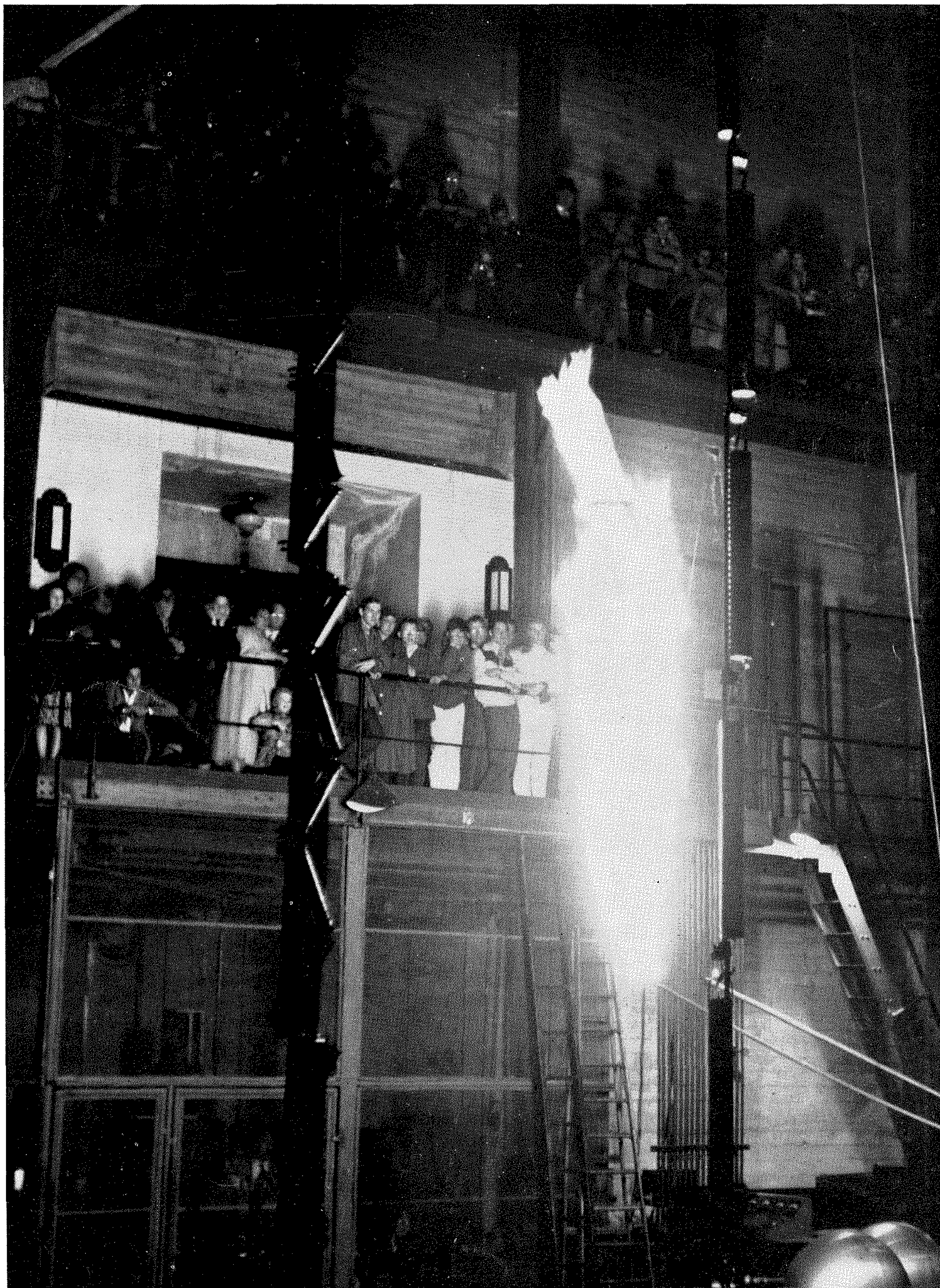
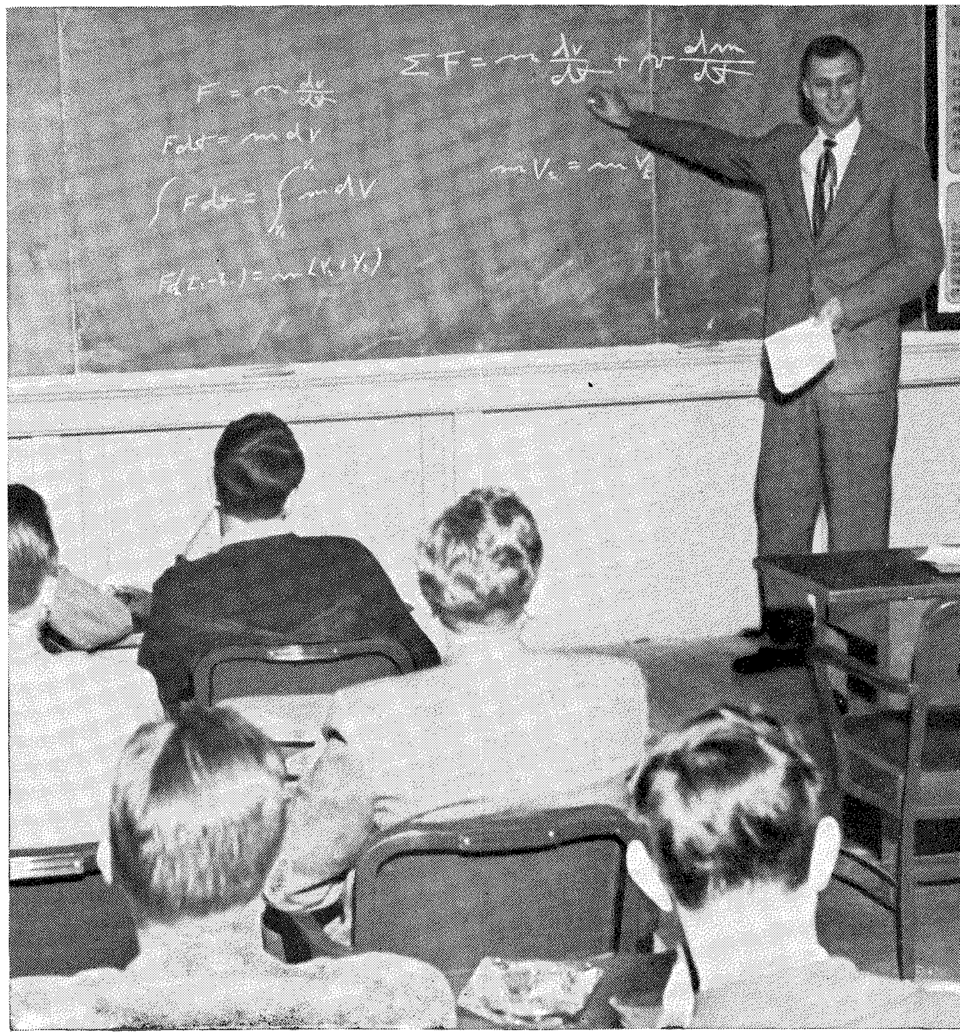
February 1949

ENGINEERING AND SCIENCE



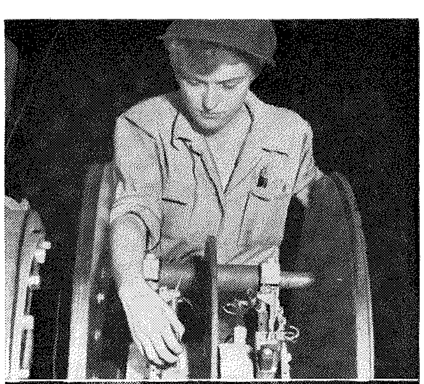
High voltage demonstration . . . page 16

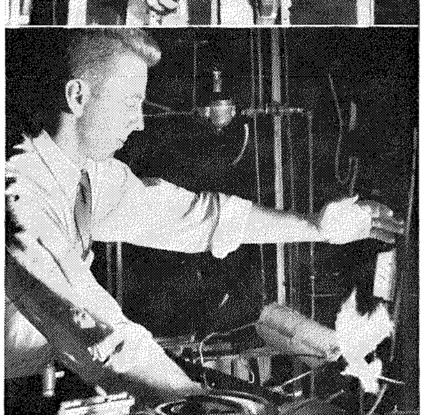
PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION



STUDYING WITH GENERAL ELECTRIC

In 1948, enrollments in G-E courses totalled more than 21 thousand





To graduate engineers, including women, General Electric offers further study in its "Test" Course, in its A, B, and C Courses of increasing specialization in engineering problems, or in its Sales Engineering Program. Business administration and liberal arts students study the broad list of subjects provided by the Business Training Course. There are other courses for advertising recruits, chemists, stenographers. Young people without college degrees may enroll in the company's Apprentice Training Program, offering training in subjects ranging from blueprint reading to applied metallurgy. All in all during 1948, the company provided free instruction in 96 courses, taught by more than 500 instructors. Total enrollments numbered 21,482. By developing new skills and new talents, G-E employees improve their jobs and increase their contributions to the quality of General Electric products.

You can put your confidence in

GENERAL ELECTRIC

ENGINEERING AND SCIENCE
Monthly

The Truth Shall Make You Free

IN THIS ISSUE

On the cover

The picture on this month's cover was taken at the recent Friday Evening Demonstration Lecture in the High Voltage Laboratory—details of which can be found on page 16. The particular demonstration shown on the cover is known as the horn gap, or Jacob's Ladder, and, just to prove that the camera can lie like anything, that isn't the way it actually looks at all.

The horn gap is used as a protective measure, a part of lightning arresters on transmission lines. As over-voltage is produced on a line it causes an arc by jumping a horn gap to another wire grounded through a resistance, thus preventing excessive voltage between wires. As the current jumps from one wire to the other, the air is heated by the arc, which carries the current stream upwards in ever increasing arcs until it runs out. On our cover these arcs appear as one continuous flame—the result of a time-exposure. Thus, at the expense of scientific accuracy, the camera was able to record some of the startled spectators' reactions to the spectacular demonstration. Hugh Stoddart took the picture.

Friday lectures

Speaking of demonstrations, these are the Friday Evening Demonstration Lectures scheduled for the remainder of the term. They're given in 201 Bridge, at 7:30 p.m., and are, of course, all open to the general public.

February 18—"Liquid Air", by Professor E. C. Watson

February 25—"Genes and Enzymes", by Professor N. H. Horowitz

March 4—"The Determination of Stress by Photoelasticity", by Professor George W. Housner

March 11—"The Kinetic Theory of Gases", by Professor R. A. Millikan

Spring Recess

April 1—"Rocks under the Microscope", by Professor Ian Campbell and R. von Huene

April 8—"Plant Growth Regulators", by Dr. S. C. Wildman

April 15—"Flow in Rotating Channels", by Professor R. T. Knapp

(Continued on page 2)

CONTENTS FOR FEBRUARY, 1949

ENGINEERING AND SCIENCE MONTHLY

Published at the California Institute of Technology

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IN THIS ISSUE--cont.

Sea water

Every week, as William W. Aultman says in his article "Fresh Water from Salt", we read somebody else's wide-eyed account of how we can solve all our water problems by reclaiming the salt water in the ocean for domestic, agricultural, and industrial use. Like a lot of other people, probably, we've been reading these stories for years—and waiting impatiently for the reclaiming to begin. Not until we read Bill Aultman's level-headed piece, however, did we get any practical information on the situation. When you read the facts about sea water reclamation in the Aultman story on page 3, you'll look at that next Sunday supplement story on the subject with a newly-jaundiced eye.

Bill Aultman is particularly well-qualified to write on the subject of sea water reclamation. After he was graduated from Caltech in 1927, Bill worked for two years as a geophysical engineer with the Radiore Co. in the western United States and Mexico. For another year he worked as a research engineer on carbon black investigation with the Electroblack Co., Inc.

In 1930 Bill went to work for the Metropolitan Water District. He did preliminary investigation, hydraulics study, and special preliminary research studies on the design and construction of the 100,000,000-gallon-a-day water-softening and filtration plant. Since 1941 Bill has been Water Purification Engineer for this plant, at La Verne, Calif., in charge of plant operations and studies—with the exception of the three years from 1943-45 when he was a Lt. Commander in a construction battalion of the Seabees.

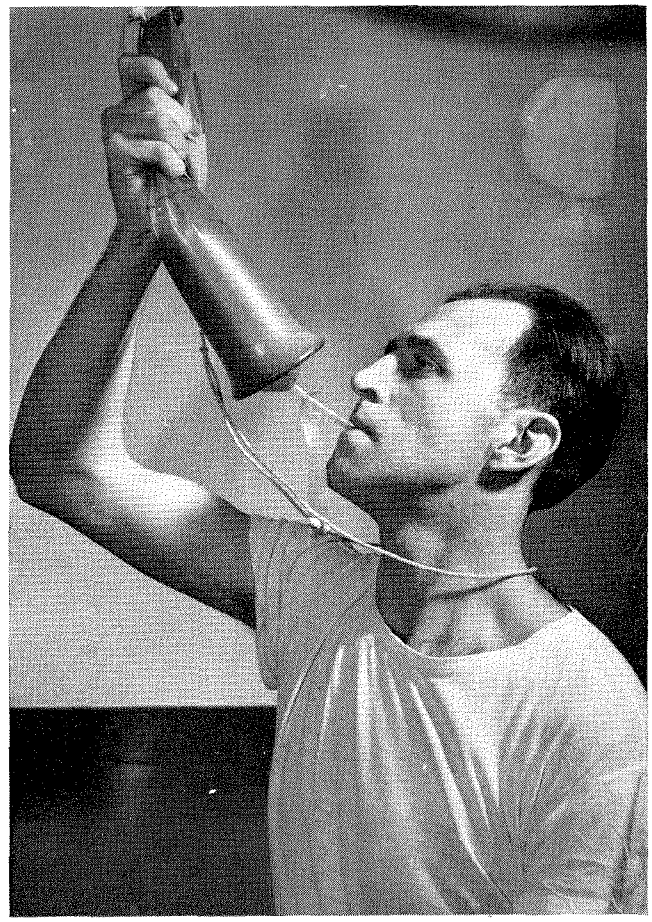
Picture Credits

Cover—Hugh Stoddart '49

pp. 3-7—Official U. S. Navy Photographs

p. 10—Hugh Stoddart, Ross Madden-Black Star, Hugh Stoddart

p. 16—Hugh Stoddart



Plastic processing bags, for converting sea water into potable drinking water, became standard life-raft equipment during the war.

Seawater reclamation is just around the corner? Here's the straight story on our chances of getting

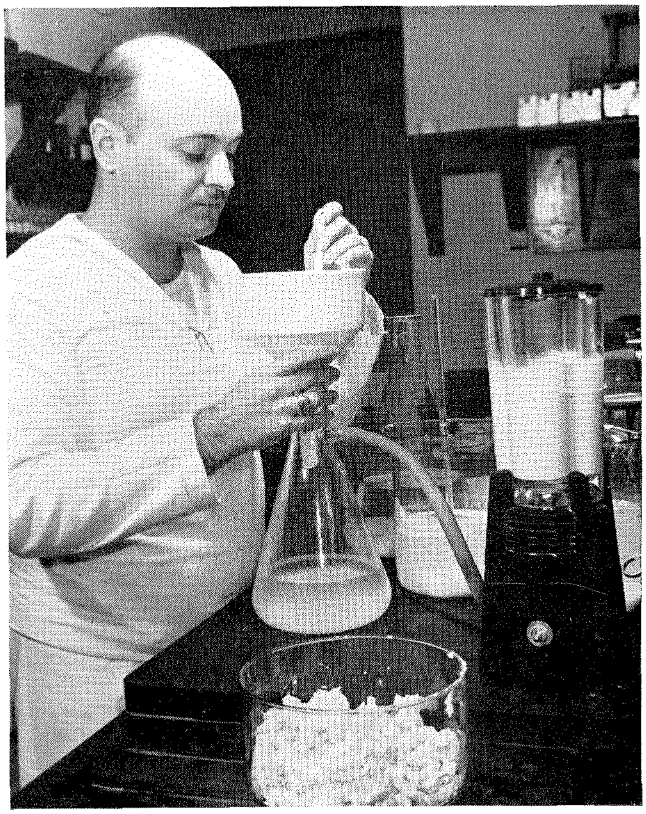
FRESH WATER FROM SALT

by William W. Aultman '27

THERE HAS BEEN A GOOD DEAL of publicity in recent months about the possibility of producing water for agricultural, industrial and domestic purposes from sea water. The publicity has been given added impetus by the severe drought conditions which have prevailed in the Pacific southwest. But what are the facts behind the publicity? A brief summary of some of the factors which affect this problem may help in evaluating the articles which now appear almost weekly.

Where cost is not a consideration it must be admitted that the reclamation of sea water is a possibility. A cost of $5.00 per pint for drinking water produced from sea water by the ion exchange process aboard life rafts was inconsequential when it meant saving men's lives. The entire supply of drinking and cooking water for over 30,000 Army and Navy personnel on Iwo Jima was produced by various types of distillation units, as was the supply aboard many ships and on other Pacific islands. The gallon of fuel that it took to produce from 15 to 85 gallons of potable water from sea water by such distillation equipment was a very small part of the cost of modern warfare, but even that cost was kept at a minimum by limiting the use of such water to 5 to 10 gallons per person per day. This compares with an average use around southern California of over 140 gallons per person per day. But when consideration is given to methods of producing domestic, industrial or agricultural water, cost is a primary factor.

A study made in 1931-32 by the California Division of Water Resources showed that irrigation water in southern California cost from $2.14 to $38.75 per acre foot, depending upon the location and the source of the water. An acre foot of water is that quantity which will cover one acre of area to one-foot depth, which is 325,851 gallons. Domestic water rates may be more than double these irrigation rates, for the distribution of such water to the consumer comprises a large portion of the retail sale price. Continued on page 4



Wartime workers at Naval Medical Research Institute developed method for producing drinking water from sea water.

Production of natural Colorado River Aqueduct water at present costs $12.00 per acre foot or 3.6 cents per 1,000 gallons, exclusive of interest and bond redemption. Ultimately this cost will be reduced to $8.00 per acre foot. At the present time, the approximate total cost of the untreated water, including interest and bond redemption, is about $20.00 per acre foot or six cents per 1,000 gallons. Softening and filtering this supply for domestic use adds another $10.00 per acre foot to the cost, bringing the total cost of treated water at present to about $30.00 per acre foot or nine cents per 1,000 gallons. This is the cost of the water available at relatively high elevations, from which little or no boosting is necessary to get it to the consumer. A sea water supply must be boosted from sea level to the desired elevation of use. In both cases the cost of getting the water to the consumer's tap must be added.

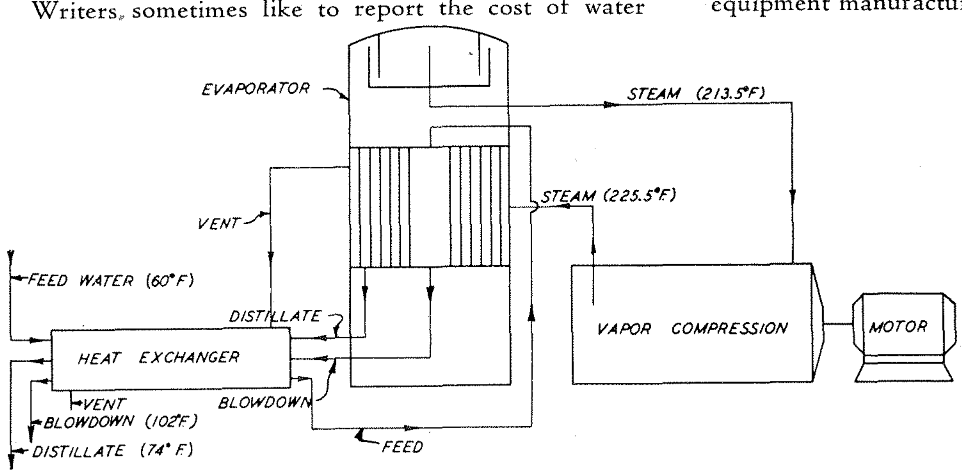
Writers, sometimes like to report the cost of water as so many cents per ton, because, in these terms, it sounds like a lot of water for very little money. A cost of five cents per ton for water is equivalent to $67.80 per acre foot or 20.8 per 1,000 gallons. So water costing five cents per ton is not **cheap** water.

A study of some of the methods which have been suggested for producing fresh water from sea water clearly indicates their economic infeasibility.

The method which presently appears to be the lowest in cost is distillation by multiple-effect evaporators in compression distillation. This type of unit is known as the "Kleinschmidt still", or as a vapor-compression or thermal-compression distillation unit. A good description of this type of equipment is given by Dr. Richard G. Folsom (B.S. '28, M.S. '29, Ph.D. '32) now Professor of Mechanical Engineering at the University of California in Berkeley:

"The compression distillation plant consists of three principal elements—the compressor, evaporator, and heat exchanger. The operation of the unit follows closely that of a normal household refrigerator, except that the latter is a closed system and the former is an open system. In the refrigerator the refrigerant is continuously circulated inside the equipment, where the compressor increases the pressure of the refrigerant and forces it through the system; the heat exchanger removes heat from the refrigerant and transfers it to the outside air, and the evaporator absorbs heat from the box, or area to be refrigerated, and adds it to the refrigerant—which in turn is pumped by the compressor to the heat exchanger, in order to transfer the heat to the outside.

"In the distillation system there is a continuous addition of raw water and a continuous drawing off of brine and pure distilled water. In operation the raw water (sea water) passes through the heat exchanger, where it absorbs heat from the distillate and brine, which in turn is discharged from the system at a temperature slightly above that of the incoming raw water. The hot raw water passes to the evaporator, where it mixes with a relatively large volume of recirculated brine, and heat is added. Steam is then formed at, or slightly above, atmospheric pressure, and is drawn off to the steam compressor, which is similar to an air compressor and raises the steam pressure by about three pounds per square inch and 10°F. The output from the steam compressor passes to the other side of the evaporator, where it is condensed by the removal of heat which is used to create steam from the incoming mixture of raw water and brine. The steam then passes to the heat exchanger, where it is cooled and discharged from the system as the distillate. In the portable equipment manufactured for Army and Navy purposes,



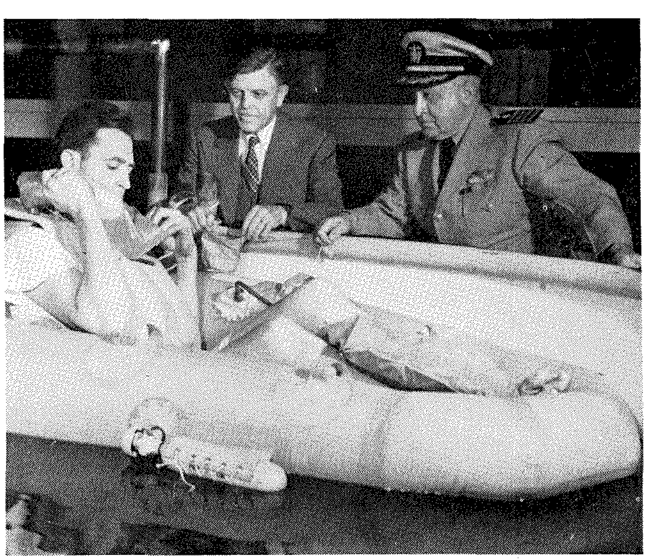
VAPOR-COMPRESSION DISTILLING UNIT: This method of converting sea water into fresh water—described in text above—appears, at present, to be lowest in cost.

the optimum performance appears to be between 175 and 200 pounds of water per pound of fuel, such fuel including the mechanical power to drive the compressor."

One of the major problems in operating vapor-compression distillation units has been the scaling of the evaporator and heat exchangers. As the scale builds up, the efficiency of operation decreases until it is no longer economical to continue the process. Present units have an operating history of about 700 hours before they must be shut down and cleaned. A unit which at the start of operation is able to produce 200 pounds of water per pound of fuel, will produce about 100 pounds of water per pound of fuel by the end of 700 hours of operation. Recent work on this problem for the Army—by Professor W. F. Langelier and his associates of the University of California College of Engineering at Berkeley—appears to have greatly reduced the scaling of the evaporator, so it may be possible to obtain a consistent 200 to 1 fuel efficiency for long periods.

Possible--but practical?

Assuming that a production of 200 pounds of water is obtained from each pound of fuel (192 gallons to 1 gallon), what would such water cost? To produce 1,000,000 gallons of distilled water from sea water would require 5,208 gallons of Diesel oil, or an equivalent amount of mechanical energy. At the lowest quotation presently obtainable for this type of fuel, 9.5 cents per gallon f. o. b. El Segundo, the cost would be $495 per million gallons, or $161 per acre foot of water **for fuel only.** Labor to operate and maintain the stills is estimated to cost from $40 to $200 per acre foot, depending upon the size of the distillation unit obtainable. Allowing for the effect of load factors actually attainable in year-round operation of a water-producing plant, interest, amortization, depreciation, and charges for pumping—since the water is produced at sea level—the total cost will probably be $400 to $500 per acre foot delivered. This is 13 to 17 times the present cost of softened Colorado River water. Distilled water quality is not necessary for a domestic supply, but only 1.4 per cent of sea water could be mixed with distilled water and still maintain the U. S. Public Health Service standard for potable water—500 p. p. m. (parts per million) dissolved solids. This ratio is so small that it would not appreciably affect the cost of producing a potable water from sea water.



Naval Research Institute held wartime demonstrations of sea water conversion in experimental water tank at Bethesda, Md.

To produce 1,000,000 acre feet of potable water a year, the designed capacity of the Colorado River Aqueduct, would require 1,700,000,000 gallons (40,400,000 barrels) of Diesel oil, or its equivalent source of mechanical energy, per year—or about one-quarter of California's total fuel oil production per year. It is entirely possible that larger, more efficient stationary distillation units will be built, but at a water to fuel ratio of 200 to 1 the efficiency of heat recovery is already very high, so it is doubtful if the increase in efficiency could be sufficient to bring the cost of such distilled water within the range of present or future local water production costs.

The immediate question of the layman is, "Why not use atomic power?" Dr. L. A. DuBridge has, I believe, quite adequately answered that in his article on "The Future of Atomic Energy," which appeared in the November 1947 issue of ENGINEERING AND SCIENCE. He says, "I am inclined to believe that 30 to 50 years will elapse before uranium can possibly become a **major** source of power, comparable, say, to present production of electrical energy. And even this assumes that military requirements for plutonium will not take the whole output for the next few years, as they are likely to do. Furthermore, by the time uranium is likely to be a large-scale source of power our power needs will have multiplied so greatly that we will still need full-scale production of coal, oil and other existing fuels."

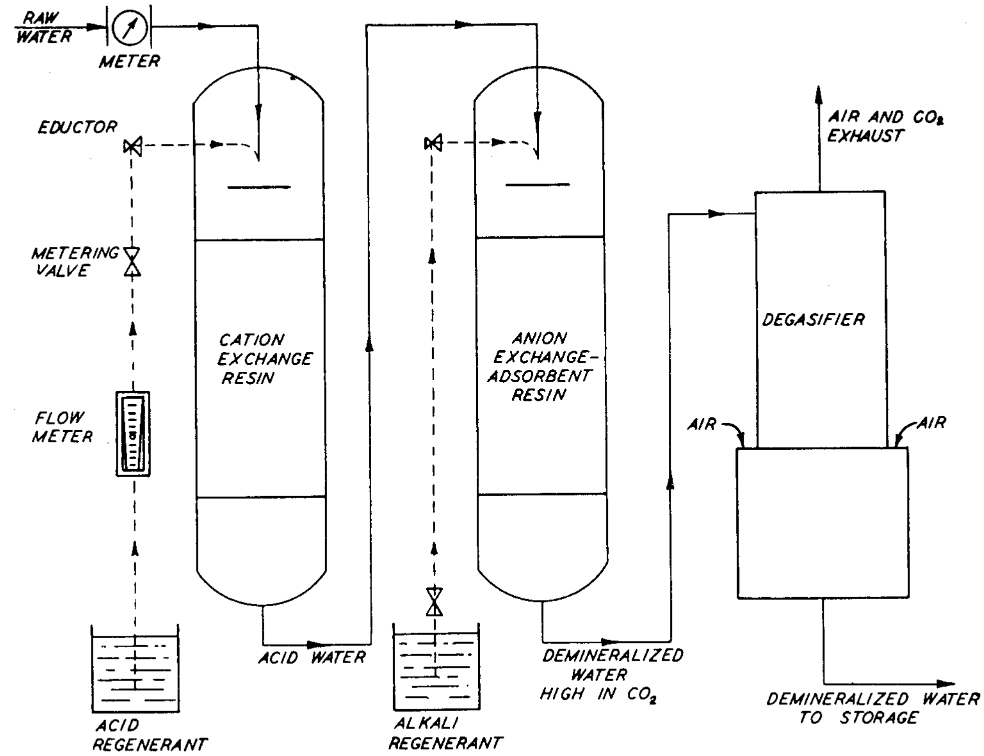
Cheap nuclear fuel?

About the cost of such power when it is available, he says, "Including both plant investment and fuel costs (and neglecting vast development costs) uranium power will certainly cost much more than power from coal . . . . it is hard to see how uranium power can be very cheap . . . . An over-enthusiastic press—and some over-enthusiastic scientists—have created the impression that the **large scale** use of **cheap** nuclear fuel is just around the corner. The sober fact is that uranium 235, while it may be concentrated, it is neither an **abundant** nor a **cheap** source of power. If we use only U-235 there is not enough of it in the world to be very interesting. We must therefore convert U-238 to plutonium, but this is a slow and costly process."

What about other sources of power—from the wind, or the sun, from waves, or tides, or from thermal differences in the ocean? Such energy sources are frequently mentioned in published articles and they sound very alluring to the uninitiated, but many of them have been under investigation for a hundred years, so far without any tangible results. Again quoting Dr. Folsom, in referring to such methods of power production, "Schemes of inventors using these types of energy must be looked at with care."

The development of organic anion and cation exchangers has made possible complete demineralization of water. Their greatest use is in various process industries where the cost of such water treatment is but a small proportion of the total process cost. The cost and the feasibility of demineralization depend upon the salinity of the water before treatment.

There is much publicity in the trade journals about producing water equal in quality to distilled water by such anion and cation demineralization. There is even a statement that this can be done for as little as

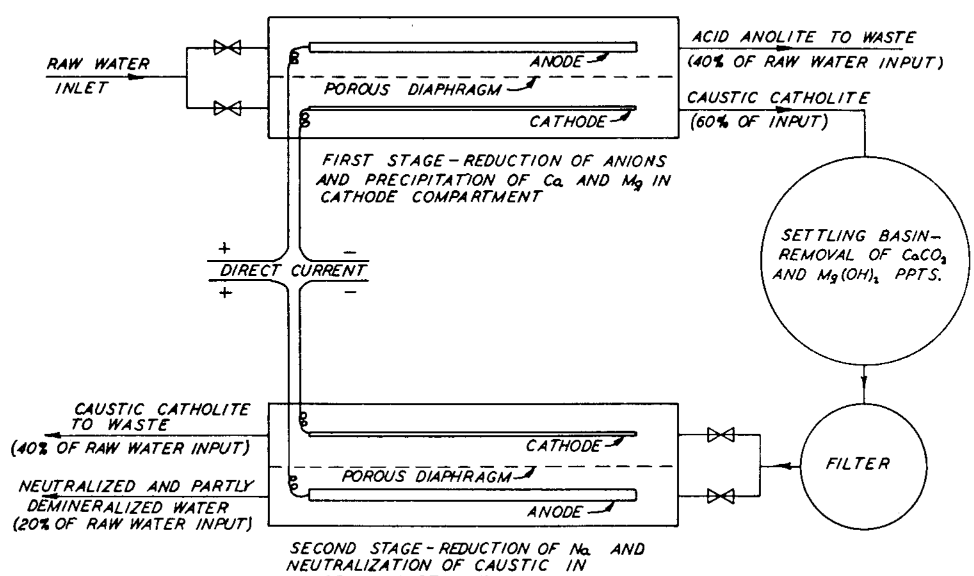


DE-IONIZING SYSTEM UTILIZING ION-EXCHANGE RESINS: Development of organic anion and cation exchangers has made possible complete demineralization of water. But how practical is the process for treating sea water?

26½ cents per 1,000 gallons, or $86.35 per acre foot—but no mention is made of the initial quality of the water being thus demineralized. This process costing 26½ cents per 1,000 gallons will demineralize water containing only about 370 p. p. m. total dissolved solids, a water which is already potable. Sea water contains approximately 36,000 p. p. m. total dissolved solids.

The unit cost of demineralization is directly proportional to the salinity of the water being demineralized. The various manufacturers of anion and cation exchangers report somewhat different efficiencies of ion removal. Assuming what is believed to be a fair average operating efficiency, the cost of the regenerating chemicals (acid and soda ash or caustic soda) required to demineralize sea water at existing chemical prices in southern California would be about $25.00 per 1,000 gallons, or over $8,000 per acre foot. This is the regenerating-chemical cost only and includes nothing for operation, maintenance, depreciation, or interest on the investment. But the factor which completely eliminates this method of producing potable water from sea water is that, when treating sea water, it requires from 20 to 30 times the amount of demineralized water produced, just to wash the regenerating acid and alkali from the demineralizing material.

Another method which has been investigated for producing potable water from sea water is the electrolytic process (below) developed by Robert E. Briggs, Industrial Chemist. This is a modification of the old three-compartment electrolytic method of water treatment. It is a process which has apparent promise in the treatment of industrial and domestic waters, and appears to compete in cost with existing methods of treatment. Studies made by the inventor show that treating sea water requires 180 kilowatt-hours of electrical energy per 1,000 gallons of fresh water produced. With



ELECTROLYTIC SYSTEM FOR PARTIAL DE-MINERALIZATION OF WATER: This process has apparent promise in treatment of industrial and domestic waters. But, for treating sea water, it has serious drawbacks.

power at 5 mills per kilowatt-hour, this would be $0.90 per 1,000 gallons, or $293 per acre foot of water porduced, for power alone. This method would require a water waste of four times the recovery, so 5,000 gallons of water would have to be pumped for each 1,000 gallons of potable water produced. The power required to produce 1,000,000 acre feet of potable water per year by this method would be 58,650,000,000 kilowatt-hours, or 12 times the power output from Hoover Dam.

Several people, in discussing the reclamation of sea water, have pointed out the potential recovery of chemicals from the concentrated salt solutions which would be produced. In attempting to evaluate the profit from the recovery of such chemicals, it would be well to consider the effect that the production of 50 tons of salts from each acre foot of fresh water recovered would have on the present price quotations for those chemicals. Their market value would probably exceed but slightly, if at all, the considerable cost of precipitating such chemicals from the reject brine.

Recently a method was suggested for producing fresh water by freezing sea water. Fresh water **can** be obtained by this procedure, but again the costs are prohibitive. It is estimated that it would cost at least $1.25 per 1,000 gallons, or $400 per acre foot, to produce water by this method.

From an engineering standpoint there is no question that fresh water can be and is being produced from sea water. But within the forseeable future there appears to be no possibility that it will be economically feasible to turn to the ocean as the source of domestic, agricultural, or industrial water along either coast of the United States. Considerable sums could be spent beneficially in developing existing local supplies by conserving more flood waters, by treating sewage and industrial wastes, and by continuing to develop and protect existing supplies before turning to the ocean as a source of fresh water. Under emergency conditions where relatively small quantities of water are needed, aboard ship, or in such places as the oil fields of Saudi Arabia, the cost of the water produced may not be the determining factor. Sea water reclamation could then be used very satisfactorily.

Some further references:

"Compression Distillation" by A. Latham, Jr. Mechanical Engineering Vol. 68, March 1946.

"Distilling-Plant Economy" by A. M. Impaghazzo. Mechanical Engineering Vol. 69, May 1947, p. 387.

"California's Last Waterhole" by J. E. Hogg. Waterways Magazine, Vol. 39, No. 11, November 1947, p. 2.

"Distillation of Seawater by the Vapor Compression Method", by J. J. Campobasso. Journal American Water Works Asociation, Vol. 40, No. 5, May 1948, p. 547.

"Fresh Water from the Sea", by C. A. Hampl. Chemical and Engineering News, July 1948, p. 1982.

"Two-Compartment Cell Softens Water Electrolytically" by Lee Streicher. Civil Engineering, Vol. 16, No. 7, July 1946, p. 312.

"Value and Cost of Water for Irrigation in Coastal Plain of Southern California". California Division of Water Resources Bulletin 43, 1933, pp. 87-90.

"Pacific Ocean—'California's Last Water Hole'" by Dr. R. G. Folsom. Electrical West, September 1948.

"The Future of Atomic Energy" by Dr. Lee A. DuBridge. Engineering and Science, Vol. X, No. 8, November 1947, pp. 5-7.

"Desalting Sea Water . . . A Practical Chemical Method" by Tiger, Sussman, Lane and Calise. Industrial and Engineering Chemistry, Vol. 38, No. 11, November 1946, p. 1130.

"Some Practical Aspects of Deionization" by J. Thompson and F. X. McGarvey. Proceedings Eighth Annual Water Conference, Engineers' Society of Western Pennsylvania, 1947, Paper No. 8.

Institute to receive Dupont grant

CALTECH HAS BEEN NAMED one of the ten U. S. educational institutions—and the only one west of the Mississippi—to receive a $10,000 grant-in-aid from the DuPont Company for unrestricted use in basic chemical research.

The purpose of the program is to increase the amount of such research, and to insure a steady flow of fundamental knowledge to industry and to the country at large. The first grant will be made for the academic year 1949-50, and if the program proves successful, will be continued for a five-year period.

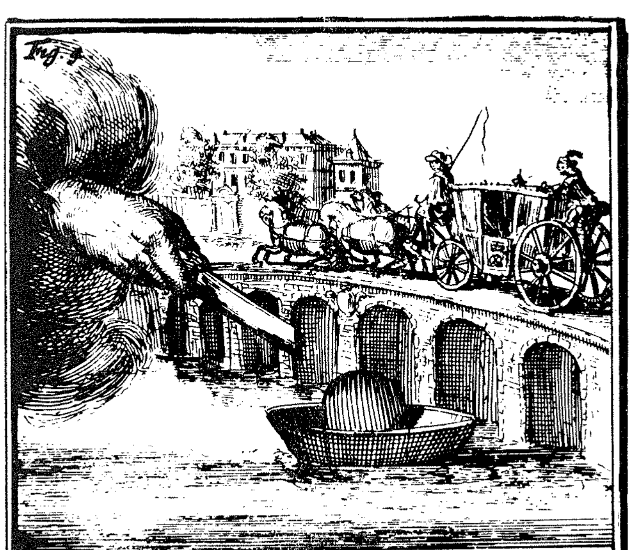
Other recipients of the DuPont grant are Cornell, Harvard, M.I.T., Ohio State, Princeton, Yale, Illinois, Minnesota, and Wisconsin. The institutions will select the research projects in which the funds will be used, the only stipulation being that they be free from any commercial implications at the time the research work is started.

In announcing the gifts, Crawford H. Greenewalt, president of DuPont, said: "It is well recognized that applied research in industry has been dependent in a large measure upon the fundamental knowledge resulting from the work carried out in the past in universities. Today, however, we see a situation in which such work is at low ebb in European universities, and in which American universities have to some degree turned to remunerative applied research at the expense of the fundamental research which they are so well equipped to carry forward.

"It is the DuPont Company's belief that industry can, both for its own and for the national interest, take a constructive part in making it possible for our institutions of higher learning to reverse this trend away from fundamental research. . . . . The company hopes in this way to contribute something to enable our universities to make further progress in the stockpiling of basic knowledge, which has been recognized as one of the paramount needs of the country for future industrial development and for national health and defense."

In addition, the DuPont Company has renewed its post-graduate fellowship in chemistry at the Institute, and has initiated a corresponding fellowship in physics, available for the first time in the coming academic year.

Frontispiece of the "Traitté de l'aiman" shows a goddess and a mariner surrounded by various magnetic devices. The divinity is apparently advising the sailor to take advantage of them.



The attraction of the lodestone to steel is shown here. In the original, this engraving is paired with a similar one which shows the attraction of one lodestone for another.

Science in art

Magnetism --- as they knew it in the 17th Century

by ERNEST C. WATSON

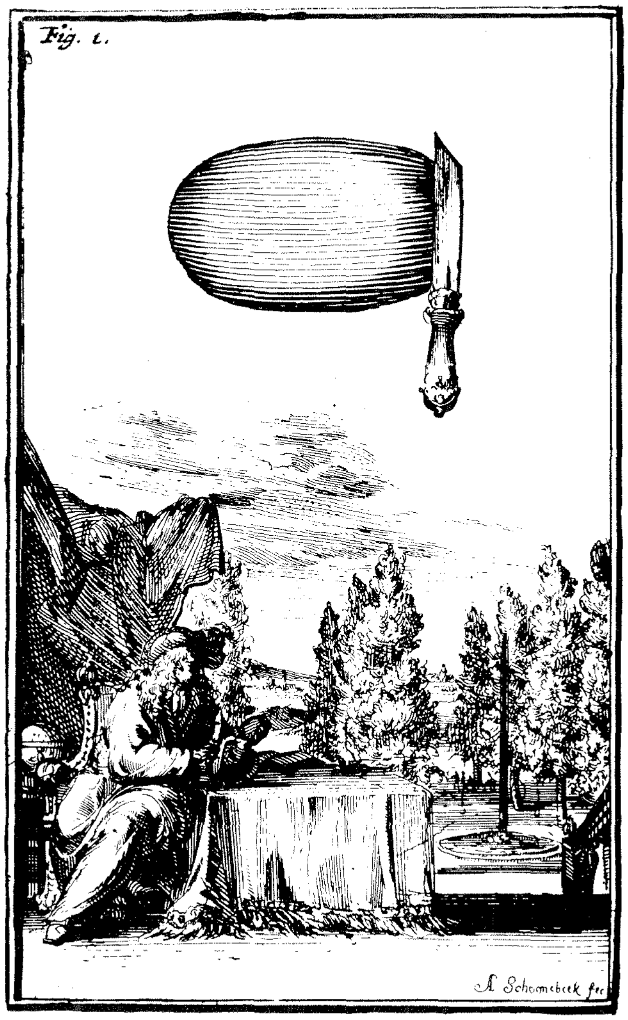
THE ENGRAVINGS by A. Schoonebeck that illustrate the **Traitté de l'aiman** by Mr. D*** (Amsterdam, 1687) provide a fascinating display of the knowledge regarding magnetism which existed at the end of the 17th century. The frontispiece and six of the 33 full-page plates are reproduced here. Many of the remaining plates are of equal interest. Very little seems to be known regarding Joachim D'Alencé, the author of this quaint treatise. Even his name is variously given as Dalance, Dalence, Dalencé, and so forth, by different authorities. He is known almost solely because of two delightful little books, this and his **Traittez des barométres, thermométres, et notiométres, au hygrométres** (Amsterdam, 1688), a companion volume also charmingly illustrated by Schoonebeck and important because it contains the first suggestion of the use of two fixed temperatures in the graduation of thermometers.

The frontispiece of the **Traitté de l'aiman** (left, above) is described by Park Benjamin, in his **Intellectual Rise in Electricity** (London, 1895), as follows:

> The lodestone, disposed in a bowl after the mode suggested by Neckam and Peregrinus, and marked with a longitudinal directing line, appears floating in front of the vessel, which the mariner, holding a rudder in one hand and a compass in the other, is about to board. The goddess, who appears to be advising him, points to the Great Bear, represented by the actual animal in the heavens, with the Pole Star situated at its tail, and also to a compass and a dipping needle, while in her left hand she has a sounding line. The idea evidently intended is that the divinity is advising the sailor to avail himself of all these means of guidance. There is also shown on the left a suspended armed lodestone, supporting at one pole a series of keys, and at the other a number of iron plates, this being possibly designed to indicate in some way the strength and consequent trustworthiness of the magnet.

The rest of the plates are so nearly self-explanatory that they scarcely need comment. In fact, one of the greatest charms of Schoonebeck's illustrations is that they give an easily comprehended summary of what was known in his day, even without the text that accompanies them.

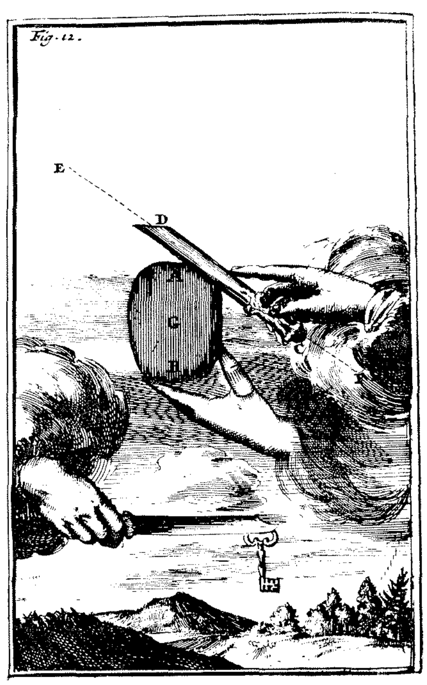
Other engravings not here reproduced show the effect of cutting the lodestone longitudinally and transversely, the dip of the magnetic needle, and several other interesting experiments revealing the difference between the action of the two kinds of poles upon each other.



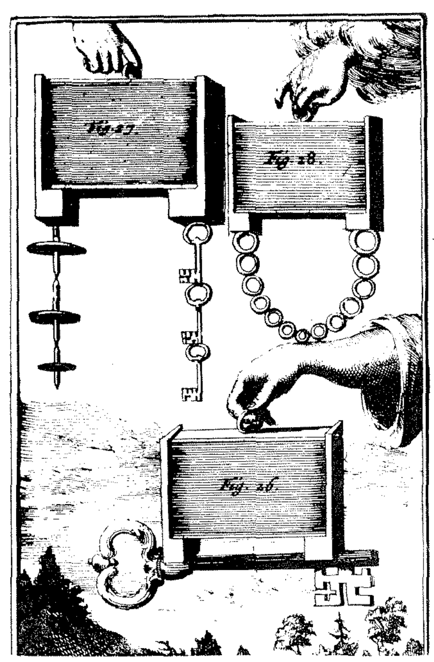
A seventeenth-century natural philosopher, holding a lodestone, ponders the fact that it attracts iron or steel.

This illustrates the attraction of the lodestone for a needle, despite the interposition of wood or paper.

Unlike poles attract, as shown at the top, while like ones shown below repel.



This is a graphic illustration of the way to magnetize a piece of steel.

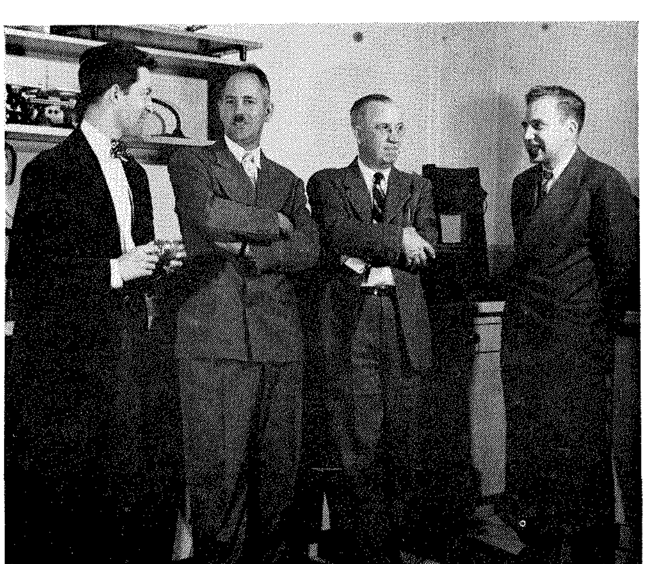


Here Schoonebeck shows some of the ways of testing the armed lodestone.

Girls meet hamsters as the Biology Division holds open house in its new laboratory annex on January 20.

Dr. Ray Owen inspects sheep in new Biology annex.

THE MONTH AT CALTECH



Dr. G. W. Beadle (second left) entertains at open house.

BIOLOGY ANNEX

CALTECH'S BIOLOGY DIVISION last month opened its new $150,000 laboratory annex. The building combines facilities for housing experimental animals and for research on immunization against disease, blood group inheritance, cancer prevention and treatment, the biological basis of pneumonia and infantile paralysis, sexual fertilization, and the physiology of nerves.

Connected with the main biology building, the underground annex is so constructed that its roof, at ground level, furnishes auto-parking space. The annex is equipped with air-conditioning apparatus which gives it a complete change of air every three minutes. There are rooms for housing mice, rats, guinea pigs, sheep, rabbits, pigeons, hamsters, chickens and other animals used in research work. One room will eventually house a tank for marine animals.

Bright and shiny as a modern kitchen, the annex has some $15,000 worth of cages, specially-designed to provide maximum comfort and cleanliness with a minimum of labor. Paper runs in large rolls beneath the rat and mouse cages, so that daily cleaning simply consists of pulling fresh paper through the cages. All walls are smooth and rounded at the corners so the rooms can be hosed down. Floors slope to central drains.

"We are seeking basic knowledge," says Dr. George W. Beadle, head of the Biology Division, "and the new annex is one of our tools. We probably won't discover anything sensational tomorrow, or the next day, or maybe not next year. But the information we gain, pooled with data compiled at other institutions, will bring us closer to comprehending the basic elements of life."

HONORS AND AWARDS

OF THE FIVE TOP HONORS awarded by the Institute of the Aeronautical Sciences at their annual meeting in January, two came to Caltech men:

Clark B. Millikan, Professor of Aeronautics, Acting Director of the Guggenheim Aeronautical Laboratory, Acting Chairman of the Jet Propulsion Laboratory, and Director of the Southern California Co-operative Wind Tunnel, was elected the 1948 American Honorary Fellow of the Institute, for "eminence in aeronautics." A past president and Fellow of the Institute, Dr. Millikan is also a Fellow of the Royal Aeronautical Society, London, and in 1948 received from the British Government the King's Medal for Service in the Cause of Freedom. He is currently serving on a number of committees of the National Military Establishment.

Allen E. Puckett, wind tunnel section chief at the Jet Propulsion Laboratory, won the 1948 Lawrence Sperry award, for "outstanding contributions to the design and development of supersonic wind tunnels." Puckett was associated with Dr. Theodore von Karman in the design of the 2½-inch supersonic wind tunnel at Caltech in 1941. This is believed to have been the first closed-circuit, continuously-operating high-Mach-number supersonic tunnel in the United States. He was also responsible for, and is now in charge of, the 12-inch supersonic wind tunnel at J.P.L., and of the 20-inch tunnel now under construction. He also advised extensively on the supersonic wind tunnels of the Ordnance Aerophysics Laboratory at Daingerfield, and of the Air Materiel Command at Wright Field.

It's getting so E & S can't go to press without checking the chemistry division for the latest honors awarded Chairman **Linus Pauling.** This month we got two: (1) the Indian Academy of Sciences has elected Dr. Pauling an honorary fellow; (2) the Academy of Sciences of the Institute of France has elected him a corresponding member. Though Pauling's work has recently been in the application of chemical methods to problems of biology and medicine, much of his earlier work was in the structure of minerals, and it is in the section of mineralogy that he has been elected to the French Academy. (Ed's note: Dr. Pauling barely got back from France in time to receive this one. He'd been over to get an honorary doctor's degree from the University of Paris).

CAMERA TO AFRICA

A STUDY OF CERTAIN TYPES of stars in the Milky Way, begun thirty years ago at Mt. Wilson, will be completed in the next three years in South Africa. The observatory is shipping its small 10-inch refractor telescope to the University of Michigan's Lamont-Hussey Observatory at Bloemfontein, for use in the study by U. of M. astronomers.

At Mt. Wilson the telescope—which is essentially a camera—has been used to locate planetary nebulae and emission Be stars in our own galaxy. Both of these objects are surrounded by a glowing mass of hydrogen. In the course of the study hundreds of thousands of stars have been photographed with red sensitive plates, to get the red line of hydrogen in the spectrum which makes identification possible. The number of known emission Be stars has increased, since the study began, from about 160 to more than 1,000; the number of known planetary nebulae has doubled, from about 130 to about 260. All of the Milky Way observable from Mt. Wilson has now been surveyed for these rare types. The remaining portion, about one-fourth, will be scanned from the other side of the globe.

Planetary nebulae and Be stars are of special interest because they are continually changing. Unlike novae, or exploding stars, they change slowly; and their explosions, which occurred thousands of years ago, are believed to have been much less violent than those of the novae. Scientists think that these changes have some bearing on certain problems in physics, such as the origin of high velocities, and a possible relationship to nuclear energy.

ARTHUR PERRY BANTA

ARTHUR PERRY BANTA, 44-year-old Associate Professor of Sanitary Engineering, died of a heart attack at his home in Pasadena, January 23.

Professor Banta received his A.B. at Stanford University in 1926 and his M.S. at Caltech in 1928. After a ten-year period with various engineering firms, he returned to the campus to join the faculty as Assistant Professor of Engineering.

During the war Professor Banta served in the Army Corps of Engineers, as chief of the engineering planning section in the Pacific Theater. He was awarded the Bronze Star for this work. In 1945 he came back to Caltech.

Professor Banta was widely known in his field and received many professional honors, including the 1941 James Laurie Prize of the American Society of Civil Engineers. He was a trustee of the Neighborhood Church in Pasadena, an active member of the Pasadena Rotary, of the New Century Club, Sigma Xi, Tau Beta Pi, and the American Society of Civil Engineers. Surviving are his wife, Elizabeth Richardson Banta, and four children.

He was buried in Arlington National Cemetery.

ASTRONOMER ROYAL

SIR HAROLD SPENCER JONES, England's Astronomer Royal, and Director of the Greenwich Observatory will address the Caltech faculty and Associates on February 21 on "The Origin of the Solar System."

Sir Harold is scheduled to speak on four other occasions at Caltech—at seminars on February 23, March 2 and 9, and on March 4 he will address the undergraduate student body in assembly.

In addition to being Astronomer Royal, highest position in his field in Great Britain, Sir Harold is the immediate past president of the International Astronomical Union, a past president of the Royal Astronomical Society, the British Astronomical Society, and the British Horological Society. He was knighted in 1943, and, in that same year, was awarded the Gold Medal of the Royal Astronomical Society and of the Royal Society.

Of all Sir Harold's many astronomical contributions, probably the most important was his determination of the mean distance between the earth and sun, thereby establishing a fundamental unit in which all measurements of greater celestial distances are now expressed.

Sir Harold will give a number of addresses in the east and middle west before arriving in California. Here he will speak at the University of California in Los Angeles, the Griffith Planetarium and the Harvard Club of Southern California, as well as at Caltech.

Books

EDUCATION IN A DIVIDED WORLD

by James Bryant Conant
Harvard University Press, 249 pp. $3

by Hunter Mead
Professor of Philosophy and Psychology

In this, his latest discussion of education in America, Harvard's distinguished president continues to increase his stature as a leader of educational thought in this country. In some ways the present book is more controversial and radical than any of Conant's previous writings on this subject—so radical in fact that one may expect to hear its author accused of "treason to his class" in the same way President Roosevelt was accused by many of his upper-class opponents. For here Conant acknowledges the civil war that has long plagued American education—the fight between the public school people on one hand and college and university educators (aided by administrators of the private preparatory schools) on the other. Then, having admitted that the warfare exists, and can no longer be considered as merely a family quarrel, Conant takes sides with the public school men. He feels that they—and not their opponents in the colleges and universities—have their feet on the ground, and their eyes on the guiding star of the democratic ideal.

To the present reviewer, this is the best evidence of Conant's capacity for growth and independent thinking. The fact that Conant is not only the head of America's Exhibit A in private educational institutions, but himself a product of the system he attacks in this book, certainly disproves the old saw that the thinking of every man is bound by his background and economic supports.

The title of this book is somewhat misleading, for the problem of education in a world split by rival ideologies is discussed specifically in only two chapters. The real subject is education in a modern democracy, although probably everyone would admit that this has close relation to the ostensible theme of the book. The subtitle gives the best indication of Conant's concern: The Function of the Public Schools in Our Unique Society. In his former writings he has considered advanced education in America, but here he concentrates on the high schools and junior colleges.

No complaint is voiced more often by college and university professors than the one that the high schools are not preparing their students for college—or, in the usual words of these professors, "We have to spend much of the first two years of college work giving the student what he should have got in high school." But, argues Conant, preparation for college is **not** the primary function of our public high schools, and hardly even a secondary function. For the majority of students who graduate from high school never even start to college—and never intend to.

In the nation as a whole, out of every 1,000 children in the fifth grade, only 770 enter high school, and only about half (417) of these graduate. Of the 417, only 146 begin college, and again only half of these graduate from college. Thus some fifteen percent of the fifth-grade students will begin college; about eight per cent graduate; in terms of those entering high school, just over one-fifth will try college at all—and only one-tenth will graduate. Yet, as Conant repeats again and again, college educators persist in believing that the public schools exist largely to prepare students for college!

Conant agrees with the public school administrators that the primary function of their institutions is the preparation of children for citizenship, and social and personal adjustment. Even more radical is his opinion that by and large the high schools of America are doing a commendable job along these lines, and that the constant sniping at the public schools indulged in by many college and university people is viciously unfair—not to say ineffectual.

This brings Conant to the inevitable question, Who is going to prepare the student for college—other than the expensive private prep schools? His answer is definite: in our unqiue society this must be the task of the public high schools (aided by the junior colleges), but not as they are now organized in most school systems. He would reorganize their work around a core of general education, emphasizing three areas: the humanities, the social studies, and the natural sciences. Conant believes the needs of our democratic society can best be served by requiring a judicious balance of work in all three—but he emphasizes repeatedly that the appeal should be to the student's innate curiosity rather than to social pressures such as future college entrance. For the gifted students (and Conant implies that they are the only ones in the public schools who should be encouraged to go to college), there would be extra studies intended as college preparation. He insists, however, that such work should be controlled by every possible means to prevent social discrimination or intellectual snobbery.

Federal scholarships--the democratic way

The most radical part of Conant's general proposal—or at least what would have seemed unthinkably radical ten years ago—is that calling for Federal scholarships on a large scale to permit gifted students to continue beyond high school. He argues for this aid on the grounds of both democracy and a fuller use of our human resources. Again he quotes some shocking figures to prove that the smug claim, "Any American student can get a college education if he really deserves it," is a myth without foundation. He shows the amazingly close relation between family income and college attendance, and feels that unless drastic changes are made we will gradually harden into a class-stratified nation.

Conant does not propose that only the really capable should go to college, but he insists that no one who is capable should be excluded from advanced education by economic barriers. If we continue to let these barriers be the primary determiner of whether or not a student goes to college, Conant believes we not only will weaken the nation, but will provide our ideological rivals across the ocean with abundant ammunition for their propaganda claims that America is not really democratic.

ROCKET PROPULSION ELEMENTS

by George P. Sutton '42
John Wiley & Sons, New York 294 pp. $4.50

by H. S. Seifert
Lecturer in Jet Propulsion

THIS COMPACT LITTLE BOOK, illustrated with style, presents, as its title suggests, the basic facts of rocketry in easily assimilable form. It has chapters on basic concepts, history of rockets, thermodynamics of nozzles, properties of liquid propellants, liquid rocket motor design criteria, propellant feed systems, flight performance, static testing, and solid propellant rockets. The necessity for condensing the material of a very broad subject occasionally means that the treatment is qualitative or even superficial; however, the concepts are clearly expressed.

The author's background has been largely in the liquid propellant field, so the emphasis is on liquid rockets—with 45 per cent of the paging devoted to specifically liquid techniques as compared with 5 per cent devoted to solid propellant techniques. It is regrettable that for security and other reasons more attention could not be given to solid propellants, which show promise of increasing importance in the future.

Sutton's writing style is fluent and his organization systematic, making the text easy to read. This reviewer found himself somewhat startled to see on page 135 a picture of a motor, to the design of which he had contributed just a few years back, labeled "Early American Rocket Motor." Apparently the ox-cart is no more obsolete that last year's rocket motor! On page 132, under "Combustion Process," the statement is made that for the oxidizer and fuel fluids, "in no case does any large part of the reaction take place in the liquid phase." It is the opinion of some workers in jet propulsion that this statement is incorrect.

This volume brings into the public domain some of the material of "Jet Propulsion," a restricted text which has been used in the Institute course in rocket systems since 1943. It should be quite helpful to those engineering students who wish to acquire perspective and physical feeling for liquid propellant rockets.

George P. Sutton '42, author of "Rocket Propulsion Elements," is supervisor of Propulsion Development for North American

ROCKETS, GUNS AND TARGETS

Edited by John E. Burchard
Atlantic-Little, Brown: Boston 482 pp. $6

by H. S. Seifert

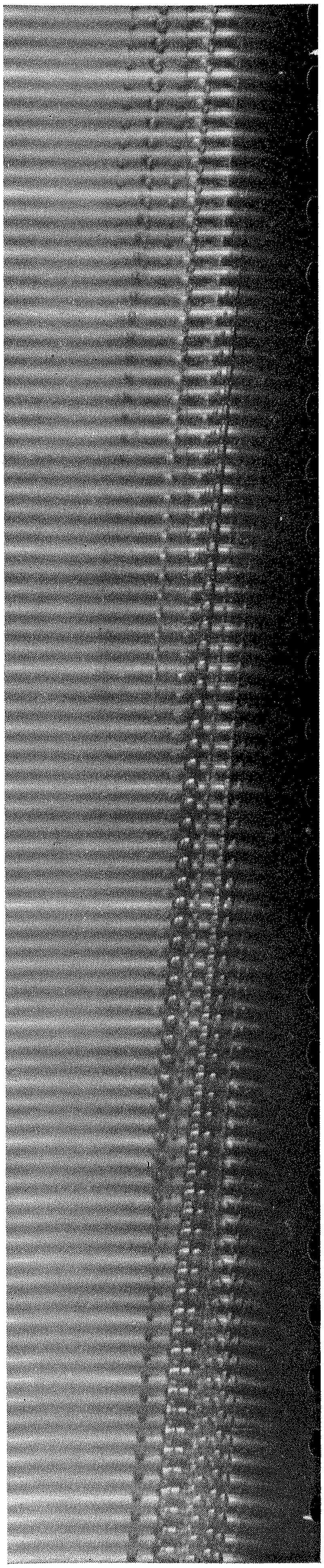
THIS INTERESTING SOURCE BOOK—one of the eight-volume series, **Science in World War II,** which records the history of the Office of Scientific Research and Development—should be of special value to Caltech readers, since the list of contributors sounds like an alumni-faculty roll call. Eleven of the thirty-six chapters are devoted to work done at the California Institute of Technology.

Rockets, Guns and Targets describes the work of three of the nineteen divisions of the National Defense Research Committee—Division 1, Ballistic Research; Division 2, Structural Defense and Offense; Division 3, Rocket Ordnance. The book, in a sense, complements **Rocket Propulsion Elements,** reviewed above, since it describes the applications of research on solid-propellant rockets rather than liquid-propellant rockets. It is, however, non-mathematical and descriptive, almost narrative in form.

The Caltech work on Rocket ordnance makes not only impressive, but stirring reading. Substantially all rockets used by the Navy were developed here—the main ones being the anti-submarine, the 4½-inch barrage, the spinner, and the forward-firing aircraft rockets. When the war ended, the Navy had contracts for rocket ordnance, with regular contractors, at the rate of $150,000,000 a month—all the rockets having been developed at the California Institute of Technology. With Charles Lauritsen as Director of Research, and E. C. Watson as administrative head, Caltech's rocket contracts totalled $80,624,000 altogether.

The book contains detailed lists of the personnel of various projects, and you will find many of your friends, and former professors' names here. (It is not intended, of course, that a distinction between professors and friends be implied.)

A blend of physics, battle incidents, tactics, and politics combines here to make exciting reading. The text is charged with feeling and gives one an appreciation of the vitality and urgency of the research and the vision and courage of the men who were prosecuting it. One seems to catch an echo of the spirit of the Pilgrims, Bunker Hill and the '49ers. Here indeed is an intimate chronicle of the physicists' war.



This section from the Hydrodynamics Laboratory's movie shows how pictures taken at 20,000 frames per second tell the life history of a cavitation bubble. Starting at sixth frame from top, right, a bubble is born, then grows, collapses and rebounds—all in less than 1/200 of a second. Through such minute observation of bubble formation engineers hope to find the fundamental cause of cavitation and so come up with a cure.

The high speed water tunnel and a movie are helping engineers design better hydrodynamic equipment

Life and death of a bubble

CAVITATION HAS BEEN A HEADACHE to engineers for years. Particularly has it been a headache to owners, operators and designers of hydraulic equipment. It attacks the propellers that push a ship, the pumps for a city's water supply, the turbines in a hydroelectric plant.

Now, researchers at Caltech have come up with some relief for this headache—in the form of a motion picture that magnifies time the way a powerful microscope magnifies tiny bacteria.

Cavitation is a kind of boiling. It is a special kind of disturbance that is likely to occur when an object moves through liquid at very high speed. Powerful forces resulting from cavitation chew up cast iron as if it were soap. Pump impellers become grooved until they are useless, pipes become peppered with holes, propeller blades chewed to pieces.

Needless to say, this is very costly chewing. The owners of the old **Mauretania** had to send her into drydock after four transatlantic trips to have her worn propeller blades repaired. The **Normandie** was a bit less fortunate in this respect; she could make but one round trip before a visit to drydock. Designers of hydraulic machinery have improved propellers since the **Normandie's** day, but fast liners must still have periodic propeller repairs—just as the turbines in hydroelectric plants have to be inspected regularly so that worn-out parts can be replaced, or new metal welded into the holes.

Through the years, engineers have found out many things about what cavitation causes, and they know in general what causes the cavitation. But they will have to find out **how** cavitation causes its damage before they can come up with a cure. This is what Caltech's researchers have set out to do. Already they have discovered some things that may ultimately affect the design of every machine that moves in a fluid.

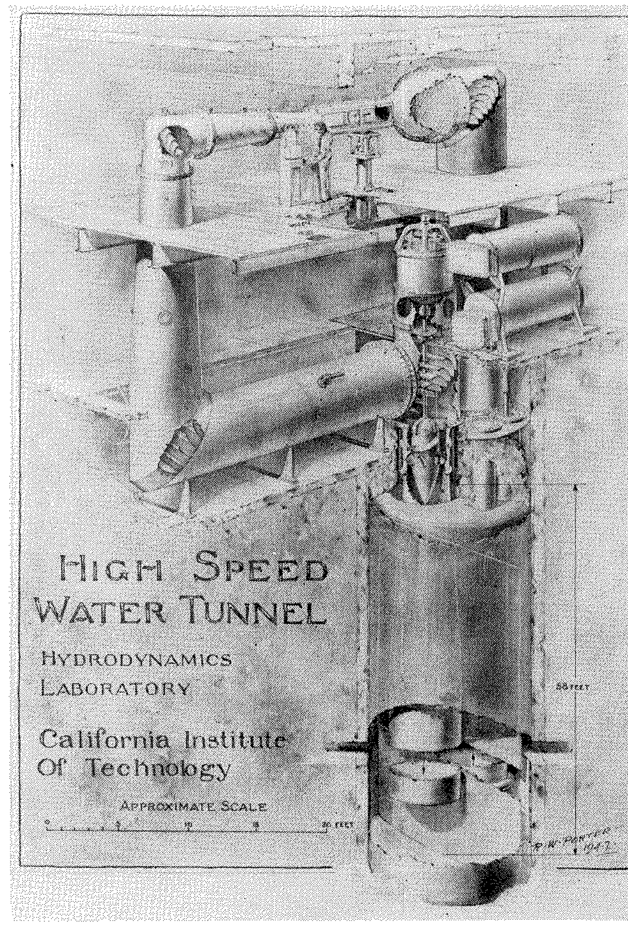
All hydrodynamics researchers know that cavitation is like boiling. But researchers at the Institute have found that cavitation is made up of bubbles—bubbles that form and break, reform and break again. The mechanics of cavitation—the way in which the bubbles, or cavities, are formed, grow, collapse and rebound—are still almost completely unknown.

This is where the Institute's movie comes in. The movie is a unique tool for examining these bubbles, for looking at them when they are formed, for studying their life and the way in which they die. The special cameras developed for making the movie can take pictures at the rate of 20,000 frames per second. When you watch the movie for twenty minutes, you are watching what happens in one second. The movie makes one-tenth of a second seem bigger than a minute, and thus becomes a time microscope, an instrument for blowing up a second until it is 1,250 times its former size, so that researchers can examine it and watch all the things that happen during it.

The laboratory in which these researchers work is the only one of its kind in the country. Set up in 1941 at the request of the Office of Scientific Research and Development, it spent the war years working on problems of rockets, depth bombs and torpedoes, and later, on the launching of the aircraft torpedo. The present laboratory building was completed in 1944. Installation of equipment for investigation of hydrodynamics problems of interest to hydrodynamics enginees everywhere, was completed in the fall of 1947.

There are facilities in the laboratory for the study of a multitude of hydraulic problems; cavitation is but one of these. Most of these problems can be explored with the aid of the water tunnel, an instrument that is very similar to the wind tunnel, the chief tool of the aerodynamics engineers.

The Institute's Hydrodynamics Laboratory has two such tunnels. One is used for the study of surface phenomena. The water in it flows at any speed up to 20 m.p.h. The tunnel is so designed that the atmospheric pressure above the free surface of the water can be controlled carefully. The other tunnel is entirely filled with water, and can be operated at much higher speeds.



Drawing shows tunnel construction. Model two inches in diameter is mounted in working section at top of system.

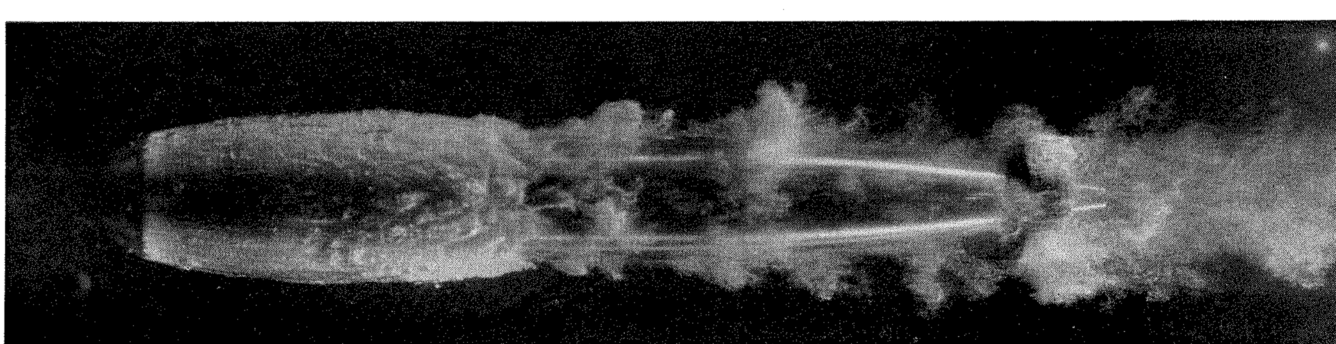
Additional facilities

Besides the two water tunnels, the laboratory operates a ripple tank for studying wave formation, as in a harbor, and a "polarized light flume" for making visible the flow patterns around a ship speeding through water—or around the spillway of a dam. There is also a tank designed for the study of launching problems. But it is the high speed water tunnel that is of greatest use in cavitation work, and no other tunnel in existence can approach it in performance.

The tunnel is like a long pipe which has been joined at the ends. The water in it travels along a carefully designed 340-foot path. The working chamber, or part of the loop in which the model is mounted, is 14 inches in diameter and six feet long. Here the water pressure is lowest, and the speed highest. At its top speed, the water travels through the section at 100 feet per second. The chamber has windows at its top and sides so that researchers can watch and photograph the bubbles as they form and break around the model inside.

The resorber system

Besides the circulating system and the instruments for controlling temperature, pressure and velocity of the water in the tunnel, there is another control system, a unique arrangement known as a "resorber." This is in fact a re-absorber; it puts back into solution any bubbles that have come out during cavitation



By studying pictures like this one of cavitation bubbles forming around a model in the tunnel, Institute engineers find out which shapes are best, which worst, for hydrodynamic efficiency in pumps, turbines and propellers.

so that the water will be smooth and even again when it completes its circuit and re-enters the working chamber. The resorber system is built into an 85-foot shaft, dug straight down into the ground under the Laboratory. Thus, behind the tiny model in its small working chamber are literally tons of equipment filling up a good part of the large building.

When the pumps are turned on, the water starts to circulate. When it gets to the working chamber it is made to rush past the model, and pressure changes occur. Cavitation bubbles are formed wherever the pressure is lowered to the water's boiling point, and each bubble or cavity formed is then pushed by the moving water along the model until it runs into an area of higher pressure. There the bubble collapses as water in areas of higher pressure pushes into the cavity from all sides. In addition to the cameras, there is a battery of recording instruments for keeping track of the forces that act on the model during this boiling process.

It is when the water smacks against itself, rushing into the cavities, that the forces are set free which are responsible for cavitation damage. But at the same time something else happens that is a mixed blessing for the hydrodynamics engineer. The water slapping against itself makes a great deal of noise—just as air does when it rushes in to fill the cavity caused by a lightning discharge. The smacking air is thunder, and the thunder of cavitation, while it warns engineers when something is beginning to cavitate, also makes pumps objectionably noisy, and causes vibration that annoys the passengers on an ocean liner. Worst of all, however, is the fact that cavitation slows down flow, or increases resistance to flow. And this, in turn, means that pumps and propellers cannot operate at maximum efficiency, and that objects running with heavy cavitation are difficult to control.

These are some of the problems hydraulics engineers face, and the problems the California Institute of Technology researchers have set out to solve. The tools of their investigation—the water tunnel, the special high-speed movies, the models—have been developed to the point where the engineers know how to control pressure and velocity in order to make any good shape cavitate or any bad shape stop cavitating. And recently, through studying their photographs, they have reached some tentative conclusions about different types of cavitations. Formerly engineers thought all cavitation bubbles acted the same way. Now Institute researchers have identified several kinds of bubbles which behave in several ways.

Engineering advances

The fruits of this research, made possible through the support of the Bureau of Ordnance, with the help of the Office of Naval Research, are being made available to industry and to other researchers. Already about a dozen firms and several universities have obtained copies of the Institute's moving picture. And the Institute research team has moved ahead into newer fields, toward more fundamental problems.

Located in a building next to the Guggenheim Aeronautical Laboratory of the California Institute of Technology, the Hydrodynamics Laboratory is an ideal spot to study the widest ramifications of its field. For the flow of water and the flow of air are related, and the research being done by these two laboratories gives promise of ever-widening discoveries and developments, which in turn give promise of more efficient pumps and turbines, better underwater shapes, even better fluid transmission for automobiles—and engineering advances that may affect every one of the millions of parts that operate in fluids in American industries.

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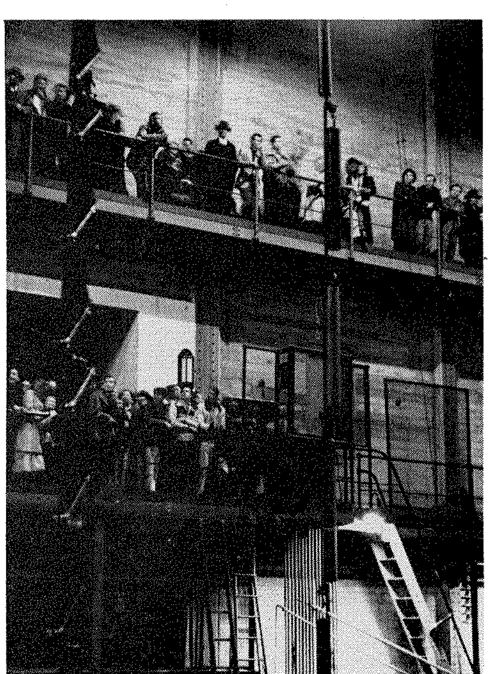
This review of cavitation studies in Caltech's Hydrodynamics Laboratory is the first of a series of reports on research in progress at the Institute.



Standing room only

Most popular of Caltech's Friday Evening Demonstration Lectures, held for the general public throughout the school year, is the one on high voltage, delivered by Prof. R. W. Sorensen. The demonstration in the High Voltage Laboratory which follows Prof. Sorensen's talk is still, after 25 years, one of the best shows on the campus. It proved to have its usual strong draw this year when, on a rainy Friday evening, almost 1,000 people stormed East Bridge. Prof. Sorensen obligingly gave his lecture twice, and the lab ran off three demonstrations, while a special police detail coped with the crush.

Specially designed for conducting researches requiring high-voltage electrical energy, the High Voltage Laboratory was built in 1924, with funds supplied by the Southern California Edison Co. The first laboratory in the country to have a reliable 1,000,000 volt power frequency, provided by a chain system of transformers designed by Prof. Sorensen, its facilities are available for research or for industrial tests. These facilities have been used to aid Southern California Edison in the development of high-voltage transmission lines, to furnish lightning protection of oil storage tanks for the oil industry, to test insulators for numerous utility companies.

ALUMNI NEWS

NEW YORK CHAPTER MEETING

THE CALTECH CLUB OF NEW YORK met on January 17 at the Hotel Holley, on Washington Square, to hear Franklin Thomas, Professor of Civil Engineering and Dean of Students, talk on "Re-Orientation at Caltech". The combination of speaker and subject drew a sizable crowd for the dinner meeting, which included wives and other guests. On hand were Bill Smyth and the Harvey Whites, '48; Ken Shaver and Robert W. Taylor, '45; the Sydney K. Golds, '42; Reuben P. Snodgrass and L. Curtis Widdoes, '41; the Cliff Burtons and the Randlow Smiths, '40; Evan Johnson and Daniel Okins, '38; the Richard T. Brices, '37; C. R. Baker and K. T. Bush, '36; James C. Davis, '35; Phil Schoeller, '32; Howard E. Baker, '30; Howard G. Dodge and Albert E. Myers, '29; M. M. Bower, Mason A. Logan, the Ellery Baxters, and the Ralph Watsons, '27; W. Howard Wise, '26; M. B. Karelits, '25; Paul R. Ames, '22; and the Harry P. St. Clairs, '20.

EMERALDS IN THE LABORATORY

CARROLL F. CHATHAM, '38, is uniquely engaged in the production of synthetic emeralds. He and his laboratory, in San Francisco, were the subject of an article in the January 8 issue of **Collier's.** According to **Colliers,** Chatham left his job as research chemist in a foodpacking concern to build his own small factory in 1946. His first quality synthetic emerald is at the Smithsonian. He is now producing about five pounds of emeralds a year, at approximately half the cost of real stones. He believes he is getting close now to producing piezoelectric crystals, which rank high on the list of strategic materials for national defense.

ALUMNI SEMINAR

SATURDAY, APRIL 9, has been set as the date for the 12th Annual Alumni Seminar at Caltech. A fine opportunity for alumni to catch up on what's going on at Caltech in 1949, the tentative program for the one-day session now runs as follows:

8:30—Registration, Dabney Hall
9:00—**Dr. Linus Pauling,** Chairman of the Division of Chemistry and Chemical Engineering
"England Today"
10:00—Choice of three lectures:
Dr. Robert V. Langmuir, Senior Research Fellow in Physics
"High Energy Accelerators"
Dr. Oliver R. Wulf, Research Associate in Chemistry
"The Effect of the Sun on the Earth's Atmosphere"
Dr. Hunter Mead, Professor of Philosophy and Psychology
"The Impact of Psychology on American Thinking"
11:00—Choice of three lectures:
Dr. Anthonie Van Harreveld, Professor of Psychology
"Nerves, Shock Treatment, and Nerve Regeneration"
Prof. W. D. Rannie, Assistant Professor of Mechanical Engineering
"Gas Turbines"
Prof. Royal W. Sorensen, Professor of Electrical Engineering
"Visit to Japan"
12:00—**Robert D. Gray,** Director, Industrial Relations Section
"The Aims of Industrial Relations"
1:00—Lunch, Student Houses
2:00—**Dr. Robert P. Sharp,** Professor of Geomorphology
"Glaciers"
2:45—**Dr. Vito A. Vanoni,** Assistant Professor of Hydraulics
"The Guam Harbor Project"
3:00—Field trip to Azusa for inspection tour of Guam Harbor Project
or
Musicale, Dabney Lounge
6:30—Dinner, Shakespeare Club
Address by **President DuBridge**

Personals

1927

Theodore C. Combs is now vice-president and general sales manager of Timber Structures, Inc., in Portland, Ore. Previously he was resident manager of the company's San Francisco and Oakland offices.

John E. Marsland has been named Senior Technologist of Shell Oil's Head Office Manufacturing Department, in New York. Marsland began with Shell in 1933 as a lab helper at the Martinez Refinery, became Cheif Technologist at the Wilmington Refinery in 1945.

1932

Maurice A. Biot, Ph.D., now professor in the Graduate Division of Applied Mathematics at Brown Unversity, has been elected a fellow of the Institute of the Aeronautical Sciences. Biot joined the Brown faculty in 1946, after four years in the Navy.

C. P. Schoeller passed through Caltech in January on his way to Rio de Janeiro, where, he says, he will be "working on a railroad" for the Morrison-Knudsen Co. Phil's peripatetic engineering career includes work in the Hawaiian Islands early in the war, on the construction of naval bases, followed by a couple of years on construction projects in Saudi Arabia. Even when he settled down to a position as office manager with Morrison-Knudsen in New York a few years ago, he managed to crowd in some business trips to Afghanistan on the side.

William R. Bergren, Ph.D. '41, has been doing advanced study on nutritional factors in bone formation at U. S. C. and, more recently, at his own laboratory in Monrovia. The suburban lab, he says, is more congenial to the large cat colony he works with.

Vincent Kelley, M.S., Ph.D. '37, is Professor of Geology at the University of New Mexico, and is engaged in a study of the iron ores of that state.

1933

Donald F. Poulson, Ph.D. '36, will return to Caltech in March as a Gosney Fellow to do some advanced work in biology. He will be on sabbatical leave from Yale University, where he is Associate Professor of Biology.

Everett C. Edwards, Ph.D., writes that he is doing consulting for the Honolulu Oil Corp. and the Humble Oil and Refining Co., but would still have time to meet and greet alums going through Laguna Beach.

1934

John F. Pearne, formerly patent counsel for the Sherwin-Williams Co., has joined the law firm of Evans and McCoy in Cleveland, Ohio.

Frances H. Clauser, M.S. '35, Ph.D. '37, Professor of Aeronautical Engineering at Johns Hopkins University, has been appointed to the subcommittee for fluid mechanics of the National Advisory Committee for Aeronautics. Clauser, who was also recently appointed a Fellow in the Institute of the Aeronautical Sciences, organized the Hopkins department of aeronautics, and serves as its chairman.

1936

Bradley T. Scheer is now Associate Professor of Zoology at the University of Hawaii in Honolulu. "I have been here since September," he writes. "We have an active and vigorous, though still very young department, and great plans for expansion in the field of marine biology. I am able, for the first time, to devote a substantial portion of my time to research in invertebrate physiology and biochemistry."

1937

Bruce Lockwood is in business for himself as a consulting geologist. He's been doing considerable work lately in Idaho, but maintains his home and office in Glendale.

1938

Russell E. Hayward, after a six-month's leave of absence spent largely at Caltech, has returned to his job with Socony-Vacuum in Bogotá, Colombia. He took with him a wife: the former Miss Dorothy Frances Warren, of Los Angeles.

1939

Robert J. Dery, graduate student 1936-39, died December 28. A physical chemist with the U. S. Bureau of Mines in Pittsburgh, at the time of his death he was making important advances in the theory of flame and turbulence.

Paul O. Engelder, M.S. '40, is now research engineer of the Oil Well Water Locating Company of Long Beach, and secretary-treasurer of the Major Play Leasing Syndicate.

William R. Cobeen, M.S., for the past several years has been engaged in engineering and geological consulting in North Hollywood. He reports that his office has successfully met the challenge of its location directly under a dance studio, and is spending about a third of its time in straight geological and petroleum engineering consulting, and the rest in contract exploration work.

1940

Cydnor M. Biddison and his wife Virginia announce the birth of a son, Mark Ellis, on January 12. Cyd has his civil engineer's license and is a structural designer with John Case and Co., in Los Angeles. He's studying for his master's degree at U. S. C.

Frank W. Dessel, Jr. writes: "I am now in partnership with my father in a drug store here in San Francisco. I have two boys, aged six and two. Also bulldog, nine months old."

1941

Robert B. Galeski is seismologist and geologist with the Honolulu Oil Corp. Bob reports that he is a member of 18 company offshore seismic operating committees. For the last three years he has been working on the California coastal and tidelands geology.

1942

George P. Sutton, M.S. '43, whose book, "Rocket Propulsion Elements," is reviewed in this issue, went to work for Aerojet after he got his master's at Caltech in 1943. In 1946 he shifted to North American, where he is now supervisor of Propulsion Development. He works on their confidential rocket development program at the Downey plant, lives in Los Angeles.

David Hill and **Harold Kuhn** (B.S. '47), represented a group of forty-six Princeton graduate students at a recent press conference in New York, held to publicize the group's protest against the dismissal of three University of Washington faculty men on charges of Communism.

In a telegram to the president of the University, the students said: "Without attempting to judge the accuracy of your policy decision in this particular case, we, the undersigned, feel impelled to protest strongly against any curtail-

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ment of academic freedom on purely political grounds . . . Whereas we do not in any sense endorse the political views held by the dismissed professors, we strongly support their right to establish and to maintain any legal political affiliations without fear of endangering their social and economic security."

Hill is taking graduate work in physics, Kuhn in mathematics.

George W. Almassy won a Charles A. Coffin Award from the General Electric Co. this month, in recognition of his outstanding initiative and ingenuity in designing and testing an improved aircraft electrical power supply system. Almassy, who is now Resident Engineer for the Industrial Control Division of the G. E. Apparatus Department at the Trumbull Electric Manfacturing Co. in North Hollywood, went to work in the Los Angeles office of General Electric in 1942, as a member of the Engineering Division. In 1943 he became a field engineer in the aviation section of the Engineering Division, and it was on this job that he devised and tested the system which brought him the Coffin Award "for work of outstanding merit during 1948."

Harrison Price and wife Anne announce the birth of twins: a boy, David, and a girl, Dana, on February 4, in Oakland. The Price family will soon be on its way to Rio de Janeiro, where Harrison will continue his work as field engineer for the Ingersoll-Rand Company.

1943

John E. Cushing, Jr., Ph.D., is now Assistant Professor of Bacteriology at Santa Barbara College, University of California. Under a grant from the U. S. Public Health Service, he is continuing his research begun last year at Johns Hopkins into the resistance of bacteria to sulfanilimide.

Paul Saunders, Ph.D., is now Assistant Professor in Pharmacology in the School of Medicine at U. S. C. **George Feigen,** Ph.D. '48, Research Associate in Pharmacology at the School of Medicine, is working with Saunders on the problem of the mechanism of cardiovascular drug action. Feigen, incidentally, was married last Halloween to Priscilla Ann Roth, former secretary to Dr. Linus Pauling at Caltech.

1944

Douglas G. Dethlefson, M.S. '48, is attending the Law School at Stanford University.

Raymond L. Ely, M.S., is a teaching assistant in mathematics at Carnegie Institute.

Jay Borden, M.S. '47, and Barbara Hughson, of Niagara Falls, Canada, were married on November 24 in Pasadena. They met in Naples in 1946 when Jay was a 1st Lieut. with the U. S. Signal Corps., stationed in Caserta and Barbara was an Army Nurse (2nd Lieut). Jay is now a research engineer on guidance and control with the Jet Propulsion Laboratory; Barbara is a nurse in the obstetrical department of St. Luke's in Los Angeles.

1945

Kenneth Gale Anderson received his master's degree in aeronautical engineering from the University of Minnesota in December.

Richard A. Dean got his master's degree at the autumn convocation at Ohio State.

1946

W. Clifford Taylor has settled in Phoenix, Arizona. He's co-owner there of the Southwestern Scale Company, specializing in Howe Scales sales and service.

1947

Alex Smith, Ph.D., is now with the St. Eugene Mining Corp. Ltd., at Vancouver, B. C.

1948

Ray Smith, M.S., is doing graduate work in geology at Princeton University. Previously he worked three months with the Venezuelan Geological Survey, expects to return there next summer.

Kenneth Wright and Margaret Jean Bell of Pasadena announced their engagement this month. They'll be married in the late summer.

Robert P. Brinkman, Robert F. McLean, Curtis Whittlesey, and **Harold Ford,** industrial designers, are all working for General Motors. After an indoctrination course last summer, which included tours of the Electromotive Plant in LaGrange, Ill., the Railroad Fair in Chicago, and various GM plants in Michigan, the boys settled down to work in Detroit: Whittlesey and McLean in Experimental Design; Brinkman in Auto Design; Ford in the Exhibit and Design Studio, which produced the Train of Tomorrow and the recent General Motors show at the Waldorf in New York.

John Attias and Ruth Margaret Christopher of Pasadena have announced their engagement. They're to be married on June 18. Attias is studying for his M.S. in aeronautical engineering at Caltech.

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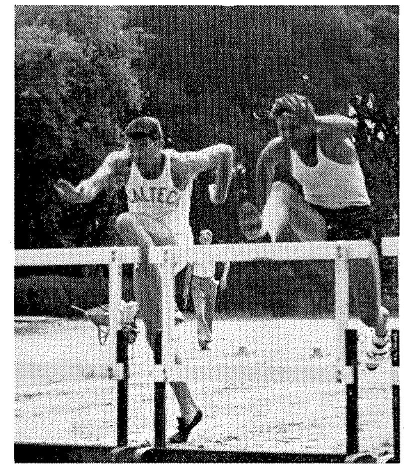

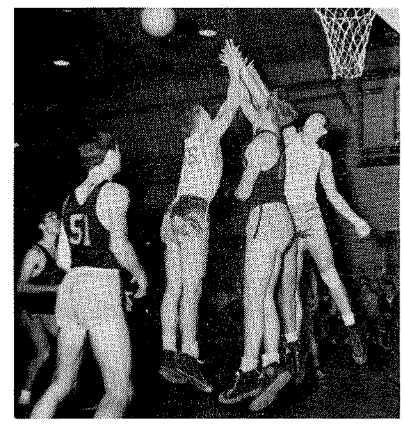

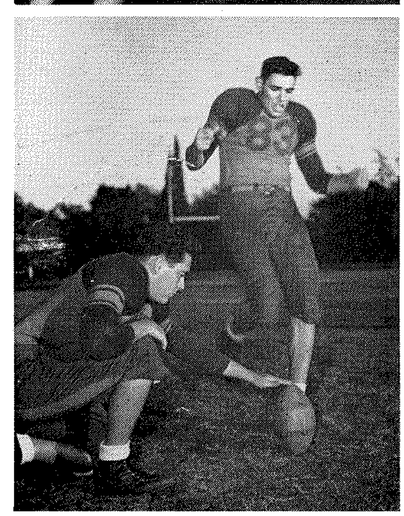

Varsity athletes need a gym—but so do weary refugees from the chem lab. And the newest alumni-to-be know it; the class of '49 has pledged $500. All contributions, large or small, bring the gym that much nearer. Contributions may be deducted from taxable income.

The Alumni Fund is one year old. Its record is impressive. It has raised over $80,000 in cash and pledges -- almost enough to buy one-third of the gymnasium that Caltech needs so badly. The institute has purchased a site, and an architect has drawn up first plans. The fund must continue to grow.

Eventually the fund may be able to help with the rest of Caltech's planned recreational center--a swimming pool, student union, more athletic fields. But right now the goal is a gym. It will cost $250,000 and the Fund has four more years to find the money.

Send your check or pledge today to:

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