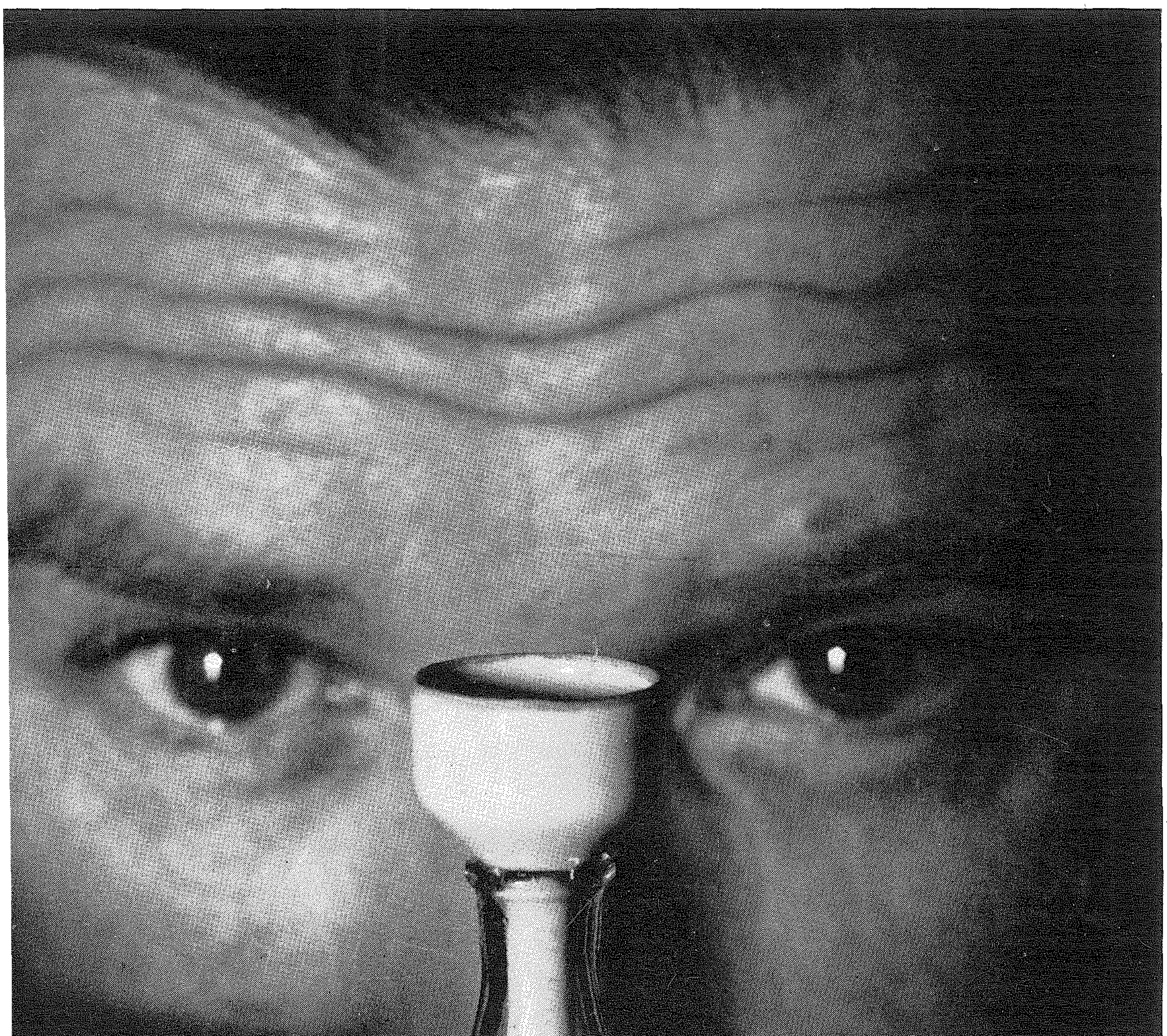
ENGINEERING AND SCIENCE



The chemistry of flavor . . . page 3

January, 1949

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

The Main Line

JANUARY, 1949

Where will you be on the night of March 1, 1949?

We know where we want to be: on the corner of Canal and Bourbon Streets—'way down yonder in New Orleans.

Why? Well, that's Mardi Gras, brothers and sisters—that most famous of fete days in that Queen City of the Southland. Need more be said?

Of course, there's more to be said in the Department of Ways and Means. But we can sum that up pretty quickly:

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The Means—either of our daily Sunset Route trains: the *Sunset Limited,* with the fastest Los Angeles-New Orleans schedule in the route's history (and at no extra fare), or the *Argonaut,* for people who prefer a night-departure train.

What kind of accommodations do you want? There's something to fit practically every purse and preference on one or the other of these trains: Standard Pullmans with everything from sections to drawing rooms... reserved-seat reclining chair cars... economy Tourist Sleepers... coaches.

Sounds interesting? Then get hold of your near-by S.P. Agent and let him work out an itinerary for you. (Ask him about the Mardi Gras special train leaving Los Angeles February 23. Space on this special has been going, going—and may be gone. But it's worth looking into.)

★ ★ ★

Speaking of dates—we can't very well ask you where you were on January 8, 1863—86 years ago this month. But we can tell you it was a very important date to this railroad. On that day the first shovelful of dirt was turned on construction of the old Central Pacific.

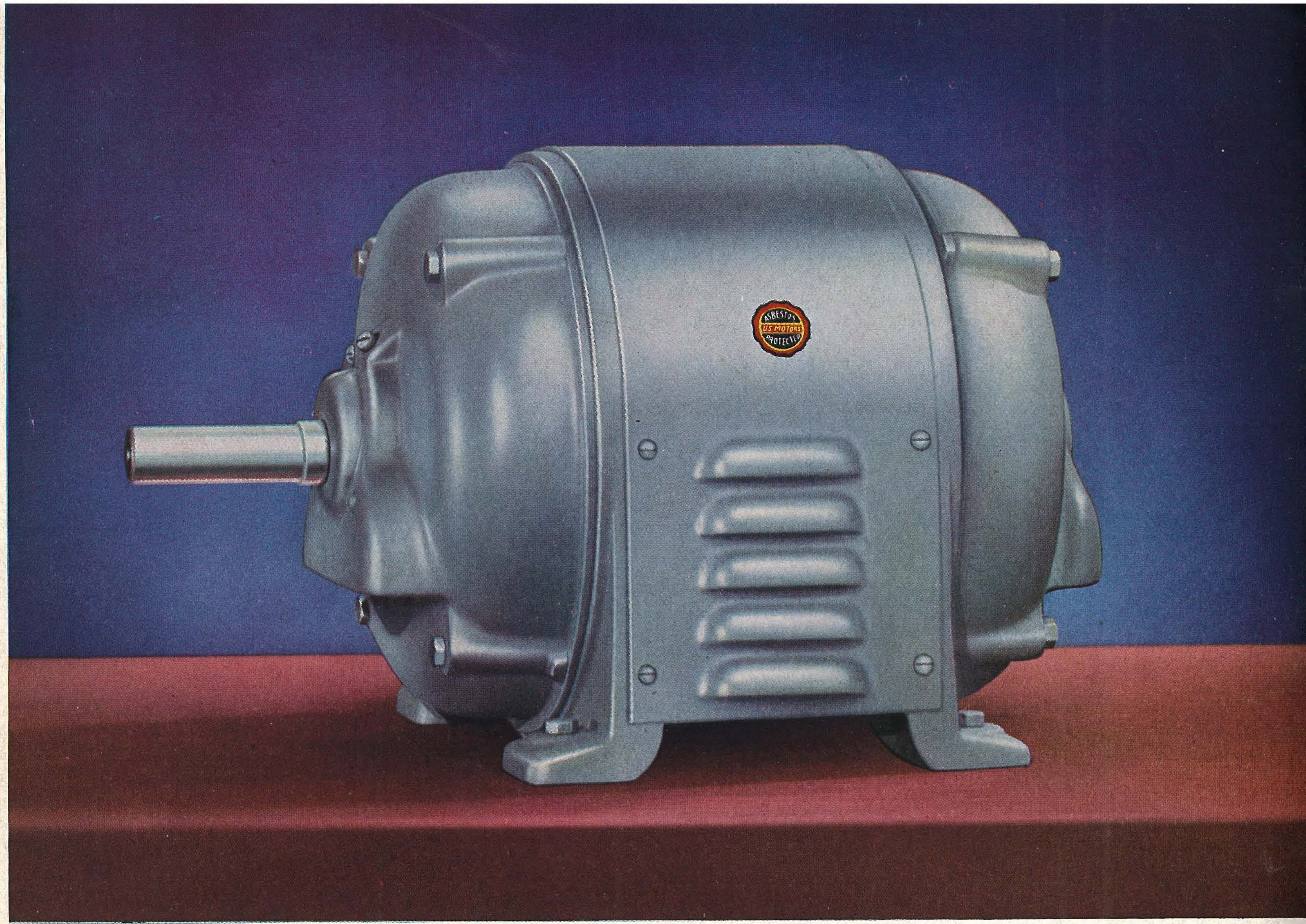
We've come a long way at Southern Pacific since then. When those four founding fathers—Huntington, Stanford, Crocker and Hopkins—started out, they had a railroad 31 miles long. Today, Southern Pacific—giant of the West and one of the nation's three biggest

railroads—has 15,379.65 miles of road in operation. And—according to our demon statistician, Lorenzo, who is a fanatic for preciseness—that includes Pacific Electric operation in Southern California, the S.P. de Mexico, the Tecate & Tijuana, and other subsidiaries!

(Another S.P. feature—a unique one: we're the one railroad with a choice of four routes East from the Pacific Coast: the Golden State, Los Angeles-Chicago; the Sunset, Los Angeles-New Orleans; the Overland, San Francisco-Chicago; and the Cascade, via the Evergreen Pacific Northwest. Next time you round-trip East, plan to go via one S.P. route, return via another—see twice as much en route. Let your near-by Southern Pacific Agent help you with an itinerary. No obligations, of course.)

S•P the friendly Southern Pacific

See next page



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IN THIS ISSUE

On the cover

The eyes on the cover belong to Dr. Arie J. Haagen-Smith, Professor of Bio-Organic Chemistry at Caltech since 1940. He is examining the end product of many months of painstaking work—a few ounces of fluid, obtained from several tons of raw material, which hold the key to the composition of flavor.

Dr. Haagen-Smit is chiefly recognized for his investigations dealing with the isolation, structure, determination, and synthesis of naturally occuring compounds. He has done valuable work in the field of plant hormones, and more recently — as described in his article, "The Chemistry of Flavor," on page 3—on studies of food flavor.

Einstein

Albert Einstein has written a characteristically succinct foreword to Lincoln Barnett's new book, "The Universe and Dr. Einstein." (The book, incidentally, is reviewed on page 16.)

It seems to us that Dr. Einstein's remarks in that foreword, on science writing for the layman, should have particular significance for the readers—and writers—of this magazine. In fact, Dr. Einstein has stated, far better than we could here, the function and purpose of a magazine like ours:

"Anyone who has ever tried to present a rather abstract scientific subject in a popular manner knows the great difficulties of such an attempt. Either he succeeds in being intelligible by concealing the core of the problem and by offering to the reader only superficial aspects or vague allusions, thus deceiving the reader by arousing in him the deceptive illusion of comprehension; or else he gives an expert account of the problem, but in such a fashion that the untrained reader is unable to follow the exposition and becomes discouraged from reading further.

"If these two categories are omitted from today's popular scientific literature, surprisingly little remains. But the little that is left is very valuable indeed. It is of great importance that the general public be given an opportunity to experience—consciously and intelligently—the efforts and results of scientific research. It is not sufficient that each result be taken up, elaborated, and applied by a few specialists in the field. Restricting the body of knowledge to a small group deadens the philosophical spirit of a people and leads to spiritual poverty."

Patents

W. Bruce Beckley, author of "Who Owns the Employee's Invention?" (page 9), was graduated from Caltech in 1936 with a B.S. in electrical engineering, and from Stanford Law School in 1939 with an LL.B. He then became a member of the State Bar of California and went into the active practice of patent, trademark and copyright law. In 1942, he spent

(Continued on page 2)

ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

CONTENTS FOR JANUARY, 1949

ENGINEERING AND SCIENCE MONTHLY

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IN THIS ISSUE--cont.

a short period as a Special Agent with the F.B.I., and from August 1942 until February 1946 he was Assistant to the Director of the University of California Division of War Research at the Navy Electronics Laboratory in San Diego. This was an independent civilian laboratory doing research in underwater sound for OSRD and the Navy. In 1946 he returned to a partnership with his old law firm — which now became Boyken, Mohler & Beckley—in San Francisco. At present, Mr. Beckley is also an instructor at the San Francisco Law School, and a registered California engineer.

Science in art

Maybe Ernest C. Watson, Professor of Physics and Dean of the Faculty, hasn't got the greatest collection of scientific prints and paintings in the world. But then again maybe he has. These prints not only cover the four walls of Dean Watson's spacious office in Bridge; they're stacked on tables, piled on counters, and filed in cases, too. And it is probably not generally realized that most of the pictures in most of the other offices at Caltech also belong to Dean Watson. Or did. They are out on permanent loan.

Dean Watson has been collecting prints of scientific interest for many years, and the collection is still growing. Proprietors of old print shops, here and abroad, know the Watson collection so well that whenever they come upon a print with the slightest scientific association they ship it to Dean Watson on approval—certain that he won't have the heart to send it back.

For a number of years reproductions of prints and paintings from Dean Watson's collection have been running in the Journal of Physics. Now Dean Watson is making some of these, and others of broader scientific interest, available to the readers of Engineering and Science. The first of this series appears on page 8.

Posers

Caltech's hard-working Director of Public Relations, George Hall, usually has an answer for everything. Last month he was stumped though. Twice.

First, he got three letters — one from Seattle, one from Saskatchewan, one from Washington, D. C.—all asking the same question. Would he please furnish further information on the "object observed at Palomar which is in the northern skies, is square with twelve lights on it, and is approaching the earth at rapid speed?"

Some detective work soon revealed that the source of this astonishing information was what must have been an especially rousing sermon broadcast from the Angelus Temple in Los Angeles.

The second poser put to Mr. Hall still remains to be answered. A few days before Christmas a lady called up to ask where she could get tickets for the Christmas play Caltech was putting on with real angels in it.

Maybe she meant NEXT Christmas.

THE CHEMISTRY OF FLAVOR

Flavor is no longer considered a gastronomical luxury. New methods of flavor analysis may bring us better food

by ARIE J. HAAGEN-SMIT
Professor of Bio-Organic Chemistry

YEAR BY YEAR, more and more of the food we eat is processed — canned, frozen, dehydrated, smoked, or otherwise treated so that it can be conserved. The public is already well aware of the importance of retaining the vitamin content in stored and processed foods. But now it is beginning to demand similar progress toward making these foods more palatable.

As a result, research programs are being set up with the sole objective of studying one of the most important constituents of our daily food—flavor. Plant physiologists, agricultural scientists, food industries, nutritionists, even medical workers are engaged in this work. They mean to find out what processes are involved in food ripening, how flavor is formed, how it behaves during processing, how it stands up under storage and marketing conditions, and how it can be improved.

Actually, we know very little about flavor. Even when we try to define it, we have to resort to a description of its effects. We know it is essential to the quality of foods, and determines whether our reactions to them will be favorable or unfavorable. We know, too, that these reactions find their origin in our senses of taste, smell, touch, and even sight. In many cases the flavoring agents are of known chemical structures, giving definite taste impressions—such as salt or sugar, which influence our taste receptors. In other cases the flavoring agents are complex mixtures, such as we find in spices and in all natural flavors, and which act through both the taste and smell receptors. These substances belong to all classes of chemical compounds, and at present it can be predicted only to a limited degree what a given substance will smell or taste like —and this only by comparison with other substances, and following empirical rules.

It is not clear, for example, why substances which have a totally different structure—such as sucrose, dulcin, saccharin and 4-nitro-2-aminophenylpropylether—should have a sweet taste in common. The chemical formulae of these substances, together with their relative sweetness as compared with sucrose, are shown on the following page.

We do know that each of these unrelated molecular structures can be varied to a certain degree, while still retaining the sweet qualities of the original pattern. For the sugars the presence of two or more hydroxyl groups is largely responsible for their sweet taste, and a number of polyhydric alcohols, such as glycol, glycerol and inositol, give similar reactions. A few of these related substances with their relative sweetness are:

Sucrose (100)	$CH_2OH.CH.(CHOH)_3.C\text{-}O\text{-}C(CH_2OH).(CHOH)_2.CH.CH_2OH$
Ethylene glycol (130)	$CH_2OH—CH_2OH$
Glycerol (108)	$CH_2OH.—CHOH.CH_2OH$
Dl-erythritol (238)	$CH_2OH.CHOH.CHOH.CH_2OH$
Inositol (50)	$CHOH.CHOH.CHOH.CHOH.CHOH.CHOH$ (ring)

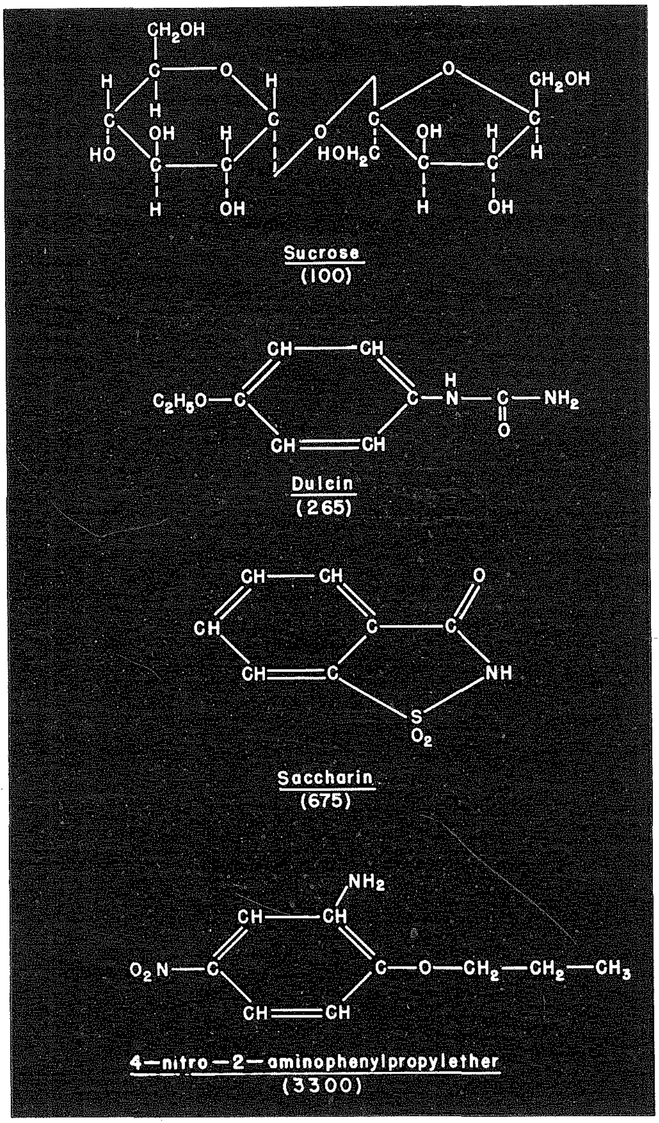
Similar observations have been made on substances giving a certain smell. While we don't know **why** a substance smells like camphor, we can empirically determine certain conditions which a compound must satisfy **before** it smells like camphor. In this case, it is generally known that organic compounds containing a carbon atom carrying several methyl groups, or groups of equal size, have camphor smell, as illustrated by the formulae on page 4.

In the case of mint flavor, we find a close relation to the camphor smell. A small change—as for example the replacement of a methyl group with a hydrogen atom—is enough to turn camphor smell into mint smell.

What makes it smell like that?

A study of the structures typical for the two types of smell shows that in all probability we are dealing with phenomena in which the shape of the molecule is of great importance. We can imagine that the shape of the molecule fits the receptors—the sensory nerve endings in the nose—and electrical impulses are set up, which travel over the sensory nerves to the brain, and give impressions corresponding to the structure of the substance.

The sensitivity of our smell and taste organs has often been used as a tool in chemical analyses. The accomplishments of these organs in a fraction of a second are quite remarkable. It often takes a chemist days to corroborate the results by strictly chemical means. For example, a trained nose can recognize nearly every member of a series of homologous alcohols, aldehydes or acids. Isomers of these compounds (molecules having the same number and kind of atoms, but in different arrangement) are more difficult to distinguish. And, in general, the variations in structure for the same type of odor and taste are so



Substances with different structures have a sweet taste in common. Figures show relative sweetness, compared with sugar.

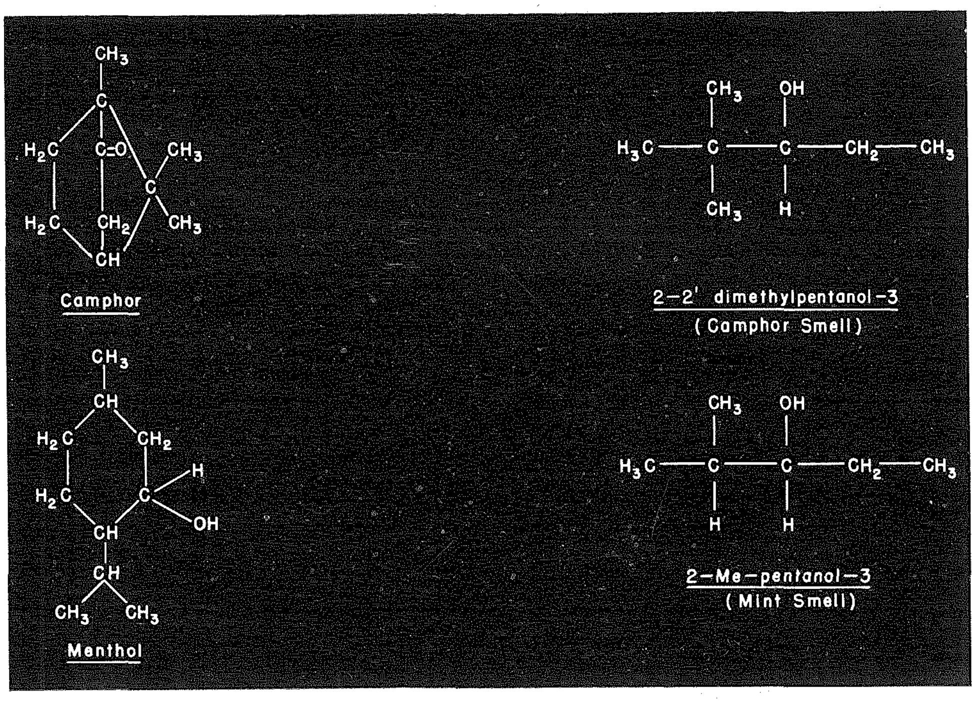
great that we cannot rely on our senses when the analysis has to be used for scientific investigations.

A more difficult task is set when mixtures of substances are present. Analysis by taste and smell breaks down completely when the substances to be recognized have not been previously isolated in pure condition. The synthetic flavor industry, for instance, can produce a more or less satisfactory reproduction of a natural flavor by skillfully combining known synthetic products. But this way of solving the flavor problem naturally reaches its limit when dealing with compounds of unknown structure. The analysis by smell and taste has, therefore, a limit set by the power of distinction of our sensory organs and by our limited knowledge of the odors of the pure compounds.

While olfactory analysis has been of great value to the composer of natural flavors, for scientific investigations such as the manner in which flavors are made by organisms, and the study of changes in flavor which occur during ripening processes, we must know the exact nature of the composition of the flavoring agents.

These considerations constitute a warning against accepting the results of smell and taste analysis, without chemical verification. Also, statements based on color reactions must be regarded with a great deal of suspicion, since closely related compounds give similar reactions. For a positive identification, the isolation of a flavor constituent or a derivative is necessary. The chemical work on flavor, therefore, consists of a process involving the isolation of the various substances contributing to the flavor, and their characterization.

The flavor substances are either volatile or non-volatile. The volatile part contains both taste and odor substances, while the non-volatile part contains taste substances only. The non-volatile substances in our food products consist mainly of sugars, fruit acids, amino acids and a number of compounds specific for the material at hand. The volatile part contains fatty acids, aldehydes, alcohols, esters, amines, and nitrogen and sulfur-containing compounds. The residue, after removal of the volatile materials, has often lost most of the flavor characteristic of that particular product. When our sense of smell is temporarily out of order,



There's no obvious relationship between menthol and camphor, but camphor and mint smells are much alike. In the simpler compounds (right) one small change — like the replacement of a methyl group with a hydrogen atom—turns one into the other.

most of our foods taste very much alike. Chemical studies, especially on fruit flavors, will therefore often be concentrated on the volatile materials.

If we compare the relative sensitivity of our senses of taste and smell, we immediately become aware of the enormous difference between the two, and of the great superiority of our odor perception. We can taste some of the bitterest substances like quinine or strychnine, in concentrations of one thousandth of a gram in a glass of water. On the other hand, we are able to detect one of the strongest-smelling substances, ethyl mercaptan (which is related to the skunk smell), in concentrations as low as one millionth of a gram in an average room. It has been calculated that our nose is about 10,000 times as sensitive as our palate. This means that, in studying the flavor constituents, we must search for odoriferous substances which occur in infinitesimal quantities. The methods to be used are therefore mostly those of the microanalyst.

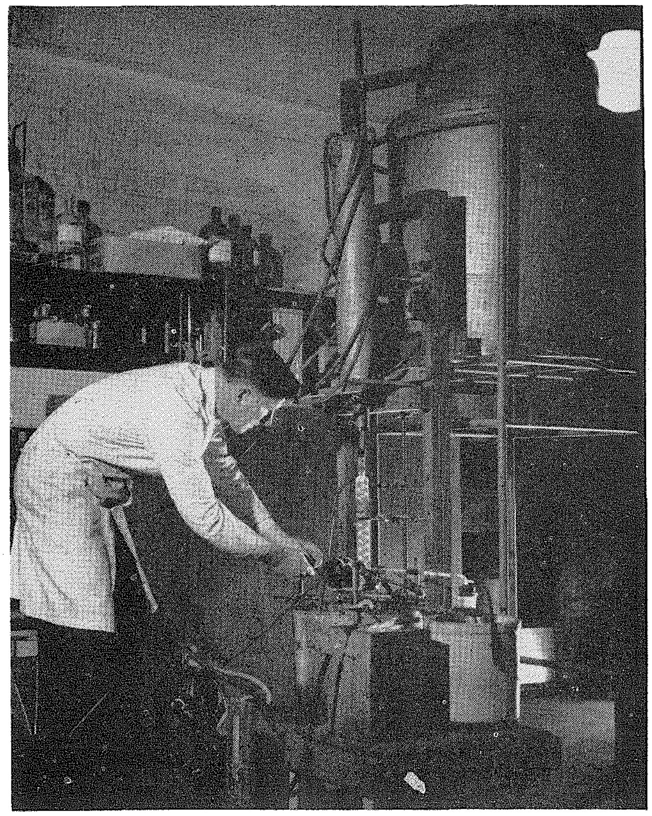
Isolating the flavor components

It is necessary to start with thousands of pounds of raw materials, however, before weighable quantities of some pure flavor components can be isolated. To obtain the volatile material we must prevent secondary changes such as are caused by heating or enzymatic reactions. A low-temperature distillation, with condensation at a lower temperature, will usually suffice to obtain all of the odoriferous substances. In other cases, solvent extraction might lead to similar results. After separation of the flavor components from large amounts of water, the individual components are separated by fractional distillation or chemical methods. The pure compounds are then characterized by the preparation of derivatives which are crystalline, and which can be compared with derivatives of known compounds of the same constitution.

These derivatives can often be used to advantage in the separation technique. When, for example, a mixture of acids is present, we can prepare the phenylphenacyl derivatives and pass the mixture through a column of adsorbent material. The different components in the mixture will be adsorbed at different heights on the column, and can be made visible in this case, since the phenylphenacyl derivatives fluoresce in ultra-violet light.

When the pure derivative of the unknown flavor substance is obtained, a comparison with the same derivative of a known substance will usually establish the identity. If the substances isolated have not been previously known, degradation methods have to be carried out to identify smaller parts of the molecule. Afterwards, the results have to be integrated to give the structure of the original compound. An example of this type of work is the analysis of pineapple flavor recently made at the California Institute of Technology.

Dr. Royal Chapman, Director of the Pineapple Research Institute, a joint enterprise of the eight Hawaiian pineapple companies, realized the importance of the exact knowledge of the pineapple flavor, for the attacking of many problems facing the industry. Such problems as the process of fruit flavor formation, and the effect of the canning process on the pineapple flavor, required for their solution fundamental knowledge of the chemical constituents of pineapple flavor. Such information could be applied to physiological and breeding work, as well as to the actual canning process. At Dr. Chapman's instigation, Caltech in 1945 undertook a research program designed to obtain such basic data.



Peeled, sliced pineapples undergo low temperature distillation, which separates flavor components from large amounts of water.

While our research was not intended as a means of obtaining a better artificial pineapple flavor, the results of our analysis would naturally lead to improved flavor formulae. For, after isolating the flavor principles, and determining their structure, it was possible to reconstruct the flavor chemically.

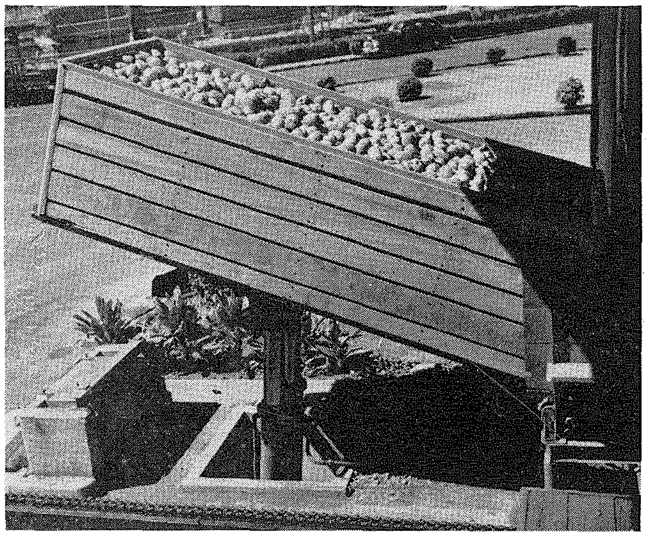
The pineapples were picked fresh at the experimental grounds in the center of the island of Oahu, and immediately brought by truck to the docks in Honolulu. They were then shipped under refrigeration, until they arrived in the harbor at San Pedro, where the Institute truck picked them up without delay. A total of approximately 6,000 pounds was used. The pineapples were peeled, cut into small pieces, and packed in large distilling flasks. (It was necessary to protect the hands with rubber gloves, because the pineapples contained an appreciable amount of protein-splitting enzyme—bromelin—which dissolves the skin rapidly, whereupon the hands become slippery, as if they had been treated with lye. Tasting experiments with fresh pineapple must also be conducted with care, since the surface of the tongue is painfully affected after some time. In canning, this enzyme is denatured).

A part of the water present in the pineapples was then drawn off under vacuum, at room temperature, to prevent any secondary decomposition. The water, which carries with it the volatile flavor components, was condensed at low temperatures (—80° C.). The condensate was redistilled, and thus the volatile flavor components were concentrated in the second distillate. Starting with several tons of material, we obtained a few ounces of volatile product which had the typical pineapple smell.

Of this quantity, ethyl alcohol and acetaldehyde formed by far the larger part. After these components had been distilled off, only a few grams were left, which contained the substances more specific for the pineapple flavor. This distillate was fractionated further by physical and chemical means.

In this fractionation process, relatively pure compounds were obtained, their properties were determined, and derivatives were made to characterize them. The majority of the compounds consisted of esters. These were hydrolyzed—chemically split into alcohols and acids through the addition of water. From the alcohol part, 3, 5 - dinitrobenzoates were prepared; from the acid part, phenylphenacyl compounds. This mixture consisted of the ethyl and methyl esters of the following acids:

Acetic acid	n-Valeric acid
Isocaproic acid	n-Caprylic acid
Hydroxyvaleric acid	Isovaleric acid



Six thousand pounds of pineapples, picked fresh, were shipped from Hawaii to Caltech for work on analysis of their flavor.

One of the fractions contained sulfur, and we were able to obtain a pure derivative by oxidation of the fraction, whereby this compound was transformed into a crystalline sulfone. Our analytical results showed that we had to deal with a compound with five carbon atoms ($C_5H_{10}SO_4$). To economize on our small amount of product, we decided to synthesize the nine possible isomers, and we found one of these identical with the natural flavor component.

Reproducing fresh pineapple flavor

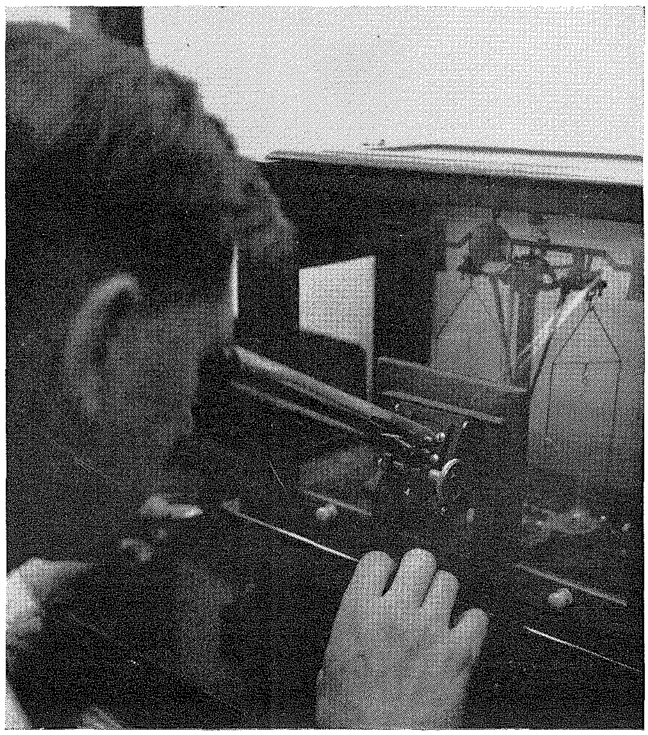
After we had analyzed about 98 per cent of the volatile components, it was interesting to see what a reconstruction of the flavor would yield. The result was a satisfactory reproduction with a fresh pineapple smell. For reproduction of the full flavor, the non-volatile substances such as sugars and different plant acids had to be added. This flavor is considerably different from that which we usually consider as typical pineapple flavor. Through the canning process some of the esters present in the fruit are hydrolyzed, and some of the fatty acids are set free, which impress upon the canned material its typical taste.

In the analysis of the flavors of natural products, the chemist tries to avoid any secondary changes in his material in order to prevent unnecessary complication of his work. However, a number of food products have been made to undergo changes for the sake of the development of their flavors. These changes may be a consequence of enzyme action, heat treatment or oxidation.

An example of the action of enzymes on the production of taste and odor is found in the onion. Chemical analysis has shown that a glucoside present in the onion is decomposed, and gives allyl sulfide and thio ethers. An example of the action of heat on a natural product is found in the production of maple flavor from maple exudate. In such a case we find not only the original components, but also their conversion products responsible for the typical maple flavor. Sugars are converted into cyclic compounds, and brown-colored products appear (caramel, coffee, toffee, etc.)

The analysis of the mixtures of chemical substances

Starting with over two tons of pineapples, Dr. Haagen-Smit got a few ounces of volatile product with typical pineapple smell.



obtained through these secondary changes involves a considerable amount of work. The problem becomes a great deal more complex when the starting material is not homogeneous of origin (as it is in the pineapple, maple sap, or the onion) but rather the result of the cooperation of several organisms, as, for example, in fermented products. In such cases we must try to identify not only the contributions of the original material but also the products produced by the micro-organisms on this material.

Such an investigation is now being carried out at Caltech on wine—the result of the action of yeast on grape juice. This study, instigated by the Wine Advisory Board of California, involves separate analysis of the grape and of the wine made of it. In order to control and modify the wine flavor it is necessary to find the pathways by which the substances making up this flavor are formed. And a prerequisite for this is a knowledge of all the constituents of the grape, both flavor and non-flavor components, and the action of yeast upon these. Such studies are expected to be a material contribution to the direct analysis of the bouquet of wine and to the expression of its small variations in chemical terms.

Complications in condiments

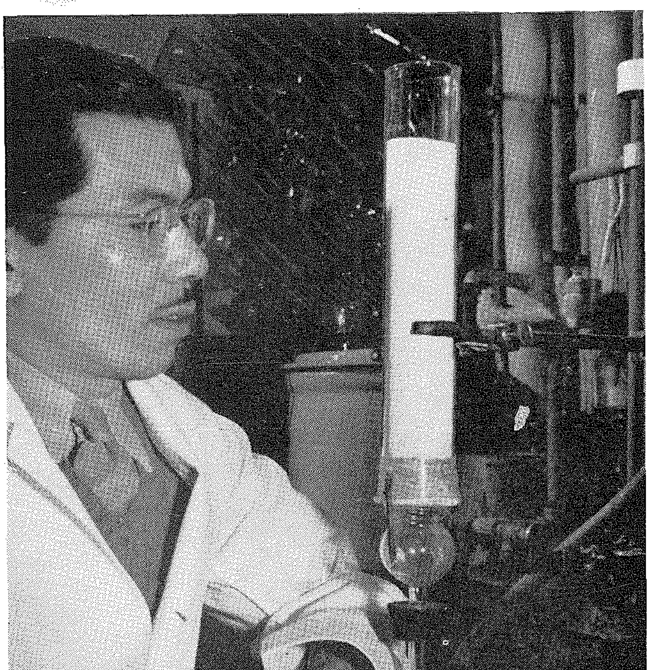
We can go still further in complicating our starting material if we combine heat treatment and growths of several fungi and bacteria. These difficulties in analysis are combined in a condiment such as soy sauce. Not only are the starting products of different origin, namely, rice and grain, but these are used as nutrient media for a number of fungi, subsequently heated, and again fermented, alternately aerobically and anaerobically (in the presence and absence of air). Many food products of great importance have such a complicated history, like bacon and other processed meat products, jellies, and preserves. With a knowledge of the chemical composition of these flavors, the effect of the different stages in processing can be accurately determined, and a better understanding of the processes involved is the result.

The knowledge of the composition of a flavor allows us to make predictions about the origin of the components. It is interesting to see in the case of our studies in pineapple that the esters found can all be derived quite easily from amino acids by processes involving deamination and esterification. The sulfur-containing ester, especially, shows quite clearly its precursor was an amino acid, either cysteine or methionine, and it is certainly more than a coincidence that in this fruit we find considerable quantities of a protein-splitting enzyme, and its methionine-containing activator, glutathione.

From these facts our attention is drawn to the amino acid metabolism in the fruit, rather than to the sugar metabolism, in the formation of the typical pineapple flavor. On the other hand, the general "fruitiness" of the summer fruit, caused by the presence of ethyl acetate, as compared with the bland taste of the winter fruit, links this part of the flavor to the carbohydrate metabolism. Agricultural experiments designed to improve these flavors have to modify each one of these processes. Predictions made upon the basis of these analyses can now be verified with the help of radioactive isotopes. Since a number of flavor components in the pineapple are now known, the isotope dilution method can be used to great advantage in the determination of small variations in the flavor constituents.

Among the food processing firms, it is the dehydrator who most needs the help of a systematic food analysis. In his processes, mostly based on the evaporation of water, a great many of the volatile flavoring components are removed. Dehydrated food, therefore, has received a poor reputation which can only be remedied by changed methods of dehydration and reflavoring of the dehydrated material. If the flavoring components are known, the water can be removed by a selective adsorption process in an atmosphere of the flavoring agents. In this way, odoriferous substances are prevented from escaping, and the resulting dry product retains its natural flavor.

Especially in the case of feeding large groups of people, where the free choice of food is not feasible, it has been recognized that flavor studies are of prime importance. Large organizations such as the Army and Navy, and some of the larger manufacturers of food products, have learned that in drifting farther and farther away from the use of natural foods, the processing often leads to inferior products as far as flavor is concerned. Since nutritionists have started to realize that we need palatability in addition to calories, vitamins and amino acids, flavor is no longer considered a gastronomical luxury.



After separation of flavor components of pineapples, pure compounds were characterized by preparation of crystalline derivatives. Mixture of phenylphenacyl derivatives was then passed through a column of adsorbent material (left). Different components of the mixture were adsorbed at different heights, were made visible by exposure to ultra-violet light (right).

The Air Pump

The Orrery

Science in art

Three paintings by Wright of Derby

by ERNEST C. WATSON

The Alchymist

THE THREE GREAT SCIENTIFIC pictures—"The Orrery," "The Air Pump," and "The Alchymist"—painted by Joseph Wright (1734-1797) deserve to be better known to teachers and students of science than they are, for they accurately, as well as beautifully, reflect the state of physical science during the artist's lifetime. "Wright of Derby," as he is often called, was not only a distinguished artist, especially noted for his rendering of artificial lighting effects. According to F. W. Shurlock[1] he was also "an interested and careful student of contemporary science whose knowledge of the scientific details portrayed in his pictures was surprisingly accurate." In a very real sense "the three pictures may be regarded as typical of the state of astronomy, physics, and chemistry respectively in the latter half of the eighteenth century."

The scientific accuracy and interest of these three great paintings have been so happily discussed by F. W. Shurlock that I can do no better than to refer the reader to this delightful paper.[1] Any student who will study the paintings under the guidance of this paper will acquire a new insight into the background and spirit of eighteenth century science.

The reproductions for this article were made from the beautiful mezzotint engravings of the original paintings which were executed during Wright's lifetime by William Pether, Valentine Green and T. Boydell. These engravings are approximately 23 x 18 in. in size and are among the finest examples of the mezzotint art. The mezzotint process, with its affinity to painting in black and white, is well adapted to the reproduction of the unusual lighting effects that are a characteristic feature of Wright's work; but of course it can give no hint of the taste and skill with which the artist "united the blazing reds and yellows of the central glare to the rich brown of his transparent shadows, warmed and cooled these shadows with gleams of red coat and glimmers of blue sash and white dress, and led the eye, untired, from the ruddy glow of the chamber to the cool night outside."[2]

1. "The Scientific Pictures of Joseph Wright," **Sci. Progress** 17, 432 (1923).
2. W. Bemrose, **The Life and Works of Joseph Wright, A. R. A., Commonly called "Wright of Derby"** (London, 1885).

WHO OWNS THE EMPLOYEE'S PATENT?

In patent matters the interests of employers and employees are often contrary. Here's sound advice for both to follow

by W. BRUCE BECKLEY

ONE DAY, SOME MONTHS after being employed on the wartime research project of a large university, an engineer was called to the director's office and asked to execute an assignment, in favor of the government, of an invention developed in the course of his work on the project. The engineer protested that he had not agreed to make such an assignment. Furthermore, he had previously signed a contract with his former employer, a large oil company, to assign all his inventions made for one year after he left such employment. The director said he was sorry, but the university had agreed to assign all inventions made during the course of the work, so he would try to get a release from the oil company. Upon inquiry, however, the oil company also objected, relying on its written contract with the engineer.

The same or similar scenes— too often enacted during the course of wartime research—focused attention sharply on problems dealing with patent rights, and particularly on those arising in connection with the respective rights of employers and employees. Fortunately for all concerned the engineer and the oil company in this case—as in hundreds of other instances in connection with the war effort—relented and made the necessary assignments. But in the field of competitive business, where the spur of patriotism is no longer effective, such a situation might well have led to complicated and expensive litigation.

This is so only because many employees have but the faintest notion of their rights and obligations. As a consequence, they may be entirely unreasonable in their demands, or they may foolishly bargain away valuable rights. Likewise, many employers are totally ignorant of their legal rights. Or, in other cases, they are so well acquainted with them that they obtain inequitable contracts from uninformed employees.

The subject is not a simple one. It has often led to considerable bitterness and incrimination between employer and employee. But much of this unpleasantness can be avoided if both parties are familiar with a few controlling concepts at the time of hiring.

First the contract, then the invention

The interests of the employee and employer, in so far as patent matters are concerned, are often contrary. After an invention is made, each may well feel that he is entitled to the accruing rights and benefits. For this reason alone, it is much better that a clear contractual arrangement be established at the beginning of the relationship. This does not mean that any contract which one of the parties may—by force, coercion or a greater knowledge—foist onto the other will be enforced by the courts. But a fair contract, executed with general equitable principles in mind, will eliminate to a large degree those sources of difficulty which cause controversies when neither party has previously considered the problem.

The situations which arise fall into two general categories: first, where the parties have no written contract defining their relative rights in inventions, and second, where a contract provides for such matters.

Where no contract has been entered into, the parties are bound by the common law, which holds that their respective rights are dependent upon the nature and purpose of the employment. The clearest case is, of course, one where an employer hires an employee to invent or develop a certain thing. Here, it is normally understood that the employee is being paid for his ability to develop or invent, and that a part of his wages or salary is being paid for just that ability. In such instances the law is clear, that the employer is entitled to any inventions so made, and may require an assignment of any resulting patent. The employee, having received his wages, is entitled to nothing more. However, in these cases the Supreme Court has held that it must be very clear that the employee was assigned to invention or was expected to invent.

At the other end of the scale is the situation where an employee, hired by an employer engaged in a particular business, makes an invention on his own time and with his own materials, in an entirely different line of endeavor. In this case, the law is equally clear, that the employee is entitled to all of the rights in the invention and the patent, and the employer to none.

Unfortunately, most cases fall somewhere between these two. The employee, not hired to invent, makes an invention useful in his employer's business, on the employer's time, or with the employer's material. The employee, hired to invent, makes an invention on his own time in an unrelated field. The employee, not hired specifically to invent, but in a position to become familiar with his employer's business and product, makes an invention useful in the business.

These, and related questions, require an objective view, a consideration of the position of both parties, and often lead to an application of the much misunderstood doctrine of "shop rights."

A shop right may be briefly defined as the right of an employer to use an invention (a non-exclusive license) in his business, without further compensation, if the invention is made by an employee, on the employer's time and with his material, and is useful in the employer's business. This appears entirely equitable, as it permits the employer to use the thing which his facilities and money have made possible, and which he has essentially requested the employee to produce. However, the employee retains title to the patent, and may assert it against all except his employer.

The shop right doctrine is not made entirely clear in the many opinions discussing it. Some seem to require that the employee must have permitted the employer to use the invention—either expressly or by silent acquiesence—before the shop right arises. It is felt that the better view would not insist upon this requirement, for in the normal employer-employee relationship, suggestions and improvements are a part of what both expect the employee to furnish the employer. In other words, neither expects the employer to furnish his time and materials and to pay a salary to a workman, if the man is likely to use the results of his endeavors contrary to the interests of his employer.

Other difficult questions arise when an invention developed by an employee has application not only to his employer's business, but also to other fields of endeavor. In this situation, the courts will normally hold that the employee is entitled to the application of the invention to other fields, even though the employer may have rights to the use in his business. Thus, where an employee was requested to develop an electronic device for sorting cigars, he was entitled to file independently for a patent covering an application of the same invention to the sound recording field.

Limitations as to the time at which an invention is made, as well as its industrial application, are also important. Generally, an employee is entitled to an invention made after the employment is terminated, in the absence of contract. However, the courts will look with suspicion on inventions applicable to an employer's business made very soon after such termination. And it is obvious that an employee should not instigate a termination to claim the benefits of an invention which he has already made, or which is essentially completed. Nor may an employee claim an invention to which his employer is otherwise entitled, merely because it was perfected after hours.

Thus far we have been concerned with the rights to inventions where there is no question as to whether the employee is the inventor. Somewhat different, but associated, problems arise in determining whether the employer or the employee actually made the invention. Parenthetically, it should be noted that a patent, to be valid, **must** be applied for in the name of the person or persons who made the invention, and that a patent can only be applied for by a person or persons —and not by a company or corporation.

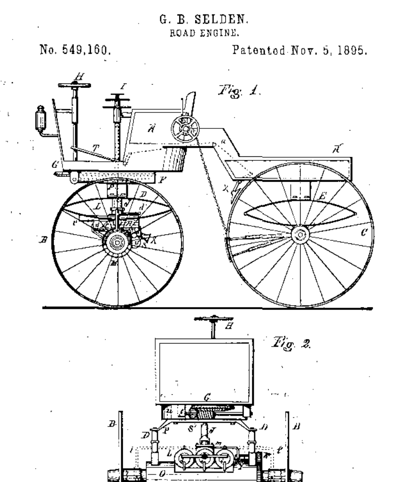
The question of who made the invention is solved by determining whether a problem was assigned for solution, or whether the employee was merely requested to construct a practical and efficient means or method of embodying a problem already generally solved. In the former case, since the employee actually solved the problem and made the advance in the art, he is the inventor—irrespective of whether the employer may be entitled to a shop right or an assignment. In the latter case, the employee is not an inventor, unless his final embodiment so departs from the originally developed idea as to incorporate an entirely different principle of operation. But minor improvements suggested by the employee, and embodied in the final invention, belong to the employer. This doctrine was stated by the Supreme Court of the United States as early as 1868.

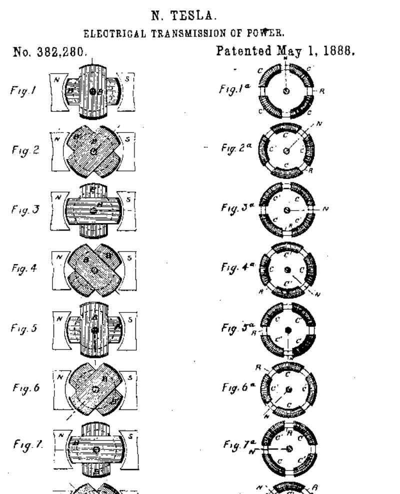
This indicates the desirability of having a written employment contract containing specific provisions with regard to inventions. It not only insures a consideration of the problems at the time of employment, but may well subsequently avoid exaggerated cases of "bad memory" or misunderstanding.

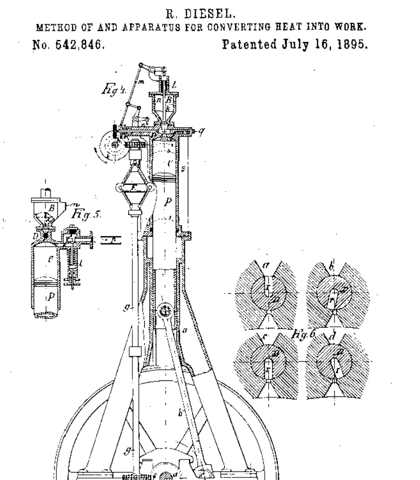
Most courts will naturally uphold any reasonable contract in this connection. Thus, a contract to assign all inventions dealing with the employer's business will be specifically enforced—particularly as against an employee who is hired to invent, or who may reasonably be expected to do so. It would not seem advisable or equitable to have such a contract apply to unskilled persons—janitors, office workers, laborers, drivers, etc.—although it would probably be valid.

Some courts have upheld contracts to assign all future inventions in a particular field, if the consideration received by the assignor is sufficient. But a written contract with an employee, to assign any and all inventions in any field at any time in the future, is unenforceable, on the ground that the employee would be prevented from ever getting other employment.

As said by one court, "A naked assignment or agreement to assign, in gross, a man's future labors as an author or inventor—in other words, a mortgage on a man's brain, to bind all its future products—does not address itself favorably to our consideration." And,







although contracts to assign all subsequent inventions in a given field, or all improvements on existing inventions, will be enforced, if reasonable, they will be strictly construed. It is felt that contracts of this nature should be limited, in time, to improvements on existing inventions, and should certainly not extend for more than one year after termination of employment.

What constitutes a contract?

One other aspect of the employer-employee contractual relationship deserves mention. The basic contract law generally requires that each party to a contract give or promise something he was not already bound to give or promise, in order that the contract may be held valid. Thus, as to **existing** employees, a mere agreement by the employee to assign future inventions, without any additional payment or consideration, has doubtful validity, because the employee receives nothing for his promise to assign. Several ways of overcoming this doubt—by coupling the agreement with a raise in salary, a bonus, or a promise to continue employment for a specified period—may be worked out. But the difficulty does emphasize the practical necessity of inserting provisions concerning patent rights in the original contract of employment.

No easy formula for determining the respective rights in these relationships can be evolved. A committee of eminent lawyers—appointed by the Section of Patent, Trade-Mark & Copyright Law of the American Bar Association—recently agreed that an employer could fairly require assignments of inventions made by employees hired to invent and those hired for other duties and placed in a position of confidence, where inventions are likely to result. But the committee also stated:

> ". . . special factors involved in operations of different employers make it impossible to arrive at any general formula applicable to all employers. Even in the case of individual employers, it is difficult to provide a formula applicable to all situations without creating injustice and serious internal friction."

This committee's report goes on to recommend to employers and employees alike a consideration of those factors held of primary consideration in the Second Report of the National Patent Planning Commission. That Commission set forth two basic common law rules, and urged their adoption as a part of the employment contract:

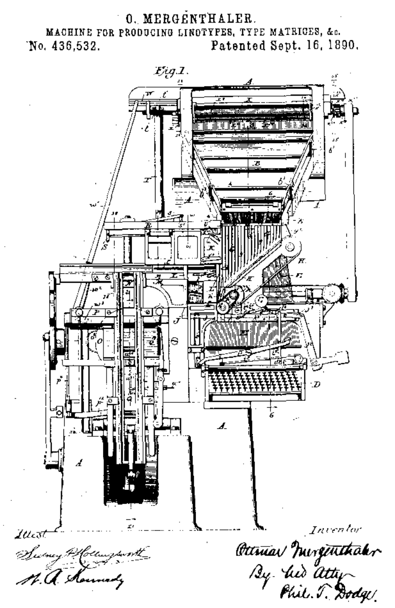
(a) Inventions made within the specifically designated duties of the employee shall be assigned to the employer since he has only produced that which he was employed to invent;

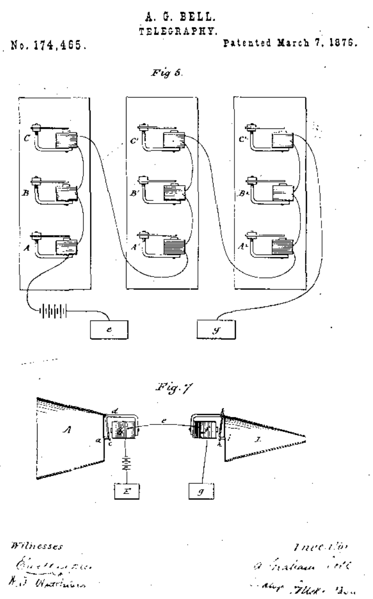
(b) Inventions made by an employee on his own time, without the use of his employer's facilities, and in a field unrelated to his employment, shall be the exclusive property of the employee, who shall be entitled to all patent rights.

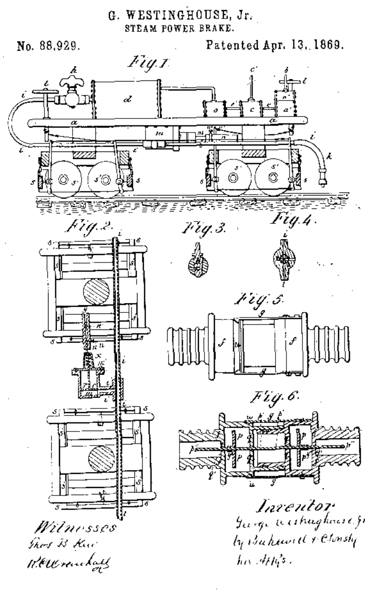
As to other inventions, the Commission(which was concerned with governmental inventions, but whose recommendations would seem equally applicable to private employers) said:

> "It is in the area not covered by (a) and (b) above that the least uniformity exists in Government practice because of the many variables involved. Within this area it does not seem practicable to devise a uniform law or order which could equitably apply to the many combinations of circumstances which can, and do, arise. The conditions of employment under which the inventions may be developed; their relationship to Government work; the character of the contribution of the inventor; the needs of the agencies and of the Government as a whole, and probably contribution to the public welfare—all are variable factors, and a great degree of flexibility is necessary. Accordingly, the Commission concludes that it should be left to the agencies initially to determine the action which will best serve the interests of the public, the Government as represented by the agency, and the encouragement of inventiveness by the employees."

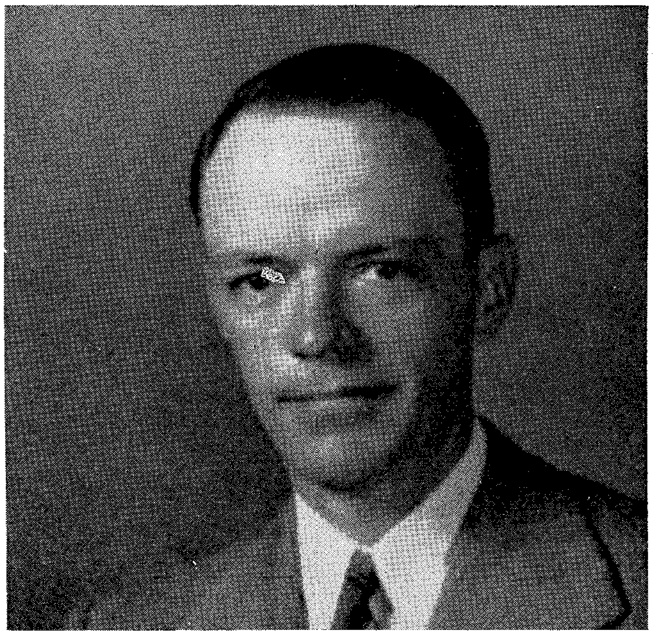
The law is clear when the employee is hired to invent, and also when he develops an idea not concerned with his employer's business, and with his own time and materials. It is the situations in between which are fraught with difficulty, and which demand contractual agreement at the time of hiring. Being a source of practical and psychological friction, these are problems in human relations as well as business and law. And any attempt at their solution has an infinitely greater chance of success if steps are taken before unpleasant, expensive controversies arise.







THE MONTH AT CALTECH



Hallett D. Smith will be the new Chairman of the Division of Humanities, succeeding Prof. C. K. Judy who retires July 1.

NEW CHAIRMAN FOR HUMANITIES

DR. HALLETT D. SMITH, '41, Professor of English at Williams College, Williamstown, Mass., has been appointed Chairman of the Division of Humanities and Professor of English at Caltech. He suceeds Professor Clinton K. Judy, Humanities Chairman since 1923, who is to retire on July 1 to become Professor Emeritus of English.

Dr. Smith, a native of Chattanooga, Tenn., received his B.A. degree from the University of Colorado and his Ph.D. from Yale. An authority on Elizabethan literature, he spent a year at the Huntington Library recently (1947) doing research under a Guggenheim Fellowship, on the history of Elizabethan non-dramatic poetry. Dr. Smith, who has been on the faculty of Williams since 1931, will come to Caltech following the 1949 summer school session at Columbia University in New York, where he is to give two courses in the Graduate School.

HUGHES FELLOWSHIPS

HOWARD HUGHES last month established a series of fellowships in creative aeronautics at Caltech, intended to develop engineers capable of dealing with problems of advanced theoretical aeronautics. The primary objective of the fellowships, says President DuBridge, is to "remedy a shortage in a class of engineers upon which the future development of aeronautics depends."

Two or three men will be chosen annually for a program of work which will be divided between Caltech and the Hughes Aircraft Co. in Culver City. Each fellowship will be worth a minimum of $5,000—$1,500 to Caltech to cover tuition and research expenses; $1,500 or more to each fellow (depending on individual qualifications); and a salary of not less than $2,000 to each fellow for advanced development work at the Hughes plant.

Applications must be submitted before Feb. 15, and announcement of the awards is to be made on April 1. Those selected will begin the program on July 1, with a ten-week advanced development project at Hughes Aircraft.

TWO PROMOTIONS

DR. HERSCHEL K. MITCHELL, one of a group of scientists to first isolate the vitamin folic acid, a curative factor in dietary deficiency, has been promoted from the rank of Senior Research Fellow to Associate Professor of Biology. Dr. Mitchell, who came to Caltech as research fellow in 1946, has also played a major role in the synthesis of pantothenic acid, another vitamin essential to health. And last spring, working with Research Fellow Joseph Nyc, Dr. Mitchell synthesized a new chemical compound, 3-Hydroxyanthranilic Acid. This substance is important in reactions which make it possible for the body to convert tryptophane, an indispensable amino acid, into nicotinic acid—which acts to prevent pellagra. At present, Dr. Mitchell is continuing his research in chemical genetics—the relation of genes to enzymes and chemical reactions.

Dr. Robert B. Leighton, Research Fellow, has been promoted to Assistant Professor of Physics.

Dr. Leighton designed and built the first cloud chamber to operate successfully with free-flying balloons. The chamber made its initial flght from a Colorado peak in 1947, photographing cosmic rays at an altitude of 85,000 feet.

Dr. Leighton, who graduated from Caltech in 1941, received his M.S. in 1944, his Ph.D. in 1947, and has been a research fellow here since that time. During the war he served with the Naval Experimental Station at Inyokern, on the design and development of aircraft rocket launchers. He is now working with Dr. Carl Anderson on meson studies.

SEISMOLOGISTS TO NEW ZEALAND

DR. BENO GUTENBERG, Professor of Geophysics and Director of the Seismological Laboratory, and Dr. Charles F. Richter, Associate Professor of Seismology, are leaving this month to attend the Pacific Science Congress in New Zealand in February. The month-long Congress includes alternate weeks of seminars and trips to different localities of New Zealand for scientific study. About 50 U. S. scientists will be at the Congress, which is meeting for the first time since the war. In peacetime the Congress meets once every three years to discuss various problems related to the Pacific areas. The last session was held at Berkeley, in 1939. This year's Congress in Auckland will include sessions on Geology and Geophysics, Meteorology, Oceanography, Zoology, Forestry, and Public Health.

Dr. Gutenberg, who has been invited to attend the Congress by the Royal Society of New Zealand, of which he is an honorary member, will deliver a paper on "Geophysical and Geological Observations in the Pacific Area." Dr. Richter's paper is to report on "Seismicity and Structure in the Pacific Region of North America."

PROFESSOR OF PALEONTOLOGY

DR. CHARLES W. MERRIAM has joined the Division of Geology as Associate Professor in Invertebrate Paleontology. The son of John C. Merriam, distinguished paleontologist and president of the Carnegie Institute of Washington, Dr. Charles Merriam received his bavhelor's degree from the University of California in 1928, and his Ph.D. from there in 1932. He taught Paleontology and Stratigraphy at Cornell from 1934 to 1944 and has been working since then for the U. S. Geological Survey. He came to Caltech January 3.

FORD FOUNDATION

DR. CHARLES C. LAURITSEN, Professor of Physics, is one of a committee of six distinguished educators requested by Henry Ford II to undertake an intensive study to determine "the areas of human welfare in which the resources of the ($205,000,000) Ford Foundation can be most effectively expended."

The Ford Foundation, largest public trust in the United States—and probably the world—was created in 1936 by the late Edsel Ford "to receive and administer funds for scientific, educational and charitable purposes, all for the public welfare." Its assets, contributed almost entirely by the late Henry Ford and Edsel Ford, include 81.2 per cent of the stock of the Ford Motor Company. When the late Henry Ford's estate is settled it will own 89.4 per cent.

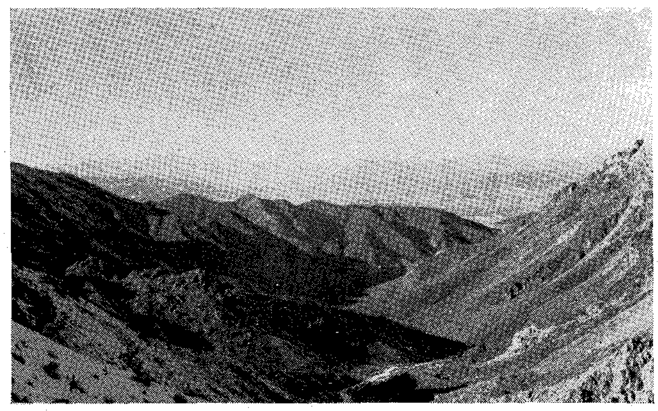
Aside from Dr. Lauritsen, who represents the natural sciences on the committee which will undertake this study for the Ford Foundation, advisers in respective fields include: Peter Odegard, University of California (Political Science); Thomas H. Carroll, Syracuse University (Business); Donald G. Marquis, University of Michigan (Social Sciences); Francis T. Spaulding, Commissioner of Education of New York State (Education); Dr. T. Duckett Jones, Harvard Medical School (Health).

The committee is expected to report its findings and recommendations by midsummer. While the scope of the study is unlimited, special emphasis is to be placed on inquiries into the social sciences, the natural sciences, and education.

HONORS FROM COLUMBIA

DR. THEODORE VON KARMAN, director of the Guggenheim Aeronautical Laboratory, has been made an honorary professor of mechanical engineering at Columbia University—the third person to receive such a distinction in Columbia's history.

GEOLOGISTS EXPLORE WASTELAND



A desolate waste contains the key to a major geologic fault.

DR. RICHARD C. JAHNS, Associate Professor of Geology, and Dr. A. E. J. Engel, Assistant Professor of Geology, spent part of the Christmas vacation in the Avawatz Mountains, in one of the few unexplored areas left in the United States. This was no holiday, though. The desolate area, some 40 miles south of Death Valley, has only one known spring in it, no trees, and very few bushes. According to Jahns, "even a jack-rabbit would have a tough time living there."

Jahns and Engel got a start on what will be the first complete survey to trace the active Garlock fault, sister of the infamous San Andreas fault, which has been responsible for California's worst earthquakes. Because the area has never been mapped except from the air, geologists have had to speculate as to the course of the Garlock fault. In making their survey Jahns and Engel may also discover what geologists have long suspected, that this area contains the key to some of the most important regional geological structures in the southwest.

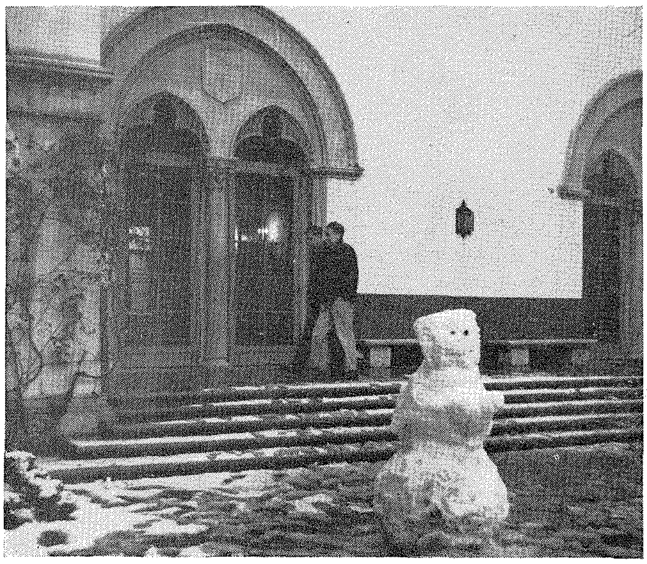
On January 11, morning after the big "blizzard," Caltech's campus and mountains looked like a New England winter scene.

THE BIG SNOW

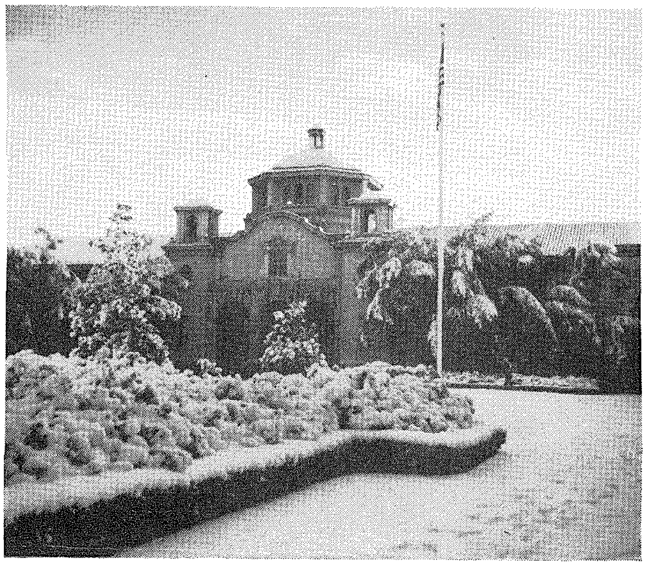
A pictorial record of some very unusual weather

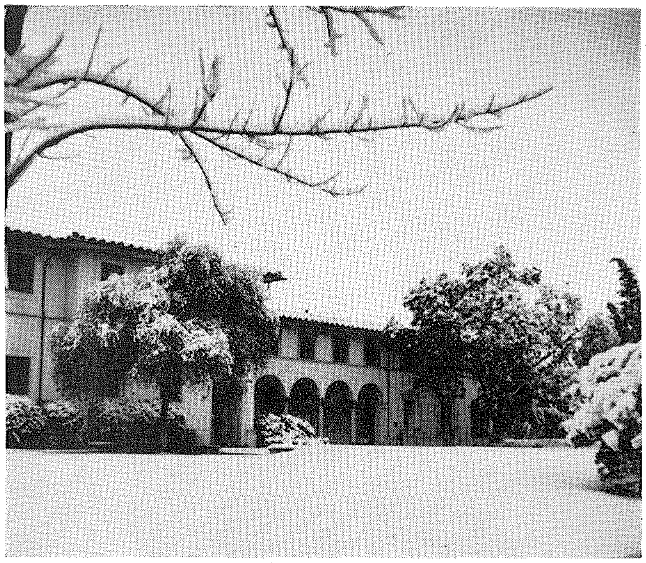
Pictures by Hugh Stoddart

Inexperienced sculptors made a limp, short-lived snowman.

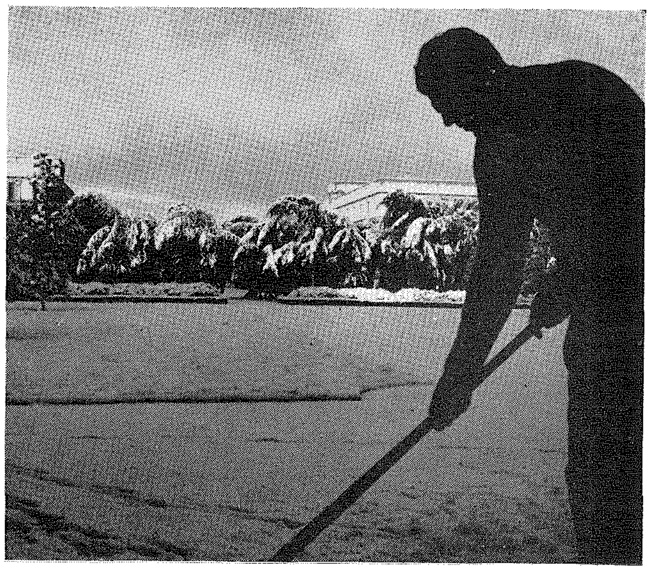


Throop Hall looked wintry at 10 a.m.; snow melted by noon.





Student houses got their share of Pasadena's four-inch fall.



Shovelling out wasn't very hard; but, still, it was necessary.

Olive trees between Throop and Athenaeum had an unfamiliar look. So did one student who appeared in a raccoon coat.

Books

THE UNIVERSE AND DR. EINSTEIN

by Lincoln Barnett: With a foreword by Albert Einstein
William Sloane Associates, New York 127 pp. $2

by H. P. Robertson
Professor of Mathematical Physics

I SUPPOSE EVEN THE MOST pessimistic of scientists must admit that the tenor of science reporting to the general public has improved remarkably during the past couple of decades. Further evidence of this improvement is to be found in this excellent little book by Lincoln Barnett, a somewhat elaborated form of a series of articles of the same title which appeared recently in Harper's Magazine.

Mr. Barnett has quite appropriately chosen to weave his popular account of the rise and meaning of the quantum and relativity theories about the dramatic personality of Albert Einstein. His general thesis is that these developments—for so much of which Einstein is responsible—herald the retreat from a mechanistic "explanation" of the physical universe to an abstract mathematical "description" of it. In support of it he makes a praiseworthy, and, in the opinion of this reviewer, successful attempt to tell what aspects of experience the newer theories deal with—and even to explain their proposed solutions in words that he who has forgotten (or never knew) their differential equations may yet understand. The book should inspire those who can to go further in their exploration in this most exciting of intellectual territory; for them Barnett adds at the end of his account a "Reader's List," as a kind of Baedeker to guide them.

He begins with an account of the origins, around the turn of the century, of the quantum theory, whose principal domain is the **microscopic** world of electrons and protons, and the other primary or secondary units into which the physical content of the universe can be broken down. Here the trend of greatest philosophical interest is found in the surrender of classical concepts of casuality and determinism, resulting in the attribution to these units of the apparently contradictory properties of both particles and waves.

Turning then to the other great field, of relativity, Barnett gives a good non-technical account of the origins of the special theory. Here the theme of the trend toward abstraction is supported by the special relativistic requirement that the old picture of a physical world extending in three dimensions and enduring in time be surrendered in favor of a world existing in a four-dimensional space-time. Which results in the well-known curious behavior of (other people's!) clocks and measuring rods, and in the rejection of the classical Newtonian notion of absolute simultaneity.

Following the path taken by Einstein from 1905 to 1915 in his attempts to extend the relativity of observers moving with constant velocities to those which are accelerated, Barnett renders as painless as possible the transition to the general theory of relativity. This theory, dealing as it does with the **macroscopic** aspects of the physical universe, leads in turn to the cosmological problem of the nature of the physical universe as a whole. And thus smack into the theory of the expanding universe, so much of which was developed here at Caltech in the investigations of the late Dr. Tolman, and in the observations of Dr. Hubble and his associates at the Mt. Wilson Observatory—and on which we confidently expect much new light to be shed by the new Palomar Observatory. In a very few pages Barnett describes the current attempts of Gamow and Whipple and others to introduce into this relativistic frame an evolutionary cosmogony of the birth and being and death of stars and nebulae.

Barnett has now a quantum-theoretic description of the **microscopic** aspects of the universe, and a relativistic account of the **macroscopic;** he pins the hope of reconciling these two apparently disparate aspects of reality on Dr. Einstein's lifelong search for a unified field theory which will encompass both gravitation and electricity, both nebulae and neutron, in one single universal frame. Mr. Barnett has done him and science a genuine service in presenting this excellent and generally understandable account of the search and of the successes which have so far come out of it—even though from Dr. Einstein's point of view they may be but by-products gleaned on the way. Best wishes to Dr. Einstein on his 70th birthday; may it be crowned by the final success which his long search deserves!

THE ROAD TO REASON

by Lecomte du Nouy
Longmans, Green, and Co., New York 254 pp. $3.50

by P. S. Epstein
Professor of Theoretical Physics

IT IS GENERALLY AGREED that the moral education of our youth does not keep pace with the scientific. This fact has become one of the gravest social problems of our time, and is usually attributed to the waning influence of religion, which serves as the foundation of morality in our Western civilization. What the author of this book craves and what he calls "The Road to Reason" is a more balanced world view in which the equilibrium between science and religion would be reestablished.

However, the way in which Lecomte du Noüy tries to attain his goal will hardly meet with the approval of critical scientists. The bulk of the book is devoted to an attempt at depreciating modern science, which is accused by him of a failure to give "understandable explanations" of atomic phenomena; to define "the difference between life and death"; to explain "the origin of life."

The first of these accusations may be treated briefly here, although it accounts for a large part of the book. It does not mean much to say that the explanations given by the modern quantum theory are "mathematical and unsatisfactory to the understanding," since Lecomte does not take the trouble to define the criterion of **understanding** and **explaining.** His discussions evince a vague kind of uneasiness in the face of the revolutionary character of modern science, especially of the principle of indeterminacy. This attitude was fairly common in the popular scientific writings of from fifteen to twenty years ago, but it is now antiquated, because the profundity and logical consistency of the new point of view has been recognized even in the popular press.

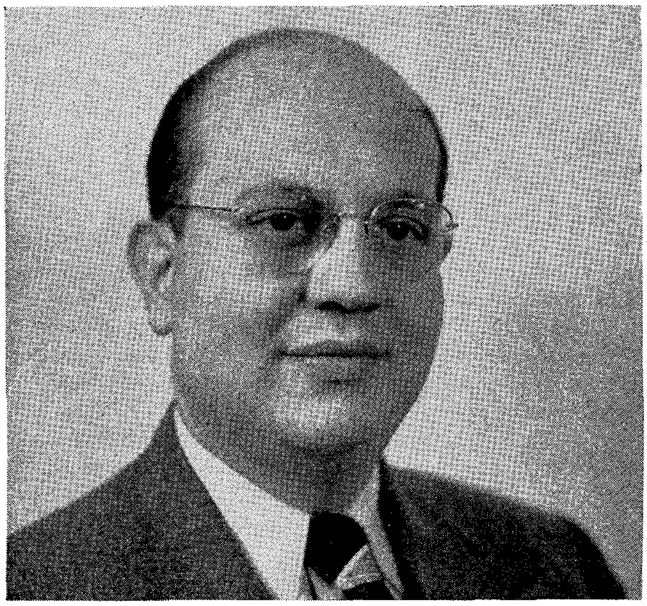
More definite and detailed are Lecomte's criticisms of modern science in connection with the problem of the **origin of life.** He puts the question whether one of the simplest building stones of living matter, a protein molecule, could have originated in nature by pure chance. He cites the French writer Charles-Eugene Guye, who published in a popular scientific book an estimate of the probability of the formation of such a molecule. As calculated on purely geometrical lines, the probability comes out so extremely small that it amounts to a practical impossibility. Hence, our author concludes that life could not have originated without supernatural interference.

According to the publisher's blurb, the late Pierre Lecomte du Noüy held the degrees of Ph.D. and Sc.D. He must have been well versed in some branches of science. But his qualifications did not include an understanding of statistical mechanics, any more than a knowledge of quantum theory, or else he would have known that the frequency of occurrence of a physical system is not determined by its absolute geometric probability. Indeed, the pertinent probability is that which prevails under certain subsidiary conditions, of which the most important is that it must correspond to the smallest possible internal energy of the system. In the cases where such a calculation can be completely carried through, the energy condition turns out to be so important that it often entirely reverses the result. States which are extremely improbable as long as this condition is neglected prove to be the only possible ones when it is taken into consideration.

Thus Guye's calculation has very little relation to the actual problem. In the present state of our knowledge we cannot say whether life on this planet could have originated by chance or not; the answer must be left to the future. Lecomte's contention that a natural origin is impossible is an example of the very intransigent dogmatism with which he reproaches the scientists.

Equally unrewarding are the passages of the book which touch upon religion. The author admits that its recent decline is at least in part due to the shortsightedness of the religious leaders, who, underestimating the power and usefulness of science, bitterly fought its progress instead of using it as their tool. But the reader would look in vain for any practical suggestions as to how religion could reconquer the lost ground. On the whole, it is fair to say that Lecomte's book does not bring the problem of the "Road to Reason" any nearer its solution.

ALUMNI NEWS



A. M. Zarem is 1948's Outstanding Young Electrical Engineer.

HONORED BY ETA KAPPA NU

DR. ABE MORDECAI ZAREM, M.S. '40, Ph.D. '44, manager and chairman of physics research for the Stanford University Research Institute in Los Angeles, has been selected the Outstanding Young Electrical Engineer of 1948 by Eta Kappa Nu, national honor society for electrical engineers.

The Eta Kappa Nu Recognition Award is made annually "for meritorious service in the interest of (his) fellow men" to an electrical engineer no older than 35 who has been out of college for no more than ten years. On January 31, Dr. Zarem will receive a plaque at the Recognition Dinner to be held at the Henry Hudson Hotel in New York, during the winter meeting of the American Institute of Electrical Engineers.

Dr. Zarem was valedictorian of his class, and was named Honor Man of All Departments when he graduated in 1939 from the Armour Institute of Technology (now the Illinois Institute of Technology). He was given a graduate scholarship in electrical engineering at Caltech, and while working for his M.S. he served as an instructor in physics, electrical engineering and mathematics. Under the direction of Dr. Royal W. Sorenson, Zarem received his doctorate **magna sum laude** for research on the physical properties of the electric spark.

He then became research and development engineer for the Allis-Chalmers Manufacturing Co. in Milwaukee. There Dr. Zarem invented what he called "an automatic oscillograph with a memory," an automatically operated camera used to study electrical transients at irregular and unpredictable intervals.

In May, 1945, Dr. Zarem returned to Caltech as a research engineer and group leader for the Manhattan District Project, in work connected with the atomic bomb.

He then joined the staff of the United States Naval Ordnance Test Station at Pasadena, and in January, 1947, was named to head the electrical section of the newly formed physical research division. Here he continued his study of transient electrical discharges and of a method for photographing them. His development of an electric-optical shutter and camera-control, capable of sub-microsecond effective exposure times, opened the field of "synchronized microtime photography" for the United States Navy.

His invention of the Zarem camera, with a framing rate up to 100,000,000 per second and effective exposure time down to 0.000,000,001 second, is probably his outstanding achievement. This camera is used to study intense light sources and other phenomena. Synchronization of camera operation and occurrence of phenomena to within 0.005 microsecond has been accomplished.

In the past few years, Dr. Zarem has been acting as consultant to industrial and governmental organizations in such varied fields as electro-magnetics, transient electrical studies, gaseous discharge phenomena, oscillography, and electronic pulsing techniques. He also has conducted test work on equipment for measuring blast pressures, and electrical breakdown characteristics of natural minerals, plastics and oils.

In his present position as manager and chairman of physics research for the Stanford Research Institute, Dr. Zarem is responsible for the co-ordination of technical and administrative activities of his office in such fields as acoustics, electricity, magnetism, light and optics, spectroscopy, analytic mechanics, and heat transfer.

The Eta Kappa Nu award which Dr. Zarem has received is given not only for technical ability and accomplishments, but also for interest in cultural and civic advancement. Dr. Zarem rates high here too. He is an associate of the Pasadena Playhouse, a music lover and devotee of the opera, an avid reader, an amateur woodworker, an expert photographer, and a pretty fair limerick writer. He lives in Pasadena with his wife, the former Esther Merritt, whom he met at the Armour Institute, and two children—Janet Ruth, three years old, and David Michel, not yet one.

DINNER-DANCE

THE NEXT EVENT scheduled by the Alumni Association is a dinner-dance to be held at the Oakmont Country Club on Friday, March 4. John Farneman, dance chairman, has planned a full evening, including organ music from seven to nine p.m., dinner at eight, and dancing to Hal Lomen's orchestra from nine to twelve p.m. The bar will be open from seven o'clock on. The affair is to be semi-formal. Members of the dance committee: Carl Friend, Claude Davies, Gardy Wilson, Stan Wolfberg.

CRYSTALLOGRAPHER HARKER

DR. DAVID HARKER, Ph.D. '36, has been named to head a newly-formed Division of Crystallography at the General Electric Research Laboratory in Schenectady.

Crystallography, formerly part of the laboratory's metallurgical division, actually cuts across the fields of chemistry, electronics, and physics, as well as metallurgy. The work of the new division will center on problems of inter-atomic arrangement, particularly with respect to the structure of crystals.

Dr. Harker, an authority on electron microscopy, received his B.S. from the University of California in 1928. After receiving his Ph.D. at Caltech in 1936 he taught chemistry at Johns Hopkins University for five years. He has been at the GE Research Laboratory since 1941.

NEW AEC RESEARCH DIRECTOR

DR. KENNETH S. PITZER, '35, who has already distinguished himself as one of the nation's leading physical chemists, has been appointed Director of Research for the U. S. Atomic Energy Commission. Dr. Pitzer, who took over his new duties on January 1, was professor of Chemistry at the University of California. He had been a member of the faculty at Berkeley since 1937.

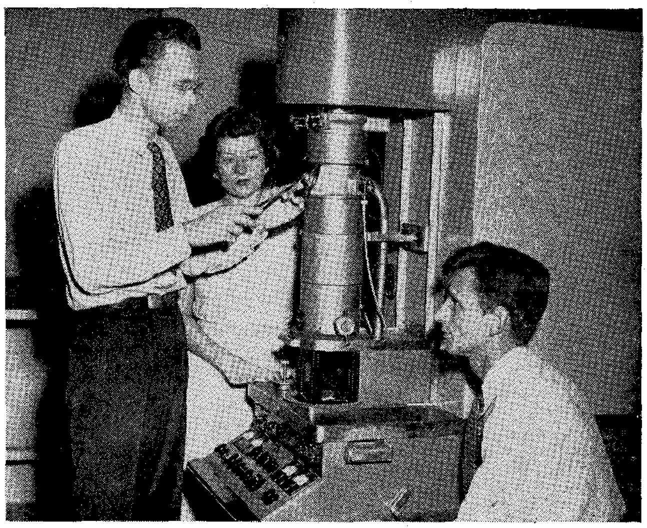
As Director of Research, Dr. Pitzer will have charge of the AEC's research program in the physical sciences, and supervise the administration of the isotope production and distribution program.

GENE PHOTOGRAPHER PEASE

DR. DANIEL C. PEASE, M.S. '38, and Dr. Richard F. Baker, both of the University of Southern California, reported this month that they had observed and photographed genes—the infinitesimal particles that transmit physical characteristics of living things from one generation to another.

Dr. Pease is Assistant Professor of Anatomy at the U.S.C. School of Medicine. Dr. Baker is Assistant Professor of Experimental Medicine. They made their observations with a standard electronic microscope on unprecedentedly thin cross-sectional slices of animal tissue. Chromosomes of the fruit fly, which are relatively large, were used in the experiments. By hardening the tissue specimen with paraffin, collodion, and air chilled by dry ice, and using a new cutting technique which they developed themselves, the two scientists obtained slices only 1/250,000th of an inch thick. Electrons were thus able to penetrate the tissue sections to reveal their structure.

Observation of genes has been an ambition of scientists ever since Gregor Mendel first indicated the existence of these smallest particles of life, almost a century ago. If these actually are genes which Pease and Baker have observed and photographed, their discovery will be of enormous importance to medical and biological research. To date, though, other scientists are skeptical, waiting for further proof before they agree that genes have finally been seen.



Pease (right) and Baker aim an electron microscope at genes.

Personals

1923

Hubert Woods has resigned from the Riverside Cement Co. in Los Angeles to become Director of Research of the Portland Cement Association at its new research laboratories in Chicago.

1928

Carl F. Renz, M.S., materials engineer for the Ohio Division of the U. S. Engineers, has been named President of the Cincinnati Section of the American Society of Civil Engineers.

1929

Thomas H. Evans, head of the Civil Engineering Department at Georgia Tech, visited the Caltech campus early this month.

William G. Young, Ph.D., a member of the UCLA faculty since 1930, and now Physical Science Dean at UCLA, has been elected chairman of the Division of Organic Chemistry of the American Chemical Society.

1936

Robert G. Parker, Ex-'36, petroleum engineer at Seal Beach, Calif., for the Continental Oil Company's producing and drilling department, has been promoted to the post of assistant district superintendent at Wichita Falls, Texas.

1938

Joseph F. Ware, Jr., M.S., reports he is a flight test engineer with the Lockheed Aircraft Corp. in Burbank.

Samuel E. Watson has returned from Venezuela where he spent seven years as a mining engineer for the Texas Company. He is now stationed in Bakersfield—still working for Texas.

Henry K. Evans, staff engineer of DeLeuw, Cather & Co., Consulting Engineers, has been appointed western representative of the firm, which has established a western office at 79 McAllister St., San Francisco.

1939

Edwin F. Sullivan, engineer with the U. S. Bureau of Reclamation in Sacramento, has been elected 1st Vice-President of the Sacramento Section of the American Society of Civil Engineers.

1940

Frank W. Brown, M.S., Lt. Comdr. with the Medical Service Corps, U. S. Navy, was married in October to Miss Sue Heath in Larchmont, N. Y. He is now assigned to the Radiological Laboratory at the San Francisco Naval Base.

C. Fink Fischer, M.S. '41, Comdr. U.S.N., is now with the Pilotless Aircraft Development Laboratory of the Naval Air Development Station in Johnsville, Pa.

Keith E. Anderson is with the Iowa Geological Survey in Iowa City.

Jerome Kohl resigned in December from the Tide Water Associated Oil Co. to accept a position as Chemical Engineer in charge of Industrial Application for the Western Division of Tracerlab Inc., 2295 San Pablo Ave., Berkeley. He writes:

"Tracerlab's headquarters are in Boston. The three basic elements of its business are Instruments, Radiochemistry, and Industrial Applications of Isotopes. The Western Division, which has just been opened, includes two other Caltech men on its staff: **Lloyd Zumwalt**, Ph.D. '39, Technical Director, and **Walton A. Wickett**, Ex-'37, in charge of sales."

(Continued on Page 20)

1941

Gilbert A. Jones was recently married to Miss Hazel May of Lynchburg, Va. They are living in Richmond, where he is employed as an office engineer by the Stone & Webster Engineering Corp., on power plant construction.

J. Vern Hales, M.S., heads up the new department of meteorology at the University of Utah, in Salt Lake City. Hales joined the university staff in 1946, after he returned from overseas duty with the Air Force weather service.

Quentin Elliott, M.S. '42, and Mrs. Elliott announce the arrival of a son, Quentin Benedict—on Christmas day.

1942

Phil T. Mahaffey, M.S., was married in October to Miss Sally Ruth Rettys in Fort Worth, Texas. He is with the Consolidated-Vultee Aircraft Corp. in Fort Worth.

Alvin R. Piatt was married in Los Angeles on December 31 to Miss Glenna Hartley. They are living at 2505 South Hope St., Los Angeles.

1943

Robert M. Francis is an equipment designer for Pacific Airmotive Corp., Burbank. He and his wife have a year-old daughter, Leslie Louise.

David Shonerd, M.S., '48, and his wife announce the arrival of their first child, a boy, on December 2. Dave is studying for an A.E. degree at Caltech and working at the Jet Propulsion Lab.

1944

Ray A. Saplis writes that he and **Delos Flint** '39 have been on Okinawa for the past two and a half years mapping the island for the Army. Visits have also been made to the other islands in the Ryukyus. They hope to return to the States this spring.

1945

Merritt A. Williamson, M.S., is Associate Director of Research and Development at the Pullman-Standard Car Manufacturing Co. in Hammond, Ind. He is living in Chicago.

1946

Fred Robins and his wife have a baby girl, Jan Marie, born in October. Fred is teaching Science and Math at Trona Unified Schools, Trona, Calif.

1947

Arthur J. Critchlow writes that he, **Jim Smith** '47, and **Louis Dameson** '44, are working with **Owen Olds** '44 on a U. S. Army guidance project at the Ryan Aircraft Corp. in San Diego.

William R. Bellew is studying at the Stanford Graduate School of Business.

Edwin J. Cowan was married in October to Miss Joyce Kullgren. He is working with the Day & Night Manufacturing Co. in Monrovia.

Bob Weidman spent the year after graduation at Indiana University, a summer doing geology field work with the Indiana Dept. of Conservation, and is now taking graduate work at the University of California, where he holds a teaching assistantship.

1948

M. D. Quigley is employed as a geologist with the Sinclair Oil Co. in Salt Lake City, Utah.

Index to Advertisers

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