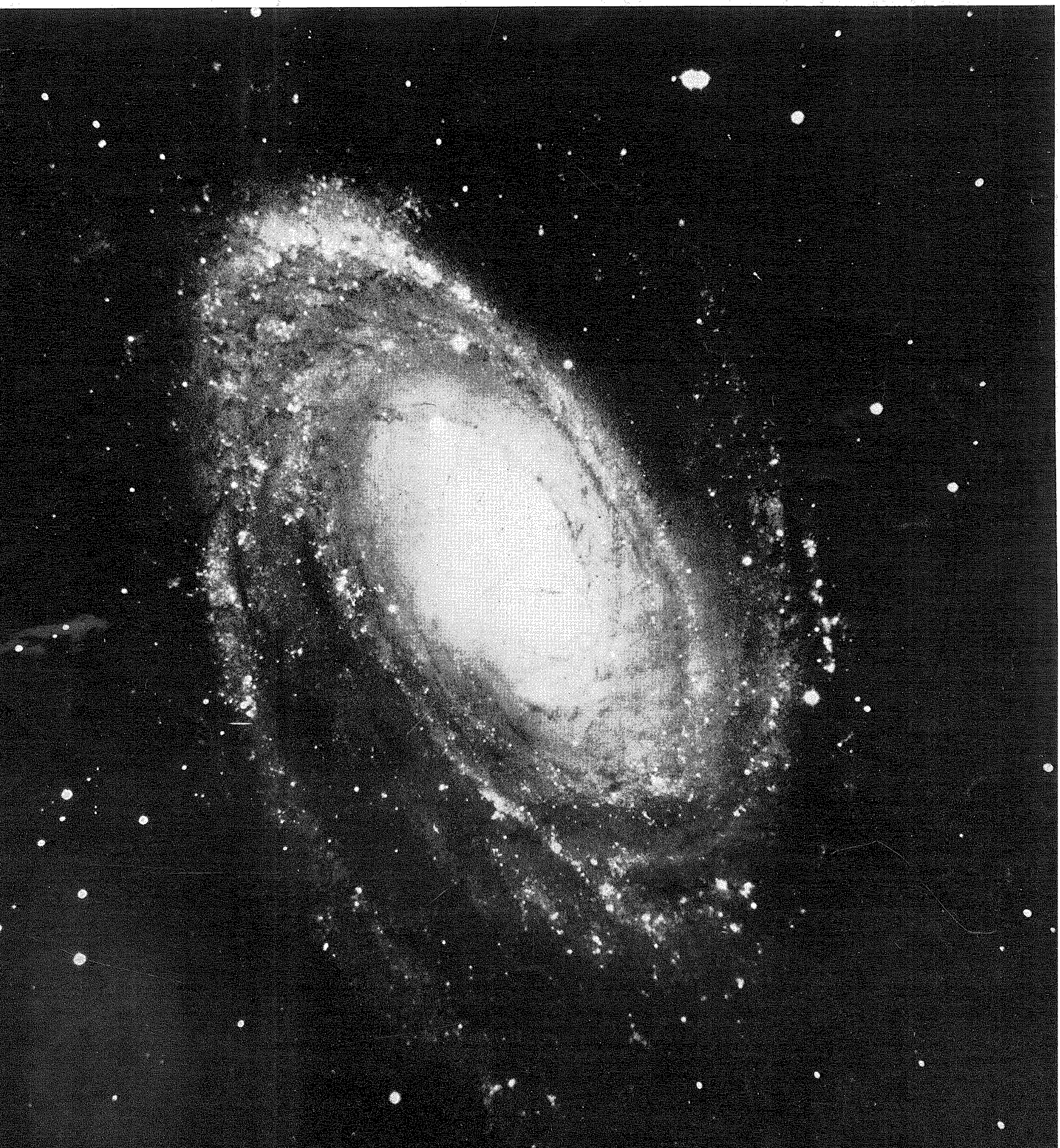
ENGINEERING AND SCIENCE

May, 1949



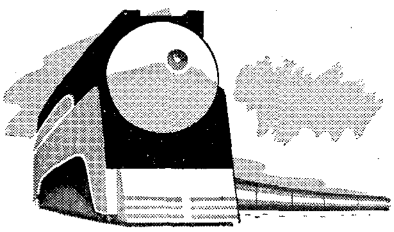
PUBLISHED BY THE CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

The Main Line

MAY, 1949

May, traditionally, is the month of flowers. The tradition undoubtedly stems from the somewhat Pollyanna-ish dismissal of April showers as being the forerunner of May flora.

But whether you subscribe to the old bromide, or are more inclined to credit pollenization by the bees and butterflies, there is no denying that May is the month of flowers along our lines in the west.



Wild flowers are currently out in profusion. If you haven't seen all you'd like to, we suggest you take a round-trip ride on our *Daylights* between San Francisco and Los Angeles. If you go one way on a *Coast Daylight*, and the other way on the *San Joaquin Daylight*, you'll see enough poppies, lupine, mustard and other California finery to last you all summer.

Incidentally, it's a very inexpensive trip—just $13.50 plus tax round-trip—which, we think you'll agree, is one of the greatest travel bargains in the country. That entitles you to a reserved seat, all your own, on two of the world's most famous streamliners.

Big Pane

Speaking of seeing things, now seems like a good time to lift one corner of the veil covering our first postwar streamliner, the *Shasta Daylight*. (While the exact starting date hasn't been announced yet, we expect it to be in service between Portland and San Francisco early this summer.)

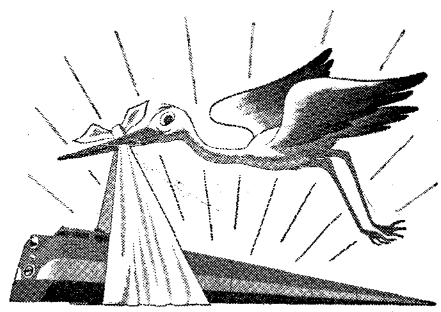
Among its many new features are the biggest windows you've ever seen in a train. Not only are they six inches wider than the huge five-foot windows on the California *Daylights*, but they've been especially designed for the spectacular Siskiyou-Cascade mountain country the train serves—they're six inches *higher*, too. On the *Shasta Daylight* you won't have to scroonch down in your seat to see the top of the mountains.

We'll tell you more about it next month.

Fast Ride

With new trains, as well as wild flowers, budding (you should excuse the expression) here and there, we'd like to remind you that some of our "old" trains are still pretty smooth articles.

For instance, the extra-fare streamliner *City of San Francisco* is still half a day faster than any other train between Chicago and San Francisco. Runner-up to the *City*, at no extra fare, is the *San Francisco Overland* . . . from the Golden Gate to the Windy City in 48 hours, with a daylight trip over the High Sierra. And don't overlook our *Daylights*, *Lark* and *Golden State* streamliners.



We have a lot of new trains coming, too. As they arrive we expect to make a tremendous hullabaloo about them. But when that happens, we don't want you to think we're just a bunch of johnny-come-latelies. We've been in the streamliner business for some twelve years already.

Still Looking

If you're thinking about going someplace "different" on vacation this year, ask us for the low-down on Crater Lake and Sequoia-Kings Canyon National Parks. We have a couple of new folders that are loaded with down-to-earth, brass-tack information about these places. If you'd like copies, drop a card to Mr. Geo. B. Hanson, 610 So. Main St., Room 406, Los Angeles, 14.

In this issue

On the cover is one of the first pictures to be taken with the 200-inch Palomar telescope. The spectacular object is a spiral nebula known as Messier 81, a galaxy very much like our own Milky Way. Though it is 300,000,000 times brighter than our sun, it is invisible to the naked eye—very possibly because it is about 3,000,000 light years away. For other Palomar pictures turn to page 3.

Edison Hoge, who wrote the Palomar story on page 3 is a graduate of the Throop Institute of Technology, class of '18. As an undergraduate he was photographer for the school magazine under Frank Capra, and he's been combining science with photography ever since. A member of the Mount Wilson Observatory for many years, he produced the popular movie, "The Palomar Story."

Richard H. Jahns, Associate Professor of Geology, was graduated from Caltech in 1935 and received his Ph.D. here in 1943. He is a Senior Geologist with the U. S. Geological Survey. The only proof we have that he's seen all (well almost all) the desert floods he describes in his story on page 10, is that he took (almost) all the pictures that illustrate the article. (Well, he says he did.) Some of these he got at no small risk to life and limb—like the ones on page 12, taken from a large cottonwood tree that, happily, was not washed away by the flood. The man running for cover in those pictures, incidentally, is William P. Irwin of the U. S. Geological Survey, now a graduate student at Caltech.

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LETTERS

Engineer in France

In Paris last summer Franklin Thomas, Dean of Students and Professor of Civil Engineering, stopped a student on the stairs of the Ecole Nationale des Ponts et Chaussees to ask directions of him. The student answered his questions and then—when he found out who Dean Thomas was—loosed a barrage of questions of his own about engineering education in America in general, and Caltech in particular. Dean Thomas came up with more about the same in France. This exchange of information was continued in a sporadic correspondence after Dean Thomas returned to Caltech in the fall. The letter below is part of this correspondence—a lively account of what it's like to be an engineering student in Paris today.—*Ed.*

Sirs: I'd be happy to tell our American fellow-students of Caltech, and its alumni, something about technical education and training in France.

Most of our engineering and scientific schools have grown up independently, and they are still in a somewhat independent position. They are, and they carefully keep themselves, apart from the actual universities. They are the Grandes Ecoles—the Great Schools.

Most of them are in Paris, and most of them are now state-sponsored. Each has its own individuality, guards it zealously, and tries to label its students with exclusive habits and traditions. Because students do their preparatory studies elsewhere, the Great Schools have only two- or three-year courses. Their students are few; an average class numbers about 50.

The oldest and most renowned of these schools, which give training of a high scientific level but still cover a wider field than the specialized schools, are the Ecole Nationale des Ponts et Chaussées (Bridges and Roads) and the Ecole Nationale des Mines. These century-old names are now somewhat misleading. Actually the first covers architecture, electrotechnics, and all the branches of civil and structural engineering. The second is devoted to mechanical and

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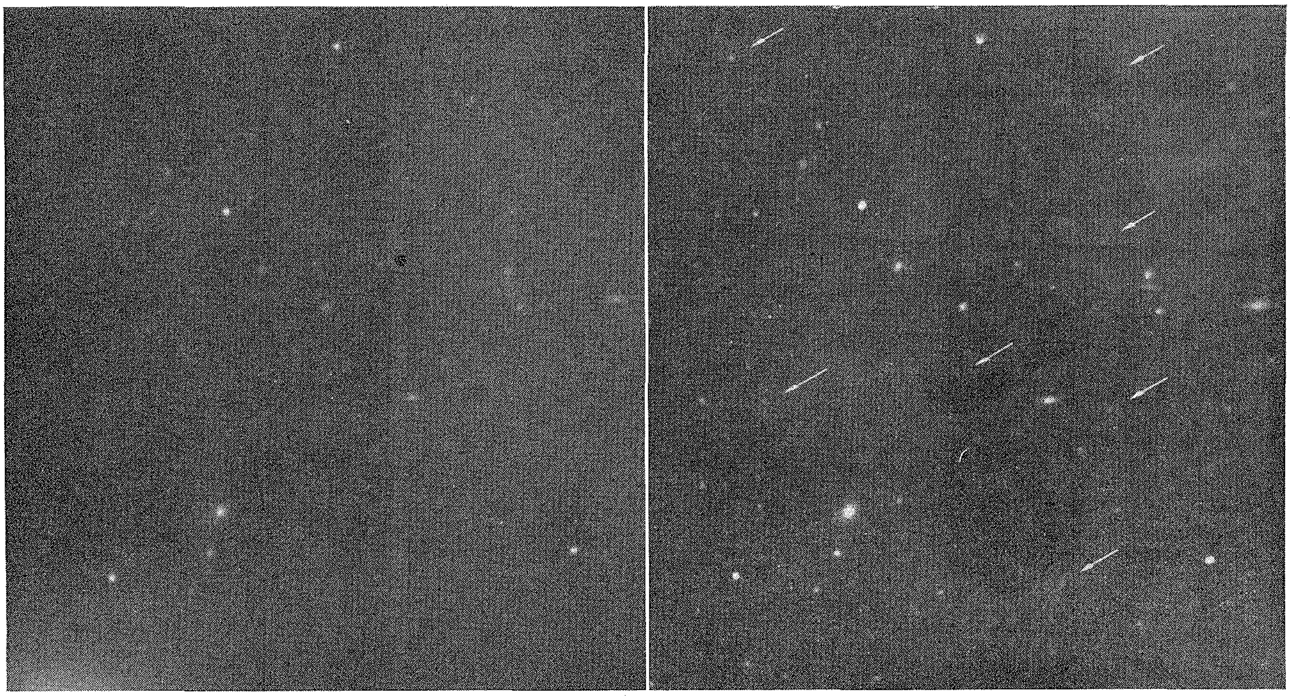


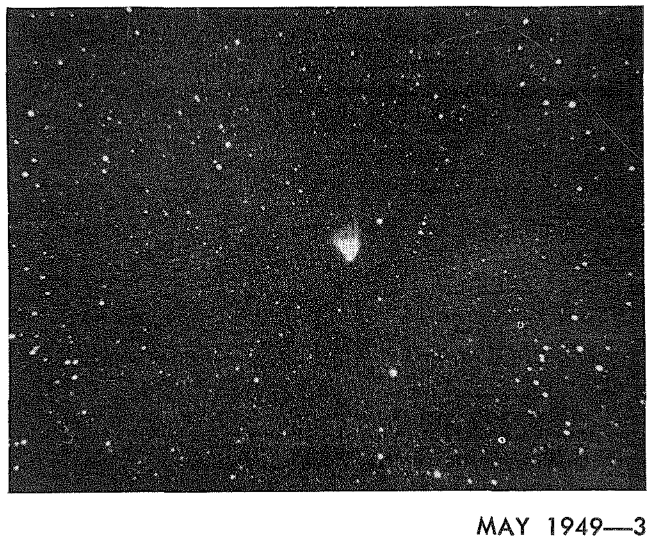
Comparison of pictures taken by the 100-inch (left) and 200-inch telescopes shows the kind of minute detail obtainable by the Hale telescope (arrow, right) which is of utmost significance to astronomers.

THE 200-INCH TELESCOPE

takes its first pictures

by EDISON HOGE

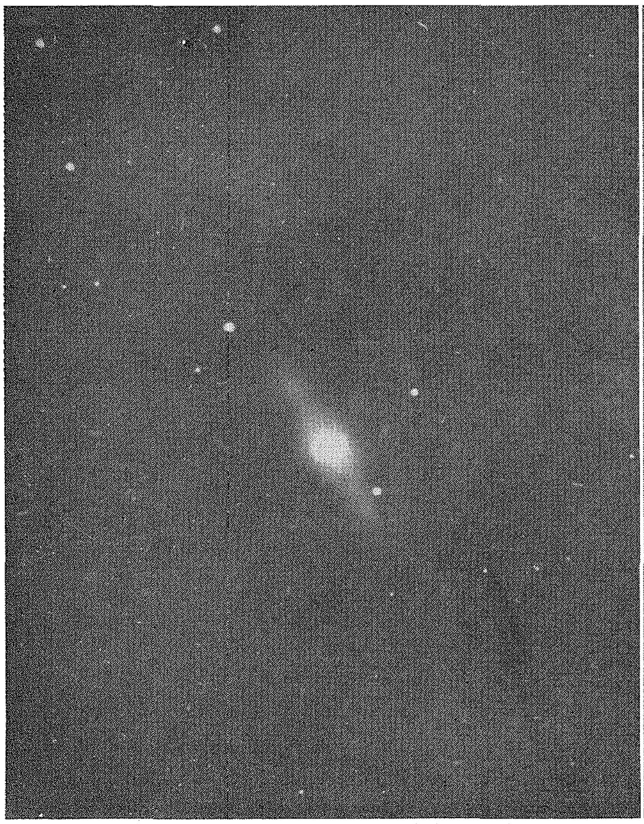
P.H.-1, first picture taken with the 200-in. telescope is not much—astronomically speaking—since it was only made to try out the telescope. Taken by Dr. Hubble, it shows Hubble's Variable Nebula.

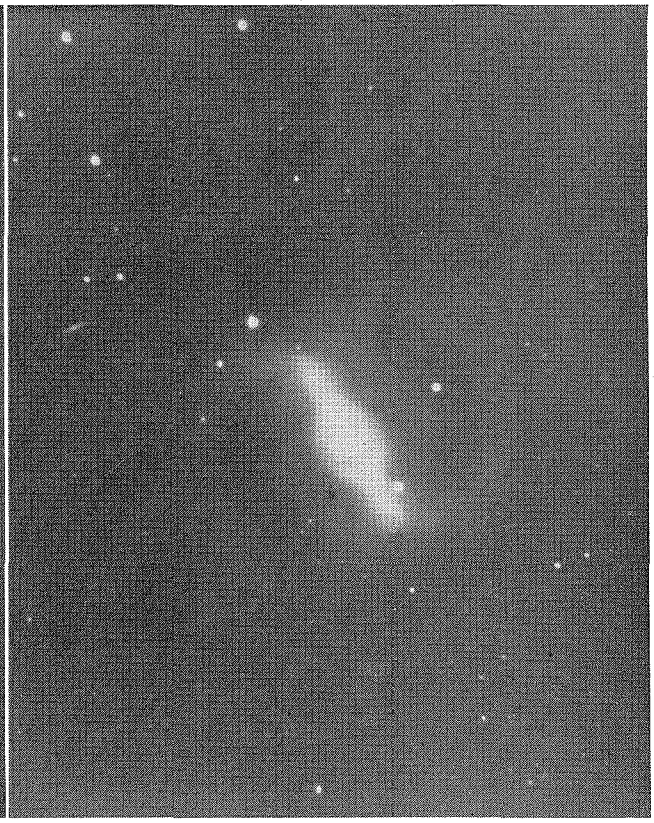


QUIETLY and without fanfare, on the night of January 26th, 1949, at 10:06 p.m. P.S.T., Dr. Edwin Hubble pulled the slide of the plate holder starting the exposure on plate number P.H.-1. The P stands for Palomar, the H for Hale, and the 1 means that this was the first astronomical photograph taken on the first observing schedule of the 200-inch Hale telescope at Palomar Mountain. To date 62 plates have been taken with the 200-inch telescope.

To the layman these first photographs will probably look just like thousands of other astronomical photographs, taken with other large telescopes. To the astronomer, however, these first Palomar plates are tremendously exciting. Even though they were taken under from poor to average conditions of "seeing," they clearly indicate that the 200-inch Hale telescope is capable of doing the work for which it was designed.

These first observations have already pushed back the horizons of our observable universe from 500 million to 1,000 million light years. Some of the plates show detail and resolution equal to the finest plates thus far taken with the 100-inch telescope on Mt. Wilson. The light-gathering power of the 200-inch mirror assures stellar and nebular spectrograms on a greater scale and with finer detail than ever heretofore obtainable. Due to the novel design of the Hale telescope a large area about the North Pole, not within the range

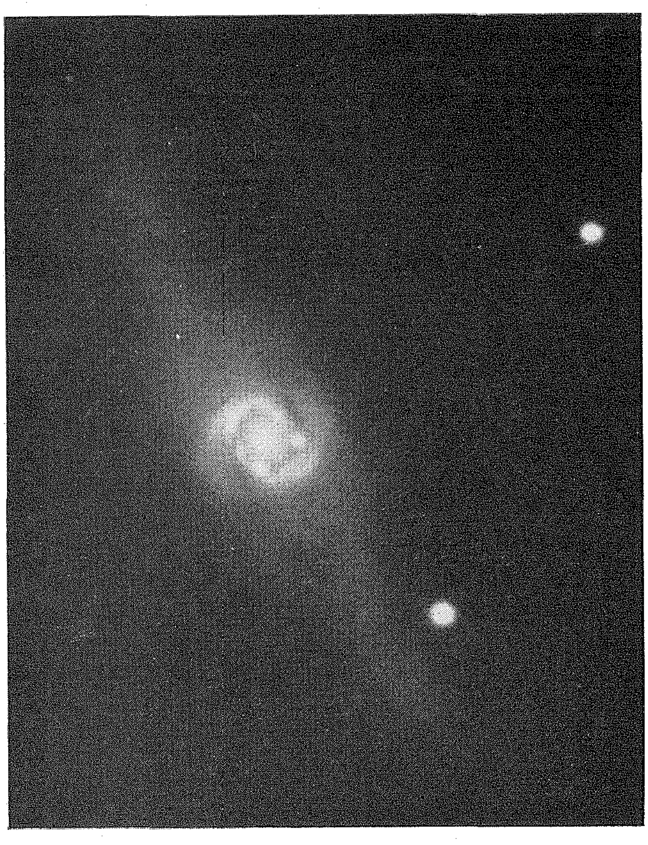




Spiral nebula, left, was photographed by the 100-in. telescope; same nebula, right, by the 200-in. telescope.

Unexciting?

"Unfortunately," says Dr. Hubble, "the most exciting pictures astronomically (the ones where the most distant objects have been photographed) become the least spectacular . . . on the printed page". But these pictures of a nebula 5,000,000 light years away seem to contradict Dr. Hubble's modest statement.



Blow-up of 200-inch plate reveals nebula's nucleus.

of the 100-inch telescope, now becomes observable with a very large telescope for the first time.

These first plates from Palomar were taken as a practical test of the great telescope. When first installed, the 200-inch mirror was given a thorough optical test in place by Dr. Ira Bowen. The outer 20 inches of the mirror was found to be turned up a few millionths of an inch. To correct this minute irregularity it has been decided to polish this outer rim down to as nearly the correct figure as possible. This work, which will take about six months, will bring the 200-inch Hale telescope to its highest possible working efficiency before the regular observing program is resumed.

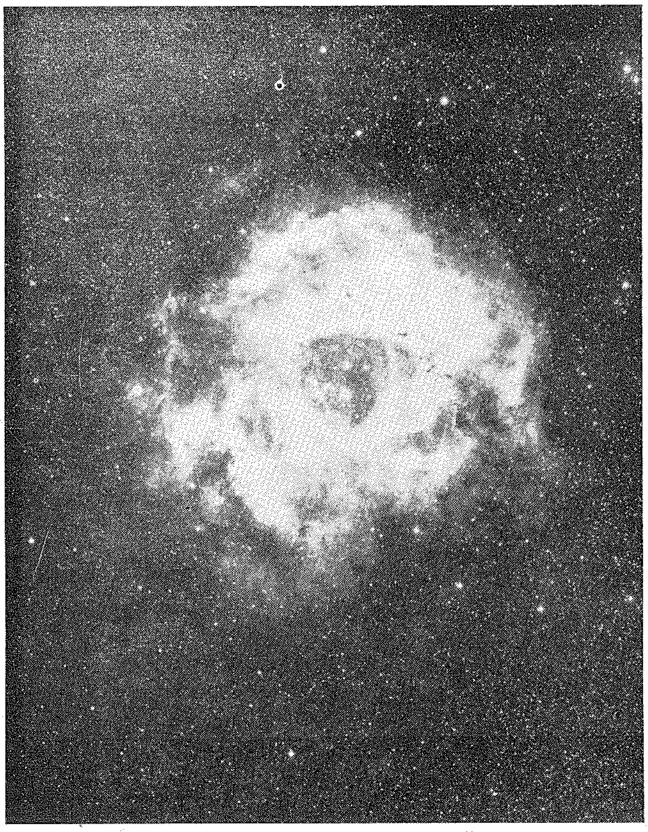
Advancement in scientific research is not always accomplished by merely building larger and more powerful equipment. New types of instruments often result in great advances too. The 48-inch Schmidt telescope at Palomar admirably illustrates this point. Although the 48-inch Schmidt has not been much publicized, it will be of outstanding importance in the astronomical research program at Palomar.

The Schmidt type of telescope is unique in that it may photograph with a relatively short exposure a very

No other astronomical instrument can obtain as vast a region of the sky as the 48-inch Schmidt camera which scouts the skies for the 200-inch, and creates a good deal of astronomical excitement on its own. This typical plate (the original is approximately 14" x 14") was taken in the center of the central line of our Milky Way.

large area of the sky in exquisite detail. This makes it extremely valuable as a "mapping" telescope, with great possibilities for discovering new astronomical objects. The 200-inch Hale telescope, on the contrary, has an extremely narrow angle of view, but the 200-inch reflecting mirror gives a very great light gathering power and the large diameter provides a very high degree of resolution. These unique characteristics of the 200-inch telescope are well adapted to examining in detail—both by direct photography and by spectrographic photography—astronomical objects that may be discovered with the Schmidt telescope.

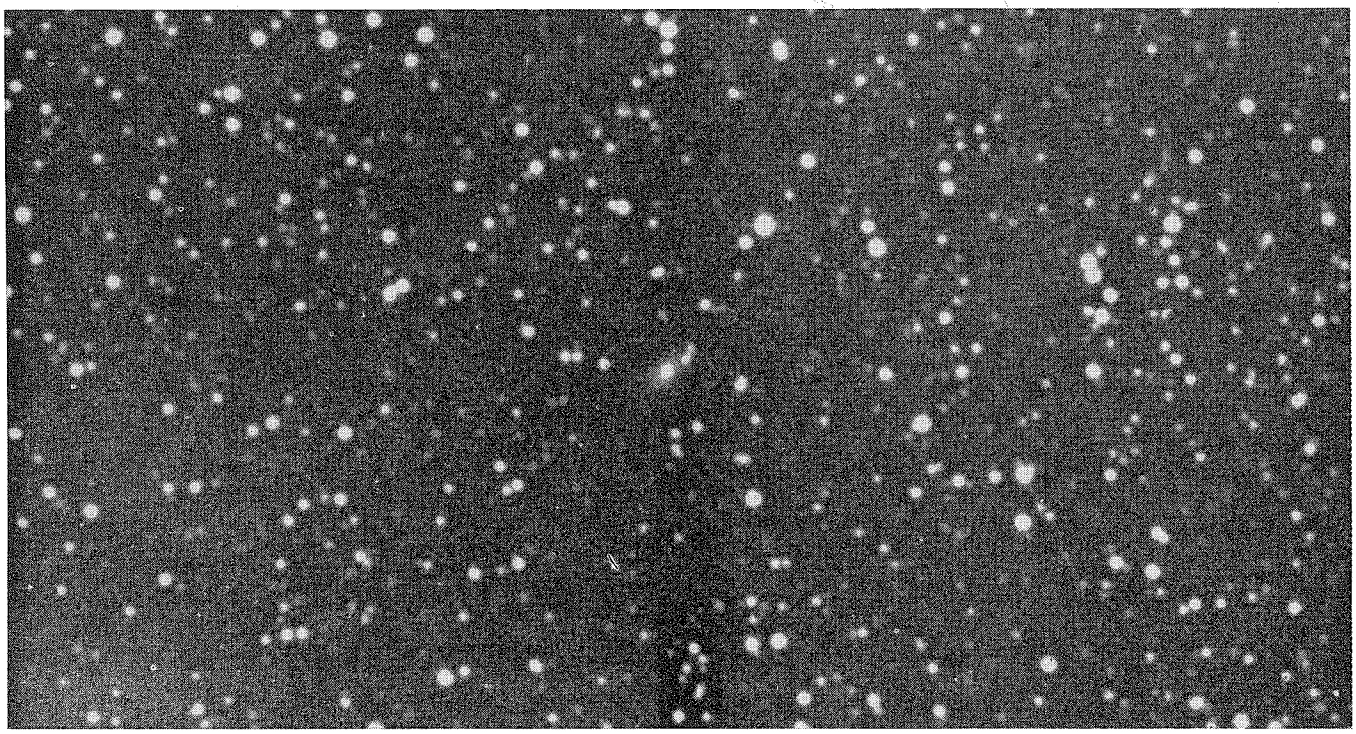
The future, indeed, holds great promise for the Palomar astronomers who may use this team of great telescopes to expand our basic knowledge of the universe about us. CONTINUED ON PAGE 6



Enlargement of section of Schmidt plate shows details of Rosette Nebula—a cloud of dust and gas illuminated by hot blue stars in the cloud.

Further enlargement (six times) shows dark markings in Rosette Nebula in sharp detail. Nebula is in Minoceros in the Milky Way.

The 48-inch Schmidt finds a window in the Milky Way



Enlargement of a section of the Schmidt plate shown on page 5 reveals an opening or "window" (fuzzy object in center of picture above) in the gas and dust clouds of the Milky Way. Through it, astronomers saw a nebula never before found in this region. It would have been sheer luck if this nebula had been found by an instrument like the 200-inch telescope, which has a high degree of resolution but an extremely narrow field.

Caltech researchers are finding out how guayule, a native wild shrub, manufactures excellent natural rubber. Will they be able to duplicate the process in the laboratory?

New source of natural rubber

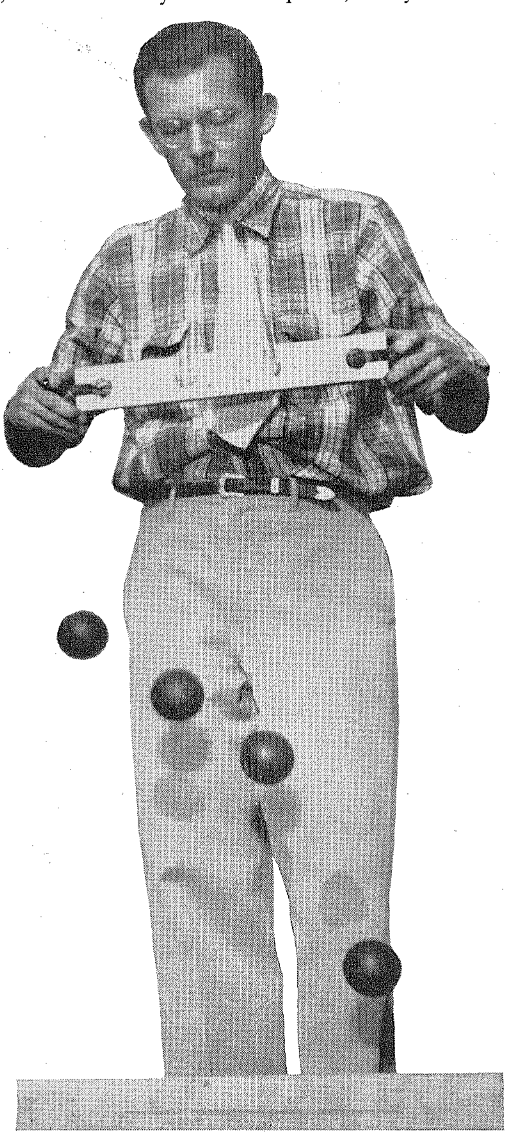
THE gentleman bouncing the rubber balls below is Dr. James Bonner of Caltech's Biology Division, and he is illustrating a point that to most is no news: For many purposes natural rubber still has it all over the synthetic product.

The four balls shown here are of identical size, and they were compounded in the same way. From left to right, the first two are natural rubber, the third is GR-s or Buna rubber, and the fourth is butyl. Dr. Bonner dropped them all at once from the same height, and the photographer caught them at the top of their bounce.

Caltech's interest in rubber centers mainly around natural rubber from guayule—one of 2,000 known rubber producing plants, and one of 600 which have been tried, at one time or another, commercially. Of the 600, guayule appears to be one of the most energetic. About 20 percent of its dry weight may be rubber. Yields of rubber from guayule vary greatly depending on the climate, but mature guayule plants have been known to yield as much as 2,700 pounds of rubber per acre. Furthermore, getting rubber from guayule plant to finished product involves about 1/20th as many man hours as is the case with rubber from the rubber tree.

Guayule is native to the Chihuahuan desert of northern Mexico and the Big Bend region of Texas, but it has been grown in parts of California, Arizona, New Mexico, and in several foreign countries—including sections of South America, Europe and Russia. The first commercial shipment of rubber from wild guayule shrubs reached this country in 1904 from Mexico, and by 1940 Mexican shipments were amounting to about 10,000 tons of rubber a year.

Production from the wild shrub still continues. While our rubber consumption is now so great that production from guayule has become less and less significant, guayule's potentialities were considered of such importance during World War II, that 32,000 acres of government-owned guayule were put under cultivation in this country. During the war a good deal of research was done on these plants— research on how to increase the plant's rubber production and on how to improve the processing of the rubber itself.



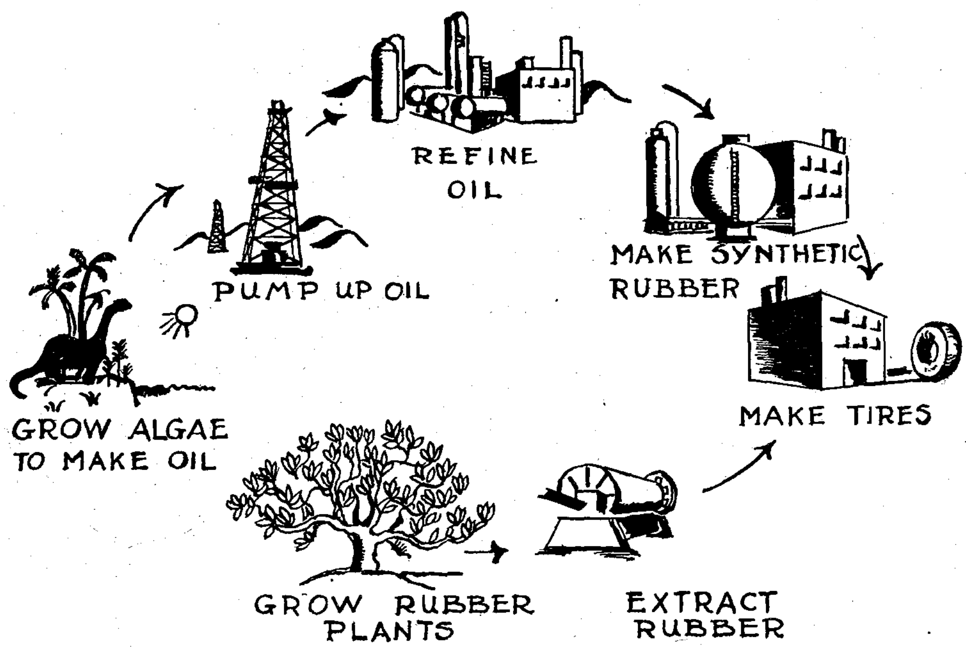
But strangely enough, in spite of all that was learned during this time about guayule nutrition, and the factors which influenced its growth—correct night temperature and light intensity, for instance—very little work was done on the actual chemical mechanism by which rubber is made in guayule.

How does the guayule do it? Plant physiologists wish to answer this question so that they can synthesize natural rubber outside the living plant. When they find out what the chemical precursors to rubber are, and what the enzymes and conditions of polymerization are in the plant, they can use this knowledge to consider the possible synthetic production of real, natural rubber—not a rubber substitute. This is the basis for continuing research on guayule at Caltech.

Chemically, natural rubber is an isoprenoid compound. But isoprene itself has never been found in plant tissues, even though it has been extensively sought there. Plant physiologists feel, therefore, that probably some other compound possessing the same carbon skeleton may be the elementary unit which is polymerized, or changed into rubber, in the plant. The search for this compound and a study of the mechanism by which it is formed—a search for the rubber precursor—is the object of a cooperative research project by the United States Department of Agriculture's Bureau of Plant Industry, Soils and Agricultural Engineering and Caltech. And, as the American Chemical Society's Symposium on Plant Synthesis heard recently in San Francisco, the project has made considerable headway.

At Caltech, research on the problem is being conducted along two parallel lines—with seedlings of guayule plants, and with cultures of the rubber-producing parts of the guayule plant, grown in isolated solutions.

Rubber is produced in the bark



A plant physiologist (understandably prejudiced) suggested this comparison of two ways of getting rubber. Starting at the left, one can either wait for algae to form oil, pump the oil, refine it and use by-products for synthetic rubber; or one can go right to the guayule and simply extract natural rubber. This reasoning has one obvious fault: production from guayule could never meet present rubber consumption. A better method would be to find out how the guayule does it, then learn how to copy its chemical process.

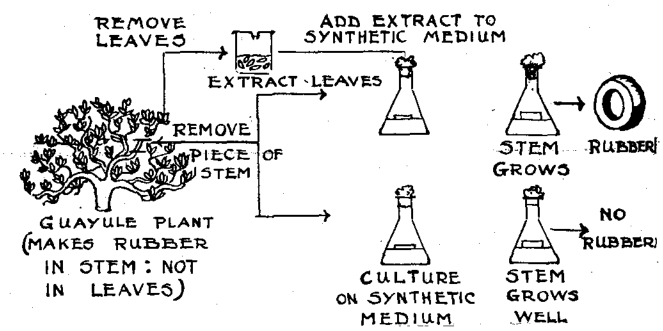
and stems of guayule, not in its leaves. But, as shown in the accompanying diagram, without the leaves the guayule plant cannot produce rubber at all. Obviously the leaves contain something which is essential to rubber formation in the stem tissues. As yet the nature of this compound is unknown, and researchers feel that its identification is going to be a complex job. Meanwhile, they are finding that the most fruitful approach lies in testing pure synthetic compounds for their ability to support rubber formation in isolated stem cultures.

Stems or seedlings are grown in synthetic nutrient solution, under controlled environmental conditions, so that rubber formation at the expense of rubber precursors present in the plant can be carefully controlled. To the nutrient solution, then, are added compounds which are regarded as possible rubber precursors or intermediates. If a compound causes an increase in rubber formation, it is considered a possible intermediate. Final proof is based on experiments which are being conducted with isotopically tagged molecules of the intermediate chemical compound.

When stems or seedlings are grown as described above, they produce but little rubber. But the addition of an extract of leaves from plants actively engaged in rubber formation actually increases the amount of rubber formed and accumulated in the stem tissues.

A number of compounds, such as isovaleraldehyde,

THE SECRET OF GUAYULE'S RUBBER MAY LIE IN ITS LEAVES.



tigaldehyde, tiglic acid and an amino acid, valine, which have the carbon skeleton of isoprene and which are known to appear in nature, were tried and found to be inactive in rubber production. Other compounds which have been suggested by workers in the field, such as simple terpene compounds and betamethylcrotonaldehyde, were also tried and found to be inactive.

Results of the experiments conducted at Caltech did indicate, however, that a reaction in which acetic acid and acetone combine to produce a compound known as betamethylcrotonic acid, is of importance in rubber formation. When acetate was added to the nutrient solution in which either stem tissues or seedlings were grown, a considerable increase in rubber formation took place. And acetone, like acetate, was found to affect rubber formation by seedlings. Another substance, glycerol, was found to influence rubber accumulation too. But glycerol is known to be rapidly converted to acetate and to acetone by various microbial systems, and it was thought to be entirely possible that the activity of glycerol in rubber formation in plant tissues was caused by some such conversion.

How do acetate and acetone bring about rubber formation in guayule? The Caltech plant physiologists decided to find out whether or not betamethylcrotonic acid might be a condensation product of the two substances. When tested for its ability to support rubber formation, this substance turned out to be as active as acetate and acetone, both with the seedlings and with the isolated stem tissue cultures.

The next step was to find out how acetone might arise in the stem tissue. And at this point it was found

Caltech researchers have devised a striking experiment, left, to show how an unidentified chemical, produced in leaves, is vital for manufacture of rubber in stems. Stem sections alone can be made to grow in synthetic medium, but produce no rubber. When leaf extract is added to medium, stems produce rubber as usual.

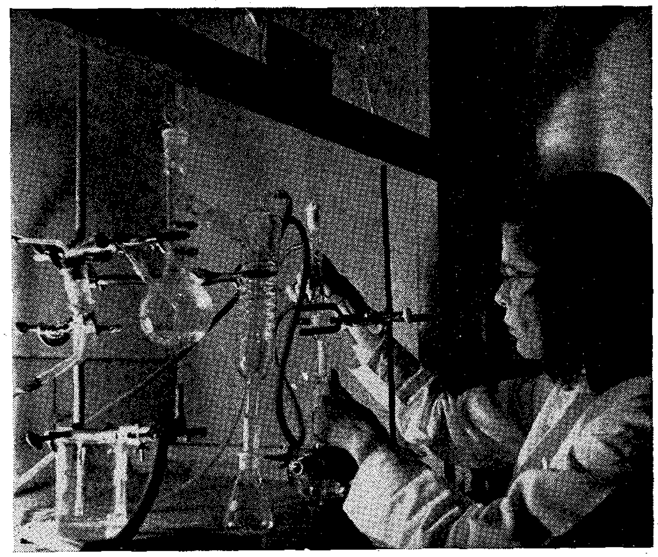
that acetoacetic acid, which is known to be an intermediate in the forming of acetone from acetate by various species of bacteria, is active in replacing acetone in rubber formation in guayule tissue. It seemed possible, therefore, that acetone arises in guayule, too, through acetoacetic acid.

These investigations were then extended to a study of the metabolism of radioactive acetate—acetate tagged with $Carbon_{14}$. When the tagged acetate was fed to seedlings or to mature plants, it turned up within three days in the plant's rubber. In one experiment 75 per-cent of the acetate metabolized by the plant appeared in the form of rubber within three days, and the rest of the radioactive acetate metabolized appeared as resins which are also isoprenoid compounds. When radioactive acetone was supplied to the plants the same thing happened. Radioactivity was recovered in the rubber the plant made.

As for betamethylcrotonic acid—it has actually been found in plants, but efforts to isolate this substance from guayule have been unsuccessful. But a striking experiment recently performed at Caltech indicates that it is indeed formed when acetate is metabolized by guayule.

In this experiment, guayule plants were fed with radioactive acetate. After three days the plants were harvested, and the organic fraction which *should* contain betamethylcrotonic acid was isolated. To this fraction researchers added a large amount of inactive betamethylcrotonic acid, recrystallized the material and found that it contained radioactivity. The radioactivity could only have come from radioactive betamethylcrotonic acid in the plant extract, and is strong evidence that this acid is a by-product of acetate.

In establishing this relationship between acetate, acetoacetate, acetone and betamethylcrotonic acid, the Caltech researchers have made a big step forward in an understanding of the biosynthesis of natural rubber. The next step is to find out how betamethylcrotonic acid turns into rubber itself. The compound possesses the same arrangement of carbon atoms as the isoprene of which rubber is composed. If betamethylcrotonic acid molecules are combined to form rubber, the process must necessarily involve reduction and elimination of oxygen, since rubber contains only carbon and hydrogen. This kind of a condensation and reduction would not be unprecedented in nature, however, since biochemists have shown that the long hydrocarbon chains of fatty acids are formed by such a condensation and reduction of acetate. In this further work, scientists will be on the final lap: reproducing the plant's rubber producing process in the laboratory, and perhaps on a commercial scale.



Research Assistant Betty Jean Wood traces acetate metabolism in guayule with radioactive C14. Research Fellow on project is Dr. Barbarin Arreguin, Dep't. Agriculture.

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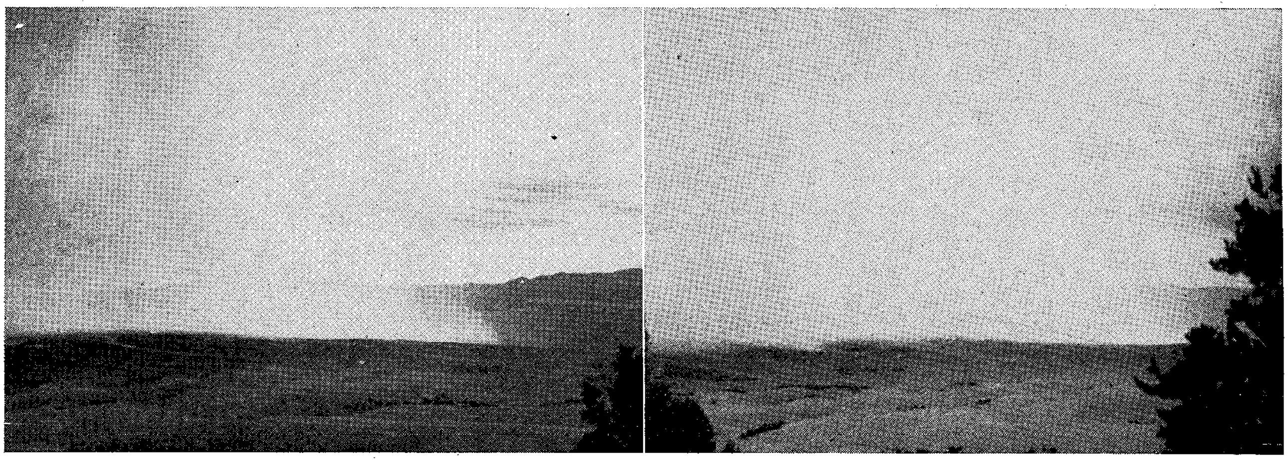


Typical summer storm starts in high-desert country; three minutes later creeks begin to flow.

by RICHARD H. JAHNS

Desert floods

Not many people see them— but those who do never forget them

IT WAS a 15-foot wall of water, moving toward us about as fast as a man could run. We had crossed the wash only a few minutes before, when already we could hear the roar of the flood not far upstream. It passed us with a rush, making such a commotion that you couldn't hear a man yelling right into your ear. It was about midnight and too dark to see much in detail, but the front of the water was nearly vertical, and huge granite boulders and chunks of trees kept dropping over its edge. This edge was much higher in the center than along the sides of the wash, and it didn't seem possible that water could have such a slope. The whole business moved on down the channel, giving us the feeling that nothing could stop it this side of Glendale."

As he spoke of the great débris wave that poured from Blanchard Canyon during southern California's New Year's flood of 1934, this resident of La Canada Valley seemed scarcely disposed to believe what he had actually seen.

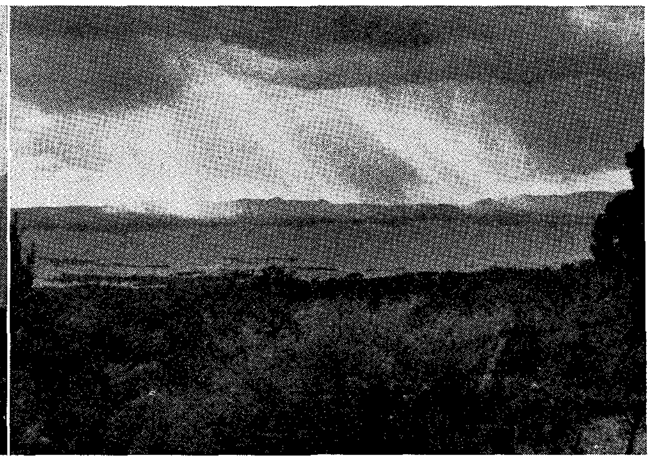
Anyone who happened to be out of doors in this area on that particular New Year's Eve, had a rare opportunity to observe one of the principal features of the desert flood—the débris wave—and to see that previous reports of such things as "vertical walls of water," "thunderous roaring," and "irresistible force" were not just the dubious products of overactive imaginations. Such eye witnesses often are later troubled with doubts, and the nightmarish qualities of such floods may well cause them to question the intrinsic reliability of their own observations.

Few persons *do* see such things, it is true, and yet spectacular floods are quite characteristic of arid and semiarid country. They are even responsible for many familiar features in the desert landscape. The infrequency of such floods, their most common occurrence in sparsely populated areas, and the unpleasantness of the weather generally associated with them cause many to pass unobserved. Few have been described in detail, and rarely do conditions permit their inclusion in the photographic record.

The word "desert" is used here in its most general sense—which of course is contrary to that preferred by organizations like the Los Angeles Chamber of Commerce and the New Mexico Boosters. Much of the southwestern United States is arid or semiarid country, and ranges from such true deserts as the Colorado, Papago, Gila, and Mojave to areas of intense cultivation and considerable settlement. Development of the latter generally is founded upon the introduction of water from nearby mountain areas or from more distant rivers. Much of the desert country is characterized by profound contrasts of landscape and climate. Ranges in altitude are great, and commonly occur within short distances. Deep, precipitous canyons drain rough, mountainous country in some places, and high, rolling tableland in others; in turn they debouch onto relatively flat-floored valleys. Bold mountain scarps that rise to heights of 4,000 feet or more are by no means rare.

Temperatures are high, in both winter and summer, and daily and longer-term temperature ranges are great. Strong winds are common during certain seasons. Annual precipitation and humidity are low except in the highest mountains and near the southern California coast. On the other hand, heavy rainfall in the most arid regions results from single storms in some years. Much of the country is so dry that all streams are intermittent, and indeed rarely flow, but elsewhere the desert areas are traversed by large rivers fed from distant sources. Nearer the coast are mountain masses that capture enough moisture from the air to supply small perennial streams of their own.

Whether wet or dry, the stream courses are everchanging in their appearance, and it even seems that the longer the periods of their inactivity, the more catastrophic are the changes wrought by the following floods that traverse them. Even the permanent streams vary considerably in their behavior from one season to another. In his *Southern Sierras of California*, Charles Francis Saunders speaks feelingly of the changing moods of



Six minutes later storms begins to move off; 15 minutes later storm has passed, sun is shining.

the Big Tujunga, in the San Gabriel Mountains of southern California:

> During storms, and for days afterward, it goes thundering and gnawing at its banks, ripping out trees, undermining rocks and cracking them together till the sparks fly, rolling great boulders around like marbles. The stream may then be a hundred feet across and twenty deep, and the sound of its fury may be plainly heard a mile away; but with the passing of the rainy season its passion is forgotten, and in July, following its tortuous course for miles, I found it in tenderest and most lovable mood. Now it would be rippling past gravelly beaches open to the sun, now idling in the still shadows of cottonwood and willow; now, slipping round a corner, it would widen out and sparkle through a setting of sedgy mead under perpendicular white cliffs, suggesting a miniature Yosemite and returning echoes to my call; again dropping musically by proper little cascades from rocky shelf to shelf, it would gather comfortably in drowsy lins of restfulness.

He also points out, however, that most of the streams "prove on inspection to be, during eight or nine months of the year, little more than floods of sand littered with cobbles, where lizards bask and snap up flies and top-knotted quail toe about dry-shod."

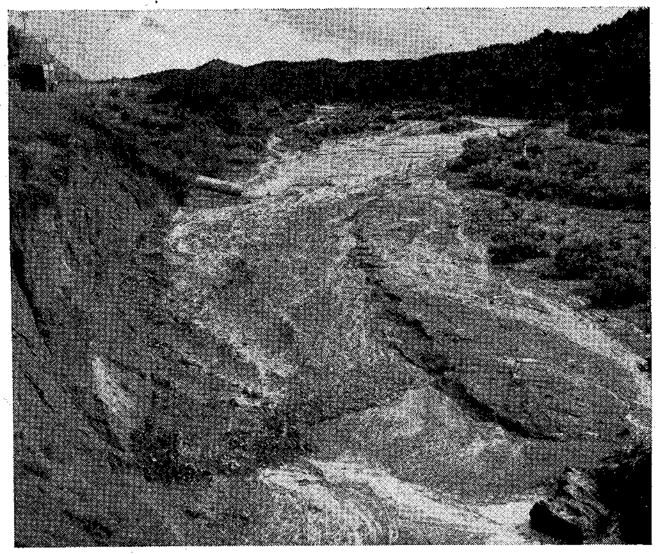
Desert floods typify a land of contrast. In most areas they are rarities as measured by human standards. Geologically, however, they are common and recurrent features, and represent the chief mechanism for the erosion of the mountain ranges and deposition of sediment in the lowland areas. These floods usually result from torrential downpours of the cloudburst type, which develop either from cyclonic storms or, more commonly, from thunderstorms. The cloudbursts ordinarily are irregular in distribution, affect rather small areas, and involve short-time precipitation of exceptionally high intensities. A downpour at Opid's Camp, in the western San Gabriel Mountains, seems to hold the all-time record of slightly more than one inch of precipitation in a period of 60 seconds during the early morning of April 4, 1926. Reports of half an inch in five to ten minutes are by no means rare, and doubtless cloudbursts of even greater intensity have gone unrecorded in more remote regions.

The distribution and duration of a typical summer thunderstorm in the "high-desert" country of southwestern New Mexico are shown in the pictures above. This small storm generated a cloudburst of the type known as a "saddle-blanket shower," in tongue-in-cheek testimony of the oft repeated statement that such a blanket would cover the wetted area. Thunder clouds gathered over a period of about 35 minutes during the early afternoon of an August day in 1942, and suddenly precipitation began over a well defined area of not more than four square miles. The storm shifted in a rather irregular path, but in general travelled slowly from northwest to southeast. Within a few minutes of the original downpour, water began to course down several of the dry creek beds. Within 15 minutes the storm had passed, but some of the creeks continued to flow for as long as half an hour.

In many regions where there is some cover of vegetation and where stream gradients are not very steep, cloudbursts of moderate intensity result in rather quiet, "orderly" floods. In one such flood the waters of a creek, which "came down" as a result of a thunder shower in the Black Range of southwestern New Mexico, were nearly free of debris, and did not disturb the coarse gravels or even the low bushes in the stream bed.

In some contrast was the flow of a larger stream a few miles to the north. The waters, derived in greater abundance from the same storm, formed a débris-laden front that traveled down the valley at a rate of about five miles per hour. As shown on page 12, they coursed down a channel whose bottom was marked by sun-cracked and hoof-printed mud, only partly dry. The front of the wave was distinctly higher and steeper on one side of the channel than on the other, apparently because the water there was more heavily freighted with stones, fragments of vegetation, and other detritus. As more and more solid matter was picked up from the bottom and from caving banks of the wash, the forward progress of the water in contact with the bottom was slowed distinctly. Relatively clear water, traveling faster at positions higher in the wave, constantly flowed over the débris-rich portion as a sort of waterfall, only to be in turn slowed by additional débris picked up from the dry stream bed. In this way an essentially vertical wall of water was maintained to a height of about eight inches. Some of the relatively clear water at the surface of the flow reached the front of the wave as series of low, relatively fast-traveling ripples, most of which were 50 feet to more than 200 feet apart.

As the water approached the observation point, a separate lobe began to develop, and to travel more



In torrent of silt-choked waters well-defined waves gnaw at bank of this arroyo near Santa Fe, N.M.

rapidly than the remainder of the front (right below). This lobe was marked by a distinctly lower frontal wall, evidently a reflection of a relatively lower content of solid matter. This in turn may well be ascribable to the course of this lobe over mud and gravel of the stream bed that was still wet from a previous flood, and that hence contained relatively little loose material. Upstream from the front of the flood waters, the surface of the flow rose gently for a distance of at least 150 feet, where the water had an average depth of about four feet. The general flood crest fell rather rapidly, however, and within an hour the water was only three inches deep and fairly free from solid matter.

Damaging Flood Waves

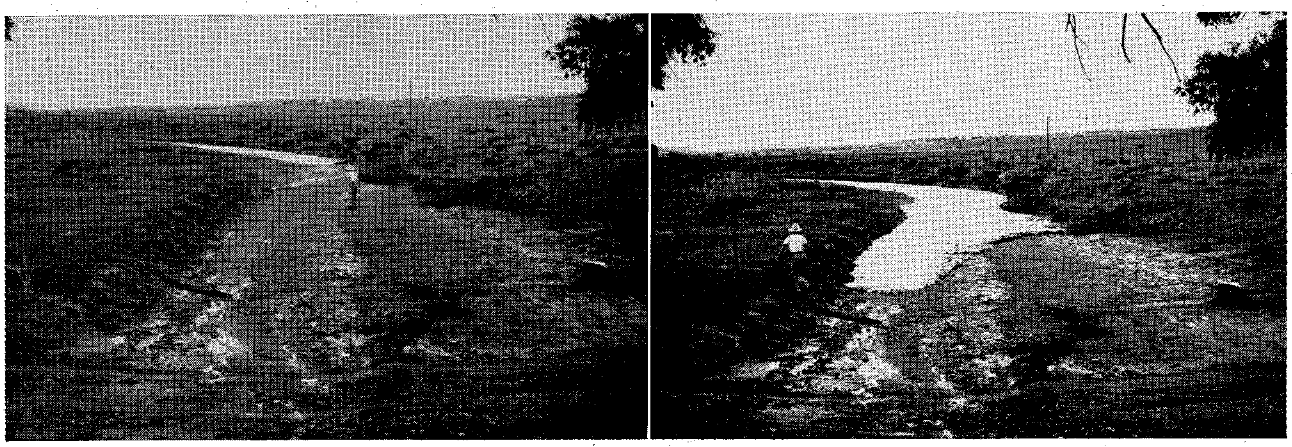
Though fascinating to watch, neither of the floods noted above was particularly unusual, as neither overtopped the banks of the arroyo in which it flowed. On other occasions both of these streams have developed damaging flood waves in response to much more severe storms. Their banks were overtopped, meadow and pasture lands were gutted and rilled, some boulders were strewn on their surfaces, dwellings and other buildings were broken into by the flood waters and partly banked with débris, and there was some loss of life.

A rather energetic series of flood waves was observed in June 1948, north of Santa Fe, New Mexico, where a large arroyo drains an area underlain by soft, fine-grained rocks. The flood waters hence contained no boulders, but instead formed a reddish-brown, mud-choked torrent. The soft banks of the arroyo were vigorously attacked, and from time to time great masses of the bank material dropped into the rapidly moving waters. Large and distinct waves marked the flood. These were spaced 25 feet to more than 100 feet apart, and in general were three inches to two feet high. Most appeared to travel by the same rolling mechanism as that described above for a less tumultuous flood. In the last stages of the flow, individual waves were travelling over moist ground with very little surface water.

Of somewhat different aspect are the rare floods of the most arid, desert parts of the Southwest. These generally stem from sudden and violent storms on steep, rough slopes with little vegetation, and the waters rush down dry canyons in which all sorts of detritus may have accumulated for years. Thus an abundant supply of boulders, rubble, and other débris usually is incorporated with the flowing water to form flood waves that may contain as much as 90 percent solid matter. These are known as mudflows or débris flows. They behave as viscous liquids, and hence travel much more slowly than clear water. Some mudflows contain more solid matter than others, the ratio of liquid to solids depending largely upon such local conditions as topography, stormwater supply, and type of rock.

I was fortunate enough to witness a rather spectacular mudflow in the extremely dry country about 30 miles northeast of Parker, Arizona, in January 1943. A cloudburst of unusual magnitude was indicated by a formidable display of lightning and thunder in a very heavy overcast that enveloped a part of the nearby mountain range. No rain fell at the mine I was visiting, but within an hour there was a great roar in an adjacent steep-walled canyon, which emptied onto a valley flat at the base of the range. At first dull and punctuated only now and then by booming sounds, this roar became almost deafening even before the flood appeared.

The flood was an awesome sight. A dark reddish-brown mass of water-lubricated débris moved—very slowly, it seemed—down the last tortuous part of the canyon. It formed a curving, but extremely steep wall, which must have been about 35 feet high at the point where it burst from the narrow mouth of the canyon. Masses of rock more than 30 feet in maximum dimension cascaded down this front and quickly disappeared from view beneath its base. The entire mass moved much like wet concrete, and its tremendous bulk and leisurely pace gave it an appearance of almost irresistible force.



Flood waters course down bed of New Mexico creek; one lobe advances more rapidly than rest of front.

A feature of peculiar fascination was a series of dust clouds that rose from the sides of the flow, where dry soil and rocks of the canyon walls were sheared off by the moving mass. It was not unlike puffs of dust rising from the hopper of a rock crusher.

Patches of soil, mats of brush, branches and even trunks of cottonwood trees, and boulders of many sizes floated along the upper surface of the flow, and in the more turbulent places they bobbed up and down or even were briefly tossed into the air. Evidently these masses were very buoyant in the heavy, sludge-like "liquid" of water and ill-sorted débris, and were held up also by the almost solid mosaic of rock fragments between them and the bed of the wash. Waves more than eight feet high traveled slightly faster than the front of the débris flow itself, and succeeded one another at intervals of 50 to 100 feet.

After the initial wall of the flow had passed, the roaring noise diminished perceptibly in volume, but by no means was it less than a roar. The part of the flow that succeeded the front became progressively richer in water, and behaved more and more like an ordinary stream. Each succeeding wave, however, obviously was more heavily freighted with solid fragments.

It was impossible to follow the initial flow as it spread out along the valley floor, but inspection a short time later indicated that it had come to a halt about a mile from the canyon mouth. Evidently it had fanned out somewhat and had stopped when enough water had soaked into the dry sand and gravel of the valley floor to reduce internal lubrication materially. In this, its final position, the front was very steep and about 15 feet in average height. The top of the flow, which dried within a matter of a few hours, was studded with boulders, most of them several feet in diameter. It was also marked by large wrinkles, generally six inches to more than two feet high, that lay essentially parallel to the margin of the flow.

The steep front of the original flow had been breached in several places by later flows of more liquid material, and each of these had in turn been "dried up" and hence halted a short distance beyond. Perhaps each of these successive flows was represented by one of the huge, débris-laden waves that had been seen in the canyon proper. It was interesting to note that nowhere was any stream of water issuing from beneath the halted mudflow, nor was there evidence of free water at any other point examined. Digging beneath the outer margin of the principal flow disclosed patches of essentially dry sand and gravel that evidently had been incorporated into the flow from the surface over which it traveled.

In desert floods there appear to be all gradations between the mudflow, with a maximum proportion of solid particles lubricated by some water, to relatively clear water with much greater velocity and tremendous cutting power. The latter is much more common along the lower courses of large, well defined lines of drainage, especially those with perennial streams. It also occurs in conjunction with mudflows—either preceding or succeeding them, or both. The timing of the two are easily evaluated.

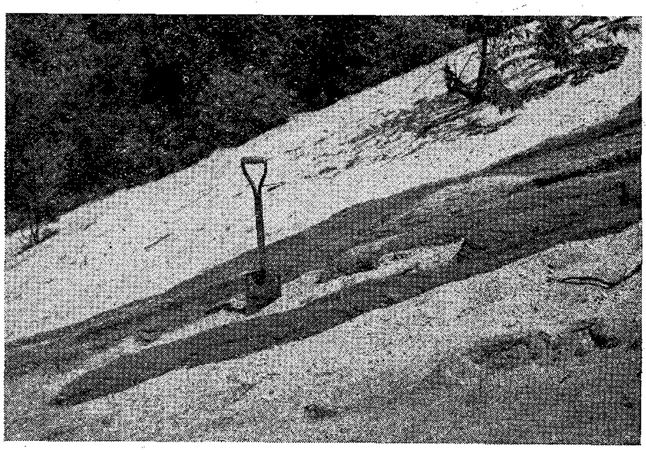
The mudflow deposits are characteristically poorly sorted and stratified, consisting as they do of a jumbled mass of sub-angular fragments. In contrast, the deposits of more ordinary flood waters are sharply bedded, and are composed of rather well sorted particles of sand, silt, and gravel. Where desert-flood sediments are exposed in cross section, they commonly comprise interlayered deposits of the two general types.

The desert landscape is constantly being modified and adjusted by floods of varying degrees of intensity. Complex, generally steep-walled canyons are carved into the bold mountain masses, and broad, fan-like accumulations of rock waste are built outward from their mouths where the streams spread onto the flatter valley floors. The alluvial fans that fringe the southern margin of the San Gabriel Mountains are excellent examples of these accumulations, and many others border the mountain ranges of the Mojave Desert and areas far to the north and east. These fans are characteristically cone-like in form, with slopes that gradually steepen upward toward the mouths of the canyons from which they were built.

The fan materials are coarsest nearest the canyon mouths, and become progressively finer-grained as traced away toward the central parts of the valleys. The fans themselves generally coalesce along mountain fronts to form an apron-like deposit of coarse detritus. As time goes on, their surfaces are continually modified by flood waters, and they show abundantly the effects of this trimming, rilling, and incising. Ordinarily, for example, a mudflow is never reactivated, once it has come to a stop; instead, subsequent flood waters gradually form trenches and channels in it, and at later times their own mudflows course through these channels before coming to a halt farther down the slope.

The surfaces of some alluvial fans are marked by

This jumbled mass of granite boulders is a typical mudflow deposit in the alluvial fan near Pala, Calif.



Sand flows duplicate mudflows in all but violence.

Avawatz Mountains — typical desert mountain range.

perennial streams, whereas others are not wetted by flowing water for periods of months or years. Few real changes are made in the general appearance of any of the fans, however, except during times of extraordinary floods. It is then that large mudflows debouch from the canyon mouths, or tumultuous streams with relatively little solids cut actively into the surfaces of the fans. The amount of material transported during a single flood can be very great. During the New Year's flood of 1934, for example, the waters of Pickens Creek, with a drainage basin of only 1.6 square miles, probably laid down at least 70,000 cubic yards of detritus in La Canada Valley. This is sufficient material to cover the Caltech campus to a depth of about 18 inches.

Similar rapid deposition takes place on much larger scales, too. The great mudflow fan from Agua Tibia Creek, in northern San Diego County, California, was once built so rapidly across the valley of the San Luis Rey River that it formed an effective dam. A lake was developed on its upstream side, and remained there until the river could cut headward through the lower part of the fan and drain the valley once again. The fan is shown in the photograph below, right; the mouth of Agua Tibia Creek appears just beyond the reservoir near the upper right-hand corner. The San Luis Rey River flows from the center foreground away from the observer and out of the picture near the upper left-hand corner. The steep-walled canyon cut by this river is clearly shown near the center of the photograph.

Playa Lakes

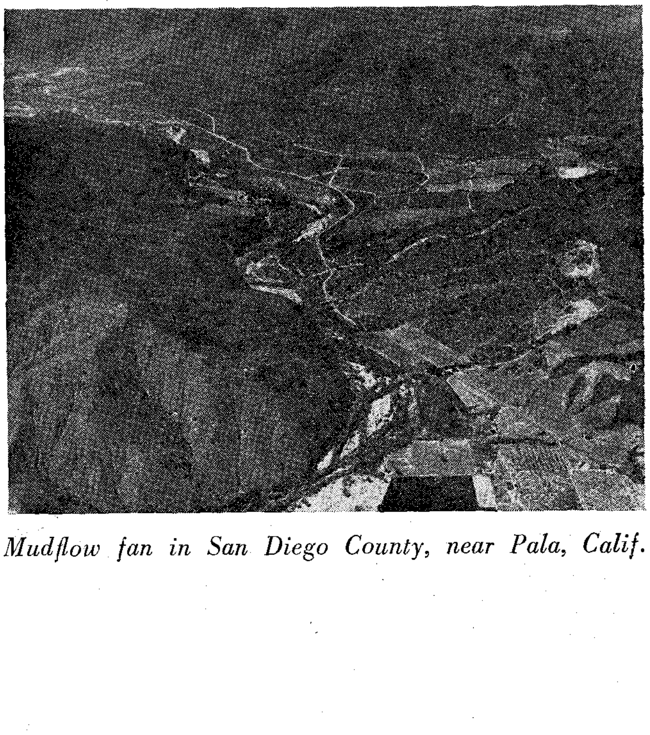
In some desert regions the drainage is internal, and flood waters from mountain ranges flow into lakes, rather than ultimately into the ocean. These playa lakes, most of which ordinarily are dry, are particularly numerous in the Mojave Desert region of southeastern California. They are underlain by thinly bedded silt and clay, but here and there are layers of coarse detritus that represent particularly energetic and long-lived mudflows derived from adjacent mountain masses. Indeed, at least one geologist has shown that individual boulders probably can be skated across the wetted surfaces of playa lakes by unusually brisk winds.

The flooded playas typically have only a few inches of water, even after heavy rains, but some storms are so severe, so widespread, or so long lasting that they introduce extraordinary quantities of water into desert drainage systems. Such a series of storms in 1938 contributed more than eight feet of water to Soda Lake and Silver Lake, in San Bernardino County, California. During this storm, mudflows were rather widespread through much of the Mojave region, but in addition the waters of some rivers contained so little débris that they were able to cut energetically into canyon walls and damage highways, railroads, and buildings.

It is fortunate that most vigorous desert floods occur in regions of little or no settlement. Others, however, constitute unwelcome visitations to populous areas, where they inflict great damage and even loss of life. The relation of floods to human activities in such areas is a difficult and complex problem, but suffice it to say here that such floods will course down the surfaces of alluvial fans and valley plains in the future, just as they have in the past; they will appear on the thickly settled fans that fringe the San Gabriel Mountains and Peninsular Ranges of southern California, just as they will occur in the more arid regions farther east. There is nothing in the records to suggest that future floods will become more frequent or less frequent, as viewed over a long period of time. Their effects, however, will become more and more troublesome as human settlement of any given desert or semi-desert area is continued.

As laconically expressed by the Mississippi Valley Committee, "The ideal river, which would have a uniform flow, does not exist in nature." Departure from this ideal reaches its maximum in arid country. The floods may be less frequent, but many spell an awful finality for those works of man that lie in their path.

A resident of a flood-ravaged valley may not be compellingly interested in knowing whether the wreckage of his home was accomplished by a mudflow that filled it with débris or carried it bodily for a few city blocks, or by a torrential stream that undermined it or simply chewed it to bits; yet these possibilities might well have been considered before he chose a location for his dwelling. He might have studied it with respect to the channels on the surface of the fan, the positions of large boulders and other deposits of previous mudflows, and the general topography and amount of vegetative cover in the nearby mountains. Much of the fan surface may have been modified by the effects of settlement, to be sure, but critical scrutiny from a high place, or even a study of aerial photographs generally will disclose the details of the natural drainage pattern. After all, it is a grand experience to witness a débris flow—but not in your own back yard!



Mudflow fan in San Diego County, near Pala, Calif.

The Beaver

A STUDENT'S MONTH AT CALTECH

THE Beaver put down his slipstick, lit a cigarette, and gazed out on the afternoon sun in the House court. A dozen of his friends were basking around the green steel card table, in comfortable shirtsleeves, just like the perennial Yearbook pictures of Leisure in the Student Houses. No use fighting this thing, he decided, and gathered up books, blankets, pillow, and portable radio. Out on the wide lawn between the Houses and the parking lot sprawled the other sunworshippers. He spread out the blanket, peeled off his shirt, and sprawled, too. "What an easy life!" from some ironic voice.

Spring had definitely infiltrated into Tech, he mused, and indolently closed the cover of his English book. Raises hell with good intentions. He wondered if the biologists had analyzed its insidious influence on Techmen's snake-blood. With spring came bock beer, and mutual approbation societies were springing up to quaff it on warm evenings at the Skip Inn—at least those sentimentalists who didn't like chrome-plated bars and had a soft place in their hearts for the sudsy 65-cent pitcher at the Skip. While it was here, bock even replaced our incessant mugs of stout, which the wise chemists, after diligent research, had reported was as high as 10 percent alcohol. Bock was simply the essence of spring.

Tops were down on the convertibles; last Sunday they had helped open the season at Corona. Lay there in the warm sand and worried about an unfinished lab report and the looming reckoning with blue slips. But now blue slips were out and the Beaver was still alive. He only got one, and he didn't like the professor anyway. He rolled over on the blanket and listened to the others talking about how easy it would be to make the roof between Fleming and Ricketts into a long sun-deck with a little privacy. It was a good idea, but these things that sound easy never seemed to get done. Buildings and Grounds moved in devious, hierarchial ways.

Senior Ditch Day

With spring would come Senior Ditch Day. The Beaver wondered if the Senior wheels had set the secret day yet; the guys in his class wanted to know and even sent a spy to the last Senior Class meeting. He remembered with some satisfaction how last year the news had leaked and several Seniors had been barred and bolted in their rooms the night before with diabolic efficiency. The Beaver decided, come his Senior year, he would leave early, but in the meantime he would hope no Seniors did this year.

The Institute was raising tuition to $600 for next year. The Beaver beaked long and loud with his friends and listened to the blossoming financial arguments pro and con from everyone who had taken Econ 2, or who claimed to know about the Budget up in Throop. They discussed where best to scratch up the $100 needed to supplement the GI Bill, and idly wondered what companies would hire green ME's and Physicists for summer work. For all their bitter complaining, the Beaver knew that the High Command in Throop was implacable. They were probably up to their ears with creditors anyway, he decided. Next year's student body would be smaller, almost down to pre-war size, and it would again be high school graduates who came as Freshmen—not Army graduates, as the Beaver's class had been. He had gone the noon of the Frosh entrance exams to scrutinize the hopefuls for the Class of '53 over a cup of caffeine in the Greasy Spoon, and had sorrowfully watched a strangely eager throng of high school seniors neglecting lunch for the rapt discussion of quadratic equations, faradays of electricity, and f=ma. They looked so young and eager, he thought, but they'll learn. He drowned his aged experience in bitter coffee and lit a philosophical cigarette.

Joy in Techville

A warm glow suffused his innards as the Beaver browsed over the *California Tech's* sports page. Every event had been a victory. It was a great season: Swimmers Splash Easily Over Redlands; Engineer Baseballers Drop Whittier; Thinclads Take Honors Over LA State and Loyola. Even the hated Oxy had seen ignominious defeat at the murderous hands of the Caltech tennis team. There was indeed joy in Techville, as the mighty Goon had enthusiastically crowed in his column, and Hustlin' Hal Musselman's bald and worried head was now perpetually wreathed in an Eisenhower grin around his eternal cigar. This sort of thing, the Beaver realized, doesn't happen often, but he was happy to be here when it did. He penitently resolved again to get out and cheer for the team next Saturday.

The Beaver, stricken with curiosity, climbed the stairs in Ricketts and entered the kitchenette where he could join the others in viewing Haufe's Monster—an impressively clicking electrical machine which pitted its wits against yours in tit-tat-toe. Fascinated, he watched the skeleton of wire (a quarter-mile of it) and relays dictate plays to a tit-tat-toe board, lighting up the squares mysteriously as it beat or tied comer after comer. The machine never lost unless its master threw a special switch, causing it to lose interest apparently, and let mere humans beat it. He wondered if the infernal thing stayed up all night while people slept, and thought up new and clever stratagems. The creative imagination of these EE's follows strange paths, the Beaver thought, as he recalled Boblett's Van de Graaf generator which had terrorized the maids in Blacker, or the great sparking devil's head they had built for the big Interhouse Dance.

Like most Techmen, the Beaver took satisfaction and pleasure in scoring his professors and instructors in the Tau Bate poll. There was faintly vengeful satisfaction here in having a means to zero those instructors who lectured dully or didn't care about the student's problems and those who were unjust or self-righteous and superior with their great knowledge. But he was also pleased to lavish laurels on the men who were humanly interested in students, who were dynamic and clear in lectures and made him enjoy their courses by simple force of their own enthusiasm. The poll was a good thing. He had watched many men examine their teaching after the first poll last year and come up with better courses. The Beaver had always felt that students were the best judges of their courses; he slid his slide rule and notes under his chair in the lecture room and filled in the twenty answers on the sheet with loving care.

—*Jim Hendrickson, '50*

Science in art

First free ascent of a balloon carrying humans, as seen from the terrace of Benjamin Franklin's house in Passy.

Man's first aerial flight

by E. C. WATSON

ON November 21, 1783, two Frenchmen, Jean Francois Pilatre de Rozier and Francois Laurent, Marquis D'Arlandes, entered the wicker gallery of M. de Montgolfier's aerostatic machine and, rising majestically over Paris, achieved the first aerial voyage of man.

In an eyewitness report to the President of the Royal Society in London, Benjamin Franklin, who was living in Passy at the time, describes the alarmingly simple mechanism of the flight:

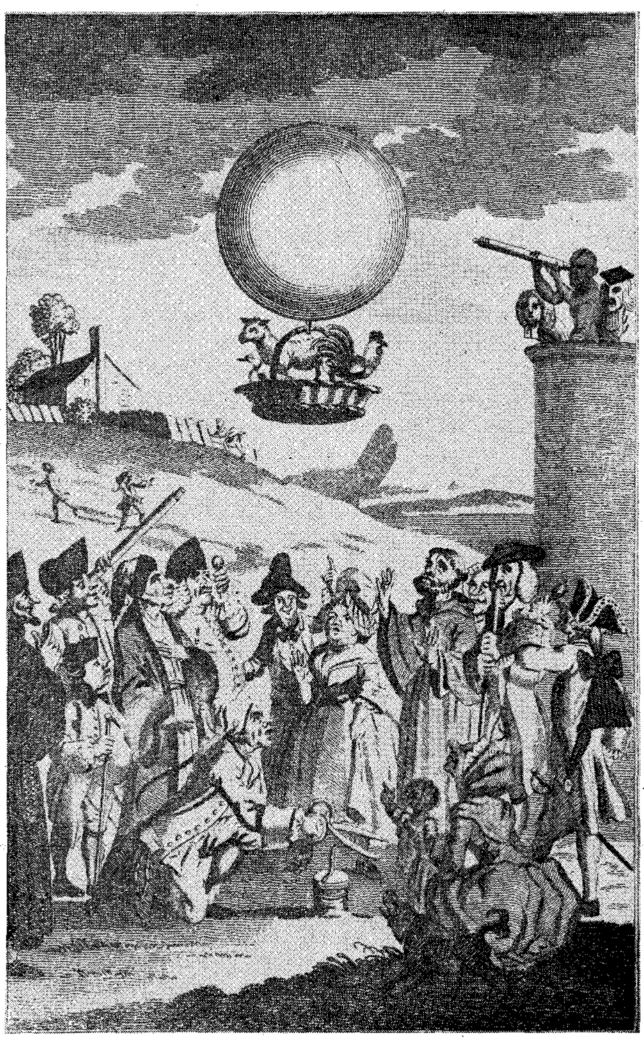
> This balloon was larger than that which went up from Versailles, and carried the sheep, etc. Its bottom was open, and in the middle of the opening was fix'd a kind of basket grate in which faggots and sheaves of straw were burnt. The air rarefied in passing thro' this flame rose in the balloon, swell'd out its sides & filled it.
>
> The persons who were plac'd in the gallery made of wicker, and attach'd to the outside near the bottom, had each of them a port thro' which they could pass sheaves of straw into the grate to keep up the flame, & thereby keep the balloon full. When it went over our heads, we could see the fire which was very considerable. As the flame slackens, the rarefied air cools and condenses, the bulk of the balloon diminishes and it begins to descend. If those in the gallery see it likely to descend in an improper place they can, by throwing on more straw, & renewing the flame, make it rise again, and the wind carries it further.

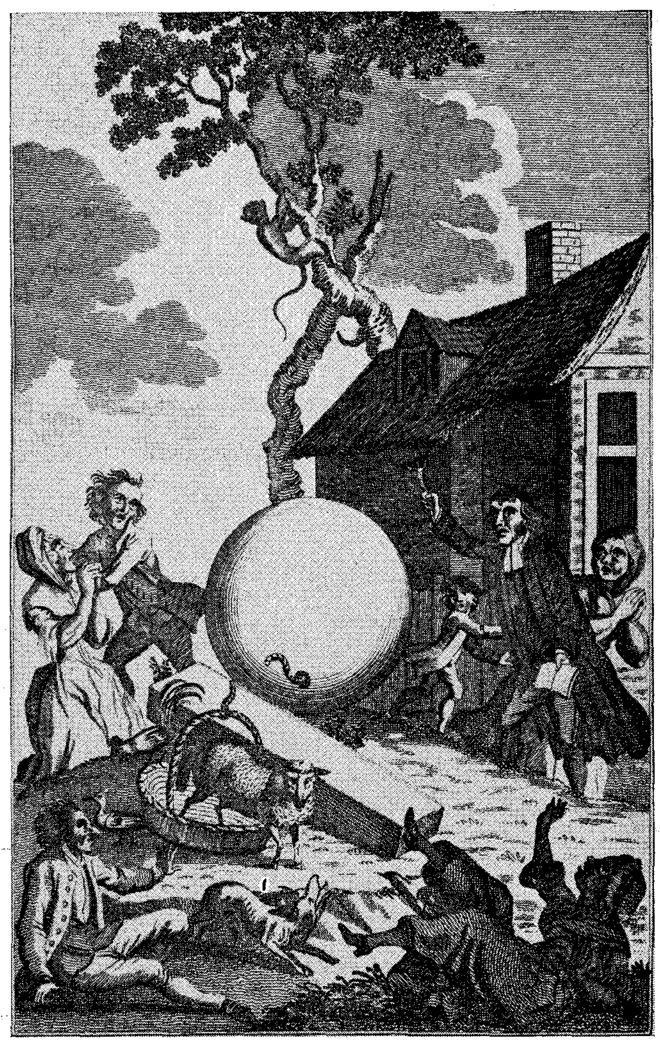
What actually happened is told with amazing detachment and simplicity by one of the participants, the Marquis D'Arlandes. In a letter to a friend, written a week after the ascent, he gives the following circumstantial account:

> We set off at 54 minutes past one. I was astonished at the smallness of the noise or motion occasioned by our departure among the spectators: I thought they might be astonished or frightened, and might stand in need of encouragement. I waved my arm with little success; then I drew out and shook my handkerchief, and immediately perceived a great movement in the garden. It seemed as if the spectators all formed one mass, which rushed, by an involuntary motion, towards the wall, which it seemed to consider the only obstacle between us.
>
> At that moment M. Pilatre called out "You are doing nothing, and we do not rise." Pardon me, I replied.—I threw a bundle of straw upon the fire, stirring it a little at the same time, and then turned again quickly, but I could not find *la Muette*. In astonishment, I looked for the course of the river, followed it with my eye, and at last found where the *Oise* joined it. I said to my brave companion, "Here is a river which is very difficult to cross."—"I think so," said he; "you are doing nothing." — "I am not so strong as you," I answered; "and we are well as we are." I stirred the fire and took with the fork a bundle of straw which, being too tight, did not take fire easily. I lifted and shook it over the flame. The instant after I felt as if I had been lifted up from under the arms, and said to my companion, "We are rising now, at any rate."—"Yes, we are rising," he answered, emerging from the interior, where he had been seeing that all was right. At this moment, I heard a noise, high up in the machine, which made me fear it had burst. I looked up and saw

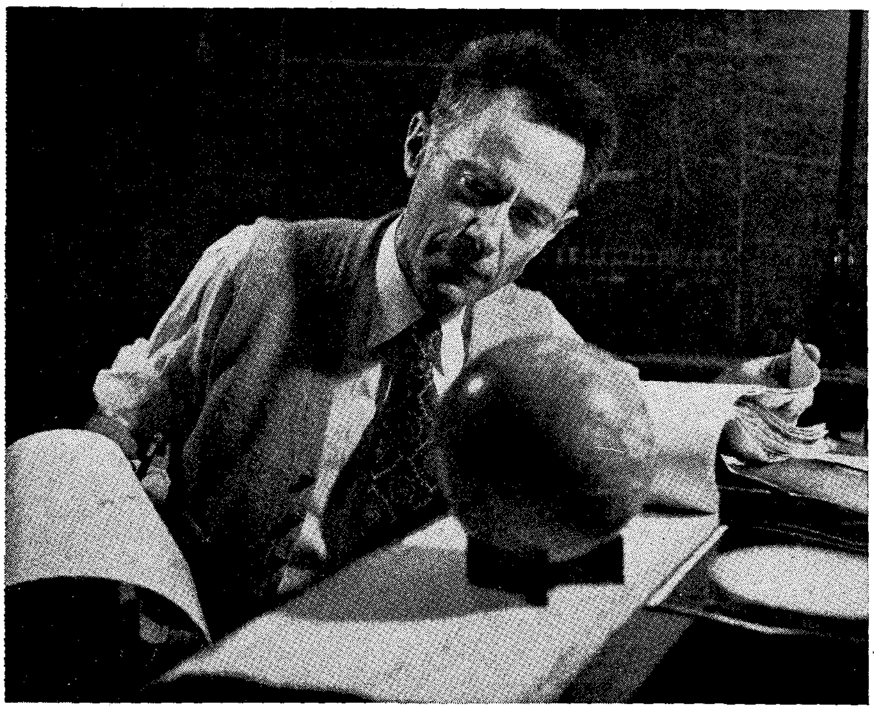
nothing; but as I was looking up, I felt a shock, the first I had experienced. The direction of the motion was from the upper part downward, and I cried out, "What are you doing? Are you dancing?" — "I am not stirring," said he. — "So much the better," I said; "this must be a new current, which will, I hope, take us off the river." I heard a new noise in the machine, which I thought came from the breaking of a cord. This fresh admonition made me examine attentively the interior of our habitation. I saw that the part of the machine which was turned towards the south was full of round holes, many of which were of considerable size. I then said, "We must get down." — "Why?" — "Look," said I. At the same time I took my sponge and easily extinguished the small fires which were around some of the holes that I could reach; but, leaning on the lower part of the linen to observe whether it adhered firmly to the surrounding circle, I found that the linen was easily separated from it, on which I repeated to my companion, "We must descend." He looked down and said, "We are over Paris." — "Never mind that," said I, "but let me see: is there no danger for you? Are you secure?" — He said, "Yes." I examined my side and found that there was no danger to be apprehended. Further I wetted with my sponge the principal ropes that were within my reach. They all held firm except two, which gave way. I then said, "We can cross Paris." While this was happening, we passed close to the roofs of the houses; we increased the fire and rose again with the greatest ease . . . We passed the *boulevarde* and I called out, "Let us now descend." We extinguished the fire, but the brave Pilatre, who never loses his presence of mind, and who was in front, imagining that we were going against the mills that are between the *Gentilly* and the *boulevard*, admonished me. I threw a bundle of straw on the fire, and shaking it in order to inflame it more easily, we rose, and a new current carried us a little towards our left. M. Rozier said again, "Take care of the mills!" But, as I was looking through the aperture of the machine and could observe more accurately that we could not meet with them, I said, "We have arrived". . . . We alighted at the *Butte-aux-Cailles*, between the *moulin des Merveilles* and the *moulin Vieux*. The moment we touched the ground I raised myself up in the gallery and felt the upper part of the machine pressing lightly on my head. I pushed it off, and leaped out. When I turned towards the machine, which I expected to find full, to my great astonishment it was entirely empty and flattened.

Ironically—the man who wrote this account of one of the most hazardous adventures in human history was broken for cowardice during the French Revolution.





Barnyard animals stoically made an experimental balloon ascent at Versailles for an astonished crowd shortly before man's first flight over Paris. According to contemporary sources: "M. de Montgolfier's Air Balloon, after having Ascended an Amazeing heighth above the Clouds & being Carried in the Air 45 Leagues, fell down near a Cottage, where the poor Country People were exceedingly frightened & Astonished. The Cock, Sheep & Duck came out of the Basket which had been tyed to it, unhurt."



Oliver Wulf — new member of the National Academy of Sciences.

THE MONTH AT CALTECH

National Academy

The National Academy of Sciences, which convenes annually in April at Washington, D. C., consists of 450 of the country's top-ranking scientists in all fields. This April they added to their distinguished roster the names of two more members of the Caltech staff: Max Delbrück, Professor of Biophysics, and Oliver Reynolds Wulf, Research Associate in the Division of Chemistry and Chemical Engineering.

Max Delbrück, who was born in Berlin 42 years ago, began his scientific career as a mathematical physicist. His early work dealt with problems of atomic structure, and later with nuclear constitution, a field in which he is regarded as a pioneer. He then became interested in biology, and has since been variously classified as a geneticist, microbiologist, virologist, botanist, and—by Caltech—a biophysicist. In 1937 he turned his attention to bacterial viruses, and it is in the study of these that his significant contributions to biology have been made. Dr. Delbrück came to Caltech from Vanderbilt University in 1947.

Oliver Wulf received his Ph.D. from Caltech in 1926. He was with the U.S. Department of Agriculture for eleven years, rising to the position of Senior Physicist in the Bureau of Chemistry and Soils. In 1939 he moved to the Weather Bureau as Senior Meteorologist, and in 1945 was assigned to Caltech as Research Associate in Chemistry. Dr. Wulf is an authority on—among other things—the photochemistry and physics of the atmosphere, the relation of solar activity and geomagnetism to the circulation of the atmosphere, and the absorption of solar radiation by the constituents of the atmosphere.

The National Academy of Sciences was incorporated by an act of Congress in 1863 and approved by Lincoln. Its membership was originally restricted to fifty. Since then it has grown, but has continued, in war and peace, its function of supplying to the Government the nation's best scientific thinking. Election to membership is the reward not of a single brilliant achievement, but of a career of achievements. It is a mark of highest scientific distinction.

Col. Goldsworthy Dies

Col. Elmer C. Goldsworthy, Master of Student Houses and Assistant Professor of Mathematics, died of a heart attack on April 30. He was 56.

Born in Stockton, Calif., Goldsworthy left the University of California in 1914 and joined the Canadian Army. He became a fighter pilot with the Royal Air Force and served with the British forces until 1919. In 1923 he received his Ph.D. from the University of California and remained there to teach mathematics. In 1931 he became assistant dean of undergraduates.

He entered the U. S. Air Force in 1941 and served until 1945 as officer in charge of instruction at the Orlando, Fla., school of applied tactics. He had been a member of the Caltech faculty since his retirement from the Army as a lieutenant-colonel in 1945.

Hughes Fellows

The first Howard Hughes Fellowships in Creative Aeronautics, established to encourage the development of top-grade aviation research engineers, have been awarded to Leo Stoolman, 30, and Harold M. Hipsch, 27. Stollman and Hipsch, selected from several hundred applicants by a committee of Hughes and Caltech representatives for their technical ability, originality, and personality, will start the Hughes Fellowship program on July 1 with a ten-week development project at the Hughes plant. They will be enrolled at Caltech in the fall, and will continue their advanced projects at the aircraft plant on a schedule which will not interfere with their studies.

Leo Stoolman, born in Chicago, received a mechanical engineering degree in 1941 at the Illinois Institute of Technology, and served there briefly as an instructor.

In 1942 he received his M.S. at Caltech, and then spent five years as an aerodynamic engineer with the Vultee Aircraft Co. in Downey. Since 1947 he has been engaged in aero-thermodynamics research at Caltech's Jet Propulsion Laboratory. He has also been serving as a lecturer in mechanical engineering at USC.

Harold Marvin Hipsch comes from Kansas City, Mo. He was graduated from Caltech in 1947 and received his M.S. here last year. He has had three years industrial experience as an aerodynamicist and flight test engineer, and is now working toward a Ph.D. in Aeronautical Engineering at Caltech.

Cancer Grants

A total of $88,900 has been granted by the American Cancer Society to 17 scientists in California engaged in cancer research at Caltech, the University of California at Berkeley, Stanford, UCLA, and under the Rees-Stealy Medical Research Fund in San Diego.

The Caltech grant of $10,600 goes to four men.

Dr. James Bonner, Professor of Biochemistry, and Dr. Frits Went, Professor of Plant Physiology, are to get $7,000 for work on the biochemistry of auxin, a tumor-inducing chemical in plants.

Dr. Sterling Emerson, Professor of Genetics, receives $3,600 for genetic and physiological investigations of adaptive changes in neurospora.

Dr. George W. Beadle, Chairman of the Division of Biology, carries over from last year a grant of $5,700 for research on gene action and mutation as related to growth and other metabolic processes in neurospora.

Quakes and Tremors

Caltech's seismologists can scarcely open their mouth these days without catching somebody's foot in it.

After the Pacific Northwest earthquake last month, the Los Angeles Disaster Coordinator got in touch with Dr. John Buwalda to ask whether the same quake was likely to travel south along the coast. Dr. Buwalda said it wasn't at all likely. Within a few short hours he was quoted on the wire services as saying that southern California would not be having any more earthquakes for a while.

No sooner was this situation straightened out than Dr. Beno Gutenberg, presenting a paper on earthquake action by Dr. Hugo Benioff in Washington, was quoted as saying that the Pacific Coast was headed for another big earthquake—or a series of small ones.

Dr. Benioff spent the day on the telephone amplifying the published statement so that an excited public might understand the true facts.

"I had hoped to be able to calculate the development of strains along the San Andreas Fault," he said. "But . . . I found the job impossible for the time being. We have had good instruments only since 1923. To make calculations of any real value in determining the likelihood of a major quake here, we should have had to have such instruments in 1910. . . However, there is hope that another technique . . . will yield direct information.

"Of course, we have had great earthquakes on the San Andreas fault before and there is no reason to think we won't have some in the future. . . There has been no major quake on the fault since San Francisco's, but we have no idea what intervals to expect between major movements. . . My charting does not show that the distortion of the subsurface and resulting strain released by the San Francisco quake is building up again. It may be—but we can't prove it."

In other words there is no more reason to expect a big earthquake now than there ever was. The seismologists could legitimately predict that there would be one sometime, somewhere—but where or when were questions no one could yet answer.

Purer Air

In Pasadena last month impatient citizens organized a Pure Air Council of Southern California "to speed smog eradication through force of public opinion and

Max Delbruck—21st Caltech man to be elected to National Academy.

co-operation." Heading it up is Dr. Edwin Powell Hubble, Research Associate in Astronomy and staff member of the recently combined Mt. Wilson and Palomar Observatories.

The organization of the Pure Air Council, said Dr. Hubble, was the result of an eight-month survey which proved that "public education regarding the smog problem and persuasion of all citizens to cooperate is vital in eliminating the smog menace."

The council plans to set up local complaint bureaus throughout the county; produce bulletins, news releases, educational exhibits, and public speakers to emphasize the fact that "pure air is as important as pure water"; educate the public to better control of backyard burning; work to have police forces assigned to the Air Pollution Control Office; and seek state and Federal aid for working on problems involved in smog elimination.

Headquarters are at 465 Herkimer St., Pasadena, California.

The Arts

The Caltech Women's Club held its second annual Arts and Crafts Show last month, April 6-9. The exhibit, set up in Mudd Hall, included samples of work from more than 100 Caltech students, faculty, employees, and wives, and ranged all the way from furniture to shell jewelry to three-dimensional "objects." A quick survey revealed that Aeronautics personnel had the most entries in the show, and Chemistry and Chemical Engineering placed second. Humanities trailed all the rest—a fact that *should* have some highly significant meaning.

A week later, on April 14, at an Associates' dinner in the Athenaeum, two noted collections of drawings and documents went on display. Dr. Elmer Belt, Los Angeles physician and a member of the California Institute Associates, exhibited a selection of drawings from his priceless DaVinci collection, in which Leonardo anticipated the airplane, automobile, submarine and countless other present-day developments. And from the collection of Prof. E. C. Watson, Professor of Physics and Dean of the Faculty, came 16th and 17th century editions of the works of men like Copernicus, Galileo, Boyle, Hooke, Pascal, and Newton.

The Belt-Watson exhibit held especial interest for the California Institute Associates. Said Dr. DuBridge:

"The history of great scientists is often the history of great patrons. This fact, which is demonstrated through all the history of science, is shown again in this exhibit. Most of the scientists whose work we see here owed much to the aid of philanthropic patrons . . . but the philanthropists and patrons of the time did not truly think they were investing in the cars of today. They were not that 'practical'. Nor were they simply charitable, as they might have been if they had endowed an orphanage or a hospital. Instead, they chose to endow the thing that Einstein calls 'holy curiosity' . . . In supporting this pure curiosity—this *pure science*—philanthropy expressed its faith in the mind of man—and faith in the man of science.

"This exhibit is itself the work of two men of science . . . In offering it we are proud to honor the patrons of pure science. These patrons do not belong only to the time of Ludovico Sforza or Charles II. In a real and literal sense, they are with us today in the California Institute Associates, a group dedicated to the support of science, without restriction as to purpose or kind . . . For this support of free inquiry, all the people of a free nation should be thankful."

ALUMNI NEWS

Successful Seminar

The 12th annual Alumni Seminar, held on Saturday April 9, brought 350 alumni—and 100 wives—back to the campus for a one-day refresher course.

Linus Pauling was unable to give the opening talk, and Edward Sobel, Production Manager of NBC's Hollywood television station, KNBH, substituted with a discussion of television progress and program trends. Otherwise the seminar ran as scheduled (E & S, March '49), and with nary a noticeable hitch.

Wives were invited to the seminar for the first time last year, when a separate program was set up for them. This year, with the exception of a separate luncheon for the ladies, everyone joined in on the regular program. This seems to be one feature of the seminar that is still open to argument—a few diehards still maintaining that the seminar ought to be strictly an *alumni* affair.

Aside from this major point of difference most alumni were in complete agreement—on everything from the success of the 12th seminar to the fact that next year the printed program ought to contain the words to the alma-mater for the benefit of all those who manfully tried to bluff their way through the singing at this year's banquet.

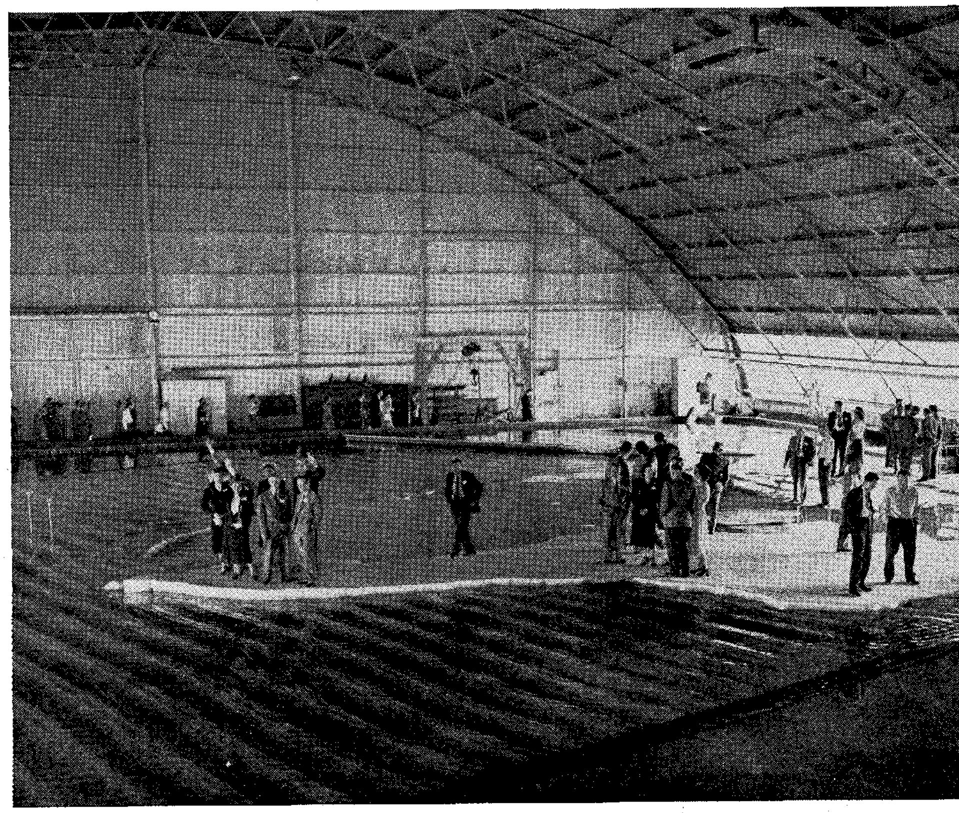
Chapter Notes

The California Tech Club of Chicago met at the Engineers Club on April 4. L. W. Jones, Dean of Admissions, gave an informal talk and showed the group two films devoted to the work of the Caltech Hydrodynamics Laboratory.

The San Francisco Chapter held a meeting on April 6 at the Veneto restaurant to hear Foster Strong, Associate Dean of Freshmen, discuss student recruiting problems. Bob Jones, who conducted the meeting, read a letter from Howard Lewis giving the status of the Alumni Fund Drive for 1949, and the chapter is making plans to aid the Drive. Present were Fritz Karge '18, L. Dean Fowler '23, Eugene W. Smith '24, L. P. Henderson '25, Manley Edwards '26, H. P. Henderson '26, Maurice T. Jones '26, J. B. Sturgess '30, J. H. Amann '31, J. J. Halloran '35, R. P. Jones '35, Virgil Erickson '37, R. B. Connelly '39, Carl G. Schrader '40, John W. Otvos '43, D. W. Otto '48, George W. Roe '48, E. F. Roskowski '48, and John H. Thomas '48.

On April 15 the Cal Tech Club of New York held an informal get-together at the Hotel Holley to meet Dean L. W. Jones (gets around, doesn't he?) on his annual trip to New York.

On March 30, while attending the M.I.T. Convocation, President DuBridge met with alumni in the Boston area for dinner at the M.I.T. Graduate House. Net result of the highly successful and well-attended meeting is the possibility of an imminent re-organization of the dormant Boston Chapter of the Alumni Association. There are some 85 alumni in the area.



Highlight of the Alumni Seminar—field trip to Guam Harbor Project in Azusa.

PERSONALS

1924

E. Dale Barcus has recently been appointed Protection Engineer in the southern California area of Pacific Tel. & Tel. In the group reporting to Dale are **Warren T. Potter, Jr.**, '35, M.S. '36, and **George Van Osdol**, '34.

1927

Charles Bradley writes: "Have been here (Corning, N.Y.) with Corning Glass Works for 13 years, and for the last three have been Director of Glass Melting Operations. Demands of glass for television tubes are, and have been, keeping us busy.

"My four children (twin boys, 15; son, 11; and daughter, 10) are all growing up so fast it makes me feel old."

C. Lewis Gazin, M.S. '28, Ph.D. '30, the Curator of the Division of Vertebrate Paleontology at the U. S. National Museum in Washington, was recently elected President of the Society of Vertebrate Paleontology, following in the footsteps of Caltech's Chester Stock, who held the office in 1947.

1929

Bolivar Roberts, formerly Acting General Plant Supervisor, has been appointed General Plant Supervisor of the southern California area of Pacific Tel. & Tel.

1930

Chester F. Carlson, inventor of the new electrostatic printing process, Xerography, which he described in E & S for Nov. '48, brings us up to date on Xerographic progress.

Xerography, he says, was (1) named one of the ten outstanding scientific achievements of 1948 by *Current Science and Aviation Magazine*, (2) discussed extensively in the annual report of the Haloid Co., its commercial sponsor, and (3) the co-subject, with Haloid, of an article in the June issue of *Fortune*.

This summer the Haloid Company expects to announce production of a Xerox Copies Office Copying Machine—under, we trust, a somewhat catchier trade name.

1933

Robert D. Fletcher, M.S. '34, Ph.D., '35, entered M.I.T. in 1938 to study advanced meteorology, received his D.Sc. in 1940. For the next four years he was Supervising Forecaster for the Weather Bureau in the southern California and Arizona area, situated at Burbank. He also taught meteorology at UCLA. In 1944-45 he was Technical Consultant in Meteorology for the U.S.A.A.F., first in the China-Burma-India theatre and later in Panama. For this work he received the Award of Commendation in 1947. Since 1946 he has been Chief of the Hydrometeorological Section of the Weather Bureau in Washington. Fletcher lives in Bethesda, Md., and has two sons, Bob Jr., 12, and John, 7.

1934

Glen W. Weaver returned to Pasadena the first of the year, as General Manager of the Arnold O. Beckman Company, Inc., manufacturers of oxygen analyzers and recorders, and dosimeters (pocket gamma ray detectors). Previously he was with the Western Electric Co.—in New Jersey from 1940 to 1946, and for the last three years in Hollywood with the Electrical Research Products Division, working on various phases of engineering.

1936

Ray A. Jensen, M.S. '37, and his wife, Elizabeth, belatedly report the arrival of a son, Eric Bruce, on July 21, 1948.

Sidney Schafer, M.S., is located in Houston, where he has been doing consulting work in the interpretation of geophysical data for the past four years.

Clarence F. Goodheart writes "not much new." He is evidently referring to his job (in the Electrical Engineering Department of Union College, Schenectady) rather than to his daughter Carol Frances, born last February 17.

1937

Andrew Fejer, M.S. '39, Ph.D. '45, who has been Director of the Fluid-Dynamic Division of the Packard experimental turbo-jet plant in Toledo since 1945, has just been named Engineering Consultant for the University of Toledo. He will report on the facilities of the turbo-jet plant and all possible research projects which might be undertaken there. His report will be used to support the university's bid for the plant, which is to be leased by the Air Corps for aeronautical research.

George M. Dorwart, M.S. '39, has been transferred by the Union Oil Co. of Calif.

to the Bakersfield office, as Assistant to the Production Superintendent of the Valley Division.

Willard D. Pye, M.S., is Chairman of the Department of Geology and Geography at North Dakota Agricultural College in Fargo. Willard says his main activity is "teaching geology on the flat plains to students who have never seen a mountain and scarcely a real rock." His second child, Brian Hurst, arrived in March.

Carl E. Larson finished a big job last month. He was construction superintendent of the new $11,000,000 headquarters building of General Petroleum Corp., in Los Angeles—reputedly the biggest office building in southern California.

Carl B. Johnson and **John K. Minasian,** '38, M.S. '44, are in business together as Consulting Structural Engineers, in Los Angeles. Carl has two daughters now—Ann, 8, and Christine, 3.

1938

Samuel E. Watson, Jr., reports that he started out in oil in Venezuela, tried it for two years, and then switched to mining. He worked for Anaconda in Chile for five years, then in Butte, Montana for six months, and was then sent to Mexico as an exploration geologist to examine metal prospects. His home is in Bakersfield.

1940

Gilbert R. Van Dyke is a Petroleum Reservoir Engineer with Signal Oil at Long Beach.

George R. Brown is now District Petroleum Engineer for the Texas Co. in Wichita Falls, Texas. He married Floy McWilliams, of Midland, Texas, in March, 1948.

1941

Frank G. Casserly is a Major in the U. S. Marine Corps. He's stationed at the U. S. Naval Post-Graduate School in Annapolis, where he is working for his M.S. in Electronics Engineering. Frank has two children—a five-year-old son and a two-year-old daughter.

Eldred W. Hough, M.S., Ph.D. '43, married Jane Ruth Elder (Occidental '46) on December 28, 1948.

1942

Forest M. Clingan stayed in the Navy after the war as an Ordnance Engineer. He is now Lieutenant, stationed in Washington as a Section Head in the Bureau of Ordnance. Last summer Forest made a 17-day flying inspection trip to Guam and Saipan. This summer he's due for transfer, to parts as yet undisclosed.

S. Kendall Gold was married last October to Philis Jane Ludlam of San Francisco. The Golds are living in Rye, N.Y., and he is working for the California Texas Oil Co. on refining projects for Bahrein Island, Persian Gulf.

Roger Brandt writes: "I am teaching at Hotchkiss, a prep school here in the East. This year, which is my first, I'm teaching advanced algebra, geometry, and chemistry. Good work, poor pay, and lots of fun. I hope to go to summer school this summer and take graduate work in psychology, if possible. Plans are not too definite, but I may go to the University of Wisconsin."

Robert A. Cooley, Ph.D., has been Associate Professor of Physical Chemistry at the University of Missouri School of Mines and Metallurgy since September, 1948. "I am told that this locality has the energy of the North, the hospitality of the South, the culture of the East, and the initiative of the West," he writes noncommittally. Bob has recently been elected Commanding Officer of Naval Reserve Research Unit 9-9 at the School.

Robert Greenwood, M.S. '43, became the father of a daughter, Dephne, born March 28, in Ticonderoga, N.Y.

1943

Robert E. Allingham was graduated from Harvard Business School with an M.B.A. in October, 1947. He then joined the Ford Motor Co. in Dearborn, Michigan, as an Industrial Analyst in a Management Planning Group. Bob, Jr., joined the family last December 31.

Thomas S. Lee received his Ph.D. from the University of Minnesota in March.

1944

Frank C. Smith, Jr., writes from Houston: "I have been reading Bruno Pilorz's copies of *Engineering and Science*, but will now look forward to receiving my own. Bruno and I are practically the only C.I.T. men around here, and we see one another often.

"In February I left Humble Oil and Refining to join the Texas Steel and Tubes Co., a small and relatively new firm engaged in supplying pipe, tubing and various related fabricating and engineering facilities to the chemical, refining and construction industries in this area. We operate what I believe is the only draw bench in Texas, and will soon have annealing and hydrostatic testing facilities. . . .

"Visitors from Caltech are always welcome here, but come too seldom."

1945

Wayne A. Roberts and his wife announce the birth of a son, Wayne Arthur, Jr., on February 23, at Grand Junction, Colorado.

Leslie H. Levin hopes to get his master's degree this June from Harvard Business School. He and Robert Bearson, '47, are roommates there.

Robert E. Leo, who dropped out of (our) sight in 1947, has come through with the following eye-opening travelogue:

"Dear Friends About 10,000 Miles Away: Your letters, circulars, magazines, yearbook and everything have been a long time in reaching me (through no fault of yours), but they've finally caught up with me in Arabia.

"I left New York in November, 1947, to handle radio, communications, and truck repair with the Gatti-Hallicrafters Expedition. On a 48-day ship voyage we stopped at Capetown, Durban, Tanga, Dar es Salaam, Zanzibar, and finally reached Mombasa on the east coast of Africa—practically on the equator.

"We were in Africa until August 1948, in Tanganyika, Kenya, and Uganda, in a partial encirclement of Lake Victoria. While there we climbed the highest mountain in Africa, Mt. Kilimanjaro, nearly 20,000 feet high and capped by a glacier of snow and ice year round, though almost on the equator.

"In the Serengetti plain—probably one of the largest game areas in the world—we saw herds of zebra, giraffe, wildebeest, gazelle, ostrich, and lion.

"In Uganda we saw the source of the Nile as it leaves Lake Victoria at the Ripon Falls at Jinja. Near here we saw the hippo and elephant that inhabit the shorelands of Lake Albert and Edward.

"I left Africa from Mombasa on a Norwegian tanker and went to the Persian Gulf, debarking at Bahrein Island and heading for Arabia, to visit my dad who worked there. Soon I too was working there—and still am.

"Just received a lot of old Christmas cards from my friends at Caltech and it made me think of the good old days in Pasadena. We are really not so far away though. Five TWA flights a week arrive here at Dhahran. And a letter from my Dutch girl friend, living in Seattle now, usually takes only four or five days."

1946

Samuel T. Martner, M.S., is doing seismic interpretation in the southeast portion of the Anadarko Basin, southwest of the Arbuckle Mountains in Oklahoma.

Bertram W. Downs, Jr., was awarded an M.S. degree by the University of Minnesota in March.

Robert F. Sensibaugh, now in his second year at Harvard's Graduate School of Business Administration, has been selected as a George F. Baker Scholar—highest scholastic honor awarded to students before graduation.

1948

James S. Allen and his wife Dotty are parents of a boy, Martin Gregory, born March 17. Jim is with the Commercial Engineering Department of Sylvania Electric Co. at Emporium, Pa.

Bruce D. Gavril is a Research Assistant at M.I.T., where he will get his M.S. in Mechanical Engineering this June. He's working on analytical methods of determining temperature distributions in supersonic wings. Bruce plans to return to M.I.T. next fall and further study.

Arthur Cox, still single, is at Los Alamos, doing whatever it is people do at Los Alamos nowadays. His future plans include Indiana University and an advanced degree in astronomy.

Robert J. Sidford Brown tersely reports the presence in the Physics Department of the University of Minnesota of himself, **Leo Levitt,** '41, **Bert Down,** '46, and **Don Dodder,** '45.

Letters CONTINUED FROM P. 2

electrical engineering, mining and geology.

The specialized schools include the National Aeronautical School, the Superior School of Electricity, the National School for Telecommunications (electronics and radio), the National School of Naval Building, the National School of Agronomy, and the National School of Arts (architecture, painting, and sculpture). These are all in Paris. In Grenoble there are the Hydraulic and Electrotechnic Institutes.

In a third class come the "practical" technical schools such as the School of Arts and Manufactures, the School of Building and Public Works, etc. Most of these are private institutions, and (as a financial consequence) admit many more students, with classes of 200 or 300.

In making any comparison with the States, remember that our industrial development and all activities requiring engineers are on a smaller scale here. There is more variety than mass production, more centralization than independent departments and compartments and hardly any two engineers have the same job to do.

We think of an engineer as an individual who comes to his position with all the faculties to adapt himself to it in not too long a time, rather than as one who rises from his mould, and whom a unilateral training has prepared for just one job. (I don't think the United States system is basically different; I should refer, rather, to technical training in the U.S.S.R., where I understand there are engineers graduating in Reinforced Concrete, Foundations, or Steel Structures, who know little or nothing of each other's subjects of study.)

The standing of our engineers is based chiefly on "quality." Those who are able to form broad conceptions and to survey more than the narrow field of one subject are called to leading positions, as well as to major planning and drafting. They are few, of course. To train such men is the purpose of the first-mentioned schools, which, incidentally, also carry on the greatest amount of research.

Admission into these schools is determined by competitive entrance examinations which are more difficult for the top schools. Candidates for these examinations are young men between 20 and 24 who have completed their secondary studies. They have to continue by doing two to four years of additional studies which emphasize analysis, superior algebra, analytical and projective geometry, descriptive geometry—in France much emphasized for its educational value—rational mechanics and kinematics, some branches of physics and chemistry, as well as English and German. The work is hard and steady. These two to four years (according to the student's capacities) require intellectual stamina, and allow little time for leisure.

The competitive examinations take place every year in the May-June period. They are scheduled to permit the candidates to take the examinations of several Great Schools. If a student is accepted by more than one, he naturally chooses the top-ranking one.

The two highest on the list I have not previously mentioned, as they are exclusively scientific rather than engineering schools: The Ecole Normale Supérieure and the Ecole Polytechnique. The former is the basic school for training college and university professors, and is connected with the university system, which in France is entirely state-supported. The Ecole Polytechnique is a military school providing high-level scientific training. In some cases students take their first year of study here, and then transfer to one of the Great Schools. (This is the case with most French state engineers, who are civil servants.) Competition is always stiff, and may reach a ratio of fifteen candidates to one admission in the top schools.

In France, then, one may be a smart engineer or an ordinary one—according to the Great School one has attended. Is this a good system? Some drawbacks are immediately apparent. One my say, for example, that a good engineer is not necessarily a good scientist, and that the present system of competitive examinations may bar from the best schools many young men showing practical ability or particular aptitude for industrial leadership and business management. The answer may be that theoretical work is and should always be done first in the training of an engineer, that our admission system is thus justified, and that there may be a greater statistical probability of success in both scientific and practical engineering among those who have successfully survived the arduousness of our competitions. In any case I think there is matter here for an interesting discussion.

Ponts et Chaussées

The Ecole Nationale des Ponts et Chaussées—my own school—is fairly old. Two years ago it celebrated its second centenary. In its early days the school was a preparatory institution for civil servants of the Public Road Administration. During the Napoleonic era it gradually enlarged its field and reached a high scientific level.

Today, about half the students here become engineers in government services. Most of them come from the Ecole Polytechnique under state contract; they are given free training and a salary, and after graduation they are automatically placed on civil service. The other half—20 to 30 students a year—are preparing to enter private industry. These students pay a tuition of about 8,000 francs a year, which is $30 at the official rate of exchange.

The school building is a renovated mansion of the nineteenth century, situated in the heart of Paris not far from the Louvre. The laboratories are elsewhere in Paris, and brand new. The school is thus only an academic institution; it bears little resemblance to the American campus with its resident students and professors. None of this is possible in the crowded center of Paris. A modern student hostel provides living quarters for some of the students who are not residents of Paris.

Curricula

The curricula cover a three-year period. The school year lasts from October 15 to July 15, with short vacations at Christmas and Easter. For reasons which I hope I have made apparent, the curricula are uniform and compulsory, with no option whatever for the student. Each course is covered by a general examination at the end of the year, and sometimes by partial examinations during the term. Courses in physics, electrotechnics, testing of materials, and geology involve laboratory work, which also counts in the student's record.

But the most important and profitable additions to the main courses, I believe, are the so-called projects. Practical engineering problems are assigned to the students. A complete solution is required, as well as the calculations for the design of structures. In some cases cost estimates must be given too.

These projects are designed to give the student experience with real engineering problems. He also gets actual practical experience during the two compulsory summer practice periods, when, for two months, he works in the service of the State Administrations of Roads, Canals, Harbors, or Electricity—or with private firms or contractors. Sometimes these practice periods help the student to decide on his future field of activity.

As our system of instruction suggests, most of our professors are also practising engineers. They are graduates of the school themselves, and they have outside professional positions—some of them very important ones. The courses are conducted as lectures, and comprehensive textbooks and notes are issued to accompany the lessons and help the student prepare for the final examinations.

All examinations, laboratory work, projects, etc. receive grades of from 1 to 20, which are multiplied by coefficients (of from 1 to 15) according to their importance. An average of 13/20, or 65%, is required to pass into the superior year and to graduate. A grade of 7/20, or 35%, means the test must be taken again.

Textbooks are frequently revised to keep up with the newest theory and practice. As the present tendency is to bring professors and students into closer contact, some assistant professorships have recently been created and assigned to young engineers of the school. Another innovation consists of group visits to factories, manufacturing plants, and various construction projects in the Paris area, as well as longer trips to important harbors, canals, dams, etc.

What about our out-of-school life? We have always had good rugby and football teams, and last year we won the Paris University Championships. There are plenty of cultural opportunities, such as lectures and much-appreciated free or half-price theater and concert tickets. A few dancing parties are arranged during the term. The social event of the year is the Great Bal of the school, which is honored by the presence of the President of the Republic. Another event is the yearly School Revue, a comic play acted by the students, and based on school events and the biases and whims of the professors.

For many years the school has had an alumni association, and I think the fact that neither the alumni nor students are numerous contributes to a real and active solidarity. One of the purposes of the association is to help find positions in private industry for young graduating engineers. Actually, those students who are going to be in government service already have contracts with the state while they are in school. For the others there is always a large choice of jobs.

In the French technical education system, there are of course as many similarities to the system in the United States as there are differences. Whatever the differences may be, though, I think you will agree with me that the two systems at least have a common aim, to which we all look forward—the engineer's career, which is, we are sure, a very grand one.

Valentin Letia

Paris

Spring is busting out all over!

So? **A SPRING SPORT DANCE** sponsored by the Alumni Association for its members and friends and co-sponsored by the Associated Students, on Saturday, May 21, 1949 at 8:30 p.m., for the reasonable price of $2.50 per couple, including a generous amount of tax. Buy tickets at the Alumni Office or at the door.

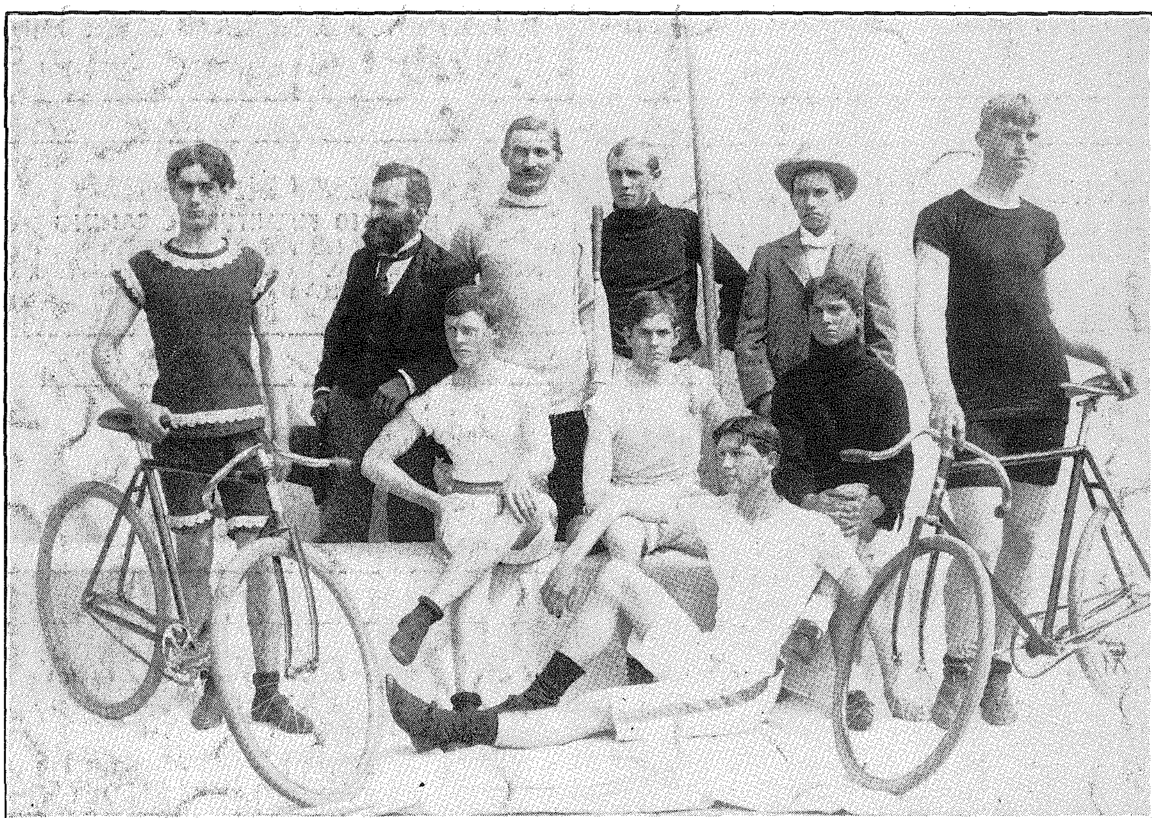
Where? **ALTADENA TOWN AND COUNTRY CLUB**

Dress? **SPORT SHIRTS AND SLACKS.** You will be equally at home in your oldest, most comfortable clothes, but will not be refused admittance if you must wear a tie. Wives have full choice of dress but will probably wear sweaters and skirts or sun dresses.

Music? **EDDIE MILLER AND HIS ORCHESTRA,** which includes most of the original Bob Crosby "Bob Cats" and other nationally known musicians. This orchestra is the feature attraction of the dance.

POSTMASTER: Return postage guaranteed.

Anybody here you know?



You'll see a lot of your old friends--and meet the members of the class of '49--at the Alumni Association's Annual Meeting and Dinner. It will be held at the Los Angeles Athletic Club on Wednesday evening, June 8, 1949. Professor Horace Gilbert will be the principal speaker, and his subject will be "World Economic Prospects--the Twilight of the American Business Boom and Hopes for World Recovery."

Wednesday, June 8 is reunion day, too. Festivities have been planned for the classes of 1944, '39, '34, '29, '24 and '19. Class Day is set for June 9th, and Commencement for the 10th.