical possibilities, concern events which are so improbable as not to warrant serious consideration at the moment. Some of the statements made by scientists, whether intentionally or otherwise, have been very frightening to our citizens. Back of such statements seems to be the idea that if the United States citizen will just become sufficiently frightened, somehow we will not have any more war.

There is no question that the hydrogen bomb has terrifying possibilities. It is our very deep obligation, however, as citizens in a democratic country to consider this whole question objectively, dispassionately and, as carefully as we can under the circumstances, to decide just what our country should be doing. It will not improve the judgement of the citizen to scare him to death first. Our future safety and security depend today on keeping our heads and using wise judgement.

Many people have been able to formulate their opinions of the hydrogen bomb very quickly, on moral grounds alone. They say, and with justice, that it is a weapon of tremendous mass destruction and that accordingly no civilized country should consider its development and use. This is a comfortable position and one very easy to take, but where do we stop? Atomic bombs are also weapons of mass destruction. Are they moral or immoral? Nothing could be more gruesome and immoral than the reports of some of the hand to hand conflicts during the past war.

There is no question about it: War inevitably leads to many acts which are immoral. The relative immorality of various weapons and acts of war becomes difficult to distinguish. The hydrogen bomb, being a weapon of tremendous destruction, is more to be condemned than lesser weapons on these grounds if used for needless mass destruction. Indeed, no one can argue that the moral position of the United States will be improved by the possession or use of this bomb. Immoral as it is, war consumes a large part of the efforts of the people of the world. Situations arise in which war seems to be the lesser of two evils. The real question is: "What should the United States do in order to diminish the probability of world conflict?"

I have no complete answer to this question, but what we do about the hydrogen bomb is directly related to it. One man says that to make the hydrogen bomb starts us on a weapons race which will inevitably lead to war; another, that we can only maintain our security if we make hydrogen bombs and thus are able to hold an aggressor at bay. Which one is right?

Many of our citizens have lost all faith in the United Nations and believe that there are no possibilities for international agreements which will have any meaning. Others feel that we have not made the right approach to the Russians as yet. Certainly there is little reason from our experiences in the United Nations to be very hopeful. If international accord seems so unlikely, we should be interested in whether a vigorous development and production of the hydrogen bomb will increase or diminish the probability of war.

Of course some will argue that any weapon development at all leads to war and that therefore we should make no development of any kind. Though this is in agreement with some of our most deeply rooted Christian ideas, there is no question at all in my mind that for our nation to pursue such a policy would greatly increase the probability of a world holocaust and a national calamity.

Throwing aside such a pacifist view, let us ask the questions: "What weapon development is important to the national security? How important is the hydrogen bomb to national security? Will hydrogen bombs increase our chance of winning a war with minimum loss?"

Technical background of the bomb

Before trying to answer these questions let us look briefly at some of the technical background of the hydrogen bomb. It has been known for a great many years that if one could somehow find a way of putting light atomic nuclei together to make heavier nuclei, it would be possible to extract energy. It has also been known for a long time that if one could take the heaviest nuclei and split them apart one would be able to obtain energy.

The first indication that either of these processes might be important to us as a source of energy came from the suggestion by Hans Bethe that the fusion of the light elements was our fundamental source of energy in the sun and stars. Dr. Bethe worked his ideas out in some detail, and scientists now believe that this fusion is the origin of solar energy. These ideas were well developed before the fission of uranium was discovered. This discovery, in 1938, was immediately recognized as a possible source of energy for man. If it were released gradually, he could use this energy for power. If released suddenly, the energy could provide an explosion.

Two fundamental scientific discoveries which followed soon after the discovery of fission were of far-reaching importance. The first of these was that in the fission of uranium caused by the absorption of low energy neutrons, additional neutrons were released in the process. The importance of this fact is that the fission of uranium could produce neutrons which could then produce another fission, hence the term "chain reaction." These neutrons released in fission could make the reaction self-perpetuating.

The second discovery was that some of these neutrons were emitted some time after the fission took place. It was this fact that made the controlled chain reaction or nuclear reactor a possibility. Without these delayed neutrons we would have no way of controlling a nuclear reactor.

With the fusion of the light elements the situation is entirely different. Here the basic nuclear reactions which lead to the release of relatively large quantities of energy are those which occur when the nuclear particles collide at high velocity or high relative kinetic energy. At the center of the stars the temperature is many millions of degrees Centigrade and the particles of matter are moving at such high speeds that these nuclear reactions may take place. Even then, only a few nuclear reactions are possible. There is no possibility that the energy release from this type of reaction can be controlled on the earth. In the stars the reaction is controlled because of their great size. On the earth these self-sustaining thermonuclear reactions will either give an explosion or nothing at all.

Can it be made?

Whether a hydrogen bomb can be made depends upon whether it is possible to create on earth an assembly of materials which will produce a nuclear reaction if they are heated to a sufficiently high temperature, and then to devise a way to raise these materials to that temperature.

The temperature required is comparable to that reached in the interior of the sun, which is more than 10,000,000 degrees Centigrade. The only way that we know to reach such a temperature today is in an atomic bomb, where the sudden release of energy causes the materials of the bomb to be heated to an extremely high temperature.

The main light element to which I have been referring is, of course, hydrogen. Now ordinary hydrogen just won't work. The scientific evidence for this seems to be quite clear. But hydrogen as it is found in nature has two forms or isotopes. The heavy hydrogen discovered by Urey nearly 20 years ago is a possibility. In recent years heavy hydrogen, as contained in water, has been separated in relatively large quantities.

There is another possibility. For more than 15 years it has been known that a still heavier isotope of hydrogen called tritium—because it has mass three—is produced in nuclear reactions. This material is radioactive and ordinarily does not exist in nature. It has a half life of only 12 years, but its nuclear properties are such that it is of basic interest in the release of energy by fusion.

It has been known for many years that tritium could be produced in a nuclear reaction in which neutrons are absorbed. The big nuclear reactors which are now in operation produce neutrons in large quantity. These neutrons are ordinarily used in the production of plutonium, but they could be used just as well to produce quantities of tritium. Any nuclear physicist can sit down and figure out the theoretical limit of the amount of tritium that can be produced with a given number of neutrons. It would be necessary, of course, to know a great deal about the actual workings of a nuclear reactor in order to say just how much tritium could be produced in that reactor if one were willing to forego the production of a certain amount of plutonium. It sounds as if the production of tritium in quantity is at least a fairly expensive if not formidable process.

That these two isotopes of hydrogen can possibly play a fundamental role in the release of nuclear energy by fusion is well known. Just exactly what relative role they play and how they might play it, is not a subject for open discussion today. These questions are secret. But any nuclear physicist will quickly grasp the basic science requirements, even though the bomb technology is much more complicated.

How do you get it going?

The real problem in developing and constructing a hydrogen bomb is: "How do you get it going?" The heavy hydrogens, deuterium and tritium, are suitable substances if somehow they could be heated hot enough and kept hot. This problem is a little bit like the job of making a fire at 20 degrees below zero in the mountains, with green wood which is covered with ice, and with very little kindling. Today, scientists tell us that such a fire can probably be kindled.

Once you get the fire going, of course, you can pile on the wood and make a very sizeable conflagration. In the same way, with the hydrogen bomb, more heavy hydrogen can be used and a bigger explosion obtained. It has been called an open-ended weapon, meaning that more materials can be added and thus a bigger explosion obtained.

Let us look for a moment at what sort of an explosion is imagined. In 1945 President Truman stated that the atomic bomb was equivalent to 20,000 tons of TNT. In talking about the hydrogen bomb it has commonly been speculated that such a bomb would be 1,000 times as powerful as the bomb dropped on Hiroshima. This would mean that it would have an explosive effect equivalent to about 20,000,000 tons of TNT.

Now it happens that the radius of damage from a big explosion increases as the cube root of the energy is released. With a bomb 1,000 times more powerful than the Hiroshima bomb the radius of damage will be 10 times greater. Since the radius for almost complete destruction from the blast was approximately one mile at Hiroshima, the corresponding radius for a hydrogen bomb 1,000 times as large would be approximately 10 miles—sufficient to cause almost complete destruction of any metropolitan area known today.

There are other damage effects from atomic weapons. At Hiroshima people who were in the open, and exposed directly to the light of the bomb, were seriously burned. With a hydrogen bomb these effects will be much greater and may extend to an even greater radius than that of the blast effects. On the other hand, the radiation which produces these burns is easily absorbed. It is very much like the radiation from the sun, against which a shadow or a blanket of smog is a great protection.

Generally speaking, one would expect the flash burn effects to increase as the square root of the power of the bomb. For a bomb 1,000 times greater than that used at Hiroshima the effects would be expected to extend roughly 30 times as far. At Hiroshima flash burns were severe out to two-thirds of a mile. Similar burns might be expected out to 20 miles for a hydrogen bomb. Such a damage radius would mean that shadows of buildings, trees, bushes, and other objects would be very important in cutting down the direct effect of flash burn. If you couldn't see the bomb directly, you would expect no effect of flash burn.

Both atomic bombs and hydrogen bombs may be expected to release neutrons and penetrating gamma radiation. These particles and rays, however, are absorbed fairly easily in air and will not have an appreciably greater radius of action for a hydrogen bomb than for an ordinary atomic bomb. People who are sufficiently close to be killed by penetrating radiation will very likely be killed by blast effects in any event.

There has been a great deal of speculation about the radioactive products of a hydrogen bomb. The disintegration products of the explosion are themselves not radioactive, as are the fission products of an atomic bomb. But since an atomic bomb would be needed in order to get the conflagration going, some fission products from that bomb would doubtless be present. And large quantities of radioactivity may be produced from the neutrons which are released in the nuclear conflagration.

If the neutrons released in the hydrogen bomb explosion are absorbed in some material which becomes artificially radioactive, then a very large quantity of this radioactive material will be produced in a big explosion. On the other hand, many of these neutrons might be absorbed in material that did not become radioactive. If the neutrons escaped into the air, many of them would be absorbed by nitrogen and, by a nuclear reaction, produce radioactive carbon. This material is most disagreeable as a radioactive contaminant since it has a half life of many thousands of years.

If such a bomb were exploded under water, however, very few of the neutrons would escape. Most of them would be used to produce radioactive sodium, to activate other elements in sea water, or to produce heavy hydrogen by neutron capture in ordinary hydrogen.

Effects of radioactivity

The radioactivity effects of a hydrogen bomb are thus difficult to estimate, since they depend so much on where the bomb is exploded and what material surrounds it. Under conditions in which the largest amount of radioactivity is formed it would be a dangerous hazard. One of the real scare stories about the effects of radioactivity has postulated the complete explosion of 500 tons of deuterium, which, while not impossible as far as anyone can say, is stretching probability a long way.

From this brief analysis of well known scientific information it appears that a hydrogen bomb would require a considerable quantity of heavy hydrogen, both deuterium and tritium perhaps, as well as an atomic bomb to set it off and raise the temperature sufficiently so that a nuclear conflagration could exist. Technically the problem is to figure out how a sizeable fraction of the energy of the heavy hydrogen can be released before the material is cooled too much by emitted radiation or dispersed by the explosion. In the stars the radiation is retained, because the stellar atmosphere is relatively opaque and there is an enormous temperature difference between the center and the outside of the star. In a hydrogen bomb there is no such protective layer, and the central problem is to get a large fraction of the energy released while the temperature is still high enough.

Whether this can be done will of course not be certain until it has been done. There are many opinions as to how difficult it may be. Since the President has directed the Atomic Energy Commission to continue with the development, we can assume that it is regarded as both possible and feasible.

So much for the technical problems which must be solved in order to develop a hydrogen bomb. Assuming that the problems can be solved, let us try to determine whether or not hydrogen bombs will add materially to our national security by considering their effectiveness as military weapons, and comparing them with atomic bombs already in existence.

If we assume that the hydrogen bomb is 1,000 times as powerful as the Hiroshima bomb, it will have a radius for blast damage which is 10 times as great—about 10 miles. For flash burn damage, the radius will be theoretically 30 times as great. But absorption and shadow effects will cut this down so that an effective radius for flash burns for those in the open may be roughly the same as for severe blast damage. Effects of neutrons and hard gamma radiation from the hydrogen bomb would not be expected to extend very much further than they would for an atomic bomb.

The effects of radioactivity would depend very greatly on where and how the bomb was exploded. If the bomb were exploded in the air, the effects of radioactivity from a hydrogen bomb would be quickly dispersed, and for long-lived activity the effects would be almost the same for all parts of the world, unless brought down by rain. It might be possible to enhance these radioactive effects by surrounding the bomb with the proper materials and to arrange it so that the active material would be deposited near the point of explosion. How successful such an unpleasant operation might be would again depend upon where the bomb was exploded and upon the general climatic conditions which existed at the time. In any case, the effectiveness of radioactive contamination from a hydrogen bomb designed and exploded to enhance that effect seems to be somewhat uncertain, and at least in part unpredictable.

Hydrogen bomb and atom bomb

We can easily see that a hydrogen bomb is capable of destroying any major city, with the exception perhaps of some of the outlying districts. How does this prospect compare with what could be done with atomic bombs? We have been comparing the hydrogen bomb with the atomic bombs used at Hiroshima but it has been stated that since the war there have been significant improvements in atomic bombs. These improvements have resulted in more powerful bombs and in a more efficient use of the valuable fissionable material.

Most large metropolitan areas include many districts that are covered by water, or otherwise unsettled, so that the reach of a hydrogen bomb would include many square miles whose destruction would contribute in no way to the effectiveness of the bomb. Atomic bombs could presumably be dropped so as to avoid these areas. Furthermore, it was found in the last war that a saturation raid which greatly hampered fire fighting caused damage far beyond the areas of immediate blast effects. Considering all these factors, it seems likely that there is no metropolitan area which could not be thoroughly destroyed with 25 atomic bombs. It is more likely that less than 10 atomic bombs would be needed to destroy major metropolitan areas, and that two bombs would completely paralyze even large cities.

Except for the psychological effects, and for the most unpleasant and somewhat unpredictable effects of the radioactivity produced, it appears that a hydrogen bomb which is 1,000 times more powerful than an atomic bomb might cause more destruction but would probably not be much more effective than 10 atomic bombs. For smaller industrial targets it would not be much more effective than a single atomic bomb.

One begins to wonder just how powerful a military weapon the hydrogen bomb would be. There does not seem to be very much force to the statement that the hydrogen bomb is such a tremendous new weapon that it can completely revolutionize warfare.

But what about the atomic bomb and the damage which might be inflicted with a sizeable stockpile of these weapons? Suppose, just to take a round number, that the United States possessed 1,000 atomic bombs of the improved variety. If they could be delivered to military objectives at all, they would go a long way at the rate of 10 for a major metropolitan area and perhaps an even smaller number for major cities. There would be a great many for relatively minor military objectives, and I imagine that the military commanders would have a hard time figuring out what to do with the last hundred.

The bigger the better?

It appears that if any nation has as many as a thousand atomic bombs, that the world is already in the position where any nation could be blasted thoroughly and completely. If this is the case, of what additional military use is a hydrogen bomb? For the most part it just seems that everyone is fascinated by the idea of "the bigger the better." There are a few examples in the history of the world that should lead us to question this view. We should not forget the dinosaur or the dodo. We should not forget the battleship, now almost extinct.

Of course it might turn out in a war that it would not be possible to deliver atomic bombs or any big bombs, to the targets which the military commanders might want to destroy. If this is the case, then, from the military standpoint, the solution of this problem is vastly more important than the question as to exactly what kind of bombs would be carried.

If hydrogen bombs would not add very much to the military effectiveness of the United States we might ask whether they would add much to Russia's military potential. Here, of course, one gets involved in even more speculation. One is not able to judge very well whether the Russians have an appreciable chance of delivering the hydrogen bomb by air against the radar defense of this country which is now being constructed. But even if such a defense is reasonably effective, and even if the Russians do not have the same strength of long-range bombers which the United States has, still there is another method of delivery which for the enemy would be perhaps quite effective.

Many of the big metropolitan areas of the United States are located on the seacoast. Into these harbors, or at least reasonably close to them, a hydrogen bomb might easily be brought in the hold of a tramp steamer. While this might not be the most effective place in which to detonate a hydrogen bomb, it would provide a simple method of delivery for a surprise attack. Another variation might involve the use of relatively small unmanned craft which could run ashore with a hydrogen bomb aboard. Practically no Russian cities could be reached in this way. This means that the hydrogen bomb would be a more effective weapon for the Russians than for the United States.

Some people have argued that if we develop the hydrogen bomb and can really keep its details secret, the Russians will never be able to develop it. There is absolutely no reason to believe that this would be the case. Recent experience has shown that the Russians have an atomic energy enterprise adequately developed to make a sizeable atomic explosion. In addition they probably have fairly detailed information on our atomic weapons work, and at least some of the early thoughts on the possibility of a hydrogen bomb—as a result of well known scientific information combined with the blundering indiscretions of some months ago, and also from their espionage activity. Given adequate time, they can most surely make a hydrogen bomb if it is possible at all.

While it is a terrible weapon, the military effectiveness of the hydrogen bomb seems to have been grossly overrated in the mind of the layman. He thinks it can save the country from attack. Pumped full of hysteria produced by Red scares and aggravated by political mud slinging, the average citizen is easily convinced that he can find some security and relief in the hydrogen bomb.

Here we have an instance of what can happen in a democracy when decisions of far-reaching national significance are made without public scrutiny of pertinent information. While most of the pertinent information is not secret at all, some of the information which the citizen should have in order to judge whether a national policy is sound, is secret. One of the most important facts which the citizen should know in order to make a reasonable judgement is the approximate number of bombs in the United States stock pile. It would be quite surprising if the Russians could not figure this out from the information which they obtained. But when Senator Brian McMahon, Chairman of the Joint Congressional Committee on Atomic Energy, raised the question of making the number of atomic weapons available generally, he was vigorously criticized. As of last spring, not even the members of the Joint Committee knew how many atomic bombs the United States had.

In a democracy it is possible to have good government only when the citizens are well informed. It is difficult enough for them to become well informed when the information is easily available. When that information is not available, it is impossible. The hydrogen bomb and its potential usefulness to the United States as a military weapon is a subject of national importance, not only because this is a weapon whose effectiveness has been grossly exaggerated, but also because it is one on which we can place relatively little reliance for the future. Quantities of hydrogen bombs will not contribute very much to the security of the United States. Unfortunately the citizen today believes that they will.

How to increase our national security

If the development of the hydrogen bomb will not do much to increase national security, how else might we do it? There are probably many answers to this question, but let me make one suggestion.

If the Russians should decide to move into Western Europe, we would immediately be faced with the prospect of fighting a war. Presumably, we could use atomic bombs. It would not be long, however, before we would need a big United States army and supplies not only for that army but also for our allies in Europe.

But just how would we get those supplies to Europe? During the past war, on at least two occasions, the Germans came dangerously close to shutting off our supplies to England. This was before the development of the Schnorkel type of submarine, which we are told the Russians now have in quantity. The Schnorkel submarine, while not absolutely impervious to detection by radar, is most difficult to run down. No method of detection has been developed which can locate it at any great distance under water, and it appears that a determined enemy with adequate bases and submarines could go a long way toward preventing us from delivering men and supplies to Europe. We could presumably deliver a certain amount of material by air, but when it comes to delivering millions of tons, our experience with the Berlin air lift should show us that this is not a feasible solution.

Here is a problem whose solution would contribute greatly to our military strength and therefore to our security. Its solution might even deter the Russians from overrunning Western Europe if they planned to do so. On this ground it seems to be much more important than the more spectacular hydrogen bomb development.

Atomic energy for war or peace?

It seems likely that there are many developments related to military strength which may be important for us to pursue. For some of these, as in the case of the development of atomic energy, we may need to choose between weapons and other developments of nuclear power which may have long-range peacetime significance. By adding to our industrial strength, such developments might make a greater contribution to our long-range strength than the more immediate development of weapons.

At the present time it is most difficult to ascertain how our government decides what policies to follow regarding national security. High government officials find themselves advised to pursue this or that development and to construct this or that weapon without being very sure how one weapon compares with another. Where the development of a weapon may compete with a long-range industrial development the problem is still more difficult. The real way to make sure that a reasonable policy is followed is to have all policies, and the information on which they are based, open for public scrutiny.

Furthermore, although the United States is a rich country, we are not in the position of being able to follow every recommendation that anyone believes will increase our national security.

The citizen should have the answers

The citizen must choose in so far as that is possible. Today if he tries to come to some conclusion about what should be done to increase the national security, he runs up against a high wall of secrecy. He can of course take the easy solution and say that these are questions which should be left to the decision of the upper echelons of the military establishments. But these questions are so important today, that to leave them to the military men is for the citizen essentially to abrogate his basic responsibility. If, in time of peace, questions on which the future of our country depends are left to any small group not representative of the people we have gone a long way toward authoritarian government.

The United States has grown to be a strong nation under a constitution which wisely has laid great emphasis upon the importance of free and open discussion. Urged by a large number of people who have fallen for the fallacy that in secrecy there is security and, I regret to say, influenced by many—including eminent scientists who prophesy doom just around the corner—we are dangerously close to abandoning those principles of free speech and open discussion which have made our country great. The democratic system depends on making intelligent decisions by the electorate. Our democratic heritage can only be carried on if the citizen has the information with which to make an intelligent decision.

TWO NEW PARTICLES

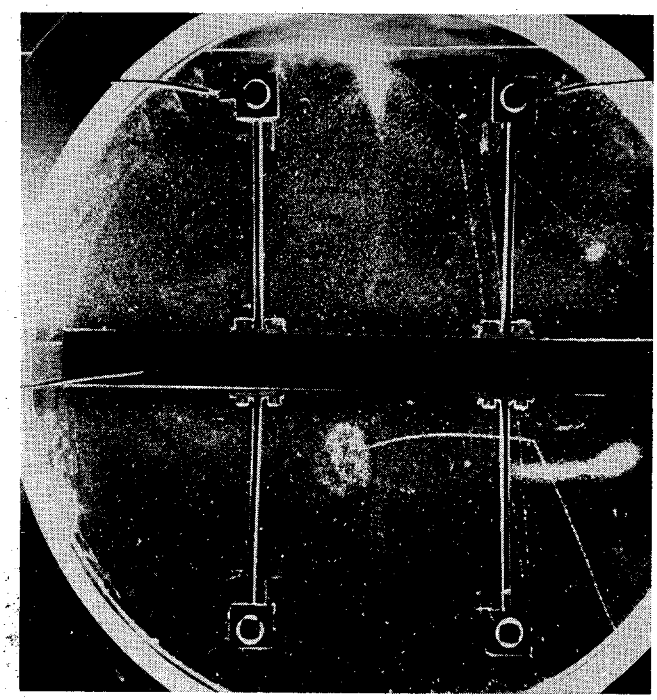
by C. M. STEARNS

Caltech researchers re-discover two elementary particles of matter—but, far from simplifying our understanding of nature, the discovery makes it even more difficult

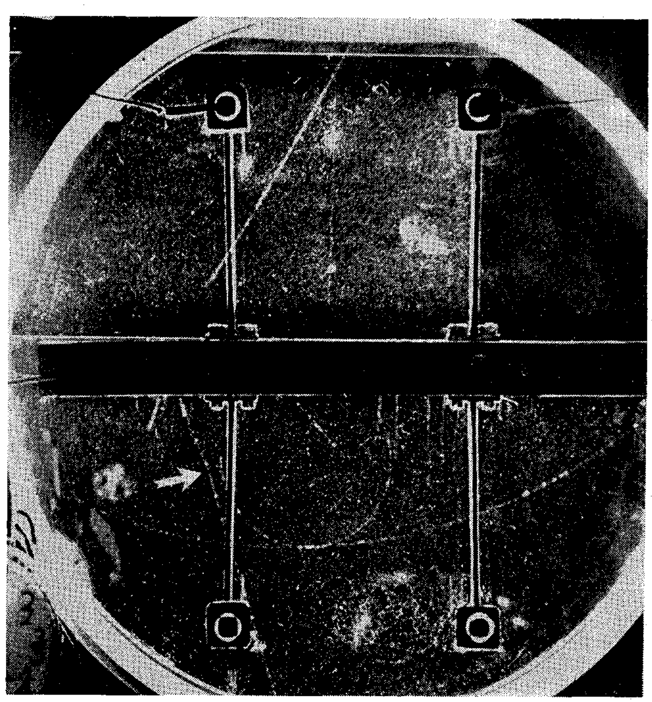
A GROUP OF PHYSICISTS at the Institute has found definite evidence for the existence of two new elementary particles. These particles have been on the "possible" list ever since 1947, when G. D. Rochester and C. C. Butler of England's University of Manchester first found them on two photographs taken in the course of studies of cosmic rays; now Aaron J. Seriff, Robert B. Leighton, Robert C. Hsaio, Eugene W. Cowan, and Carl D. Anderson have virtually proved that the particles do exist.

In all, the Institute physicists have 34 pieces of evidence pointing to the new particles—30 pointing to one of them, and 4 pointing to the other. In each case, the evidence is a photograph of a cloud chamber in which the particles left their tell-tale traces. Some of the photographs were made on the Institute campus; the rest at an elevation of about 10,500 feet on California's White Mountain, where the cosmic rays that produce the particles are somewhat more plentiful.

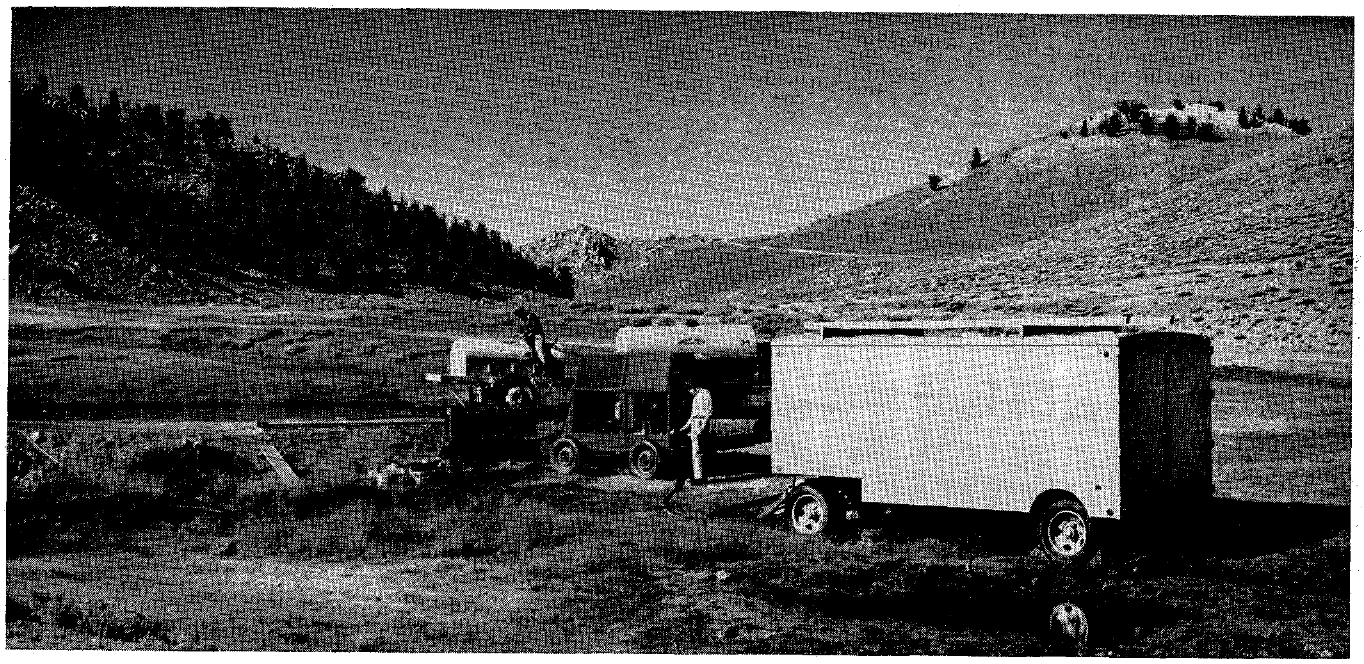
Each of the 30 photographs that apply to the first of the new particles shows two tracks that form an inverted "V" in the cloud chamber. It is the electrical charge on any such particle that causes a vapor-trail in a cloud chamber; and since this first new particle has no charge, it leaves no trace above the V. But when it disintegrates into two *other* particles—both of them charged—which make the tracks that form the V, the V proves that the original particle must have been there to disintegrate. Particle Number 1, then, is an uncharged, unstable particle that suddenly turns into



Particle Number 1 is an uncharged particle, so it leaves no track in the cloud chamber photograph above. But it reveals its presence by suddenly turning into two charged particles—whose tracks form inverted V at lower right.



Particle Number 2 is charged, leaves track at lower left above. Arrow shows where it disintegrates into a secondary charged particle—which continues track at a new angle—and an uncharged particle, which leaves no track.



Cloud chamber, mounted in this trailer, was taken to the top of White Mountain (10,500 ft.) in the scientists' attempts to verify the existence of the new particles. Of 11,000 cosmic ray photographs taken, 34 showed the particles.

two charged particles—quite possibly into mesons of a type already known.

By studying the tracks that form the V, the physicists have learned a few things about Particle Number 1. First, of course, is the fact that it has no charge; this they know because the particle leaves no trail in the cloud chamber. Furthermore, by studying the thickness of the tracks that form the V, their curvature in a magnetic field and various other factors, the physicists have got some idea of the mass and energy represented by the particles that make the tracks—and therefore some idea of the mass and energy represented by the parent, Particle Number 1, that gave birth to them. They have concluded that Particle Number 1 is more massive than any similar particle previously discovered among the cosmic rays; it is at least twice as heavy—and possibly seven times as heavy—as its predecessors.

Particle Number 2

The photographs that apply to Particle Number 2 show a different picture: a track not like a V, but like a dog's hind leg—a track coming down from above and then bending off at a new angle. Obviously, the investigators say, the track coming down is Particle Number 2 itself, and it must have a charge or the track would not be there. The bend means that Particle Number 2 disintegrates into a charged particle, which continues the track on a new angle; and into an uncharged particle, which of course leaves no track.

Since there are fewer photographs relating to Particle Number 2 than to Particle Number 1, fewer conclusions can be made about Number 2. It is, though, a charged particle, and again differs from any particles discovered earlier.

The two new particles bring the total number of known elementary particles to 13. Of the previously discovered 11, it is the mesons which give the best clue to what the newcomers may be.

Among the elementary particles of the universe, the mesons fall in a class apart. For one thing, mesons appear only where enormous amounts of energy are involved. Electrons take part in the day-to-day chemical activities of the world—the burning of coal, the use of food by living organisms, the explosion of gasoline or gunpowder. These are all, relatively speaking, *low-energy* events. Neutrons and protrons, the foundation blocks that make up the heart of each atom, do not become involved until more violent activities are reached, activities such as that of the sun or of an atomic bomb. These are *high-energy* affairs. Mesons, however, are found only in connection with activities more violent still. They are to be found only in the atomic rubble left when a cosmic-ray projectile from space (or, more recently, from one of the more powerful atom-smashing machines) plows into a piece of the earth or the atmosphere. Mesons, in short, are involved in events that are so violent, even if on a submicroscopic scale, that they can best be described as of *enormously high energy*.

That is one way of separating mesons from their neighbors in the table of elementary particles. A second turns on the idea of stability.

Stability is a clue

Left to their own devices, the best-known of the elementary particles are relatively stable. A proton, unless it gets in the way of a cosmic ray or finds itself a part of one of a few radioactive atoms, remains a proton. A neutron, even when away from its normal home in the heart of an atom, remains a neutron for an average of 20 minutes. An electron is similarly stable under ordinary conditions. But mesons are unwilling inhabitants of the physicists' world; they live only a few billionths (or, at most, millionths) of a second before decaying into something else, or disappearing into some nearby nucleus.

Such are the mesons—the ones so far recognized; and the two new particles clearly have some things in common with them. Like mesons, the new particles are found associated with cosmic-ray projectiles carrying enormously high energies (there is no way of knowing when man-made machines will be able to produce the new particles as they have recently produced the older, more familiar mesons). Like mesons, the new particles disintegrate into something else after a short and violent life (there would be time for three billion of them to be born, to live, and to die, one after another, in the passage of one second). The new particles were not predicted by any recognized theory—and, again like mesons, they find no theory that explains them adequately.

The two new particles *differ* from mesons, however, in life expectancy. Theirs is generally shorter, being about three ten-billionths of a second in the case of Particle Number 1 and probably still less in the case of Particle Number 2. Only the neutral meson, just pinned down at the University of California, has a shorter life span. The new particles also differ from mesons in their mass, which is still unknown, but which, in the case of Particle Number 1, is probably either about 600 or about 2200 times that of an electron. So the new particles should probably not be called mesons. But the word "meson" has already been stretched into a sort of catch-all name for mysterious new particles, and the two new ones may be added to the batch until the physicists know enough to give each meson a proper and individual name.

What is the significance of the two new particles? It is of course too early to say. However, whether or not they actually turn out to be variations on the meson theme, they share the importance that mesons have in physics—which is considerable. The study of mesons and related "events" in cosmic-ray phenomena has changed basically the physicists' concept of the elementary particles of matter. Physicists no longer think of these particles as permanent objects which always preserve their identity, and which serve only as building blocks of matter by joining together in groups to form the more complex chemical atoms. The unstable particles have changed that. One must recognize, instead, the fact that an elementary particle may have only a transitory existence. Today the universe seems composed of elusive units capable of changing from solid mass to radiant energy and back again billions of times a second.

If the universe is made up of a few basic building blocks, where in all this shifting scene do those blocks appear? And, above all, what holds them together in atoms with a force that, once released, can level a city?

It may be that meson-like particles hold the key to both riddles. The only theory today available to account for mesons holds that they are, in some way, pieces of the force that holds atoms together. The name "cosmic glue" has been applied to them, and is as good as any.

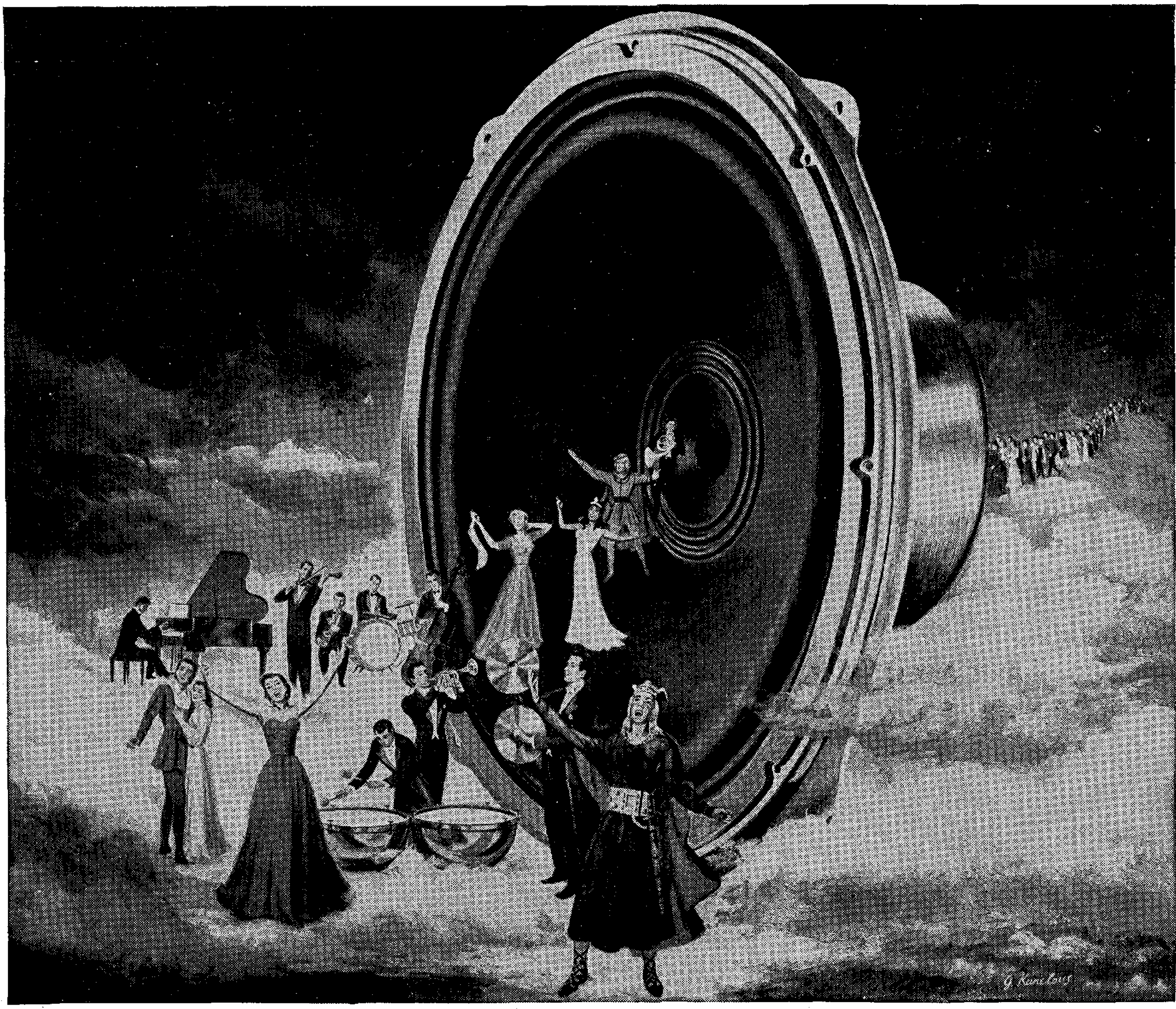
It may be, then, that inside an atom a meson—either a piece of energy, or perhaps a wildly-oscillating abstraction that is energy one instant, and solid the next—helps to hold things together; but that when that atom, or any part of it, is hit hard enough by the super-projectiles found in cosmic rays and cyclotrons, the meson is knocked loose, and is momentarily observable as a solid particle.

Such specific description of a meson may make a physicist wince, since far too little is known about the meson as yet to detail its behavior. Still less is known at this point about the two new particles. However, this picture of meson-like particles as solid bits of cosmic glue may very well turn out to be close to the truth; and it is certainly difficult to account for mesons in any other terms.

The two new particles, then, may join with the mesons that preceded them to help physicists explain once and for all how things are put together.

ELEMENTARY PARTICLES

Particle	Charge	Mass	Existence Recognized	Key Figures
Electron	—	1	1890-1900	J. J. Thompson
Proton	+	1836	1890-1920	Several
Photon	0	0	1900-1905	Several
Neutrino	0	0 (?)	1925-	Pauli, Fermi
Neutron	0	1836	1932	Chadwick
Positron	+	1	1932	Anderson
Mu meson	+, —	215	1936	Anderson, Neddermeyer
Pi meson	+, —	284	1946	Powell
Neutral meson	+, —	about 280	1950	York, Moyer, Panotsky, Steinberger
New Particle #1	0	600-2200	1947-1950	Rochester, Butler; Seriff, Leighton, Hsaio, Cowan, Anderson
New Particle #2	+, — ?	?	1947-1950	



THE MONTH AT CALTECH

National Academy Elections

■ THE NATIONAL ACADEMY of Sciences, which convenes each April in Washington, D. C., last month added two members of the Institute staff to its roster of top-ranking United States scientists—Dr. James F. Bonner and Dr. Ralph E. Wilson.

Dr. Bonner, Professor of Biology at the Institute, and one of the country's outstanding biochemists and plant physiologists, was graduated from the University of Utah in 1931. He received his Ph.D. at Caltech in 1934 and was the first graduate student to get a degree in plant physiology here. He has been a member of the Institute faculty since 1935.

Dr. Bonner's first researches were on the mechanism by which growth hormones exert their effect on plant growth—and he is still continuing these studies. As a National Research Council Fellow in Holland and Switzerland in 1934 he began to study the specific effect of growth hormones on the growth of plant roots. This led to a program of research on the role played by vitamins in plants.

In studies of the substances given off by injured tissue that have to do with wound healing in plants, Dr. Bonner (with A. J. Haagen-Smit and James English) chemically isolated a wound hormone in pure form. In 1938 he began an investigation—which was suspended during the war and only recently revived—of what makes plants flower.

As a logical extension of his work on growth hormones in plants (which, in simple language, are substances in one part of a plant that tell another part what to do), Dr. Bonner began a study of plant sociology—specifically, the chemical substances in one plant which tell *another* plant what to do.

During the war Dr. Bonner began to investigate the chemistry and physiology of rubber formation in the guayule plant, working toward possible synthetic production of natural rubber. This work is still continuing, as are two other research projects begun during the war—one on general investigations of the proteins and enzymes of plants, another on viruses in plants.

Dr. Bonner is President of the American Society of Plant Physiologists, and Chairman of the Physiological Section of the Botanical Society of America.

Dr. Ralph Wilson, Mount Wilson and Palomar Observatories Astronomer and Research Associate in Astronomy at the Institute, has been on the Mount Wilson staff since 1938, with Caltech since 1948.

He is best known for his work in stellar astronomy, concerning the motion, position, luminosity, etc. of stellar bodies. During the last war he was a consultant with the OSRD's Office of Field Services on the development of altimeters and oxygen apparatus. In World War I he was the American Representative on the Committee of Allies at Santiago, Chile, and also an aeronautical engineer for the Bureau of Aircraft Production at Dayton, Ohio.

He is a member of the American Astronomical Society, of which he was Councillor from 1934-37; and the Astronomical Society of the Pacific, of which he was president in 1946. In 1926 he was awarded the Gold Medal of the Royal Danish Academy of Sciences, and in 1948 he represented the Carnegie Institution of Washington and the National Research Council at the meeting of the International Astronomical Union in Zurich.

The election of Dr. Bonner and Dr. Wilson to the National Academy of Sciences brings the total of Caltech men in the Academy to 27. The others: Carl D. Anderson, George W. Beadle, Robert F. Bacher, Eric T. Bell, Max Delbruck, Lee A. DuBridge, Paul S. Epstein, Beno Gutenberg, John G. Kirkwood, Charles C. Lauritsen, Max Mason, Robert A. Millikan, Linus Pauling, Chester Stock, A. H. Sturtevant, Theodor H. von Karman, Frits Went, Oliver R. Wulf—and, from the Mount

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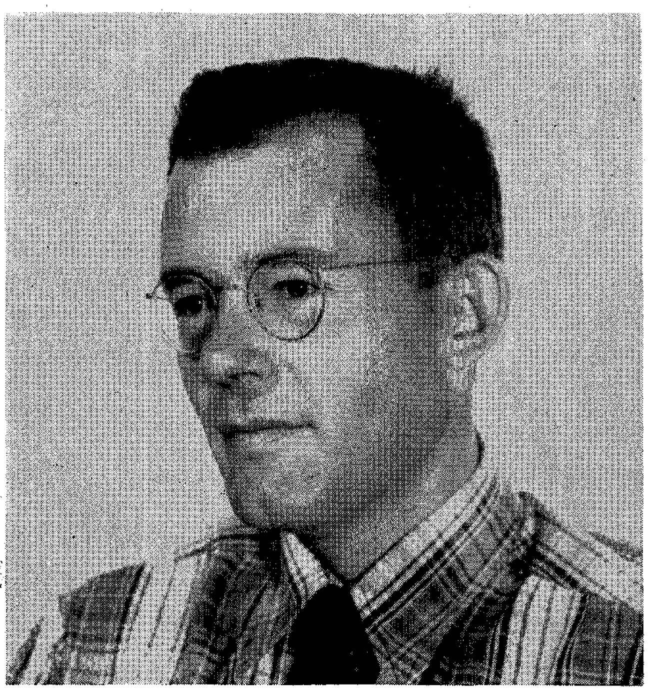
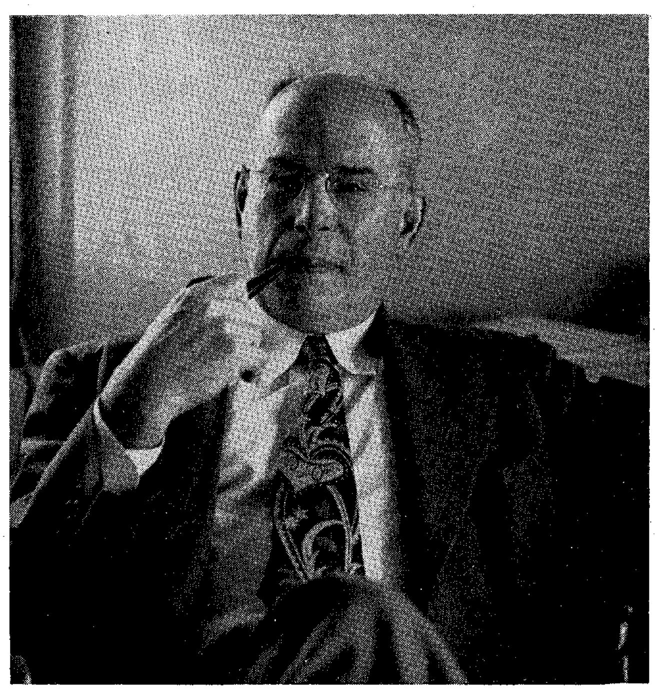


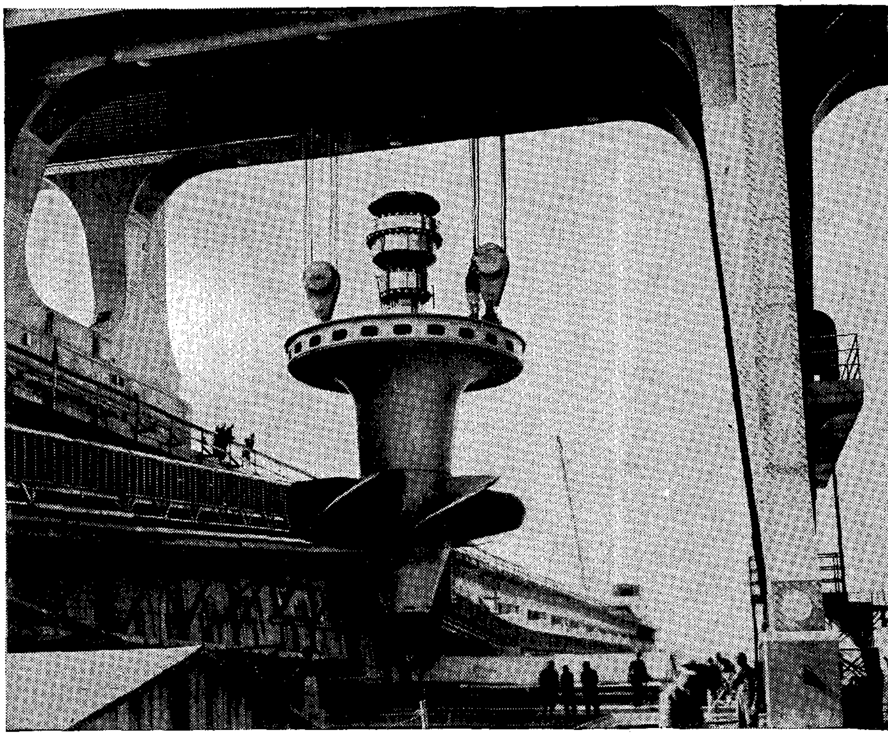
Bonner



Wilson

SPRINGBOARD TO A CAREER IN ENGINEERING

by J. F. ROBERTS
Manager, Hydraulic Department
General Machinery Division
ALLIS-CHALMERS MANUFACTURING COMPANY
(*Graduate Training Course 1919*)



Kentucky Dam TVA Field erection view of 250-ton gantry crane lowering hydraulic turbine assembly. One of five 44,000 hp, 48-ft. head, Kaplan type turbines.

YOU HAVE to start somewhere—and as far as I know, flagpole painting is the only job where you start at the top. Next best thing is to get in where there are many opportunities, and many interesting, worthwhile paths to follow—particularly if you are not entirely sure just what type of work you want to do. You then have a chance to try more than one field, and eventually find the work that will give you the most in satisfaction and success.

J. F. ROBERTS

Growth of Hydraulics

The field I'm best qualified to discuss is hydraulic engineering. Crude waterwheels were man's first mechanical source of power. Today, in highly perfected modern form, they're still a major source of abundant, low-cost electric power. The field is constantly expanding and holds a world of opportunity. Hydraulic power becomes increasingly important to the nation as the need for low-cost power steadily increases. Moreover, a hydraulic plant once installed produces energy with a minimum of manpower. There's no fuel to mine, prepare, ship, unload and burn—small operating personnel is required.

Right now at Allis-Chalmers we're designing and building turbines for vast new hydro-power projects, not only for the U.S.A. and Canada, but also for Mexico, South America, Norway, New Zealand and the Philippine Islands. We're also restoring many veteran turbines to better-than-original efficiency and capacity after long years of faithful performance.

Hydraulics was a field that I hadn't seriously considered as an undergraduate at the University of Wisconsin. I graduated as a Mechanical Engineer in 1918, and entered the Allis-Chalmers Graduate Training Course in January 1919. It was there that I got interested in the big waterwheels.

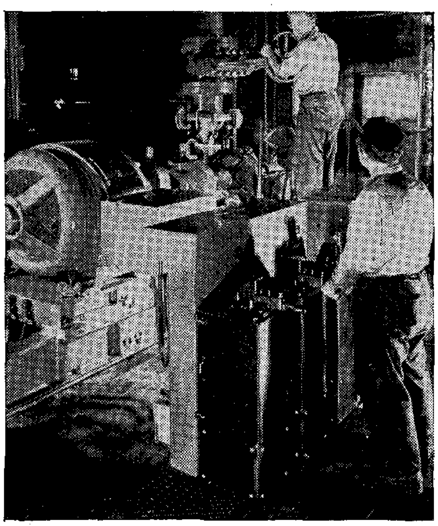
My first assignment was in steam turbine erection. Then I moved over on the hydraulic turbine test floor. In May 1919 I was sent to North Carolina on the acceptance tests of a big hydro-electric power installation. I continued with hydraulic field work such as tests and trouble shooting until 1925, when I went into the sales end of the work. Two years later I left the manufacturing side and became Hydraulic Engineer for the Power Corporation of Canada, supervising the design and installation of some 15 plants.

In 1936 I became Hydraulic Engineer for the U. S. Government TVA, involving 12 projects and 30 large units. I returned to Allis-Chalmers in 1942 as Manager of the Hydraulic Department—and had the unique experience of building some of the same turbines that I had purchased for TVA.

Vantage Point for All Industries

These personal notes serve to illustrate two interesting facts about the Allis-Chalmers Graduate Training Course. First, it's tailor-made for each student. Since 1904, graduate students here have been helping plan their own courses—making changes as they went along and new interests developed. They've had an opportunity to divide their time between shop and office—follow important projects through from drafting board to installation.

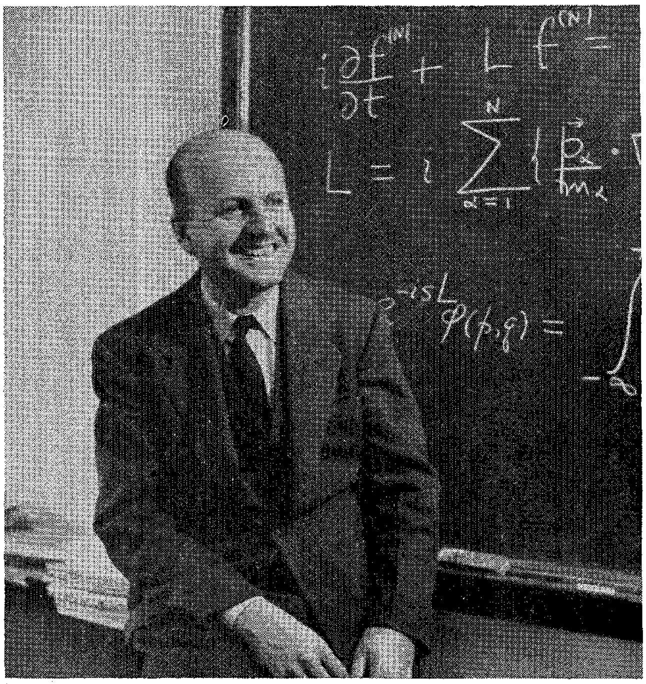
Second, the organization is in close contact with virtually all phases of industry: hydraulic or steam electric power plants and utilities; mining, smelting and rock products; public works; steel and metal working; textiles; food processing; flour milling. Allis-Chalmers builds basic machinery for ALL these industries and many more. Its engineers, executives, salesmen and production experts have a ringside seat for industry in action.



Graduate students conduct performance tests of centrifugal pump units.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



Kirkwood

Wilson and Palomar Observatories staff; Walter S. Adams, Horace W. Babcock, Ira S. Bowen, Edwin P. Hubble, A. H. Joy, Paul Merrill, Seth Nicholson.

Richards Medal Winner

DR. JOHN G. KIRKWOOD, Professor of Chemistry at the Institute, has been awarded the American Chemical Society's Richards Medal for 1950. One of the highest awards in the field of chemistry, the medal is presented every two years for "conspicuous achievement." Dr. Kirkwood's most conspicuous achievements have been in the field of statistical mechanics, and its application to chemical problems; and in the field of protein chemistry. He has developed a new method of separating proteins—the most recent specific example of this work being the separation of that part of the human blood which contains the antibodies to disease.

Dr. Kirkwood is the ninth recipient of the Richards Medal, and the third member of the Caltech faculty to win the award. Dr. A. A. Noyes, who inaugurated the Institute's program of instruction and research in chemistry, was the first recipient. Dr. Linus Pauling, Chairman of the Division of Chemistry, received the medal in 1947.

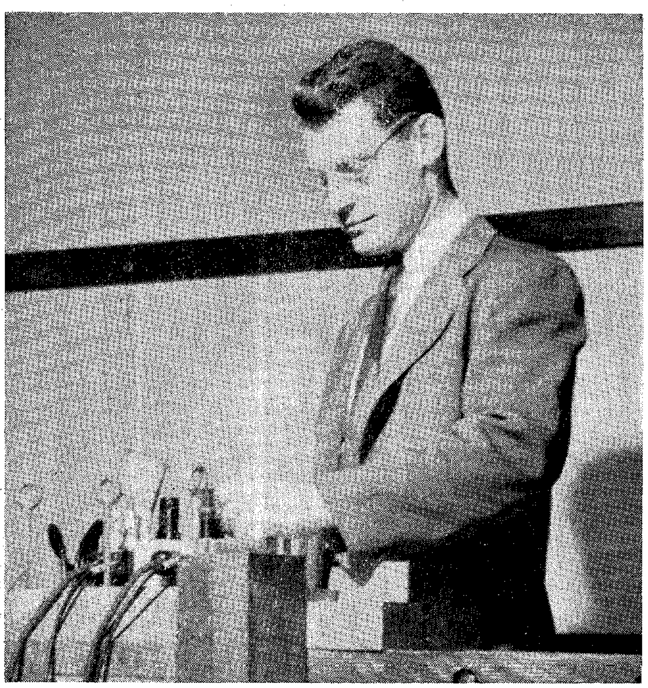
Guggenheim Fellows

WHEN THE JOHN SIMON GUGGENHEIM Memorial Foundation announced its annual awards last month, two members of the Institute were named to receive Guggenheim Fellowships for study abroad—Dr. Frank Host Dickey, Merck Research Fellow in Chemistry and Biology; and Dr. David A. Lind, Senior Research Fellow in Physics.

Dr. Dickey will leave in September to spend a year which will be divided between Cambridge, Upsala, and Paris, and devoted to studying the mechanism of the formation of antibodies, enzymes and genes. Dr. Lind leaves in June for the Nobel Institute for Physics in Stockholm, and—later in the year—the Eidgenossische Technische Hochschule in Zurich, where he will study the methods and techniques of precision nuclear spectroscopy.

Dr. Kenneth S. Pitzer, Caltech '35, Director of the Division of Research of the Atomic Energy Commission in Washington, D. C., also received a Fellowship for 1950-51, for a study of the chemical applications of quantum and statistical mechanics.

Though he was awarded his Guggenheim in 1946, Dr. Arthur W. Galston, Senior Research Fellow in Plant Physiology, hasn't utilized his Fellowship yet. This summer he leaves for a year at the Medical Nobel Institute in Stockholm, where he will continue his studies of the effects of light on plants.



Lind

Dickey

ALUMNI NEWS

13th Annual Seminar

■ CLOSE TO 400 ALUMNI, their families and guests came back to the campus on Saturday, April 15, for the 13th Annual Alumni Seminar at the Institute.

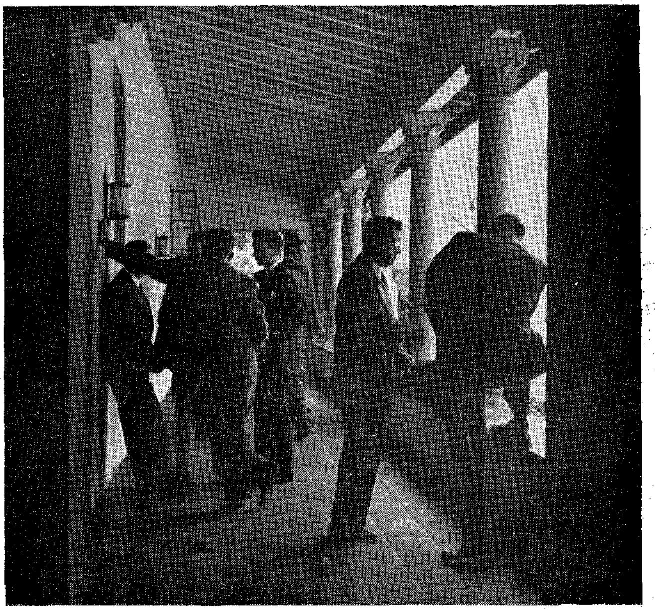
The morning program included lectures by Frits Went, Professor of Plant Physiology, on work in progress in the year-old Earhart Plant Research Laboratory; Dean Franklin Thomas, Professor of Civil Engineering, on California's water problems; Jesse Greenstein, Professor of Astrophysics, on investigations into interstellar space; Alan Sweezy, Visiting Professor of Economics, on the cold war; A. E. J. Engel, Professor of Mineralogy, on the search for the earth's primordial crust; and a panel discussion by two members of the Institute's admissions committee—Harvey Eagleson, Professor of English, and Carl Niemann, Professor of Organic Chemistry—and Ward Foster '27, on how Caltech selects its students.

After lunch (in the student houses for the men; at the Athenaeum for the ladies) laboratory exhibits were open from 2 to 4. There were 12 of these to choose from—the Animal Annex, Radiation Genetics and the Protein Synthesis laboratories in Biology; the Hydrocarbon Thermodynamics and Hydraulics and Heat Engines labs in Chemistry; the Vertebrate Paleontology laboratory in Geology; the M.E. lab; the Hypersonic Wind Tunnel; the Hydrodynamics lab; the Kellogg Radiation laboratory and the Digital and Analog Computers. But it took a fleet-footed alum to cover more than four of these.

At 4 p.m Hunter Mead, Professor of Psychology and Philosophy, gave a talk on the psychology of leadership. Then, after a social hour from 5 to 6 p.m.—during which some of the crowd listened to the music in Dabney Lounge, some worked out in the game room in the Athenaeum, and some scattered to just rest their feet, or quench their thirst, or both—the group gathered for dinner at the Masonic Temple in downtown Pasadena. Alumni President Joe Lewis and Institute President Lee DuBridge gave short talks after dinner, and Ray Untereiner, Professor of Economics, delivered a speech on "What's Around the Corner?"

Though perhaps not the most notable, at least some of the most memorable portions of the program were the definition, which was given in the Engel lecture, of an enthusiast as "a man who, having completely lost sight of his objective, redoubles his efforts"; the Eagleson anecdote concerning the old grad who recently complained that one thing the Institute should have had all along was a course in etiquette—and who, when asked by Doc Eagleson whether he would have attended such a course if it had been given when he was here, replied simply and resoundingly, "—— ——, Doc, NO!"; and finally, the Mead information, given for what it was worth, that studies have proved that one of the few things all leaders have in common is a habit of looking you in the eye when they talk to you.

The committee in charge of the seminar, which was headed by Carl Tutschulte '31, included John Nichols '45, Jerry Foster '40, K. F. Russell '29, Richard Henry '45, Robert Bennet '45, Jack Kettler '44, Jim Gregory '34, Ernie Hugg '29, and Paul Smith '39.



Alumni Seminar—informal discussion group

Open house: Vertebrate Paleontology lab

Open house: Analog Computer

THE BEAVER

The Seniors Go Dissolute

EVERY YEAR ABOUT THE TIME the bock beer goat becomes a familiar face and other familiar faces begin to tan from opening beach seasons, the Beaver watches the Seniors go slowly but pleasantly dissolute. When the spring term opens the Senior faces his books hesitantly, with faraway thoughts on his mind. He suddenly realizes that he has fumbled, fought, and worried his way through eleven long terms at Caltech and in this last—making it a round dozen—he feels that no one will have the heart to flunk him out now.

His plans for next year have probably materialized too; he's abandoned comfortable Levis many times for his pressed blue interview suit and filled out questionnaires until memory aches, but now someone satisfactory has accepted him and it seems unreasonable to have to work hard in the face of that.

Many Seniors, each in his own manner, have devised means of appreciating their last college term to the utmost. They lift their red, raw noses up from the spinning grindstone, rub them tenderly and peer about, blinking in the spring sun. In the cultivation of leisure, Senior Beavers are seen over coffee in the Spoon, over beer at the Skip, over sand at the beach, or over programs at a concert, but seldom enough over books and slide rules in the heavy early-morning hours.

Still the coveted sheepskin must yet be won, and the brittle bitterness of the beaks is turned upon those adamant professors who fail to account for the proverbial turning of a young Senior's fancy in the warm green season. Too many Seniors look ahead to hard work enough and now, wistfully or desperately, grasp at the fast-disappearing leisure of college—even at Caltech.

Ditch Day

Apropos of the spirit of the Senior's final term is Ditch Day, a cherished ritual in which, at least for a day, the long-suffering graduating class can quasi-legally flaunt its merriment and disappear en masse, leaving somewhat bewildered profs to walk into empty classrooms.

For weeks prowling, prying Juniors try to worm the secret date out of unexpecting Seniors in the traditional hope of trapping some of the escapees on campus after 8 a.m. Last year it had been well-known the day before, and some Seniors awakened on the fateful morning to find their rooms nailed shut or barred up tight. The only remains of one such imprisoned but clever Senior was a tell-tale rope of tied sheets and blankets hanging from his second-story window—with no habeas corpus for the Juniors to seize at eight o'clock. This year fleeing Seniors found their cars incapacitated by lack of wheels, distributors, spark plugs, or electric wiring, but almost all escaped, nevertheless—on hands and knees if necessary.

By noon the troops arrived at the Corona beach to unload Larry Knight's big truck of its five beer kegs, endless quantities of hamburger, potato salad, and eating paraphernalia, then proceeded to tan their collec-

While the Seniors are away the Juniors tie it up

Senior lawn—restored for Ditch Day

tive classroom pallor by playing volleyball, taking brave short swims in the icy ocean, or simply lying in the radiant glow, quaffing tall glasses of foaming brew and gloating quietly over the classes they were missing.

In the warm yellow sand, in the pungent smoke from the beach fires, in the exuberant yelling of guys and dates the Senior Beaver, if he stopped to think at all, recognized some element which would turn into pleasant reminiscence, which would add flavor to the memory of college years in some future time. It would be refreshing to be able to remember these classmates not only in Levis and slide rules but also in bathing suits and towels. The Senior Beaver, like all Seniors before him when graduation loomed close, occasionally felt old and looked back on his four years to wonder if they had been all they might have been. Ditch Day helped make the answer to that query a favorable one.

Rats at Play

True to the envious and vengeful attitude of underclassmen toward Ditch Day, much went on in the Houses during the day; the rats indeed played in earnest in the cats' absence. The Beaver, browsing around to survey the diabolical handiwork of the underclassmen, came upon a strange sight in Blacker court. Proudly standing in mid-court were the complete, reassembled rooms of two Seniors—beds, desks, chairs and dresser drawers artistically surrounded by sham walls made of room doors, closet doors, disassembled molding, windows, sinks, radiators and hanging clothes. In the vacated rooms there remained only white walls and bare floor, with breezes lazily wafting through the windowless and doorless apertures in the wall, and through the holes where electrical fixtures had been.

In Dabney court, the Beaver was staggered by a mountain pyramid of Seniors' bed springs towering over his head and swaying sickeningly in a light wind. Ricketts court was festively decorated with the neckties of fifty absent Seniors, draped colorfully on trees and bushes and eaves, on furniture in the lounge, in fact everywhere he turned to look.

The spirit of constructive activity had gone beyond Senior-sabotage in Fleming, where a ten-foot canvas tank had mysteriously sprung up full of water. With lower jaw agape, the Beaver stood and watched a couple of lively Sophomores diving into it from a high ladder, splashing great mushrooms of water onto the bedraggled orange trees and onlookers.

Blame it on Spring

And everywhere the Beaver stuck his inquisitive nose he saw distraught groups of House Presidents, Resident Associates, and sundry wheels gathered in worried talk, shaking their heads in despair. The Beaver stopped to light a cigarette and wondered if the springtime didn't bring on these strange outbursts of activity. He remembered the ill-fated Mount Wilson safari of several years ago when Willie Boutelle broke his head and William Randolph Hearst blew his top; and the spring a couple of years ago when a cement-mixer found its way into Dean Johnson's room. The season was still as unpredictable as ever, the Beaver decided, and ingenious utilization of its inspiration had not passed from the campus.

—Jim Hendrickson '50

PERSONALS

1911

Royal V. Ward, still working as an engineer with the San Bernardino County Flood Control organization in Upland, writes that the outfit is about to move into a new laboratory, and that its budget is now five times as big as it was in 1939—the first year. Royal's daughter Dorothy now has two fine daughters, 2½ and 5½, and his son Vincent has two fine sons, 1½ and 6½. His wife is enjoying painting (pictures, that is) as a hobby. And for himself, Royal is playing around with an automatic radio-broadcasting water-level warning gauge.

1918

Fritz Karge retired on October 31, 1949 from the Union Oil Company of California, after 31½ years of service. He is now a consulting engineer in civil and mechanical engineering, working largely on projects of the petroleum industry. Fritz plans to build a house at Laguna for his final retirement—to be near the ocean on which he sailed for 11 years in his youth. He lives in Whittier now, has two daughters and two grandchildren.

James P. Steele writes from Laramie, Wyoming that he is now President and General Manager of the J. P. Steele Construction Co.—which is presently engaged in completing a $5,000,000 building program for the University of Wyoming, among other projects in the state. Jim is President of the Wyoming Section of the A.S.C.E., and President of the Wyoming State Contractors Association.

1923

Charles P. Walker was unanimously elected mayor of Manhattan Beach last month. He has lived there for 18 years, and has a long record of public service to the community. Two years ago he was elected to the City Council with the highest vote received by any candidate in the history of Manhattan Beach elections.

1924

William L. Holladay presented a paper on the design of low-temperature test chambers before a joint meeting of the A.S.R.E. and the A.S.H.V.E. in San Francisco on April 21. And he's to present a similar paper before the spring convention of the A.S.R.E. in Kansas City on June 6. Bill has been with the Hieatt Engineering Co. in Los Angeles since 1947.

Orval E. Liddell is Chief Engineer and Superintendent of the Property Service Division of the Santa Catalina Island Co. in Avalon. In this capacity he has charge of the diesel electric plant, the gas plant, water supply, utility distribution and all Catalina Island engineering work. He lives in Avalon, and is the proud pa of two little boys—one 8 months old, one almost 3 years old.

1926

Joseph Matson Jr. is working as a civil engineer with the Agricultural Co., Ltd. in Waialua, Hawaii. He has three children—Muriel, 15; Kathleen, 12; and Lorna, 10. During the war he was a Colonel on the Engineering Staff, Planning & Construction, Pacific Ocean Areas, with headquarters at Fort Shafter in Honolulu. He was awarded the Legion of Merit in 1945.

Robert W. Moodie is working as a senior structural engineer with the Division of Architecture, State Department of Public Works, in Los Angeles.

J. A. Van den Akker writes that he and his wife (who will be remembered as Adelaide Carrier of the Caltech staff) and his daughter Valerie are about to move into their new home—a California redwood bungalow suitably modified to withstand the rigors of Wisconsin winters. Joy has just completed 15 years at the Institute of Paper Chemistry in Appleton, Wisconsin, where he is in charge of the physics department.

1929

Kenneth E. Kingman is now Manager of Manufacturing in the L. A. office of the Union Oil Company. He has a daughter, now at Scripps College, and two sons. Some other Tech men in the L. A. Union Oil office—*Homer Reed '29, Bob Bungay '30, Jack Sturgess '30, Ray Labory '31.*

Lawrence Grunder, Chief Research Engineer of the Richfield Oil Co. in Los Angeles, delivered a speech on "Heavy Duty Motor Oils" before a recent meeting of the Northern California Section of the Society of Automotive Engineers.

1930

Harvey S. Eastman takes over the chairmanship of the Mohave Desert Section of the A.C.S. this month. He's still working for the American Potash & Chemical Corp. in Trona—and so, he reminds us, are such other Tech men as *Julien Phillips '24, William Allen '25, Robert Sherman '32, Henry Suhr '33,* and *Ralph Whistler '34.*

Tamotsu T. Hiyama writes from Tokyo that, after graduating from Caltech, he went to Cornell and received an M.E.E.

degree. Early in 1932 he returned to Japan, where he has been working ever since with the present Nippon Columbia Co., manufacturing records, gramophones and electrical sound equipment. He is now head of the Engineering Department. He has two daughters and two sons.

Josef J. Johnson, Ph.D. '35, teacher of Astronomy Ay 1 for what he describes as "lo these many years," has been compelled to retire because of ill health. He takes this occasion, though, to send his best regards to his many former students.

1931

Howard Smits, M.S. '33, has been made President of Pacific Iron & Steel. He has been serving as Executive Vice-President.

1932

William L. Kent comes up with the following progress report, from Palos Verdes Estates: "Have worked for the Research Dept. of Union Oil Co. for the past 7 years. Mostly I run laboratory engines, specialize in fuels and lubricants. Have three children, 1 horse, 2 dogs, 1 cat (pregnant), 1 turtle, also a wife."

Grant D. Venerable has become a member of the George R. Healey Manufacturing Co. in Montebello, Calif.

1933

Wyatt Lewis is Quality Control Engineer at the Ontario (Calif.) works of the General Electric Co.—where electric flatirons are made. On April 17 he was guest speaker at the meeting of the San Francisco Bay Area Section of the American Society for Quality Control.

Gregory K. Hartmann, Ph.D. '39, last month became chief of the Explosives Research Department at the Naval Ordnance Laboratory in White Oak, Maryland.

He has been head of the Laboratory's explosives research program since early in 1948. During the war he was a consultant in experimental physics, primarily concerned with explosive phenomena at the Navy's Bureau of Ordnance. Later he was technical director for the Bureau's Instrumentation Group with the Bikini Task Force, and was assigned the duties of measuring the air blast and water shock for both Bikini atom bomb tests, and for measuring radiation intensities at the time of the explosions.

After graduating from Tech, Dr. Hartmann entered Queen's College, Oxford University, England, as a Rhodes scholar, and received a B.A. degree in mathematics there in 1936. Upon his return to the U. S., he became an assistant in physics at Brown University while working for his Ph.D. He joined the staff of the Bureau of Ordnance in 1941 and went to the Naval Ordnance Laboratory—center of the Navy's underwater weapons development program—in November 1946 as associate chief of the former Explosives Research Division.

1935

Kenneth S. Pitzer, Professor of Chemistry at the University of California, now on leave to the Atomic Energy Commission as director of research, last month was awarded the $1000 Precision Scientific Company award for work in the nuclear chemistry of hydrocarbon molecules—and was also named to receive a 1950-51 Guggenheim Fellowship (see page 16).

Arthur Ippen, M.S., Ph.D. '36, Professor of Hydraulic Engineering at the Massachusetts Institute of Technology, will be a member of the visiting faculty for a symposium on Fluid Mechanics and Aerodynamics scheduled for this summer at the University of Michigan.

Charles Patrick has moved to San Diego where he will be Director of Vocational Education of the San Diego City Schools.

1937

Andrew Fejer, M.S. '39, Ph.D. '45, head of the department of Aeronautical Engineering at the University of Toledo, Ohio, will also be a member of the Symposium on Fluid Mechanics and Aerodynamics to be held this summer in Ann Arbor, Mich.

Hugh Warner is still working for Westinghouse in Sunnyvale, Calif., at present as Manufacturing Engineer on Switchgear assembly.

Chuck Van Dusen, USN, writes that he has been in Washington for over a year, on duty in the Main Navy Department Building as Deputy Director of the Photographic Division in the Bureau of Aeronautics. He also represents the Navy on matters photographic in the Research and Development Board Panel on Photography and Optics. Prior to going to Washington he had command of a Navy Photographic Squadron and photographed roughly 100,000 square miles of Alaska for the Hydrographic Office and the Geological Survey. Chuck was promoted to full Commander last July.

1938

Richard Folkins is an Associate Engineer with the California State Highway Department. He and his wife had a daughter, Barbara Jean, born January 20.

1939

Keats Pullen is living in Baltimore and writing articles in technical literature. His sons are now 2 and 4.

Tyler Matthew, Lt. Comdr. USN, has been the Senior Assistant Navy Supply and Fiscal Officer at MCAS, Cherry Point, N. C., since June 1948. In his spare time he is singing in the choir at the Station chapel, playing golf, and has become a charter member of the Cherry Point Toastmasters' Club.

1940

David Varnes, with his wife and baby son, is in southern Korea mapping coal deposits for the U. S. Geological Survey. The Varnes' left last month and will return in June 1951.

Edward Dickerson is still with North American in Inglewood (where he started in 1940). His present position is Supervisor in charge of Fuselage Structures. He and his wife have two children—Dickie, 6, and Penny, 3.

Gordon B. Weir writes that he is still employed as a meteorologist by the National Weather Institute, with his primary duties being to advise the movie studios on meteorological matters. He also adds that he is probably the only graduate of 1940 who is still a bachelor.

Pierre Honnell, M.S. has been promoted to Professor of Electrical Engineering at Washington University in St. Louis.

1941

Reuben Snodgrass has been with Sperry Gyroscope Co., Ronkonkoma, New York,

ALUMNI

The Annual Meeting of the Alumni Association Will Be Held on June 7

Reunions for 1915, '20, '25, '30, '35, '40, '45 since 1948 as Engineering Test Pilot. He says that for neighbors he has *Neal Thomas* '39 who is chief engineer for Lockheed Aircraft Service in Sayville, N. Y., and *Lawrence Widdoes* '41, engineer for the National Dairy Research Laboratory in Oakdale, N. Y.

Wayne Abraham was married on March 19 in Claremont to Miss Alice van Mourik. They are living in Palo Alto.

1942

Robert R. Staley, M.S. '43, has been appointed Instructor in English and History at Amherst College, Mass. He received an M.A. from Stanford in 1948.

Henry Menard is living in San Diego and is associated with the Navy Electronics Lab. as an oceanographer.

1943

Bill Snyder, M.S. '46, has been attending Stanford since Oct., 1949 working for a Ph.D. in Electrical Engineering. For the three years previous he was with the Department of Electronics and Guided Missiles of the Hughes Aircraft Co.

1944

William Lockwood writes that since being released from the Navy in 1946 he has been employed by the Continental Can Co.—first as an Industrial Engineer in Oakland (Aug. '46 - Aug. '47), then as Plant Industrial Engineer in Walla Walla, Wash. (Aug. '47 - Mar. '49). In March 1949 he was sent to the company school in Chicago for two months and then transferred to Seattle, where he currently holds the title of Chief Inspector.

He was married last year to Elizabeth Richter Babb of Columbus, Ohio.

Arthur Carson received an M.S. from George Washington University, Washington, D. C., in February.

Edward Atchison has been working as an engineer and estimator for W. C. Baker & Co. (Heating and Air Conditioning Contracting) in San Francisco for the past ten months. He has been married for three years to Jessica Archibald of Oakland, Calif. and they have an eight-month-old son—Edward Jr.

Jep Garland has been "batching" with *Bill Bair* '44 in South Pasadena while working for the Fluor Corp. of Los Angeles in a two-year training course (due to finish up this June). For the past two months Jep has been on an assignment for Fluor as one of the job engineers constructing a gasoline plant for Shell in Hallettsville, Texas.

Lewis Grimm is teaching engineering at Pomona College, as well as teaching at Chaffee High School. He is married and has two sons—3 and 2.

George Shor is now in Homer, La. running a seismograph crew. On June 11 he will be married in Pasadena to Miss Betty Nobel — daughter of Tech's Prof. James Nobel.

John Gardner was married on March 11 in Los Angeles to Miss Barbara Seaver, who, for the past two years, has been in Germany and France with the Bizonal Delegation of the Office of European Economics. They are now at home in Dhahran, Saudi Arabia, where John is petroleum engineer with Arabian American Oil.

1945

Roy G. Killian has been associated with the U. S. Navy as a Naval Aviation Observer (Aerology) flying typhoons and hurricanes during '46, '47, '48, and '49. At the present he has the honor of having flown into more tropical storms than any other living man! He is attached to the Naval Air Station in Miami, Florida.

He was married in September, 1947 to Florence M. Taras of Minersville, Penna., and Denver, Colo. They have two daughters, Janis Lorraine, born in May 1948, and Joyce Tara, born March 4, 1950.

Richard E. Springer is in charge of the Physics Department at Monterey Peninsula College, Monterey, Calif. Next year he will start studying applied physics in Europe—his special field of interest being snow structure and avalanche study.

Walter H. Goodwin, M.S., is a design engineer at Western Gear Works. He and his wife have two children—"Hardie," 2½, and Louise Starr, 1.

John Stern and his wife announce the birth of a daughter, Deborah Ruth, born on March 10. John is a real estate broker with the Walter H. Leimert Co.

Dudley B. Smith received a Bachelor of Laws degree on February 22 from George Washington University, Washington, D. C.

1946

Frank Gates is a Lead Engineer at the El Segundo plant of Standard Oil. He was married on December 3, 1949, to Miss Marinel June Grandy.

George H. Kronmiller, M.S., Lt. Comdr. USN, received his aviator's diploma this spring at Corpus Christi, Texas. After a few days leave he reported to the Pacific Fleet for operational flight training.

1948

Mitchell Cotton will be married in June to Anne Denzler of Riverside, Calif. He is working for his master's degree at Washington University in St. Louis.

1949

Dick Patterson is living in Independence, Calif., and working in the Aqueduct Division of the Department of Water and Power.

LETTERS

ARIZONA SPEAKS UP

SIRS:

While no one questions the sincerity of the viewpoint expressed by Dean Franklin Thomas in his article in the October E & S ("The Battle of the Colorado"), advocating the California side of the Colorado River controversy, there is another side—that of Arizona.

The great State of California—the only state which contributes *nothing* to the flow of the Colorado River and which has in the Basin the smallest land area (1.7%)—now gets 51.8% of the total water available to the Lower Basin, and still aspires to more. Not only more water at the expense of Arizona either. If the position advocated by its spokesmen is adopted, California will be the only state within the Colorado River Basin which can make use of Colorado River water to any appreciable extent.

California is and will continue to be the colossus of the West, the greatest beneficiary of the continuing migration of the people to Western areas. We in the hinterland recognize our subordinate position, and offer no objection to this development, but do seek the right to live.

What are the issues involved in the river controversy between Arizona and California? They are: (1) the interpretation of beneficial consumptive use of water; (2) the question of whether or not the one-million acre-feet allocated to the Lower Basin—under Paragraph III, Article (b), of the Colorado River Compact—is apportioned or surplus water; and (3) the right of California to take a full share of water from the river, with all stream and dam losses chargeable to Arizona in event of shortage.

Taking each in order, it is the contention of the State of Arizona that consumptive use should be measured in terms of depletion of the main stream. That is to say, when the virgin flow of a river is estimated, each state should be charged with the amount that flow is reduced in proportion to the contribution a tributary makes to the main stream.

Consumptive Use

To the exact contrary, the State of California (and we think this term should be *Southern* California) adopts the position that each drop of rainfall, each acre-foot of water pumped, each acre-foot which may be re-used, represents consumptive use. In practical application, while the Gila River, on a virgin basis, would contribute to the Colorado 1,270,000 acre-feet, the State of Arizona should be charged with an amount variously estimated by so-called California experts from 1,650,000 to more than 3,000,000 acre-feet annually.

The Southern California spokesmen have adopted a position of particular benefit to them because their state contributes neither a direct contribution nor reflow to the river, whereas Arizona uses and re-uses water and contributes a substantial direct flow as well as reflow.

(2) Dean Thomas mentions certain provisions of the Boulder Canyon Project Act and the suggested compact therein between the three important states in the Lower Basin. But he does not mention the provision whereby the Gila River, then estimated at one-million acre-feet, was made available exclusively to the State of Arizona.

When the Colorado River Compact was agreed upon at Santa Fe in 1922, Arizona made known its objection to the agreement in the form then under consideration. The representative of the State of Arizona finally placed his signature on the Compact only because of two things: (a) the agreement of California and Nevada representatives that they would enter into a subordinate tri-state compact ceding to Arizona the full flow of the Gila River—then as now in almost complete use; and (b) inclusion in the Compact proper of the so-called 3b water, by which the Lower Basin was entitled to increase its use by one-million acre-feet annually.

That this is true is proven by the expression of every Arizona representative there in attendance, all of whom have made affidavits to that effect. Unfortunately, this has been disregarded—but never specifically denied—by representatives of the two other affected states. While it must be granted that the failure of Nevada and California to recognize their solemn agreement leaves Arizona in the position of having to depend upon the Compact as written, this does not increase the rights of California to river water on the one hand or reduce the rights of the State of Arizona on the other, for reasons which will hereinafter be explained.

(3) California spokesmen have adopted the unbelievable position that their contracts with the Federal government, being first in time, should be fulfilled in their entirety —and, if on some future occasion a shortage should exist, that shortage must be absorbed exclusively and entirely by the State of California.

This unreasonable conception of sovereignty is so far-fetched as to be unworthy of argument, for each state that was represented at Santa Fe was on a parity and continues to be at this hour.

The Colorado River Compact provides for a division of excess or surplus water in October 1963. Despite this, the State of California assumes the position that because it succeeded in securing a contract for 962,000 acre-feet of water over and above its self-imposed Limitation Act of 4,400,000 acre-feet annually, this contract must be fulfilled and the State of Arizona made secondary both in importance and in participation of river water.

The desire of the State of California to grow and prosper is both commendable and one to which we offer no objection. But to suggest the possibility of shortage at a time when the Metropolitan District is using approximately 16 percent of its primary water right, and a million acre-feet of California water is annually flowing into the Gulf of California while the Imperial Valley is wasting in excess of a million acre-feet into the Salton Sea, is hardly to be accepted as evidence of need.

Certainly there are Southern California cities which need water, but water is available. Why doesn't Southern California take it? We ask only that California observe the limitation which was self-imposed; and what it does with its water is its own problem. We strenuously object, however, to being accused of piracy at a time when California has more water than she can properly employ and can, by reallocation, serve a metropolitan area in excess of 12 million people.

California spokesmen long have contended for adjudication of this controversy in the Supreme Court (despite the fact that Arizona on several occasions went to the Court, over the violent objections of the same people). Now that authority to sue has been written into the authorization act in behalf of the Central Arizona Project, the question of water-rights has been forgotten while a flood of propaganda has been released over the nation, pointing exclusively to the so-called lack of feasibility of our Project.

We must have our share of water to continue to live and prosper. We have no desire to secure this at the expense of the legal rights of any other state. But, after repeatedly attempting to negotiate, arbitrate and litigate without success, and facing, as we now face, the continued opposition of Southern California spokesmen, we are constrained to believe that these men want not merely Arizona's share of the river, but the entire river for their exclusive use and enjoyment. And, if they succeed in this unfortunate effort, California will find it has blighted the growth of the West to its own future disadvantage.

Wallis T. Fleming '45
Cashion, Arizona

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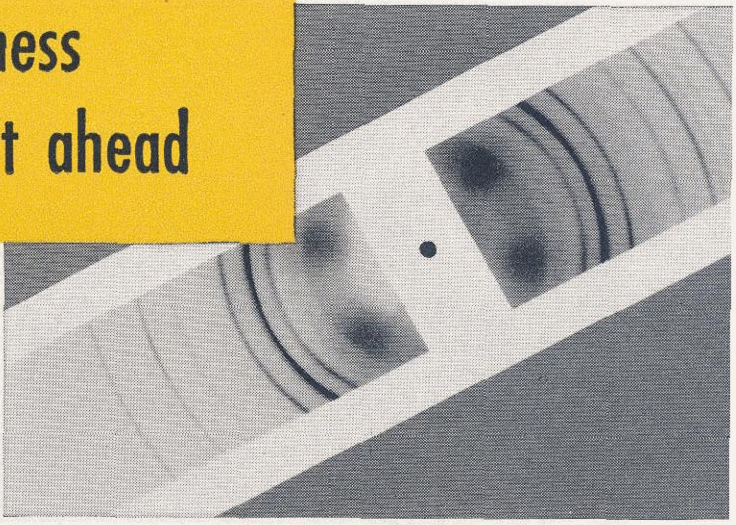

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On Bigness

We are today a much larger country than we were short years ago. Comparing 1930 with 1948, Federal government expenditures have grown from $3.6 billion to $40 billion. National income has grown from $75 billion to $226 billion.

* * *

Is small business holding its own with big business in this growth? Or being driven from the American scene, concentrating business into a few hands?

* * *

In 1900, there were 15 firms for each 1000 people. Today there are 18. (Apparently small business is not losing ground.) The average firm has the same number of employees as at the beginning of the century.

* * *

According to a survey by the Federal Reserve Board covering approximately 2,000 concerns, during the war, the small and medium-sized firms in total increased their profits, assets and net worth faster than did large concerns. In 1948, there were in operation one-third more business units than in 1944.

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Can new businesses crowd in and climb to the top? In 1935, to take the electrical business as an example, only 153 companies did over $500,000 business. By 1947, there were over 342 companies with sales in that higher bracket.

* * *

General Electric, in spite of its growth during the past 20 years, has only been able to keep pace with the growth of industry and of the country. We estimate that our percentage of production in the electrical industry was about 23% in 1930, 25% in 1940, and is today approximately 24%.

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It is the job of all business and all industry to supply the ever-expanding needs of people. Big jobs require big tools. No company and no industry in the American economy is yet big enough to bring enough goods to enough people.

You can put your confidence in—

GENERAL ELECTRIC