YOUR COMPLEXES

How to Overcome Them

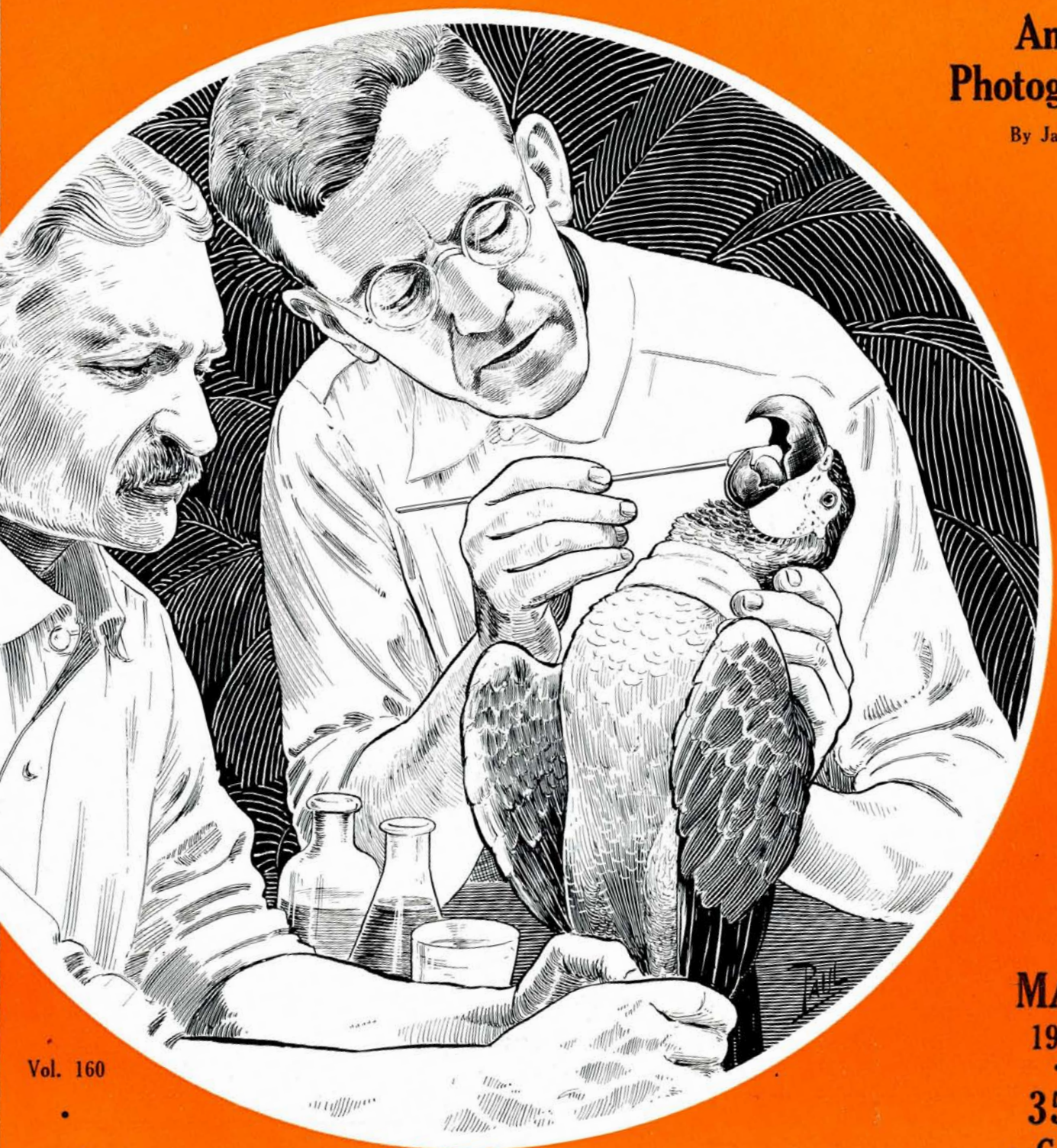
SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography

By Jacob Deschin



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No. 5

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1939

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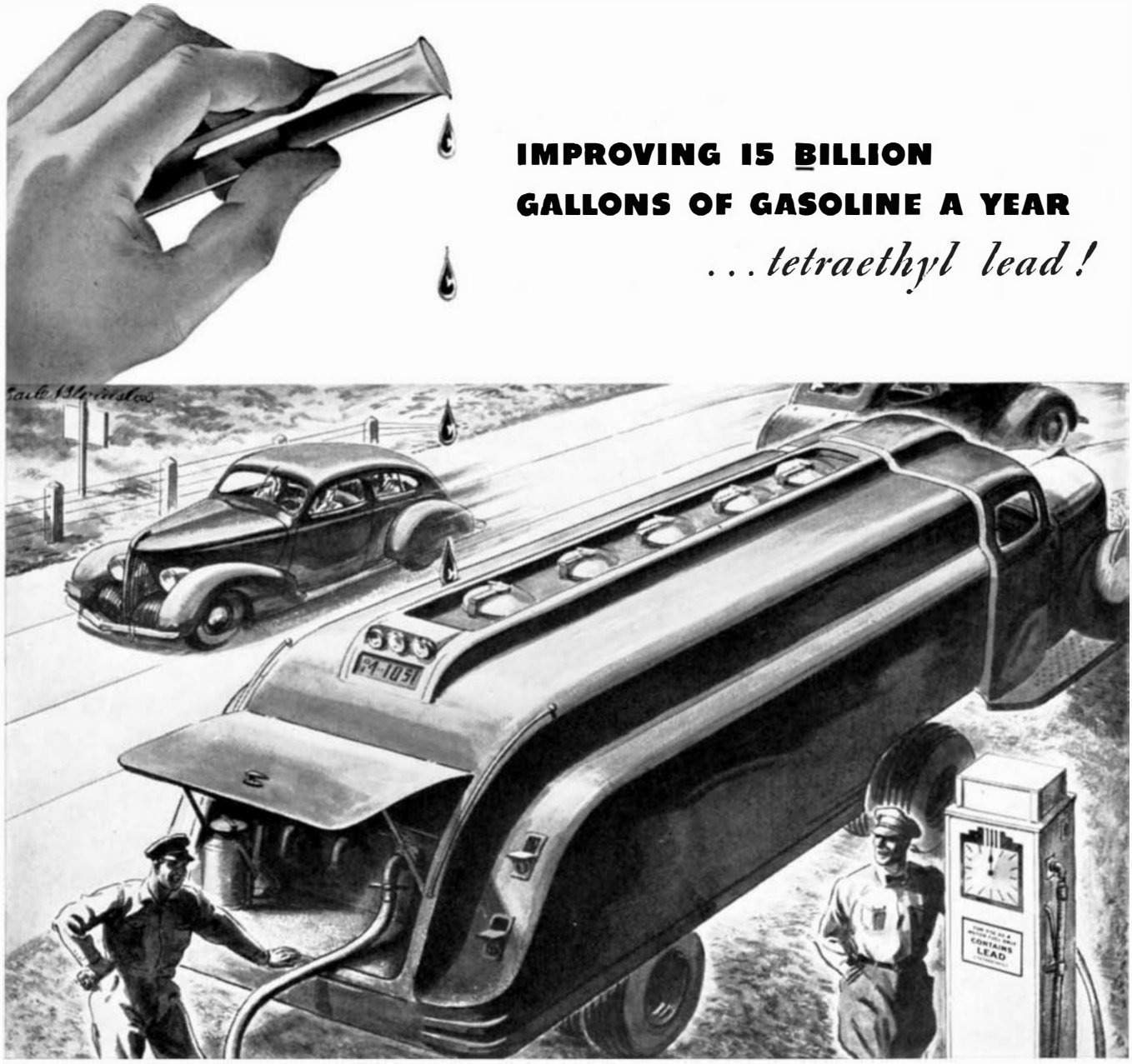

IMPROVING 15 BILLION GALLONS OF GASOLINE A YEAR

. . . tetraethyl lead!

THE automobile, airplane, tractor, bus and truck engines of America not only have a tremendous appetite... but they are fussy in their tastes, too. They will deliver only the performance that the anti-knock quality of the gasoline you feed them permits.

That's why tetraethyl lead is, today, almost as important as gasoline itself. Just a small quantity of this powerful, volatile liquid added to a gallon of gasoline improves its anti-knock value. It acts to prevent the annoying, power-wasting "knock" or "ping" that years ago threatened the development of the modern high-compression engine.

As the active ingredient of the anti-knock fluids made by the Ethyl Gasoline Corporation, tetraethyl lead is now used by oil companies in the United States and Canada to improve more than 15 billion gallons of gasoline a year . . . over 70% of all motor fuel sold in these two countries. It is this "leaded" gasoline that is helping modern high-compression engines give more power with less weight, run farther and faster on less fuel.

At the right you see what tetraethyl lead means in the performance of your automobile:

TODAY EVERY CAR HAS 3 GRADES OF PERFORMANCE

Because there are different grades of gasoline sold today, your car has different grades of performance, depending on the gas you buy and the spark setting. Use the chart below to help you make your choice:

BEST PERFORMANCE—with gasoline marked "Ethyl" on the pump or globe. It is highest in anti-knock and all-around quality. Contains enough tetraethyl lead so that your engine's spark can be *advanced* closest to the point of maximum power and economy without "knock" or "ping."

GOOD PERFORMANCE—with "regular" gasoline, which permits the spark to be considerably advanced without "knock" or "ping." Most "regular" gasolines now contain tetraethyl lead, as shown by the "Lead" signs on the pumps.

POOR PERFORMANCE—with low-grade gasoline, poor in anti-knock quality. With low-grade gasoline in a modern car, the engine's spark must be *retarded*—which means *loss* of power and economy.

THIS THURSDAY NIGHT TUNE IN ON "TUNE-UP TIME" featuring Walter O'Keefe, Andre Kostelanetz' Orchestra . . . Kay Thompson and Rhythm Singers . . . Columbia Broadcasting System, 9 p.m., E.S.T.

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

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NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

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SEVERAL years ago the United States became alarmed at the outbreak of a serious disease, psittacosis, carried by parrots and related species of birds. Hence, nowadays, parrots are very carefully watched to prevent a recurrence of the disease which is discussed in the article on page 282. Our cover drawing shows John Regan, Keeper of the Bird House of the Philadelphia Zoo, swabbing the throat of a parrot, while Patrick Conway, Assistant Keeper, holds the bird.

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Books

SELECTED BY THE EDITORS

PLASTICS, PROBLEMS AND PROCESSES

By Dale E. Mansperger and Carson W. Pepper

THERE has long been a need for just such a book as this, which tells the hobbyist or experimenter how to make all sorts of objects from molded plastics. This volume not only discusses completely the method of working such plastics, but also gives a large number of plans, carefully dimensioned, for making many decorative pieces, such as desk sets, candlesticks, dominoes and dice, book ends, drawer pulls, table lamps, napkin rings, and many others. (187 pages 6¼ by 9¼, well illustrated.)—$2.70 postpaid.—*F. D. M.*

CONSTRUCTIVE METALWORK

By James H. Evans

WE might say that this volume should be a companion piece to the one immediately above. It also tells how to make most attractive pieces such as lamps, candlesticks, coal tongs, and such practical things as soldering irons, carpenters' bevel gages, and tea kettles—all in metal. We would characterize this a "must" book for all amateur metal workers. (95 pages, 7½ by 10, well illustrated.)—$3.10 postpaid.—*F. D. M.*

RADIO TROUBLE-SHOOTER'S HANDBOOK

By Alfred A. Ghirardi

PACKED into the pages of this large book is a tremendous amount of data which will be of use to the progressive radio service man as well as to those whose interest in radio carries over into a study of modern receivers, their care and repair. The material is presented in 52 sections arranged from "Case Histories" for common troubles in 2313 models of radio receivers through trouble shooting charts, servicing portable sound recorders and automobile radio sets to transformer design charts, tube data and directory of manufacturers. (1300 pages, 9 by 11½ inches, drawings and tabulations.) —$3.25 postpaid.—*A. P. P.*

PRACTICAL SEISMOLOGY AND SEISMIC PROSPECTING

By L. D. Leet

OF the total content of this very practical book, five sixths are devoted to seismology and one sixth to seismic prospecting, a commercial application of the former. The main part deals not superficially but at close grips with the laws governing the propagation of elastic waves in the earth's materials, the characteristics of instruments for recording earth vibrations and the important types of instruments (specific structural details omitted, however), the practical study of earthquakes with their cause and distribution, and the interpretation of seismograms. The fundamentals of principles and procedures can be mastered by readers who have studied trigonometry, and the book will require study for most readers—it isn't something that can be romped through, but is meaty and solid. It is, however, such a work as has not previously been available to the amateur seismologist. (430 pages, 5¾ by 8¾, 185 illustrations.)—$6.10 postpaid.—*A. G. I.*

FUNDAMENTAL PRINCIPLES OF PHYSICS

By Herman G. Heil and Willard H. Bennett

A UNIVERSITY physics textbook mainly for engineering students, stiffer than many and based mainly on the calculus. It is not designed for reading but for plugging. The treatment runs more to mathematics than to words. (631 pages, 6 by 9 inches, 331 illustrations.)—$5.10, postpaid.—*A. G. I.*

INTRODUCTORY COLLEGE PHYSICS

By Oswald Blackwood, Ph.D.

A BEGINNERS' course for mature students of physics who do not, however, plan to become engineers and do not wish to go far in depth or detail or to use mathematics stiffer than the very simple algebraic equations occasionally sprinkled in. It is full of homely illustrations of force, energy, and so on, from things around us, such as the motor car. (487 pages, 6 by 9 inches, numerous illustrations.)—$3.60, postpaid.—*A. G. I.*

OH DOCTOR! MY FEET!

By Dudley J. Morton, M.D.

FOOT sufferers may throw away arch supports, stop exercises, leave ugly special shoes in the closet's darkest corner and, by getting their feet X rayed and applying the fundamental science—essentially simple engineering—so clearly set forth in this little book, learn the basics of the successful treatment of this orthopedist. He is an Associate Professor of Anatomy at the College of Physicians and Surgeons, Columbia University, but your reviewer remembers him best as a scientific authority, widely recognized, on the evolution of the human foot. It would appear that even the average physician has given but little thought to feet, while the shoeman's approach is often superficial. (116 pages, 5 by 7½ inches, illustrated with X-ray photographs.)—$1.60, postpaid. —*A. G. I.*

MARIHUANA

By Robert P. Walton

HASHISH, or marihuana, is the plant used in "reefer" or "Mary Warner" cigarets, fast becoming a sociological problem. This is a comprehensive general source of information on marihuana smoking—its history, distribution, present status in this country, its menace; also the plant source, technic of its use, with vivid or lurid descriptions of the hashish experience, and acute and chronic effects; also its legitimate therapeutic applications, pharmaceutical and chemical considerations relating to the drug, chemical composition, and nomenclature. (233 pages, 6 by 9 inches, 17 illustrations.)—$3.10 postpaid.—*A. G. I.*

SCIENCE EXPERIENCES WITH INEXPENSIVE EQUIPMENT

By Carleton John Lynde, Ph.D.

A COMPANION book to that small volume "Science Experiences With Home Equipment" which has enjoyed a very large sale. This one deals with physical principles that when practiced by the amateur in the home savor of magic to the observer. A few examples are: How to remove a bottle cork without touching it; Centrifugal force demonstrated with an egg beater; Lifting a bottle with a soda straw; Making bubbles that float and burn. Each of the 200 experiments is well illustrated with several clear drawings. (255 pages, 5¼ by 8.)—$1.70 postpaid.—*F. D. M.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

FOR OTHER BOOKS YOU WANT, SEE PAGES 322 AND 324

OUR POINT OF VIEW

Modern Alchemy

ARE American research chemists asleep? Are their efforts puny in comparison with the efforts of chemists abroad? Are the self-sufficiency drives of some foreign nations—to discover laboratory-made products to supplant imports or eke out a diminishing native supply—putting to shame the American democratic system of free enterprise?

Such questions have been asked often and as often answered—in the negative. Dr. C. M. A. Stine, of the duPont Company, answered them again recently in a talk which emphatically stated that "no nation anywhere, whatever its form of government, has surpassed this country either in the quantity or quality of the new materials of its industrial science." American chemical products now represent half the world's output. We have established our self-sufficiency in dyes and most drugs; we make nitrates from the air and camphor from southern turpentine; and silk, bristles, and gut may some day cease to be imported products for we have a new synthetic, nylon, which can take the place of all three and can as well be made in sheets and solids. Several rubber substitutes are available to give vital aid in an emergency; and if we were faced with a shortage of wool, we could make a substitute from milk from a formula already known. Indeed, scanning the chemical field we find that practically everything announced—with the layman correspondent's usual awe—from Europe is already an accomplished fact in America but simply not commercialized because we are not economically hard up, or else is in the laboratory ready to emerge when needed.

Dr. Stine's statement that "more than 200,000 compounds wholly new to man have emerged from the chemical laboratory in less than a quarter century," confirms this writer's contention that we have entered upon a synthetic chemical age. Moreover, it bids fair to surpass in spectacular accomplishment, in economic importance, and in social values any other comparable period through which man has passed. Already, gigantic industries have been built on some of the new chemicals—rayon, plastics, and now comes nylon—while a host of smaller ones have grown up around hundreds of lesser chemical developments. Other industries will certainly spring from the new products now being worked out painstakingly by thousands of our most brilliant chemists. Their success is assured because their approach is right; they have ceased looking upon wood, coal, metal, fibers, and the like as raw materials and have gone further backward to basic elements. They now work primarily with carbon, oxygen, hydrogen, and nitrogen—from the air, water, soil, from coal and many forms of plant life. The superabundance of these elements promises, in our opinion, long life to the new Synthetic Chemical Age.—*F. D. M.*

Safety for Private Fliers

TRAGEDY stalked two young aviators recently—and caught up with them in a fog over Long Island, New York. And the truly unfortunate part of the whole affair was that their deaths could have been avoided with facilities that are available but were not in use at the time. If it were compulsory that private planes be equipped for two-way radio communication, it is quite likely that these two young men would still be alive.

The way it all happened was this: Having rented a plane for a week-end trip, the fliers started from a point in Connecticut and headed for Long Island. The weather was good at the point of take-off and flying was uneventful until fog was encountered over Long Island. Circling lower and lower in an effort to get their bearings or make a landing, a wing-tip struck a water tower and the plane dashed to the ground.

While it is true that weather reports could have been obtained if these men had landed at one of the large airports in Connecticut, such information was not available at their starting point. Without radio equipment they could not obtain reports en route, and thereby lies the point of our plea. Simple, lightweight, relatively inexpensive two-way radio equipment is available for aircraft use. It enables the pilot at all times to keep in touch with ground stations, to know in advance what weather conditions are ahead of him and thus to be prepared for any emergency. Knowing, for example, that there is fog at the airport toward which he is heading, he can turn back or land safely at a nearby field.

There is nothing new or untried about aircraft radio. It is in daily use by air-transport lines. It has proved its value times without number. But there is no rule or regulation that makes its use on private planes compulsory. Here is a job that the Civil Aeronautics Authority should take over immediately. With two-way radio equipment on private planes, especially those for hire, their pilots would have the same safety advantages as do those men whose daily routine on the air-transport lines has piled up such an enviable record of flights completed without accident. The radio weather reporting system is in operation. The private flier needs only to have the necessary equipment to make use of it. If he will not have it installed of his own free will, the CAA should see to it that he does for his own safety and for the good of aviation as a whole.—*A. P. P.*

No Peace On Earth

EARLY in 1929, just a decade after the world's preoccupation with its War Number One had relaxed sufficiently to permit it to become for the first time aware of Professor Einstein and his theories, transatlantic cables announced that he had completed a new theory bringing under a single set of laws the phenomena of electricity and gravitation. In the intervening ten years the press had so surrounded him with an atmosphere of mystery and romance that people flocked to his Berlin apartment and Frau Einstein told reporters that he was being driven crazy by the attendant publicity. He acquired a worried and nervous manner and a defensive exterior and pleaded that he hated publicity.

The absurd antics of an absurd world struck him as ridiculous. So inflated was curiosity in this nation that one enterprising New York newspaper went to the expense of cabling his published paper from Berlin—which would not have been an unusual feat had his written theory not consisted almost entirely of the most abstruse mathematical hieroglyphics each of which had to be described at some length because there is no cable language for mathematics.

In the meantime the great physicist hid behind the iron door of his attic retreat, with his piano and fiddle and small telescope, until the persecution waned.

A few years later another variety of persecution drove Professor Einstein to this country, where he thought persecution would end, yet he never has been quite able to escape it. While the dozen reporters who are themselves scientifically backgrounded have behaved admirably, others have continued to bombard him with such questions as "What do you think of American women?"

Now he has announced another try at the field theory and in doing so he has actually been forced to leave his home and hide from the hounds of undesired publicity. Our national nosiness drove Col. Lindbergh from his native land: Are we now to drive the great physicist away again or else crazy?—*A. C. I.*

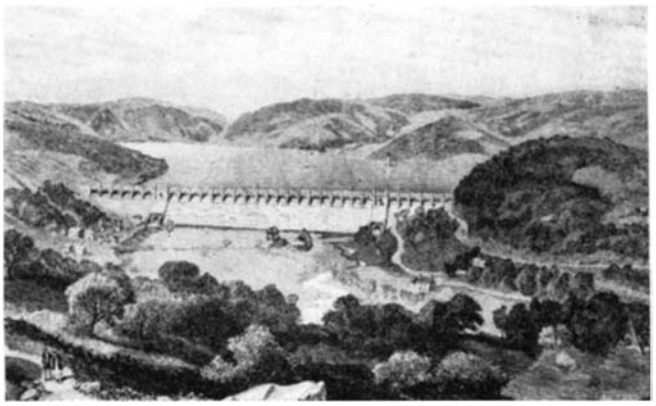
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1889)

CANAL—"The most serious feature of the Nicaragua canal project, in a contracting and financial sense, is the great rock cut at the eastern divide, 3 miles long and averaging 120 feet deep by 80 ft. wide on the bottom, containing in all some 7,000,000 cubic yds. of material, or say 440 cubic yds. per lineal foot."

WATER—"One of the grandest engineering works of modern times, undertaken by the Corporation of Liverpool to supply that city and its suburbs with an abundance of the purest water from a sequestered valley high up among the mountains of North Wales, is now approaching its successful consummation. . . . The stone of which the dam is built was taken from a quarry about a mile distant, to the



north. . . . The stone was too hard for pick work; hammer and chisel, or hammer and set, were, therefore, almost exclusively used. When brought to the dam by locomotives and wagons running on a 3 foot gauge railway, they were lifted into position by steam cranes and deposited on a bed of Portland cement mortar. . . . The total length of this huge masonry dam across the mouth of the valley is 1172 feet; its greatest thickness at the base is 120 feet; its height, from the lowest part of the foundation to the parapet of the carriage road on the top, is 161 feet."

STEAMER—"The first trip of the new passenger steamer *Puritan*, of the Fall River line, from New York to Newport, via Long Island Sound, was made April 24, with much success. She attained a speed of over 20 miles an hour with 65 pounds of steam. When her new machinery is worked down and full power applied, which is 110 pounds, it is believed she will surpass in velocity any passenger boat afloat."

WAR SHIPS—"According to a careful estimate, the number of war vessels launched last year by the naval powers of the world was 60, while more than 100 were building when it closed. England led, with 15 vessels launched and 28 building; France launched 9, and laid down 15; Russia launched 2, and began 10; Germany put 6 vessels into the water, and ordered or laid down 4; Italy launched 10, and laid down 18 . . . Japan ordered 3, and launched 3; the United States launched 6, and laid down 6."

IRRIGATION—"The Russian government decided about a year ago to commence some irrigation works near Merv for the purpose of rendering the crown lands more suitable for the cultivation of cotton, and during the period which has since elapsed the first part of the scheme has been completed. A dam—30 feet high—has been built across the river Murghab, in the Merv oasis, at a distance of fifty miles from the village of Sultanbund, and the vast quantities of water which are collected in this manner are being distributed to the surrounding country by means of a network of sluices and canals."

PRINTING—"English and Scotch manufacturers of machinery are beginning to find out that (notwithstanding their proverbial prejudice to many things American) their catalogues can best be illustrated on this side of the Atlantic, and many firms are now not only getting the engraving done in this country, but also the printing."

BOSTON—"The Boston *Herald* says that one-third of Boston is now resting on spruce stilts, some 112 ft. long, though in ordinary cases a length of 30 feet is sufficient. But in certain localities 'mud holes' occur which require piles of over 100 feet in length to reach firm bottom."

BURLS—"Burls, used in making veneers with remarkable eccentricities of grain, are excrescences that grow upon various trees, such as the walnut, rosewood, mahogany, oak, and ash. They weigh from 1000 to 6000 pounds, and the largest and best come from Persia and Circassia, and cost in the rough from 15 to 40 cents a pound."

RABBITS—"It is stated that M. Pasteur's plan of exterminating rabbits by inoculation with transmittable virus has proved to be a failure in Australia. The reward of 100,000 dollars offered by the N. S. W. government for an effective mode of destroying the rodents is as yet unclaimed."

TELEPHONES—"*The Medical Press* says there is talk of applying telephones to the infectious wards of the French hospitals, so as to enable the sick people isolated in their contagious sufferings to have the comfort of hearing their relatives' voices without any risk of conveying infection by an interview."

MILK—"It is said fresh milk may be preserved indefinitely by freezing it and maintaining it in the frozen state until wanted for use. Many of the steamers now sailing on distant voyages are provided with steam refrigerators, in which milk and other foods may readily be preserved for any length of time."

EIFFEL—"There are three systems of elevators to be used in the Eiffel tower. From the ground to what may be called the first story, where great restaurants will be established, there will be four elevators, two of the Otis pattern and two of the system of Roux, Combaluzier, and Lepape . . . From this story to the next one, about 400 feet from the ground, the Otis elevators only are employed, in two of the legs of the tower . . . The top lift, a vertical distance of 493 feet, is made by elevators on the Edoux system, in which the carriage is worked by an enormous piston. Those who go above this distance to the lantern will have to climb a spiral staircase."

Personalities in Science

JOEL H. HILDEBRAND

IN recognition of outstanding achievement in physical chemistry, Professor Joel Henry Hildebrand, of the University of California, has received the William H. Nichols Gold Medal of the New York Section of the American Chemical Society. Professor Hildebrand is the thirty-third chemist to receive the Nichols Medal, founded in 1902 "to stimulate original research in chemistry" by the late Dr. William H. Nichols, charter member of the American Chemical Society, and leader of the chemical industry in this country.

More than 400 scientists united in honoring Professor Hildebrand, who was cited for "his study of the solubility of non-electrolytes." The scientific accomplishments of the medalist embrace more than 30 years of research on liquid and solid solutions.

Professor Hildebrand is internationally known in the broad field of physical chemistry. More than that, he has been one of our few contemporary real teachers of chemistry. His public service has been of the highest order. His work in chemical warfare has contributed greatly to our national defence, both in the field and in the laboratory. His whole life has been one of service to science and the public weal.

In responding with his medal address on "Order and Disorder in Pure Liquids and Solutions," Professor Hildebrand declared that "the shapes of molecules have important effects upon the properties of pure liquids and the solubility of one in another.

"The molecules of mercury, for example," he explained, "are spherical, those of paraffin are shaped somewhat like sausages, those of benzene are flat hexagons, while water molecules are right-angled.

"Liquids and concentrated solutions have been much harder to deal with than gases or solids. Some of the earlier theories pictured liquids as analogous to gases, others as quasi-solids. Recently, however, the efforts of a number of competent investigators are combining to develop a general theory of the liquid state more in accord with the actual properties of liquids and solutions.

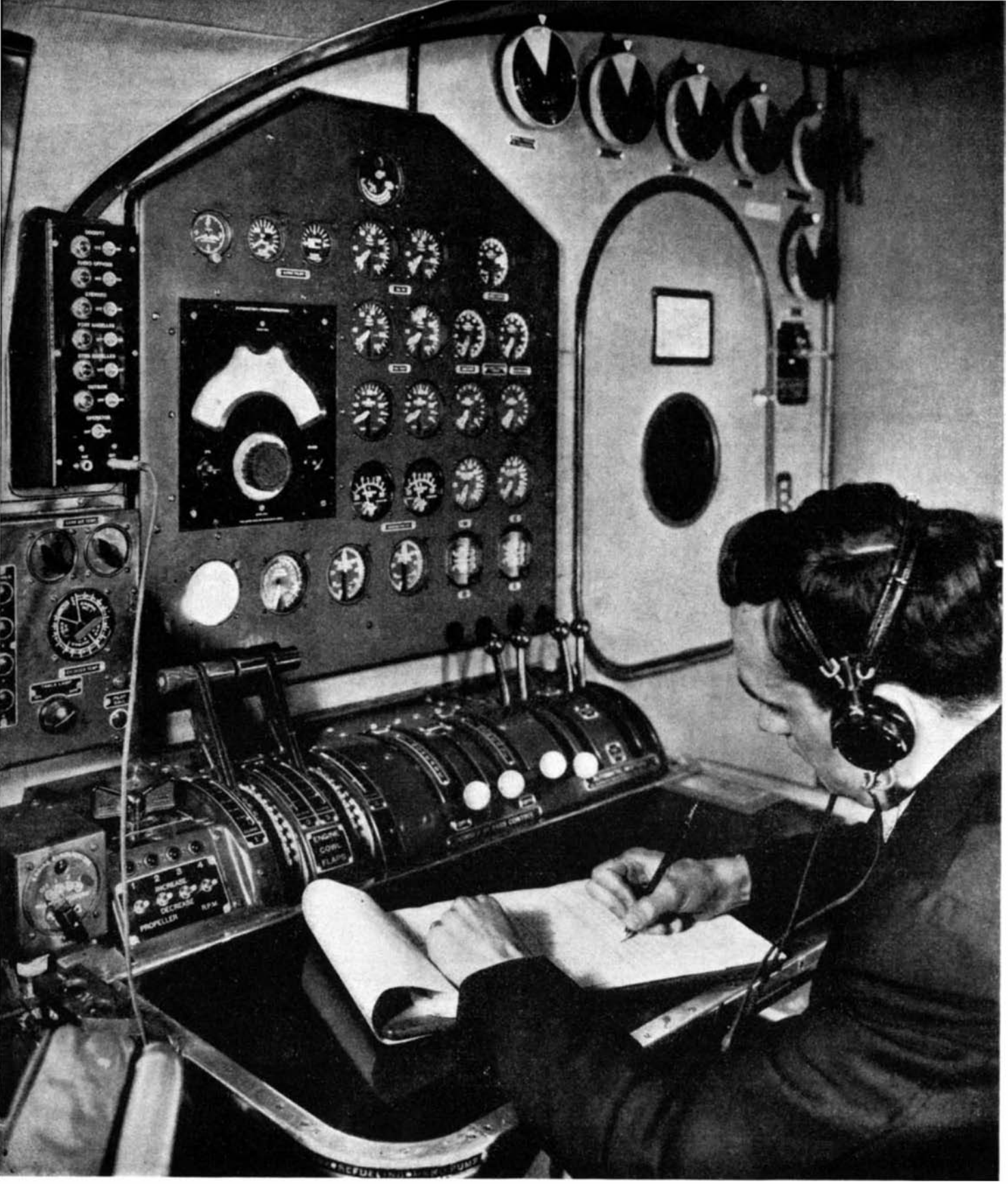
"Light recently thrown on the structure of liquids has been largely responsible for this progress. The scattering of X rays has been a most powerful means of revealing structure, not only of solids, where a large body of knowledge has already been accumulated, but also of liquids. In the case of solids, a lattice structure is revealed, but with liquids the structure is best expressed by a so-called 'distribution function,' a wavelike curve which expresses the frequency at which molecules are found at different distances from any one molecule arbitrarily chosen as a center of reference.

"An artificial model has been constructed, which corresponds closely with the structure of mercury as revealed by X rays. The model consists of gelatin balls suspended in a solution of gelatin, which has been boiled to destroy its power to set."

During the World War, Professor Hildebrand was first commissioned captain of the Ordnance Reserve Corps, then major and later lieutenant-colonel in the Chemical Warfare Service. As director of the Chemical Warfare Service laboratory at Puteaux, near Paris, and as commanding officer of Hanlon Field, near Chaumont, he played an important rôle in organizing the American Expeditionary Force Gas Defense School and the experimental field for gas warfare research under practical conditions, for which he received the Distinguished Service Medal.

He suggested to the United States Bureau of Mines the use of a mixture of helium and oxygen in place of air for divers and caisson workers to prevent the dangerous caisson disease or "bends." The effectiveness of this artificial atmosphere was recently demonstrated by Max Nohl, engineer, with the collaboration of Dr. Edgar End, physiologist of Marquette University, in increasing the record for deep diving by 100 feet.

Professor Hildebrand is a member of the National Academy of Sciences, a past president of the American Physical Society, and a fellow of the American Association for the Advancement of Science. He is president of the Sierra Club and in 1936 managed the United States Olympic Ski Team.



NERVE CENTER OF THE "YANKEE CLIPPER"

LARGEST aircraft in the world, the *Yankee Clipper*, designed for transoceanic passenger service, is the first of a fleet of six being built by Boeing. The ship is an all-metal, double-deck flying-boat powered by four 1500-horsepower Cyclone engines. She will accommodate 74 day passengers or 40 passengers in berths. All engines are accessible for servicing or repair during flight. In the photograph is shown the Engineering Officer at his post where are grouped the instruments and controls for the power-plants. From this point he can communicate by telephone with any of the Flight Officers at their respective stations.

The flying laboratory of United Air Lines. Here is carried on research work that, conducted under actual conditions of flight, yields results which will directly affect future airline policies

How Safe Is Air Travel?

Rapid Advance in Air-Transport Operations Has Been Made Possible by Applied Research That Aims To Take Every "If" Out of Air Travel

By R. E. JOHNSON

THE question, "How Safe is Flying?" is in the minds of 90 percent of the people today who do not travel by air; fear of flying is the reason given by all but 10 percent of non-fliers when they are asked why they do not travel by air.

This fear is wholly out of proportion to the actual risk involved in modern air transportation.

It is predicated on ignorance of the rapid advancement in air-transport operations. It is exaggerated by imaginary conceptions of the inherent and natural obstacles to flying in the form of air pockets, tail spins, and other bugaboos. It is aggravated by dramatization of airplane accidents—airline, private flying, military, and otherwise—which over-emphasizes the extent of airline accidents. It is being gradually eliminated by educating the public and familiarizing them with the facts of the case. Complete public acceptance of air travel will come sooner, perhaps, than is expected, because of the speeding up of visualization facilities for the exchange of thoughts and ideas, and because aircraft manufacturers and accessory producers are going persistently about the job of taking every "if" out of air travel.

In 1938, the airline accidents claimed 25 passenger lives in air-transport planes in regular scheduled operation and flew 22,445,019 miles per fatality, a mileage-per-fatality increase of 88 percent over 1937 when 40 passengers were killed during a year that scheduled planes flew 11,915,079 passenger-miles per fatality. Six times as many people were murdered in Chicago during 1938 as were killed in all of the domestic air-transport accidents during the same year.

The airlines' record is one that stands up well under close scrutiny and attests the success of engineering concentration on those factors which in the past have contributed to airline troubles. In barely more than ten years—air transport last year celebrated its tenth anniversary of air passenger service in the United States—the airlines have inexorably eliminated obstacle after obstacle in the pathway of the highest possible rate of operating dependability.

MECHANICAL failure was a frequent factor in flying ten years ago. This covered a multitude of troubles, the principal one of which can be considered as engine failure. In the early days of single-engined operation, engine failure was a fairly common occurrence and it meant at least a forced landing on the spot.

Another cause of early-day accidents was getting lost, which paved the way for such accident-causing situations as getting off the airway and getting into terrain considerably higher than that on the route, running out of fuel, and so on.

The problem of radio static, which may cause the pilot to get lost by interfering with his use of radio navigating and communication facilities, has figured prominently in certain accidents. Weather likewise has long been a trouble-maker for airlines—ice, fog, unexpected high-velocity winds at upper elevations, and so on.

These, then, have been the principal causes of accidents: engine and other mechanical failures, failure of the human element, and weather. But many things have been done about these conditions in the last few years both in the development of facilities specifically intended to eliminate accident causes and in policies and practices designed to neutralize the human element as the important factor which it has been in the past. Consider mechanical failure, for

A laboratory set-up for creating man-made static for use in testing aircraft radio equipment

example. Modern aircraft engines are truly standards of precision and mechanical efficiency. Instead of engine failure being frequent, or even occasional, it is very infrequently experienced in modern airline operation. Furthermore, there are two engines on modern transport planes, each capable not only of sustaining flight, but also of enabling the airplane to climb as high as two miles above sea level. Thus, in the event of the failure of one engine, the modern airliner, unlike the plane of 1928, can continue with adequate power produced by the other engine. In every other respect there has been mechanical refinement and application of precision workmanship to the point where the modern airplane is an extraordinarily efficient piece of equipment constantly maintained in that condition by the operating machine.

THE questions of weather and human element more or less go hand in hand. It is the recognition of weather conditions and the use of judgment in dealing with those conditions, rather than the presence of the conditions themselves, that determine the effect of weather on airline operation. For example: Today's airplanes are equipped with efficient de-icing equipment in the form of boots along the leading edges of wing and tail surfaces, as well as spinners and fluid de-icing protection for the propellers. However, under extremely severe icing conditions, airplanes with this protection can still get into trouble.

Modern airlines diagnose weather conditions to determine the presence and degree of icing conditions. If they are severe, flights are dispatched around the conditions when that is possible; otherwise they are cancelled. Science will eventually bring to the airplane complete protection against any and all icing conditions but, in the meantime, airlines are exercising conservative discretion in the use of the facilities now available. This is the underlying principle of all transport policies and practices and to a great extent explains the high safety record attained by domestic airlines last year. The recognition of the margins which are allowable on various equipment under various conditions, and the constant adherence to the conservative side of those margins, spell the success that is now attending the advancement of United States airline operations.

Under certain weather conditions, static interference is so bad as completely to put out of commission all radio contact with the ground, either by voice or by directive radio-range signals. Years ago, United Air Lines established a project to attack this problem of static and uncovered information that paved the way for a solution that is as simple as it is effective. After extensive research and experimentation in laboratories, both on the ground and in the air, a simple trailing wire device for the eradication of static was developed and installed at the close of 1938 on all United planes and made available for installation on other airlines. By pressing a button which releases the wire from the tail of the airplane the pilot can eliminate the noises that range from sounds simulating bacon frying over a hot fire to the crashing of cymbals.

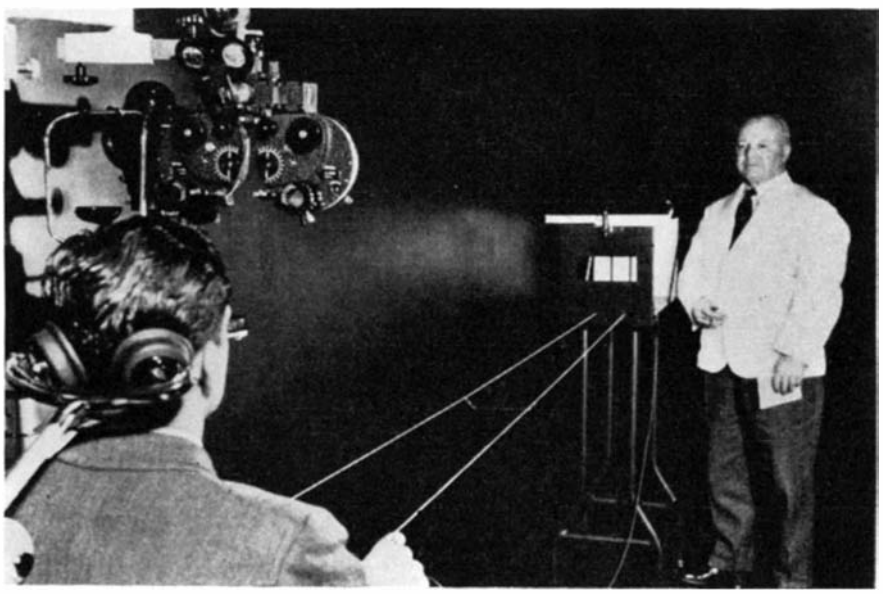
The importance of this development to the safety of air transportation may be better appreciated by realizing that certain accidents have been caused directly and indirectly by lack of such protection against static. Now this simple length of wire, with one end attached to the metal tail of the airliner and the other to a paper drinking cup, which parachutes the wire out into the slipstream and holds it extended, sends this once paralyzing static streaming off harmlessly into space, keeping always clear the precious code radio-range signals and two-way voice messages between the plane and ground stations.

Check and double check and even triple check is the by-word of airline engineers in their offensive against accidents. Trouble was caused in the past when an airplane, flying in the clouds on instruments and losing its radio reception because of static, drifted off its course and flew into terrain substantially higher than that on the airway itself. Several problems of facilities and policies were involved in cases of that kind. One of them, of course, was the elimination of static, which has been accomplished. Another was the development of a device which would tell the pilot how high he was above the ground and warn him should he approach terrain as high as his flight altitude.

THE orthodox altimeters, of course, record elevation in terms of sea level. When a pilot is on course and knows his position, he can easily calculate his elevation above the ground by compensating his elevation above sea level with the known altitude of the terrain over which he is flying. But if he is not sure of his exact location he cannot determine exactly the height of his flight level above the ground.

For more than two years United worked with Western Electric and the Bell Laboratories to develop the answer to this problem. Recently, in a series of exhaustive tests and demonstrations, the answer was made public in the form of a terrain clearance indicator, or an obstruction indicator, which in reality is a radio altimeter recording the plane's elevation in terms of feet above the terrain.

Still another way to solve the problem is to establish prescribed flight altitudes below which pilots are not allowed to

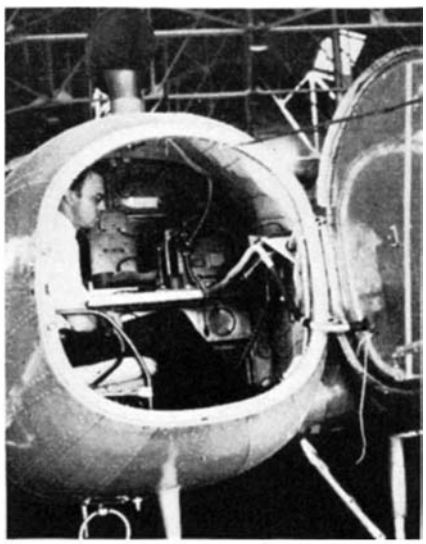


Checking depth perception of an airline pilot's eyes

fly. These altitudes, varying on divisions according to height of the terrain along the routes, are for instrument flying—at least a half a mile above terrain at all times—and are adequate to clear the highest points for some distance on either side of the route. As a check on the maintenance of these altitudes, the airline maintains an automatic recording barograph in the tail of each airplane. This device constantly charts the elevation of the plane's flight and is checked by the dispatcher at the end of each flight to make sure that minimum altitudes are being maintained. Penalties for deviation from these minimum altitudes, without express permission under conditions which would make for increased safety, are as severe as possible.

COMMERCIAL application of instrument landings is practically in effect, with the completion of installation of landing system apparatus at eight airports in the United States and the plans of airlines soon to install necessary receiving equipment in transport planes.

In August, 1937, a series of instrument landing demonstrations were made at Oakland Municipal Airport before commercial airlines, Government civil air authorities, and military aviation officials. These demonstrations culminated five years of intensive work and paved



Equipment in the nose compartment of the airplane shown on page 279

the way for the successful completion of the instrument-landing method.

A basic instrument-landing system had been installed in Oakland by the Department of Commerce in 1933 and turned over to United for any use it might make of the existing equipment. Pilot R. T. Freng, now director of flying for the company, did the major share of the actual flying during the experimental program and, in 1934-1935, with the cooperation of J. R. Cunningham, Director of Communications, developed the use of the automatic pilot in instrument landings. Their work simplified the problem and paved the way for a ready acceptance of this important aid to air safety. Freng made approximately 475 landings on the instrument-landing system during the development period.

Because judgment is so important in air transportation, the airlines have been developing their personnel to increase the effectiveness of the judgment exercised. For example, one airline, through its own school of aeronautics, provides a thorough and complete system of home study training to all employes at no cost. Its employes thus are educated in the latest safety aids and practices. Practical courses covering every phase of airline operation—meteorology, power plants, mechanics, navigation, air law—have been developed by the faculty of the school and department heads of the airline.

These courses are made available to all employes, who may take any or all of those included in the curriculum. Certain courses are required. For example, all flying personnel have been studying meteorology and advanced meteorology in the past three years. In many cases the courses are conducted in seminars, and, in any case, the student's work is thoroughly checked and a written report on each lesson is given by the faculty.

The purpose of the extensive home-study program is both to improve the employe's ability and efficiency in his particular work and to develop him and prepare him for advancement. The net effect is considerably increased efficiency in employes.

Still another move being made by the airlines on the scientifically laid out program of accident elimination is in the medical direction. Every airline maintains health checking service for its flight personnel, but Colonel A. D. Tuttle, M.D., formerly Commandant of the Army's School of Aviation Medicine and now company medical director for an airline, has gone further and has just completed the world's first continuing medical study of the physiological effect of flying on passengers.

Representing an examination of the records of 261,370 passengers carried on one airline's planes during the past year, the study showed that only 0.59 percent of passengers "suffered discomfort of any kind, including nervousness," Colonel Tuttle stated.

Only three passengers in a thousand were troubled with air-sickness, a rate not only much lower than that applying to sea-sickness, but one comparing favorably with land surface transportation, according to comparisons made by Colonel Tuttle with National Safety Council statistics.

Aside from air-sickness, one interesting feature of the study was the fact that there were cases of ear trouble reported in only 0.05 percent of all passengers carried during the entire period. Despite the occasional evidence of the effect of altitude changes on the ears of passengers during ascents and descents, the survey revealed that only 1441 out of 261,370 passengers underwent ear discomfort. This can be attributed to the company policy of restricting descents to a rate not to exceed 300 feet per minute and climbs to not more than 400 feet per minute. Thus the gradual change of pressure is not too great for compensation in the ear passages.

Hearing of air pilots is regularly tested by means of an audiometer

Although numerous estimates have been made in the past as to the prevalence of air-sickness, ear trouble, and other discomforts, this is the first authoritative study to be made on the subject to determine the real facts in the light of modern air transportation.

It is believed that, if the continuing study had been started several years ago, results would have been definitely less favorable in respect to the observable rate of air sickness; in fact, it is quite probable, according to Colonel Tuttle, that five years ago, or even less, the percentage of those passengers discomfitted by air sickness was substantially higher than is now indicated and very probably approximated the estimate of 3 or 4 percent made by airline publicity people.

In those days airplanes flew at relatively low levels. Flight altitudes of 1000 to 2000 feet above the terrain were average and in the case of schedules operating in the face of appreciable headwinds, even lower cruising elevations were maintained. This alone aggravated susceptibility to air sickness as those flight conditions much too frequently encountered rough air. In contrast, today's operations average from 4000 to 6000 feet, and even more, above the ground; generally speaking, at those flight altitudes smooth air is the rule rather than the exception. Almost invariably the air is smoother at high altitudes than at low altitudes.

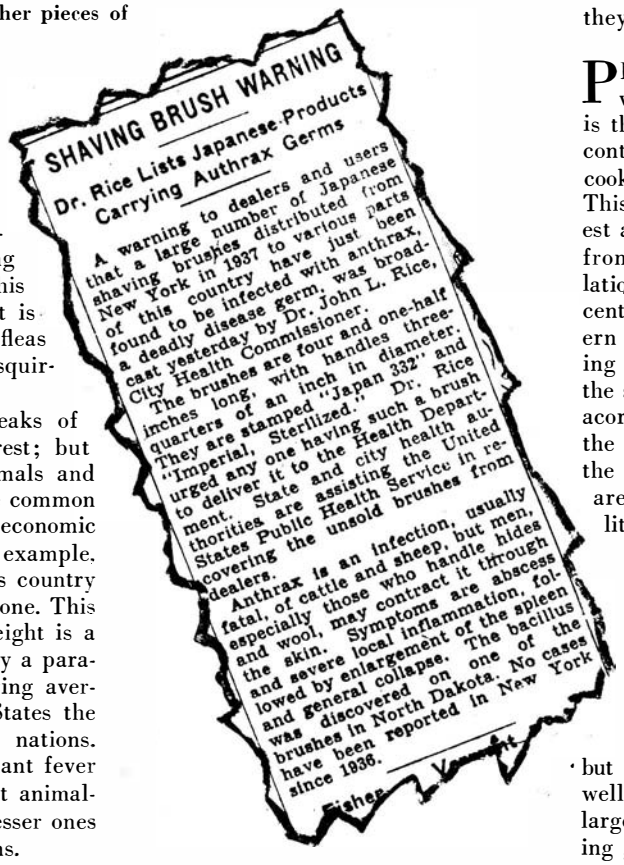
Animals Bring Us Diseases

Pets, Domesticated and Wild Animals Carry Bacilli Deadly for Humans . . . Are Hosts to Parasites Causing Serious Human Ailments, Death

By WILLIAM WOLF

ANIMALS are carriers of certain diseases which can be transmitted to man despite the zoological gap between him and the animals in his immediate environment. Several such diseases entered the news recently. Typhus, for example, broke out in Poland among Jewish exiles from Germany. Tularemia, or rabbit fever, cases showed a sharp increase in the United States in 1938. Rocky Mountain spotted fever, having journeyed across the nation to the east, entrenched itself more firmly in the Middle Atlantic states and caused a number of fatalities. More alarming was an epidemic of bubonic plague among rodents in the far west, for this dreaded pestilence of the past is carried to man by bites from fleas which desert infected rats and squirrels.

Making a culture of anthrax in the laboratory, using infected goat hide with other pieces of hide in the search for a disinfectant. *Below:* A clipping from a New York newspaper



SHAVING BRUSH WARNING

Dr. Rice Lists Japanese Products Carrying Authrax Germs

A warning to dealers and users that a large number of Japanese shaving brushes distributed from New York in 1937 to various parts of this country have just been found to be infected with anthrax, a deadly disease germ, was broadcast yesterday by Dr. John L. Rice, City Health Commissioner.

The brushes are four and one-half inches long, with handles three-quarters of an inch in diameter. They are stamped "Japan 332" and "Imperial, Sterilized." Dr. Rice urged any one having such a brush to deliver it to the Health Department. State and city health authorities are assisting the United States Public Health Service in recovering the unsold brushes from dealers.

Anthrax is an infection, usually fatal, of cattle and sheep, but men, especially those who handle hides and wool, may contract it through the skin. Symptoms are abscess and severe local inflammation, followed by enlargement of the spleen and general collapse. The bacillus was discovered on one of the brushes in North Dakota. No cases have been reported in New York since 1936.

These, plus endemic outbreaks of rabies, held the public's interest; but other diseases carried by animals and acquired by man are far more common and cause greater health and economic concern. It is estimated, for example, that 16,000,000 persons in this country are infected with trichinosis alone. This means that one out of every eight is a victim of this disease caused by a parasite found in pork—a staggering average which gives the United States the highest incidence among all nations. Bovine tuberculosis and undulant fever are among the other important animal-conveyed diseases, while the lesser ones pose their own health problems.

Animals provide food for man, they serve as beasts of burden, they furnish fur and wool for clothing. Man lives intimately with some as pets and he tolerates the existence of rodents. The price paid for this proximity and employment of animals sometimes is illness and death. It is a needless payment, too; for, with a few exceptions, every one of these diseases could be controlled or eradicated.

Trichinosis, the most important of these diseases at present, is caused by a small nematode worm, the *Trichinella spiralis*, which is found in the flesh of swine, and some other animals. Man takes in the trichinae through eating pork products, and in the human body they enter the digestive tract, the lymphatic, systemic, and pulmonary circulations, the brain, the heart muscles, and the striated, skeletal, and other muscles as circulating larvae, matured adults, or as degenerate larvae which become encysted—and eventually calcified—in muscular tissue.

Here is a health menace of major proportions, for there is no reason to doubt Public Health Service investigators' conclusions that 12.5 percent of the country's population is affected. Indeed, that percentage may be conservative, for mild cases may be diagnosed as almost anything, some 50 disease conditions having been listed as having been confused with trichinosis. The number of trichinae in human beings depends entirely upon the number ingested, for they do not multiply in the body of man.

PIGS become carriers of trichinae in various ways, but the most important is through the consumption of garbage containing scraps of raw or partly cooked pork infested with trichinae. This accounts for the fact that the highest averages of trichinosis are reported from Boston (27.6 percent of the population) and San Francisco (24 percent), since both the eastern and western seaboards have large garbage-feeding establishments supplying pork. In the south, hogs run wild and forage for acorns, grain, and vegetable feed with the result that the southern states have the least number of cases. Where hogs are grain-fed in the midwest, there is little trichinosis.

In recent studies on trichinosis, Maurice C. Hall and Benjamin Collins, of the U.S. Public Health Service, emphasized the fact that pork is a wholesome, desirable meat, and that the widespread prevalence of trichinosis is not a reason for not eating pork, but an excellent reason for cooking it well. Thirty minutes to the pound for large, thick cuts is an approximate cooking guide.

Unlike trichinosis, bovine tuberculosis, another disease contracted from animals, has been studied and well under control for many years.

The consumption of raw milk from infected cows spreads this disease to human beings. However, county by county, area by area, and state by state, tubercular cattle have been eliminated from herds until today the percentage of reactors to the tuberculin test, devised by Robert Koch in 1890 and later improved, is only 0.7 percent, whereas in 1917 it was 3.2.

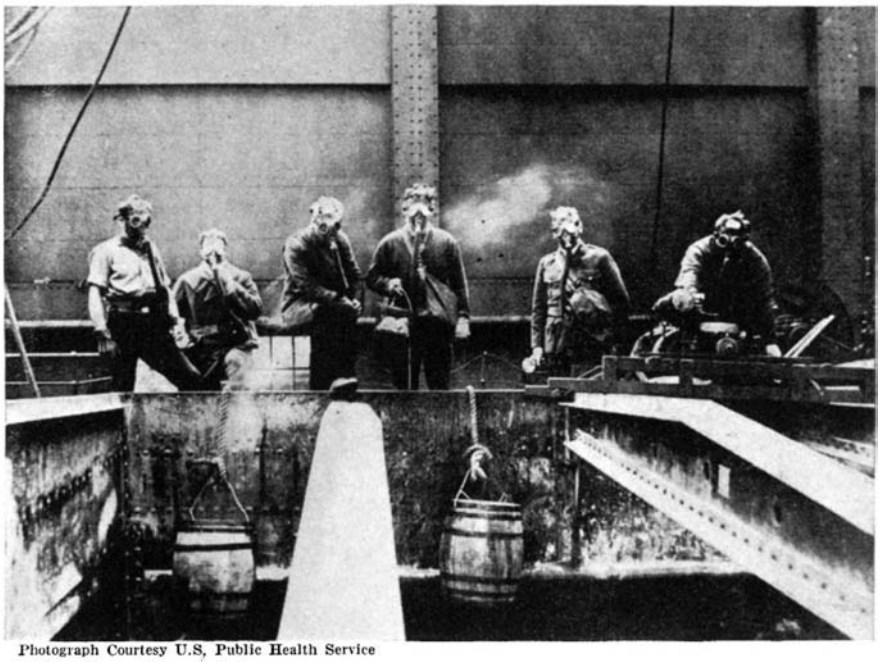
Chronic brucellosis, or undulant fever, another human disease due to the use of raw, or unpasteurized, milk, is increasing, however. By the end of August, 1938, there were 2000 reported cases in this country, twice as many as in all of 1937, indicating a peak year. The first reported epidemic here occurred at Phoenix, Arizona, in 1922.

Medical interest in undulant fever dates back to the Crimean War when thousands of British soldiers in the Mediterranean basin were stricken with Malta fever, a variant caused by goat's milk. In 1886, the germ was discovered; in 1897, the germ causing contagious abortion in cattle was isolated; and in 1918, bacteriologist Alice C. Evans, of the U.S. Public Health Service, announced that the two were closely related, later proving that the human disease originates in cattle, goats, and swine.

The disease often is incorrectly diagnosed because its milder forms resemble influenza and the more severe attacks are similar to tuberculosis, rheumatism, typhoid, and malaria. It receives its name of undulant fever from the distinguishing tidal fever which advances in the afternoon, reaches a peak from two to five P.M., and then recedes in the evening. Fatalities fortunately are rare, but the disease leaves the heart weakened.

TWO tapeworms better illustrate the close and long-continued relationship between man and domestic food animals than any of the preceding diseases, for their immature or larval stages are lived in animals and their adult stage only in man. Human beings, in other words, are essential to their life cycle. They are the pork tapeworm, *Taenia solium*, and the beef tapeworm, *Taenia saginata*, both of which enter the small intestine of man when released by the digestion of raw or slightly-cooked meat.

In 1934, some 300 inhabitants of Sackville, a woolen-working town near Philadelphia, packed up and deserted their homes in a dramatic mass exodus because the 134-year-old village was threatened with a major outbreak of anthrax. Anthrax is an infectious disease attacking the skin, respiratory, or digestive systems. It is caused by a specific micro-organism, the anthrax bacillus,



Photograph Courtesy U.S. Public Health Service

The first line of defense against the importation into this country of bubonic plague and typhus fever: ship-fumigating squad at a U.S. Quarantine Station

and is common to cattle, horses, sheep, goats, and wild herbivorous animals.

The cylindrical bacilli, on being released from an animal's body, produce, on contact with air, elliptical spores highly resistant to heat, cold, drying, and disinfectants. In the Sackville case, the anthrax spores were in the soil and in the old houses, and the bacilli and spores were in the factories where the men worked.

Man acquires the disease through handling wool—hence the name "wool-carders' disease"—from hides in leather-working establishments, from infected carcasses, or from the soil. Pennsylvania, a tannery center, gets from 15 to 20 anthrax cases annually. A fourth of these human victims die.

Glanders can be contracted by man from horses and mules, but is of little importance medically. Horses, however, are responsible for an entirely new disease, encephalomyelitis, a brain infection which killed a dozen children in New England recently. It is carried from horses to human victims by the bites of mosquitoes.

The cry of "mad dog" still rouses terror in human beings, for rabies is a 100 percent fatal disease if contracted, although the Pasteur treatment, in general use for several decades, is 100 percent effective *if employed in time*. This nation, strangely enough, tolerates rabies. According to John R. Mohler, of the Bureau of Animal Industry, "there is no communicable disease which is more easily prevented and eradicated than rabies."

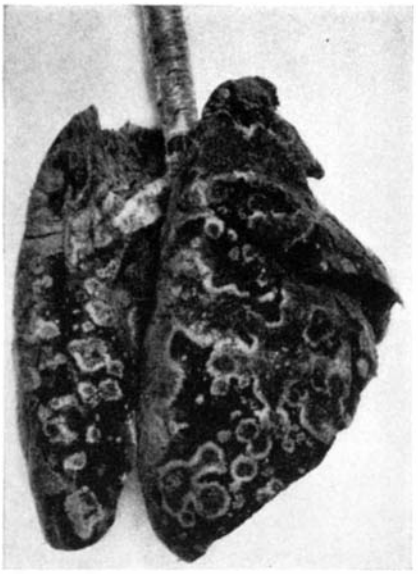
Rabies is conveyed to man, of course, principally through the bites of infected dogs or through saliva from a rabid dog entering a break in the skin. Five years ago a three-months-old puppy became a pet in a California C.C.C. camp and developed rabies. Seventy-two persons, including 62 C.C.C. men, four U.S. rangers, and six civilians were bitten, licked, or otherwise exposed, and all 72 took the Pasteur prophylaxis.

There are two types of rabies in dogs: the furious, violent, or irritable, and the dumb, or paralytic, type. Furious rabies are of greater concern to human beings, for the violent dog will roam, fight, and bite. Cattle bitten by rabid dogs develop both types. Cats usually contract paralytic rabies.

The Pasteur treatment has no curative value and is useless after rabies develops, which, mercifully, isn't until approximately a month after exposure, allowing time for the treatments. Usually 14 injections are given, but in face or neck wounds a series of 21 or even 28 will be administered. Bites about the head are particularly dangerous because of their proximity to the brain and spinal cord.

NOT all bites from rabid animals cause rabies in man. The virus is transmitted in about 30 percent of cases; but all persons exposed should be given the prophylaxis. There are occasional curious cases of lyssophobia, or pseudo-rabies, in which the imagination creates all the symptoms of hydrophobia—except that the "victims" recover.

The cost of rabies to this country is not reckoned so much in the number of deaths—about 100 a year—as in suffering and anxiety. And it is so easily eliminated. Denmark, Sweden, and Norway have practically eliminated it by requiring that all dogs at large should be muzzled. Great Britain was free of rabies for 16 years until 1918 through strict quarantines; then the disease en-



Photographs Courtesy Army Medical Museum

Lungs and windpipe of a rabbit killed by tularemia. Diseased parts are grayish spots with darker centers. *At right:* Primary ulcer from handling tularemia-infected rabbit

tered the country again and was not checked until 1922. Since then there have been no further cases.

Man's pets are responsible for other human diseases, and the dog is guilty a second time in the case of the eastern type of Rocky Mountain spotted fever, for canine carriers spread the American dog tick which is the vector of this disease. An average of 140 cases are reported annually in the eastern and southern states, an incidence which seems to be increasing. The human mortality rate is about 25 percent—high enough to put spotted fever in the deadly disease class. The western Rocky Mountain spotted fever, caused by the wood tick, *Dermacentor andersoni*, which is common to many rodents, is even more virulent, 75 percent of the cases in central western Montana concluding fatally. The American dog tick, *Dermacentor variabilis*, spreads westward along northern boundary states, overlapping the domain of *andersoni*.

Both ticks are blood-suckers, feeding on human beings at the hairy back of the head or the armpits and, if infected, spread the disease to their human hosts.

The same ticks may carry tularemia, tick paralysis, and Colorado tick fever, a mild infection without the skin eruptions which characterize Rocky Mountain spotted fever.

Psittacosis, or parrot fever, deserves some mention under the diseases caused by pets. It is borne by the psittacine birds such as parrots, parrakeets, Amazons, Mexican doubleheads, cockatoos, macaws, and lovebirds and is caused by a mysterious virus about which the present knowledge consists largely of the fact that it is filterable, as demonstrated in 1930. A major outbreak occurred in 1929-30; another in 1932 caused restrictions to be placed upon the importation of carrier birds. In adults over 30, the disease was 24 percent fatal.

The world-shaking great plagues of the past are not dead—only sleeping. The "Black Death" which swept Europe in the 14th Century, destroying one fourth of its population; or the "Great Plague" of London which killed 70,000 in 1665, are no farther removed from us than the states of California, Nevada, Montana, Idaho, Oregon, Washington,

and Utah. Not that many human beings are affected in those states, but rats and squirrels are victims and the disease is spread to man by fleas which desert plague-killed rodent hosts. There were five human cases early in 1938, enough to make the U.S. Public Health Service increase its efforts toward exterminating rats and ground squirrels in the area. Health officials were not caught unprepared, for they had warning in 1924 when the plague struck 24 persons in Los Angeles.

There are two types, the bubonic plague, transmitted by fleas, and the deadly pneumonic plague which can be carried by the bites of infected animals or even by the breath of stricken humans. In the latter, there is a high fever, constant coughing, and usually fatal termination in three or four days.

Typhus, a highly contagious fever, is another plague borne by fleas and lice from rats. At present it is an ever-present menace to world health, for a typhus outbreak followed the cholera epidemic in China's war zones in 1938; and, in Spain, refugee camps swarming with women, children, and vermin create ideal conditions for an epidemic that could easily become pandemic. The means of prevention are at hand here, however. In 1932, Dr. Dolla E. Dyer, U.S. Public Health Service, developed a vaccine for the flea-borne type and then Dr. Hans Zinsser, of Harvard, prepared a vaccine for louse-borne typhus.

Some idea of what typhus means to the human race can be gained from past epidemics. In 1914, the disease killed 150,000 Serbians and 30,000 of their Austrian prisoners of war. From Serbia, it spread to Russia where it attacked the amazing total of 25,000,000 persons, killing 3,000,000. It was kept out of the United States by de-lousing American soldiers before demobilization.

Rats also are responsible for occasional cases of rat-bite fever and infectious jaundice. Man acquires the latter through eating, touching, or drinking food contaminated by contact with infected rats.

TULAREMIA, or rabbit fever, is the last of the important rodent-carried diseases and has caused recent consternation among health officials because of a sharp increase in cases. Illinois was particularly hard hit last fall with 10 deaths in less than a month and 243 stricken, but other widely-scattered states had fatalities. The Middle Atlantic states reported a number of deaths. East St. Louis, Illinois, barred the sale and transportation of rabbits after 26 cases within 15 days.

The disease is acquired by handling the flesh or entrails of infected animals with the bare hands, or through the bites of various tularemia-infected insects, including the Rocky Mountain spotted fever tick. An ulcer usually marks the site of infection, appearing two to eleven days after infection. If the infection is from an insect bite, the ulcer usually appears on the neck, face, hands, or arms or other exposed areas; if from a tick, any part of the body but the feet; if from contamination through handling infected animals, on the hands. Chills and fever, profuse sweating, and pains in all muscles follow.

The active organism is *Bacterium tularense*—the name of the disease being derived from Tulare County, California, where the first outbreak among ground squirrels was discovered in 1912. Cottontails, jackrabbits, and snowshoe hares cause 90 percent of the human cases, although the disease also is carried by sheep, tree and ground squirrels, sage hens, red fox, ground hogs, muskrats, skunks, cats, dogs, and opossum.

Health officials advise wearing rubber gloves when handling rabbit carcasses, protection against insect bites when in the woods, and extra precautions and prompt treatment if exposed.

Most of these diseases are well under control. The few exceptions fortunately are diseases which can be eradicated by forceful action on the part of public health officials and intelligent co-operation by the general public. Trichinosis, for example, can and will be controlled as soon as the public awakens. Rabies will be reduced to an unimportant disease as soon as dog owners voluntarily or under compulsion follow the advice of health authorities. Care in the use of raw milk will prevent bovine diseases.

On the Site of Armageddon

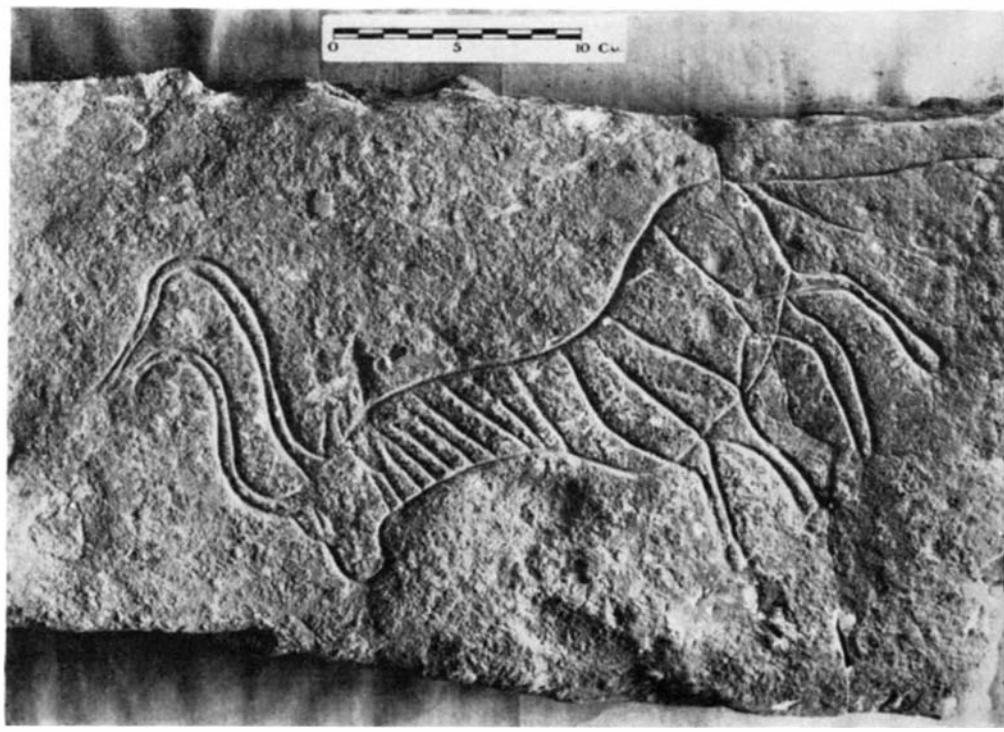
ARMAGEDDON, ancient city mound of Megiddo, in Palestine, around which was a frequent battlefield of the ancient nations, apparently was a walled city as early as 3000 B.C., according to Gordon Loud, field director of the Megiddo Expedition of the Oriental Institute of the University of Chicago. The expedition has excavated more than 150 feet of a great stone wall 15 feet high and 24 feet wide, which probably encircled the entire city site. The city mound has been built up from the debris of some 20 periods of civilization. The expedition made a large cut through one section of the mound only, but the wall continues into the unexcavated portion.

Characteristic of early Bronze period construction, the wall shows considerable skill in the workmanship of the joints of the rough limestone blocks. The two faces of the wall are much more carefully constructed than the inner part, which was filled with stone and rubble. Apparently the original thickness of 12 feet was inadequate, for the construction shows that the width was later doubled.

In completing the cut, the expedition reached bed rock—a soft, chalky limestone which slopes away from the site. Bed rock is immediately below the 20th level of culture represented in the mound.

The cut exposed one cave in the soft limestone which may have been the home of the first inhabitants of the famous site. Neolithic flints, and sherds and bones were found in the cave.

Part of a large, ornamented flagged paving at stratum 19, about 3000 B.C., was disclosed by the cut. Outline drawings of horned animals and of human figures were incised in the stones of the paving.



Top: Ancient city wall exposed by excavations at the third level from the bottom and the eighteenth from the top of this very ancient "stack of pancakes" (superposed city levels). Dump cars and a light railroad used in excavation show in background

Above: An animal cut in a flagstone covering an area at the culture level dated about 3000 years before Christ

Left: Storage bins cut at the very bottom of the big mound—cut and used when, at the very beginning, there was but one city on the Neolithic site

The German Navy At a Glance

FROM "pocket battleships"—limited in size to 10,000 tons—up to actual battleships of 35,000 tons, Germany has expanded her navy effectively in recent years. In this drawing by Oscar Parkes, third of the series which we publish through the courtesy of *The Illustrated London News*, are shown typical ships of the new German navy. It will be remembered that by the Anglo-German agreement, Germany's tonnage in no category except submarines may exceed 35 percent of British tonnage. This restriction is not, however, as stringent as the bare figures would indicate. Greater use of welding and of lighter metals has enabled Germany to devote a larger proportion of tonnage to protective armor and to crowd greater fire power on a given hull. This practice, first observed in the "pocket battleships," will make the new 35,000-ton battle-

ships bigger and presumably superior to similar new ships in other navies. While the drawing (made some time ago) indicates two or three such 35,000-tonners, recent reports have it that three are now under construction and a fourth one is authorized. The first of these, the *Bismarck*, was launched last February. These ships will mount eight 15-inch guns. These guns do not have the range of 16-inchers, but the Germans seem convinced that firing observation from planes, as is necessary with the greater distances involved with the larger guns, is ineffective. Accuracy of fire would be spotted from the ship herself. Furthermore, use of the smaller guns gives an enormous saving in weight, for the 15-inch gun weighs only 844 tons as against 1270 tons for a 16-inch gun. Since the German constructors are still pledged to the pre-war tradition of constructional strength that enabled German ships at Jutland to take a terrific punishment without sinking, it may be assumed that this saved weight will be used in providing greater structural strength as well as added armor.

Your Inferiority Complex

Few of Us Attain that Perfect Balance Between the Two Extremes of Actual Inferiority and Self-Importance that Constitutes Emotional Maturity

By PAUL POPENOE, Sc.D.
Director, The Institute of Family Relations, Los Angeles
Lecturer in Biology, University of Southern California

EVERYONE starts life with feelings both of inferiority and of superiority.

On the one hand, he can not help having his inferiority impressed upon him continually. He is constantly overshadowed by his big, strong parents (and other adults) who can do just as they please with him. He can not even get through a door without their help—he is not tall enough to reach the doorknob—and can only stand and yell until someone comes to assist him.

Things he does with immense effort, or fails to do after endless trials, the grown-ups do without half trying.

How could he help feeling weak and inferior? If he didn't, there would be something the matter with his mind!

On the other hand, the infant is inevitably egocentric, completely selfish, and impressed with his own importance. To himself, he *is* more important than anything else in the world. Lacking perspective, lacking experience of life, lacking ability to judge his own powers, and having a strong will to dominate others (perhaps finding that his parents and others can actually be dominated), of course he develops feelings of superiority.

During the process of development, these strong but contradictory feelings are gradually modified, tempered, and fused into a normal outlook on the world in which the individual recognizes both his own capacities and his own limitations, profits by both, and reaches a balance which represents emotional maturity, good mental hygiene—in a word, sanity.

Many, however, never attain this balance. They are overweighted in one direction or the other. They become the victims of complexes.

A complex is merely a group of related ideas strongly colored by emotion. Because of this emotional tone, it has the tendency to attract to itself and incorporate in itself all sorts of other and originally unrelated ideas.

One may develop a superiority complex because he is clever, finds that he can do things better than other people with whom he is associated, gets along easily where they struggle desperately—in short, because he is riding on top of the waves. ("It's not conceit," said the Bishop; "it's just the consciousness of superiority!")

Even at its best, however, the superiority complex is largely an infantile type of behavior. The genius does not underestimate his own capacities; but he is mature enough, has a broad enough outlook, to know that there are, and have been, other able men in the world, and that none of them has the wisdom to understand fully even the affairs of everyday life.

Indeed, the greater a man is, the more likely is he to be modest and genuinely humble, as seen almost universally among the great men of science.

The man with a superiority complex is therefore really a bright boy who retains the infant's egocentricity, has not grown up enough to recognize his own limitations, and will never be, emotionally, anything more than a precocious and somewhat spoiled child. He has the "Little Jack Horner" complex. (There is another type of conceit which is merely an over-compensation for an inferiority complex, and will be described later.)

THE inferiority complex is probably commoner, and one hears of it much too often. The idea is by no means new—probably it goes back far beyond Aesop—but in recent years it has become a part of the common vocabulary. A student thinks his failure in college is sufficiently explained by the glib assurance, "But I have an inferiority complex!"

As I pointed out above, the inferiority complex has a perfectly natural basis in the experience of childhood, and everyone carries through life what might be called a normal inferiority complex, which is largely responsible for his achievements. He works to accomplish something because he recognizes that it has not yet been accomplished, and he is not satisfied with his own lack of knowledge.

If Einstein had felt perfectly satisfied after mastering Newton's ideas of gravity, he would have gone no farther. He would have said to himself, as Buddha did when he stood under the sacred Bo-tree, "I know it all!", and would have been content to spend the rest of his life imparting this knowledge to his students.

It was his discontent, his feeling that he did not understand, which made him continue to work on the subject.

In a very real sense, therefore, this normal inferiority complex ("Not as though I had already attained") furnishes the driving power for creative achievement.

But the name is usually reserved for an abnormal or pathologicial state which (due to the tendency of the complex to draw unrelated ideas into itself) leads the individual to depreciate himself, to become unduly sensitive, to be too eager for praise and flattery, to adopt a derogatory attitude toward others.

All this, again, is largely a survival of infantile attitudes which, facing adult difficulties, build up for their possessor a more or less organized system of ideas concerning his own place in the world.

Such an inferiority complex may have grown out of some personal handicap, some physical deformity; or it may be an environmental handicap; or both.

If a girl is quite unattractive, she may easily develop an inferiority complex; but she may likewise do so because her parents are divorced and she feels that she is therefore not like other girls; that she lacks something which they, happy in their home life, have had.

This boy grew up subject to constant taunts and ridicule because he was knock-kneed. That one has just as much of an inferiority complex, but it is because his parents made him feel a failure when it transpired that he did not have the talent for mathematics which his older brother possessed, and was constantly bringing home from school low grades in that subject.

There is almost no limit to the possible points of origin of an inferiority complex.

Once it becomes established, of course, it makes its possessor very uncomfortable. He reacts biologically by trying to get rid of this feeling—by trying to make himself more comfortable.

If he can not do this in conscious and useful ways, he will find some unconscious method of easing the situation. He may *repress* the whole thing in his mind,

so that it no longer obtrudes itself on his attention. He may *regress*, that is, drop back to more childish ways of behaving, and try to get the consideration from others that he enjoyed when he was an infant and was not expected to accomplish much. He may *day-dream*, creating for himself an imaginary world in which he can rule as he likes—where he can select the most beautiful movie star as his queen, where he can turn everything into gold at a touch, where he can tell the boss just where to get off!

Characteristically, however, the victim of an inferiority complex attempts to escape from his discomfort by *compensation*—that is, by some sort of mental activity which will bring him feelings of personal worth not attainable in the usual way, and which will thereby enable him to "forget" his feelings of inferiority.

These "attempts to compensate for an inferiority complex" have become traditional; they are innumerable and extraordinarily diverse in form; which one of them an individual unconsciously selects will depend on his own background and personality. Among the best-recognized of them are the following:

1. *Bluffing.*

The boaster and the bully alike are open to suspicion of trying to cover up their own feelings of inferiority. The test is to challenge them in the very field in which they profess particularly to excel. If a man tells you that he has a grand opera voice, ask him to sing before a group. You will suddenly learn that he has a slight cold; or he needs his own special accompanist. The bully is notoriously ready to fight at the drop of a hat—but only with one smaller than himself. Equally notorious is it that the man who is constantly boasting of his sexual prowess is likely, in fact, to be impotent.

Similarly the aggressive back-slapper who knows it all, who is never arguing but always just telling you, who laughs loudest and talks most, who is blustering or snobbish as the case may be, and who is often supposed to have a superiority complex, is much more likely to be suffering from an inferiority complex, which he is trying to cover up.

2. *Posing.*

This is a little more subtle than the bluffing just described. It affords wide scope for the subject's imagination and his ability to dramatize himself.

Mr. W., for example, is a prophet. He is always predicting what will happen and he insists that you attach great importance to his telling you so. "Mark my words" is an injunction even dearer to him than "I told you so"—and usable much more frequently. By dealing only in future events, he can avoid having to face realities. He can attract enough attention for his purpose by assuring the bystanders in the most solemn manner—and adjuring them particularly to remember that he warned them—that America will have its first communist president in 1948. He knows that in the intervening ten years everyone will have forgotten him; but for the present he gets a minute's immersion in the grateful warmth of the limelight.

Mr. B., similarly motivated, is "an inventor." Nothing stands to his credit in the Patent Office, and his rent is often unpaid, but he continues to be mysterious—much as he trusts you, he dare not confide even to you what he is working on: it might cost him his life. Meanwhile, it is at least a good alibi for laziness.

"The greater a man is, the more likely he is to be modest and genuinely humble, as seen almost universally among the great men of science." Prof. Einstein, whose manner is utterly natural and simple—entirely free from pose. With a wide variety of disputatious persons, many of them fanatical cranks in their bitter opposition (if not actually paranoids), trying for years to draw him into argument about his theories, he offers no battle, no resistance, simply letting his work stand or fall on its own merits and going his usual calm, peaceful way, smoking his pipe: he is not "on the defensive." Emotional maturity

Mr. G. credits himself with profundity, which he impresses on you delicately by talking over your head. He likes the words in the back of the dictionary. Of course you understand the "center-standive principle of procedurity". Not entirely? Well, that's too bad; but then, it's no use for him to try to explain—you wouldn't be able to follow the discussion.

And so on through an endless procession of posers, many of them not merely harmless but amiable, who help to entertain the world and fool no one except themselves. They are all trying to cover up their inferiority complexes by a show.

3. *Passing it on to others.*

If one feels inferior, he can always find someone else whom he considers even more inferior and, by comparison, make himself feel quite a personage. Much race prejudice stems from this source. The "high yellow" Negro looks down on the ordinary mulatto who in turn considers himself much superior to the black. Among Jews in America, those of Mediterranean ancestry consider themselves socially superior to the German Jew who, in turn, does not like to accept the Russian Jew as an equal.

4. *Reforming others.*

One who is trying to redeem people from their vices or sins can scarcely help feeling superior to the unfortunates whom he is uplifting. As he looks at the drunkard, the virtuous man may say, "There, but for the grace of God, go I"; but unconsciously he can scarcely help reflecting, "At any rate, *I* don't go there."

Moreover, psychologists generally agree that when a man shows a particularly strong emotional aversion to some human frailty, it is likely to mean that he himself has a strong unconscious tendency toward that frailty. Zeal in reforming others may help to distract his attention from his own shortcomings and thereby enable him to live more at peace with himself.

5. *Rationalization.*

This is the process of dressing up an unpalatable fact so that it becomes attractive. It is a common component of mental life. As the late old J. Pierpont Morgan once remarked: "A man always has two reasons for doing anything—a good reason, and the real reason." Rationalization, or the process of finding "a good reason," is particularly employed to compensate for an inferiority complex.

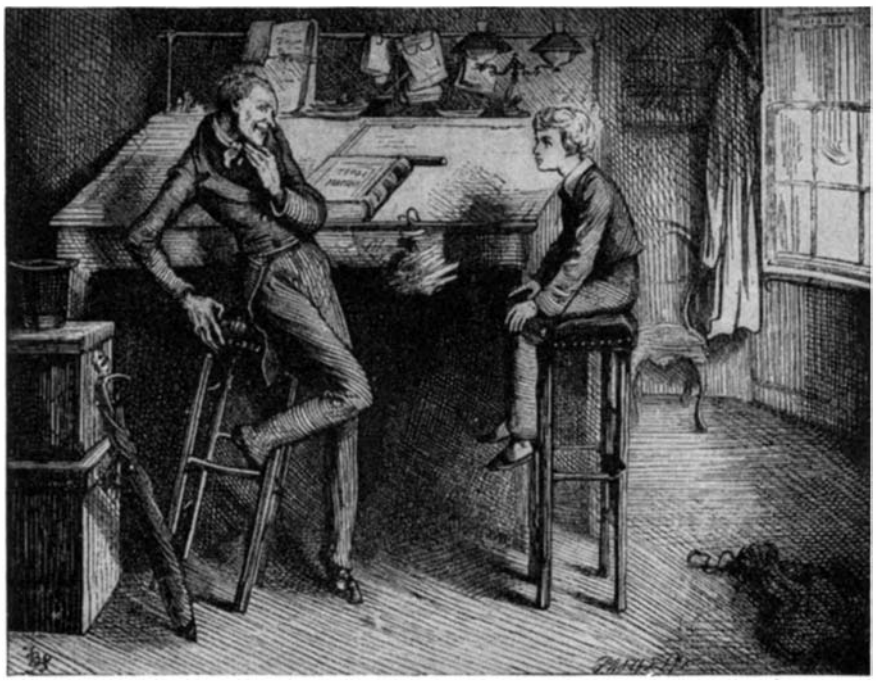
The "sour grapes" attitude is proverbial. The "sweet lemons" attitude is merely another manifestation of it, exemplified by Pollyanna and more pretentiously by the old philosophy that "Whatever is, is right."

Mr. O. is afraid to marry. He is afraid of life, afraid of sex, afraid of himself. Naturally, he won't confess these fears, even to himself; won't admit that he thinks no woman could be attracted to him, and that if she were he couldn't hold her. He will rationalize. He will continually praise marriage and explain that it is so important that he doesn't want to make any mistake when he marries. One shouldn't marry until one finds just the right girl. If you know Mr. O., you know that he will take great pains never to find the right girl.

6. *Humility.*

A common and tiresome device of people with an inferiority complex is to disparage themselves. Dickens' famous character, Uriah Heep, was continually announcing that he was "the most 'umble person" that ever lived. The girl who is not sure of herself is incessantly reminding you that nobody loves her. The scientist with an inferiority complex asserts at every opportunity: "I know absolutely nothing about this subject."

Of course, all of them want merely to be contradicted. The bait is annoyingly



Uriah Heep and David Copperfield. "'Umble as I am," says Uriah to David

obvious. The girl wants to be told: "Who could help loving you?" The scientist wants to hear you say: "If I knew one tenth as much as you do about it, I'd be a wise man." They would be considerably disconcerted if you merely agreed with them!

7. *Throwing up a cloud of dust.*

Everyone knows Mr. L.—the type of business man who is always in a hurry, always "going through the motions." He hasn't a moment to stop and talk with you because there are so many big deals awaiting his attention at the office. While he is telling you about them and lamenting the tremendous pressure under which he lives, which doesn't permit him to stop a minute to pass the time of day with a friend, he has killed half an hour of your time.

Arriving at the office, he signs one letter while he is opening another, grabs the telephone at the same moment that he lights a cigar, calls his stenographer before he takes off his overcoat—and keeps her standing idly by while he cleans out the drawers of his desk and then telephones to a friend to talk about the good time they had at the club last night.

His room is littered with Work-Organizers, Time-Treasurers, Fact-Finders, Future-Filers, Appointment-Announcers, System-Establishers, Ready-Reckoners, Second-Savers, Minute-Makers, and Efficiency-Increasers.

The general result of this pressure of activity is the same as that obtained by a small boy when he puts the gears of his father's automobile in neutral and then steps on the accelerator. The car doesn't go anywhere, but it does produce a very satisfying lot of noise and vibration.

This pressure of activity, which throws up a cloud of dust in which no one can see just what the thrower is accomplishing, is a common way of covering up a feeling of inefficiency, inadequacy, and inferiority.

8. *Hitching your wagon to a star.*

One of the most "high-toned" ways to avoid competition and to escape the possibility of defeat is to adopt some lofty and unattainable goal.

Prof. M. has been working for 20 years on some sort of chemical process. No one except himself knows quite what it is, but everyone knows that it is very important —definitely fundamental, in fact. He has actually done an immense amount of routine work. He assures you that he isn't the man to "rush into print" with a half-baked announcement; he is going to publish as soon as he has really completed the job. Since it is humanly impossible to *complete* such a job, he will die unpublished; meanwhile he has more of a reputation than he deserves because people take his hints seriously and don't know that this pose of profundity merely serves as a cover for aimlessness and futility.

Miss F. is going to marry as soon as she finds the right man. The man who gets her will have to be a good man. In fact, he will have to combine in one person all the best qualities of Robert Taylor, Edsel Ford, Max Schmeling, Glenn Frank, Henry Cabot Lodge, Gary Cooper, and Nelson Eddy. Since few of us mere males can attain such a composite standard of excellence (though of course most of us come very close to it), Miss F. will unquestionably die unmarried.

This device of setting up a fictitious and unattainable goal is a particularly good one because it seems to denote a lofty spirit, and because of course there is much truth in the idea that "Not failure, but low aim, is crime," and so on, as poets and philosophers have remarked at great length. But the goal should be at least reasonably realistic. While one man is "standing by," waiting for a chance to get a hitch on to a star, another has hitched his wagon to a tractor and accomplished a good day's work.

All these compensatory mechanisms, and others that will occur to the reader's mind, help to make life interesting. Few of us can pretend to have avoided them altogether. But when they lead toward false goals, when they prevent worthwhile achievement, when they merely reflect inadequate personalities, they need attention.

The practical question, then, is: What can be done with an inferiority complex?

1. Recognize your disabilities.

Don't try to fool yourself. Unfortunately, it is much easier to fool yourself than to fool others. They can see you plainly because they don't look at you through an emotional fog as you look at yourself.

It's just as great a mistake to exaggerate your disabilities as to depreciate them. Expert appraisal by a disinterested person will often help you to correct the perspective.

In the case of mental qualities, emotional attributes, special talents, and professional aptitudes, the use of some of the modern batteries of tests may be a great help. No one pretends that they are micrometrically accurate, but they are good rough-and-ready measurements in the hands of one who has the training and experience to interpret them. Measurements of this sort should be given to every young person, as a routine procedure, somewhere in the high school period. They would help boys and girls to find their places in the world without too great a tendency either to over-value or to under-value themselves. They would keep square pegs out of round holes.

2. Overcome your disabilities if possible.

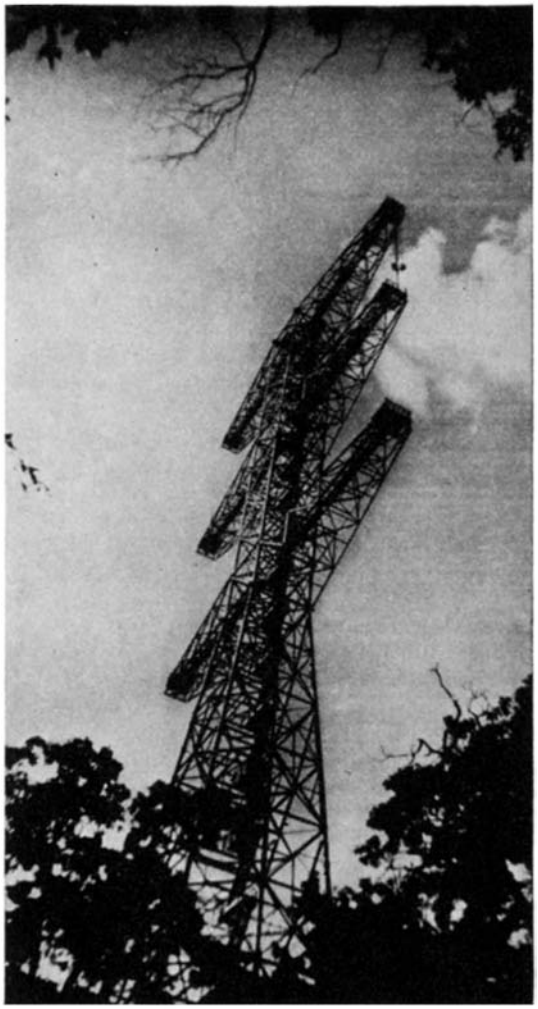
The process of doing so is often the road to achievement. The elder Theodore Roosevelt was a puny boy: by determination he overcame this handicap and developed into the exponent of "the strenuous life." Ted Shawn determined to outgrow the effects of infantile paralysis and became an outstanding dancer. The story of Demosthenes overcoming his speech impediment by talking with pebbles in his mouth, and developing into the greatest orator of his time, may not have much historical basis, but it is at least symbolic of what many another has accomplished under the stimulus of a will to overcome.

3. If you can't overcome a handicap, act as if you didn't have it. As Beethoven became deaf, he worked with more and more industry at his musical composition, turning out better and better work.

4. Finally, develop your strong points. Find out what you *can* do successfully, and *do it.*

STATICLESS RADIO

Invention Opens Up New Uses for the High Frequency Channels . . . Receiver Automatically Rejects Static Impulses



The tower of W2XMN, designed for use with the new Armstrong staticless radio system

EDITOR'S NOTE: *The radio system described below is for use on the short waves only and cannot be adapted to the standard broadcasting waves.*

THE first high-powered, staticless radio station in the world employing a "frequency-modulated" system of transmission and reception, will be put into scheduled operation early this year, with the call letters W2XMN, it is announced by Major Edwin H. Armstrong, professor of electrical engineering in Columbia University, who designed and built the broadcasting equipment.

The new system will use an invention of Major Armstrong's which wipes out static, tube noises, and interference. It will greatly relieve the danger of the air waves being monopolized, which has given so much concern to Congress, by making possible a service on the ultra-high frequency channels that are comparatively unused at present.

Construction of frequency-modulated receiving sets of the new type has already been started on a commercial basis by General Electric. The new sets, when produced on a quantity basis, will cost no more than the ordinary good set of today and will be able to receive both the old and the new kinds of broadcasting much the same as sets now receive both the short- and long-wave programs.

Station W2XMN, built in a wooded section of Alpine, New Jersey, atop the Palisades, has a 400-foot tower with three 150-foot crossarms. The aerial consists of a series of copper plated steel bars fastened to a boom suspended between the tower's crossarms. The adjustment of this antenna proved to be the most difficult part of the whole construction. For a period of two months last summer Major Armstrong sat in a boatswain's chair several hours a day, 400 feet up, regulating the transmission lines. "As this had to be done with the power on; the combination of dodging the high voltage and the frequent thunder storms made the day's work always an interesting one," Major Armstrong said.

Two similar stations, built on an experimental scale, are in existence, one in Albany, New York, owned by General Electric, and the other at Storrs, Connecticut, erected by Professor Daniel Noble of Connecticut State College. Six other stations are being constructed in the east.

W2XMN is at present licensed by the Federal Communications Commission to broadcast in the vicinity of 40 megacycles, which corresponds to a wavelength of about seven meters. While this is an extremely short wavelength judged by ordinary broadcasting standards, the invention can be used equally effectively on still shorter wavelengths.

The new frequency modulation differs from the amplitude modulated transmitter now in use in that the frequency broadcast by the improved method is changed in accordance with the fluctuations of the voice, and not the intensity of the radiation, as in the existing amplitude modulation method of broadcasting.

FREQUENCY modulation programs, at any given listening point within the range of the station, will, in general, have from one one-hundredth to one one-thousandth the disturbance of programs broadcast by the present method, it is claimed. This means much better reception within the service area for the new station, conservatively estimated at 100 miles. The receiver automatically rejects a signal that is too weak to be received satisfactorily, such as man-made or natural static noises, but receives all waves sent out from the high-powered transmitter.

In addition to the advantages in sound production, it is said that the method can be used for multiplex sending, and that as many as four programs have been simultaneously transmitted and received by one transmitter and one receiver. The theory on which the system works is a direct reversal of that on which engineers have previously worked to eliminate noises. The old principle has been to narrow down extraneous sounds, while the Armstrong system does just the opposite. It is this necessity for a wide band which makes the new system impractical on the wavelengths now customarily used for ordinary broadcasting.

When the invention was demonstrated before the Institute of Radio Engineers, a sound-reel recording was played, comparing the reception during a thunder storm of the old and new types of broadcasting. The recording was made from broadcasts received at a distance of 85 miles from a two-kilowatt frequency-modulated station, and from WEAF, a 50-kilowatt station. While WEAF came through strongly, its program was sometimes unintelligible because of crashes of static. In contrast, the frequency-modulated signals provided an uninterrupted, clear program, free from static, despite the fact that its power was only 4 percent of that of the larger station.

THE CURIOUS CASE

Wherein a Liquid is Discovered to Behave like a Cat-footed Burglar and to Puzzle Scientists by its Extraordinary Fluidity . . . Still Is a Puzzle

WHEN an automobile manufacturer wants to know whether the springing of his new model is adequate, or the radiator large enough, he does not have the car driven over smooth concrete roads. He puts it in charge of a test driver who "gives it the works," as it were, by taking it over rough country and making it do all manner of things an ordinary driver would never attempt.

Similarly, in scientific research, much more can be found out about the way materials behave, and the way molecules behave, if they are tested in unusual circumstances. Sometimes high temperatures are used, or strong electric fields, or high pressures, or very low temperatures. It is with the last that we are concerned here.

When scientists write about low temperature research, they are thinking of temperatures about 450 degrees below zero Fahrenheit, or about —270 degrees centigrade. In some of his experiments, the scientist tries to reach as low a temperature as possible, and it is at least comforting to know that there is a natural limit of temperature beyond which he cannot go, and which represents the greatest degree of cold attainable, or even imaginable. This absolute zero is at 273 degrees below zero centigrade. Nothing has ever been quite as

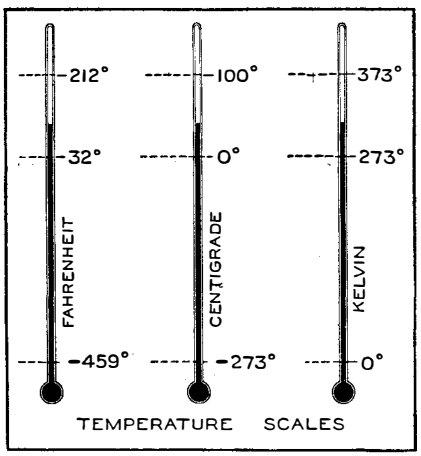


Figure 1: **Three temperature scales, the Kelvin being the most logical**

cold as this, but very nearly, within a few hundredths of a degree, in fact. But those last few hundredths are the hardest ones to surmount. A temperature of —275 degrees C. not only has never been attained, but it is just as much a contradiction in terms as a square circle or a wooden piece of steel. To make the numbers smaller, temperatures are often reckoned from the absolute zero as a starting point, and when this is done, the Kelvin scale results (Figure 1). Thus a temperature of 4 degrees K. is the same as —269 degrees C., and the boiling point of water, 100 degrees C., is the same as 373 degrees K.

Everything is frozen solid at temperatures below 14 degrees K., except helium, the light gas that is used in airships. Hydrogen, the next best thing, melts at 14 degrees K. and boils away to hydrogen gas at 20 degrees K. Liquid air is really hot—it freezes at 55 degrees K. and boils at 91 degrees K. All these cold substances, of course, must be kept in double-walled Thermos bottles.

Low temperature research is complicated and expensive. Only a few laboratories are well equipped for it. The most notable on this continent is at the University of Toronto, where Professor Burton and his colleagues make about a quart of liquid helium weekly.

LIQUID helium boils at 4.2 degrees K., at atmospheric pressure. If the boiling is quickened by pumping off the gas, the increased evaporation lowers the temperature gradually. Meanwhile the liquid boils vigorously. All of a sudden, at 2.19 degrees K., the liquid seems to stop boiling; at least it is quiet, but evaporation continues, as shown by the gas which can be pumped off, and the temperature keeps on falling. This observation is merely one of many which show that the temperature, 2.19 degrees K., marks a transition point between two states of helium. For want of better names they are called helium I and helium II. Helium I is the warmer, helium II the colder. The name λ-point (Greek, lambda) is given to this transition temperature.

Even its most prosaic properties make liquid helium a remarkable fluid. We think of water as a typical liquid—a quart of it weighs just over 2 pounds. A quart of liquid helium would weigh only about 5 ounces, just 3/20 as much as water. It has been known for some time that helium II possesses an unusual heat conducting capacity far in excess of helium I, and some time ago Professor Kapitza thought this might be due to an abnormally high fluidity—or low viscosity, as the physicists call it. This would mean that the liquid would circulate with extreme ease, carrying heat by means of convection currents.

Peter Kapitza will be remembered as a Russian scientist who spent many years in Lord Rutherford's laboratory at Cambridge, England. First he was interested in producing very strong magnetic fields, which he accomplished successfully. Then he turned his attention to research at low temperatures, among other things, and a special laboratory was constructed for him, complete with helium liquefier [described in Scientific American, December, 1934, pages 300-302.—*Ed.*]. Then, suddenly, while he was on a holiday in the U.S.S.R., the government apparently declined to let him leave, but offered him adequate facilities for pursuing his work in Moscow. The difficulty then was to know what to do with his new equipment in Cambridge, for a scientist's own research equipment, minus the scientist, is rather like a ship without a rudder or engines. Finally some of the equipment was purchased by the U.S.S.R. for Kapitza's use, and his friends were pleased to see in *Nature*, a little more than a year ago, a letter recording some of his experiments.

Kapitza, then, set out to measure the fluidity or viscosity of helium II. The usual commercial methods, or even the usual laboratory methods, were not very convenient at 2 degrees K., so he devised the following scheme. A tube (*A*, Figure 2, left), had fixed to its lower end a heavy glass plate *B*, with a hole through the middle. Below this was another plate *C*, whose distance from *B* could be varied by devices that the diagram does not show. The inner surfaces between *B* and *C* were optically flat. Then *B* and *C*

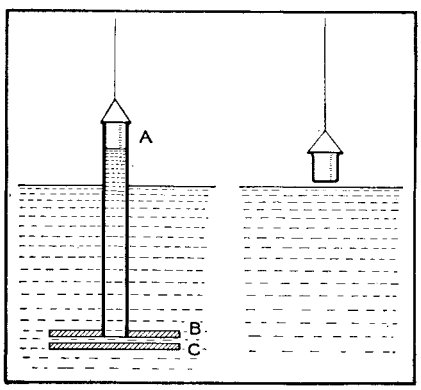


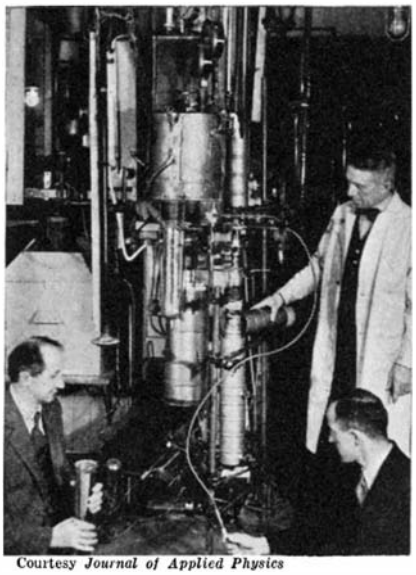
Figure 2: Left: **Kapitza's experiment.** *Right:* **The suspended beaker**

OF LIQUID HELIUM

By THOMAS H. OSGOOD, M.S., Ph.D.
Head of the Department of Physics at the University of Toledo

were fixed at a convenient distance apart —let us say 1/32 inch—and the whole thing was lowered into a bath of liquid helium II. Soon, the two levels, inside and outside the tube, were the same. Now for the experiment. The unit was quickly raised a short distance, making the level inside *A* higher than outside. This inner level was expected gradually to fall, as the liquid leaked out between *B* and *C*. But it fell faster than was expected. In another case *B* and *C* were placed in optical contact, meaning that they were pressed firmly together. You would think that the helium II inside could now hardly escape. But you are wrong. The inner level of liquid settled down in a few seconds. Here was a curious liquid, one that could slip in a few seconds through a space about a thousandth as wide as the thickness of a sheet of paper!! Indeed, in all the previous history of physics, no substance ever before displayed such remarkable fluidity; upon calculation, this helium II, a *liquid*, turned out to be about 10,000 times as easy flowing as hydrogen *gas*. It sounds almost incredible. But how to find out the truth?

THE next step is an obvious one, once it has been pointed out. If helium II can slide through cracks as easily as Kapitza's experiment showed, surely it is worth while trying to see whether it can slide through no crack at all. A report of experiments of this kind was published in the middle of 1938 by Daunt and Mendelssohn of the Clarendon Laboratory, Oxford, England, but they were careful to point out that their experiments were merely an elaboration of an observation of Kammerlingh Onnes of Leiden (in 1922) that the surfaces of two volumes of liquid helium II in two concentric vessels, adjusted themselves automatically to the same level. Daunt and Mendelssohn suspended a tiny glass beaker (Figure 2, right) by a fine fiber so that it could be lowered into or raised from a bath of helium II. Here are their own words to describe the effects. "When the empty beaker was lowered into the liquid, it filled up to the level of the bath, although the rim of the beaker was everywhere above the level of the liquid. When the beaker was partly lifted out of the bath, the level of the liquid in the beaker fell . . . and the level of the bath rose until both had reached the same height. In order to establish whether the transfer took place by distillation . . . or by transfer over the surface, the effect was examined of introducing wicks of twisted copper wire which increased the surface leading from one level to the other. It was found that this increased the rate of transfer to several times the previous rate so long as, but only so long as, the wick reached into the liquid at the higher level. When the beaker (without a wick) was completely lifted out of the bath, it was found that the liquid vanished at the same rate as when it was still partly dipping into it. This was accounted for when it was observed that the liquid collected in drops at the bottom of the beaker and dripped into the bath. The rate of transfer did not appear to differ very greatly whether the beaker was almost full or nearly empty." And the authors add, in conclusion: "If any of these phenomena occur above the λ-point (that is, with helium I) the rate is so slow that they could not be observed in our experiments."



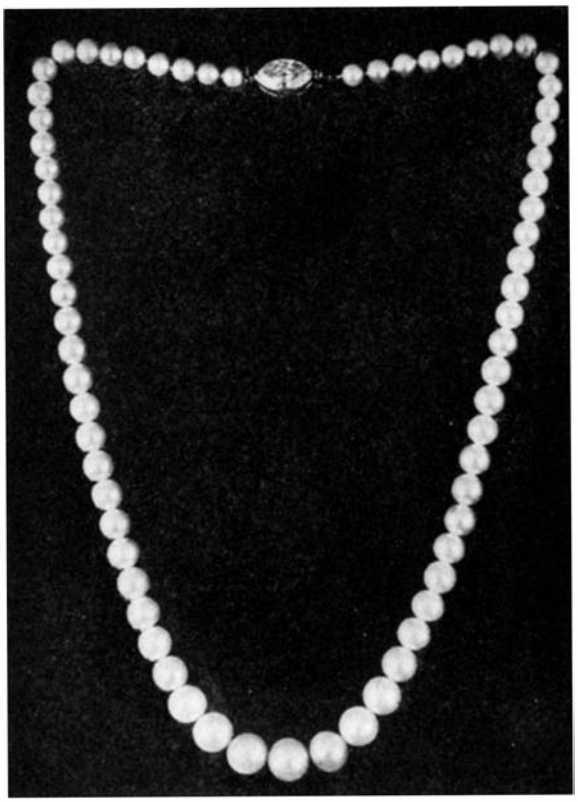
Courtesy *Journal of Applied Physics*

Figure 3: **Apparatus for making liquid helium, University of Toronto**

Thus it seems clear that the surface of a solid in contact with helium II is covered with a helium film which transports the liquid to the lowest available level, and that the helium II creeps over the cold surface in an uncanny way. No wonder Kapitza was misled in the interpretation of his experiments! What happened, of course, was not that the helium II slipped through the crevice between plates *B* and *C* of Figure 2, left, but that the levels were equalized by the liquid creeping over the *top* of the open tube *A*. Perhaps "creep" is hardly the right word, for the moving film of helium is so thin that it must move at a speed about equal to that possessed by the molecules themselves —a few hundred meters per second, that is, several hundred miles an hour.

LATER experiments in several laboratories, especially at Toronto, have shown that the fluidity or viscosity of helium II is not nearly as low as Kapitza suggested. It turns out to be about the same as for gaseous hydrogen. But this in itself is low enough to set the theoretical physicists to work to try to explain why the helium II has these superfluid properties. The theories which are being proposed make the assumption that helium II is a sort of a cross between a gas and a liquid—a degenerate Einstein-Bose gas, to use the technical term. The problem is essentially this: In a gas, the molecules are, to all intents and purposes, quite independent of one another; the only thing that restricts them is the solid wall of a container, such as the shell of an oxygen tank which keeps in the oxygen. But open the valve, and out the oxygen rushes. On the other hand, the molecules in a liquid always stay at about the same distance apart. If you like a crude picture, you might say that the molecules are somehow hooked on to one another, by hooks which do not stretch. If you open a bottle of medicine, the medicine does not suddenly rush out into the room like the oxygen from the tank. In the case of helium II, then, the helium molecules must be attached to their neighbors by non-stretchable hooks, for the substance is a liquid. But at the same time, it can not have its extraordinarily low viscosity unless the molecules can slide past one another with the greatest of ease. This means that they must be able to change neighbors very readily. The question is, therefore, what kind of "hooks" do these molecules have which are firm enough not to stretch, and yet which automatically couple and uncouple their neighbors, but do not let those neighbors go free?

The "hooks" of which we speak must necessarily be electrical forces. Whether or not the theoretical physicists are on the right track, time and further experiments alone will tell. But when it is known how these "hooks" work, a new discovery will have been made about molecular forces.



The attractive result, a gleaming and lustrous string of matched natural pearls, one of the finest of its kind now on sale by jewelers in this country

SCIENCE DISSECTS

By A. E. ALEXANDER, Ph.D.
Pearl Fellowship, Mellon Institute, Pittsburgh, Pa.

THE lovely natural pearl has been for countless centuries the subject of speculation in fable, song, and story. The only gem that comes from the sea, and the only one made by a living process, it aroused long ago the intense interest of those who were able to use only their imaginations to conceive of its origin and characteristics.

Now, however, thanks to the advances of science, we can study this most interesting of all gems with a thoroughness that might have amazed its early admirers.

In a recent article in Scientific American we discussed the attempts that have been made by man to simulate the natural pearl, which nature alone can fashion. Despite the ingenuity of man and the wonders of science, no artificial or "cultured" pearl can be produced that can compare with that warm, rose-colored bit of loveliness from the Persian Gulf that is the handiwork of an inspired Mother Nature. And although cultured and imitation pearls are available, they bear a similar relationship to the natural pearl as gold-filled articles do to solid gold jewelry, silver plate to sterling, or reproductions to genuine old masters.

The entirely natural formation of the genuine Oriental pearl occurs, for example, where by chance a tiny grain of sand or other foreign particle enters an oyster shell, or where some abnormal condition results in the growth of a pearl.

This tiny particle becomes the nucleus of the gem. Layer upon layer of nacre is deposited upon this heart as the pearl grows. These films that form the pearl vary in thickness, being much thinner than a sheet of tissue paper. The most lustrous pearls are those in which the constituent layers are the thinnest, while those of less attractive appearance are made up of thicker and coarser layers of nacre.

We have authority for believing that the pearl generally takes its color from the shell lining, and even from that part of the shell near which it is formed. A rose- or cream-colored pearl would not be expected, according to this explanation, in an oyster in which the shell lining is of any other color.

Pearls may be rose, cream, white, grey, bronze, black, pastel shades of lavender, blue, yellow, mauve, orange, brown, or green; but the more desirable colors are rose, cream, white, and black. The temperature and composition of the water and the state of health of the oyster are thought to determine the color of any given pearl. The appealing iridescence for which pearls are prized is due primarily to the reflection and refraction of light which take place on the surface of the gem.

THE beauty and splendor of the pearl have been sung in the sacred books of the Christians, the Hebrews, and other religions. St. Matthew, for example, had a high appreciation of this gem: "The Kingdom of Heaven is like unto a merchant man seeking goodly pearls, who when he had found one pearl of great price, went and sold all that he had and bought it."

The gates of the Holy City were described as 12 pearls by St. John in the Book of Revelations. In the Talmud there is a reference to the pearl "that has no price," and also to manna that was "as white as pearl."

Hindu legend attributes the discovery of the pearl to Krishna, the form in which the preserving god Vishnu appeared in all his glory. According to this tale, he took the pearl from the depths of the ocean to adorn his daughter on her wedding day. This is the source of the tradition that links pearls to brides even to the present.

In the classical period of Sanskrit literature, about the 3rd Century of the Christian era, there were abundant references to the pearl. It was generally called "mutka," the pure, and there were numerous words for pearl bracelets, necklaces, and other pearl ornaments in the dramas of Kalidasa, the Hindu Shakespeare.

According to "The Kingdom of the Pearl," by Leonard Rosenthal, it is believed that pearls were the first gems known to man. It is likely that the discovery of the pearl was made by some member of a fish-eating tribe on the shores of India. The Ancient was possibly attracted by the brilliance of the gem when he opened the mollusks that were intended for his food. As his natural taste for beauty developed, he used it to satisfy his desire for adornment, which characterizes alike the most primitive tribes and the most refined civilizations.

The Chinese knew and appreciated the pearl at a very early date. The gems were accepted by them in payment of tribute. Some fantastic Chinese tales tell about pearls so brilliant that their glow could cook rice a thousand miles away. And about the beginning of the Christian Era it was reported that one pearl was found so lustrous that it could be seen in the dark at a distance of three miles!

The tale of Cleopatra drinking wine in which she had dissolved a pearl from an earring is known to every student of legend. Science, however, must modify the story by pointing out that a pearl cannot be readily dissolved in sour wine unless it is first powdered.

But there is record in subsequent history of the drinking of a valuable pearl. During the reign of Queen Elizabeth, Sir Thomas Gresham, who possessed a famous pearl worth 15,000 pounds, ground it to a powder, and drank it to his sovereign's health when he was entertaining the Spanish ambassador at dinner. His purpose was to show the Spanish of what luxury the English were capable; and probably, also, to prove that England had the wealth to raise a fleet to protect herself!

Catherine de Medici owned the most exquisite pearls in the world, according to the historian Bapts, when in 1533 she married Henry, Duke of Orleans, afterward Henry II of France. She had two large pear-shaped pearls weighing about 92 grains each, which were presented to her by Francis I, and which she later gave to Mary Stuart.

Of the very large pearls generally mentioned by writers, three undoubtedly exist: La Pellegrina, the Beresford Hope,

THE PEARL

Oldest Gem Gives Up Its Secrets . . . How and Why Make-Up Varies . . . Iridescence . . . Nucleus Usually Absent . . . Microscope, X Ray, Other Tools Used

and one of medium quality in the Austrian crown weighing about 1200 grains. The finest is La Pellegrina, which is perfectly round and so lustrous that it appears to be transparent.

For many centuries the finest pearls in the world have come from the Persian Gulf, chiefly from the waters around the Island of Bahrein. Here, most of the population depends for livelihood upon pearl fishing, according to a British writer, on whose recent account some of the material in the next few paragraphs is based. Some 75,000 natives depend for their living on pearl diving, as have their ancestors for nearly 2000 years.

The present ruler of the tiny independency is Shaikh Hamad bin Isa al Khalifah, a member of an ancient Arab family which came originally from the mainland of Arabia. Though he encourages modern methods and improvements, he lives as an Arab Shaikh, always wearing the dress of his country, surrounded by picturesque retainers, and spends much of his spare time in hunting, coursing with Saluki hounds, and in hawking.

Although the richest pearl banks in the world are around Bahrein, the Shaikh receives no direct income from pearls. The revenue of his state is mainly derived from customs duties upon imports and from oil royalties. The value of importations, however, depends upon the success of the diving season, which lasts from the middle of May until the end of September, while the water is warm.

On a day appointed by the Shaikh, which is announced by public proclamation, the pearling fleet, consisting of several hundred sailing dhows, very like Roman galleys, sets out from Bahrein to the pearling banks. Until they clear harbor, the boats are propelled by heavy oars, each pulled by two men, who sing the song of the pearlers as they row. Often the fleet returns at night when the moon and tide are full. The sound of the sailors chanting and the sight of hundreds of white sails colored orange by the light of fires burning on the decks is, indeed, very picturesque.

Section of a typical Oriental salt-water pearl, showing concentric arrangement of mineral matter throughout. An ideal pearl, structurally. Magnified about seven times

The pearl divers use no mechanical apparatus of any kind, and the diving methods have changed little since they were first described by 14th-Century travelers. Each diver wears a clip like a clothespin over his nose, and leather sheaths to protect his fingers and to enable him to wrench the shells from the rocks underneath the sea. Each of his big toes is guarded by a similar sheath. Grasping a stone as a weight, he descends on a rope to the bottom. Around his neck is a string bag, which he fills as rapidly as he can during the minute and a half he is able to stay under water. When the air in his lungs is exhausted, he gives the signal, and is pulled up to the surface by his companion in the boat. A good diver can descend about 30 times in a day, often to a depth of 14 fathoms.

The shells are piled on deck to be opened later under the watchful eye of the captain, who carefully guards the pearl treasure in a chest. The shells are thrown back into the sea, for the divers believe that oysters feed on them. They believe, too, that the pearls are formed by drops of dew that fall into the oysters at night!

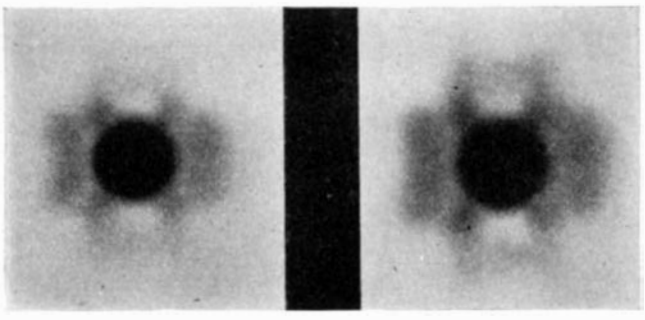
The men receive no regular wages, but share in the profits of the boat to which they are attached. The general principle of the diving system is fair, especially since the present Shaikh delegates government employees to check on the books kept of the season's catch. A certain percentage of the crew, chosen by the men of each boat, must witness the sale of the pearls by the captain to satisfy themselves that they receive a proper share of the profits.

WHEN sold, the pearls go from Bahrein to the great markets of India. Here steps are taken to bring out their sublime luster. Each jewel is carefully washed and polished by expert workmen. Next, the pearls that are to be used in necklaces must be drilled by hand. The skilled craftsmen in charge of this step employ a delicate method of drilling that has not changed in 3000 years.

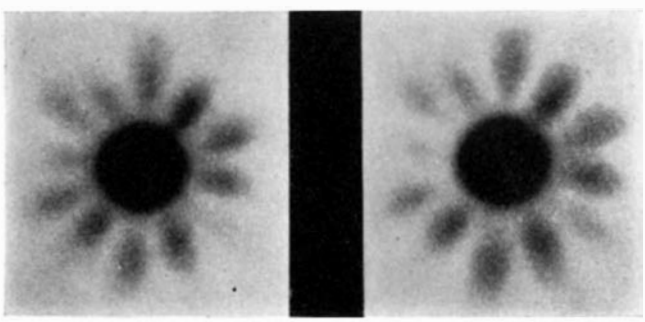
In India, the gleaming finished pearls are purchased by dealers who take them to Paris or London. To these pearl centers, buyers from this side of the Atlantic travel to select their stocks.

Interesting as may be the facts we have discovered, the scientist must delve still deeper into the physical characteristics of the pearl. Science must view not only the surface, but must go beneath it.

The best way to seek out the story behind the pearl is to examine its internal structure microscopically. To do



An ideal "Maltese cross" X-ray diffraction pattern (two exposures) produced from a cultured pearl of 7.36 grains



Two characteristic diffraction patterns produced from a natural pearl (7.44 grains) with fine concentric layers

this, one must thin-section the jewel. A pearl to be thin-sectioned is first ground on a coarse diamond lap or polishing surface until its maximum diameter has been reached. A few turns over a finer textured diamond lap will eliminate the scratches produced by the previous grinding operation. The pearl is next cemented to a microscope object glass, using Canada balsam. After the balsam has hardened, the remainder of the pearl is ground to wafer thinness, first on a coarse diamond lap and finally to a thickness of 0.03 millimeter on a lap of very fine grain. A cover glass is cemented over the specimen and the thin-sectioned pearl is now ready for microscopic examination.

The optical properties of the mineral matter are best observed using polarized light. From such a thin-section one finds that a natural pearl is, in general, structurally not unlike an onion, in that the numerous layers of mineral matter are concentrically deposited from the innermost part of the jewel to the exterior. Because of this interesting structural arrangement, a pearl can be "skinned" very much as an onion can be peeled.

CHEMICALLY, the pearl is composed almost entirely of calcium carbonate. This material, on examination, is found to be deposited around a tenuous network of organic matter, which has been termed conchiolin, much like the enamel around the dentine of a tooth. Limestone and marble are composed of the hexagonal variety of calcium carbonate, calcite. Few pearls have this mineral in their constitution. The form most generally present in pearl substance is the orthorhombic variety of calcium carbonate, aragonite.

The gem, exquisite as it is, is in a sense an abnormal growth. Unlike other concretions and pathologic products in animal and vegetable life, however, it is strikingly beautiful in its evidence of disordered physiologic change. In the case of the pearl-oyster, some irritation is presumed to have been set up in the musculature system of the mollusk. The microscopic irritant, if from an external source, may have been of organic origin —perhaps some species of trematode— or, again, it may have been inorganic in character, as for example, a grain of sand or an agglomerate of silt. The mollusk, unable to rid itself of the unwelcome intruder, seeks to reduce the attendant irritation by coating the substance with nacreous material.

Certain epithelial cells within the mantle of the oyster have the ability to extract from the sea water those salts necessary to produce calcium carbonate. It has been stated that it is not temperature that controls the crystallization of calcite and aragonite so much as it is the acidity or alkalinity of the carbonate solution. Calcite crystallizes from an acid solution while aragonite forms under alkaline conditions.

The interior of some natural pearls has been found, in instances within the writer's experience, to consist of coarsely crystalline calcite around which have been deposited concentric layers of aragonite. In the case of this particular pearl, then, the physiological state was such that only calcite could be deposited in the beginning. Later, the physiological-chemical processes of the pearl-oyster changed to the extent that alkalinity prevailed and calcium carbonate in the form of aragonite was laid down.

Many natural pearls, when sectioned, reveal no evidence whatever of an irritant. From this observation we must assume that the nucleus has been of organic nature or perhaps of internal origin. Shortly after deposition began, decomposition of the organic matter ensued, with the result that the final product reveals no evidence of what initiated the process.

To look further into the subject of iridescence, we must call on the principles of optics, in order to explain how light acts on transparent and translucent substances in thin films. Light entering a medium, unless the latter is amorphous in character, will deviate from its normal course. The beam reacting in this manner is said to be refracted. If light is directed on an object from an angle, a certain amount will be cast back into the eyes of the observer. This light has been totally reflected. On microscopic examination, using polarized light, the concentric laminae of natural pearl substance—viz., aragonite—are found to lie in a basal plane; that is, in a plane perpendicular to the vertical crystallographic axis. These laminae are exceedingly thin and tenuous. Furthermore, they overlap one another. Their edges, when examined closely, resemble to a marked degree certain contour lines seen on topographic maps, which are used to designate rough and rugged country. The surface of a pearl, when examined microscopically, may not be entirely smooth in some cases. In fact, it may have a hammered appearance, not unlike that seen on hand-wrought copper.

A natural salt-water pearl possessing a central area composed of radiating crystals of calcite, around which have been deposited concentrically arranged layers of aragonite

The modern trend toward specialization has reached the jewelry field, and the handling of pearls has become a definite specialty. Just as a dealer in fine paintings or rare antiques devotes his life to the study of these works of art, so does the pearl expert develop his skill to an uncanny degree in identifying and evaluating pearls. Not only have many of these specialists gained the ability to distinguish by the naked eye between a genuine pearl and a "cultured" product, but they can also tell by visual recognition the geographical region in which a pearl originated.

In addition to the identifying work of

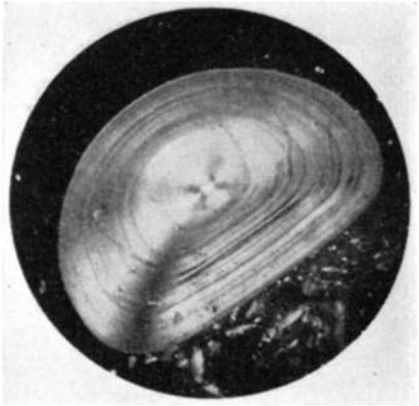
The deck partner of a pearl diver is holding the small string bag which the diver fills in a quick descent. Oysters are accumulated and are not opened until the end of the pearling day

gem experts, however, there are definite scientific tests by which the exact differences between genuine pearls and their simulations can be made a matter of precise knowledge. These methods scientists have devised over a period of years, and all are now in more or less active use. Each procedure will now be considered separately.

One of the simplest methods of distinguishing between natural and so-called "cultured" pearls is the accurate determination of their specific gravity. The easiest means of making this test is by immersing them in liquids of known density. The procedure usually consists of placing a pearl in a small container partially filled with acetylene tetrabromide, to which orthodichlorobenzene is added drop by drop until the pearl is in suspension; the density of the specimen and the liquid then may be considered identical.

The specific gravity of the liquid is next obtained by means of the Westphal balance. The heaviest cultured pearl examined by the writer had a specific gravity of 2.805; the lightest, 2.715. Natural pearls have a lower specific gravity, averaging 2.685. The test, however, has its limitations.

For the past 15 years, the X ray has been used to differentiate natural from cultured pearls. This procedure is accomplished by passing a narrow beam of X rays through a metallic lead pinhole



Natural pearl, of an unusual shape, showing concentric layers extending throughout. Photographed in polarized light. No nucleus present; central spot is an optical effect

"camera" of proper thickness, having an orifice 0.02 or 0.04 of an inch in diameter. The pearl to be tested is placed over the small opening through which the X-ray beam is to pass. If the gem is natural, a uniform scattering of the X rays takes place when they impinge, and, therefore, they will produce upon a photographic plate a six- or twelve-fold "spot" pattern. This characteristic pattern is caused by the regular concentric arrangement of the aragonite characteristic of natural salt-water pearls.

A cultured pearl similarly tested, on the other hand, will usually produce a maltese cross pattern, or modification thereof: this appearance is attributable to the peculiar parallel mineral arrangement found in all mother-of-pearl substance.

Another ingenious method used to differentiate cultured pearls from the natural gems employs an "Endoscope," invented by Chilowsky and Perrin in 1926. Briefly, the apparatus consists of a carbon arc, a lens system, and a hollow hypodermic-like needle, at the tip of which are placed two platinum mirrors set at angles of 45 degrees and in opposite directions from one another.

As a typical natural pearl is composed of concentrically deposited aragonite throughout, and a cultured pearl has a large core that is distinctly layered, it is plain that light directed within such structures should react differently because of their physical differences. If a drilled natural salt-water pearl is placed on the hypodermic-like needle and then observed through the focusing eyepiece of the lens system, one finds that a flash is produced when the pearl is moved back and forth over the needle after the arc has started to burn. A similar test made on a cultured pearl will not reveal this flash. In the former case, the powerful beam of light traversing the needle is reflected from the first minute platinum mirror up to the pearl substance. Because the layers are concentrically arranged throughout, the light is totally reflected. On moving the pearl back and forth, the totally reflected light is "caught" or reflected on the second or outside mirror which constitutes the tip of the needle. The registered flash is seen in the eyepiece. A cultured pearl, having a large core composed of parallel layers, will not reflect light and, consequently, no flash is produced.

By this method only one drilled pearl can be examined at a time. Furthermore, this test cannot be applied to undrilled gems.

All mineral matter is either diamagnetic or paramagnetic. Knowledge of this physical property resulted in the invention of a new instrument by Dr. Richard Nacken, of Germany, in 1929. The structural differences in pearls mentioned in the preceding paragraph permits differentiation by the use of this method. The test, however, is not as efficient as the endoscopic procedure, and is the least used.

Pearl divers are rugged, with extraordinarily well-developed lungs. This man is rea dive and holds the rope by which his partner, on deck, will pull him up from the d

FOR many generations distinguished families have considered pearls as heirloom gems, to be handed down from mother to daughter, usually on the wedding day. We have seen how this linking of pearls with brides goes far back into history, beginning with early Indian legends. Like chests of silver, pearls never go out of style, nor does their value decrease with the generations.

There is a definite reason for this permanent value. Unlike other jewels, there is no need for a "world corner" on the pearl market. The number of really fine pearls brought up in any one year is definitely limited. No great "find" ever disrupts the market, and it is never necessary to hold up part of any year's output.

It may take years—in fact, it nearly always does—to assemble a superb necklace. When, therefore, the pearls are finally brought together into a matched string, the achievement is eventful, and their value in this form is greater together than their combined separate cost.

It is evident from what has been said that the popularity of the pearl is in no sense faddish. With 4000 years of admiration behind it, this beauteous gem may look forward to as many in the future.

INSIDE THE STARS

Why do the Stars Shine, How do We Know They Are So Exceedingly Hot inside, and What Makes them So? From Whence Comes their Vast Store of Energy?

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SOME of the simplest-sounding questions are the hardest to answer. We know a good deal about the stars by this time—their distances, their motions, their real brightness, and, in many cases, their actual diameters; but it has taken a long time to answer, even in part, the obvious question, "Why do the stars shine?"

In one sense, the answer is easy enough. The stars shine because they are hot—very hot indeed, even in their outermost atmospheres. Unless the whole surface of a star is as hot as the hottest part of a blast furnace, it will not shine brightly enough to be visible at the enormous distances with which we have to deal. We can measure this surface temperature by methods similar in principle to those which are used to find the temperature of an industrial furnace—by the intensity and color of the light which comes out through a hole in the door—and we find that, for a red star (cool as stars go) it is from 2000 to 3000 degrees, centigrade. The Sun's is 5700 degrees, and the figure rises to some 10,000 degrees for white stars like Sirius, over 20,000 degrees for the stars in Orion's belt, and perhaps 50,000 degrees for the very hottest stars.

We can calculate just how bright a star of given size and temperature will look at a distance of so many light-years; but this does not answer the question "What makes the stars so hot?" Here again we may "stall along" with a simple answer. The stars are hot outside because they are still hotter inside; and the heat leaks out to the surface. But the questioner might reply, "You can't get inside a star to find out about it; how do you know that it is hot inside?" And the answer comes: It has *got* to be enormously hot inside—millions of degrees—provided only that the matter of which it is composed is of the same nature as that which we can study in our laboratories, and there is plenty of good evidence to convince us that this is true.

From the Sun's gravitational attraction on the planets, we can find its total mass, and that its average density is 1.4 times that of water. Its attraction upon its own outer layers produces an enormous internal pressure. If the density was the same at all points, the pressure at the center (as can easily be calculated) would be 98,000,000 tons per square inch.

It is no more than a high-school exercise to calculate how hot a mass of gas would be if this enormous pressure compressed it to no more than the given density—provided that one assumes that the familiar "gas laws" of the laboratory can be applied under these extreme conditions. If the gas was hydrogen (loose atoms, not molecules) the temperature would be 11,500,000 degrees, centigrade.

It is of course practically certain that the density is greater at the center than the average, and probable that it is much greater; and to get an exact value we would have to know just how the density varied at different distances from the center. But to increase the central density means to bring the material nearer the center, and give gravity a more powerful hold on it, and this increases the pressure. Calculations made for different "models" show that these two changes nearly compensate one another. For example, a density-model which Eddington has made famous has a central density 54 times the mean; the pressure is increased 92 times, but the ratio of the two, and hence the temperature, is increased only in the ratio 1.70. Another model, recently calculated by Chandrasekhar, makes the central density 88 times and the pressure 171 times the values first considered; the factor for the temperature is 1.95.

THE temperature at the Sun's center, on these two models, comes out 19,600,000 degrees and 22,400,000 degrees—provided that the gas consists of hydrogen atoms. There is good reason to believe that these "models" represent, in a general way, the internal structure of many (perhaps not all) of the stars.

But, on the rudimentary theory, this temperature should be proportional to the atomic weight of the material. If it was iron, the value would be 56 times as great, or more than a billion degrees! Our calculations of temperature, then, depend far more upon what we suppose the Sun to be made of, than upon what pattern of internal density we assume.

Until about 15 years ago, no one would have dared to take this calculation very seriously. It seemed more likely that the atoms would be jammed together so tightly, by a much smaller pressure, that no increase could squeeze them into a much smaller space. If the atoms were rigid bodies, this might be nearly true; but as their properties became better known, it was realized that their outer layers of electrons would be shelled off and left to wander freely, leaving cores so small that the whole affair could be condensed to a very small volume. The only way to escape this, inside the Sun, is to have the particles moving about so fast that their collisions keep them from being jammed closer—and this is only a way of saying, in other language, that the material as a whole behaves like a very hot gas. So the simple calculations are good after all.

How hot the gas must be, to stand the pressure with the given density, depends on how many moving particles there are in it—since each, on the average, will have the same energy of motion. If they were all atoms of iron, which weigh 56 times as much as hydrogen atoms, the temperature would come out 56 times as high. But an iron atom has 26 electrons outside its nucleus, and, if these are all knocked off, the energy will be divided among 27 particles and the average amount, and hence the temperature of the gas, will be correspondingly lower.

This is a very fortunate thing for our calculations, for no matter with what sort of atom we start, the average weight of the pieces will be nearly the same. For sodium, for example (weight 23, 11 electrons) it is 1.92; for oxygen (weight 16, eight electrons) it is 1.78.

The calculated temperature inside the Sun therefore depends very little upon the chemical composition—with two important exceptions. A helium atom (weight 4, with two electrons) gives an average weight of 1.33 per piece, and a hydrogen atom, breaking into two parts, a weight of only 0.5.

For a star of the Sun's size and mass, built on Eddington's model, and composed entirely of hydrogen, the central temperature would (in round numbers) be 10,000,000 degrees, if it was all he-

lium, 26,000,000 degrees, and, if all of heavy atoms, about 40,000,000 degrees. Chandrasekhar's model makes the temperature 15 percent higher—a small difference compared with the effect of the atomic composition.

When we compare one star with another, we find that, for those built on the same model and of the same stuff, the temperatures at the centers (or any corresponding points) should be proportional to the mass divided by the radius. For Sirius, for example, the mass is 2.4 times the Sun's, and the radius 1.8 times, so that the central temperature should be about 30 percent higher than for the Sun. The most massive star for which we have accurate data is 29 Canis Majoris—an eclipsing system, in which the larger star has 46 times the Sun's mass, and 20 times its radius; its internal temperature should be therefore a little more than twice the Sun's. At the other end of the list of well determined systems is the faint companion of Castor—also an eclipsing pair, composed of two stars having 63 and 57 percent of the Sun's mass, and 66 and 60 percent of its diameter. The central temperature for both comes out 95 percent of the Sun's.

These stars all belong to the great main sequence which runs from faint, small, red stars of small mass to brilliant, large, massive white stars. For these, except for the biggest and hottest, the internal temperature should be much the same as for the Sun (which belongs to this sequence). Some stars, however, are quite different. For Capella, with 4.2 times the Sun's mass and 16 times its diameter, the internal temperature—other things being equal—should be a quarter of the Sun's, and for the great red giant Zeta Aurigae (mass 15, radius about 200) it should be only 7 percent of the solar value. Even this, however, is more than a million degrees (unless we assume that the star is made up almost entirely of hydrogen).

TO get a closer estimate of the internal temperature of a star, we must in some way be able to find out how much hydrogen and helium there is inside it. This looks like an impossible task; but there is a way to attempt it.

The rate of leakage—or flow—of heat from the hot interior of a star to the surface must evidently be just equal to the rate at which heat escapes from this surface into space. We know this for a great many stars. Allowance must be made for the heat which escapes in the form of invisible infra-red or ultra-violet radiation, but this is easy except for the hottest and the coolest stars.

Now the rate at which heat will flow through the stellar gas—for a temperature gradient of so many degrees per mile—can be calculated. Under ordinary stellar conditions, this heat is almost entirely carried by radiation—sent out from one atom, caught by another, relayed again to a third, sometimes outward, sometimes inward, but working gradually toward the surface. We know enough about the properties of atoms now to permit a rather accurate calculation of the net rate at which heat will flow (if we know the temperature, pressure, and composition of the gas). Applying these principles to the stars (as was first done by Eddington, years ago) it is found that the net rate of supply of heat from the interior to the surface depends mainly on a star's mass—increasing very rapidly with this—but surprisingly little on its radius or its internal density-model. This explanation of the observed relation between mass and luminosity was the first great triumph of the theory of stellar constitution.

But the same theory indicates that the star's luminosity should be greatly influenced by the composition of its interior. If this consists entirely of heavy elements, the central temperature will be high, and the temperature gradient to the surface steep. This greatly increases the heat-flow, so that such a star will be bright. The more hydrogen there is in the mixture, the lower will be the internal temperature and gradient. At the same time, the opacity of the gas—the resistance it offers to the heat-flow—will be less; but the first effect is the greater, and the calculated brightness diminishes. It is thus possible to calculate, from our knowledge of the properties of atoms alone, just how much heat a star of a given size and mass should radiate—given the "model" on which it is built, and the percentage of hydrogen in it. When these calculations are performed for the Sun (using Eddington's "standard" model of density distribution) it is found that a star with no hydrogen comes out much too bright; one with a great deal is much too faint; while one with 36 percent of hydrogen, by weight—and the rest heavy atoms—matches the Sun exactly. On this basis the mean weight per particle is 0.98, and the central temperature close to 20,000,000 degrees.

The calculated brightness, and the deduced hydrogen percentage, like the central temperature, are not much changed by reasonable alterations in the assumed density-model.

If helium is present as well as hydrogen, other solutions are possible. For example, Strömgren (to whom these calculations are due) finds a solution for the Sun with 60 percent hydrogen, 36 percent helium, and 4 percent heavy atoms. This makes the mean weight of a particle 0.67, and the central temperature 13,000,000 degrees. This series of possible solutions ends with one containing 99.8 percent hydrogen, and with a central temperature of 10,000,000 degrees. Strömgren finds, by this method, very nearly the same composition for most of the stars for which there are reliable data. For example, Sirius (the bright component of the binary) comes out with 36 percent of hydrogen, Capella with 29 percent, if there is no helium present, and the other solutions are also similar. A few stars show evidence of different composition. For example, Zeta Herculis, which is four times as bright as the Sun, though of almost the same mass and surface temperature, gives only 11 percent of hydrogen; and some of the hot stars at the top of the main sequence come out with 50 percent or more.

It is not surprising to find that most of the stars are similar in composition, for it seems reasonable—though we cannot prove it—to assume that they were somehow formed out of the same material.

The atmospheres of the stars, which we can study directly with the spectroscope, are actually very similar in composition, barring the effects of different temperatures in "stirring up" the atoms. In a few stars there appears to be an excess of silicon, or strontium, or barium. There is far more hydrogen than in the interior. Rosseland has explained this. The free electrons, which are very light, tend to rise to great heights. To prevent this, there must be a small electric field pulling them down and the charged atoms up. The electric force will have more effect on the light hydrogen ions than on heavier ones, and so will draw hydrogen toward the surface.

BUT the greatest question of all remains unanswered. What *keeps* the stars shining? At the end of the last century we thought we knew. Helmholtz and Kelvin, a generation earlier, had shown that, if the Sun, or any other star, contracted slowly, its gravitational energy would be gradually converted into heat. Half this heat, and in some circumstances more, would be required to raise the temperature of the interior (which is increased by the contraction) but the rest would be available to supply the loss by leakage to the surface, and radiation into space. The star would automatically adjust its rate of shrinkage to the right amount to meet the annual radiation, and so keep shining for a long time. Applied to the Sun, this theory accounted for about 15,000,000 years shining, at the present rate, before it got to its present size. In those days, that seemed an impressively long time. But there is now conclusive radioactive evidence that geological time has involved fully a hundred times as long as this, and that the Sun has been warming the Earth very much as at present all this while. Whence has this enormous source of energy been derived?

For the first time, a reasonably complete and satisfactory answer has been given to this question: but we must wait till next month for space to describe this.—*Princeton University Observatory, March 4, 1939.*

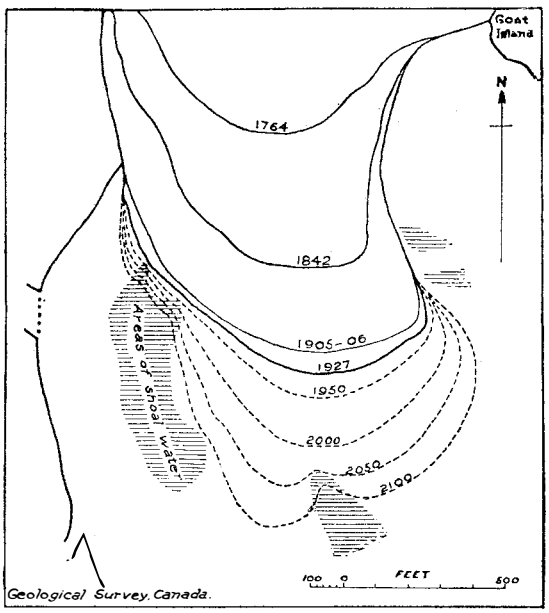
More Water for Niagara

Weir Raises Water Level in Power Plant Forebay . . . Incidentally Spreads Water Over Falls . . . Enhances Spectacle . . . Unique Problems Solved

By R. G. SKERRETT

NIAGARA FALLS can be safeguarded against serious self-impairment as a spectacle. How this can be done has recently been shown by work carried out in the upper rapids of the river. This should be welcome news to the many millions of people that consider the falls to be the greatest of our natural wonders. Once more the engineer has won his battle despite great odds.

Every now and then large masses of rock detach themselves from the crest lines of the two falls, and immediately there is excited clamor that one or the other of the two cascades is "committing suicide." If such were, indeed, the fact, then the falls have been busy at their own destruction ever since they started upon their stupendous recession some 35,000 years ago at the original escarpment, seven miles downstream from the present site. What is the puny significance of a few thousand tons of detached rock compared with the inconceivably great volume of rock that the river has carved out of the varied formations in the period mentioned while eroding a gorge miles long, from 200 to 300 feet deep, and of varying but extensive width? Each mass of rock so released is merely a recurrent reminder of the tireless forces that have been at work during past millenia and will continue for ages to come.



Changes in contour of Horseshoe Fall during the years from 1764, and predicted changes

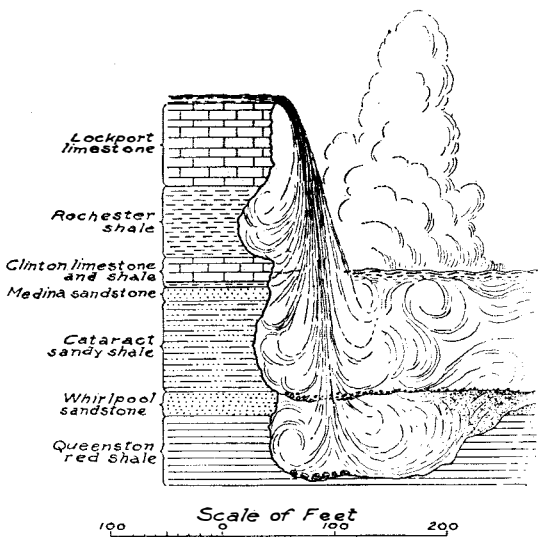
The earliest record of the contour of the Canadian or Horseshoe Fall, which has been altered by erosion in latter decades more than the American Fall, dates from 1764; and at subsequent intervals the crest line has been observed and registered by drawings. These records disclose that the Horseshoe Fall has undergone considerable change of crest line in the course of the last 200 or 300 years, but none is, relatively speaking, scarcely more than an inconsequent nibble compared with the modifications that have taken place in the past.

The Niagara River, in its approach to the two cascades, flows over a thick stratum of rock which is a hard limestone formation and highly resistant to erosive action. The river level drops about 50 feet to the mile as it descends to the falls, and because of the swiftly moving water, the lip of the Horseshoe Fall is ceaselessly exposed to erosive action. As a consequence, the recession of the crest line, due to this wear, had been found to be as much as 4.2 feet in a single year; and between 1842 and 1927, the mean annual rate of recession is known to have been 3.7 feet. Since 1905, however, the mean recession has been 2.3 feet. The lessening of the retrograde movement is largely the result of a reduction in the volume of water pouring over the falls, due partly to the diversion of water for power purposes at points upstream.

Even though natural forces are inevitably bound to continue their erosive work at both the American Fall and the Canadian Fall, and recession will persist until Niagara Falls opens the flood gates of Lake Erie thousands and thousands of years hence, it is still practicable, as has been proved lately, to direct the flow of the water at the falls in such a manner as to modify its erosive action. It is also possible to bring about a better balanced distribution of the water throughout the entire sweep of the crest line of each fall. Improvement in the entire spectacle may even be achieved with a lesser volume of water than ordinarily passes over the falls.

These betterments were indicated as feasible in a report made about eight years ago by a joint international board composed of eminent Americans and Canadians. The board disclosed that competent engineers were satisfied that erosion could be reduced and the picturesqueness of the falls enhanced by controlling the flow of the water to the cascades through the medium of submerged weirs; but nothing to that end was done at the time by either interested nation. Something now has been done, and the Horseshoe Fall has gained in beauty in consequence.

The international report to which reference has been made stated that more water could be diverted for power purposes yet still leave an ample volume to maintain the falls in their prime as a



Vertical section of the falls showing the various strata. All slope downward to left, upstream

spectacle. This is a matter of importance because the Niagara River has become a source of indispensable electric energy for nearby communities and essential industrial activities. It is a fact, however, that a condition of lowered water in the river, mainly due to nature's fickleness, has brought about the building of a submerged weir that incidentally has benefited the Horseshoe Fall. Primarily, the weir has been constructed to restore to one of the Canadian power plants the volume of water that it had at its disposal when first put in operation 35 years ago.

During the succeeding three and a half decades, the level of the river dropped because of much diminished rainfall, over a protracted period, throughout the expansive watershed of the Great Lakes. Also, the Chicago Drainage Canal, the improved Welland Canal, and the New York State Barge Canal have made increased drafts on the waters of those lakes. Furthermore, expanding power plants, with their intakes above the falls, have withdrawn more water from the river to meet the demand for larger blocks of electric energy. To satisfy their customers, power companies have successively amplified the capacities of their stations. In 1904, the total installed capacity at the Niagara Falls stations was but 122,750 horsepower. Today, it is 1,563,700 horsepower. The lowering of the river level became particularly serious for the Canadian Niagara Power Company, Ltd. To re-establish the water level in the forebay of its plant, located about a third of a mile above the Horseshoe Fall, that company, with the full approval of the authorities, recently has built a subaqueous weir about 930 feet long that extends from the Canadian shore obliquely upstream. It reaches out against the sweep of the river like the forearm of a swimmer, with a curved elbow where the structure is tied to the shore at the downstream side of the forebay entrance.

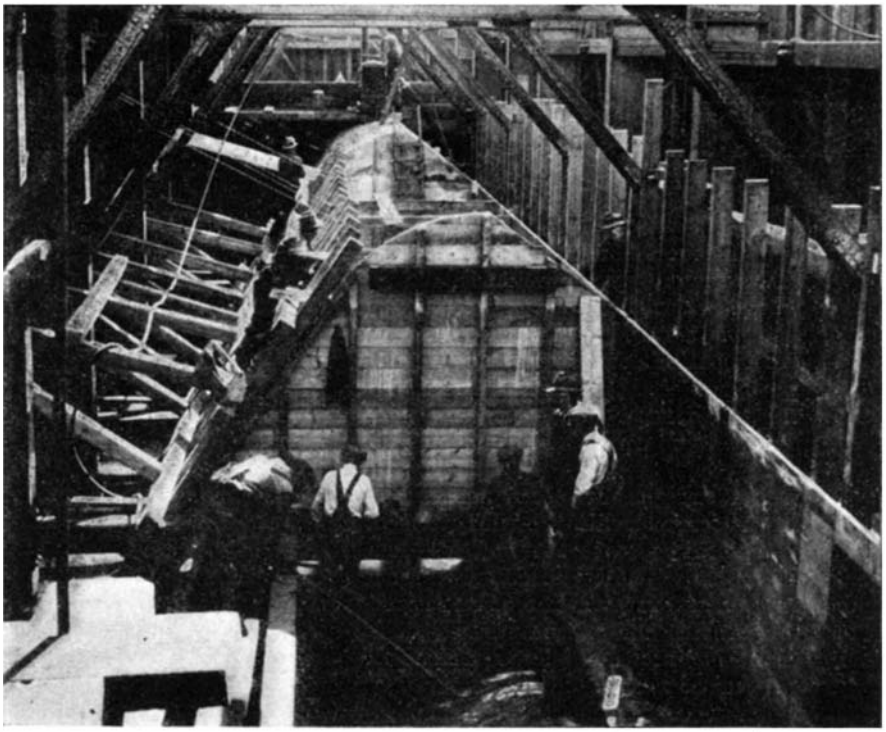
Above: **Temporary construction pier that was the base of operations.** *Below:* **One of the cells being made ready to be swung outboard and lowered into position**

The weirs proposed ten years ago were to be rock-fill structures. The weir that now serves the plant of the Canadian Niagara Power Company, Ltd., is of concrete of a superior character. The structure is designed to be permanent and capable of meeting the most rigorous conditions. Its construction called for unusual precautions and engineering expedients. The work necessitated the construction of a temporary operating pier of the same length as the concrete weir; and along the downstream side of the pier was successively formed a cofferdam of sufficient length to permit the pouring of the weir in a 72-foot section each time—the cofferdam being unwatered so that the concrete could be placed in the dry and handled in a manner that would make certain of high-grade workmanship throughout.

Although the original design of the weir was planned broadly to meet conditions under water as they were largely assumed to be, nevertheless provision had to be made for modifications as more exact knowledge of the river was obtained during the building of the temporary pier. That pier, besides affording a working platform and creating an area of relatively quiet water along its downstream side, was also to serve experimentally as a weir and, by means of various tests, to disclose just how high and how long the permanent weir would have to be to raise the water in the forebay of the power plant to the level that had existed when that station began operating and withdrawing water in 1904.

It was essential that the weir should not be visible or detract from the natural beauty of the rapids above the fall. No exact soundings had been made previously along the line chosen for the weir. The swiftly running river and the nearness of the fall had made such work not alone too hazardous but too costly. Therefore, the construction of the pier was, in itself, both a venturesome and exploratory undertaking, and it was counted upon to reveal, as it advanced outward, the changing depth of water and the varying features of the rocky river bed. The procedure was more or less like wading into a treacherous stream with the prospect of a sudden and perhaps dangerous drop at any moment.

The pier was made up of numerous unit cells fashioned of structural steel and having the form of four-legged rectangular frames, which were assembled on shore and set upon the river bed, one by one, as the pier was extended obliquely outward from the shore. Each of the four legs was a heavy I-beam, and the lower part of each leg was shortened, when necessary, to conform to the river bed. To give the cells a better and a uniform footing, each leg had welded to it a sturdy cast-steel spiked shoe, added after any excess length of the corner legs was burned off. In the upper section of each cell there was a timber-lined bin capable of holding 50 cubic yards of gravel ballast that was added each time after a cell was in its assigned place in the pier. To stabilize the pier further, each leg of each cell was anchored to the river bed by two two-inch steel dowels that were driven into holes drilled into the rock beneath each leg after the cell had been set. Before a cell was lowered



Within an unwatered length of cofferdam, beside sheltered flank of pier, while wooden forms were being erected to pour a 72-foot length of submerged weir

into place, precise soundings were made where the four legs of the next cell to be lowered would rest and the bottom was cleared of all loose material to assure a footing on firm rock. The soundings were made from a platform cantilevered out from the last cell in position. In this manner, the pier was lengthened cell by cell after deliberate and careful preparation; and in the end the pier was composed of 51 cells.

EACH cell had a width of 12 feet and a length of 24 feet, and the cells were arranged with their length across the axis of the pier. There was a gap of six feet between succeeding cells and there was a free space of 12 feet or so between the under side of each ballast bin and the bed of the river. The gaps between the cells and the spaces below the bins could be closed when or where desired by stop logs—rectangular timbers—dropped into place between the flanges of the upstream legs of the cells. This provision made it possible to obstruct the flow of water through the pier structure and permit it to function as a weir of variable height. In this way, the engineers were able to ascertain how long and how high the permanent weir should be to raise the water in the forebay to the required level. The six-foot gaps between the cells were designed to provide ready passages for floating ice so that the obstruction would not cause an ice jam that would be almost certain to shut down the power station, for the work had to go on throughout the winter.

On top of the cells of the pier were laid timber stringers, crossties, and the rails for two tracks—one for a large locomotive crane which helped to handle the cells and do other heavy work in connection with the actual construction of the weir and the erection of the paralleling cofferdam, and the second, a narrow-gage track over which were hauled carloads of concrete and other materials. The pier was extended until it was made up of 45 cells, after which stop logs were put in place and the pier was used as a weir experimentally for several weeks. After continuous observation, the engineers decided to lengthen the pier by six more cells; and when so completed and with stop logs installed, it was found that the river flowed over the makeshift weir at a level of five feet higher than on the downstream side of that barrier. To deflect to midstream the violently eddying water at the outer end of the pier, there was suspended there a cantilevered frame of steel and timber having a length of 48 feet. This served its purpose, and protected from any troublesome disturbance the area in which the weir was to be built.

The building of the weir started at the outer end of the pier and was gradually lengthened until its inner curved section met the shore. The cofferdam within which the weir was reared was formed of a series of steel frames around which water-tight walls were made up of interlocking steel sheet piling—the enclosed space then being unwatered by a group of pumps of large combined capacity. Each rectangular frame section had a length of 24 feet and a width of 25 feet, and the frames could be tied together or disconnected so as to be used repeatedly in pouring, length after length, of the concrete weir. For this purpose, four sections of cofferdam, 96 feet long, served successively for placing concrete in a unit 72-foot length of weir; and the shoreward fourth section, at the conclusion of one such operation, was left in place to form the outermost part of the next unwatered length of cofferdam within which would be poured the succeeding 72 feet of weir. Besides cleaning the river bed to expose sound rock for a satisfactory bonding surface for the concrete, the weir was further anchored to the basic rock by means of two lines of heavy steel dowels driven into the rock and projecting above it.

Despite the hazardous conditions surrounding the entire job, the work was carried forward to completion with but a single unexpected setback, which occurred where the project crossed diagonally an eroded channel 12 feet deep and 60 feet wide that was filled with a tightly packed mass of gravel and boulders. This was not serious. When the work was finished approximately $435,000 had been expended. The depth of water in which the weir was built varies from 12 to 22 feet. Work on the project was carried on for more than a year as the pier and the weir were constructed and then the former was removed.

WITH the temporary pier and all sections of the cofferdam dismantled and removed, the only evidence of the subaqueous weir is a long line of tumbling water that is much like the other turbulent areas of the rapids where the river rushes downward over hidden reefs. Aside from restoring the original water level within the forebay of the power station, the weir causes the water near the shore end of the structure to continue onward to the Table Rock flank of the Horseshoe Fall and to provide a better distribution of the water at that point. It thus adds to the beauty of that cascade where the lowered river had exposed a considerable expanse of rock contiguous to the crest line.

The weir has demonstrated how other weirs may be constructed and be effective in so distributing the flow, especially at the Horseshoe Fall, as to reduce the rate of erosion greatly at certain sections of that cataract and make the water that does drop over its crest-line the means of enhancing its effectiveness as an awe-inspiring spectacle. In short, Niagara Falls can, in a measure, be saved from self-defacement, thanks to the cunning of the modern engineer and to his associate, the well equipped and resourceful builder.

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Dr. Oscar Parkes, the noted naval authority, throws light on the puzzle of naval rearmament of the naval powers in two long articles that are coming soon. As usual, he made the drawings.—The Editor.

Comfort Cooling

Significant New System . . . Proved by Hospital Tests . . . No Costly Equipment . . . Employs Body-Radiation Reflectors, Absorbers . . . Cools No Air

AN aluminum-foil-coated operating room in Blodgett Memorial Hospital, Grand Rapids, Michigan, may hold the answer to science's long search for an ideal climate. In this unique room, air temperatures may be maintained as high as 90 degrees or above, with average humidity, without any perceptible discomfort to occupants. This amazing set of conditions has been made possible by an important development of Dr. Clarence A. Mills, professor of experimental medicine at the University of Cincinnati, and may bring about new economies in building insulation and cooling and heating through control of human comfort by radiant means.

The Blodgett installation represents nearly 10 years of research on this new type of climate control. Dr. Mills spent about two years in actual testing at the University of Cincinnati with aluminum-foil-lined compartments before the system was given its first practical test in the hospital. The Blodgett operating room has been serviced by Dr. Mills' heat-control system for several summer months, and during this time, the installation has demonstrated highly encouraging results.

The Mills system is a departure from the conventional types of heat control now in commercial and home use, which depend mainly upon transfer of heat by convection and conduction, in that it promotes the control of body heat by radiation. As most persons know, radiation is the transfer of heat between bodies of dissimilar temperatures which are separated from each other by an appreciable distance. The heat rays proceed through the air in a straight line without warming it and travel with the speed of light. In a highly heated room, for example, a closed window, chilled by the outside air, will rapidly absorb the heat radiations from a person's body standing close to it, with the result that the person will feel uncomfortably cold in spite of the high temperature of the surrounding air.

In the Blodgett operating room, the radiant heat from persons in the room passes to the walls, which are covered with embossed aluminum foil. The aluminum foil is highly reflective to these heat rays and low in heat radiation and in absorption. These properties, combined with the diffusing effect of the embossed pattern, cause the rays to be reflected at countless angles, perhaps many times, so that the majority of the heat rays tend to come into contact, sooner or later, with two black wall-panels, approximately three feet wide by 15 feet long, in which circulating fluid has lowered the temperature to 50 degrees or under. These panels absorb the heat rays as a blotter takes up ink.

One of the beneficial features of this method of hospital "comfort cooling" is the fact that the installation controls the room climate without changing the surrounding air, thus eliminating undesired drafts during surgical operations.

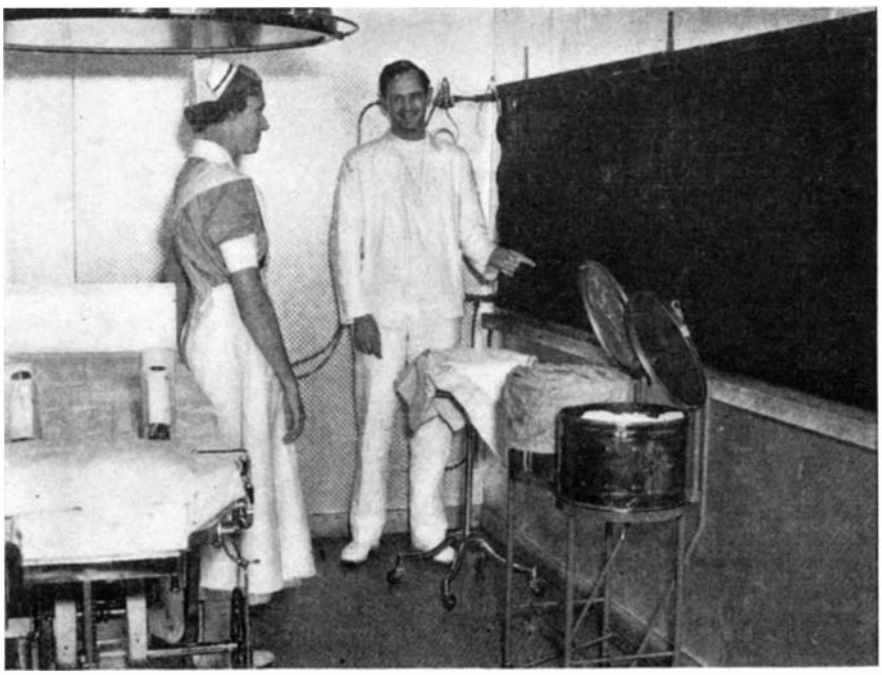
THERE is no sensation of thermal skin shock when entering the room from an unconditioned atmosphere. In spite of the high temperature of the room and the fact that heavy apparel such as heavy duck gown, rubber gloves, hat, and mask is worn during an operation, profuse perspiration of the occupants is eliminated.

Although the Blodgett installation is designed for comfort under high temperature conditions such as are necessary in operating rooms, tests have shown that, with slightly modified designs, the process can also be efficiently reversed. By heating instead of cooling the panels, heat may be radiated back to the bodies of the occupants to make low temperatures also feel comfortable.

Attention was first called to the Mills method of heat control at the meeting of the American College of Surgeons in Toronto in 1937 where it was brought out that Dr. Mills had made this novel approach to comfort cooling. As a result of the meeting, Dr. John E. Gorrell, Director of the Blodgett Memorial Hospital, became interested in a practical application of this new comfort-conditioning for hospital operating rooms.

Although Dr. Mills' development has many proved possibilities, the inventor contends that there are several features which will probably have to be improved before a desired degree of perfection is obtained. When this point is reached, the equipment will function efficiently for both home and commercial use, Dr. Mills believes.

In a comparison of costs between the new theory and present-day air-conditioning systems, Dr. Mills and impartial engineers have computed the operating expense at from one third to one fifth that of air-conditioning equipment of similar capacities.



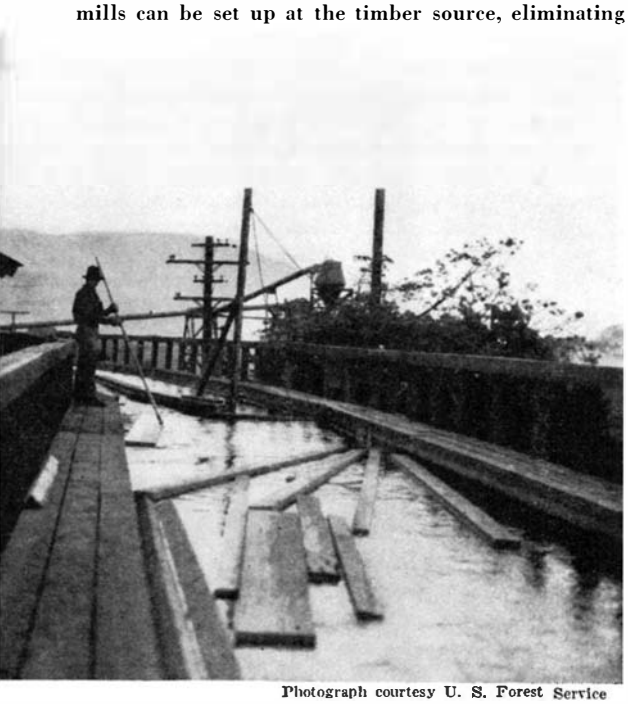
Temperatures of 90 degrees and above are comfortable because the body's heat, radiated to the aluminum walls, is reflected to the cool heat-absorber (black)

Photograph courtesy U. S. Forest Service

Portable tie mill cuts 300 ties daily, the product of four men. Such mills can be set up at the timber source, eliminating long hauls

Photograph courtesy U. S. Forest Service

Some trucks carry their trailers into the forest where, hooked together, they will carry heavy loads of timber over rough roads to mill or flume



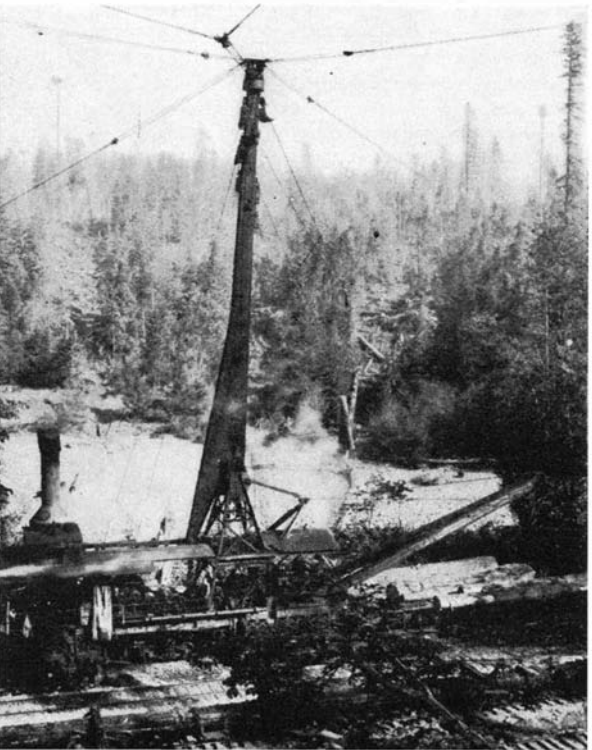
Photograph courtesy U. S. Forest Service

In some cases lumber floats down man-made rivers or flumes to a loading point on a railroad or a river

Among new machines in the forests is this combination bulldozer and fire-fighting pump. Two overhead steel tubes protect the driver against branches

Below: A tower skidder does not require a tree at the tracks; a steel spar is mounted on the machine

Photograph courtesy Weyerhauser Timber Co.



Flexible Power

STANDING sturdier than the proverbial oak, the head of a tall steel spar rears above a Washington logging camp; across canyons, strong cables skid to the side of the spar heavy logs which yesterday were 200-year-old trees. In a nearby Oregon forest a portable tie mill salvages second-growth timber, Douglas firs too small for the big outfits to fell.

These two timber-handlers represent the change in forest machinery which is witnessing the disappearance of big, costly mills and the evolution of power units with which small operators penetrate the forests, logging small areas which formerly were not touched.

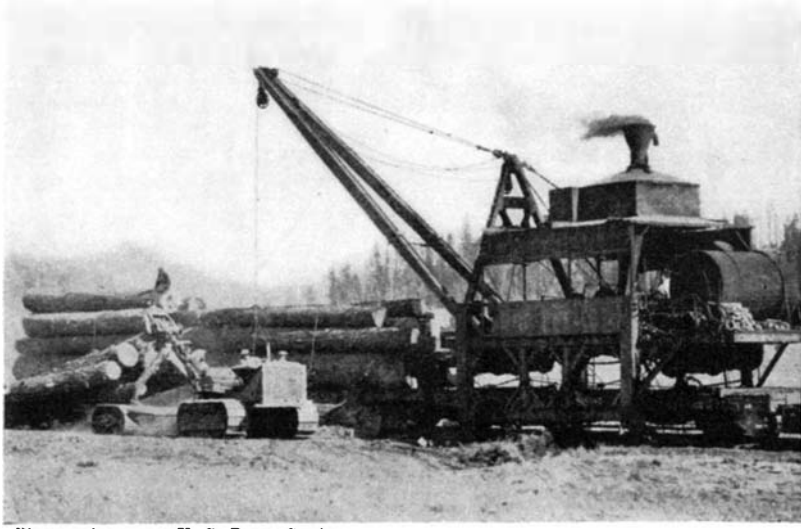
Nick Meyer, for example, operates a four-man tie mill near Lapine, Oregon, cutting 300 railroad ties daily, the product of a faller, sawyer, offbearer, and stacker. He moves through second-growth timber, some of which is less than a half-century old, cleaning up odd corners passed by former logging outfits.

Elsewhere through the northwest, other novel machines speed the cutting of merchantable timber. Saws, powered by electricity which turns endless chains, bite through the wood, felling trees in jig time. Diesel engines in multiple units, gasoline motors, and steam engines bring the big timbers to rail and water. Lumber, rough cut at mills deep in the woods, floats down man-made rivers to shipping points. From the moment a lumberjack shouts, "Tim-b-u-r-r! Timber down the hill," to warn all within hearing that a tree is falling, fast, mobile machines take up the job of rushing it to distant markets.

Standing on a railroad car bearing a steam-engine and winches into a Weyerhauser forest, the steel spar and skidder may be moved all along the line, pulling logs through the air from cutting areas a half-mile distant. The skidder system is the method commonly used for gathering in logs on large cuttings.

Loaded logging truck and Diesel converted shovel loader handling ponderosa pine logs in an Oregon forest

Less than three feet wide, this baby bulldozer-tractor builds trails in mountainous country that larger units may follow



Photograph courtesy U. S. Forest Service

Steam jammer and Caterpillar meet at railside. This is a combination frequently seen near the forests. Trailer-trucks are used for longer hauls

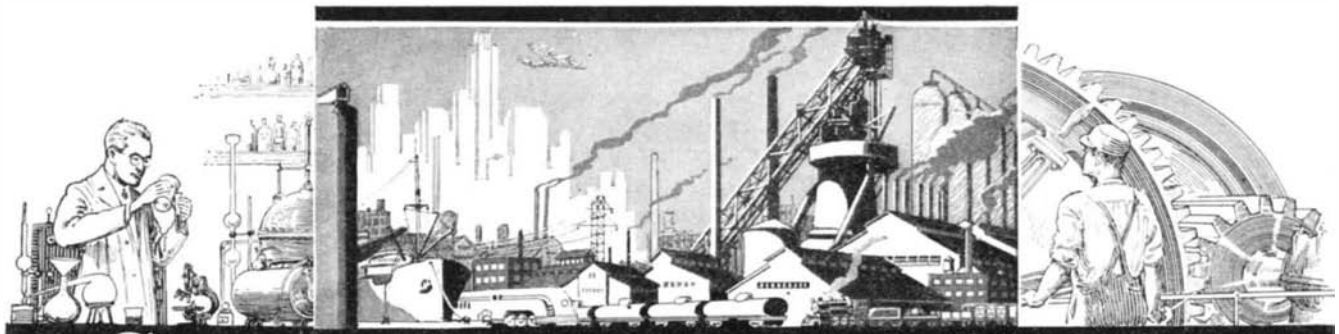
IN THE WOODS

It involves use of a skyline, or two-inch cable suspended between two supports. Along the skyline rides a steel carriage weighing nearly as much as a small automobile, to which are attached hooks for picking up one end of the logs. Back and forth moves the carriage, skidding logs to the landing.

FIVE years ago most timber reached the shipping points on railroads, built by loggers deep into the forests. Loggers recently have patterned their operations after the construction industry. Now, logs by tens of thousands are lifted by cables and towed through mud and snow on tractor-type trailers, or ride over solid truck tires and truck differential housings to forest roads cut by sharp-edged bulldozers. Only recently there appeared in Oregon two such machines built by the U. S. Forest Service, one a baby scarcely three feet wide, the other a snorting giant capable of building several miles of six-foot road between breakfast and dinner. By swinging two levers, the operator can convert this machine into either a water pump or an oil pump, for fighting fires or setting backfires when a logging camp is threatened.

Unable to turn around on the narrow roads, trucks carry eight-wheel trailers on their backs to the loading points. There other machines pick up the trailers and set them down in the roadway. After the units are hooked together, heavy loads of logs are piled on for the rough journey out of the forest. Few of these are one-purpose machines. Diesel shovels may be excavating for a road today, loading logs tomorrow. Locomotive cranes, powered by steam, lift logs or right cars over-turned in a wreck. Hundred-ton locomotives are passing, for each piece of today's forest machinery must be capable of handling several jobs to keep up the accelerating pace of logging.—*Andrew R. Boone.*

Below: Tractor hauling heavy log after a heavy winter rainstorm. The trailer uses a truck rear-end



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

Stopping the Marine Borer

PROTECTION against the ravages of the marine borers on wharf piling in all but tropical waters is now offered by a unique type of shield with an estimated life of at least 15 years. Cost of installing the shield

Applying a small section of wooden shield to stop marine borers

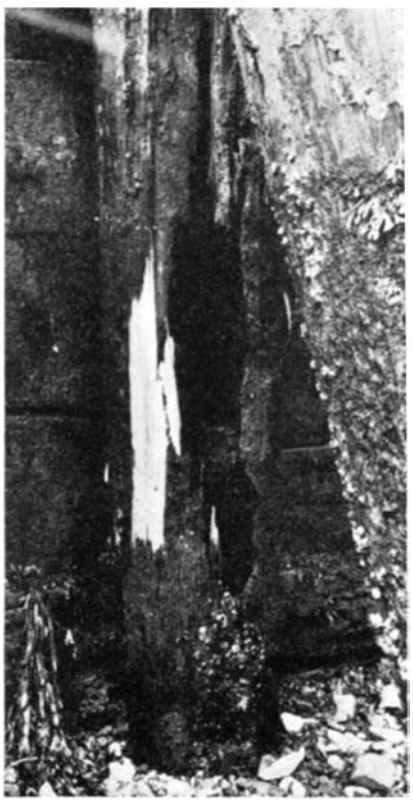
varies according to territory, but in no case does it exceed 50 percent of the replacement cost of the piling, according to its producers and INCO magazine.

Since almost all marine borers attack wharf piling between the mud line and the low-water mark, the shield is designed to cover this section only. Length can be varied in accordance with the demands of local conditions.

Essentially, the shield consists of a wooden casing treated to absolute refusal with creosote. After being applied, the casing is then filled with sand. A patented device at the base of the shield prevents the escape of sand after installation and aids in centering the shield around the pile.

The base is made up of 12 staves approximately 15 inches long, fastened in two semi-circular sections hinged together. This base is applied around the pile above the water line and the two semi-circular sections are bound together with a Monel wire hoop and Monel clip assembly. The base is then forced down as other sections of staves are added.

The section staves, each provided with internal and external members to engage the top of the corresponding stave below, vary



How marine borers destroyed a yellow-pine pile that was unprotected

in length from two to five feet. They are likewise bound together at intervals with Monel hoops.

The completed shield is forced down until it rests upon the bottom. Upon being filled with sand it will sink into the mud to depths varying from four to 15 inches.

The value of the sand as a protection medium has been definitely proved by the examination of samples taken from piles at one-foot intervals and examined microscopically, both before the shield was erected and filled with sand and after the shield was stripped from around the pile. Biological examination of these chips showed that, after the application of the shield and its subsequent removal, no form of living marine organism was found. The microscope did reveal the remains of the marine borers, known to have existed prior to the application of the shield. These were so badly decomposed as to make identification of the borers difficult.

Known as the Upton Pile Shield, the device is produced by Anderson Products, Inc.

Trunk-Size Refrigerated Container

SMALL-LOT shipments of quick-frozen foods, biological products, fish, flowers, and all types of perishables will be facilitated by a new type container manufactured by General Electric and recently put into general use by Railway Express Agency. The container, several years in development, was designed independently by Major Elihu Church and is heralded as the perfect solution to the problem of making less-than-carload shipments of perishable goods which must be kept at low temperatures.

The container is about the size of a large trunk. Its 10 cubic-foot storage space provides a cargo capacity for 300 to 400 pounds of food; and, in addition, the ice bunker

For small-lot shipments

will hold 100 pounds of dry ice, or 90 pounds of water ice. Total weight of the container, loaded and ready for shipment, is about 650 pounds.

Preliminary tests indicate that a charge of 100 pounds of dry ice will protect a shipment for more than 72 hours in average outside temperatures of 90 degrees. It was pointed out that at this rate of consumption, the refrigerant for the container in one shipment would cost but two-and-a-half cents an hour.

In addition to expanding the market for perishable food, the new container will facilitate quick transportation of biological materials requiring low temperatures in shipment.

"LOOK WHERE YOU'RE GOING"

DEATHS from motor vehicle collisions with fixed objects have increased more rapidly than any other type of motor fatality—244 percent from 1927 to 1937.

—Highway Research Abstracts.

Aero-Thread Screw Thread

MAKING use of a new system of application, the "Aero-Thread" screw thread system is meeting with wide interest from manufacturers and industrial concerns, particularly for those applications where the maximum reliability in screw fastenings is required.

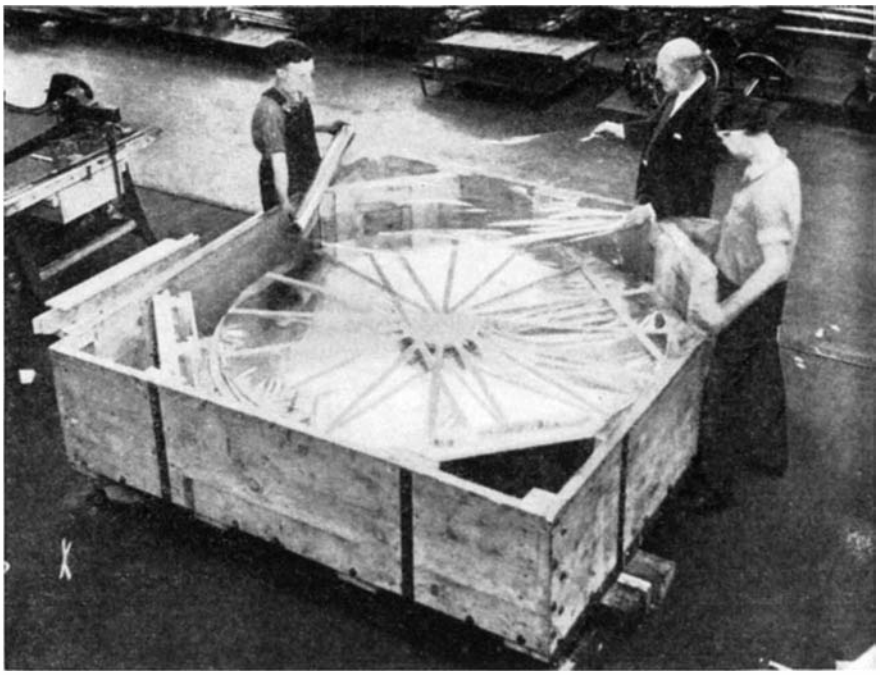
This system was developed primarily for use in the aircraft industry where high strength studs and cap screws are required. It has particular advantages for screws that fasten into tapped holes in light alloys such as those of aluminum or magnesium. Because of the especially high strength that can be obtained from an Aero-Thread screw or stud, this screw system is attractive for use in all machinery where compactness and light weight are desirable.

The outstanding feature of the Aero-Thread screw system is the use of a spirally wound insert or bushing of precision formed, high tensile, bronze spring wire. This insert fits into the tapped hole by screwing into the threads and the design of the insert is such that, while it can readily be screwed into place, when once it is installed it becomes a fixed part of the tapped hole. When the stud or cap screw is assembled, its bearing is, therefore, against and in direct contact with the hard spiral bronze insert—instead of against the softer metal of the light alloy part.

The thread on the Aero-Thread studs and cap screws is of a shallow rounded form, fitting a corresponding form on the inner side of the insert. The complete elimination of all sharp corners in the thread on the stud or cap screw allows the use of studs and screws heat-treated to high values of tensile strength, and these screws have very much greater shock resistance and fatigue capacity than is possible with screws having U.S.S. or S.A.E. thread forms. In actual tests the Aero-Thread screws have shown two or three times the shock resistance and fatigue strength of screws with National Form Threads.

This new system simplifies the servicing of studs and screws. It protects the threads in the female parts from wear and damage and thereby eliminates the need for oversized screws and studs, or for re-tapping the holes when replacements are necessary. When an Aero-Thread stud or cap screw is removed from the tapped hole, it is generally found that it can be replaced with one of the same size and still maintain the original designed thread fit. If the insert should become damaged or worn, it can readily be replaced with a new insert and the threaded hole will be brought back to its original dimensions.

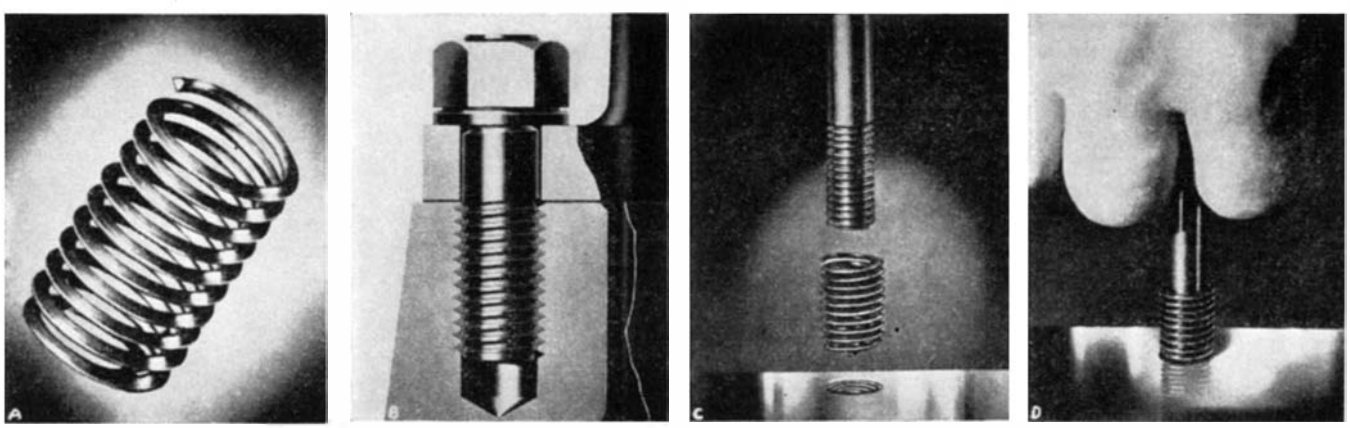
The Aero-Thread system also allows—for the first time—the unrestricted use of cap screws and removable screw fastenings in the light alloys of aluminum or magnesium, as the insert fully protects the soft threads in the tapped hole and its anti-frictional property allows smooth, non-wearing, and non-seizing engagement for the cap screw.



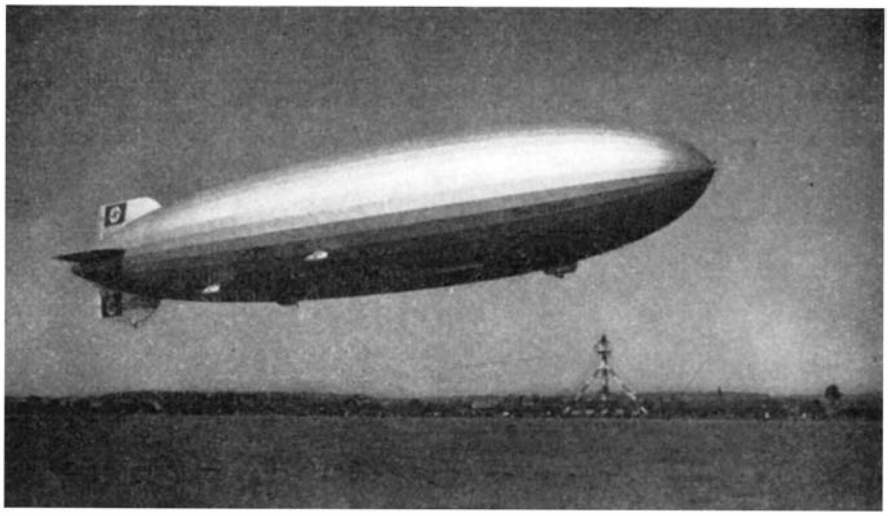
The three-ton, 82-inch Pyrex telescope mirror for the McDonald Observatory, second largest in the world and the most accurate mirror ever tested, was wrapped in Cellophane for shipment from the Warner & Swasey Co., in Cleveland, to Mt. Locke, in western Texas. Cellophane was chosen because it is nonporous and would not collect moisture during the trip. If oil or wax paper were used, there would be danger of getting spots on the mirror, which would have to be polished off. Even if the Cellophane touches the polished surface of the mirror, there is no possibility of spotting. The covering also keeps out all dust

Frost in the Bakery

QUICK freezing is expected to help bakers solve their most vexing problem, that of too quick staling of bread. Recent investigations have shown that bread can be kept fresh if it is frozen and stored at low temperature as soon as it is baked. Experts were



The new Aero-Thread screw thread system described above, and how it is applied



LZ 130 during a test flight. *Below:* A view down one of the cat-walks, showing typical construction of the airship, and the auxiliary rudder-control station

unable to distinguish any difference between freshly baked loaves and others that had been stored for as long as 20 days at 31 degrees, Fahrenheit. Even after nearly four months bread kept at this low temperature was quite salable. Possibly bakers may now add low-temperature cold stores to their plants to help take up slack between production and demand.

Within recent years, important progress has been made by bakers toward a loaf which keeps better and methods of wrapping and keeping bread fresh longer. However, none of these has provided for so long or so satisfactory keeping as quick freezing. The temperature used is lower than any met commercially except in modern quick-freezing practice.—*D. H. K.*

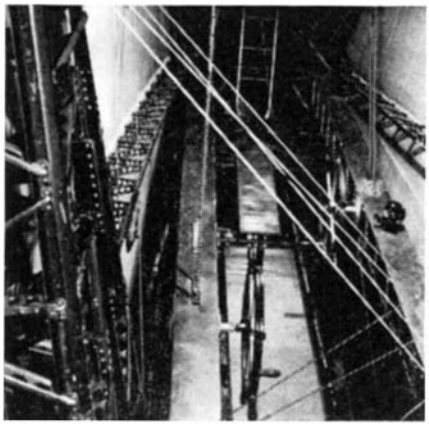
DIVES

THEORETICALLY, engineers say, there is no limit to the maximum diving speed of planes under test, and they believe the record of 670 miles an hour, set by Lieutenant Troy Keith, of the Air Corps, may be surpassed. Pulling out of a dive is the difficult thing for the pilot, for he can withstand a strain of 14*g* for only about a fifth of a second.

To Follow the "Hindenburg"

UNDETERRED by the terrible disaster of the *Hindenburg*, the German Luftschiffbau Zeppelin has completed and successfully tested the *LZ 130*, which is the 119th large rigid airship built by this company (eleven others were designed but never built). Basically, the design is very similar to that of the *Hindenburg*, although many refinements have been incorporated. The length of the new airship is 803 feet, and its maximum diameter is 135 feet, giving a fineness ratio of 6 to 1. The lifting gas capacity exceeds 7,000,000 cubic feet. The 16 gas cells were to be filled with helium, but the controversy with Secretary Ickes makes it rather doubtful that the German company will be able to obtain this valuable non-inflammable gas from the United States.

The passengers in the *LZ 130* will be housed within the hull in 20 cabins luxurious enough to stand comparison with the accommodation offered on modern ocean liners. In the construction of the furniture, duralumin has largely been used in place of wood; as a further weight-saving measure, holes are punched into the metal ribs and braces of the furniture.



Compared with the airship the airplane is childlike in its simplicity. The structure of an airship is an engineering problem of enormous complexity. The structure of the *LZ 130* is of the classical type with 36 longitudinal girders and wire-braced frames at intervals to house the gas cells and reinforce the longitudinals.

Some curious statistics are supplied to us by the Luftschiffbau Zeppelin. The total length of frame girders is about 14 miles, the number of rivets used is 5,500,000, the total length of steel wire used is about 80 miles, and the area of cotton material for the outer cover is about 33,000 square yards. Four Daimler-Benz water-cooled Diesel engines, of 800 to 1000 horsepower each, supply the power. The Diesel, with its great reliability, is the logical power plant for the airship where weight of engines is not quite of the same consequence as in the airplane. One of our photographs shows the *LZ 130* in flight. Another photograph illustrates typical construction, showing the interior of the keel and the auxiliary rudder-control station.

It is sometimes believed that all airship work in the United States has ceased and that Germany alone is active in this field. A symposium on airships held at the Annual Meeting of the Institute of Aeronautical Sciences belies this pessimistic view. Thus, the Navy has recently received a 400,000 cubic-foot non-rigid airship or "blimp." In the field of large airships, Congress has authorized the construction of a rigid airship of only 1,000,000 cubic feet to be used for training and research purposes. Dr. W. F. Durand, Chairman of the Special Committee on Airships, speaking at the above mentioned symposium, pointed out that since the great disasters to the *Akron* and the *Macon*, an immense amount of structural, aerodynamic, and wind-tunnel research has been carried out, which has filled up many gaps in our knowledge. Dr. Durand expressed his views as follows: "In our opinion, we are now in a position to design and construct airships with an assured margin of safety abundantly adequate to justify continued construction and operation."—*A. K.*

Flight by Woman Power

A WELL known engineer of Philadelphia, Enea Bossi, has built the "Aero-Cycle" which has been flown for three quarters of a mile with all the power supplied to the propeller of the very light monoplane by the legs of a muscular man. The actual exploit took place in Milan, Italy. In Germany, studies in man power flight are being undertaken in all seriousness. In Italy, the government has offered valuable prizes for flight by human muscles. Richard C. du Pont is reported to have said that given a glider with a foot-driven propeller, to be used occasionally, he could keep aloft indefinitely and fly across country at will. Evidently the question of muscular flight is not a fantastic one, and is being entertained in many responsible quarters.

Dr. W. F. Gerhardt, of Wayne University, is attacking the same problem in a totally different manner. He has built a "giro-cycle" which is in reality a helicopter of the simplest possible form. Its lifting element is a two-bladed, variable-pitch propeller of 14 feet diameter. The airscrew is mounted on a vertical shaft driven through a 2 to 1 pinion gear by ordinary bicycle foot pedals. As set up in the Doctor's laboratory the giro-cycle is not yet a free-flying vehicle, but is controlled laterally by a stationary tripod. The

One woman-power

charming Mrs. De Tuscan shown in our photograph has created three records with this unique device: the first vertical "flight" by muscular power, the first "flight" by muscular power ever achieved by a woman, and an ascent or jump-off of one eighth of an inch. At any rate, this is a beginning.

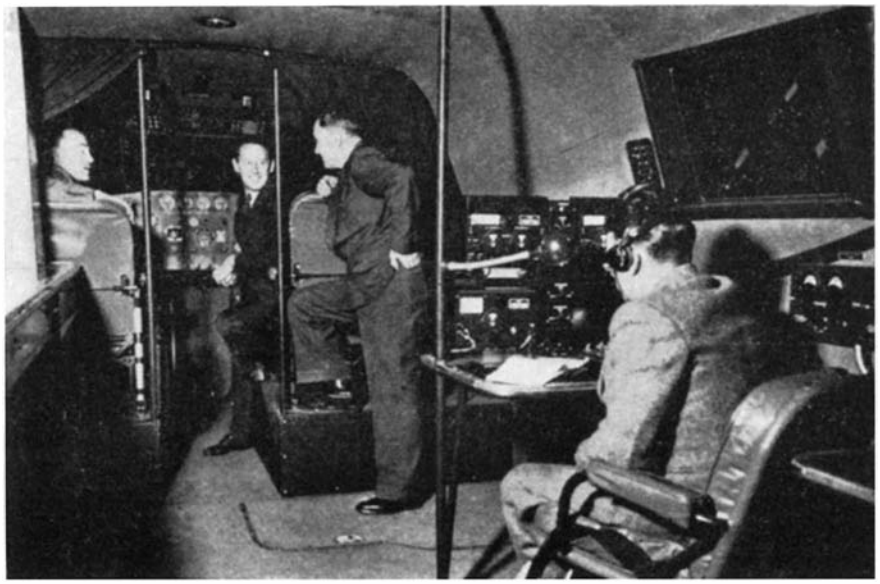
An interesting piece of research would be to determine whether a light plane with conventional leg-driven propeller, a flapping-wing machine, or a species of helicopter would be best adapted for muscular flight. —*A. K.*

Modern Cockpits

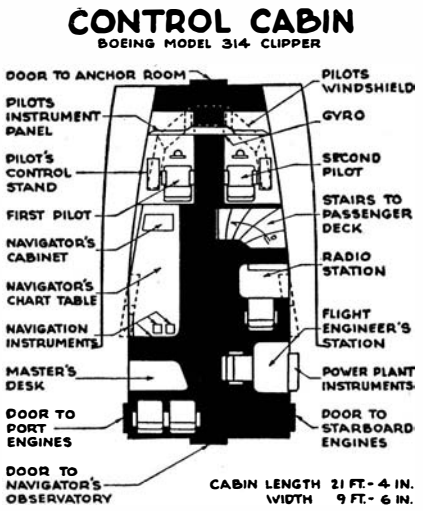
THE Boeing Clipper built for Pan American has passed its manufacturer's tests with flying colors. One of our photographs shows the Clipper alighting after a test flight, with the flaps depressed to diminish the impact. The design of the Boeing flying boat is of such interest that a small book could be written on its description and analysis. We propose here to focus attention on one significant feature, the control room.

In the early days of flying the pilot's cockpit was little more than a cubbyhole. Even a large mail-passenger plane of 1927, such as the Boeing *40-A*, had a cockpit volume of only 37 cubic feet. The new Clipper's control room has a volume of 1078 cubic feet, more than twice the volume of the entire passenger compartment of the Boeing *247-D* twin-engined land transport. Much room is needed to give the crew complete comfort in the execution of its duties, and to house a multiplicity of equipment. Both comfort and equipment are essential to safety.

The control room is, of course, located on the upper deck of the hull, with ready access to the engines through doors on each side of the room. There are six posts of duty in the room. The first and second pilots' stations are at the forward end, with a door to the anchor room at the very front end of the cabin. In front of these stations are the simplified instrument panel, the gyro pilot, and the windshield. There are four other posts of duty. A real advance in control room design and practice has been made, which relieves the pilots of the almost intolerable complexity of duties they have to undertake in smaller ships. If the instrument panel ahead of the first pilot has been so simplified, it is because duties have been subdivided among five or six men and the pilot's duty is now merely to control the flight in a given direction at the altitude and speed prescribed by the navigator. The navigator has plenty of



The spacious control room of the latest Pan American Clipper ship and, *below*, the arrangement of the flight deck. See also illustration on page 278, this issue



room for his cabinet, chart table, and navigational instruments. The radio operator, placed to the right, maintains contact with the ground stations and furnishes radio bearings to the navigator. The flight engineer has at his disposal the complete set of power-plant instruments and is close to the doors leading to the engines. The master or watch officer correlates the functions of the other crew members, assuming the functions of a captain. At the back of the control room is the door to the navigator's observatory. Furnishings are simple, unobtrusive, highly comfortable.

For relief members of the crew off duty there are sleeping quarters located in an aft compartment of the upper deck. It is remarkable how these large flying boats approach the character of the large surface vessel. —*A. K.*

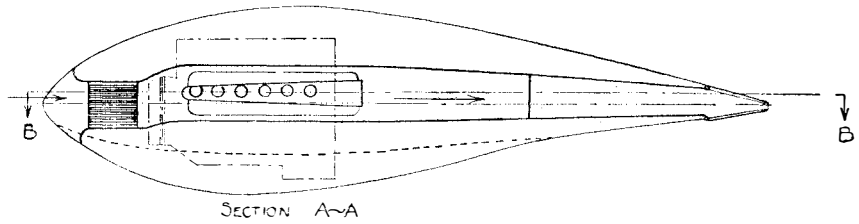
Yankee Clipper during a test run

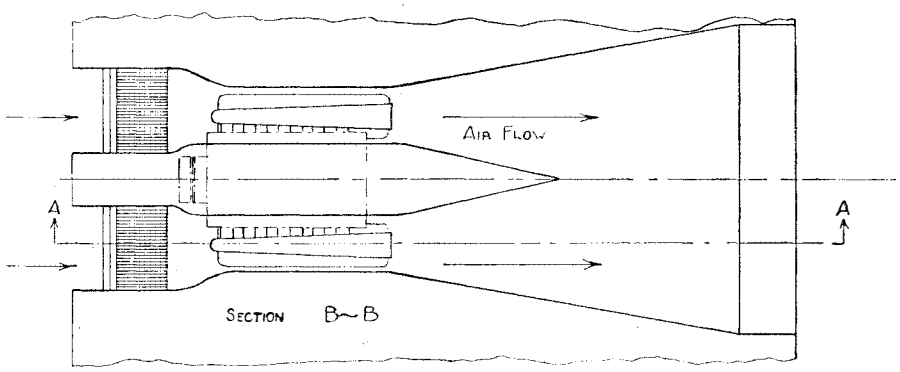
Military Airplane Secrecy

HIGH-RANKING Army officers have pointed out how difficult it is to maintain secrecy in regard to new airplane designs. Once a machine has been flown, it cannot escape observation and the telephoto lens can be brought into play by the possibly hostile onlooker. Finally, when an accident happens, the front pages of the daily press immediately communicate a wealth of information for the benefit of foreign countries and there is nothing in a democratic country to prevent the most valuable information being made available to skilled European interpreters.

Take, for example, the accident of the Army's "fastest plane" as reported so admirably in our newspapers, with photographs to make the situation clearer. It will be remembered that Lieutenant Benjamin S. Kelsey crashed the plane after a highly successful transcontinental trip from March Field, California, to the Cold Stream golf course just east of Mitchell Field on Long Island. We have not the slightest hesitation in discussing the machine here, even though we deplore the disclosures, because military designers in Europe will scrutinize the news stories with even greater care and will learn even more than the writer of these lines.

The speed is given as 390 miles an hour for a single-seater, so says the press, and notice is thereby served that only speeds of over 400 miles an hour will give a nation speed supremacy. The engines are streamlined into the wings on each side, and there is no inkling of an air-cooled cowling. The inference is that high-powered liquid-cooled Allison engines, of twelve-cylinder design, are now available for airplane construction. Why two engines for a single small cockpit?





Sketches above and below show details of the novel English scheme for cooling water-jacketed airplane engines without introducing undesirable air resistance

Because there is no way of getting higher speed with a single engine, and because control, laterally, with a single powerful engine is very difficult.

The news stories speak of two booms to carry the tail surfaces. The inference is that aerodynamic drag is saved thereby. It is evidently better to build a tiny cockpit just big enough to house the pilot, and use booms or outriggers, than to construct a conventional fuselage to support the rear control surfaces.

We read of the use of a tricycle landing gear. That means that even for the fastest military machine, the tricycle landing gear has come into its own. The cabin is supercharged for stratosphere or sub-stratosphere work. In the streamlined nose of the cockpit there are six ports for the machine guns, which can be closed by steel slides flush with the surface. The new machine can outfly the "flying fortress" bombers. Again it can be deduced that the new pursuit is designed to be a most formidable enemy of the bomber.

So the accident served to give the foreign students of the art a mine of valuable information.

The machine was built by Lockheed Aircraft in 18 months of hard work, and the accident in no way invalidates the skill of the designers. These extremely fast ships, even if they carry the latest instruments and flaps and other devices, still require great skill, and still encounter accidents even in the hands of such fine veterans as Lieutenant Kelsey. In fact, the question arises whether the new *XP-38* is so advanced, so clever, that the practical mark of military design has been overshot. Here is a ship which must cost, even in production, something not far from $100,000. Here is a ship which evidently requires great care in flying. Here is an all-metal ship, beautifully streamlined and finished, which it is not easy to repair or maintain. Here is a case of putting a great many eggs in one basket. Would it be in time of war feasible to build and operate a sufficient number of such machines? Would it not be wiser to have a greater number of airplanes, simpler in design, not quite so fast, but built at less expense and easier to operate? Where will we find the super-men that the world's fastest planes require for handling?

We hope and presume that those responsible for our military aircraft equipment do not overlook these considerations. We do not want an air force of theoretically perfect aircraft, but in insufficient numbers to put up a real fight.—*A. K.*

Engine Radiators Without Resistance

A FEW months ago we mentioned briefly, and on the basis of incomplete reports, that two young English engineers, Charles John Stewart and Frederick William Meredith, had devised a radiator in which air resistance was found to be nil or even negative. Now a study of the patent enables us to give a more complete statement of the principles of this device.

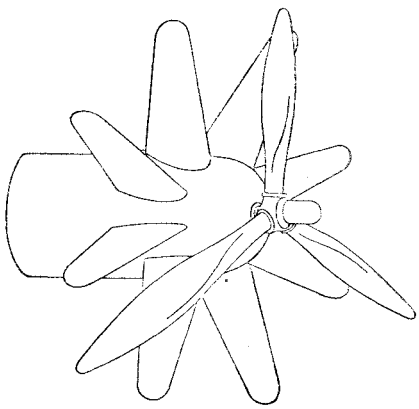
Let the reader glance for a moment at the diagrammatic sketches. The engine, with its two rows of cylinders in V-arrangement, is placed within the greatest depth of the airplane wing. On each side of the engine, air tunnels are provided with openings just behind the leading edge.

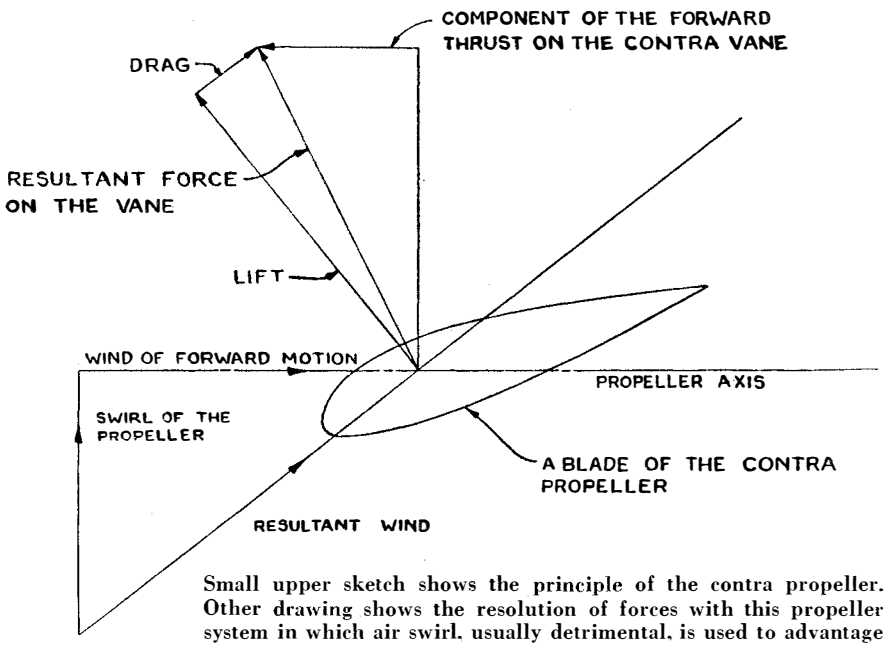
When flying at high speed, the air enters the opening of the tunnel and some of its kinetic energy is converted into pressure, so that cooling air is driven through tubular radiators placed near the entrance to the tunnel. Passing through the radiators, the air naturally loses pressure. But thereafter the air passes by the exhaust manifolds of the engine, captures heat and recovers pressure. Later, the cooling air mixes with the exhaust gas from the manifolds and again its pressure is raised or at least maintained. The two tunnels converge and pass into a narrow horizontal orifice at the rear edge of the wing, where the air leaves with great velocity.

The reaction of this air jet produces a forward thrust which more than compensates for the loss in pressure when passing through the radiators. In effect, a species of auxiliary gas engine has been provided, whereby some of the heat of the cylinders and of the exhaust has been put to work. We consider this to be a remarkably ingenious idea which deserves to be carefully tried out in practice.—*A. K.*

Experiments with the Contra Propeller

THE airplane propeller accelerates the air in a backward direction; that is how thrust is obtained. But it also imparts a ro-





Small upper sketch shows the principle of the contra propeller. Other drawing shows the resolution of forces with this propeller system in which air swirl, usually detrimental, is used to advantage

tational motion or swirl to the air stream, and this swirl is thoroughly undesirable for two reasons. Since the swirl means kinetic energy in the air stream, rotation of the air involves some loss in efficiency. Also, when the swirl of the propeller strikes the vertical tail surfaces, it produces a turning tendency for the whole airplane.

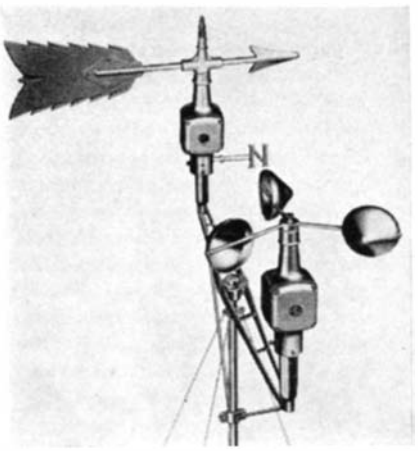
These defects have long been known, and a device to eliminate the swirl, called the contra propeller, has also been known for a long time. It is only quite recently, however, that definite figures on the contra propeller have become available through experiments at Stanford University, reported in a Technical Note of the National Advisory Committee for Aeronautics.

One of our drawings shows the principle of the contra propeller, in which fixed vanes are placed behind the propeller proper. Another drawing indicates how the swirl is taken advantage of to produce an element of forward thrust. The forward motion wind and the swirl combine to give a resultant wind which makes an angle with the axis of the propeller. The lift is always at right angles to the resultant wind and therefore produces a forward component of thrust.

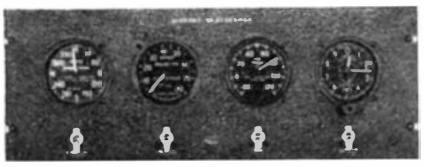
Experiments in the wind tunnel indicate that for relatively slow flying speeds, the contra propeller might increase the efficiency some 2½ percent, and eliminate half the swirl. But at high speed, efficiency was actually lost by introduction of the device. These results are less satisfactory than had been expected. Nevertheless, as very big engines are brought into use, further experiments with this device will be justified.—*A. K.*

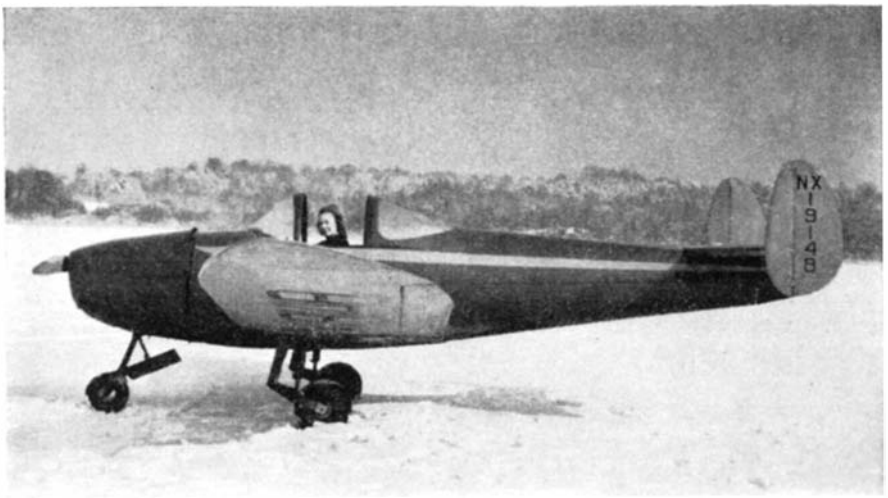
Airport Weatherman

IT is convenient for men at work inside a control room at an airport to be able to determine instantly what the weather is doing outside. Hence the development of the Julien P. Friez Airport Weatherman. Outside there are located a wind vane, a three-cup anemometer, and a thermometer. The wind direction vane operates a synchronous generator in a housing located immediately below it. The movement of the generator is communicated electrically to a companion motor in the control room, which actuates the dial of the wind direction indicator. The anemometer also operates an electric generator which works with a companion motor below. The distance-reading thermometer is equipped in customary fashion with capillary tube and registering bulb. The airport dispatcher is the man who uses the Airport Weatherman most, but it is of equal importance to others working on the airlines. —*A. K.*



The airport weatherman and, *below*, the indicating panel used with it





A light plane for the private flier

An Interesting Light Plane

FOR several years, Frederick E. Weick, Chief Engineer of the Engineering & Research Corporation, has been engaged in the problem of building a light plane which would be entirely suitable for the private owner and flier. The Model 310, illustrated in the photograph, was designed by Mr. Weick, has passed the tests of the Civil Aeronautics Authority, and offers many interesting features for the private flier.

Thus, the 310 is almost entirely of aluminum alloy construction—which is as it should be. The only concession, apparently, is that the outer wing panels are fabric-covered. A four-cylinder, inverted, air-cooled engine of 55 horsepower is provided. This is just about the right power, and the vision ahead is very good, as our photograph indicates. There is side-by-side seating, with a sliding transparent enclosure. Again we agree that light planes should provide an open cockpit for instruction and sport purposes, yet be readily enclosed at will. There is a tricycle landing gear with the nose wheel freely castorable.

We are also informed that, in a few minutes, rudder and ailerons can be linked up. We do not believe in the two-control airplane—that is, one in which the rudder has disappeared—but the co-ordination of rudder and ailerons may be useful at times and the idea has some possibilities. Also, there is so much longitudinal stability provided and so much vertical fin area below the stabilizer that it is next to impossible to stall the airplane or to keep it in a spin—two highly desirable characteristics. With a gross weight of 1100 pounds, a top speed of 101 miles per hour, a span of 30 feet, and a wing area of 140 square feet, the new design looks very neat and has aroused considerable expectation in the aviation world.—*A. K.*

"Pregwood"

THE Formica Insulation Company has announced a new product, Pregwood, made by vulcanizing together thin laminations of wood impregnated with phenolic resins. Unusual lightness with great density, strength, and resistance to water absorption are among the claims made for this new material. It is available in the natural phenolic color and is made in sheets ¼-inch or more in thickness and a maximum of 20 inches wide and 96 inches long. It may be used where close maintenance of dimensions in all sorts of weather conditions is important.

Complete Fertilizers

EMPHASIS has lately been placed on chemical elements other than nitrogen, phosphorus, and potassium in fertilizers. Numerous other secondary elements—sulfur, magnesium, copper, manganese, boron, and others—are apparently quite as vital to luxuriant growth of plants as the three primary fertilizing elements, the only difference being in the relative quantities needed. Many soils possess these secondary elements in sufficient abundance but often they must be supplied in the fertilizer.

This situation has been emphasized in recent years by some fertilizer makers with the implied suggestion that only their products contain all of these secondary elements. Now the wind is taken from their sails by a report from the Fertilizer Research Division of the U. S. Bureau of Chemistry and Soils that each of 44 samples, chosen as representative of commercial fertilizers, contain all the known secondary elements.—*D. H. K.*

House-flies Prefer Ultra-Violet

IN the *Canadian Journal of Research*, J. W. MacBain Cameron, of Macdonald College, Montreal, recently described experiments which were conducted with the object of testing the reactions of house-flies to different wavelengths of light. The insects were

reared on an artificial medium and tested by means of different wavelengths of spectral light obtained from a quartz-mercury vapor lamp. The range of the spectrum tested was from 3022 A to 5780 A and the lines were made of approximately equal intensity throughout. The comparison standard, which was used in all cases, was white light obtained from a tungsten filament frosted bulb.

Flies to be tested were removed from breeding cages ten hours before the tests began and were kept in darkness until used. It was found that the house-fly is much more strongly stimulated by ultra-violet light of wavelength 3656 A than by any other part of the spectrum tested. The influence decreases as the longer wavelengths are reached and also on the short wavelength side of the peak. The available spectrum extended as far as 3022 A into the ultra-violet, and at this point there is still an attractiveness greater than that exercised either by yellow or green.

—Nature (London)

Automatic Facsimile Telegraph

THE world's first automatic telegraph was recently installed at the Essex House, New York City, according to an announcement by Western Union and the hotel management. The automatic telegraph is the latest development of the telegraph company's research in facsimile telegraphy.

This advance in written communication provides the easiest method ever known for the transmission of a telegram, officials state. Even a child can send a telegram by this method. The automatic telegraph instrument is housed in a small cabinet fastened on the wall, and is so simple to operate that telegrams intended for transmission may be dropped into a slot in the cabinet as easily as letters are dropped into a mail box. Senders need only type their messages or write them in black ink or black pencil on a blank of special shape and drop them into the slot. An exact facsimile of the message is automatically received in the main office.

Only two simple operations are required by the sender of a telegram. First, it is necessary to push a small button, which is held until a panel reading "Deposit message" is lighted. The message is then dropped into the receiving slot face out. Nothing further is required of the sender.

Several sending machines may be connected with the same line. If one of them is busy, a panel reading "Line busy" is illuminated, and it is impossible to deposit a telegram until the line is clear. Once the message is dropped into the machine, it is automatically wrapped around a transmitting cylinder which revolves before a photo cell, and is transmitted to the main telegraph office. Simultaneously, a third panel reading "Message being transmitted" is lit. When the telegram has been properly received in the main office another panel reading "Thank you" appears, and the original telegram is automatically "peeled" from the transmitting cylinder and deposited in a container at the bottom of the cabinet.

This type of telegraphy is made possible by the carbon-bearing fibrous paper developed in the telegraph company's laboratories. The apparatus is capable of transmitting 15 square inches of matter in one minute, believed to be the highest speed thus far attained in commercial facsimile telegraphy.

A Record for Viability of Seed

FROM seeds estimated to be between 300 and 500 years old, lotus plants are being grown today at Field Museum of Natural History in Chicago. So far as can be ascertained, this represents the longest duration of delayed germination on record, according to Dr. B. E. Dahlgren, chief curator of botany. The oft-repeated story of the germination of wheat from the Egyptian pyramids is now well known to be erroneous, Dr. Dahlgren says, the germinating grain having been derived from straw packing in which the Egyptian specimens were being shipped to Europe.

The lotus seeds had lain buried in a peat bed in southern Manchuria through several centuries, and were received through the courtesy of the University of Chicago's department of botany. At the time these seeds were produced by nature—perhaps before Columbus' first excursion into the New World—there existed a small lake, about two square miles in area, covered with red lotus flowers identical with the species commonly found in Asia today.

Records show that this lake was drained some time between 160 and 250 years ago. Wind-drifted soil then gradually covered the area, and trees and other land vegetation began to grow. In this basin today are large poplars, willows, and elms. One of the poplars measures four feet in diameter, and trees that have been cut down show at least 120 annual rings. These data on the trees aid in establishing the minimum age of the lotus seeds, thousands of which have been uncovered beneath the soil bed in which the trees grow. The lower stratum containing the seeds is a peat bed that once was the bottom of the lake.

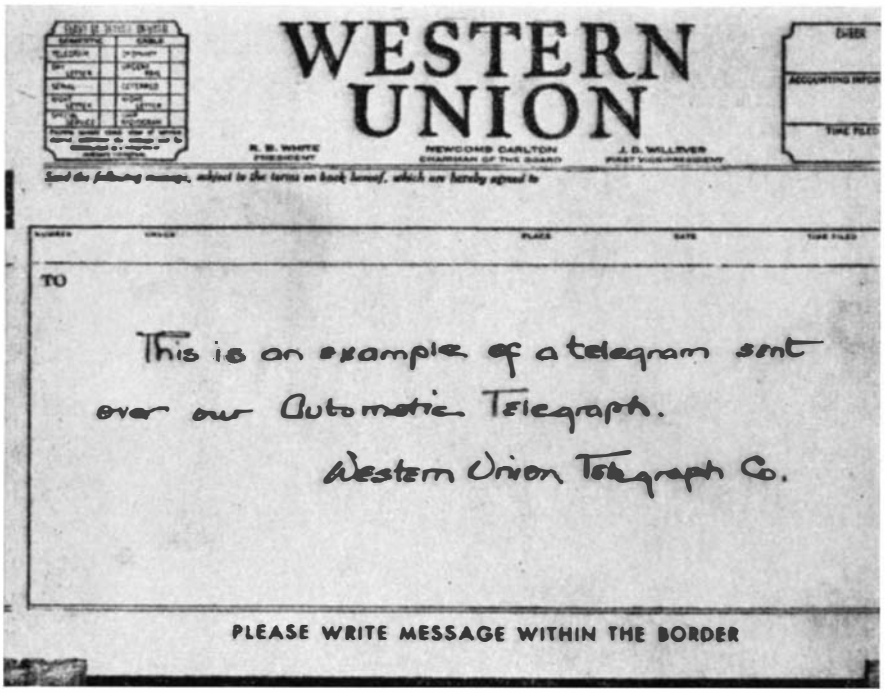
The seeds resemble small dark brown acorns. Their coats are hard as glass and highly polished. These outer covers are so impervious that the embryos inside have been protected through the centuries.

Better Water Treatment

THE lime-soda method of softening hard water normally fails to yield a product as soft as might be expected. The hardness of water treated by this process should be too low to be significant. However, this is not the case, and treated water retains in super-saturated solution amounts of calcium and magnesium in excess of their actual solubilities.

A new method of applying this common treatment materially reduces the hardness of treated water. The differences between the ordinary method of treatment and the improved process are apparently trifling modifications. One of these consists in mixing the chemicals for treating a fresh lot of water with slurry from water previously treated, the solid particles thus present providing a surface for the precipitation of more salts of calcium and magnesium. The

How messages are placed in the automatic telegraph unit and, *left*, a received message, reduced in size



stirring, filtering, and other operations of the treatment are similarly altered. The result is water having a hardness of 20 to 25 parts per million instead of 50 to 90, commonly met in water softened by the ordinary lime-soda method.—*D. H. K.*

Farmers Help Build Cars

IN the production of each 1,000,000 automobiles, it is estimated that the agricultural products from a half-million acres are used. Here is a list of some products of the land consumed in making 1,000,000 automobiles and the purposes to which they are applied: 69,000,000 pounds of cotton—tires, batting, cloth, and brake linings. 500,000

bushels of corn—butyl alcohol and starch. 2,500,000 gallons of molasses (from sugar cane)—solvents, anti-freeze, shock absorber fluids. 3,200,000 pounds of wool—upholstery, floor coverings, lubricants, and anti-rust preparations. 350,000 pounds of goat hair—mohair upholstery. 2,000,000 pounds of turpentine—solvents, paints, adhesives. 69,000,000 pounds of rubber—several hundred parts on the motor car. 112,000,000 feet of lumber—packing and other purposes.—*Automobile Facts.*

Without Interrupting Services

ANTICIPATED as a probability at the time of erection seven years ago, the all-metal office building of the Department of Public Works, Richmond, Virginia, has recently been moved 400 feet, from the corner of Twelfth and Broad Streets to a new location on Governor Street, in order that the new building of the Virginia State Library might be erected on the Broad Street site. The relatively narrow passage through which the building had to pass necessitated twice swinging through an arc of 45 degrees: once before the first forward movement could be made, and the second sandwiched in between two forward movements, each in the direction of the longitudinal axis of the building.

The Public Works building is a two-story structure with full basement. It is rectangular in shape, with a frontage of 117 feet and a width of 52 feet.

The contract time for moving the building was 60 calendar days from date of award of contract, during which time the building was maintained in a livable condition with all

Left: **The all-metal office-building ready to be moved.** ***Above:*** **An air view taken during the moving process, showing the difficulties that were encountered**

service facilities, including heat, light, telephone, water, and sewerage, without interruption to the routine work of the Department or its accessibility to the public.

Above the first floor, metal predominates on both exterior and interior surfaces, the basement being of masonry construction. The inner and outer walls are of aluminum. In the outer walls, plate and extruded shapes are employed to produce a drop-panel effect in the pilasters and entablature. The inner walls, as well as the partitions and doors, are formed from aluminum sheet. The casement windows are steel.

Because of the relatively light weight of the building, it was decided to move the unreinforced concrete basement walls with the building, in order to lower the center of gravity and to obtain additional longitudinal stiffening of the structure.

EMPLOYMENT

MORE than 7500 parts from 119 manufacturing plants go into the construction of a standard locomotive, which provides employment equivalent to the work of 50 men for one year.

You Pay for Milk Bottles

THE cost of the bottle is a big item in what consumers have to pay for milk. A quart bottle costs originally about five cents. Directly or indirectly, the consumer pays for it. The more trips the bottle makes from dealer to consumer, the less the cost to the consumer.

A study by the Bureau of Dairy Industry shows that many consumers actually do not realize when they destroy or discard milk bottles that the bottle has value and that it is the property of the seller and not the buyer, as is the case with most containers in which food is purchased. Education of the consumer, says the report, is too often neglected.

The Bureau in a study of 111 milk plants found that the average life of a bottle was 35 trips. It ranged from six to 91 trips, but the most common range was from 20 to 30 trips. The systems most widely used by dealers to get bottles back are: A commission to route men for bottles returned, a charge for all bottles sold by stores, and a milk bottle exchange. In plants that used all three methods, the average life of a bottle was over 51 trips.

For plants that used no special system to get bottles back and that were not members of an exchange, the bottle life averaged only a little over 22 trips.

Synthetic Toluene

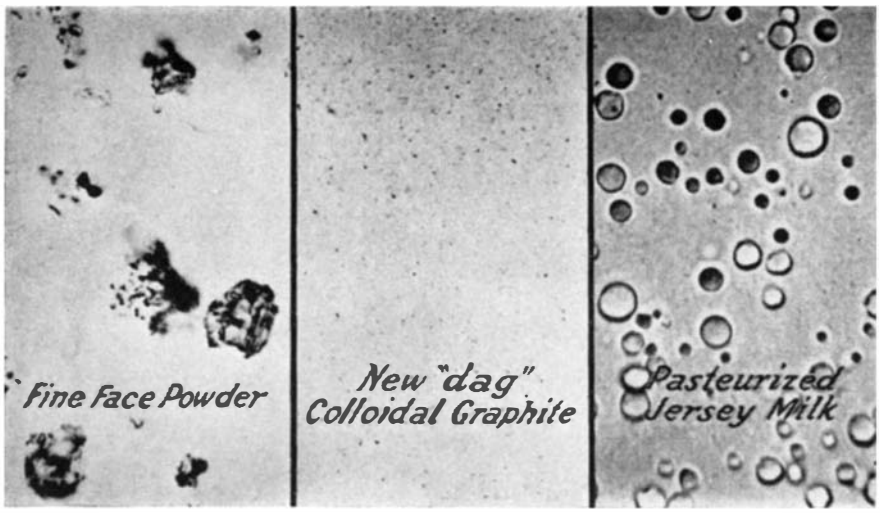
SYNTHETIC methods for producing toluene which are independent of by-product coke are being actively sought in Germany. One synthesis which has been successful on a laboratory scale uses benzene and carbon monoxide as the raw materials. Reaction between these two compounds in the presence of a suitable catalyst yields benzaldehyde from which toluene can be obtained by reduction. Yields of 94 percent are reported on the laboratory scale. The value of toluene lies in its conversion to TNT, an important military explosive.—*D. H. K.*

Magnesium Alloys in Aircraft

AMERICA'S supplies of magnesium are practically inexhaustible, said A. W. Winston of the Dow Chemical Company recently. They exist as magnesium chloride or as magnesium carbonate in dolomitic limestone and magnesite. It is the magnesium chloride found in the salt brines from wells in central Michigan which provides the nation's major source today.

Landing wheels and engine parts are the principal American applications of magnesium alloys in airplanes, Mr. Winston explained.

Landing wheels on the largest airplanes, if made of magnesium alloys, would mean a weight saving of 150 pounds, or the weight of another passenger. Thus, at present air



Relative particle sizes of three substances, all same magnification

travel fares, a plane with such wheels could theoretically save $149.95 for each New York to Los Angeles trip. Admitting that all of this saving could not be realized, Mr. Winston added, the opportunity still exists for increased payloads through weight reduction by the use of light-weight alloys.

NUMBER PLEASE

MORE than 2260 tons of nickels, dimes, and quarters are collected annually from New York City's 88,000 coin telephones. Nine-tenths of these coins are nickels.

Minute Colloidal Graphite

AFTER four years of experimentation, Acheson Colloids Corporation has developed a new process of producing pure "dag" colloidal graphite on a commercial scale with remarkably small particle size. In the new product, the maximum size of a colloidal graphite particle is one micron (equal to 0.00003937 of an inch) with small particles running considerably smaller than this.

Colloidal graphite has for a considerable number of years been used both as a lubricant and for its electrical properties. As a lubricant its prime advantage is its affinity for metal. Under friction it will deposit on metal surfaces and form a "graphoid" surface imparting to the material lubrication properties of long-lasting character. Its most extensive use in the past has been as an addition to oils for running in and lubricating internal combustion engines.

Formerly, however, the graphite would remain in colloidal suspension only in relatively high viscosity liquids such as petroleum oils, varnish, glycerine, water, and the like.

The new small particle size permits the production of stable suspension of "dag" in such low-viscosity liquids as kerosene and such volatile liquids as carbon tetrachloride. An advantage gained is that colloidal graphite can now be applied to surfaces as a dry lubricant. When the graphite in the light liquids is applied to a surface and the carrier allowed to evaporate, it will leave a graphitic coating on the surface, giving it rather remarkable properties of dry lubrication. In addition, it seems to have definite ability to retard corrosion.

The reason that the small particles will stay in suspension, apparently, is that their mass is so small that the "Brownian" movement imparted to them as a result of their negative electrical charge will keep them in continuous motion and prevent their flocculation or precipitation.

In the heavier viscosity liquids mentioned, a suspension of the new form of "dag" has the advantage of providing much greater stability. The increased activity of the particles in suspension renders them considerably more impervious to the flocculating tendency arising from a possible contamination of the carrier with either acids or alkalis. From a more practical standpoint, the new development promises to solve a considerable number of tough lubrication and electrical problems such as the dry lubrication of remote and closely fitting parts. It will also impregnate porous bodies much more readily due to the finer particle size, imparting to such bodies desirable qualities of lubricity, electrical conductivity, coloring, and so on.

Catalytic Cracking

ALTHOUGH thermal cracking processes, by which petroleum is forced to give a higher yield of gasoline, save about two billion barrels of crude oil annually, they are likely to become obsolete in the face of a catalytic process of even higher efficiency. Thermal cracking of gas oil yields 70 to 75 percent of gasoline having an octane number of approximately 72. The new catalytic cracking process produces 85 percent of gasoline from gas oil and this has an octane rating of 81 or more. The process is said to be particularly valuable in producing fuels of high octane rating which are likely to become increasingly important. Aviation motors already require fuel of approximately 100 octane rating, and such motors are likely to become more plentiful in the future.—*D. H. K.*

Business Curiosa in China

THE *China Digest*, an interesting little pocket digest published in Shanghai, quotes the *Shanghai Evening Post* on various curious money-making and money-saving schemes found in present-day China:

In Chungking, Szechuen province, the article claims, you are likely suddenly to find yourself being fanned by a "fan boy" who rushes up to cool you off as you walk along the street.

Also in Szechuen, "as soon as one enters a restaurant in a small town, a 'tobacco boy' steals up stealthily from behind and without warning thrusts a wet tobacco pipe into your mouth."

There are "toe-scratchers" who make a living in out-of-the-way towns by massaging and scratching your toes with various implements while you are having lunch.

With the withdrawal of the Chinese government from Nanking to the interior, the custom of wearing foreign style felt hats has spread. But with it has spread the custom among the villagers of covering the hat with paper or newspaper pasted from brim to top of crown. The intention is to keep the hat clean.

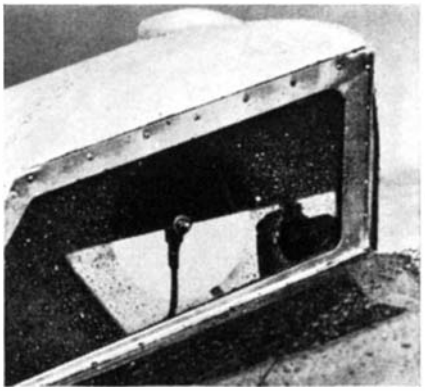
In southern China it is said to be difficult to buy oranges that are not peeled. The peels are highly valued for making a Chinese medicine. In Shanghai, there are shops which deal in nothing but broken glass. Other shops deal only in the whites and yolks saved from broken eggs.

Red Pigments from Yellow

CRYSTAL form has been found to be an important factor in the color of certain pigments, and the crucial one in the valuable red molybdenum pigments now largely used in paints and inks. Actually these pigments are made by precipitating lead compounds from solution by adding a solution of a chromate and a molybdate. Actually lead chromate is yellow and lead molybdate is colorless when each is precipitated alone. However, when these two insoluble lead compounds are formed together the mixture is neither yellow nor colorless but red or deep orange. Lead chromate normally crystallizes in the rhombic system and lead molybdate crystals belong in the tetragonal system. The mixed precipitate assumes a red color only after it has been converted to the latter system.—*D. H. K.*

Rotary Windshield Cleaner

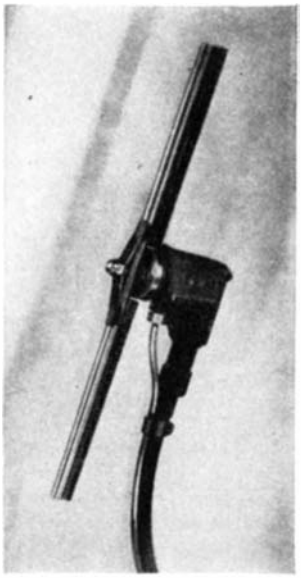
A ROTARY-TYPE windshield cleaner, designed originally for aviation use, is now available for ships, small boats, trains, buses, and trucks. Air Associates, Inc., has



Rotary wiper in use

developed a rotary type windshield wiper which, due to speed of rotation, is invisible when in use.

The blade is carried by a driving head which passes through a hole in the glass, and is driven at any speed up to 2500 revolutions per minute by a flexible shaft from a small electric motor. Pressure on the windshield is adjustable, and the wiping edge was especially developed to withstand oil, gasoline, sunlight, and extreme temperatures.



Close-up of the rotary wiper, showing motor head and flexible shaft

A special feature of the new wiper is its anti-icing attachment. A metering pump built into the head of the driving motor forces a special anti-icing fluid from a small tank to the driving head where it is distributed by centrifugal force over the area swept by the blade. This fluid prevents the formation of ice on the windshield by mixing with the snow, sleet, or spray and lowering its freezing point. When the device is installed on a boat, fresh water can be fed to the wiper to prevent the formation of salt incrustation. The fluid flow is controlled by a needle valve.

It is claimed the rotary windshield cleaner is easily installed, a special tool being provided with which it is easy to drill the required hole through the glass. The flexible drive-shaft permits mounting the motor in any suitable location.

Air Conditioned Submarines

AIR conditioning now being installed in submarines will make America's undersea fighting force a much more potent weapon in any future war, according to William B. Henderson, executive vice president of the Air Conditioning Manufacturers' Association.

The efficiency of submarines depends primarily on the fitness of those who man them and their comfort during long cruises at sea, says Lieutenant Albert R. Behnke of the Navy Medical Corps, explaining the latest submarine development.

The use of cooling and dehumidifying equipment and the provision of oxygen from tanks to replace exhaled carbon dioxide will enable submarines to run submerged probably for periods of days, thus adding another factor to their effectiveness in attack or defense.

Even with these aids, the men who operate submarines must be trained and "conditioned" for a period of at least ten days between cruises, says Dr. Behnke.

Only the fittest officers and enlisted men are chosen for submarine duty, and only about half of the Navy's personnel measures up to the stiff medical requirements.

Few persons realize the difficulties under which submarine crews work. The men must re-breathe the same air for periods of from three to 24 hours, and perhaps longer under war conditions. They must live in very cramped quarters, in which all that a sailor owns must be stored in a space about the size of his own body. A bath is something almost unheard of on a submarine at sea.

When the vessel is submerged, particularly in tropical waters or during the summer, the temperature may rise to 100 degrees, Fahrenheit, or above, and the humidity may increase to the dew-point so that sweating (which cools the body) is impossible.

Poisons Needed in Human Diet

YOU need arsenic in your food. Not much of it—so little, indeed, that ordinary chemical analysis won't detect it. But if those few thousandths of a snowflake's weight are not there you won't be healthy.

The same is true for a couple of other poisonous elements, lead and manganese.

These elements are present in most soils, but in extremely small quantities, and ordinary tillage exhausts them, said G. Douglas Jones in a recent issue of *Agricultural Engineering*. To make them more available to plant roots, deeper tillage is needed. Mr. Jones is at work on several types of new soil-stirring implements. One of them, which he calls the ripper, works to depths of three feet.—*Science Service.*

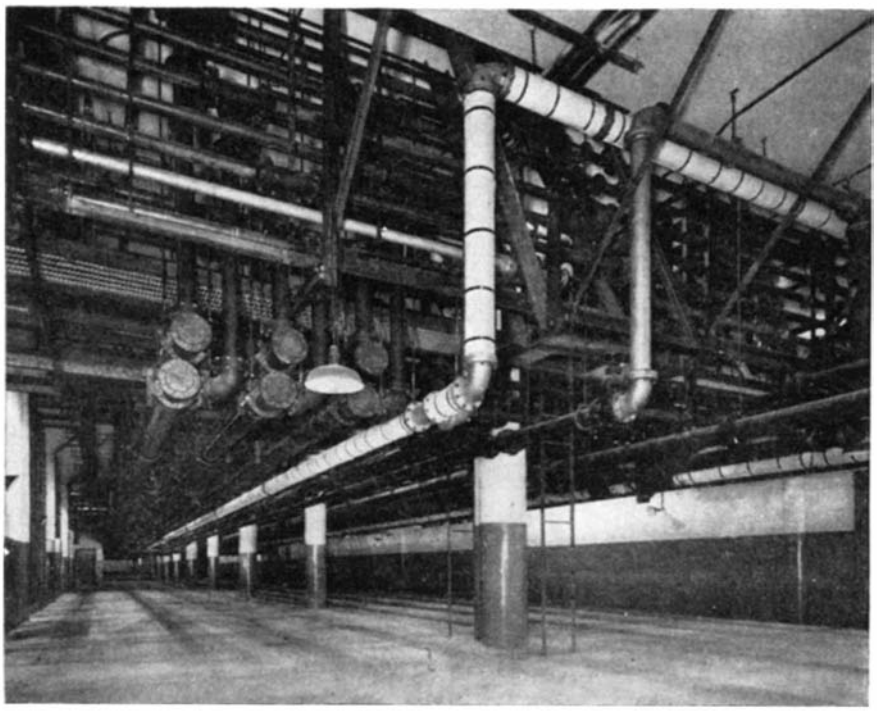
Cloth from Whales

WHALE meat has always been a large-scale waste of the whale oil industry since the carcasses of whales are commonly left to sharks after the blubber has been removed. Recent reports from Japan state that whale meat has been successfully used to make artificial fibers, one resembling wool, and another which combines the product of whale meat with viscose having a silk-like character. Details of the process are not at the moment available, but presumably include a fermentation of the meat followed by a spinning operation.—*D. H. K.*

Cigaret Smoking Raises Blood Pressure

SMOKING cigarets raises the blood pressure in both normal persons and patients suffering with high blood pressure, Drs. E. A. Hines, Jr., and Grace M. Roth, of the Mayo Clinic, found in a study of 86 persons, according to a *Science Service* report.

The effect of tobacco smoking on blood pressure is not due entirely to the action of a stimulus on specially sensitive blood vessel systems. Part of the effect, at least, is the result of some element in tobacco smoke which causes constriction of the blood ves-



Twelve miles of hard-rubber piping are part of the 50 miles of pipe installed in the Industrial Rayon Corporation's plant where rayon yarns are being produced by a new continuous spinning process. These pipes carry water, steam, and processing solutions, hard-rubber being used where other materials would be attacked by the chemicals. The hard-rubber pipes range in size from 1½ to 8½ inches in diameter and form a large part of the 290 tons of hard rubber used in equipping the plant. Here, on special machinery, will be produced rayon yarns finished to exact fineness and physical specifications laid down by fabricators

sels. This element in the tobacco smoke was not identified in the report made by the two scientists at a recent staff meeting of the Clinic.

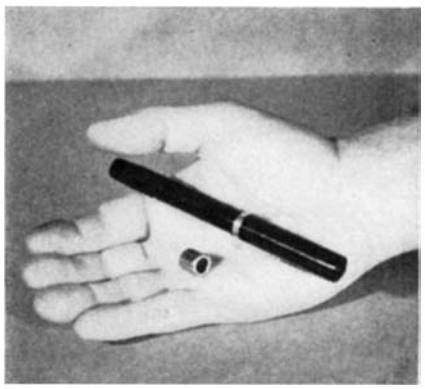
The rise in blood pressure following smoking was greater in high blood pressure patients than in normal persons except in the case of high blood pressure patients who had never smoked before. This latter difference is attributed to the fact that inexperienced smokers do not inhale as much smoke as regular smokers.

The test was made by having each person, after a 30-minute rest, smoke two cigarets of a standard brand. Blood pressure and pulse rate were watched during the smoking and for a few minutes afterward. As a control, each person went through the same procedure except that he puffed at an unlighted cigaret.

The results were also compared with results of the cold pressor test, in which one hand is immersed over the wrist in a bucket of ice water. The blood pressure response to this test indicates whether or not a person has an especially sensitive, or hyper-reactive, blood vessel system. The excessive rises in blood pressure from smoking, the scientists found, occurred only in the patients who had, according to the cold pressor tests, hyper-reactive blood vessel systems.

Tiny Anti-Friction Bearing

A COMPLETE anti-friction bearing, which, in the smallest commercial size, is no larger in outside diameter than an ordinary fountain pen, is expected to widen the field of anti-friction construction. These space-saving bearings, made by The Torrington Company, are known as needle bearings. They comprise a series of small



Bearing compared with fountain pen

diameter "needle" rollers held within a single retaining shell. Because they will carry exceptionally heavy radial loads for their comparatively tiny size, they will permit the machine builder to apply anti-friction operation in cramped locations.

Perks Have Glass Hearts!

THE heart of the percolator is the pump —and in the new Pyrex Flameware percolators it is made of a clear, stainless, sparkling tube of Pyrex glass. It never absorbs rancid odors, never discolors, and can easily be cleaned. Recently announced are a

It is claimed that better coffee can be brewed in this glass perk

six-cup size with aluminum coffee basket and stainless steel fittings, and a nine-cup size with stainless steel coffee basket and fittings. Both have the new stainless glass pump which contributes greatly to the brewing of better percolated coffee. These new percolators can be used on any heating unit.

Luminous Plastic

A PLASTIC molding powder in which is incorporated a luminous material has recently been placed on the market by a British plastic manufacturer. This powder, when molded in the ordinary way, yields parts which glow after exposure to strong light. Thus, indicator buttons, figures, letters, and similar articles which must be found in the dark, become luminous after exposure to natural or artificial light. The glow continues for approximately four hours after removal from the light source, but the luminous property can be regenerated at will.—*D. H. K.*

Hair Removal by Electrolysis May Be Dangerous

WOMEN are warned that death may lurk in the seemingly simple electrolysis process for removing superfluous hair, in an editorial in the *Journal of the American Medical Association.*

The ordinary operator is likely to have little knowledge of aseptic technique. The importance of the proper sterilization of the patron's skin, the operator's hands and arms, the needle holders, and the needles is largely unknown to these technicians or may be disregarded. Use and misuse of the machines are increasing.

Infections ranging in effect from mild to fatal may result. Examples cited are pustules, abscesses, erysipelas. There is direct communication by veins between the areas of the nose and upper lip with the lateral sinuses, and infections in these regions may cause death, the *Journal* states.

Electrolysis is also used by non-medical operators to remove moles and warts. Benign moles may become cancerous through injury. Perhaps they were malignant to begin with; the beauty operator and self-styled electrologist would not know.

Pitting and scars frequently result from the application of too much current or too long treatment, as well as from the insertion of the needles into the hair follicle. If the operator makes several stabs at a single follicle or treats too many hairs in a given area, infection and serious consequences result.

According to the medical journal, the person who uses electrolytic instruments for beauty purposes should have some understanding of the following: anatomy, physiology, bacteriology, antisepsis, tissue tolerance to trauma, the chemical reactions involved and the physics and mechanics of the apparatus used.—*Science Service.*

MILEAGE

TEXAS, with its 16,000 miles of railway line, has more railway mileage than any European country except Russia, France, Germany, or Great Britain.

Newest Vacuum Pumps Create Low Pressure

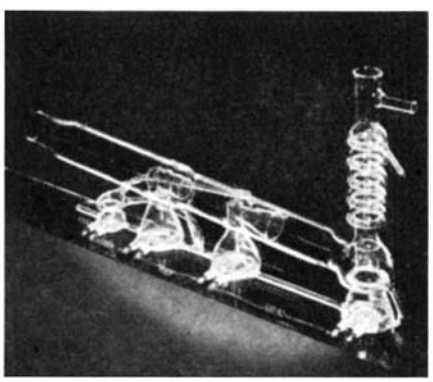
THE emptiest man-made space ever attained is now being created by the newest vacuum pumps which use oil molecules to sweep out the air from scientific apparatus.

While it is impossible to produce a perfect vacuum, a vacuum can be created in which it is possible for a molecule to travel nearly 500 feet before it would encounter another molecule.

Since a molecule is only about .0000001 centimeter in diameter, this means that in traveling 500 feet, the molecule goes more than 100,000,000,000 times its own length before encountering a companion. Here, truly, is loneliness.

If the same emptiness were applied to people it will mean that a man 5.2 feet tall would have to travel more than 100,000,000 miles before meeting anyone. The loneliness would be much greater than if there was only one man on the Earth and another on the Sun.

In terms of atmospheric pressures, the new oil diffusion pumps, as they are known, can



A four-compartment, three-jet Hickman non-mechanical vacuum pump

produce pressures of .00000005 millimeter of mercury without the use of cooling traps of liquid air.

Normal atmospheric pressure is 760 millimeters of mercury, which is more than a billion times that attained in the newest oil diffusion pumps.

In operation, the new pumps consist of

elaborate and beautiful glassware arranged in tubes and columns to make a complete circuit for the vapor of the oil.

The oil is heated at one point in the circuit and the vapor flows around the loop. As the flow passes a specific point, it comes by an opening leading to the chamber to be evacuated. Molecules of air coming out this opening are bumped by the oil molecules and the latter knock the air molecules away from the container being evacuated.

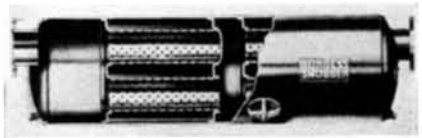
Dr. K. Hickman and his associates at Eastman Kodak Company developed the new pumps which are now in commercial production.—Copyright, 1939, by *Science Service.*

Value of Rubber

THIS year is being celebrated the centenary of the discovery by Charles Goodyear of the process of vulcanizing rubber which has made this material useful. The industry based on the chemical reaction of sulfur with rubber represents an investment of $2,698,000,000. It employs approximately 4,000,000 people and annually uses approximately 375,000,000 pounds of cotton, among other raw materials.—*D. H. K.*

Noise Snubber

A TOTALLY new type of noise-quieting device which is non-acoustic and can be placed at any point in the intake or exhaust system of an engine or compressor, has recently been developed by the Acoustic Division of the Burgess Battery Company. Since it eliminates the cause of noise produced by the pulsating gases by snubbing the peak velocities and pressures and thereby produces a smooth flow of gas, this new device is called the Burgess Snubber.



It snubs the slug

Two aero-dynamic effects are involved in the operation of the Burgess Snubber. First, the fast-moving slug of exhaust gas, which is vented into the exhaust system by the opening of the exhaust valve, is trapped in a high-resistance snubbing tube. This tube is perforated radially to allow the pent-up gas to vent gradually into the first snubber chamber. At the same time, a recoil pressure from the snubbing tube serves to slow up the flow of scavenged gases and thereby prevents pressure dropping below atmospheric pressure.

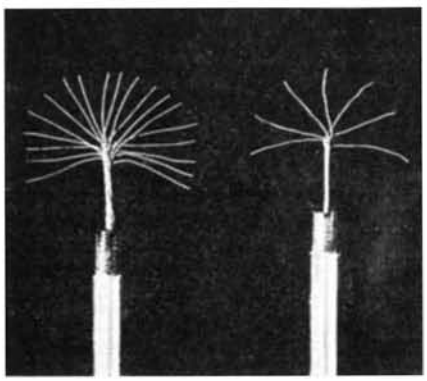
The slower moving scavenged gases do not enter the snubbing tube but are diverted through a low-resistance exhaust tube in the first chamber. A second stage of snubbing, comparable to the first, removes any remaining impulses which may be present in the exhausted gases. Back pressures can be eliminated or controlled to any desired value. The effect of the Burgess Exhaust Snubber is to prevent the sudden impact of the slug of vented gas with the atmosphere and also to stop the usual inrush of air into the exhaust pipe, after the discharge of the slug. Therefore, the sharp noise of the slug impact and the rumbling noise of the vibrating air column in the exhaust pipe are eliminated.

The same type of unit is applicable to intake and output lines of reciprocating and rotary compressors. Burgess Snubbers are available in a wide range of sizes for standard, heavy duty, and spark-arresting service.

STAINLESS STEEL IGNITION CABLE

A NEW ignition cable employing a seven-strand stainless steel conductor instead of the usual 19 strands of copper wire, has just been announced by the Sterling Cable Division of The Electric Auto-Lite Company.

Because of the extremely low capacitance —about half that of conventional copper



Copper versus stainless steel

cables—achieved by the new construction, improvements in ignition performance result. These improvements lead to increased engine efficiency and worthwhile operating economies, according to the makers.

Low capacitance, the basic characteristic responsible for the superior performance of the cable, is a term used by engineers to measure the amount of electrical energy which all cables "absorb," and which is therefore not delivered to the spark plug. The less current a cable absorbs, the lower its capacitance, and the greater its efficiency.

Low capacitance with copper was impractical. Reducing the number of strands weakened the cable. Thicker insulation increased the cable diameter beyond that of the conduits on modern cars. Stainless steel, with its great tensile strength, permitted the small, yet strong, conductor required for low capacitance in a cable of standard outside diameter.

RADIOACTIVITY UNDERLIES ALL GEOLOGIC PHENOMENA

WHEN a volcano erupts, hurling into the air great clouds of gas, rocks, and debris, and pouring forth streams of molten lava, the geologist seeks an explanation in forces working far down in the shell of the earth. When an earthquake shatters the earth's crust, causing great rifts and undermining buildings and roadbeds, the geologist again looks far beneath the surface for the cause. The immediate causes of such disturbances are pretty well known; but what is their underlying cause?

Professor Bailey Willis, of Stanford University, has for several years been seeking an answer to this question. One result of his search is the challenging theory which he

calls the asthenolith, or melting-spot, theory, and which he presented at a meeting of the Geological Society of America. In the April issue of the Society's *Bulletin*, he sets forth his theory in full or, as he himself states it, places it "on probation."

Professor Willis pictures the earth as having an outer skin or crust, a very thick, solid shell or intermediate zone, and an inelastic, presumably molten zone. This condition, he believes, has existed throughout the entire 2,000,000,000 years of geologic history.

Professor Willis believes that throughout the entire span of geologic time, there have occasionally appeared in solid portions of the earth bodies of molten matter. These bodies, out of which such rocks as granite were later formed, he calls asthenoliths, or melting spots. The melting, he believes, is caused by the intense heat generated when the radioactive elements present in the earth (uranium and thorium, for example) break up into other elements.

An asthenolith does not remain in the spot where it was formed. It grows, and at length ascends. It may rise to the surface of the earth, and the hot molten matter may escape from the mouth of a volcano, or it may well forth from a fissure as a lava flow. It may, on the other hand, end its ascent before reaching the surface, and cool and crystallize at some place within the earth's crust. In one or the other of these ways much of our granite and other rocks were formed.

Even in terms of geologic time, the rise of an asthenolith is exceedingly slow. Geologists believe that the interval that has elapsed between such intrusions is of the order of 100,000,000 or 200,000,000 years or more. Professor Willis invites consideration of his theory as an explanation of some of the most important and striking geologic phenomena, such as the rise of great mountains from basins or troughs; the process of metamorphism, by which rocks are crushed and contorted into new forms, shapes, and textures; and the activity of volcanoes and earthquakes.

Iron Tonic for Trees

LOW grade iron ore, limonite, is being used to treat high lime soil to overcome chlorosis in trees. This disease is evident in the bleaching of the green of the trees' leaves. Apparently iron acts as a tonic to overcome this disease.—*D. H. K.*

Danger of Fire From Electron-Metal?

"ELECTRON-METAL," the lightest commercial metal known to science, is a magnesium alloy, and for this reason some people have expressed doubts as to its being safe from danger by fire. It is known that magnesium powder is highly flammable and is used for flash-lights and flares. Dr. Vosskuehler, however, who is a noted expert in this field, denied the existence of this element of danger in a statement made before members of the Technical Literature Society on the occasion of a tour of inspection of the I.G. Dye Works in Bitterfeld, Germany.

Dr. Vosskuehler said that all articles made from solid magnesium alloy are in no way combustible or flammable, and that the same is true of the metal plates and waste

scraps. If exposed to extreme heat, the alloy may melt and this molten mass may burn, but the conflagration does not extend beyond the point of contact with the extreme heat. The metal shavings and scrapings which are produced when the metal is being machined can be set on fire by a strong flame and will then burn up slowly, piece by piece. Such a fire as this can easily be extinguished with dry sand. Water or other fire-extinguishers, however, should never be used to put out magnesium alloy or electron-metal pieces which are on fire, as the water breaks up into oxygen and hydrogen under the high temperature and an explosion may result.

Large accumulations of metal shavings and scrapings of this material should be avoided in the workshop or laboratory. The dust from this metal is also flammable just as coal dust or any other dust is flammable, and care should be taken that it does not collect. In grinding or polishing this electron-metal, only non-acid oils should be used. These precautions apply to the workshop and factory only, as the finished article is entirely non-flammable and cannot catch fire under any circumstances.

CCC Gets Credit

YOUNG men of the CCC camps were given credit for saving millions of acres of farm and pasture land, in a communication from H. H. Bennett, chief of the Soil Conservation Service to Robert Fechner, director of the Civilian Conservation Corps. CCC camps furnished 70 percent of the labor used to advance the soil conservation program, Mr. Bennett said.

In fighting gullies, the last and worst stage of soil erosion, CCC workers have built almost 3,000,000 check dams, dug 48,000,000 linear feet of diversion ditches and seeded or sodded 300,000,000 square yards of gullied land. In combating the less spectacular but more insidiously destructive sheet erosion, they have planted approximately 500,000 acres, put in 18,000 miles of terraces and 41,404 miles of contour furrows, and quarried 1,403,659 tons of limestone.—*Science Service.*

Efficient Megaphone

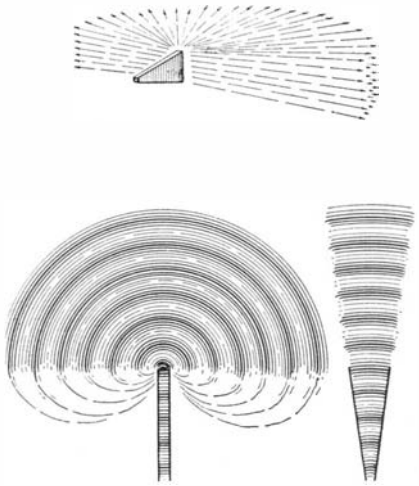
SOME megaphones are apparently designed by reason rather than acoustics. Reason dictates a long, narrow, round "directive" shape, but Prof. F. R. Watson, experimental physicist at the University of Illinois, has worked out the design of a highly efficient megaphone which some might be tempted to say in advance of test would not be successful. It is short, has parallel sides and, still more surprising, it is held in a vertical position as shown in the illustration. In acoustics, things are seldom what they seem.

"Following a suggestion by Lord Rayleigh that a megaphone with a rectangular aperture could be used to direct sound, such an instrument was constructed and found effective in directing speech sounds," Professor Watson states.

"Experiments with megaphones varying in size from six feet in length to one foot led to the adoption of the smaller size for practical use. This megaphone can be made of thin wood or metal; it has parallel sides, two inches apart, with a square mouth opening two inches by two inches, with an outer

opening from which the sound emerges two inches by six inches, and the length from the mouth opening to the outer opening 12 inches.

"The megaphone should be held with the six-inch dimension vertical, in which case the sound spreads sideways covering an angle of more than 180 degrees. When directed at the center of a row of bleachers at an athletic meet, it sends the sound to *all* the auditors, including those in the end



How the new megaphone concentrates sound, wastes little energy

seats. Very little of the energy is sent vertically up or down, so that the megaphone thus places practically all the sound effectively with the auditors.

"In addition to its directive property, the megaphone amplifies sound as all megaphones do. It can be used effectively in auditoriums, particularly in rooms with low ceilings where hearing is difficult for auditors at some distance from the speaker. It is also useful for baseball umpires in making announcements, for military officers in directing commands to an extended group of companies, and for other similar situations."

Average Age of Employees Is Over 40

THE average age of employees of United States Steel companies, as reflected in group life insurance statistics compiled as of May 1, 1938, was 40.17 years. The number of employees insured represented 97 percent of the total number on the payroll.

Employees are almost equally divided between those older and those younger than 40, the older group accounting for 49.3 percent of the total and the younger group 50.7 percent. A total of 26,207 employees, or 13.4 percent of the entire number, are 41 to 45 years of age. The next largest five-year age group, 31 to 35 years of age, totals 25,711 employees.

Coloring Portland Cement

IN coloring concrete, only commercially pure mineral pigments should be used, as others are likely to cause fading or marked reductions in strength. The amount of coloring materials should not exceed 10 percent by weight of the cement, as larger quantities may likewise affect the strength. In other

words, not more than nine pounds of pigment should be used per sack of cement. Deep shades can generally be produced with less than this amount of color by judicious choice of pigments. To insure thorough mixing the pigment should be at least as fine as the cement; the finer the pigment is ground, the greater its coloring ability.

A general guide to the selection of colors and coloring materials for various effects, prepared by the Portland Cement Association, is listed:

For *blue* shades, use cobalt oxide.

For *browns*, use burnt umber or brown oxide of iron.

For *buffs*, use yellow ochre or oxide.

For *grays*, use small quantities of manganese black, black iron oxide, or germantown lamp black; preferably black iron oxide.

For *greens*, use chromium oxide.

For *pinks*, use small quantities of red oxide of iron.

For *red* shades such as light brick, terra cotta, and so on, use red oxide of iron. Venetian red should be avoided.

For *slate* effects, use manganese black, black iron oxide or germantown lamp black; preferably black iron oxide. Common lamp black should not be used.

Different shades of color can be secured by varying the amount of coloring material used, or by mixing two or more pigments. The full coloring value of pigments can be obtained only with white portland cement. When clear white is desired, white sand and white cement should be used. The use of white portland cement with yellow and brown sands will produce varying shades of cream, yellow, and buff. If the colors can be secured without pigments such practice is recommended.

Whipping Cream with Gas

CREAM is now whipped in a siphon bottle similar to that used for soda water by being given a charge of "laughing gas." The product is whipped instantly and more evenly than by the usual mechanical operation. Each portion is whipped as needed.—*D. H. K.*

Too Much Early Enthusiasm

EXPERIMENTAL results obtained by using super-voltage X rays in treatment of cancer have not justified high hopes entertained when they were introduced five years ago, Dr. Robert S. Stone recently stated in a lecture at the University of Chicago.

"Although there is very definite improvement when X-ray doses are increased from 100,000 volts to 200,000 volts, increases beyond 200,000 volts apparently reach a point of diminishing returns," Dr. Stone said.

"The 100,000-volt X rays have been abandoned in the treatment of all but surface cancers. But after 200,000-volt magnitudes have been reached, the important opportunities for improvement lie in devising better techniques of administering the X rays, rather than in raising voltages.

"The effect of X rays is to ionize and 'knock down' cells. The usefulness of the rays lies in the fact that cancer cells 'can't

take it' and do not recover from the ionization disturbance as well as do normal tissue cells.

"It is the differential in the effect of the X rays upon the two types of cells that gives the rays any effectiveness they have. The aim of radiation therapy has been to make that differential as wide as possible, so that as little normal tissue as possible would be affected per given amount of disturbance of the cancer tissue. The danger of the increased penetration afforded by the supervoltage X rays is that they pass through one side of the body and through the cancer, and then also pass through the opposite side, injuring that tissue also.

"On the basis of the improvement in raising the voltages from 100,000 to 200,000 there should have been a slight theoretical advantage in raising them to 1,000,000. Clinically there has been none."

Casts of Rock Carvings with Liquid Rubber

A NEW and interesting method for obtaining casts of rock carvings and rune stones has been perfected by the Swedish Government Antiquarian Office. It consists of spraying a rubber solution over the object one or more times according to the desired thickness of the mold. The material dries very quickly, and afterwards the mat only has to be rolled from the carving. Such a mat constitutes an excellent and exact casting-mold of the carving from which it has been taken; from it any desired number of perfectly sharp and clear copies can be had.

In 1938, 10 rubber molds of this type were taken, and all turned out extremely well. This novel method seems to have doomed entirely the old-fashioned system by which the carvings were reproduced by means of a plaster cast.—*Holger Lundbergh.*

Count the Miles You Skate

HERETOFORE, roller skating has meant hours of aimless gliding until aching muscles told us it was time to stop. As Major Bowes might say, "we go 'round and 'round and where we stop nobody knows."

Now for the first time we can accurately measure the distance we skate. Instead of waiting for a tired body to demand a stop, we can decide before-hand how many miles we would like to glide—six, eight, ten, or even twenty—and stop when we reach our "destination." This is made possible by the Skate-O-Meter, a new invention by Samuel Segal, which records the mileage covered while skating.

Mileage measurer for skates

The Skate-O-Meter acts as one of the skate wheels and contains a series of in-

The Editors Recommend

Best Sellers in Science

(Revised List)

May Specials

1. ARMATURE WINDING—*By David P. Moreton, Carl H. Dunlap, L. R. Drinkall.*
Construction, winding, and repairing of A.C. and D.C. motors and generators, all steps clearly shown in photographs and drawings. Practical.—**$2.10** postpaid.

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Fundamentals of various types of arc welding. Equipment, methods for best results, metals to be welded, etc. Practical.—**$1.35** postpaid.

3. FRACTIONAL HORSEPOWER ELECTRIC MOTORS—*By Cyril G. Veinott.*
A systematic presentation of descriptions, data, and diagrams for 18 major types of small motors. What kinds are available, what makes them run, and what they will do. How to repair, re-wind, and connect them.—**$3.60** postpaid.

4. WINDING ALTERNATING CURRENT MOTORS—*By G. A. Van Brunt and A. C. Roe.*
Explains and illustrates best practical methods of designing, laying out, winding, and insulating coils used in modern single and polyphase A.C. motors. Modernizing older types of motors and generators, and repairing present-day designs.—**$3.10** postpaid.

5. SOILLESS GROWTH OF PLANTS—*By Carleton Ellis and Milton W. Swaney.*
Complete information, popularly presented, regarding the problems and difficulties of tank farming. Formulas for chemicals and instructions for preparing tanks and other containers are given. Recommended to both experimenters and commercial growers.—**$2.85** postpaid.

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With four other scientists, Dr. Strong has assembled a wealth of useful data of a wholly practical kind for the constructor, experimenter, and skilled craftsman. Many lucid illustrations.—**$5.10** postpaid.

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A book of 200 simple home tricks based on physical laws, each experiment being illustrated and its principle explained.—**$1.45** postpaid.

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Working drawings of practically every conceivable movement, device, appliance, and contrivance employed in the design and construction of machinery for every purpose. Nearly 3000 illustrations.—**$4.35** postpaid.

10. SUNDIALS—*By R. Newton and Margaret L. Mayall.*
The best book on sundials. A practical work by a landscape architect and a professional astronomer. Illustrated.—**$2.10** postpaid.

11. A MARRIAGE MANUAL—*By Hannah M. Stone, M.D., and Abraham Stone, M.D.*
A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects. Answers questions most often asked these authors by their consultants.—**$2.60** postpaid.

12. THE ART AND SCIENCE OF MARRIAGE—*By Esther B. Tietz, M.D., Ph.D., and Charles K. Weichert, Ph.D.*
A well-balanced, authoritative study of the body and its functions, including the reproductive system, and a practical discussion of courtship and marriage. Recommended especially for engaged couples.—**$2.60** postpaid.

13. SCIENTIFIC METHOD—*By F. W. Westaway.*
An omnibus of the scientific method for those who wish to learn to think straight. Clearly written for the serious person who, after reading it, will feel that his thinking processes have been melted down and recast.—**$3.85** postpaid.

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ternal gears which operate as the wheel turns. The gears control a pointer on the dial stamped in the face of the wheel. As the wheel turns, the pointer moves to indicate the miles and fractions of miles covered. The gear control is so adjusted that it compensates for the time the skate is off the ground. The Skate-O-Meter will record up to nine miles and then start all over again. It is standard equipment on Segal Keyless roller skates, and will be marketed for use on others.

First Natural Bed of Soda

THICK reefs of sodium bicarbonate, perhaps the first ever found in nature, have been identified by Dr. William F. Foshag, Smithsonian Institution Curator of Mineralogy, from cores brought to the surface from depths of about 300 feet under an ancient lake bed at Searles Lake, California. When holes were driven to the 300-foot level it was found that layers of almost pure sodium bicarbonate and clay alternated.

Used by housewives and dyspeptics for generations, sodium bicarbonate has always been a manufactured product, made from a base of ordinary table salt by a complex chemical process.

A Hundred Thousand U. S. Tanks

IF a major war comes, the U. S. Army will need tanks by the hundred thousand, Maj. Gen. C. M. Wesson, Chief of Ordnance, warned leading automotive engineers recently. Now it has only a few hundred. Nearly a year from the date war is declared will be required to start mass production of the track-laying battle wagons, he predicted.

Labeling an unofficial estimate of 280,000 tanks per year for war by a modern army as too high, General Wesson declared, however, "there can be no doubt that our requirements will be very large." The army is now relatively poor in tanks, having little more than enough to equip a mechanized brigade. This brigade, stationed at Fort Knox, Kentucky, is, however, sufficient for tactical experts to work out the proper ways of using the land cruisers in time of war.

Tanks are at present constructed, with the exception of certain parts, at the Rock Island, Illinois, Arsenal and not by private manufacturers because of wide variations in the number required from year to year and because the number needed is at most small.

But in wartime, the resources of the automobile industry would be needed.

American tanks are among the world's best partly because of two unique developments, General Wesson continued. One of them, scoffed at at first, is the use of air-cooled radial airplane engines to power the mobile weapons. This has resulted in the motor making up but 3 percent of the tank's weight, an unusually low percentage. Heavier guns and armor plate can therefore be mounted.

The second is the invention of a steel-reinforced hard rubber block for the track. The rubber tracks last twice as long as steel tracks, which are widely used on ordinary tractors and on tanks in other countries. They also improve the tank's performance.—Copyright 1939 by *Science Service.*

Gold-Plated Reflectors Aid in Drying Auto Bodies

GOLD, which has found its way into objects ranging from money to false teeth, has been pressed into service to dry the enamel on your new automobile in one tenth the time required by older methods.

Special heating lamps, equipped with gold-plated reflectors costing between five and seven dollars each, have been developed by the General Electric Company's Nela Park laboratories to line the walls of drying ovens in auto manufacturing plants.

So efficient are the new reflectors—about 98 percent for the warm infra-red rays—that even after operation for several minutes, the outside of the reflectors is still cold to the touch.

The new lamps, each of which consumes electricity at the rate of 250 watts, have been in service for several months in the River Rouge plant of the Ford Motor Company, for which they were developed. Steam baths hitherto used take about 10 times as long to dry the car body. Special electric controls turn the new heating lamps on and off in a traveling wave as the painted body passes through the drying tunnel.—Copyright 1939 by *Science Service.*

Powerful Antiseptic

A NEW concentrated antiseptic has been developed which is also effective against the filaments and spores of epidermal phytons, best known in their manifestations as "athlete's foot." In the concentrated form the phenol coefficient is 5 against the standard test organisms, *Eberthella typhi* and *Staphylococcus aureus.* This means that as an antiseptic, germicide, or disinfectant it can be used in a dilution of 100:1.

Aside from general uses it is replacing the familiar chlorine disinfectant of the foot baths of swimming pool locker rooms. Being odorless, it is not objectionable and being stable there is not the deterioration in strength which usually occurs. Even at a dilution of 1:1000, it kills the filaments although not the spores of the phytons.

The product is not irritant to the skin in dilutions below about 1:20 and for general disinfection where a high margin of safety is desired can be applied at that concentration. It does not damage rubber or leave a deposit on the skin.

Conducted by JACOB DESCHIN

Impromptu Portraits

IMPROMPTU portraits do not always mean "candid" in the strictest meaning of that word, photographically. A candid snapshot is generally regarded as one taken without the subject's awareness; that is, one made without so much as an if-we-may. But there is another type of portrait, which is not strictly candid because the subject faced the camera and was shot with his consent and co-operation, but yet is not a formal portrait. Let us call this the "impromptu" portrait—taken at the spur of the moment as the photographer happens to be passing by, or while at home or visiting he decides suddenly to make a portrait then and there, on the spot, with no preparation whatever.

The perfect example of the impromptu portrait is "Barney." We were going out for a picture-taking walk and stopped for a few minutes' chat with the doorman. He expressed curiosity about the miniature camera slung from our shoulder and, one thing leading to another, we stood him up against the wall near the door and shot him. The lighting was nicely diffused as it came through the glass-paned door, with the result that good modeling prevailed from the highlights to the shadows. But then one can always depend on daylight to furnish ideal lighting for photographic purposes.

The portrait of William Herrschaft, our collaborator on the recent book, "Lighting Ideas in Photography," was taken during a lull in our work on the book as we were chatting amiably and discussing the next job to be done. He was leisurely smoking a cigar. His mood was right for the picking. And the camera being handy, snap came another victim.

"Barney"

Another time we were making some flash shots at the judging of the most recent Scientific American annual contest. We had flashed Ivan Dmitri, McClelland Barclay, and Robert Yarnall Richie, the three judges, in the act of judging the show and as they stood chatting. We had come down to our last flash bulb when it was time for the session to call quits. The judges were leaving. The window panes of the elevator doors were coated with a white, powdery "paint." Someone started idly to make crude drawings on the glass with the finger, when

"Co-Author"

Mr. Barclay came along. After some kidding, he walked over to the glass and started to draw a figure on one of the panes. As he did so, we thought of that last bulb and made the best use of it we knew, with the result that you see in one of the illustrations shown here. Before shooting, knowing that one shot was all we could have, we waited until the artist had nearly completed the figure and until his profile faced the camera, smiling and full of animation.

The other two illustrations reproduced are as nearly candid as any portrait can be. The picture of Governor Wilbur L. Cross and Charlotte Greenwood, the actress, was obviously taken when neither was aware that a camera was being pointed at them. The event was a soft-ball game involving many literary and artistic lights, including Lowell Thomas, Heywood Broun, and others. With others camera-bent we had the run of the place, and shot practically at the first show of a celebrity. As the actress approached the Governor and placed her hand on his back, comradely fashion, just before accompanying him to one of the ball-throwing

ceremonies, a snapshot caught both in jovial, lively mood. An event such as this one, where the photographer can go practically where he pleases and where no restrictions apply as to what pictures he may or may not take, is heaven-sent hunting grounds for the amateur worker who is so often shunted away from subjects apparently reserved solely for press purposes.

The shot of the singer was made on the occasion of a benefit stage performance. This one is in the true candid style, with the subject completely unposed. Nevertheless, it may reasonably be called a sort of off-guard portrait of the singer, altogether different from the sort of thing one would expect in a portrait either formal or semi-formal. It is a portrait of the singer in action, a portrait of a singer's mood. The general public would look at the picture and call it a stage

Celebrities

shot; the friends of the singer might say this was her real self, the self that could not always be recorded in a straight portrait. Incidentally, the picture was shot from the front row, a distance of about 17 feet from the subject, exposure *f*/2 at 1/50th second on fast pan film.

These are a few of the opportunities that may be met with in this connection. Many of the results will be better than anything you could get in careful arrangement of posing and lighting; many of them may

On the stage

"After the Contest"

be so bad they will have to be thrown away. But have you not often heard the remark of the lady who said that that snapshot you casually shot as she was sitting on a bench in the park was the best picture anyone had ever made of her? True portraits are not always made in a studio or in an elaborately arranged composition at home.

Start with a Title

SOMETIMES the remark is made about a certain picture that the caption or title under the picture put it over. However that may be, though we are personally of the opinion that a picture should speak for itself, why not try reversing the procedure and make a picture to fit a given title? It may be a word, a phrase, something you have heard or read. This is not the easiest way in the world to make a picture, but it does offer a challenge to one's ingenuity and ability to interpret an idea photographically. And after the picture has been achieved in a manner fulfilling the thought contained in your title plan, perhaps you can dispense with the title, after all, and let the picture speak for itself, clearly, and without benefit of any title.

Cash for Korelle Shots

IF you own a Korelle Reflex, the distributors of this camera are prepared to pay you "at the usual rates for exceptional shots made with this camera." The distributors, Burke & James, Inc., invite you to send them what you think most suitable, or at least write them a description of what you have. Incidentally, whether or not you own a Korelle, they will send you on request a copy of their recently completed brochure "The Story of Korelle Reflex."

Written with particular reference to the Korelle, the brochure also has much information of general interest, discussing various branches of photography—scientific, candid, portrait, and so on.

Too Much of a Good Thing

ONE of the national photographic dealer magazines recently reproduced a photograph showing C. W. Gibbs, A.R.P.S., addressing a group of photographic fans. The picture was a flash shot which called for about a half dozen flash bulbs in order that the entire hall might be adequately lighted during the brief split-second synchronized

OVER $1250 IN PRIZES

Fourth Annual Scientific American AMATEUR PHOTOGRAPHY CONTEST

Since the preliminary announcement of this contest, which appeared in our April issue, we have extended the prizes to include Third and Fourth places in each of the three divisions.

Specific rules for entering this contest are given below. Please read and abide by them to insure against disqualification. You may submit pictures in any or all of the following divisions:

Division 1. Human—including portraits and other camera studies of people.

Division 2. Landscapes—including all scenic views, close-ups of parts of landscapes, seascapes, and so on.

Division 3. Action—including all types of photography in which action is the predominating feature.

In each division there will be prizes of two Longines watches*—"The World's Most Honored Watch"—and two Federal Enlargers, as well as five Honorable Mention Awards.

The Prizes Given for the Best Photographs in Each Division will be:

FIRST PRIZE
One $250 "Lifetime" Longines Watch

SECOND PRIZE
One $125 Longines Watch

THIRD PRIZE
One Federal #636 Variable Projection Printer (List Price $29.50)

FOURTH PRIZE
One Federal #120 Enlarger (List Price $17.95)

Five Honorable Mention Awards, each consisting of a one-year subscription to Scientific American

Remember that these prizes are to be given in *each* division—or a total of six watches and six enlargers totaling $1267.35 in value, plus 15 subscriptions to Scientific American.

*Watch winners may make their own selection of pocket style or gentleman's or lady's wrist watch.

RULES OF THE CONTEST

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14. Prints need not be mounted, but may be at the contestant's option.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry must have the following data written on the back of the print or mount: Name and address of contestant, type of camera, and film, enlarger and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups.

7. Prints must be in black and white. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1939. Results will be announced in our issue dated February 1940.

12. This contest is open to all amateur photographers who are not in the employ of Scientific American.

THE JUDGES:

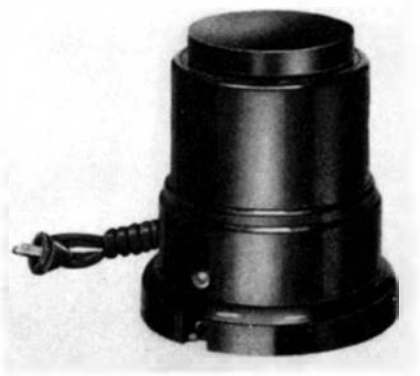
McClelland Barclay, artist
Ivan Dmitri, artist and photographer
Robert Yarnall Richie, commercial photographer

Address All Entries to
PHOTOGRAPH CONTEST EDITOR
SCIENTIFIC AMERICAN
24 West 40th Street, New York, N. Y.

exposure. The photographer was standing on the platform back of Mr. Gibbs and apparently had intended to make the shot as the lecturer was facing the crowd but just before the flash went off a little noise back of the speaker made the latter quickly turn around to face the photographer. As he did so, the photographer flashed the whole battery of bulbs in Mr. Gibbs' face as well as the faces of the audience. The result was a white-wash of the speaker's countenance with nothing to show where the face was but a blank paper-white emptiness. This would not do for reproduction so an artist was put on the job and *sketched in* Mr. Gibbs' face. And that is the way the picture stands reproduced in the magazine.

No More Scratched Film

AMATEUR photographers can now treat their own films so as to render them impervious to scratches, abrasion, and fingerprints. By means of a patented process that toughens the gelatin, and that can be applied at a cost of less than two cents a roll, all sizes



Vaporator

of film from 35 mm to 116 can be treated in a few minutes and with no more trouble than doing your own developing. The process is known as "vaporating" and is accomplished with the F-R Vaporator, with which two rolls of film of the sizes mentioned can be treated at one time, except the 116. In the latter size only one roll can be vaporated at one time.

Films are inserted into the device in the same manner as for developing and then placed in the vaporator. Chemical "A" is inserted with a dropper and the cover closed. After a few minutes, chemical "B" is inserted and in just a few minutes longer the films are completely treated.

The results obtained today from good cameras, skilful photography, and careful developing would seem to be worthy of this protection which should assure the maximum of satisfaction in picture taking.

Photographing the War Games

THE war games are being photographed on a larger scale than ever before, according to Harwood Hull, reporting the recent Navy maneuvers for *The New York Times.*

"Practically every action recordable by the photographic lens," writes Mr. Hull, "whether from the air or from surface ships, has been supplied to Admiral C. C. Bloch.

"One technique carried to a new point in the war game has been simultaneous photography from two or more planes with cameras operating under radio control.

"These pictures will supplement the maps in telling the story of the White and Black fleets at the critique. Both maps and pictures will be seen for the first time by the navy flag and staff officers when they assemble at Guantanamo."

Cleaning Glass

WHETHER you are cleaning ground glass or plain, there is a simple home-spun procedure that will do the job most thoroughly. Just wash it with soap and water, first one side, then the other. Follow with a rinse to remove the soap completely. Stand the sheet of glass so that the water runs off from one corner. Finish the routine by wiping with a clean, soft white rag. The ground surface of ground glass will seem to vanish, giving the appearance of clear glass, but this effect disappears upon drying.

Talking Slide Film Describes Indoor Photography

THE result of more than two years of research, a 25-minute talking slide film on indoor photography produced recently by General Electric's incandescent lamp department at Nela Park is now being made available on a free rental basis to camera clubs and other groups. Entitled "Pictures Indoors with G. E. Mazda Photolamps," the new talkie is said to have been "designed to meet an urgent need for trained speakers expert in Photoflash and Photoflood technique."

From "Pictures Indoors . . ."

Using non-technical language, the film covers the fundamentals of indoor photography in more than one hundred "how to" slide pictures. "Free use of the human interest appeal is employed," we are informed, "this element being provided by a genial photo veteran and a candid young amateur. The secrets of successful indoor pictures are revealed one by one as the expert and novice discuss their hobby."

Starting with a description of the types, construction, and operation of the various types of Photoflash and Photolamps, the film leads the audience step by step to an understanding of indoor photographic practice. A French doll is the subject and miniature lighting equipment plus a miniature

camera illustrate the various methods demonstrated. The presentation also includes numerous examples of interesting indoor pictures taken under the lighting set-ups described. The final sequence is devoted to interesting examples of good picture subject matter likely to be found in the average home.

To obtain a copy, a request should go direct to Incandescent Lamp Department (166), of General Electric Company, Nela Park, Cleveland, Ohio. The borrower merely pays transportation charges and agrees to return film and records promptly. The talkie is supplied by the nearest division sales office of the company. The borrower is also supplied with literature describing how to operate the film, where operating equipment may be obtained, and with a summary of material in the film.

New Kodak Building

MORE than $100,000,000 was spent on amateur photography in the United States during the year 1938, we learn from the Eastman Kodak Company as they announce the building of a new plant at Rochester.

"Sales in cameras and photographic supplies shattered all records," they report, "and the year ended with a new high of more than 18,000,000 cameras in active use in this country.

"With confidence in the future the Eastman Kodak Company has announced an unprecedented expansion program to maintain this momentum."

Incidentally, the company is dropping prices all along the camera line.

Press Photography Awards

SPEED Graphic cameras are still the favorite among press photographers, judging from the fact that Speed Graphic pictures took all five of the prizes offered this year for outstanding news pictures made during 1938, including every one of the 10

honorable mentions. The awards were made at the Annual National News Picture Contest sponsored by *Editor & Publisher*. Graflex-made cameras have made every one of the 35 prize-winning pictures since these events were inaugurated in 1936.

The award, the Graflex Press Photography Award, symbolized by a gold, diamond-studded watch charm, went to the following photographers: Ray Howard, of the *New York Journal and American*, first prize for "Death on Fifth Avenue"; Howard Jones, of

the Knoxville (Tennessee) *Journal*, second prize for "No Pictures"; Charles Haacker, of *Acme Newspictures*, third prize for "The Warde Suicide"; Ralph Morgan, free lance of Newark, New Jersey, fourth prize for "Thomas Egged Out"; and Charles Corte, of *Acme Newspictures*, fifth prize for "Conflagration."

The Folmer Graflex Corporation points out that the awards are given solely as recognition to prize-winning photographers who make dramatic, story-telling news pictures and that eligibility for them in no way relates to the kind of camera equipment used.

Prize Winner

A FEELING for composition, careful selection of viewpoint, and the most effective lighting brought Eugene Lesser, 15-year-old student at the High School of Music and Art, New York, the highest honor awarded to any contributor to the second scholastic salon of photography of the American Institute of the City of New York. The picture, here reproduced, is called "Gentatrix," showing the boughs of a palm tree photographed from below. The print was chosen as the finest of 308 prints submitted by 291 students from junior and senior high schools.

"Gentatrix"

Young Lesser has demonstrated real aptitude in several branches of the arts and it was natural that he should carry his artistic ability over into photography, towards which he seems to lean most strongly. Certainly, this provides a strong argument for the need of artistic training of some sort if one is to reach the heights in photography. Nevertheless, it must never be forgotten that photography is first of all a mechanical art, and that until the technique is thoroughly acquired, no amount of art leanings or art training is going to make one a good photographer.

Kodachrome Processing Now Includes Mounting

EFFECTIVE April 1, all Kodachrome K828 and K135 film sent to Rochester for processing will be returned in the form of individual transparencies, ready-mounted for immediate projection, and with no added charge, according to an Eastman announcement. The new service includes lacquering the emulsion side of each roll of film after processing (as a protection against finger marks), cutting the frames apart, and mounting each frame in a serially numbered

Kodaslide Ready-Mount. When returned to the sender, the Ready-Mounts, which are made of smooth-finish, specially prepared pressboard, will be numbered consecutively to correspond to the picture sequence in the film roll.

The company adds that users who wish Kodachrome strips returned in the complete rolls, as in the past, may indicate this desire by clipping a corner of the address tag when they send in film for processing.

5-AND-10 NEGATIVE DRYER

YOU may have seen in the five-and-dime store a little bamboo gadget intended for drying small articles such as socks and handkerchiefs. The gadget consists of two strips of wood each about 15 inches long and joined at the center with a hook similar to a clothes-hanger hook. The two sticks may be swung on a horizontal plane to practically any angle in relation to each other. From each stick four clothespins are suspended by small ropes, two pins on each side of the joined center. Altogether, there are eight of these pins. It struck us as a very handy negative dryer for the home-processing photographer, since it permits hanging the "dryer" from any handy support.

STEREO PROJECTION BOOKLET

CHARACTERIZED as "the first completely practical method of enjoying stereoscopic pictures by projection," the Stereoly Polaroid System of Three Dimensional Projection is fully described in a free booklet now being distributed by the manufacturers of the Leica camera. In addition to containing a description of the system, the booklet gives directions and hints on projecting and observing the pictures.

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

MAZDA REFLECTOR PHOTOFLOOD LAMP NO. R2: New, self-reflecting Photoflood lamp. Bell-shaped unit consumes 500 watts; equipped with conventional medium-screw base and may be used on ordinary lighting circuits. Circular end inside-frosted for even distribution of light. Color quality of light similar to that of standard Photoflood No. 2. Smooth illumination over spread of about 60 degrees. All-over length, 6¼ inches, width, 5 inches. Manufacturers say: "Besides providing photographers with a new Photoflood assembly that may be carried conveniently from place to place, the No. R2 delivers a wealth of photographically effective light on the subject initially and throughout its designed life. This is made possible through use of the new high-efficiency filament and special

aluminum surface of high reflection factor hermetically sealed within the bulb. Neither dust, dirt, finger marks nor other foreign matter can collect upon the lamp's mirrored inner surface to interfere with reflecting efficiency."

ARGOSTAT ENLARGER: Styled as the "enlarger built with the precision of a fine camera." Focusing disc at base of upright column. Vernier-drive mechanism makes it possible to attain critical focus of the objective lens in this manner instead of turning the lens mount itself. Reflected light employed to obtain maximum flat-field illumination. Argostat designed to take Model C or C2 Argus *f*/3.5 camera lenses as objective lens. Other 50-mm camera lenses may be used with adapters. Also available, specially mounted *f*/3.5 Cintar lens, same as used in Argus C and C2 cameras. Argostat enlarges to 12 by 18 on the base and to 11 by 14 on the Argus Micrograin Easel, recently announced in this department.

MONOBATH: Single solution fixer-developer. Developer and fixer in one bath under automatic chemical control. Inventors and manufacturers of Monobath claim negatives always develop to same density regardless of time or temperature. Solution works at any room temperature between 70 and 80 degrees, Fahrenheit. Choice of three types varying as to gamma and grain, and ranging from Mural Type, which is ultra-fine grain but low gamma, to Contact Type, which is high gamma but only standard grain. "Negatives cannot be over-developed in Monobath," the manufacturers claim. "After the specified processing time of, say, 25 minutes has passed, nothing further happens if the photographer purposely or forgetfully leaves the negative in the solution for an hour or even overnight. When the image has reached full tonal value, development ceases and fixing begins. This automatic chemical time cycle built into the formula yields definite density control without watchfulness on the part of the amateur, who is told he can now 'throw away his thermometer and clock.'"

NEW AGFA MEMO ($35): 35-mm American-made miniature camera. Announced by manufacturers as "result of several years' work in refining and improving the original Memo camera which did so much to initiate the widespread adoption of miniature outfits using 35-mm film." Features: "double-frame" miniature, using perforated 35-mm film; gives 24 pictures 1 7/16 by 15/16 inches in size, per cartridge of film. Equipped with Agfa Memar *f*/3.5 corrected anastigmat lens focusing from 3½ feet to infinity. New and improved type of shutter giving speeds of ½ second to 1/200th, bulb and time. Memo cartridge eliminates threading and simplifies loading. Cartridge supplied in four popular types of Agfa film: Superpan Supreme, Ultra-Speed

Pan, Finopan, and Fine-Grain Plenachrome. Film transport mechanism employs patented sliding lever which advances film in one rapid motion without winding or window watching. Camera finished in polished metal, black lacquer, and black morocco leather. Pressed steel frame; hinged front platform snaps quickly into picture-taking position. Brilliant direct view finder; neck-cord and eyelets; accessory clip; tripod socket; automatic exposure counter, and built-in depth of focus scale.

EASTMAN "X" FILMS IN BULK ($2.50 for 27½ foot roll): 35-mm Kodak Panatomic X, Kodak Plux X, and Kodak Super XX now available in bulk rolls for darkroom loading. New form 27½ foot length of frame-numbered 35-mm film, safety base, with leaders cut out at intervals of 36 exposures. Strip sufficient for five 36-exposure loadings. Ready-cut leaders simplify measuring and cutting. Films also available in bulk rolls without ready-cut leaders or frame numbering.

FALCON "PRESS FLASH" CAMERA ($5.95): Built-in flash synchronizer with flash reflector as part of camera body. Uses small

Superflash bulbs. Single button operates flash synchronizer and camera shutter simultaneously. Self-lighting feature may be switched off at any time to permit operation of camera in normal way. Camera uses standard 2¼ by 3¼ film (8 exposures on 120 or B-2). Price includes four extra Superflash bulbs and Penlite style two-cell battery.

A TO Z KIT ($2.) for titling home movies. Said to be only script titler on market, featuring unlimited possibilities for distinctive designs. Kit includes two volumes of over 1600 initials and 12 lower case alphabets, numerals, decorative ideas, special titling pencil, and complete directions.

BEE BEE FOCO-FLOOD ($12.50, $17.50, $22.50): Designed for simple focusing, tilting, and locking in position. Silvered aluminum reflector, with black crackle exterior, mounted on four-section chromium-finished tripod. Ten feet of cord supplied. Three models available for different bulb sizes: for No. 1 Photoflood, with 10-inch reflector; for No. 2 Photoflood, with 16-inch reflector; for No. 4 Photoflood, with 19-inch reflector, with mogul size socket.

IMPERIAL VISUAL EXPOSURE METER ($1.50): American-made extinction type meter employing "an extinction wedge accurately designed to compensate for the peculiarities of human vision." The manufacturers declare "the Imperial extinction type exposure meter does not make use of dials to take care of artificial light conditions. It employs a supplementary wedge which can be thrown into the optical path or removed from it by a single turn of a knob. This additional wedge is carefully designed to compensate for the changing visual action under artificial light. It automatically adjusts the meter for all in-

teriors and under all conditions of artificial light." To read the meter, it is held with the round mirror chamber at bottom, thus bringing the reading window, located in the top of the case, to the natural line of vision. Speed scale held toward body, thus directing lower window toward object being measured. Complete scale on back of meter takes care of every exposure factor and condition. Meter built into Bakelite case about one inch square.

BEE BEE ILLUMINATED VIEWER ($10): For mounted color slides and 35-mm film. Takes regular two by two-inch slides and magnifies image to about 2½ by 3¾ inches. Useful in viewing black and white positives as well as color and in studying negatives for enlarging values. Unit of cast aluminum in one piece. Weight, two pounds. Six foot cord and snap switch. Operates on A.C. or D.C. Special slide carrier for 35-mm film available at $1.75.

AGFA CYKON (contact) and CYKORA (projection) PAPERS: Incorporate an improved, full-scale range of tones. Intended for wide variety of subject-matter, from portraiture to pictorial and illustration work. Available in several surfaces, including popular Kashmir (in white and ivory), Crystal White, Silk White, and Royal White. In addition, Cykora line is supplied in Fabric White, Porcelain White, and Porcelain Ivory. Both papers furnished in three grades of contrast in all surfaces. Both papers generally similar in characteristics other than speed, giving warm, black tones that may be controlled over wide range through modification of development or after-treatment. Wide developing latitude may be obtained in standard formulas, and usual processing technique is followed.

KODASLIDE PROJECTOR, MODEL 2 ($33.50, $52): Compact projector for two by two-inch slides, for showing 35-mm color or "black and white" transparencies. Achieves minimum bulk compatible with efficiency. Base measures 4 by 6⅝ inches; height of lamp housing 5¼ inches. Base, turret head, and housing of die-cast aluminum with glossy, jet-black finish, contrasting with bright, natural aluminum turned finish of 5-inch lens tube. Fluted sides, finished in black crackle. Optical system consists of spherical glass reflector; 100-watt lamp; three condensing lenses; and 5-inch *f*/3.7 projection lens. Special heat-absorbing glass prevents overheating slide during projection. For long projection throws, 7½-inch projection lens available. Ventilation provided as follows: "A special shell containing glass wool surrounds the lamp. Liberal space is provided inside this shell, and a similarly generous space separates it from the outer housing. The fluted exterior surface of the housing further aids in heat dissipation. In the design of the projector top, the principle of natural-draft ventilation is employed to exhaust heat rapidly, and louver strips are set vertically to insure maximum circulation. Supplementary louvers are provided over the condenser system."

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. Suppose one were going to purchase an *f*/3.5 lens and had a choice of one from the following lenses: Xenar, Primotar, or a Tessar. Which one should he purchase and why? Will you please send me details on the above lenses as to color correction, definition, and the number of elements?—W. O.

A. The lenses you mention are all of the so-called tessar-type, consisting of four elements and fully corrected as to color and definition. Any one of these lenses will give results practically equal in quality and it would be difficult for anyone to tell from the resulting negatives which lens made which negative.

Q. I cannot find a method which will give smooth flat prints. The ferrotype plates I use give me such curled prints that I consider them useless. The method of drying them around a drum holds out fairly well, but after a few days these prints also curl. Will you please give me a method by which I can obtain flat prints or prints having a slight back curl?—K. R.

A. In a recent issue we mentioned the idea of moistening the backs of the dried prints, placing them individually between blotters and allowing them to stand in a press or under a weight overnight. Also, a number of solutions are available that claim to guarantee flat prints. Glycerine in the ratio of one to 19 of water has been recommended as a sure cure for curled prints. Have you tried using double weight papers? In any event, much can be done to prevent future curling of prints by regularly storing the prints between weighted papers, or in a file. One good method, though it may be bothersome and expensive, is the use of Holliston cloth backing for the individual prints.

Q. I would like a general idea of the cost of developing films at home, compared with commercial prices. About how many pictures a month would it be necessary to take to make it worth while to do such developing?—G, M.

A. We presume you are referring to the profit possibilities in photo finishing at home, for others, on a commercial basis. Although we do not have exact figures, the chances are very much against the likelihood of your being able to obtain a sufficient monetary yield over and above the cost of production to make the proposition worth your while. It is well nigh impossible for an individual working at home with ordinary equipment to compete with the large photo-finishing houses. The rates are much too low, for one thing, and an individual cannot turn out the large volume necessary to bring in a suitable return. Other factors militating against the idea include the difficulty of turning out the negatives on the 8-hour basis, the routine of pick-up and delivery, and so on. Production on a large, steady basis is the keynote of the commercial photo-finishing houses, and production is the one thing the home finisher is not equipped for.

Q. I am using three Correx tanks and a 3½-minute developer at present. The time required to pour in and pour out the developer is apparently giving me over-developing to some extent. Question No. 1: If I added 1000 cc. of water to 1000 cc. of, say, a 3½-minute developer, could I figure that this would give a 7-minute developing time? Question No. 2: Can you suggest any way to get the most out of a thin negative for diapositive printing to prevent too much contrast? I have several hundred hand-colored photographs and as many more colored by a commercial process that I am desirous of copying on Kodachrome. Question No. 3: Have you any suggestions as to the use of "mats" to place around these colored photos in order that an exposure meter may be used, thus saving time and material? I'd like to ask the same question regarding black and white. Question No. 4: In March Scientific American you answered a question relative to copying articles from journals. You spoke of a new type of frame to hold magazines or books while doing this work. May I have information on the construction of this frame and where it may be purchased? Question No. 5: Does a piece of sheet glass interposed between printed matter or a photograph and the camera lens require extra exposure as a rule? Does it give trouble from reflected light?—F. T. C.

A. No. 1: Dilution of the developer may

work out as you suggest but not all developers will work out in this way and the best procedure still is to follow the manufacturer's processing instructions. You may figure on a duration of about one minute for pouring developer into the tank and one minute for pouring it out again, thus allowing one minute and a half for development in the tank.

No. 2: Intensification of the negative by chemical means is probably the most effective method, permitting the intensification to proceed for the minimum period required to produce a printable negative. If the negative is not too thin, a medium hard grade of paper contrast will give suitable results. Capping a yellow filter over your enlarging lens sometimes is useful in printing from thin negatives.

No. 3: A black frame of paper or cardboard with an opening just large enough to display the picture is all you will need. Illuminate the subject evenly from both sides, each light approximately at an angle of 45 degrees to the plane of the subject. Use a meter of the so-called visual extinction type and point the meter at about the center of the picture and at a distance from the subject equal to the shortest side of the picture. At this distance you will cover an angle that will include the picture only and nothing else, thus giving you the correct exposure. In view of the expense of the material you are using, we would suggest that if the colored photographs are somewhat equal in brightness, you make a series of exposures of one of the pictures, pulling the slide of your film holder up about an inch at a time. (We understand you are using a 9 by 12 cm. camera for making these color copies.) Send this one Kodachrome for processing, and when it is returned you can select the proper exposure for the subject and the particular lighting set-up. Concerning black and white copies, the same lighting and exposure routine as for color may be employed. However, if you are to copy colored photographs on black-and-white film stock, it may be necessary to use a filter, perhaps a dark yellow.

No. 4: The frame item to which we referred was merely a general suggestion on the construction of such a frame; the frame is not commercially available.

No. 5: The use of glass in enlarging or contact printing is standard procedure. Therefore, you may employ it without hesitation. It will not give any trouble due to light reflections.

***Q.* What is a good way to label darkroom bottles without having the lettering wash off in time?—D. L. O.**

A. Every photographer has his own pet way of identifying bottles in his darkroom. One ingenious method we recently heard about involves covering the desired portion of the bottle with sulfuric acid (CP), then writing on the space with a blunt piece of aluminum. The acid is then washed off, and silvery letters are the result. This effect is permanent.

***Q.* In using an enamel ferrotype plate I notice that, when prints are dried, a slight raised outline of the print is left adhering to the plate which I cannot remove. This raised area sometimes is the entire paper area and is sometimes confined to the central, more slowly drying area. I would appreciate any information regarding this condition.—O. B.**

A. The condition you refer to is probably caused by the presence of calcium or other impurities in the wash water used for washing the prints. We would suggest that before laying the prints down on the ferrotype plate, the prints be swabbed with a viscose sponge, moistened absorbent cotton, or other soft material. We presume that the ferrotype plates are thoroughly cleaned with the usual waxing solution before the prints are laid down.

***Q.* Is there some way to quicken the drying of negatives after they have been in water for an hour or so? I have used the sun and the wind on certain days to do this, but this is not a dependable source.—E. M. W.**

A. Quick drying of negatives can be effected by soaking in two successive baths of methylated spirit (not ordinary commercial type) containing 10 percent of water, and placing in a current of air. The wind outdoors not only is not a dependable method of negative drying but also involves the hazard of dust being blown onto the surface of the wet emulsion and adhering to the latter upon drying.

***Q.* Is there a way of getting distortion under the enlarger without having to tilt the easel and thus necessitating the use of very small lens stops and long exposures?—S. E. L.**

A. Some time ago a professional photographer spoke of using a very special lens for the purpose of elongating the image under the enlarger. Recently, a lens of this type has been commercially introduced by the Blue Seal Products Company. This lens is supplementary to the regular lens and is used over the latter. The degree of elongation provided by the lens is adjustable up to about 10 percent. The lens can be made to fit any enlarging lens.

***Q.* In pouring dry chemicals out of the made-up formulas in cans into the graduate I find that the narrow shoulder at the mouth of the can causes a dispersion of the material so that the latter strikes the inner walls of the graduate and is otherwise scattered. Could you suggest an efficient method of pouring from the can into the graduate that would avoid this dispersion and permit an even flow of the chemicals into the water?—L. M. K.**

A. We have discovered that the best way to do this is to use an ordinary makeshift paper "funnel" shaped like half a cone. Chemicals poured down this "chute" will, if it is appropriately held, hit the center of the water in the graduate.

***Q.* Will you please give me the formula for an effective way to stop leaks in darkroom sinks?—L. B.**

A. There are several methods. One we heard about recently seems to do the job with complete efficiency. The formula calls for 34 parts of asphalt, 26 parts of kerosene, and 40 parts of asbestos meal. Dissolve the asphalt in the kerosene. Then pour the asbestos powder in a little at a time until you get a stiff putty. This will provide a paste that will prove fully waterproof and lasting, and the consistency is just right to do the work.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

TUBELESS and resembling some fanciful creature from Mars is a unique skeleton Cassegrainian telescope (Figure 1), built by Horace E. Dall, 166 Stockingstone Road, Luton, Bedfordshire, England. In addition to the tubeless feature it has the spherical secondary mirror, with primary figured to match it, which Dall described several years ago, and which Kirkham worked out mathematically in these columns in June, 1938. At our request Dall writes:

"Enclosed are photos of my weird-looking 15½" *'modified'* Cassegrain telescope—'tubeless' yet framed by steel tubes. It has

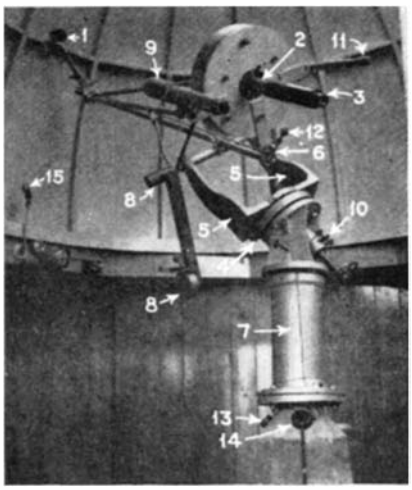


Figure 1: Dall's polypedalian

turned out to be optically entirely satisfactory and will do *all* that a 15½" can do, and that in a most comfortable manner. It is modified not alone in respect to the spherical secondary—this is the least important modification. You will recall that I described briefly the main features of the proposed modification in a letter to you early in 1932, also in the *Journal of the British Astronomical Association*, May, 1932, and for convenience I repeat the description.

"Mainly, it consists in the introduction of a high-grade intermediate lens (erecting lens if you like) between the secondary mirror 1, Figure 1, and the final image. For convenience, compactness, and so on, this lens is supported by a tube 2, through the primary perforation. The benefits resulting from the addition of this lens are very great and lie in many directions.

"(1) It enables the sky-flooding diaphragm to be moved from the eyepoint (where it is nothing but an infernal nuisance, has to be fitted to each eyepiece, and is almost impossible to keep in good adjustment because of its minute aperture) to a position between erecting lens and eyepiece where it is quite out of the way. It has a large aperture and always keeps in optical alinement. This permits:

"(2) Wide-field eyepieces with comfortable eyepoint, greatly appreciated by spectacled observers.

"(3) A good iris diaphragm to be used for the sky stop just described, so that the aperture of the telescope can be varied by a small index lever (as in the case of my 15½") from full aperture down to nothing. This can be operated while actually observing.

"(4) Location of the erecting lens between the mirrors enables the long focus of the normal Cassegrain to be shortened down to a very convenient length—an important feature of this 15½". I can secure the advantages of variability of the distance between lens and secondary and lens and eyepiece, giving me:

"(5) A final image varying in angular aperture from *f*/10.5 to *f*/26. This enables me to get a continuously variable power over a range of 1:2½ from each eyepiece.

"(6) To accommodate any *small* thermal variations of spherical aberration of the primary by opposing the aberration introduced by varying the 'tube length' from the mean position for which aberrations are nil.

"(7) It erects the final image, permitting excellent terrestrial views of great brilliance and completely free from any sky-flooding troubles. I have a fine outlook, terrestrially, from my observatory and find I can take full advantage of this unusual terrestrial aperture at all steady air periods, evening and morning, when air clarity is reasonable.

"In the case of the 15½" my erecting lens is 2¾" in aperture and enables me to have an eyepiece, 3, of lowest power (X60) of real RFT character, which will include the whole Moon and a large margin to spare. This is probably unheard of in a 15½" ordinary Cassegrain and I get it with a central obstruction of only 20 percent of the primary diameter (4 percent of the light).

"The *fully* illuminated field is almost 0.3 degrees, but cut-off is not noticeable at the edge of the low-power eyepieces. In order to get this, of course, the erecting lens is somewhat difficult and took me longer to make than the primary. Good corrections are obtained by cemented triplet construction and the residual secondary spectrum in the final image is quite negligible and visible only to a practiced eye.

"I calculated the eccentricity of the ellipsoidal primary and did the final figuring with the pinhole at near focus and the k-e at remote focus, some 120' away, the whole being quite convenient and easy. This method is the one I have always used for my spherical secondary Cassegrains.

"The driving clock, 4, is a Synclock weighing little more than ½ pound all told, and giving ample power even when I am pulling the telescope *backward* against the independent friction drive (between the polar axis trunnions, 5, 5, and the worm wheel).

"One great advantage of such a small motor—probably the smallest ever attempted for this aperture telescope—is that there are only one or two watts of heat to dissipate and the chance of warm air trouble in the observatory is thereby very much reduced.

"I had intended to put a pair of deflector sheets V-fashion below the optical cones to guide any rising warm air out of the optical paths, but have not yet done so—the need is not extreme, but I think it is desirable. I am certainly not troubled with tube currents, and it seems to me when comparing performance with my earlier 14", open-air, square wooden-tube reflector, that I am decidedly better off now. The observatory, shielding the instrument from rapid radiation, helps a lot, despite statements I have sometimes heard to the contrary. The observatory is aluminum painted to retard rapid changes of temperature due to radiation, as per my *British Astronomical Association Journal* article of January, 1938.

"Focusing is done principally with the little handwheel, 6, and extension shaft which moves the secondary, although additional spiral sleeve focusing can be done at the eyepiece end.

"The mirror lid is hinged and fastens back on the framework where it is out of the way (shown better in Figure 2).

"To save making up a new stand, all the lower part, 7, is an old Calver equatorial

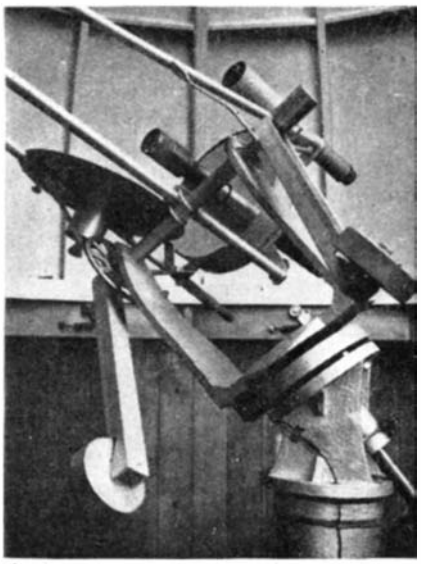


Figure 2: Close-up of mounting

stand (date 1882). It originally carried an 8½" mirror in iron tube between the trunnions but, as I couldn't get a 15½" between the same trunnions, I carried it outside and put lead balance weights, 8, 8, on the other side. The overhang is thus more than one would use from unfettered choice, but the whole system is very light—much lighter than the original 8½" Calver. I have added worm drives on the two axes, but I have yet to add circles and a few other improvements.

"The finder, 9, is 3" in aperture and the power 10X, with an actual field of more than 5 degrees.

"The photo shows the little clock, 4, but barely shows the RA worm wheel and the

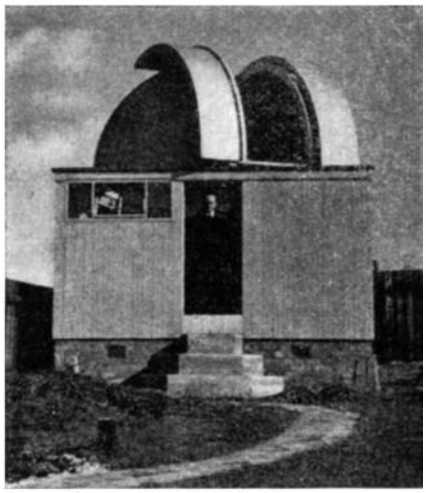


Figure 3: Dall and observatory

anti-friction rollers, 10, which I have added at each end of the 2⅛″ polar axis to reduce friction due to the polar tilt. These rollers are spring loaded and press up on the upper and down on the lower roller, respectively, with a force equal to the calculated gravity forces. A ball race takes the thrust down the polar axis.

"Other details: 11 is a handle for moving the telescope, 12 is the screw for slow motion in declination, 13 the switch for drive, and 14 the connecting box, 15 are bright and dim lamps on the dome, and nearby is the dome drive shown in Figure 4.

"The observatory (Figure 3) is 12′ x 12′ over the brickwork base, the dome being 11′ 6″ in diameter, with 20 ribs. Except for

Figure 4: Dome drive and bearing

the mechanical parts, it was planned and built largely by Perry, a neighbor. The dome rides on ball-bearing roller skate wheels attached to the wall, or fixed base, of the structure. The ash rail, which shows as a broad band traversing Figure 4, is on the *dome*—Perry's idea. This saves a lot of work. One of the skate wheels shows in the extreme right in Figure 4. It is mounted on a bell-crank arrangement—a triangle of iron pivoted at its upper right-hand corner. Attached to its lower corner and to the ash rail is a tension spring from an old mesh-type bedspring. These springs insure that each roller carries its due share of the load, within a few percent—practically impossible with fixed rollers. Incidentally, the observed deflection of the springs in a gale enables me to judge the direction and amount of the forces due to the wind.

"To the left in the same picture is the motor drive for the dome: gears and a rubber-faced wheel. The drive is by friction and works nicely.

"The shutter of the observatory dome has a 36″ opening. The flat part of the roof is covered with copper sheet."

ADDENDUM to note on ruling engines for diffraction gratings, in "Amateur Telescope Making," page 466: In an article on Prof. Michelson, published in *The Scienti-*

THE BEGINNER'S CORNER

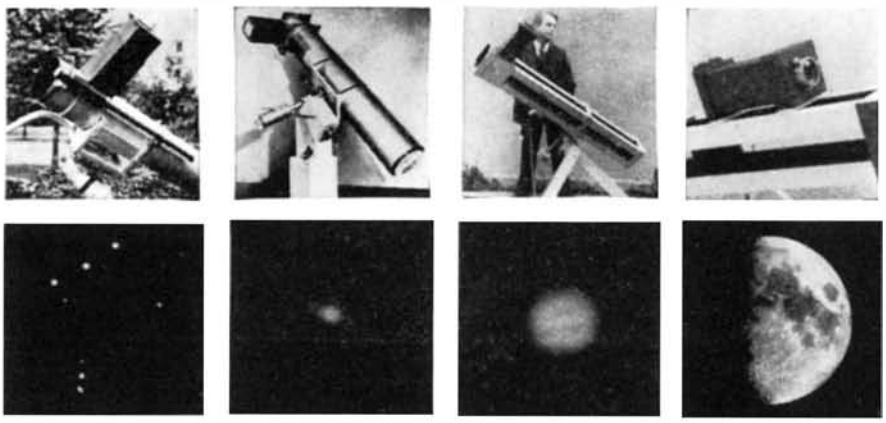
PHOTOGRAPHY of celestial objects, especially the Moon, is one of the simplest and usually one of the first stunts performed by the builder of a telescope. The book "Amateur Telescope Making" contains definite instructions for doing it, and the equipment needed consists simply of the regular eyepiece used in visual work, to which are added some kind of box and a simple photographic plate.

On this page are shown three amateurs' telescopes thus equipped. The first is a 6" reflector made by Charles E. Kratz, 3415 Copley Road, Baltimore, Md., who states that the camera is made of two telescoping wooden boxes, the stationary one curved to fit the tube to which it is fastened removably with hooks. The sliding part has a film holder or, alternatively, a ground glass focusing screen. (Anyone who has made his own mirror will know how to make ground glass, simply by brief abrasion with medium-sized abrasive grains.) Kratz' telescope is mounted on 3" pipe fittings and he says there is no shake.

The second telescope is similarly equipped and, having a worm drive, can be used for photographing the stars as well as the Moon. A. R. Karnosh, 3296 Lansmere Road, Cleveland, Ohio, is the maker.

Third telescope is the work of R. M. Watrous, M. D. and Mrs. Watrous, and is the mate to the one shown here last month, though built a little more solidly. In the Watrous telescope the same box that is used for photographing the Moon by means of the telescope may be detached, remounted as shown in the fourth photograph, a lens added, also an end to hold it, and used for direct photography of the stars. Dr. Watrous states that he made this 2" lens from common ¼" plate glass and, that, though there are striae in the glass and though it is, naturally, subject to every type of aberration a lens can have, nevertheless it will form images—of a sort. A photograph of a part of Orion, taken with it, is reproduced.

The two planetary photographs were made by H. A. Lower of San Diego, Calif., with more elaborate equipment but on the same simple principle. The first is of Saturn, exposure 30 seconds, the second of Jupiter, exposure 15 seconds. Much original detail —most of it, in fact—has been lost in the half-tone process. The lunar photo was made by B. L. Bradley, 235 N. High St., Salem, Oregon, and is typical of many that have been sent this department. Unfortunately, the half-tone process reduces them all—good, bad and indifferent—to the same level of mediocrity but many of the originals received are very sharply defined.



TELESCOPTICS

(*Continued from preceding page*)

fic Monthly, January, 1939, Prof. R. A. Millikan says that in 1900 the former "turned his attention to the problem that gave him more trouble and at the same time filled his associates with more admiration for him than any of its predecessors had done; namely, the problem of ruling very high resolution gratings. He had thought he could build a machine in a few months, or at most a few years, which would give him the desired resolution, but he spent the rest of his life without reaching the point at which he was willing to drop the problem. He often said he regretted that he ever 'got this bear by the tail,' but he would not let go, and, in spite of endless discouragements, at the end of about eight years of struggle he had produced a good 6" grating containing 110,000 lines."

Undoubtedly the note in "ATM," mentioned above, failed to lay enough stress on the supreme difficulty of this problem and a number have planned, therefore, at various times within recent years, to undertake the job. For this, your scribe blames himself in large measure. This is not to say dogmatically that the amateur *cannot* succeed, but rather to point out the worst; namely, that the job is tough, tough, tough. It was tough even for Professor Michelson, and he was the physicist's best exponent of the methods of ultra-refinement and precision, having a marked native flair for pushing these characteristics to their very utmost. Yet this piece of work took him eight years, hence the amateur, if he undertakes it, should not do so lightly.

The ruling engine as a whole is a nice piece of instrument building but it contains one item that goes far beyond ordinary or even extraordinary varieties of niceness—the lead screw, its very heart. Making a screw is not a hard job but freeing it from errors—there is the rub. A fair glimpse into the nature of this cantankerous, pernickety job and, in fact, the only glimpse your scribe has ever been able to find in print, is contained in a six-page illustrated article in the June, 1917, number of *Ma-*

chinery (New York). Its title is "Making Precision Screws for Scientific Instruments," and it is based on the method as used by Gaertner. First, the screw is made as good as can be by ordinary methods. The job has then just begun. With a special lathe and special equipment—in other words, a lot of construction has to be done before the screw can even be started—the high places due to irregularity are shaved off, leaving smaller

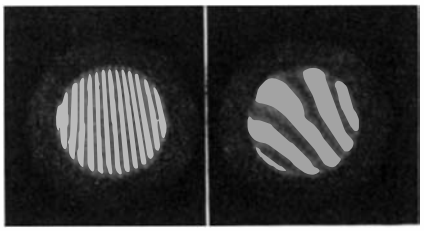


Figure 5: Fringes, warped flat

high places. The operation must be viewed with a microscope if the extremely thin cuts are to be seen at all, for the naked eye alone seems to show that the tool is not in action at all. The smaller remaining high places are again shaved off and the same process carried to finer and finer residuals. The remaining steps are too lengthy to describe here. One is the testing, which is done with an interferometer. It takes the observer one month merely to test the accuracy of a screw 3¼" long. The article tells how all this is done, but not how to do it. Probably no article can do that. One physicist, famous for his gratings, told your scribe that, if a man had it in him he would not need written instructions, while if he hadn't he wouldn't be likely to get to first base with the most detailed instructions. Sounds cynical but is probably about right. Not, however, that this will scare off the aspirant—see what Porter says, in "ATM," page 65!

"SOME may find it difficult to make a Ronchi grating, as described in ATM, page 266, by threading the edge of a brass frame, and then winding it. I found that the sharp edges of the frame cut the fine wire. However, no thread is necessary. I made two gratings, using No. 40 enameled wire (at any radio store). The brass frame should have rounded edges and be carefully chucked in the lathe between centers. Mount a simple guide in the tool post, so that the wire is fed to the frame when it—the frame—is vertical. Set the feed at about 150 to the inch, and wind the wire on with slight tension. Before removing from the lathe, paint the edges with Duco cement and a fine camel's hair brush. When dry, put a thick layer of liquid solder on one side only, and when dry, cut away the wire on that side with a razor blade. Do not attempt to cement the other side, as the wires are easily disturbed."—A note contributed by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alta., Canada.

STRAIN—warped surfaces on a flat—explains the pattern of interference fringes shown in Figure 5, two photographs sent us by Horace H. Selby, author of the instructions for making flats in "ATMA." They represent a 12" flat on an 8" disk and the chief symptom is lack of parallelism of the fringes. The appearance is exaggerated in the right-hand photograph, where the fringes are more widely separated.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

THE WATER-CULTURE METHOD FOR GROWING PLANTS WITHOUT SOIL, by D. R. Hoagland and D. I. Arnon, is a 40-page booklet that deals in detail with the science of hydroponics, a subject that was treated editorially in Scientific American on page 5 of our January 1939 issue. Complete instructions are given, as are also formulas for the preparation of nutrient solutions. Request Circular 347. *Agricultural Experiment Station, University of California, Berkeley, California.—Gratis.*

SUCCESSFUL FINE-GRAIN NEGATIVE PROCESSING gives briefly the facts about development and how a developer should be chosen and used to insure fine-grain results. *Raygram Corporation, 425 Fourth Avenue, New York City.—5 cents.*

STRAIGHT SHOOTING is a 14-page pamphlet that tells how to handle and care for firearms. On the first page is presented "The Sportsmen's Code," which if followed will do much to promote safety in the handling of guns. The brief but complete text is supplemented by a series of informative photographs. *Marlin Firearms Company, New Haven, Connecticut.—6 cents.*

226 BOAT BUILDERS is a large folded chart which lists the leading boat builders of the United States and shows the types of boats which they produce. It also gives hints as to the use of outboard motors in connection with various types of hulls. *Evinrude Motors, Milwaukee, Wisconsin.—Gratis.*

MANUAL OF RADIO SERVICING is a 12-page pamphlet that will interest technicians in the radio field as well as those who are more particularly concerned with the servicing of air conditioning and refrigeration equipment. *Supreme Publications, 3727 West 13th Street, Chicago, Illinois.—Gratis.*

LEST WE REGRET is a 36-page lavishly illustrated booklet published in the interest of automobile safety. It analyzes automobile accidents during 1938 and points out the many ways in which safety on the highway can be increased. *The Travelers Insurance Company, Hartford, Connecticut.—Gratis.*

BOAT AND MOTOR SELECTOR is a "slide-rule" type of chart which shows at a glance what type of outboard motor should be used with any particular style of boat and what speed may be expected from the combination. The chart also indicates what mileage per gallon of fuel may be expected. *Evinrude Motors, Milwaukee, Wisconsin.—Gratis.*

PHOTOGRAPHY CATALOG NO. 339 presents in 80 pages a wide selection of cameras and photographic equipment. Issued by an organization which has served amateur and professional photographers for over 42 years, its content covers the whole range of photography and will serve all photographers as a reference book in which they can find out about the latest in equipment. *Burke & James, Inc., 223 West Madison Street, Chicago, Illinois.—Gratis.*

DIRECTORY OF 16-MM FILM SOURCES presents complete information on various types of 16-mm motion picture film for educational, entertainment, and other purposes. A complete index makes any particular type of film easy to locate. *Directory Editor, Victor Animatograph Corporation, Davenport, Iowa.—50 cents.*

BUILD BETTER BUILDINGS is a 12-page folder which has been prepared especially for architects, contractors, and laymen interested in modern heat and sound insulation materials available for use in concrete wall construction. Part of the folder gives a semi-technical explanation of insulation, while another part is designed as a reference guide for those interested in any type of concrete wall construction. *The Celotex Corporation, 919 North Michigan Boulevard, Chicago, Illinois.—Gratis.*

API GUIDE FOR INSTRUCTORS IN FIRST AID is a thoroughly up-to-date booklet presenting an organized and uniform method of instruction in first aid work. It has been prepared for the benefit of teachers in first aid courses and has the approval of the American Petroleum Institute's Committee on First Aid. *American Petroleum Institute, 50 West 50th Street, New York City.—10 cents.*

THE AUXILIARY LANGUAGE QUESTION, by Max Talmey, is a 16-page paper discussing the world value of an auxiliary language—not to be confused with various "international languages" designed as substitutes for present tongues. *The American Cloro Society, 838 West End Ave., New York, N. Y.—32 cents.*

DODGE AND DIESEL is a booklet that presents a description of the modern Diesel engine, what it is and how it operates as compared with the conventional gasoline engine. A number of drawings make the text perfectly clear. The booklet was motivated by the recent introduction of a Diesel-powered three-ton truck for heavy-duty use. It will give a wider spread to an understanding of Diesel operation and advantages. *Dodge Division, Chrysler Corporation, Detroit, Michigan.—Gratis.*

NEMA STANDARDS AND DEFINITIONS is an 8-page booklet which includes suggestions for the proper selection of electric motors and types of drives. Information is also given regarding service factors and rated loads, that will be of value to anyone who buys, specifies, or maintains electric motors. Request Bulletin No. 610. *Advertising Department, The Louis Allis Company, Milwaukee, Wisconsin.—Gratis.*

MAKING UP FOR THE CAMERA is a 14-page booklet that tells how the photographer, professional or amateur, can obtain the best results in portraiture by having his subject use the correct type of make up. *Miner's, Inc., 12 East 12th Street, New York City.—3 cents.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

UNAUTHORIZED

YOU may engage in the business of repairing a particular make of automobile and you may indicate in your advertising the type of automobile that you repair even though you do not operate an authorized service station. However, in so doing you must not represent that you are the authorized dealer or agent of the manufacturer.

In a recent suit, the manufacturer of a well-known automobile brought suit against the operators of a garage or service station on the grounds that the sign that they employed created the impression that they were authorized agents of the automobile manufacturer when, as a matter of fact, they were not authorized dealers or agents. In the case in question the garage operators employed a sign bearing, in large block letters, the name of the type of automobile which they repaired. The court found that in smaller letters beneath the name of the automobile the sign contained the word "repairs" and the legend —"We . . . do not act as authorized dealers." The defendants contended that the qualifying words as set forth above indicated that they were acting in good faith and that they were not trying to represent that they were authorized dealers or agents of the manufacturer. The court found, however, that the name of the automobile was the prominent feature of the sign and that the qualifying legend was relatively obscure and was not "consistent with the good faith asserted for the defendants." As a result the defendants were restrained from displaying a sign bearing the name of the particular automobile unless the sign made it clear in equally prominent lettering that the defendants were not the authorized agents of the manufacturer of the automobile.

ART PATRON

WHERE an artist contracts with an art patron to execute a work of art the artist is not entitled to obtain a copyright on the work of art, according to a recent decision.

In the case in question an artist was retained by the City of New York to execute two mural paintings in one of the New York City high schools. The contract providing for the execution of the murals was silent as to the ownership of copyrights. In spite of this fact, however, the artist subsequently obtained a copyright on each of the murals.

Thereafter, without the permission of the artist but with the consent of the City of New York, a publisher reproduced one of the mural paintings in a history book. The artist had died and suit was brought by the artist's sister against the publisher for copyright infringement. The suit was dismissed by the court on the grounds that the art patron, which was the City of New York rather than the artist, was entitled to the copyrights on the murals and that accordingly the artist and his next of kin held the two copyrights which were obtained in trust for the City of New York.

In this connection the Court stated: "When a man, hereinafter referred to as a patron, contracts with an artist to paint a picture for him, of whatever nature it may be, the contract is essentially a service contract, and when the picture has been painted and delivered to the patron and paid for by him, the artist has no right whatsoever left in it."

WASHED UP

THE use of the trade mark "Chlorit" on cleaning and bleaching compounds has been restrained on the grounds that it is an infringement of the trade mark "Clorox." The manufacturer of a cleansing and bleaching compound of antiseptic character identified by the trade mark "Clorox" brought suit against a competitor using the trade mark "Chlorit," charging trade mark infringement and also unfair competition.

It was contended by the defendant that the name "Clorox" was not a good trade mark and that it was descriptive of the plaintiff's product since the product contained sodium carbonate and sodium hypochlorite, the latter being a compound of chlorine. The court rejected this contention and held that the name was arbitrary and fanciful and accordingly a good trade mark. The court then considered the similarity between the names and the packages of the parties and concluded that an injunction should be granted. In this connection the court stated:

"The selection of the word 'Chlorit' was not a mere coincidence. It was a deliberate scheme on the part of the defendants. Fortunately a Court of Equity can extend its arm to protect the plaintiff in the use of the name 'Clorox'."

EARTHQUAKE

EARTHQUAKES were involved in a recent suit for patent infringement. The suit was brought against a school district of Los Angeles County, California, for infringement of a patent relating to the repairing of buildings damaged by earthquakes. The patent disclosed a method of repairing whereby the damaged wall of the building was permitted to stand and a new wall was erected adjacent to and outside the damaged wall. The Court found that, prior to the patent in suit, damaged buildings had been repaired by erecting a new wall inside the damaged wall. Under the old method roofing or flooring joists were carried directly by the newly erected wall. In the patented method it was necessary to provide ledge-like projections on the newly erected wall to support the joists, since the new wall was disposed outside the damaged wall.

It was contended by the patentee that erecting the wall outside the damaged wall rather than inside and providing the ledge-like projection to support the joists constituted invention. The court in rejecting this contention stated:

"These, we think, are immaterial differences. That a new wall, designed to reinforce an old wall, may be erected on either side of the old wall is, and must always have been, perfectly obvious. Equally obvious is the fact that, if a new wall, erected outside an old wall, is to support joists previously supported by the old wall, and such joists do not extend outwardly beyond the old wall, the new wall must have joist-supporting projections extending inwardly."

DELAYED DEPOSIT

UNDER the heading, "Procrastination," in the December, 1938, issue of Scientific American, we discussed a suit for copyright infringement in which the Court held that a delay of 14 months in depositing copies of a copyrighted literary work prevented the copyright proprietor from maintaining suit for copyright infringement.

In the case in question the publisher of a monthly magazine had affixed a notice of copyright to one of the issues of the magazine but had failed to deposit copies of the magazine with the Register of Copyrights until after a lapse of 14 months. In the meantime a book publisher had published a book containing material substantially identical with an article appearing in the magazine. After the magazine publisher had deposited the copies with the Register of Copyrights he brought suit for copyright infringement against the book publisher. The lower court pointed out that the statute required that after publication two copies must "be properly deposited in the Copyright Office" and that it further provides that until this provision is complied with no action or proceedings shall be maintained for an infringement of the copyright.

Since there was a delay of 14 months in depositing the copies the lower court held that the provision providing for prompt deposit had not been complied with and accordingly that no suit could be maintained. The United States Supreme Court reversed the decision of the lower court, holding that a copyright was obtained by publication of the magazine with notice of copyright and that as long as the deposit of copies was made prior to filing the suit, the publisher of the magazine had complied with the statute. One of the determining factors in the Supreme Court decision was that another provision of the statute provides for certain penalties if the copyright proprietor failed to make deposit after a demand by the Register of Copyrights. Since the statute did contain a penalty provision it was argued that in the absence of the application of the penalties provided for, the statute was sufficiently complied with when the deposit was made prior to filing suit.

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CONTRIBUTING EDITORS

A. E. BUCHANAN, Jr., Director of Research, Remington Arms Company.

L. WARRINGTON CHUBB, Director of Research Laboratories, Westinghouse Electric and Manufacturing Company.

JACOB DESCHIN, Amateur Photography.

CHURCHILL EISENHART, Department of Mathematics, University of Wisconsin. Statistician, Wisconsin Agricultural Station.

MORRIS FISHBEIN, M.D., Editor of the *Journal of the American Medical Association* and of *Hygeia.*

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WALDEMAR KAEMPFFERT, *New York Times.*

D. H. KILLEFFER, Chemical Engineer.

IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady.

M. LUCKIESH, Director, Lighting Research Laboratory, Incandescent Lamp Dept. of General Electric Company, Nela Park, Cleveland.

D. T. MacDOUGAL, Associate in Plant Biology, Carnegie Institution of Washington.

ROY W. MINER, American Museum of Natural History.

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R. W. WOOD, Professor of Experimental Physics, Johns Hopkins University.

VLADIMIR K. ZWORYKIN, Director, Electronics Research Laboratory, RCA Manufacturing Company, Victor Division.

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For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

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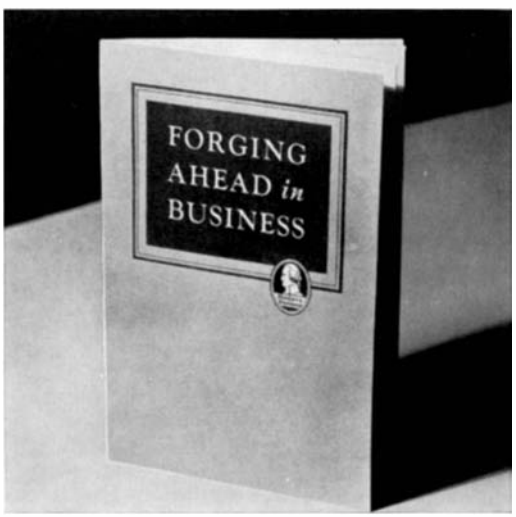

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"Gee! A Nickel Left for Candy"

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